THE LEGO® MINDSTORMS® EV3 IDEA BOOK

YOSHIHITO ISOGAWA

181 Simple Machines and Clever Contraptions

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Introduction

The LEGO MINDSTORMS EV3 set is designed to allow builders of any age to create robots, vehicles, and other contraptions with moving parts.

Each model in this book is only a small mechanism, but you can make an infinite variety of larger models by combining these ideas. LEGO bricks aren't designed to fit in just one specific place or in one particular way. Your imagination is your guide when building with LEGO, and I hope that you will create your own wonderful masterpieces using this book as inspiration.

To build the models in this book, all you need is the LEGO MINDSTORMS EV3 set (home edition #31313).

Where Are the Words?

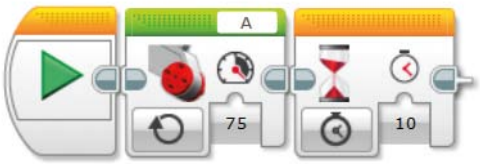
Other than this brief introduction and the table of contents, this book has almost no words. Instead, you'll find a series of photographs of increasingly complex models, each designed to demonstrate a mechanical principle or building technique.

While the book lists the pieces needed for each model, it does not include step-by-step building instructions. Look at the photographs taken from various angles and try to reproduce the model. Building in this way is something like putting together a puzzle. You'll get the hang of it after a little practice.

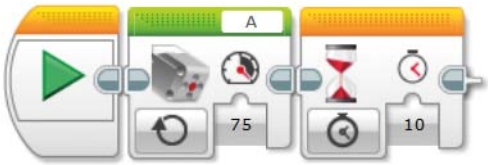
This is an idea book; it's about imagination. Rather than tell you what to see or think when you study the models, I encourage you to interpret them in your own way. Your interpretations will lead you to invent your very own models or use my mechanisms in entirely new ways!

What About Programs?

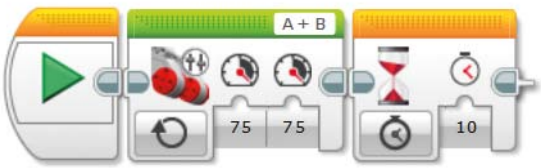
This book is about exploring the mechanical side of EV3 and robotics, rather than programming. You'll need only a few simple programs to test out your mechanical creations. Prepare these three simple programs in advance.



This program will rotate the Large EV3 motor, then rest for a period.



This program will rotate the Medium EV3 motor, then rest for a period.



This program will rotate two motors, then rest for a period.

A few of the models in this book require special programs. Take note of these programs, as they are written to avoid damaging parts by overextending a mechanism's range of motion.












PART 1

Basic Mechanisms

Gear ratios

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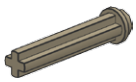
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#2

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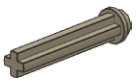
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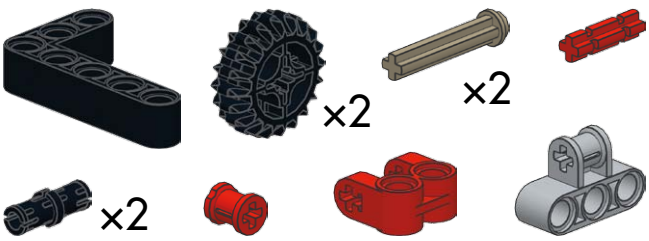

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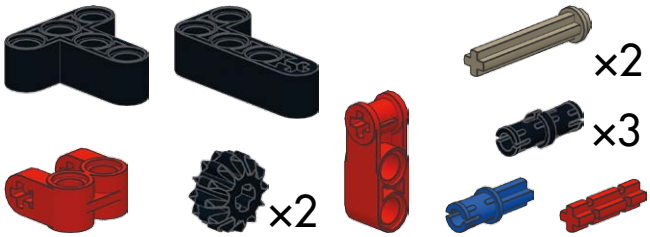

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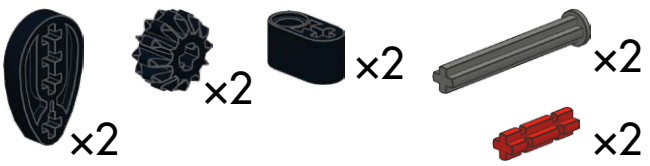

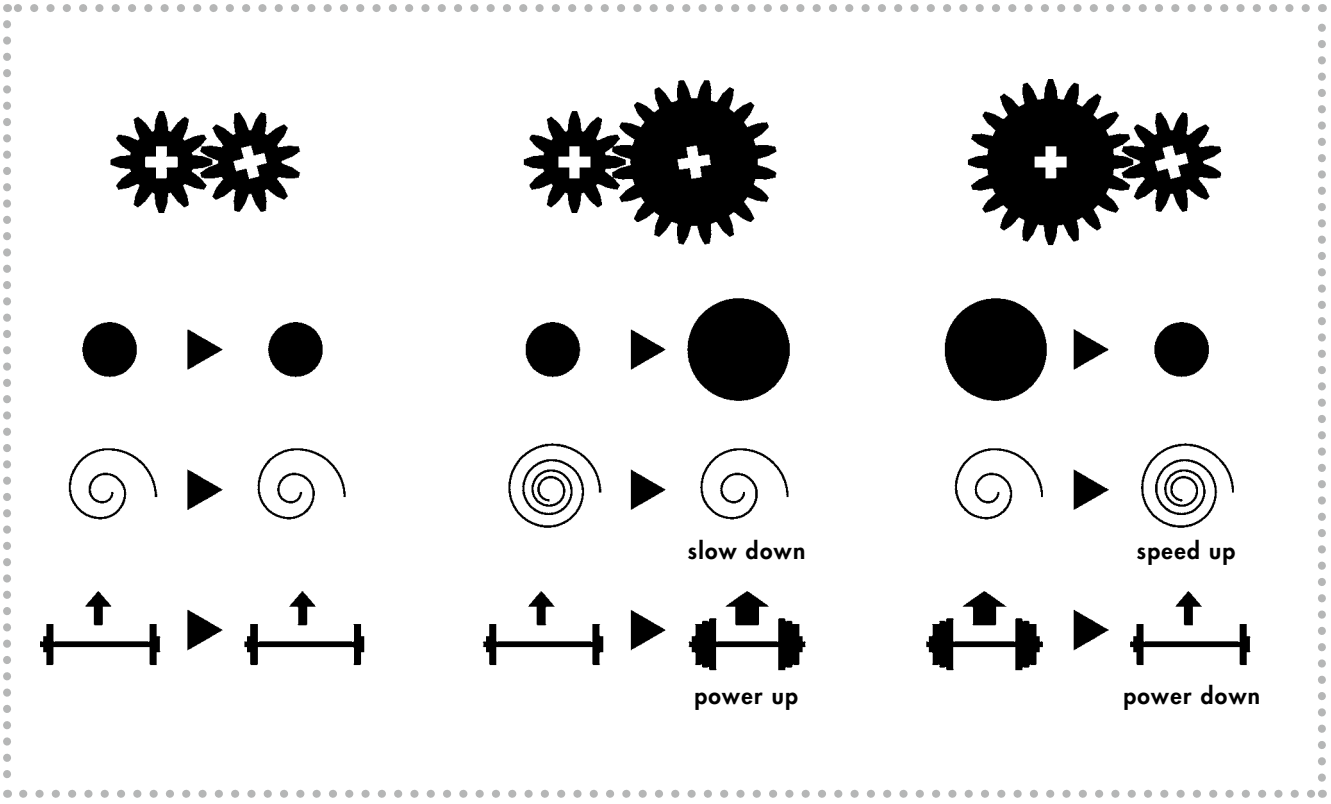

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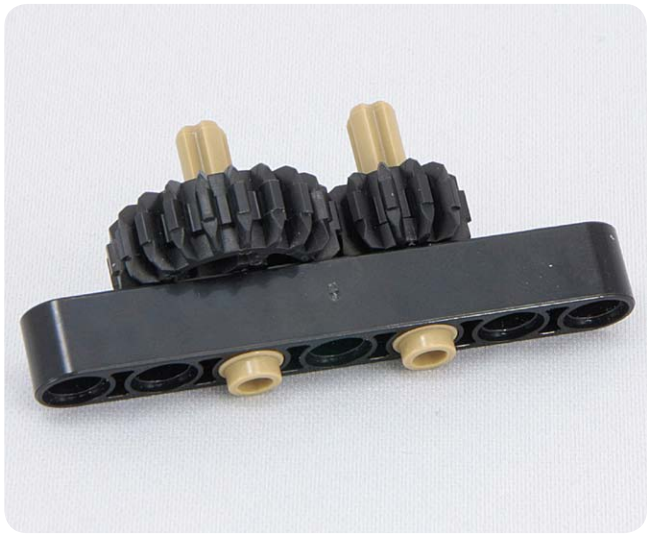

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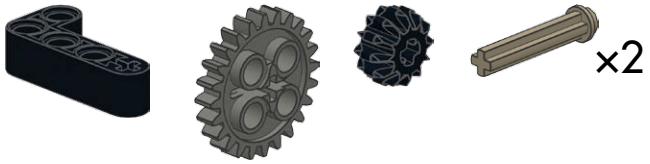

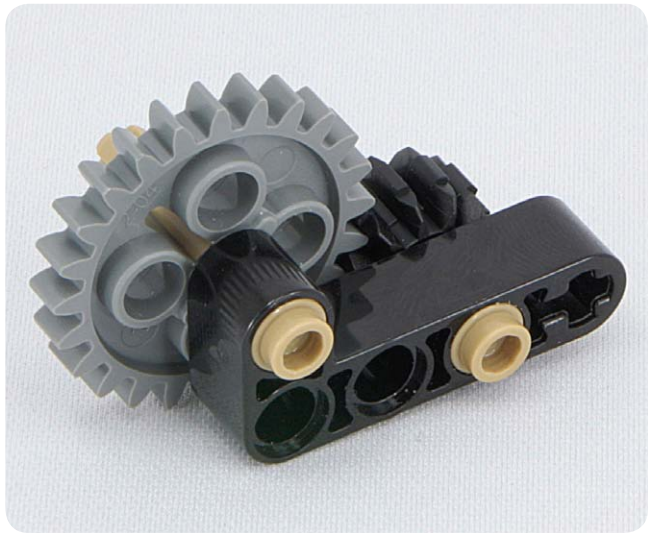

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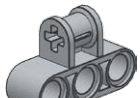
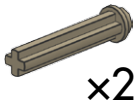



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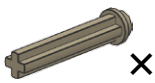

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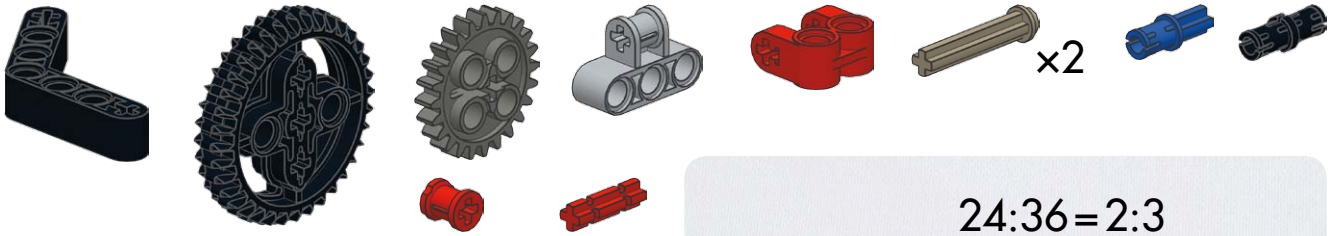

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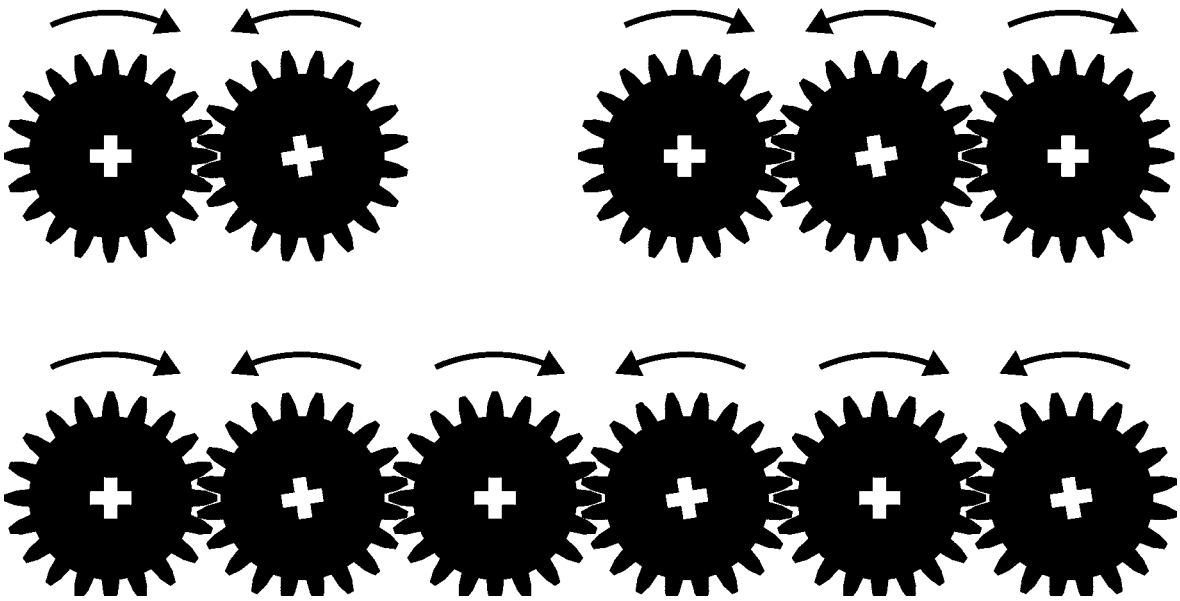

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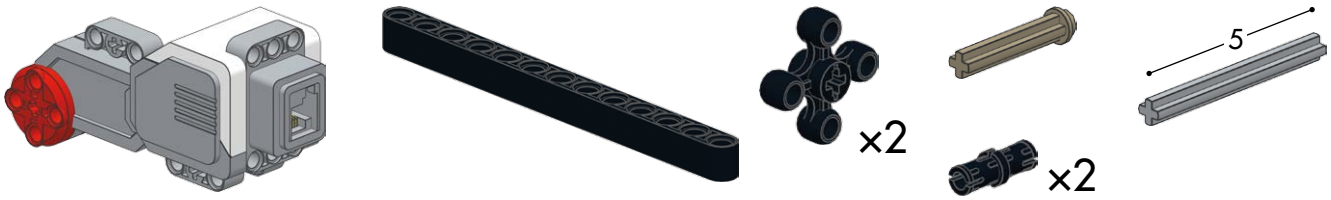

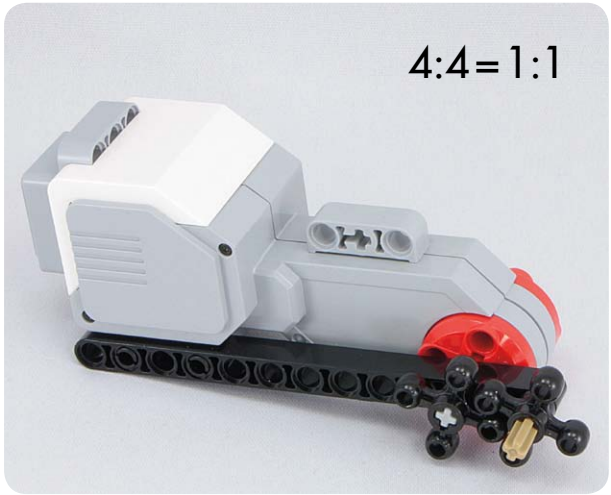

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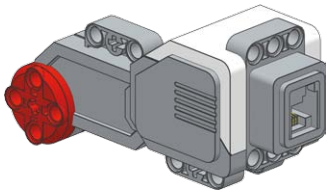


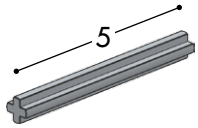



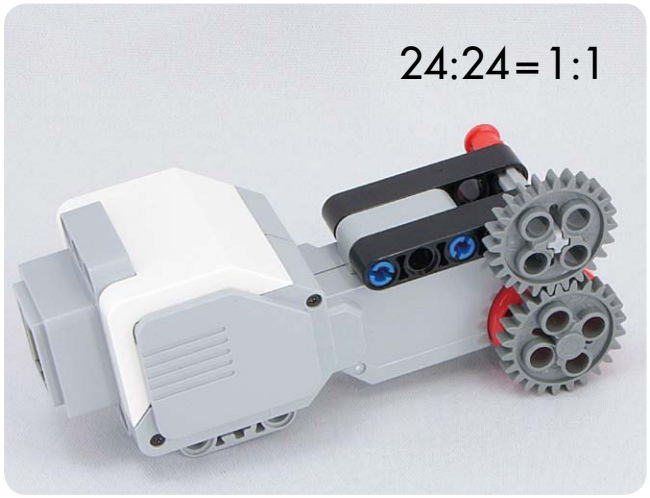

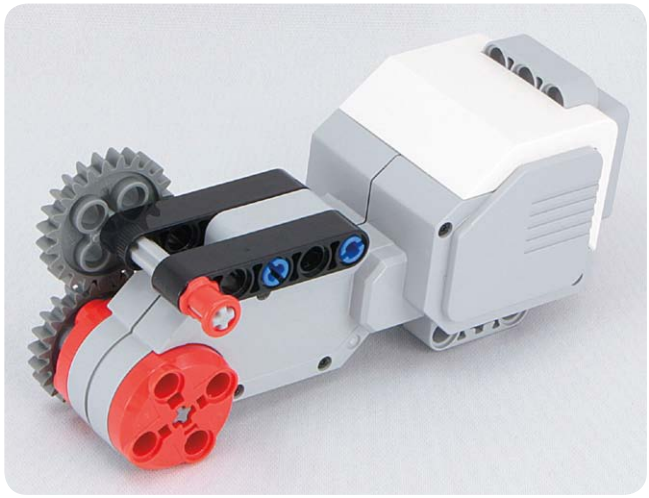

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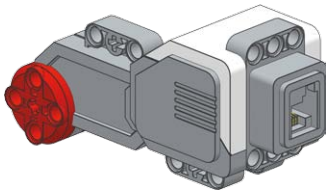




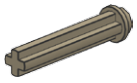


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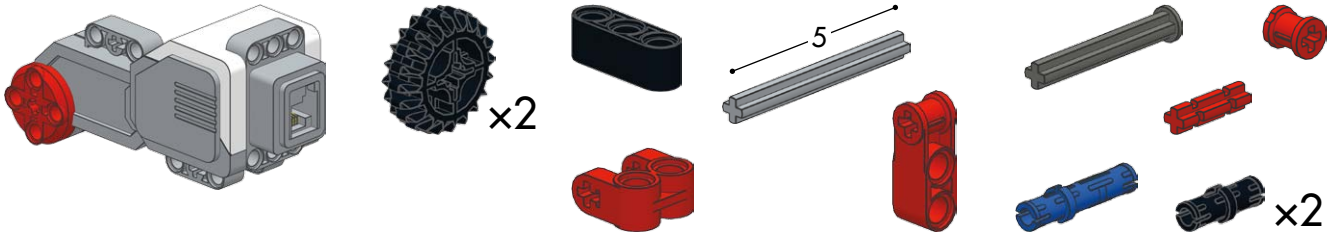

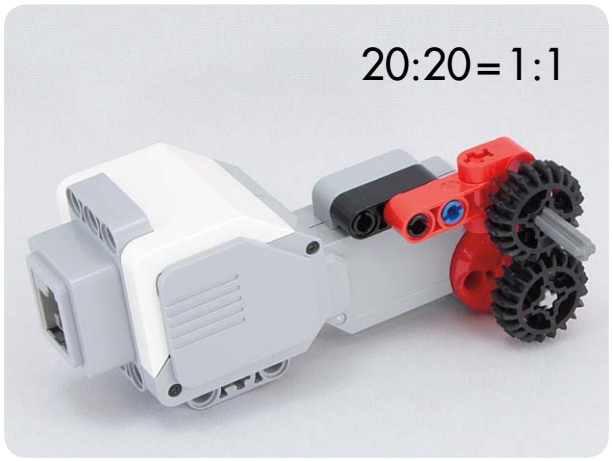

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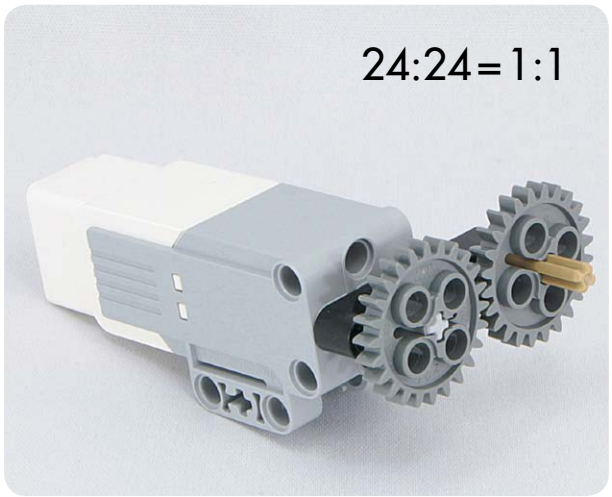

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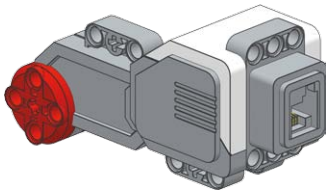

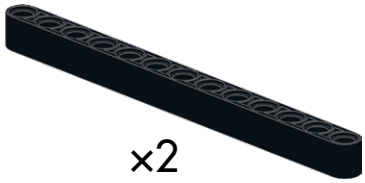

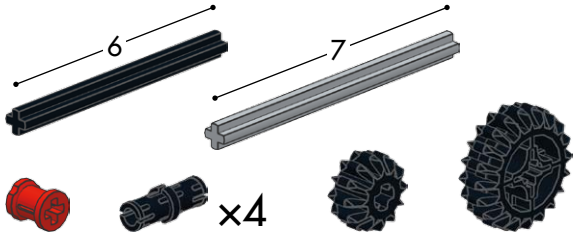

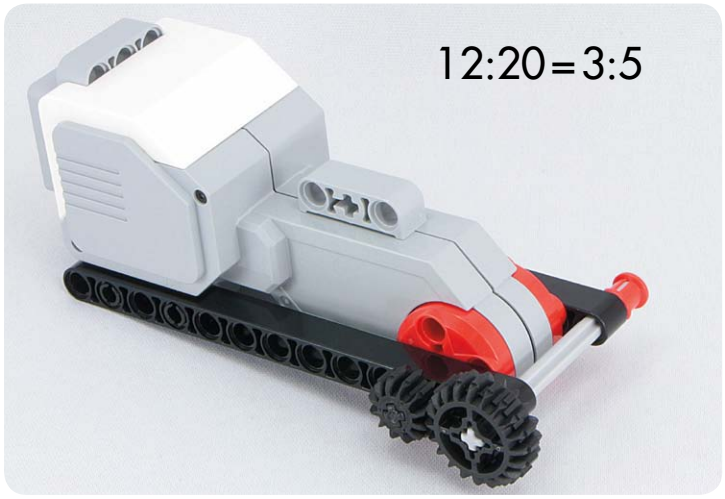

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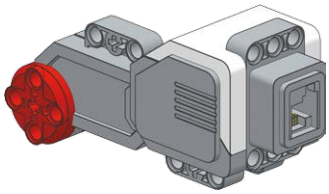

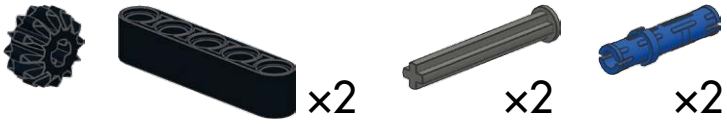

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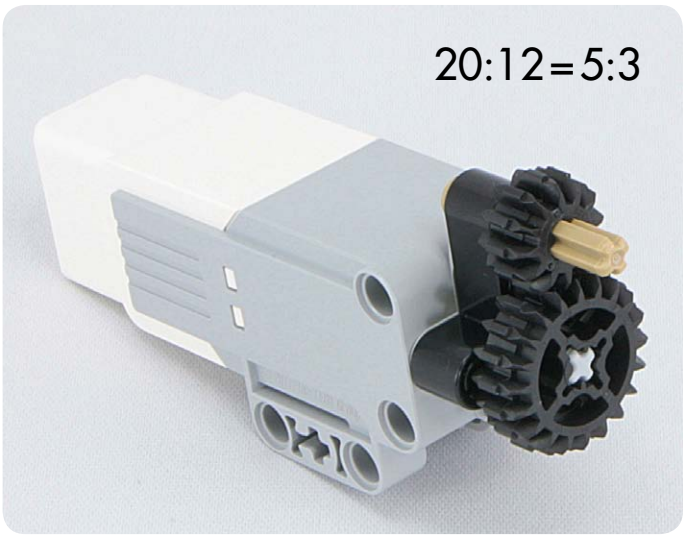

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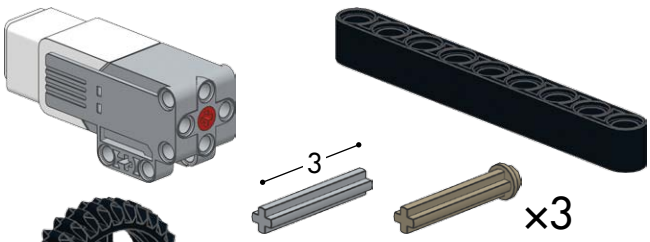

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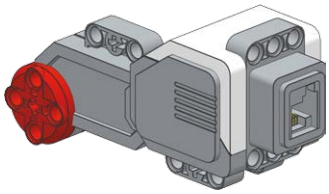

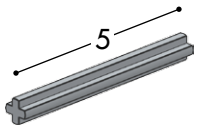

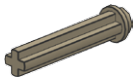

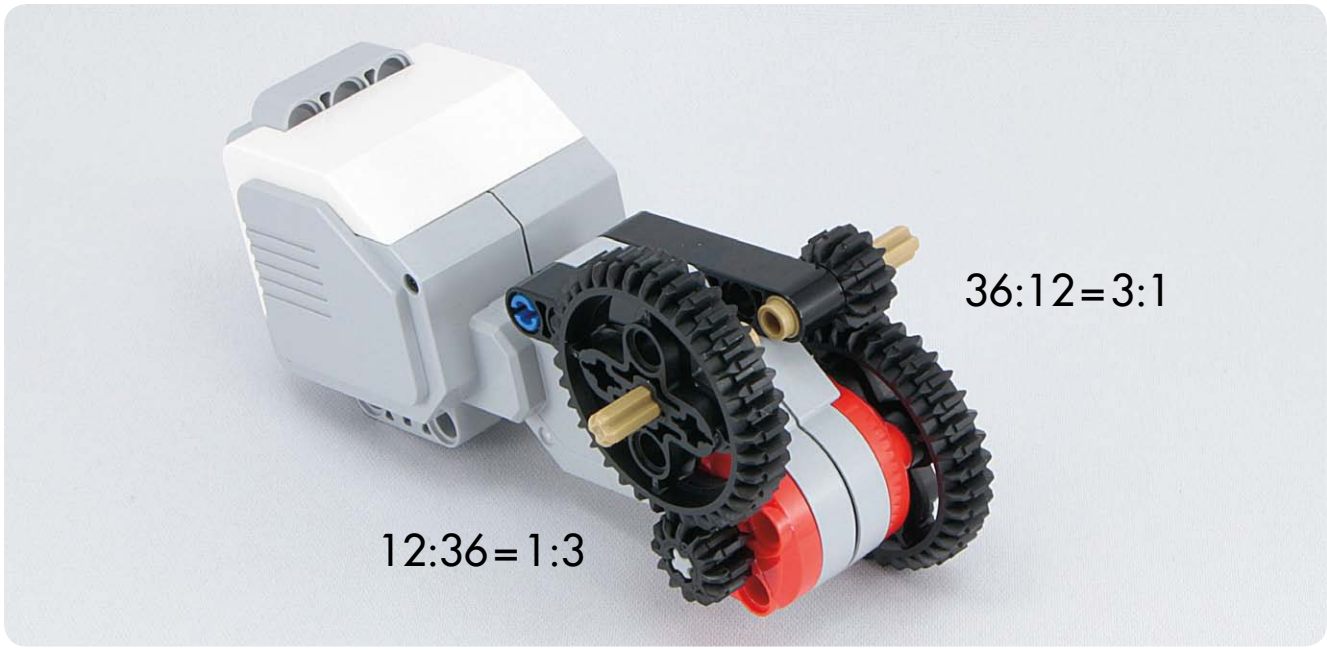

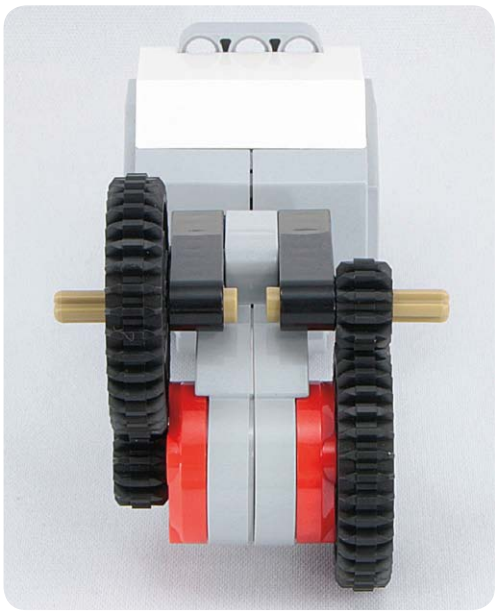

Compound gear systems

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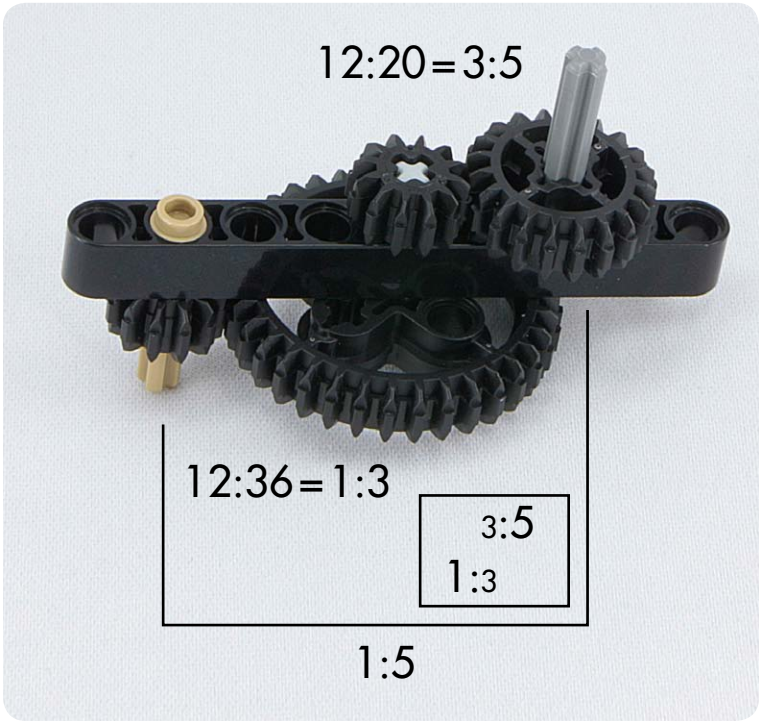
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3:5
1:3
1:5


×2
3

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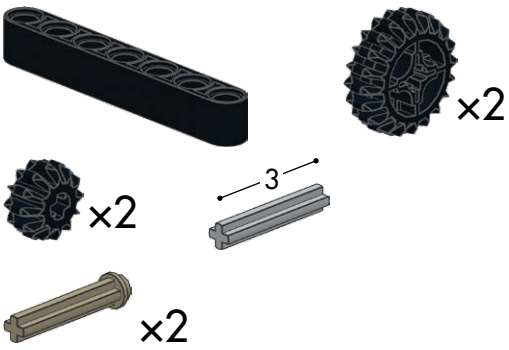
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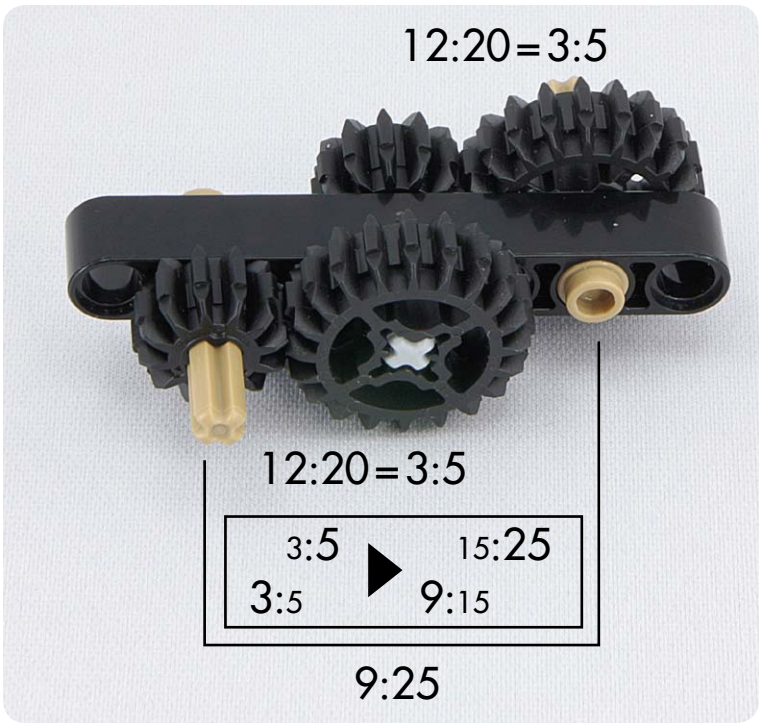
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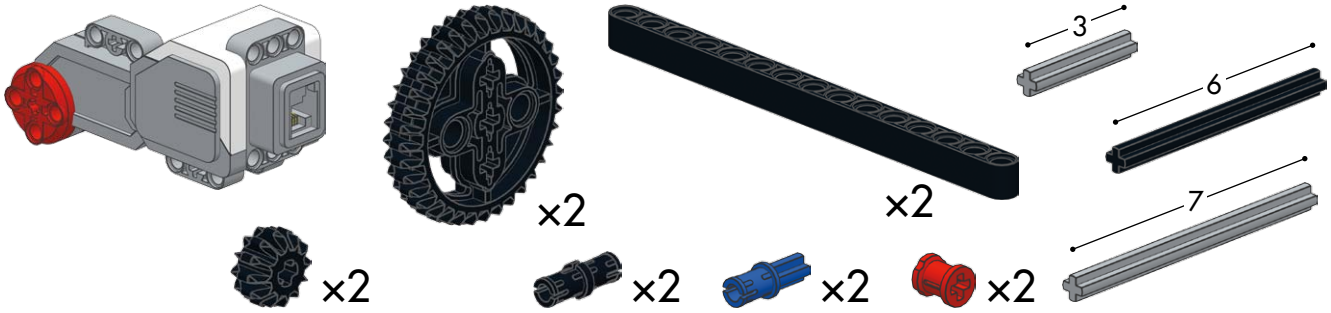
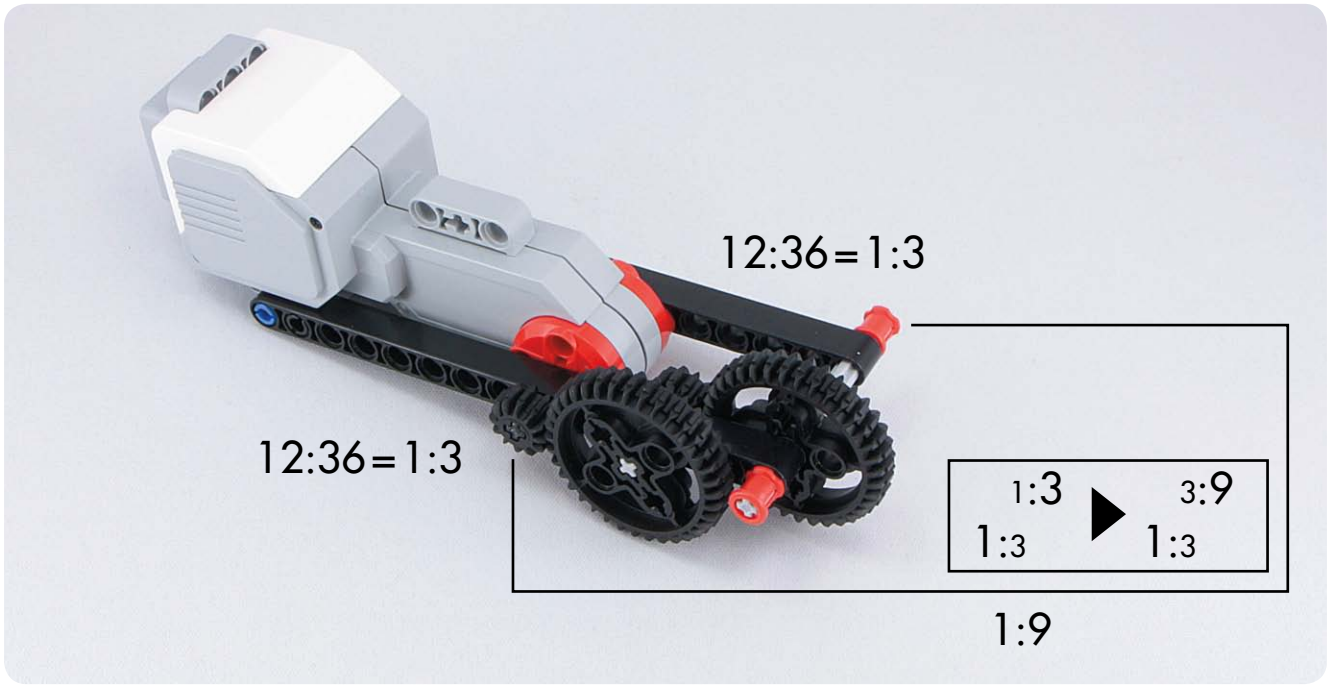
#29





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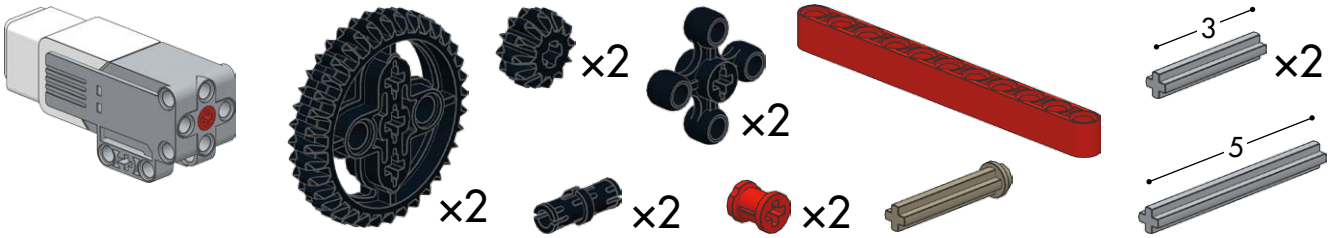

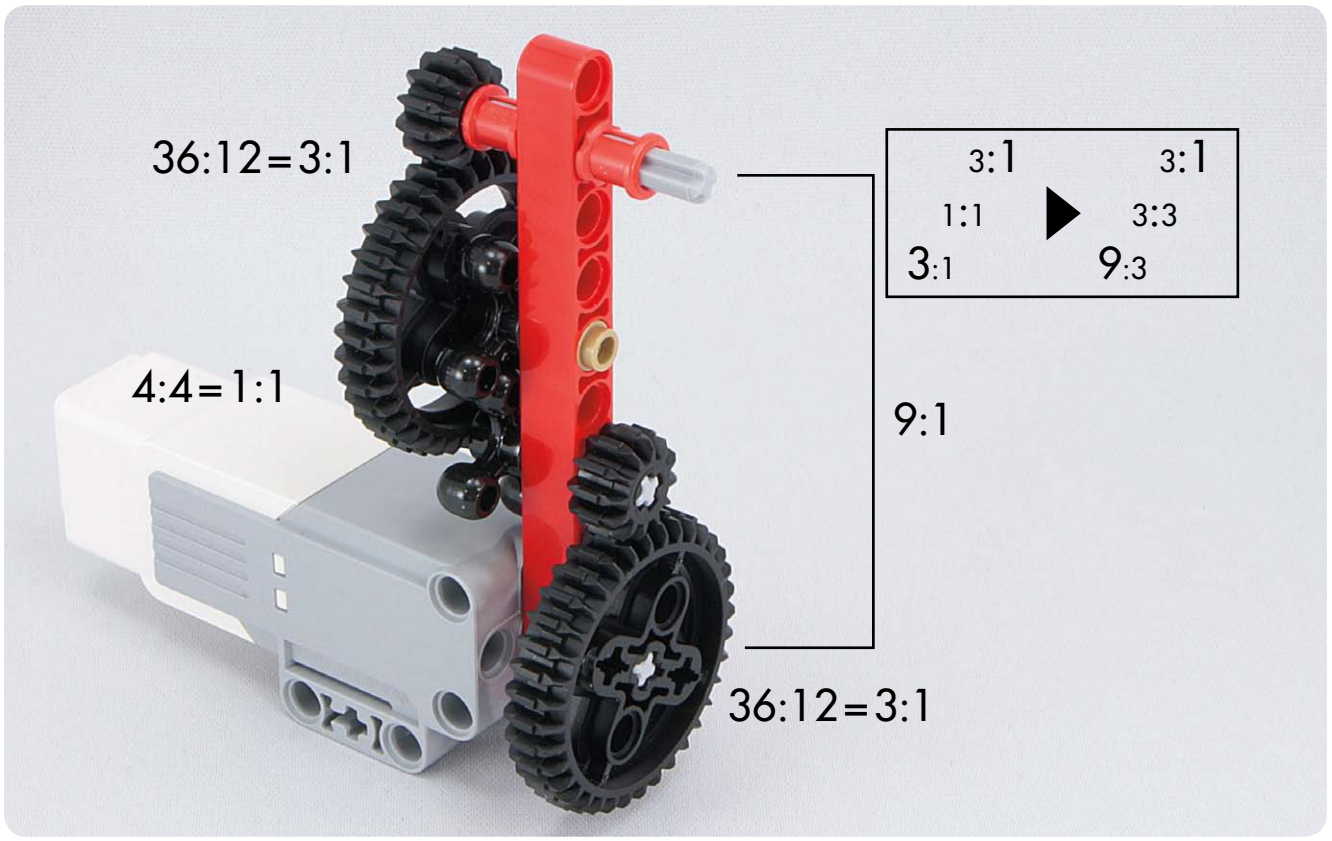

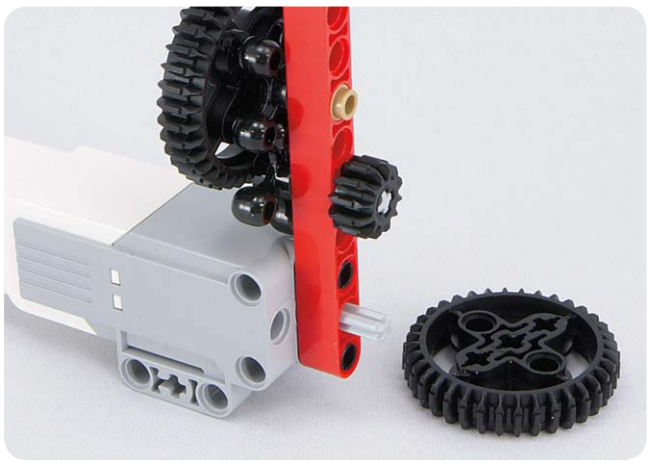

Changing the angle of rotation

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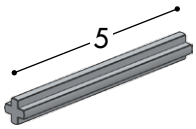

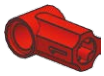

×2

×2

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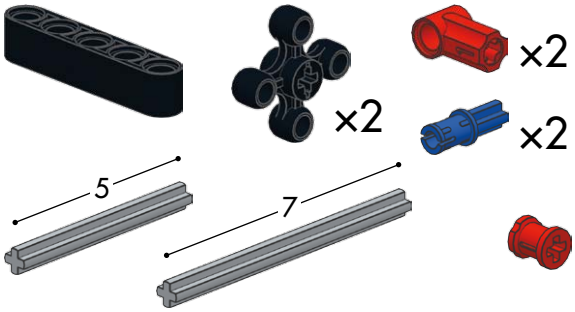

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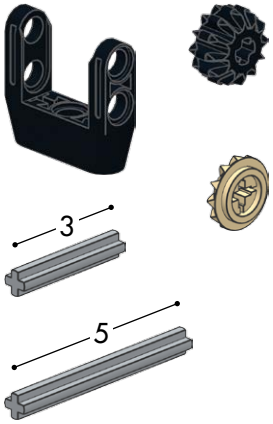

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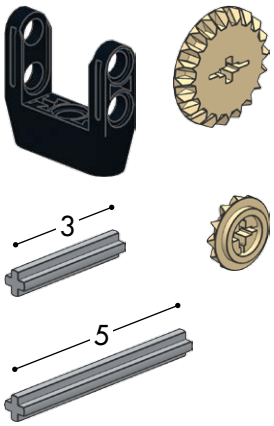

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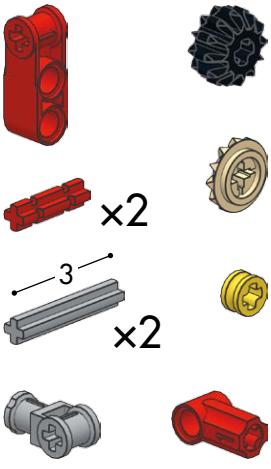

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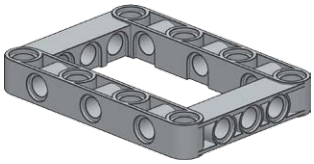


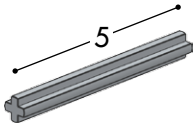

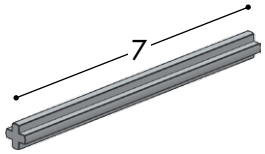

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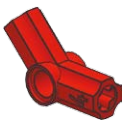


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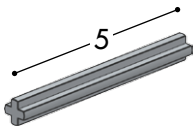

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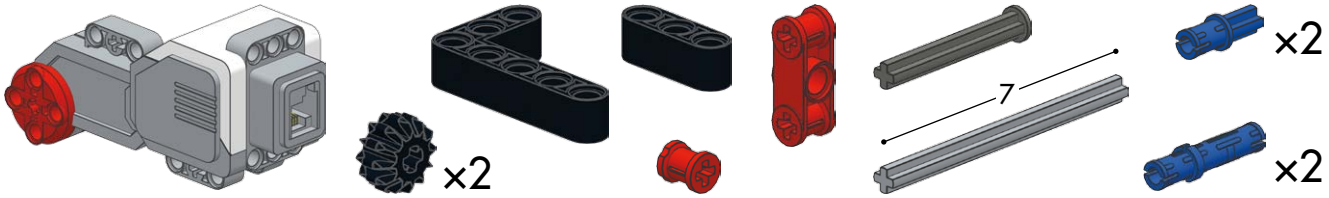

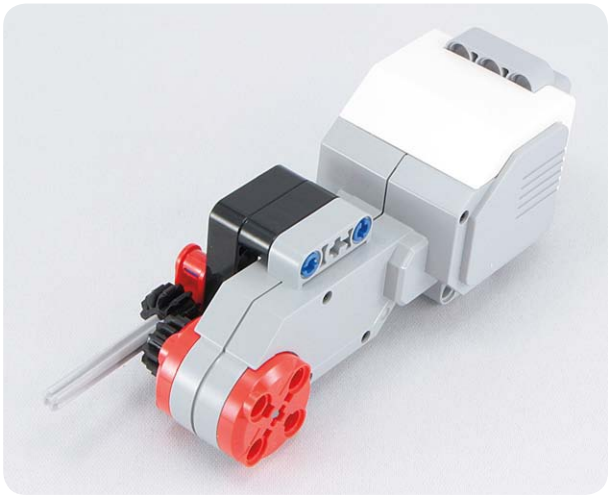

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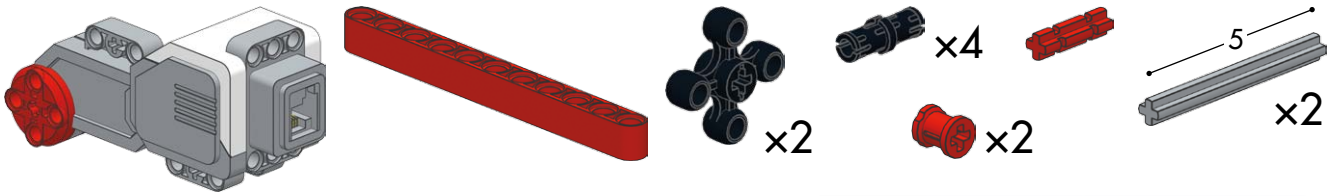

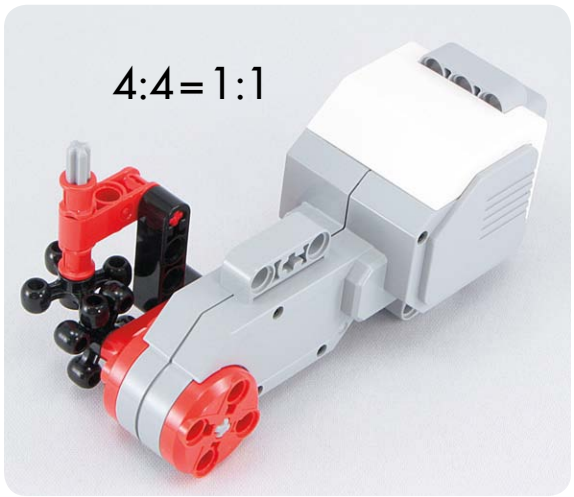

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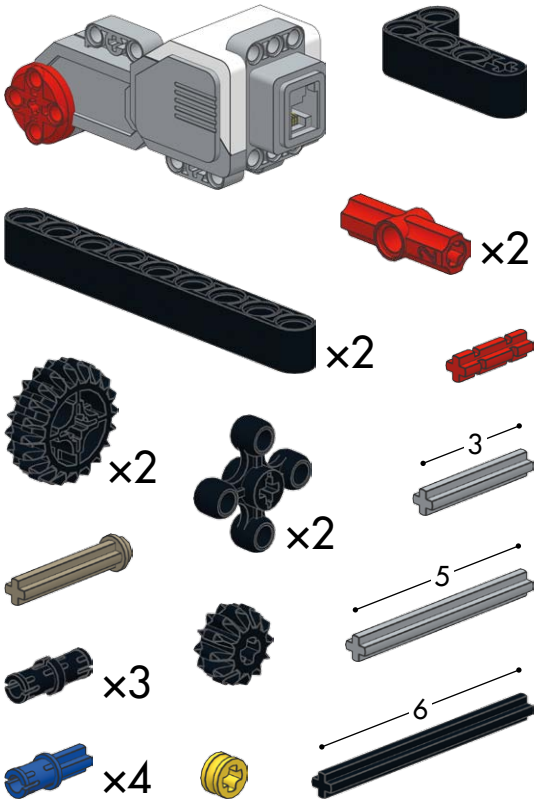

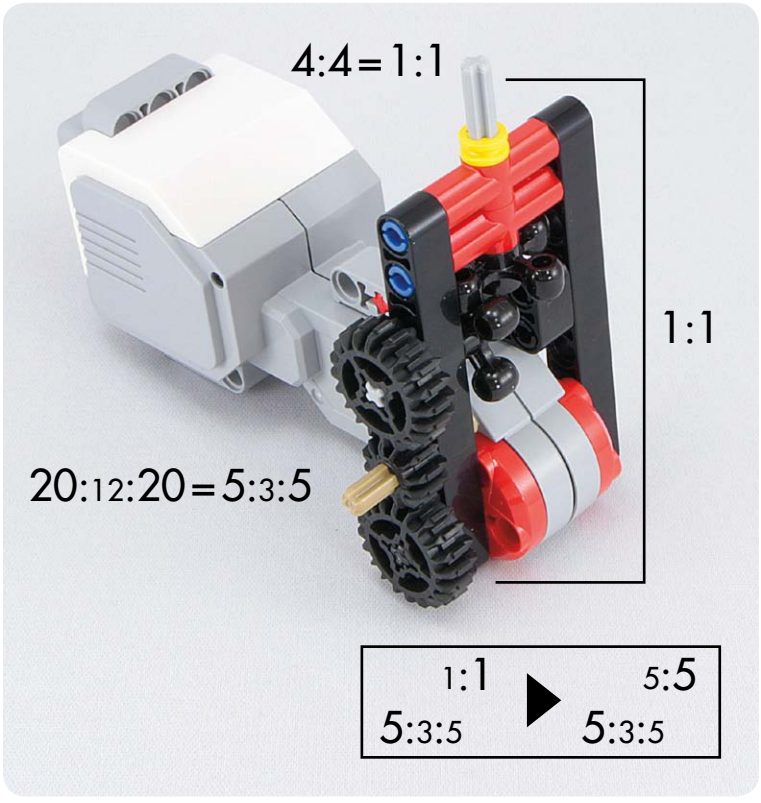

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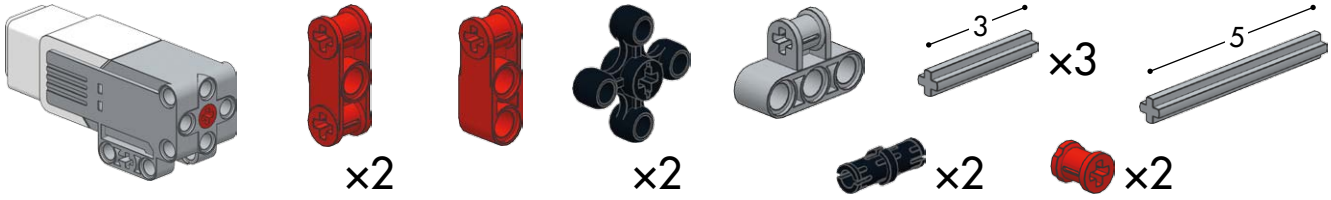

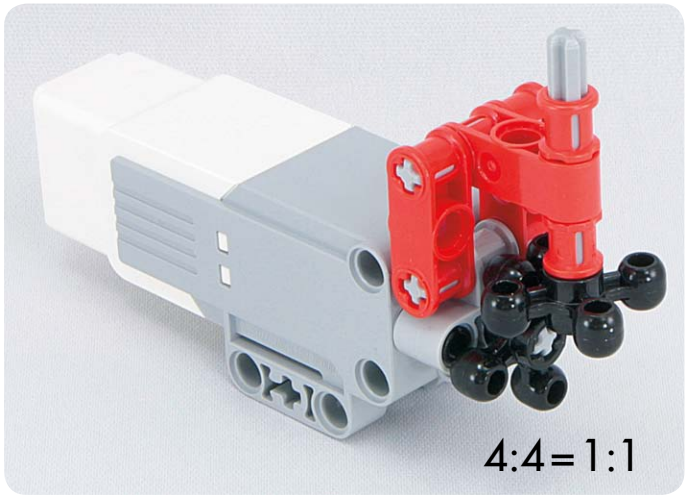

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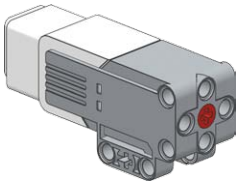

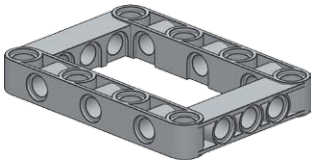

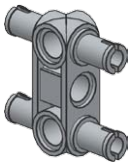

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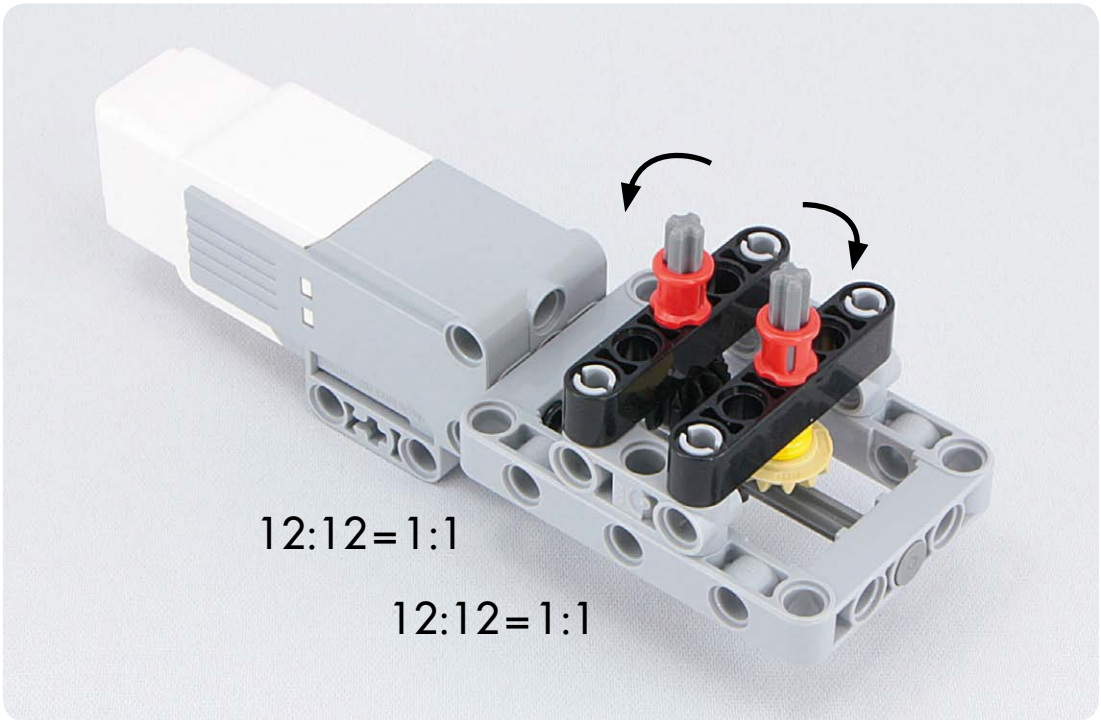

Using worm drives

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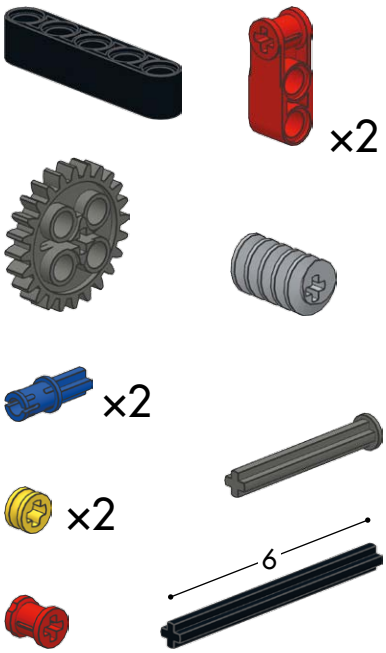

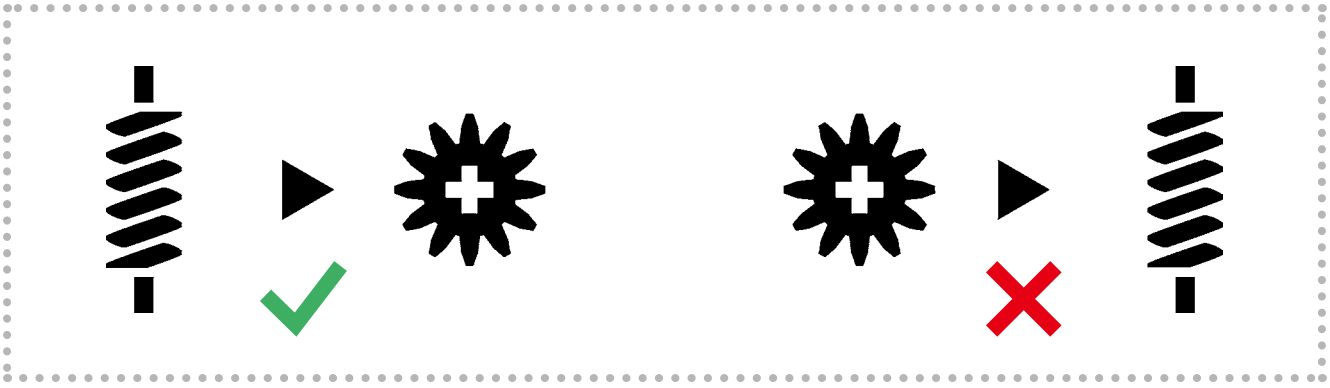

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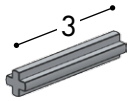
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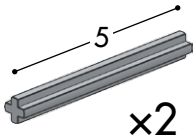
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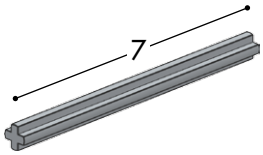
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×4


×2


×3

1:24

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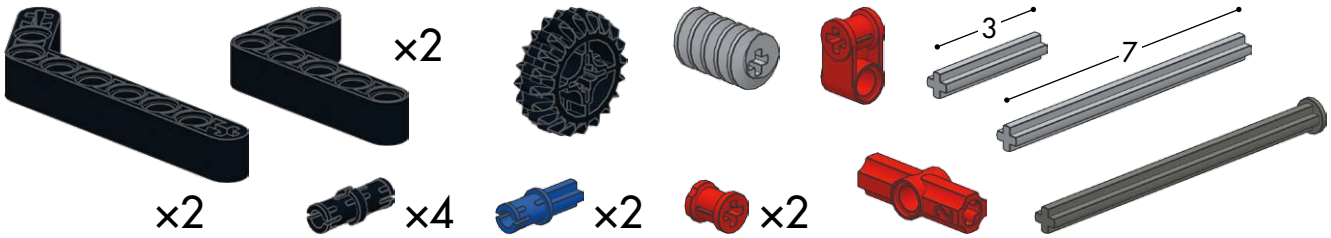

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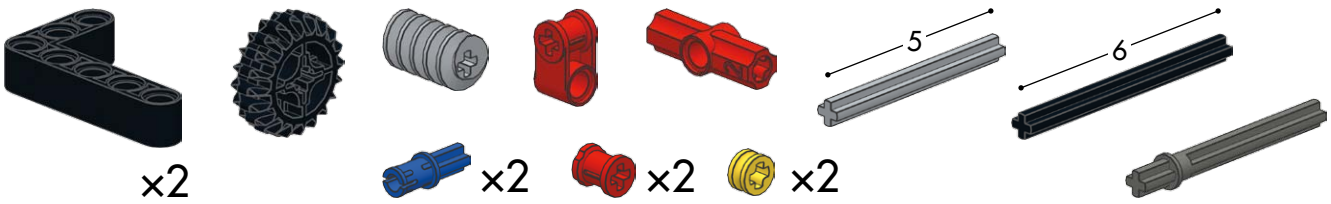

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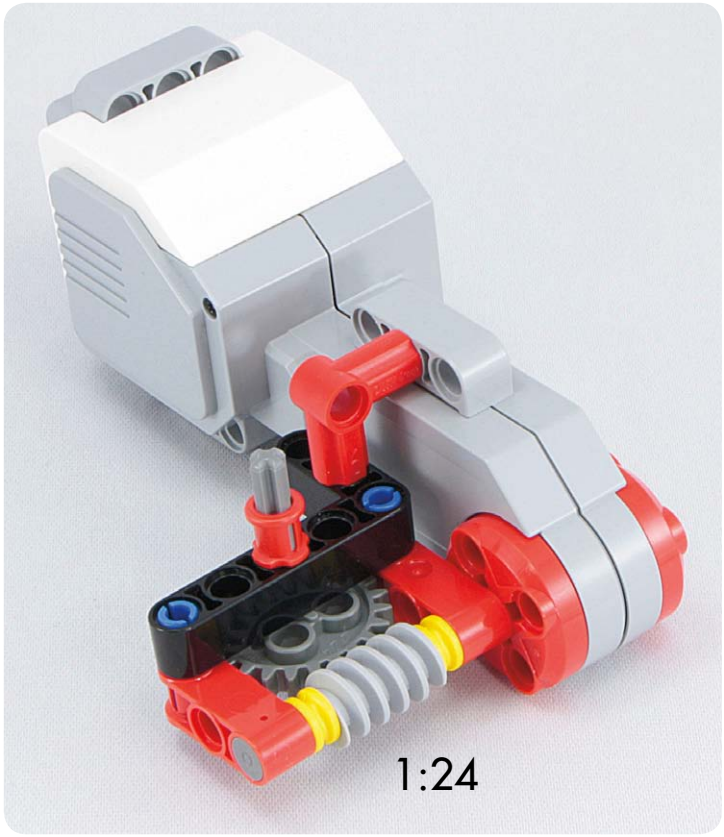

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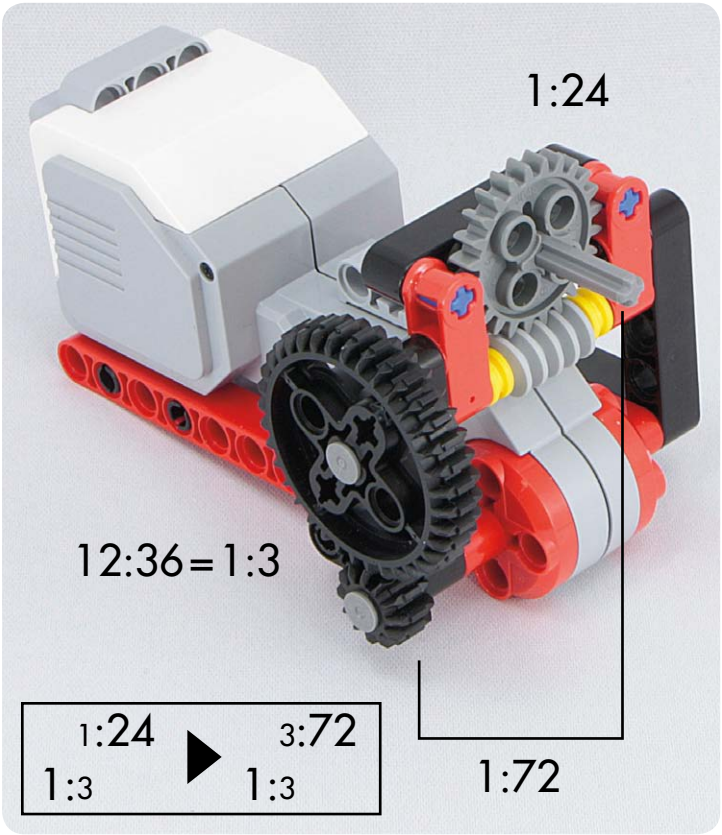

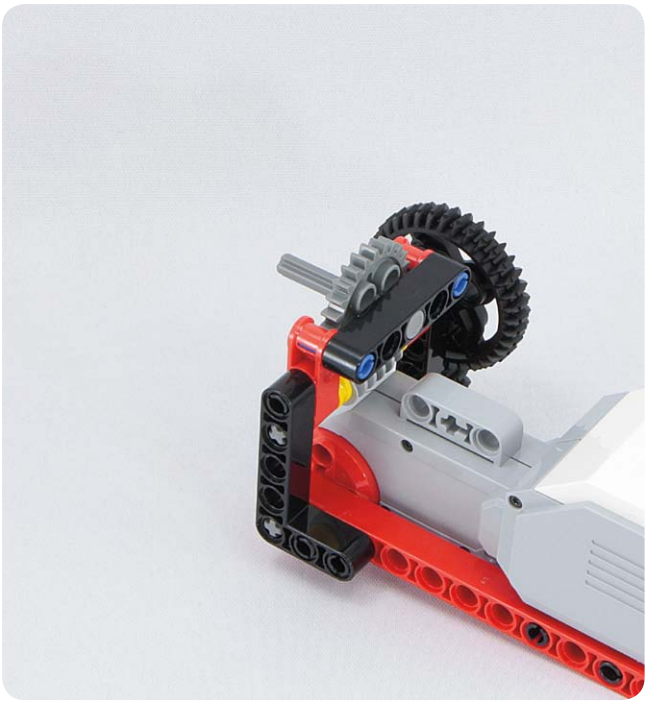

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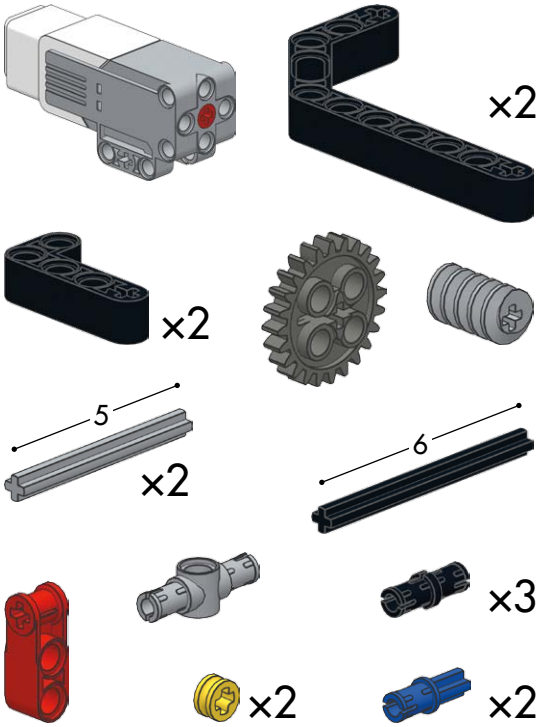
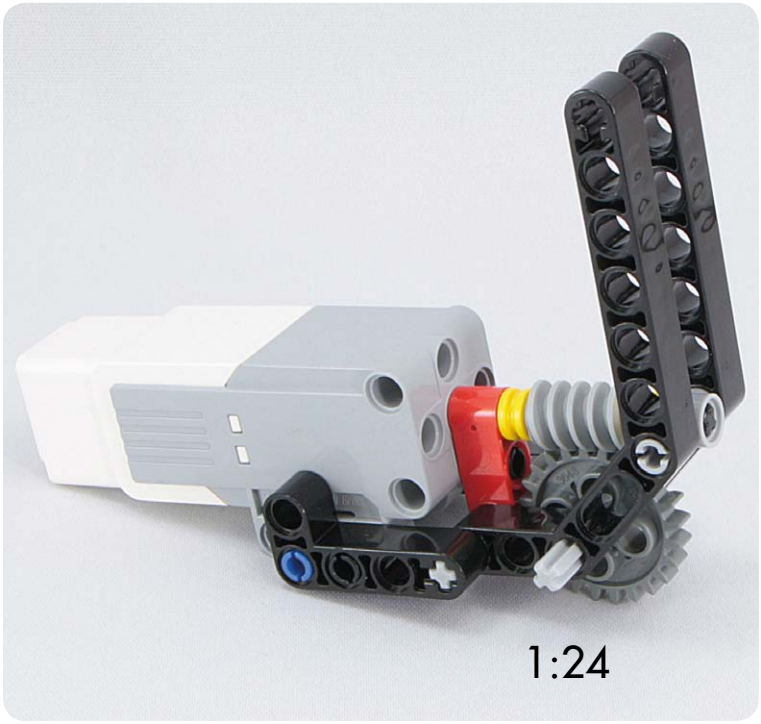
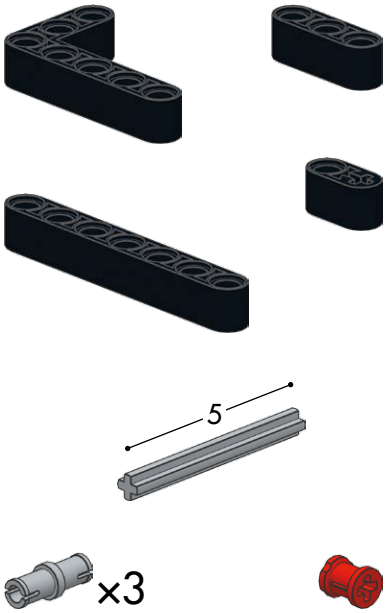
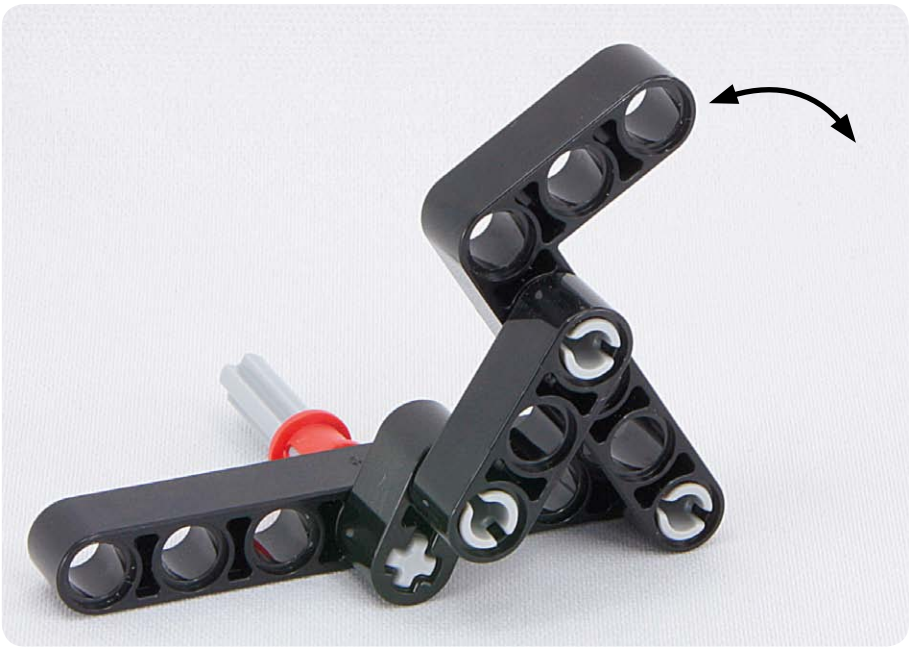




Swinging mechanisms

#52





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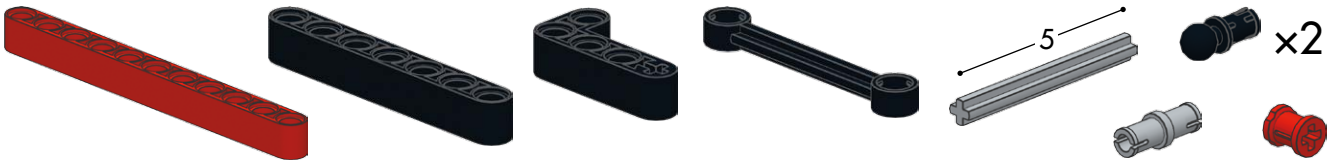

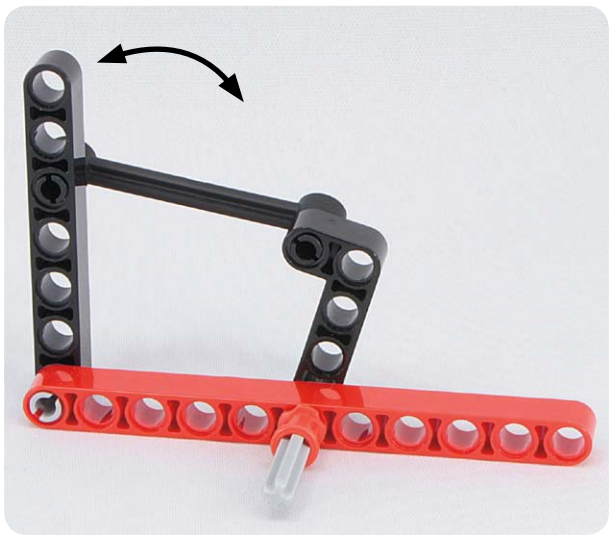

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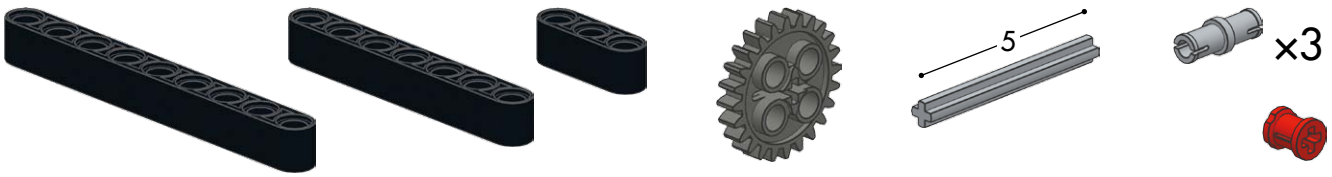

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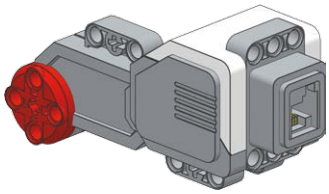

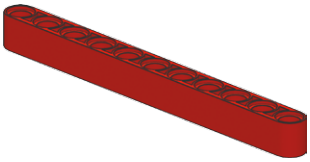

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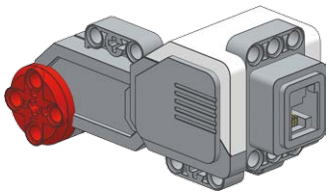

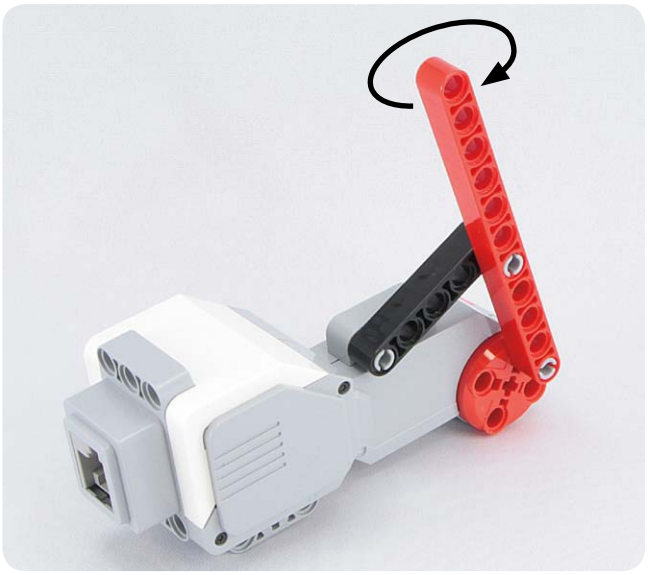

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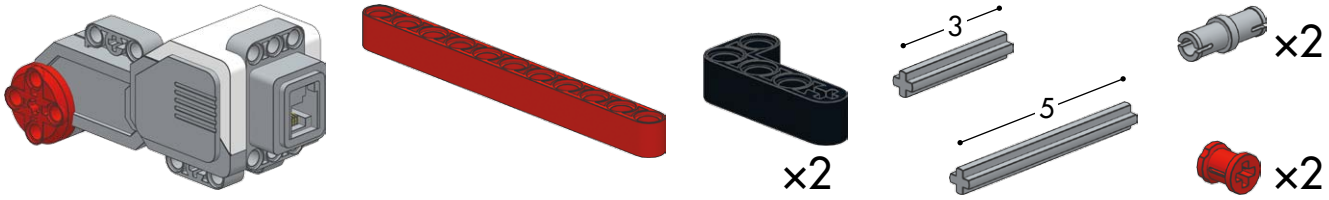

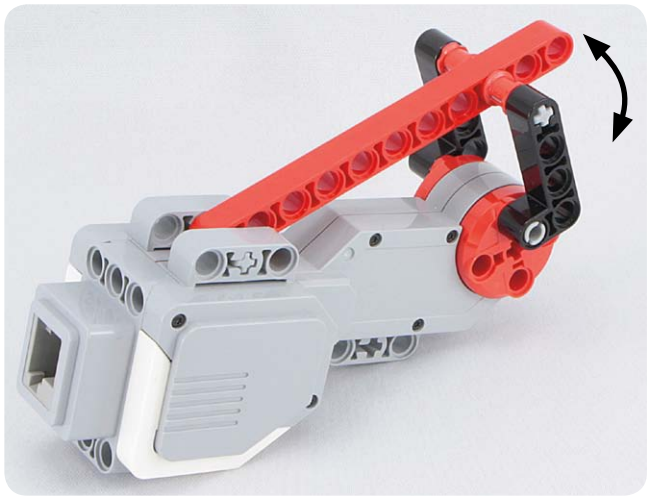

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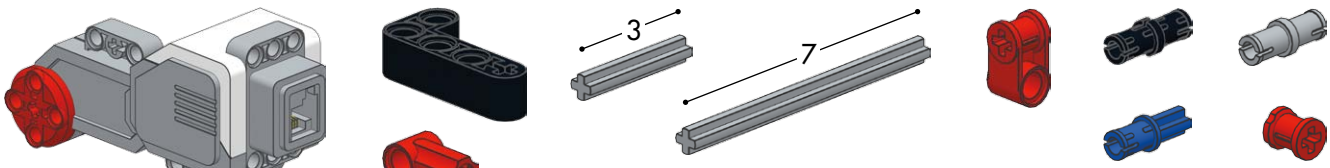

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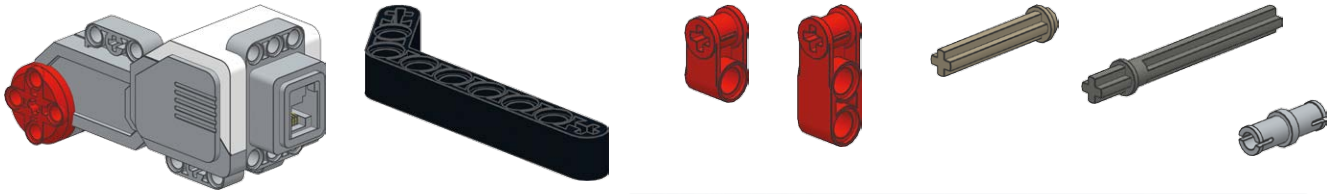

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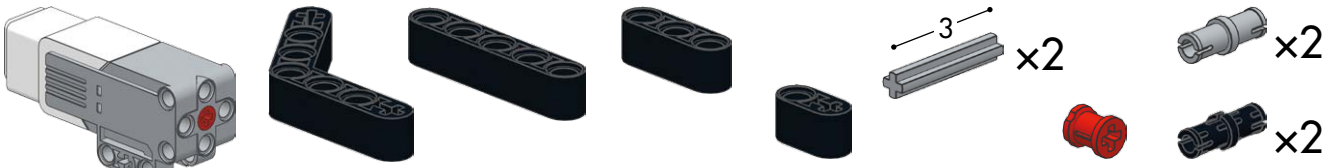

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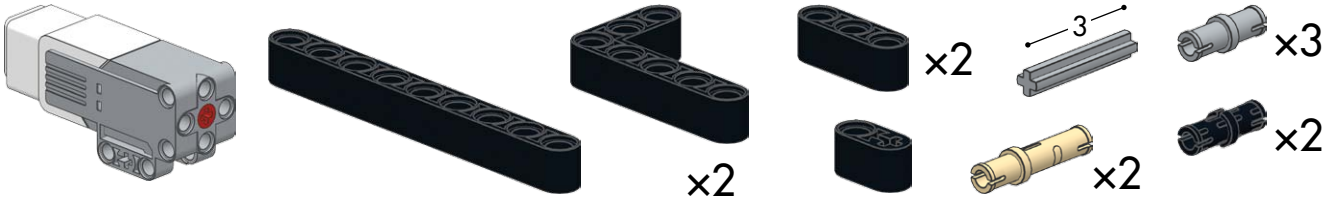

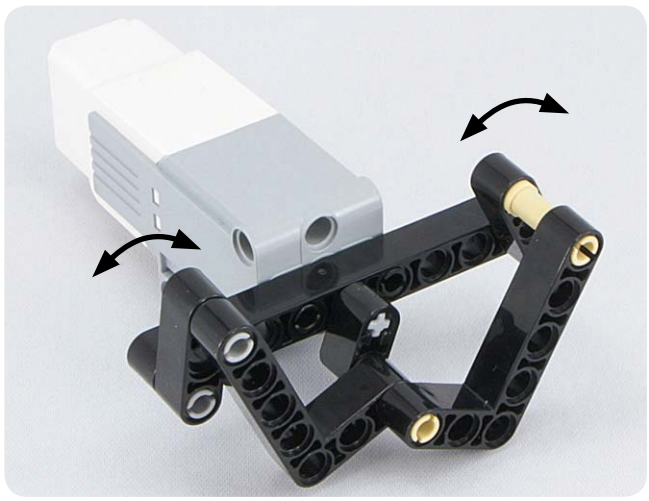

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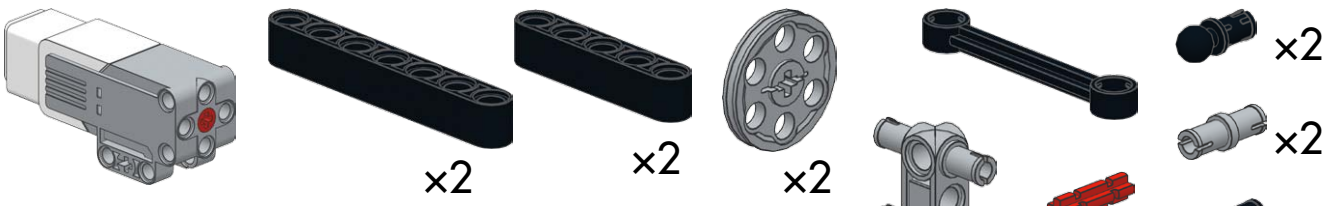
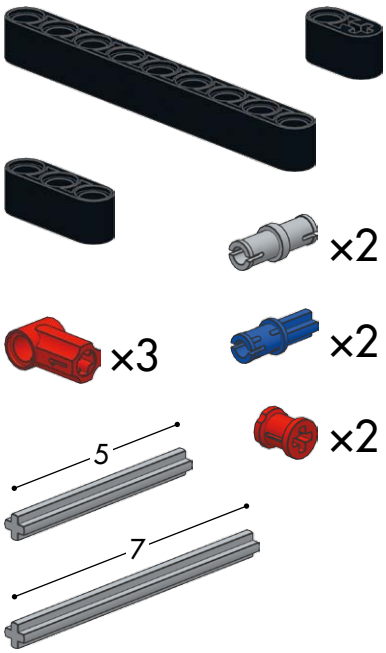


Reciprocating mechanisms

#63



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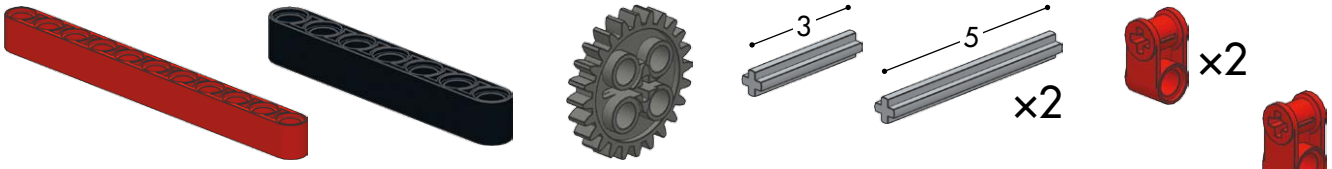

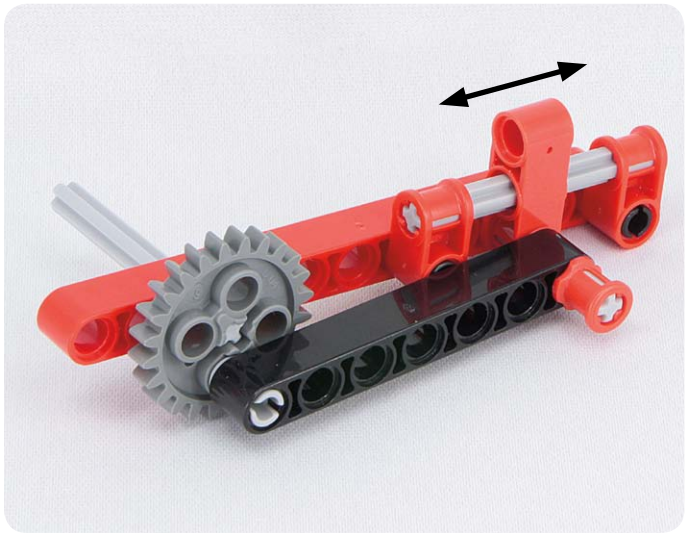

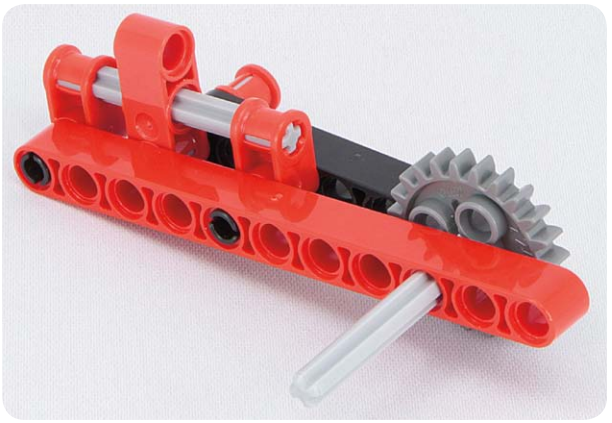

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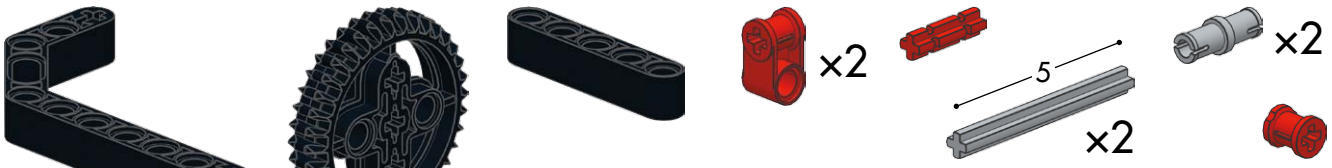

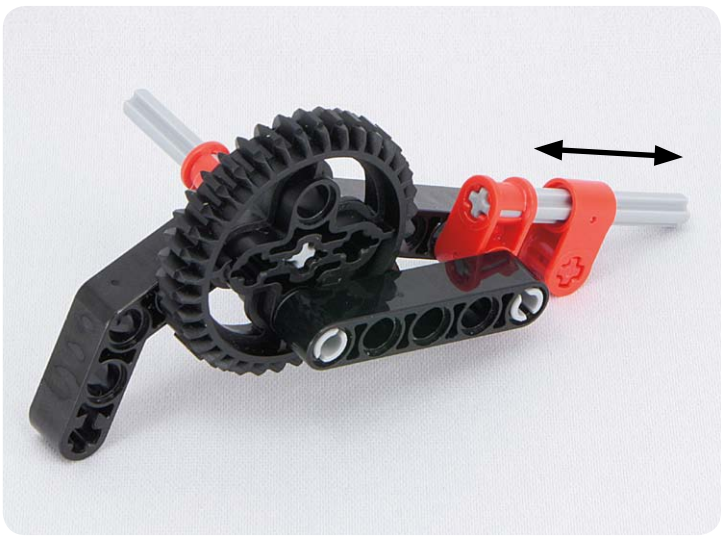

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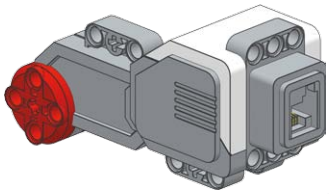

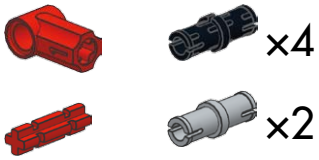

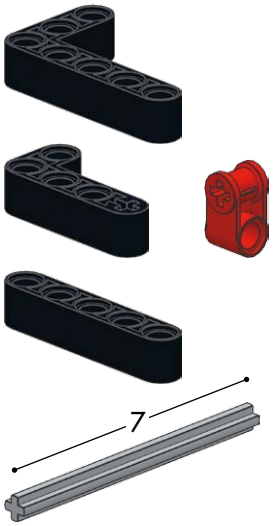

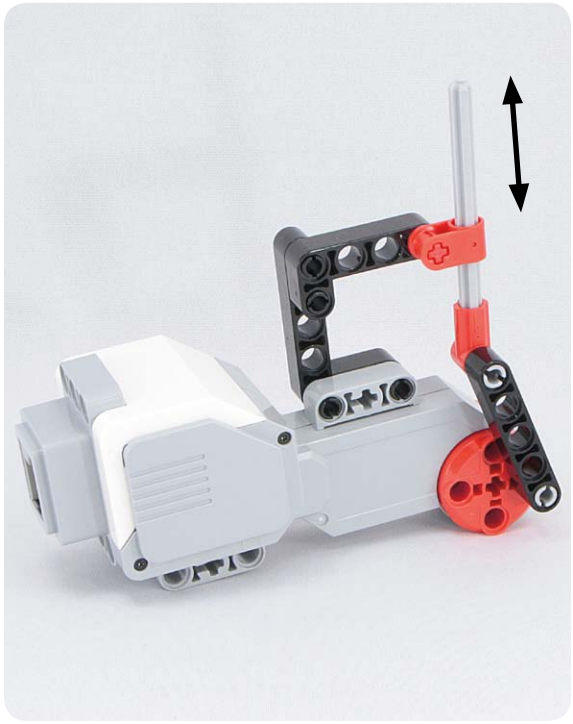

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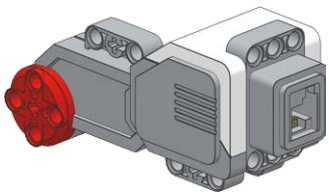

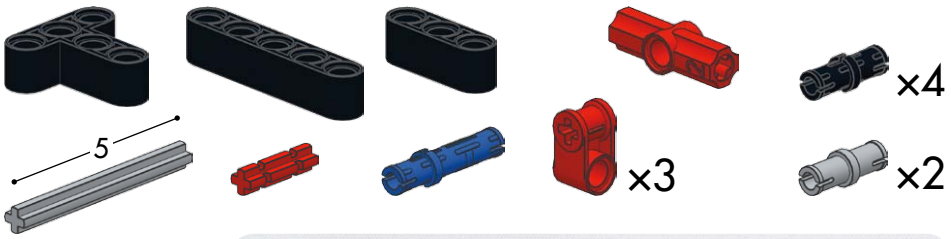

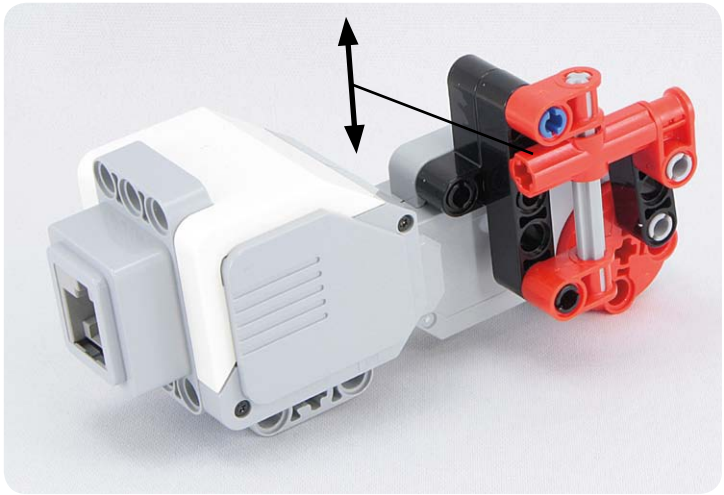

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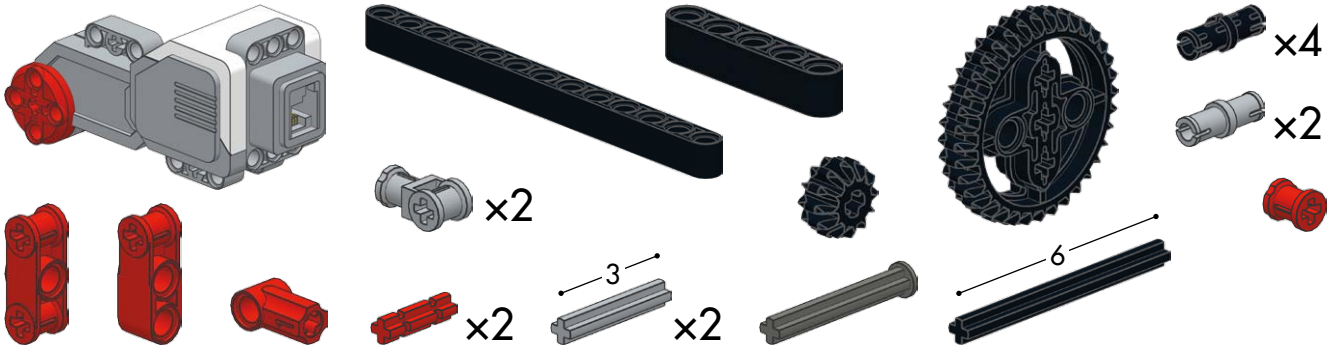

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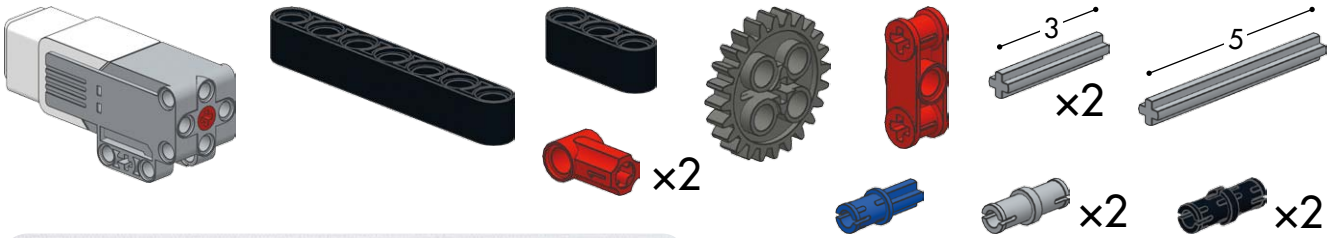

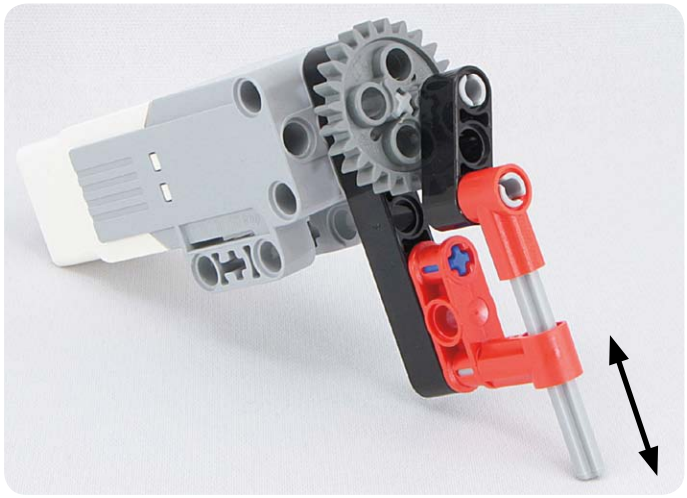

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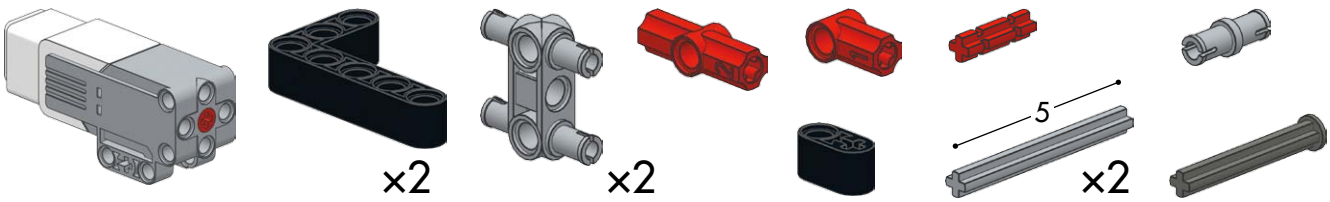

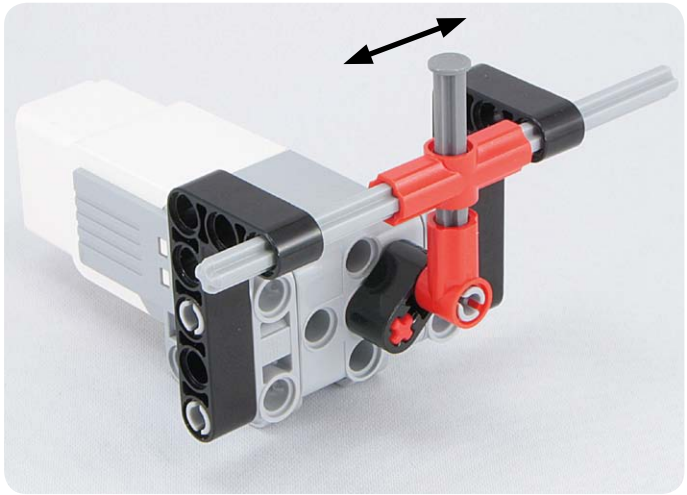

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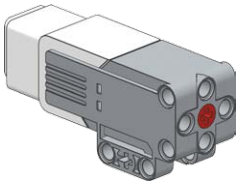
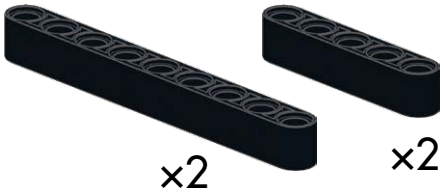
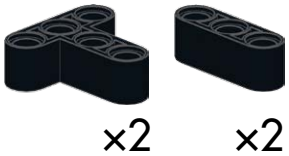
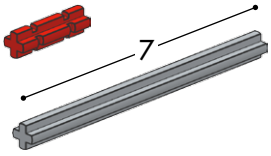
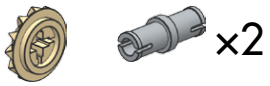
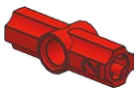


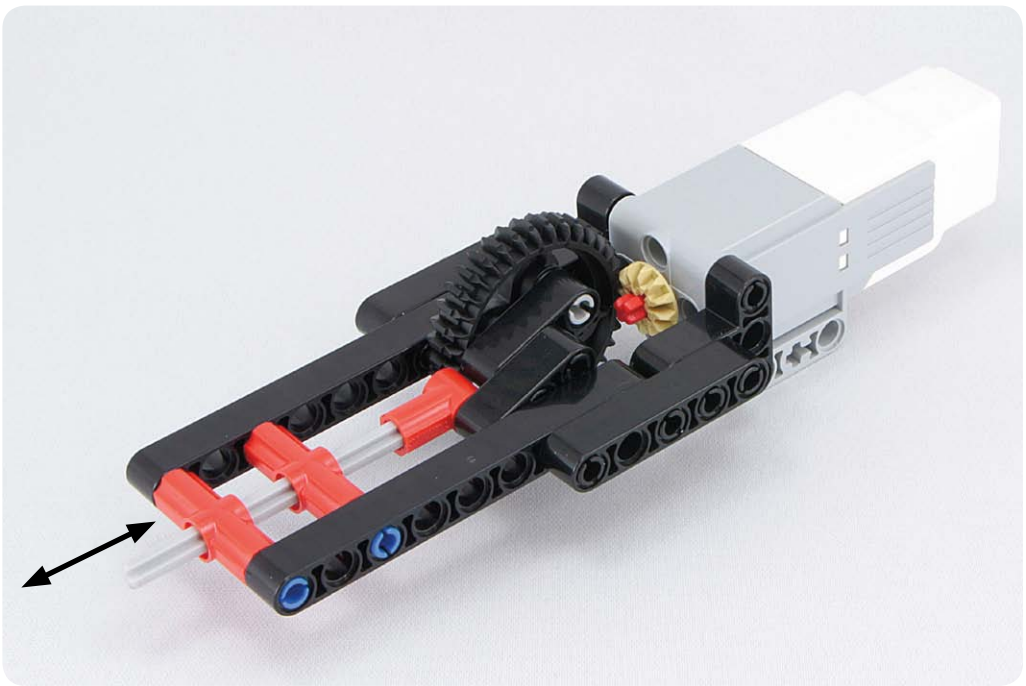


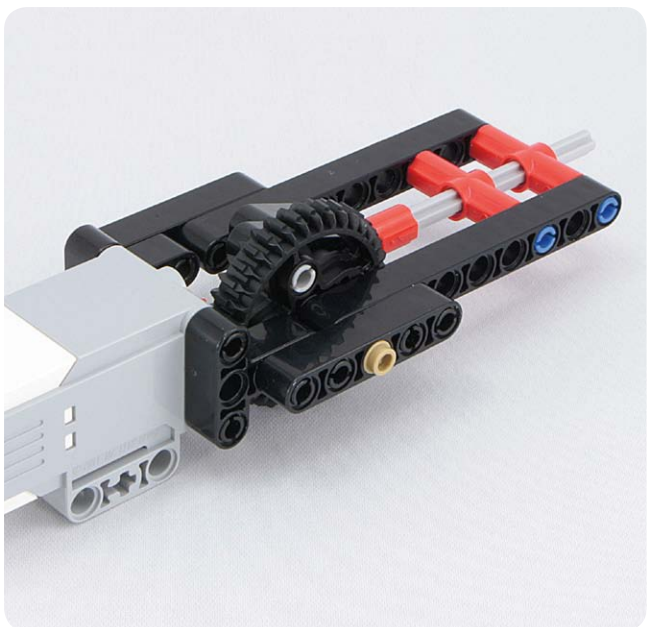


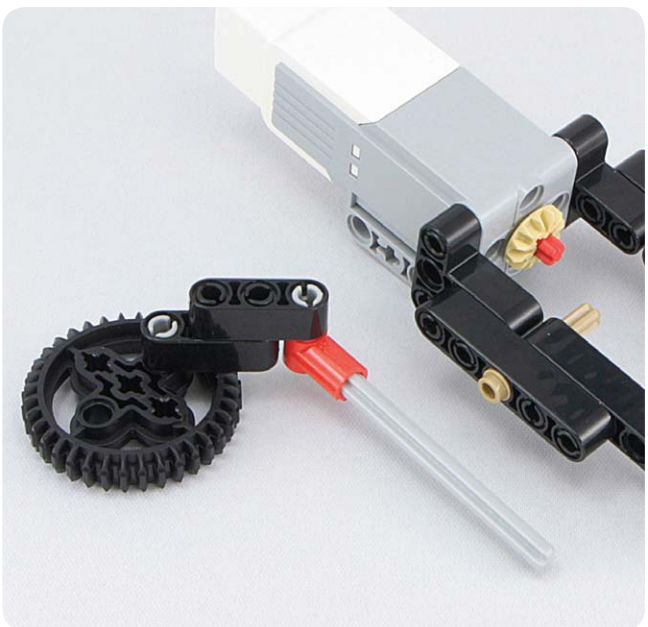






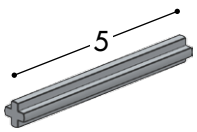


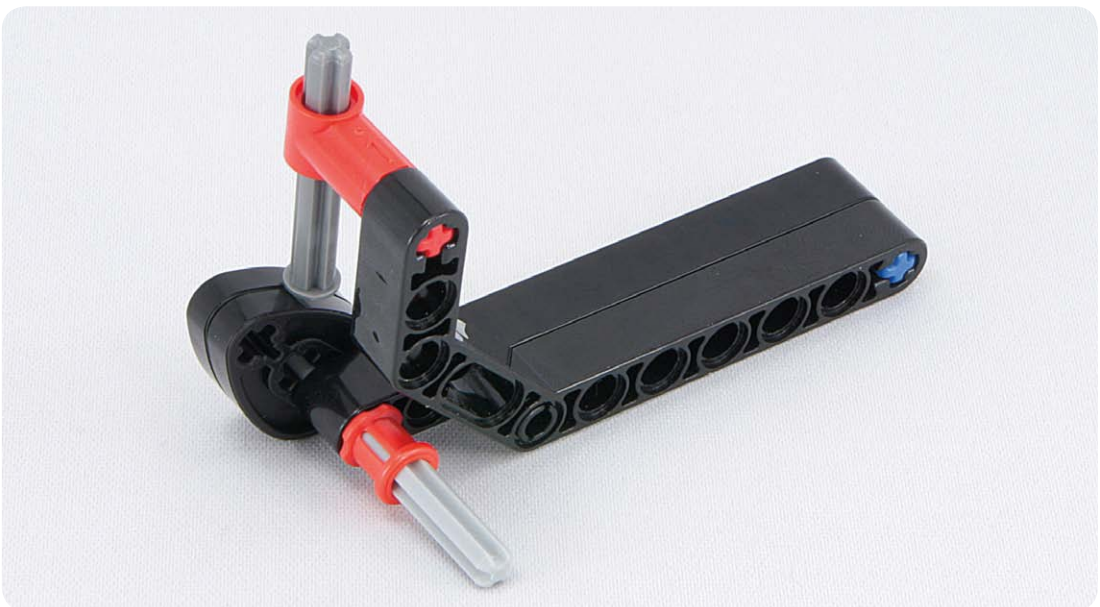




Cam mechanisms

#72





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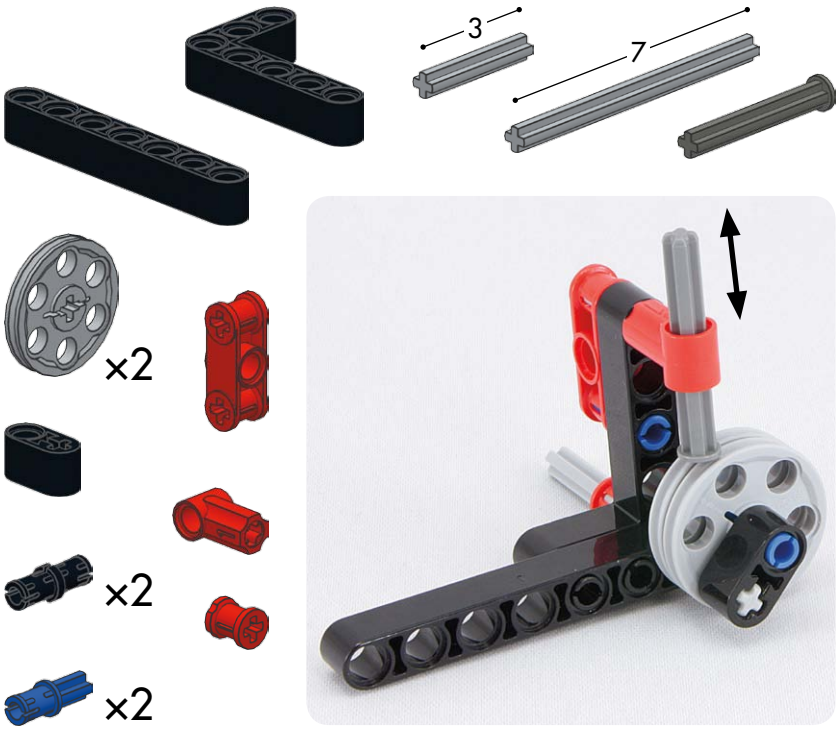
#74



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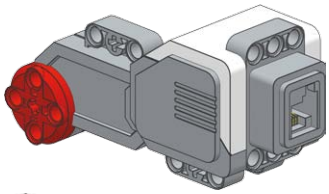

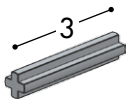

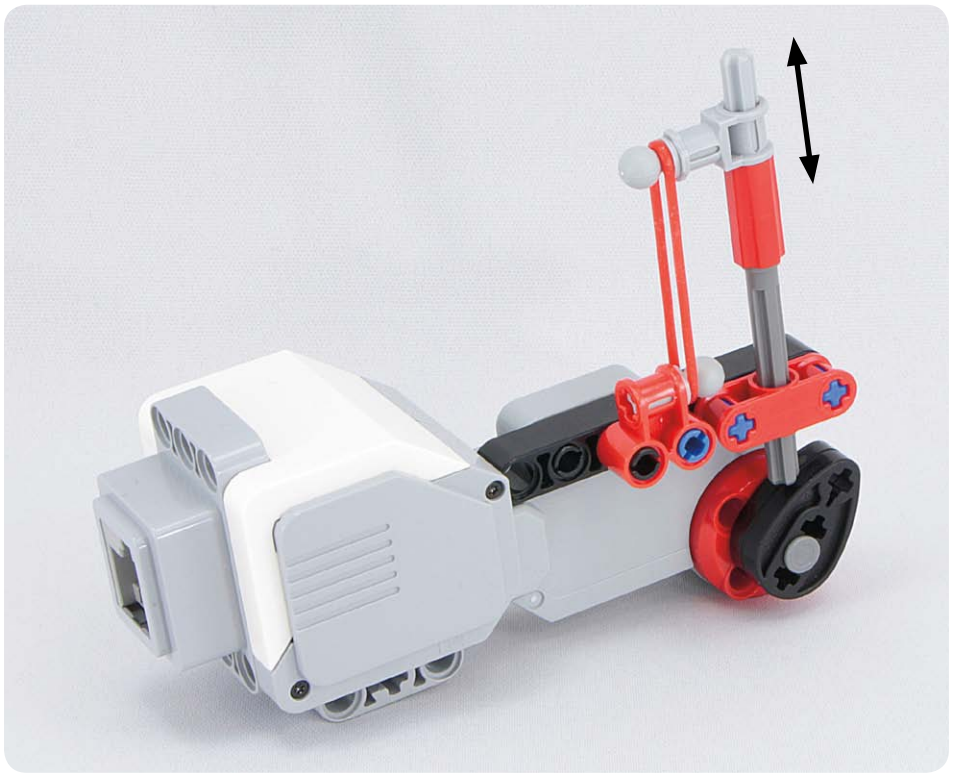

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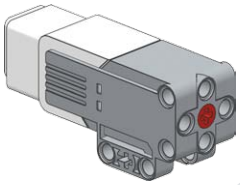
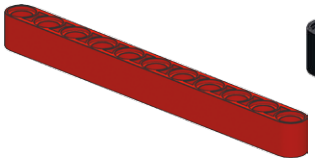
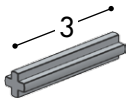
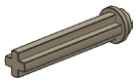
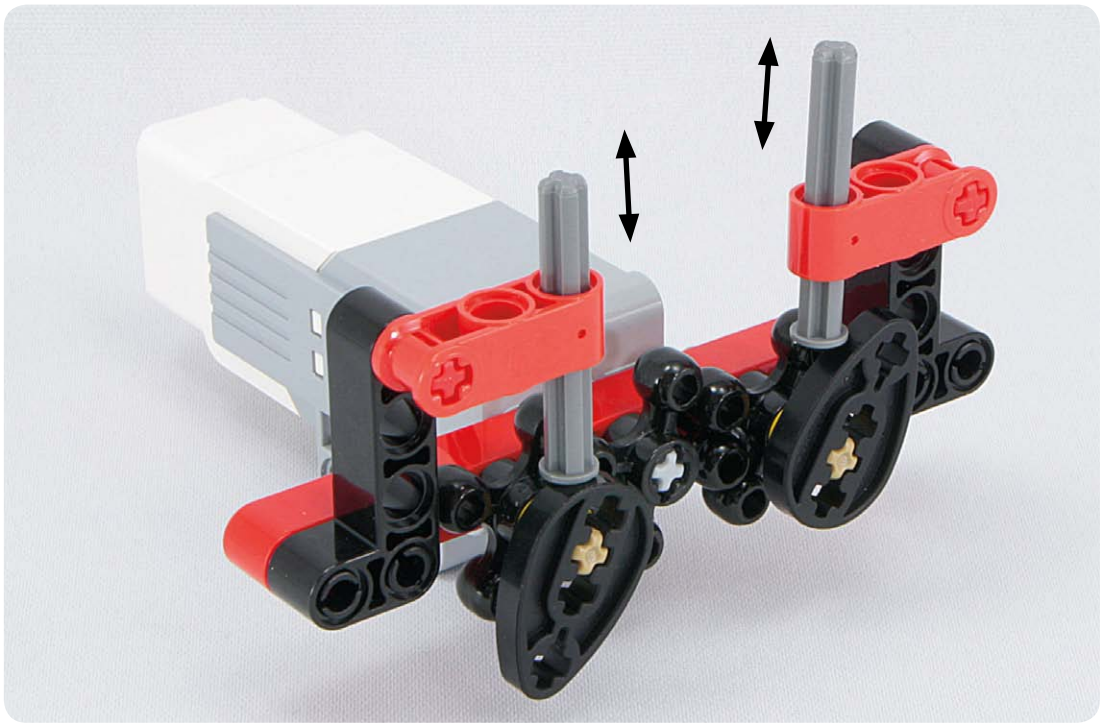




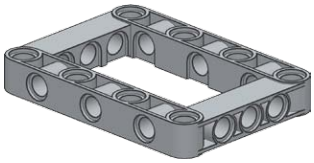


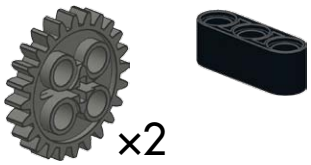


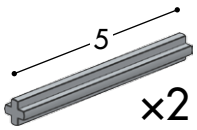


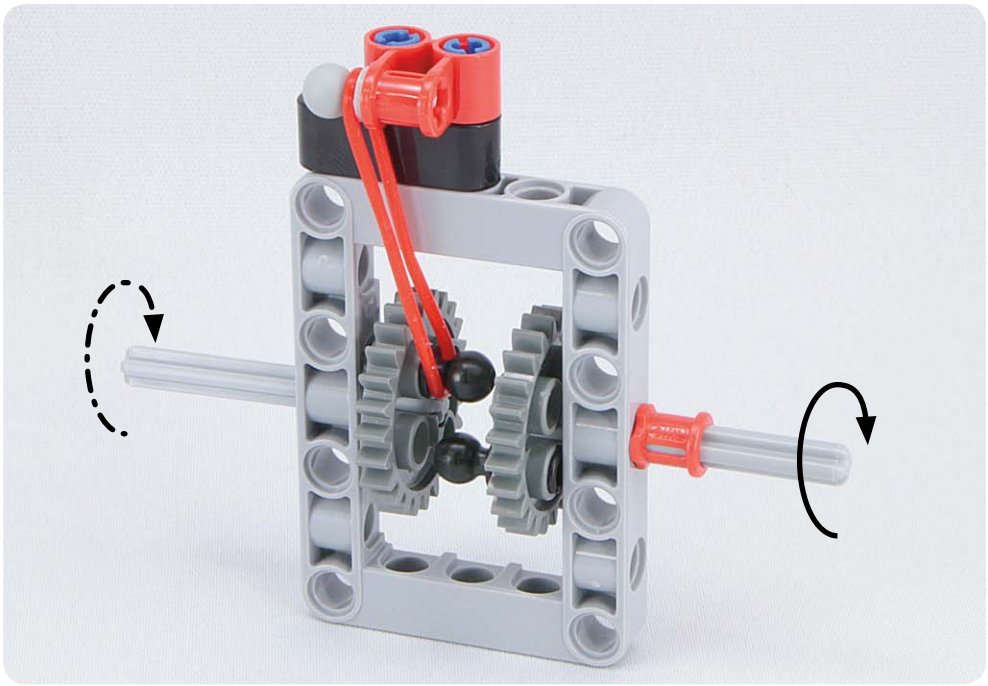
Intermittent motion

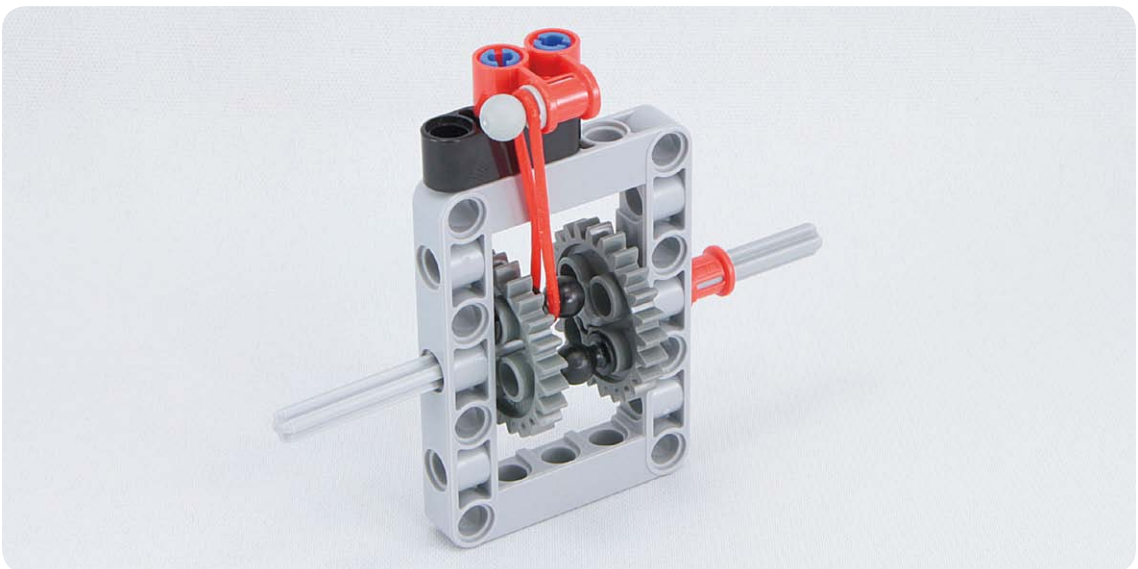
#77











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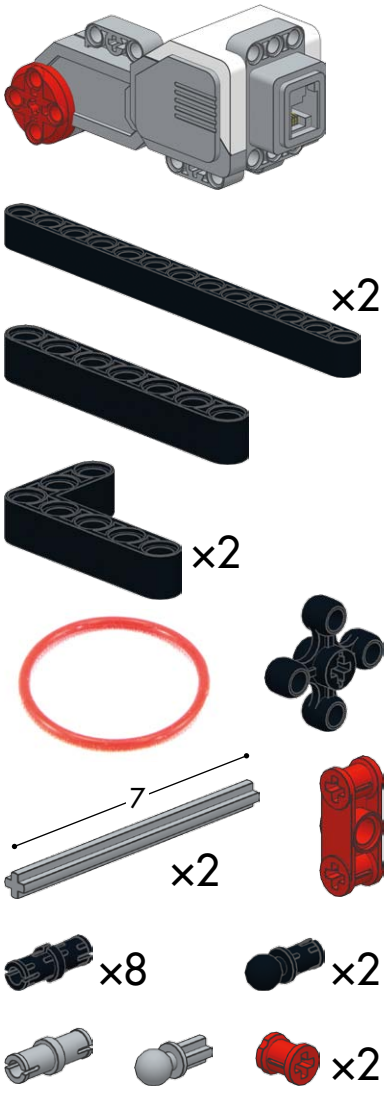

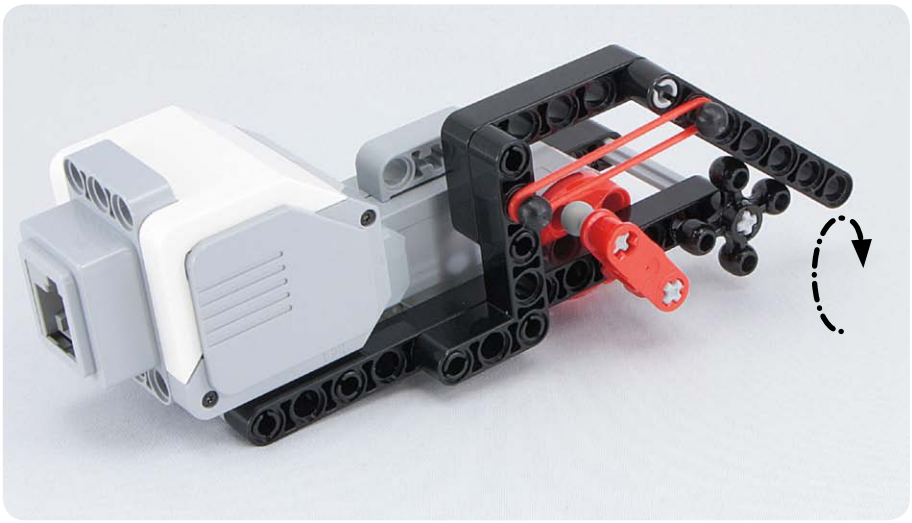

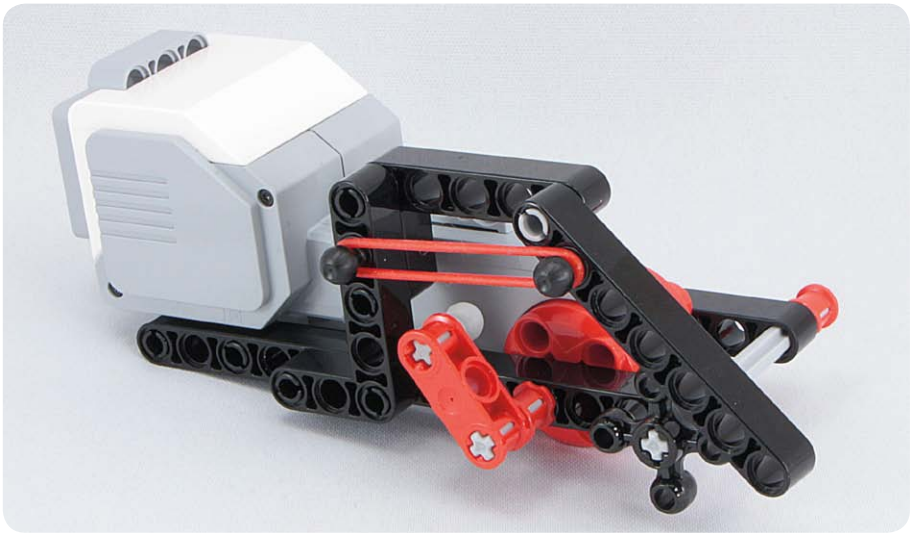

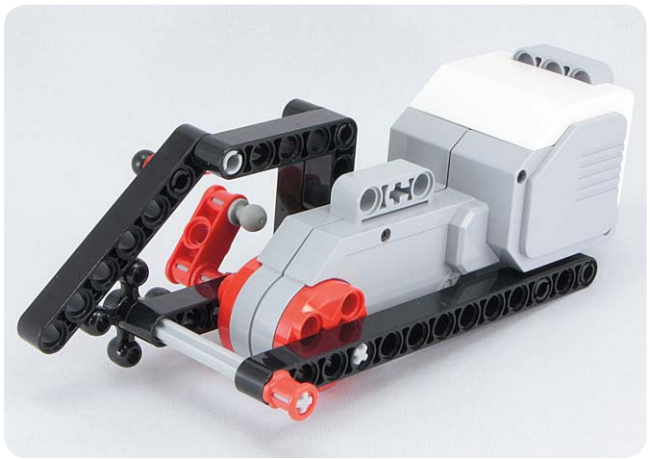

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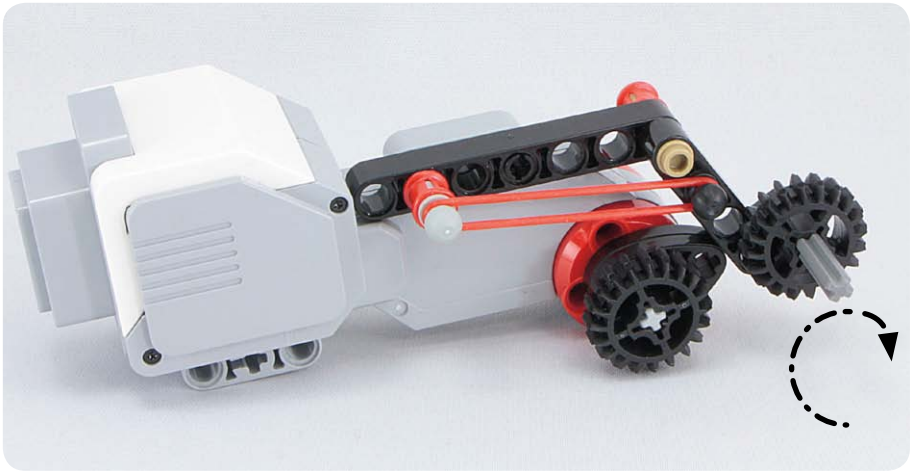

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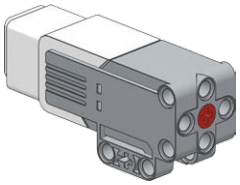

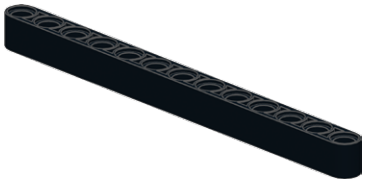

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×3

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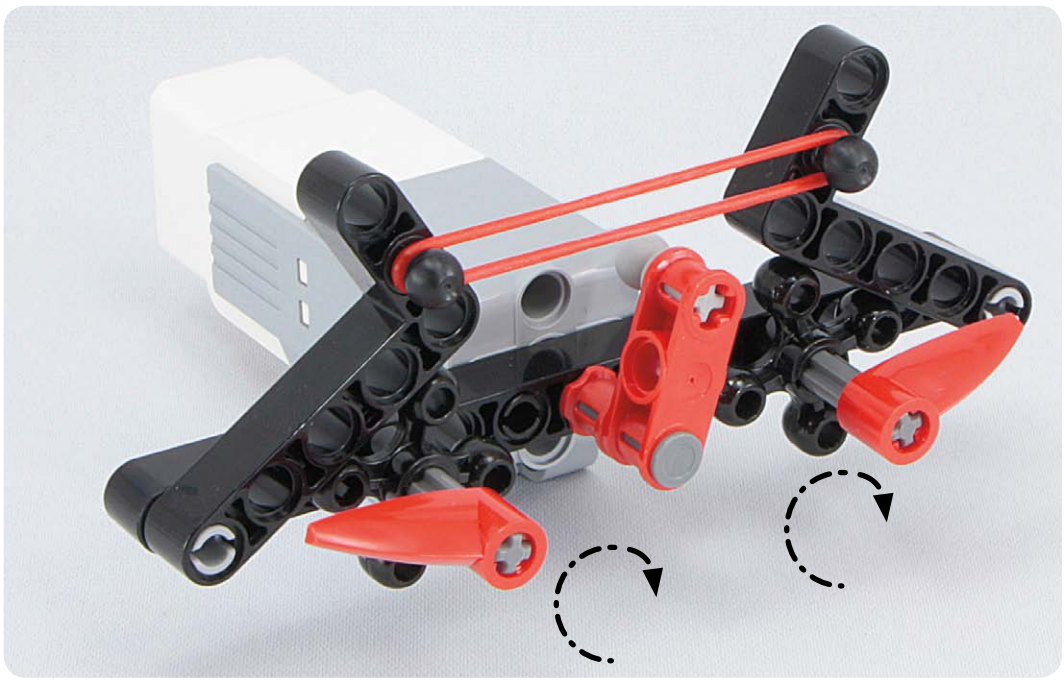
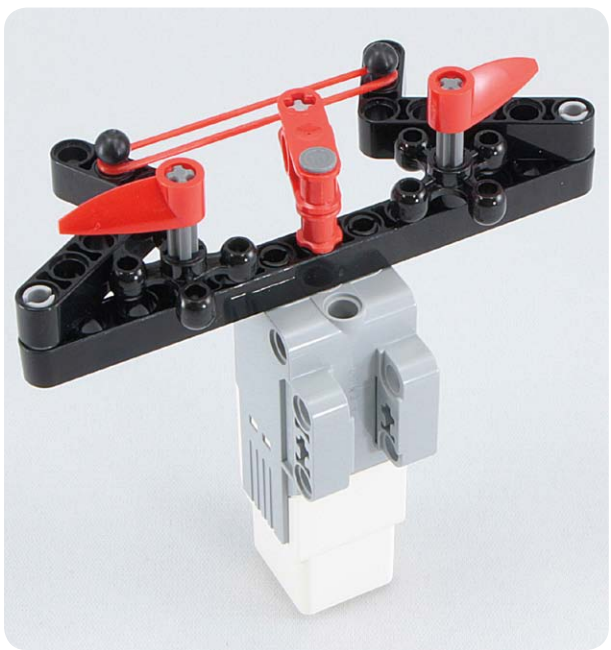
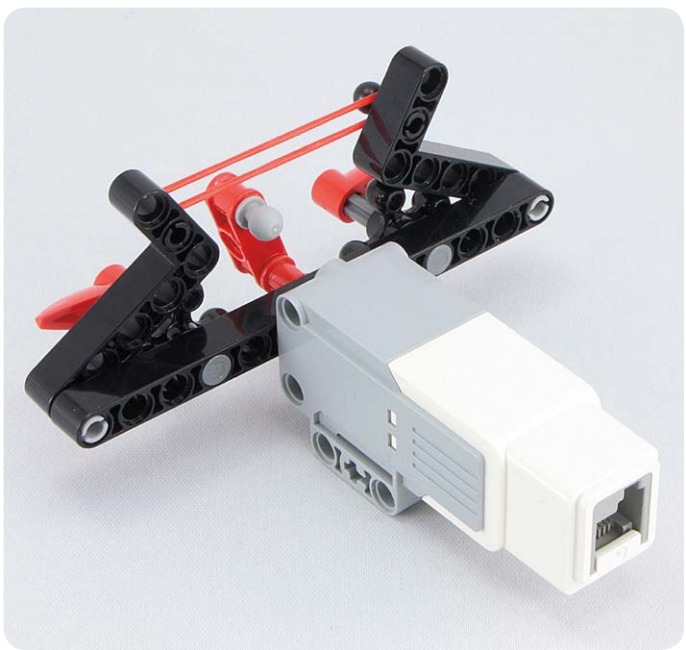
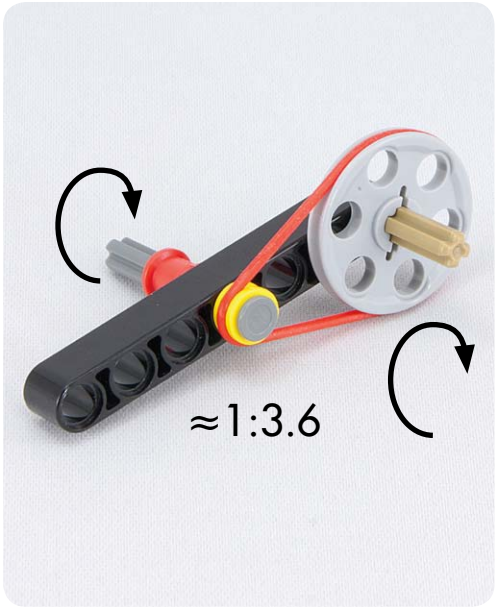


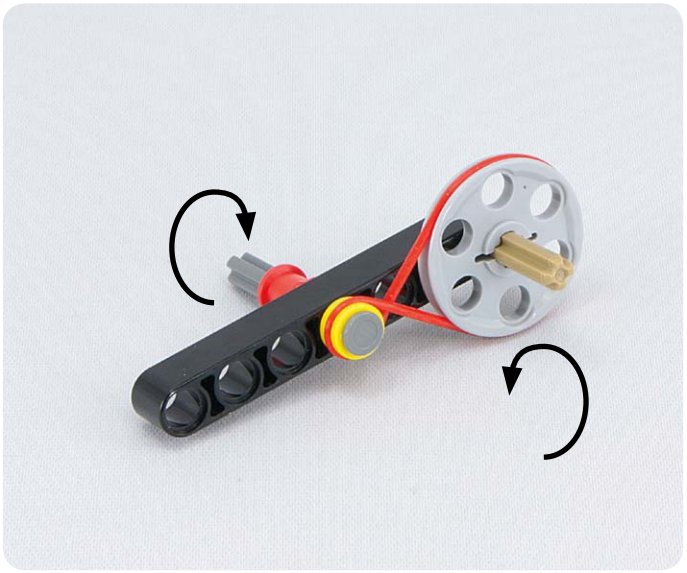




Transmitting rotation with rubber bands

#81

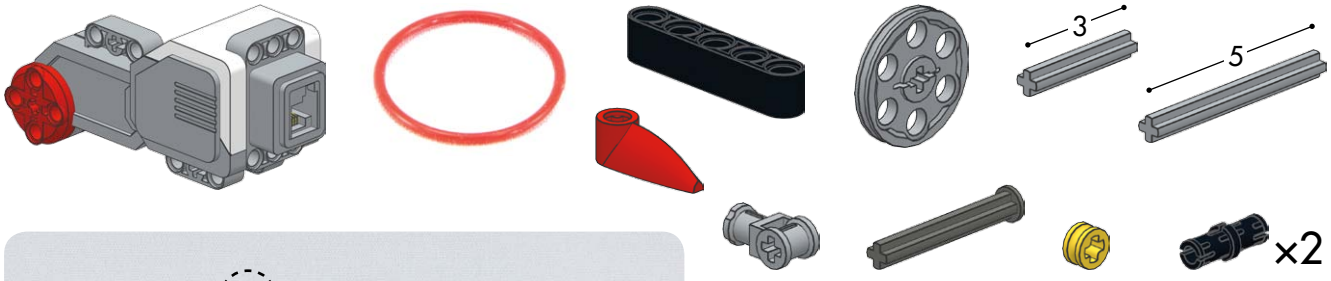


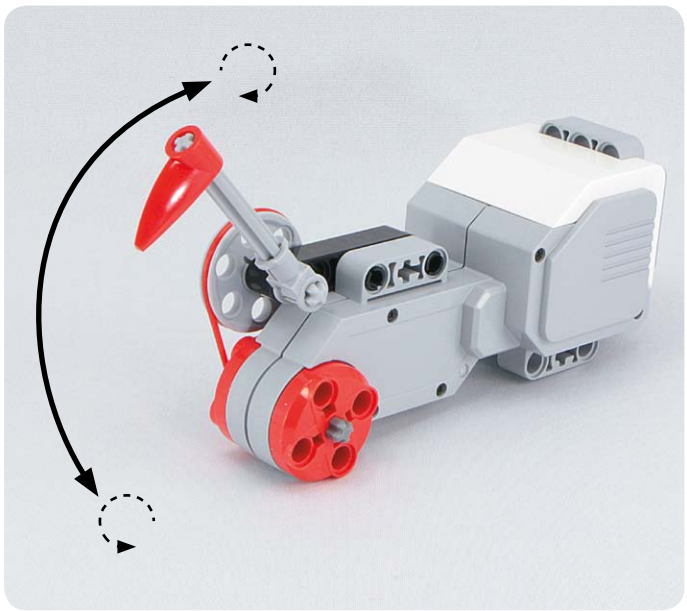


#82

#83

#84





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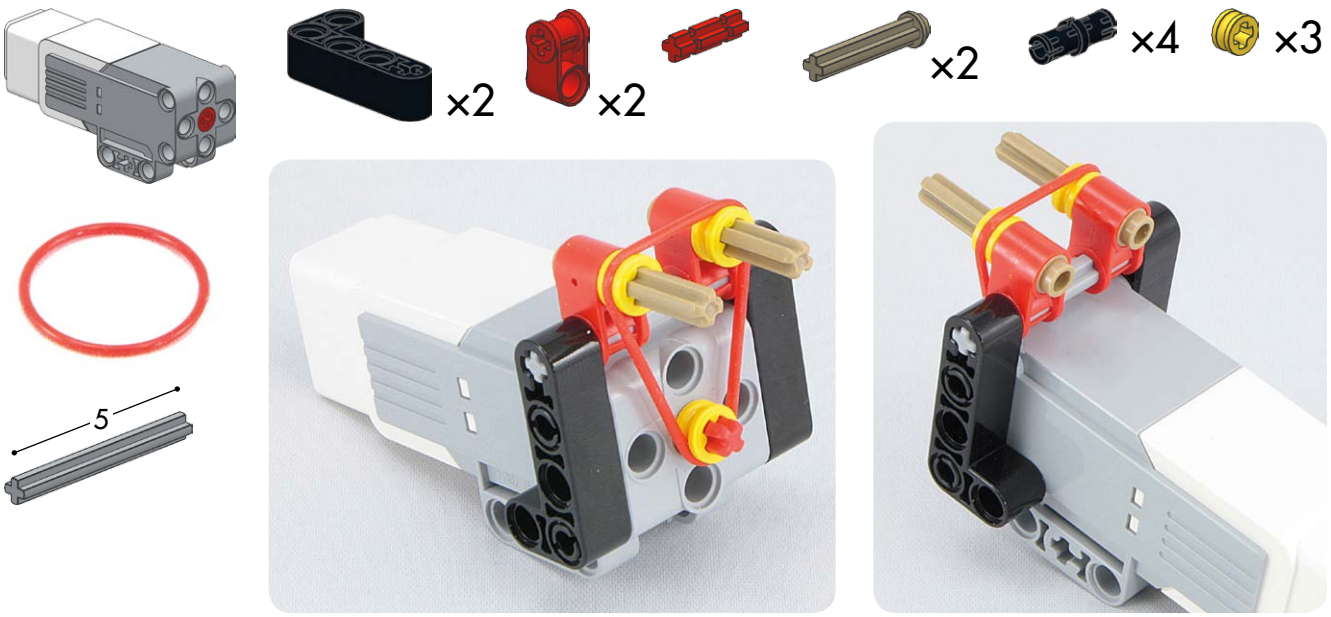

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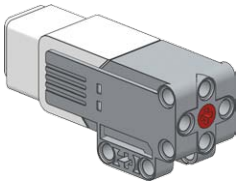
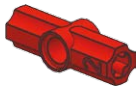
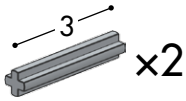
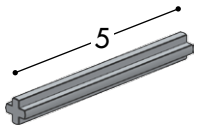
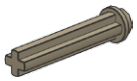
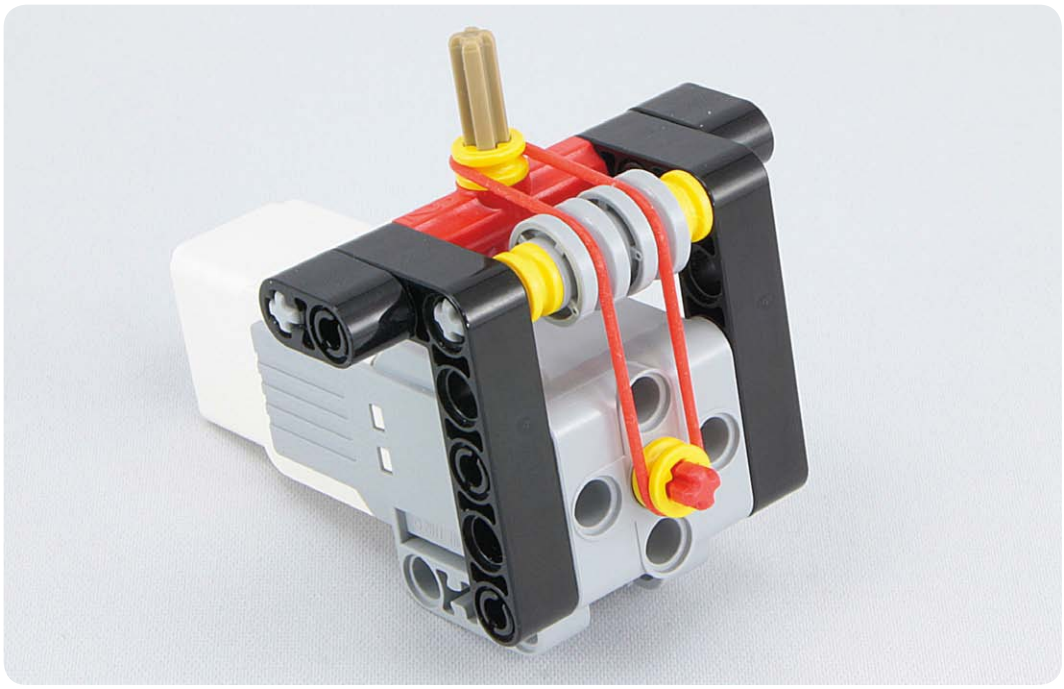






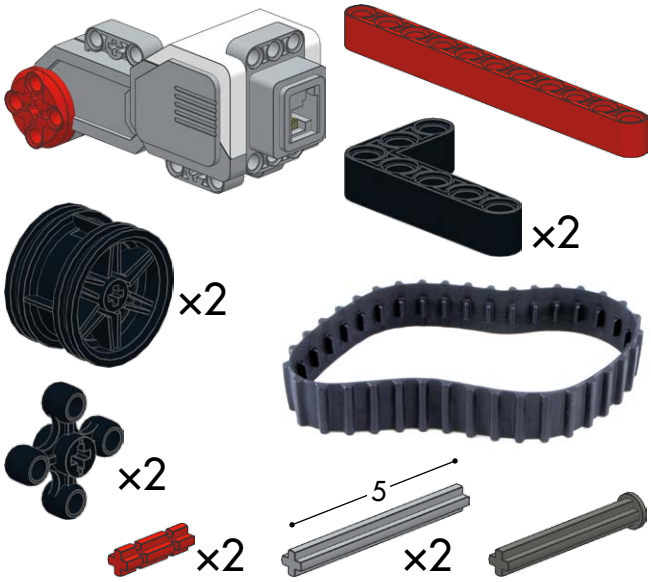




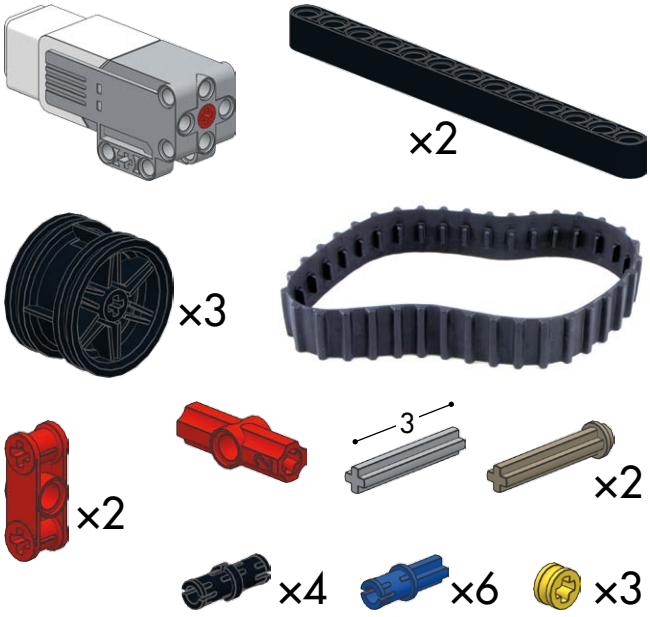


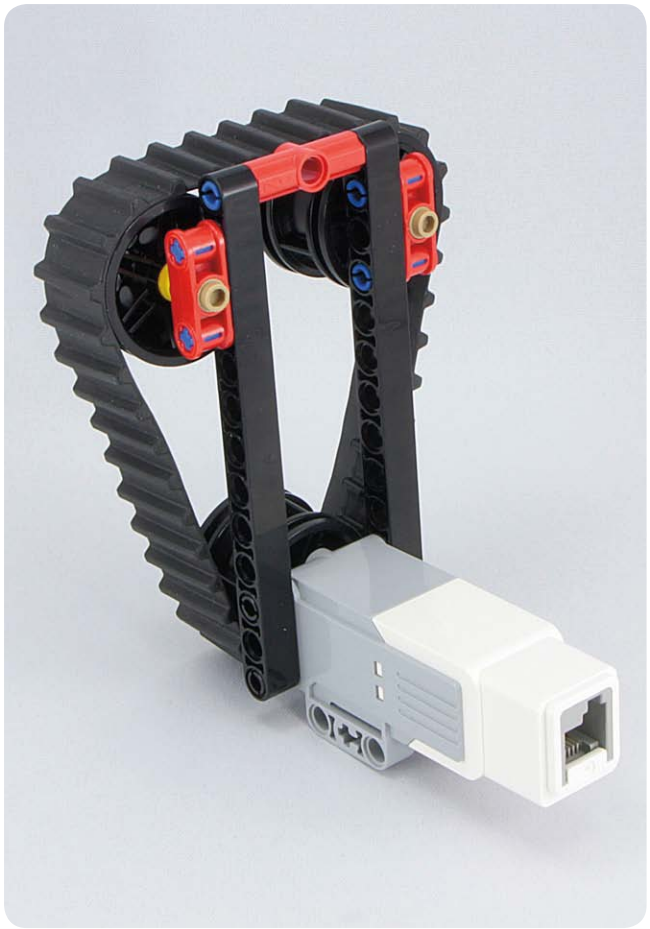
Transmitting rotation with caterpillar treads

#87



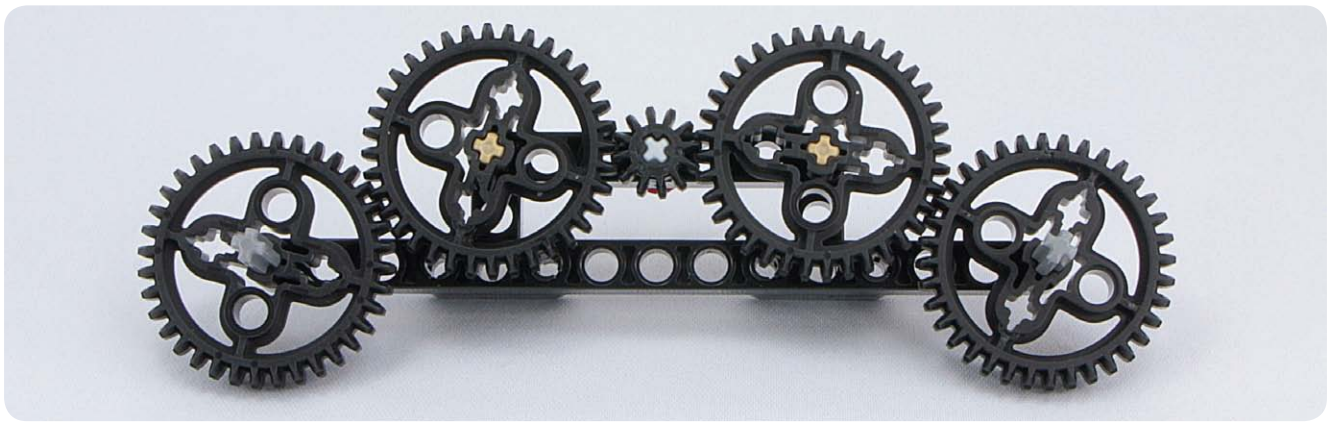
#88





Transmitting rotation over a long distance

#89



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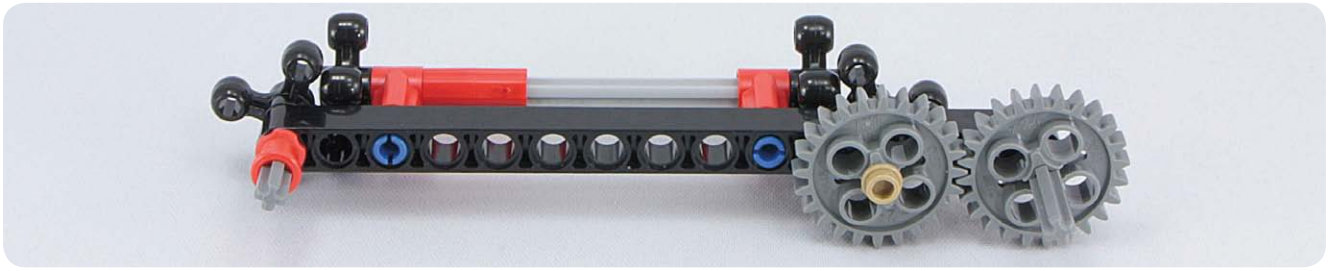
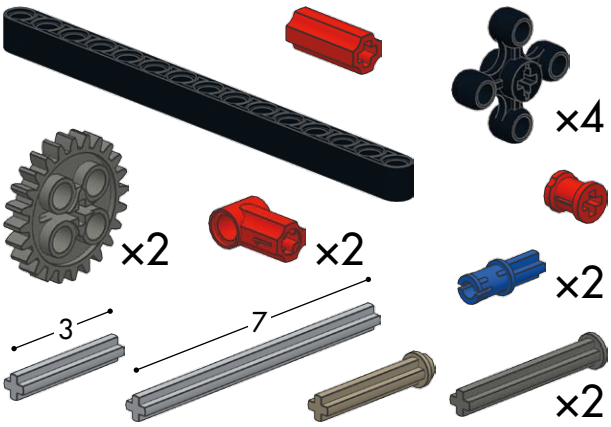
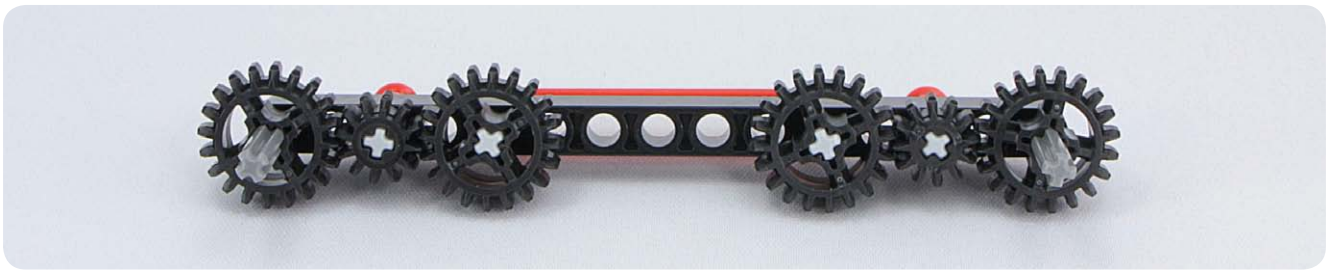
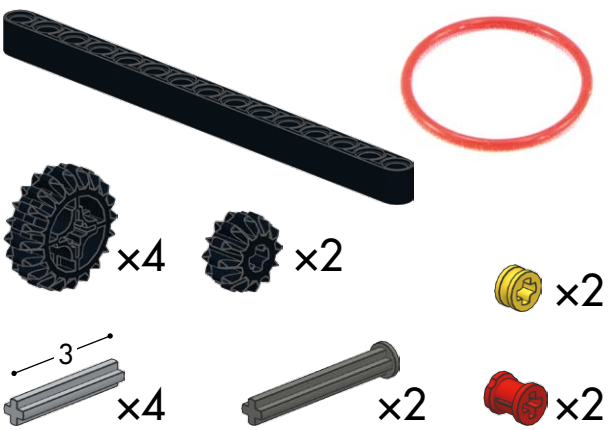




#91

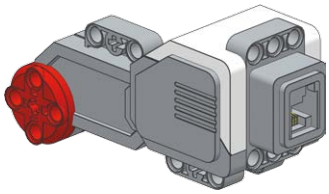




Off-center axes of rotation

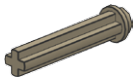
#92

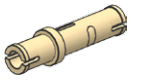
#93

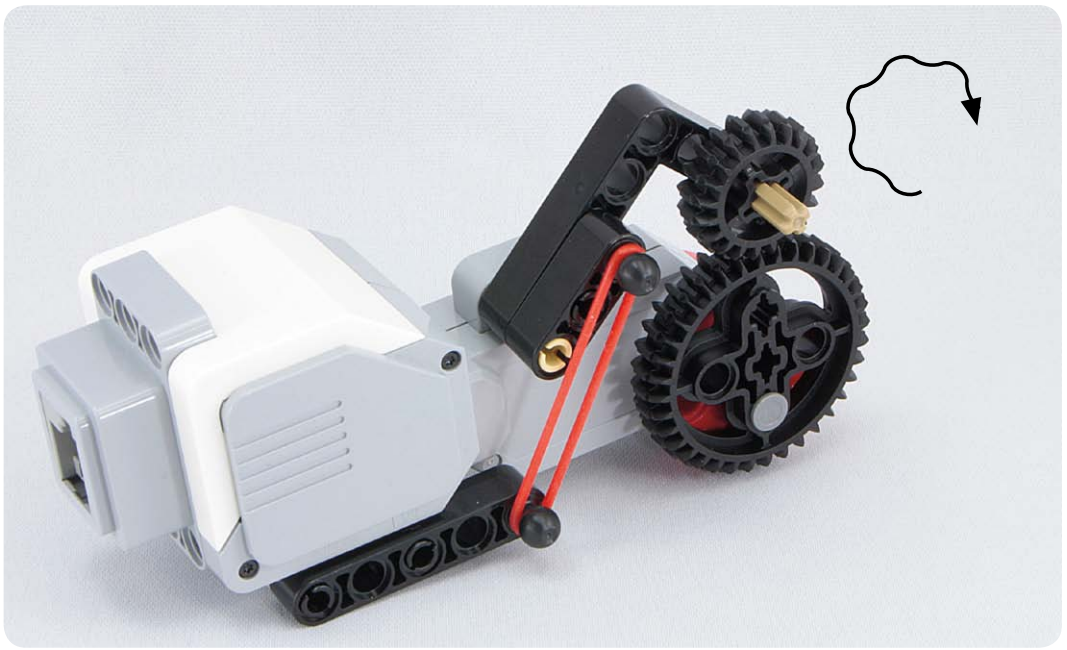




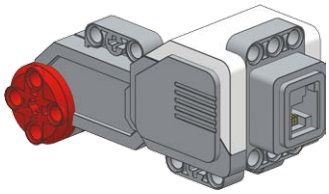


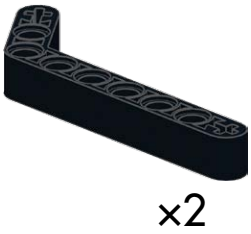



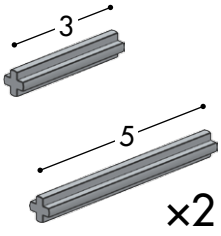




#94







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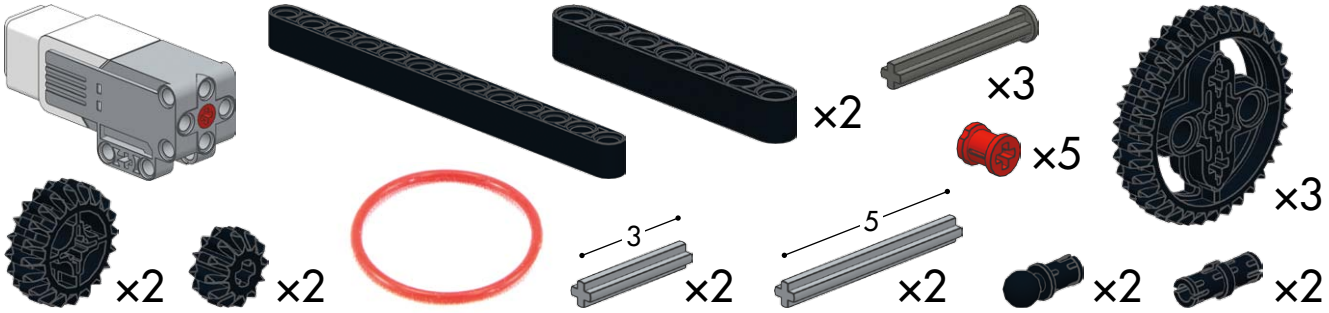
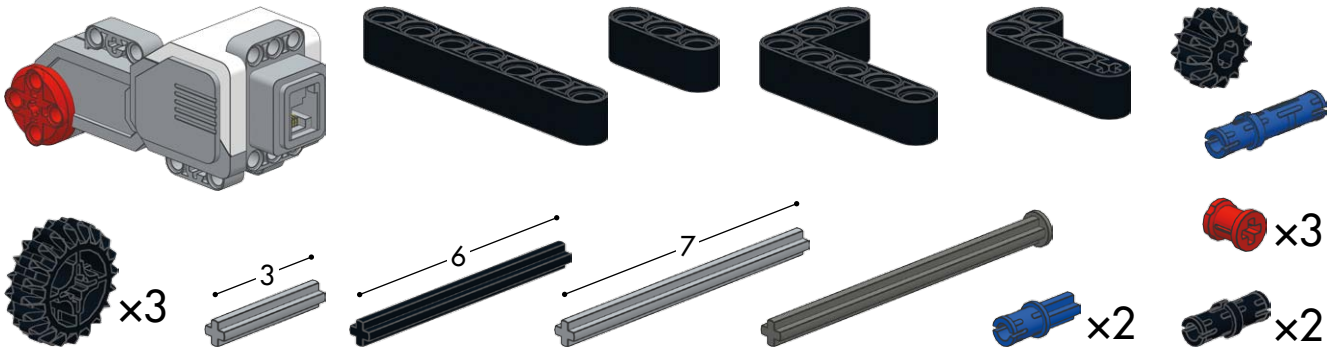
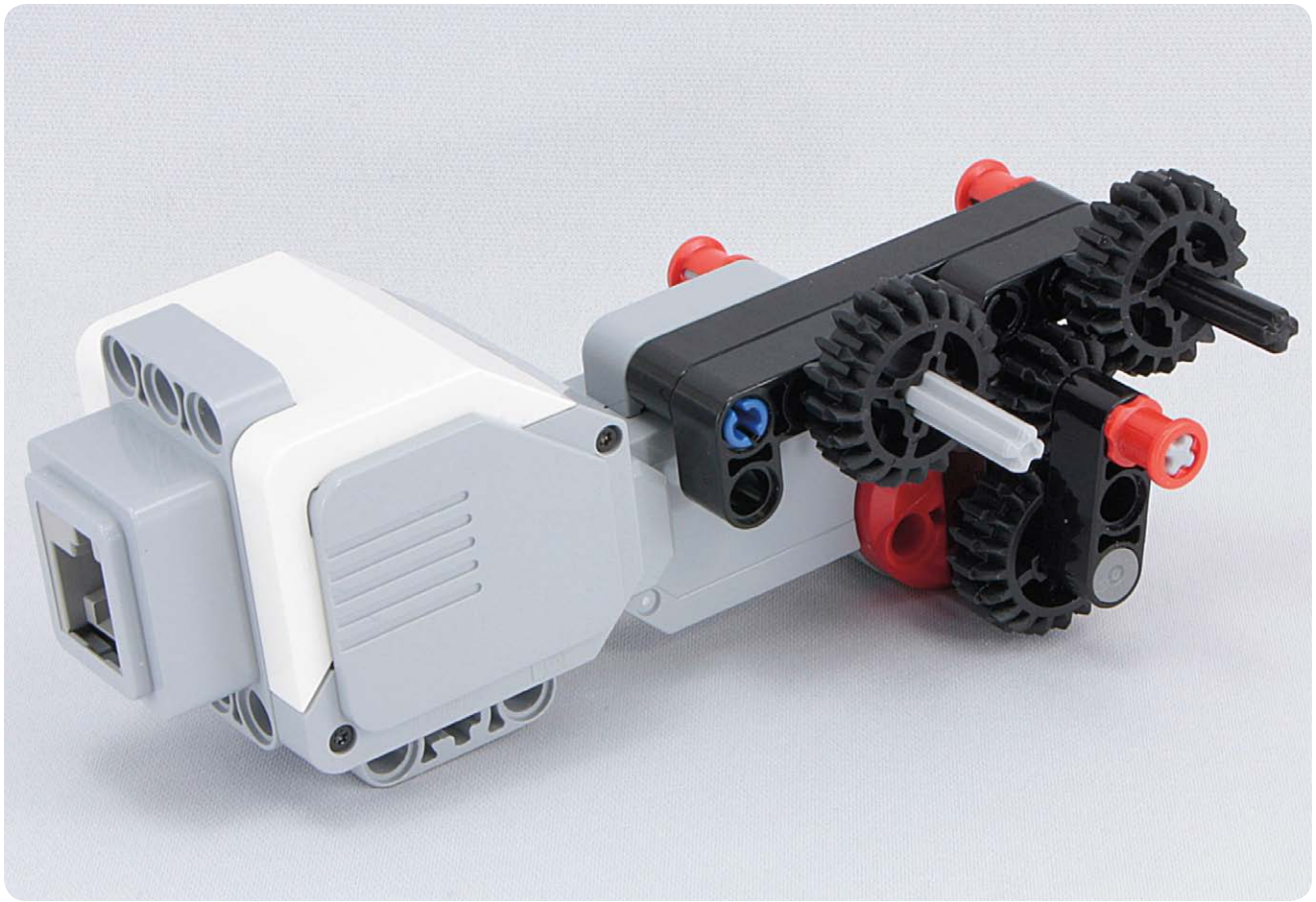


Changeover mechanisms using rotational direction

#96





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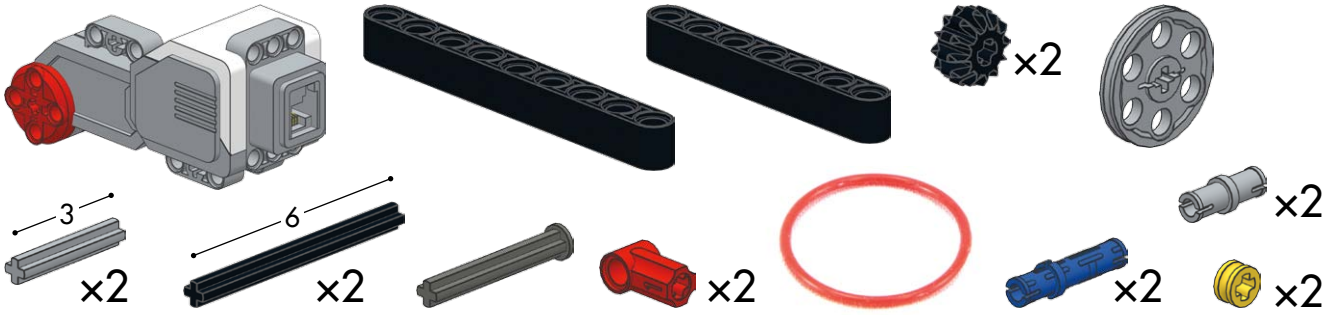

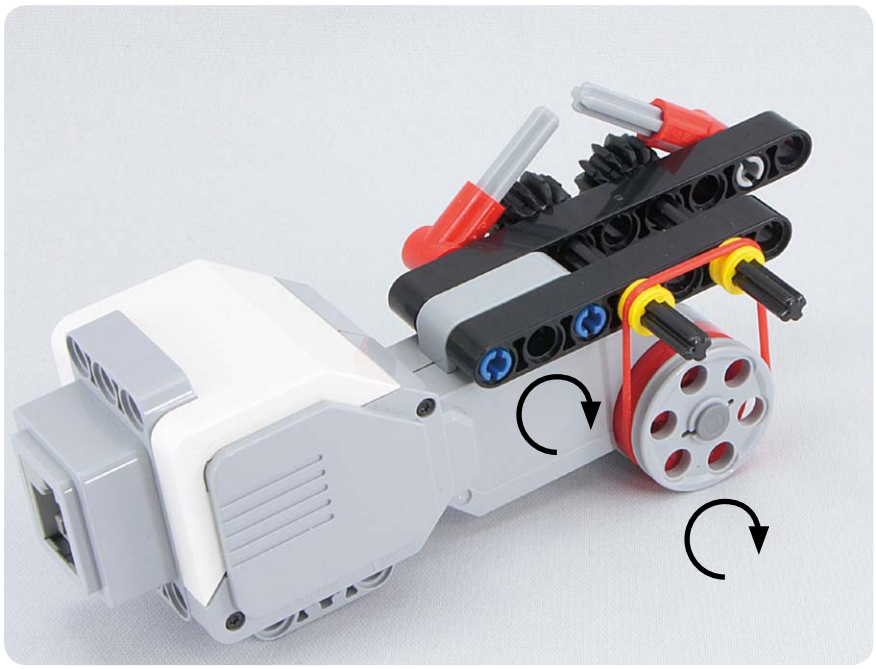

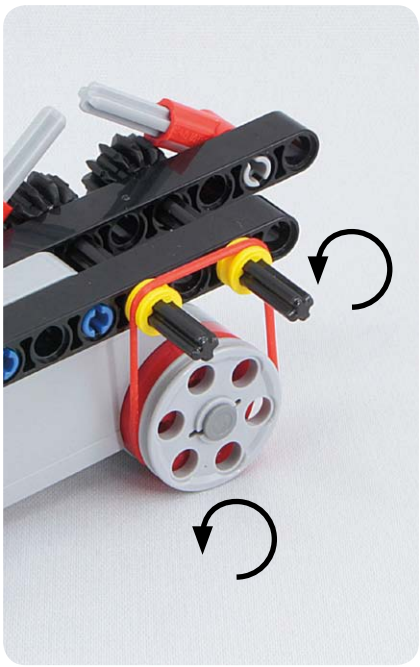

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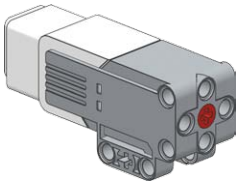

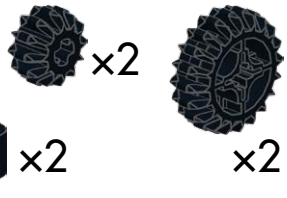

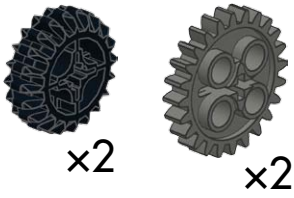

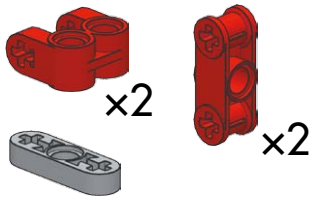

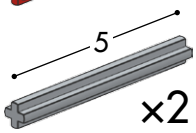

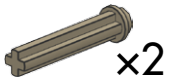

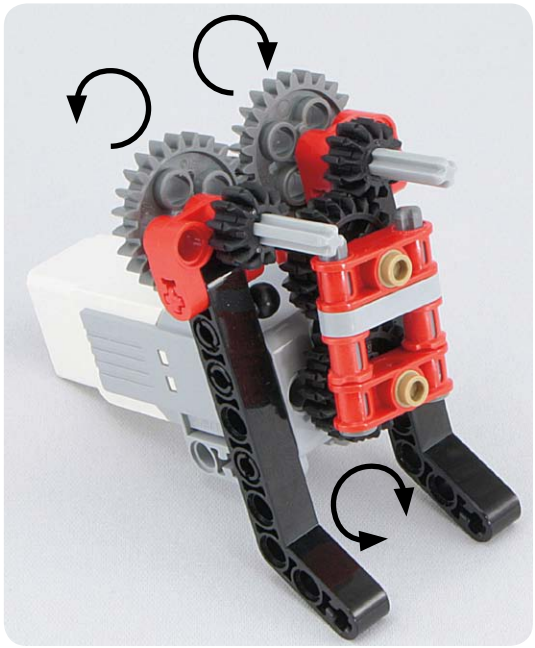

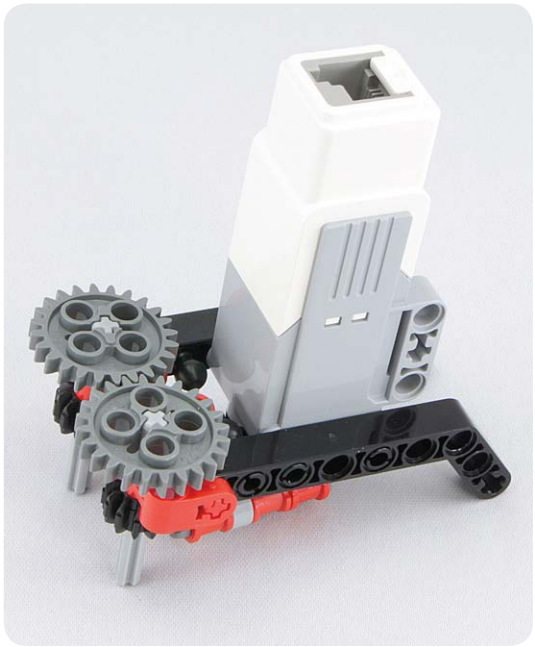

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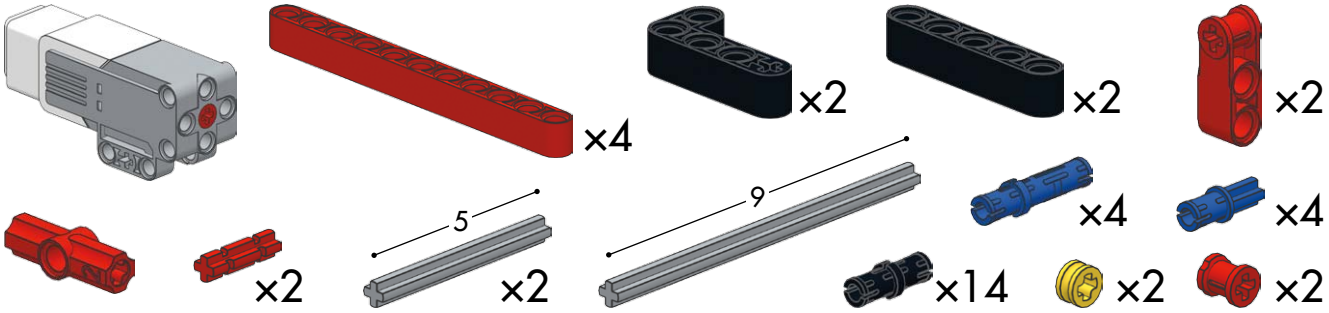
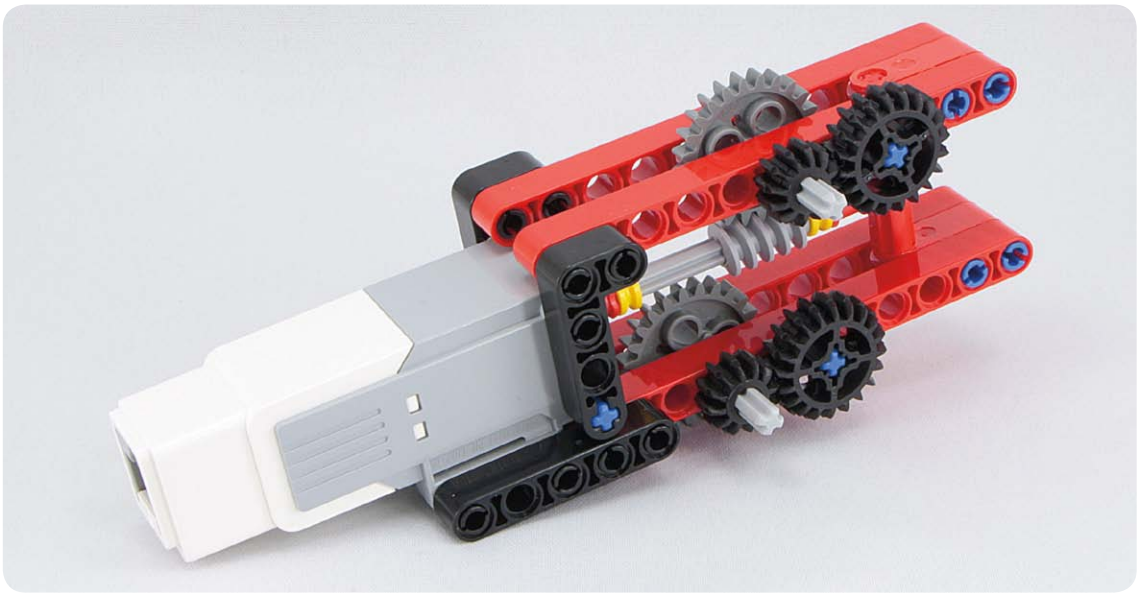
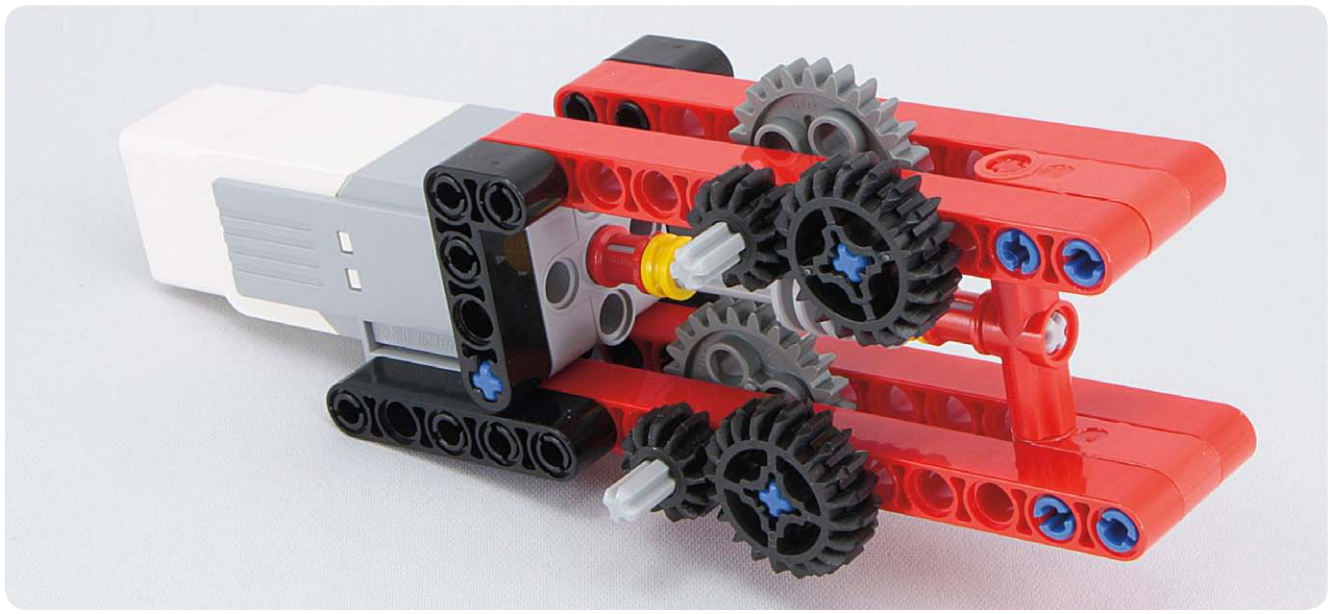
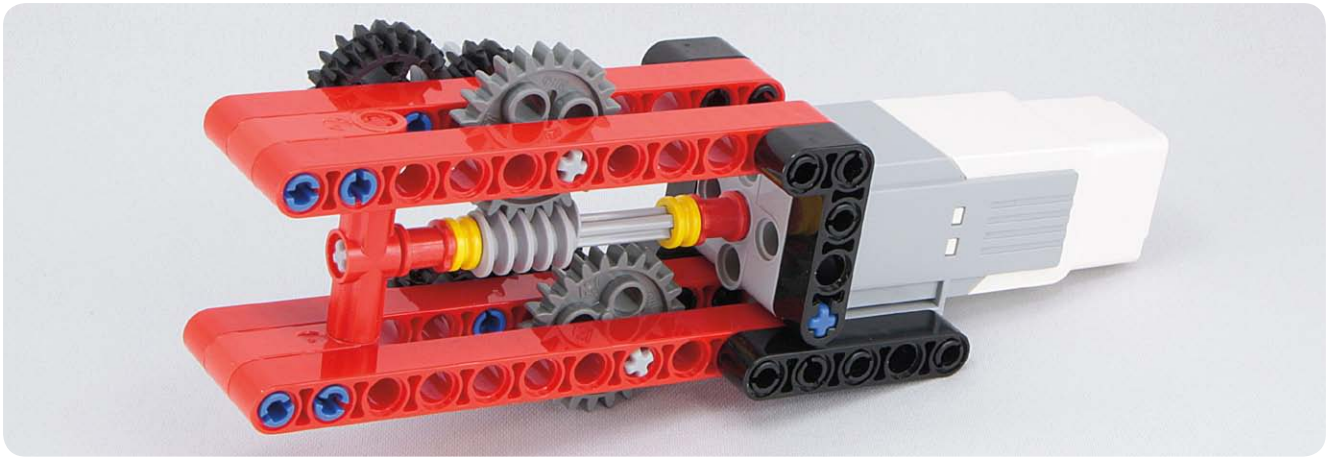
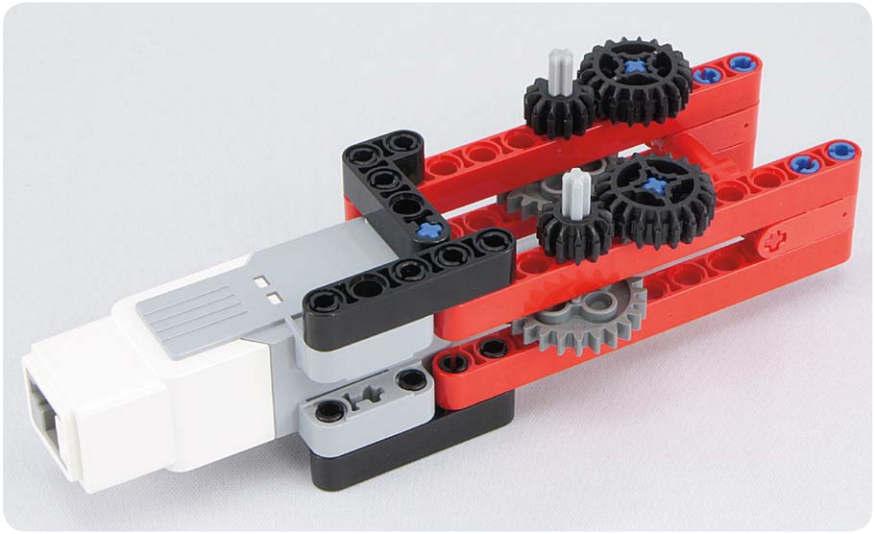
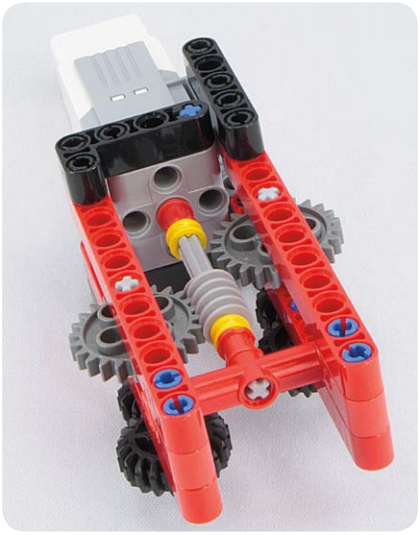


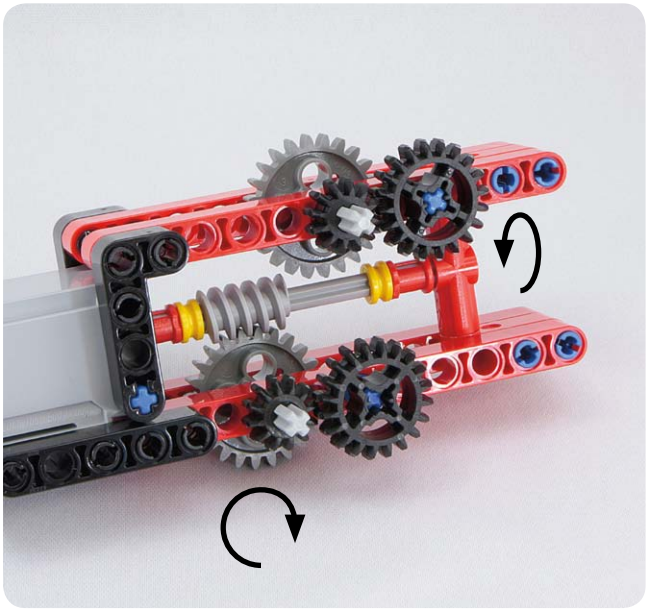


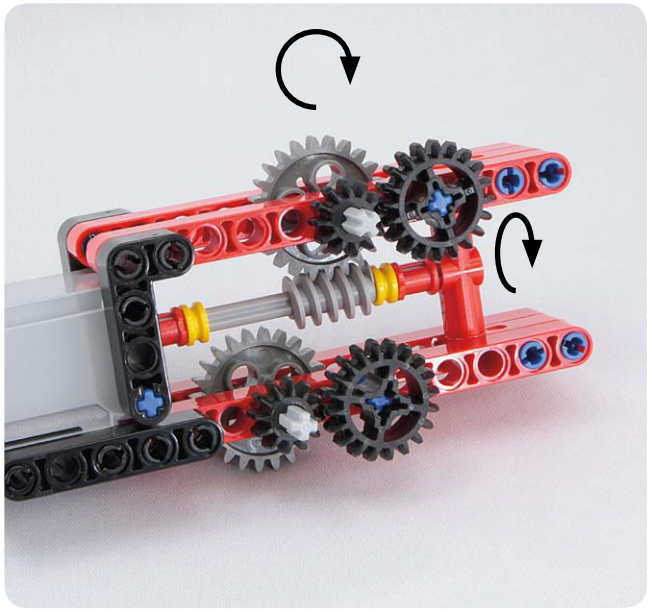






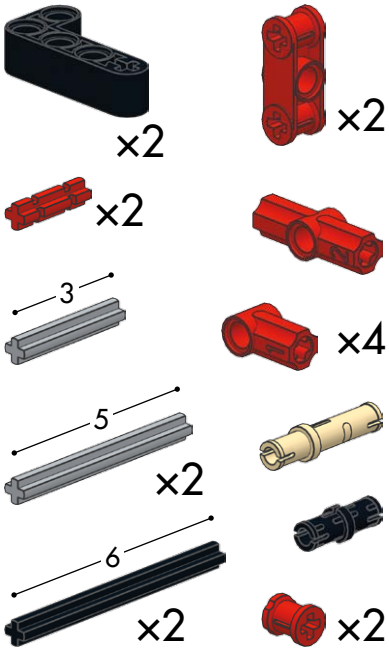






Universal joints

#100



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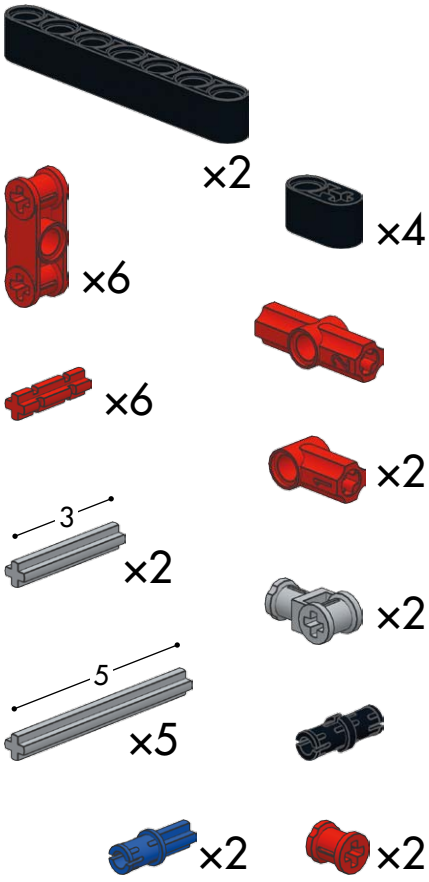






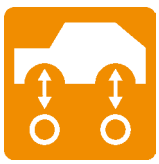


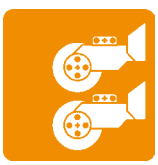





PART 2

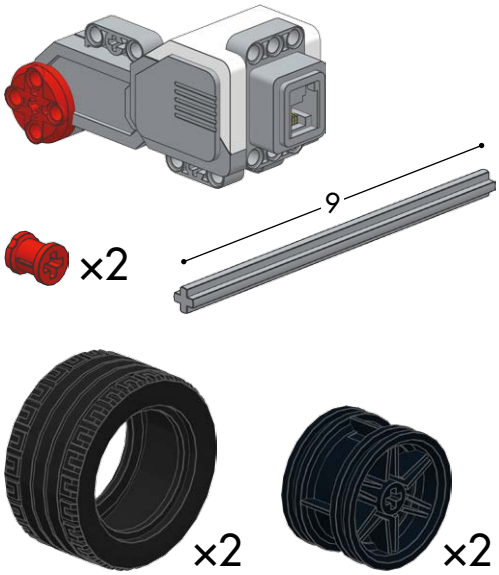
Vehicles

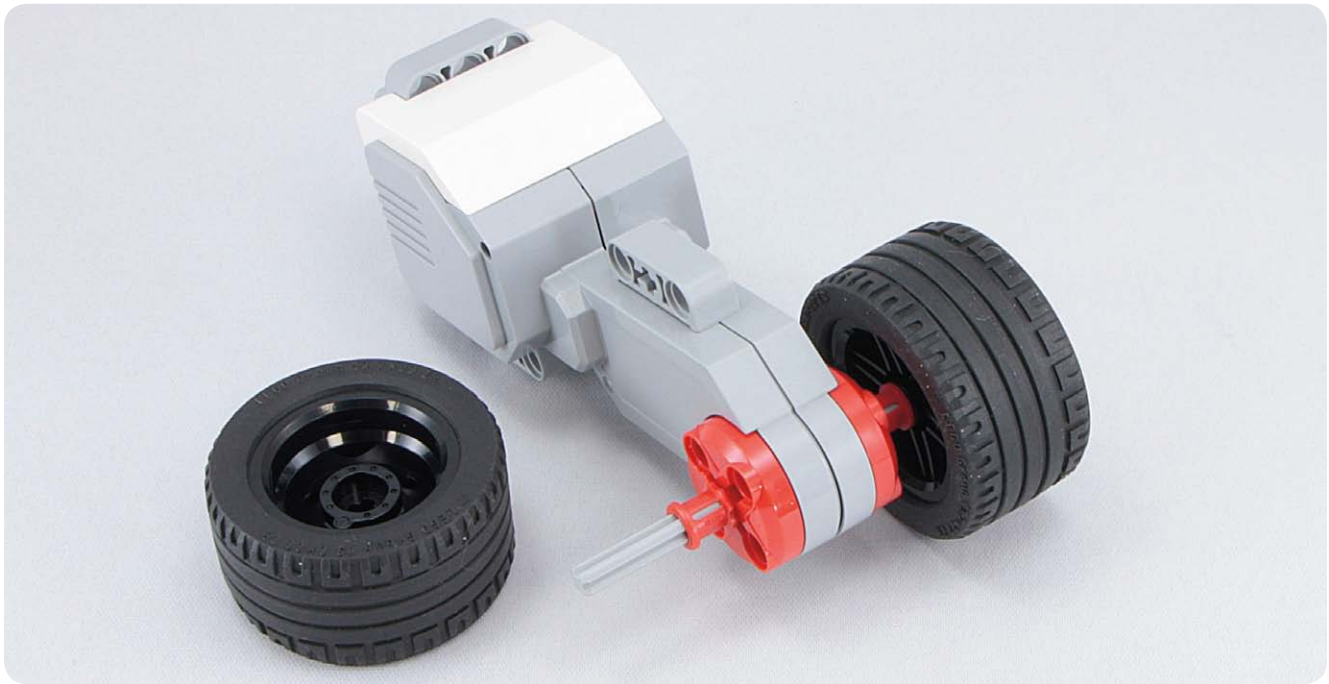




Driving wheels with a motor

#102





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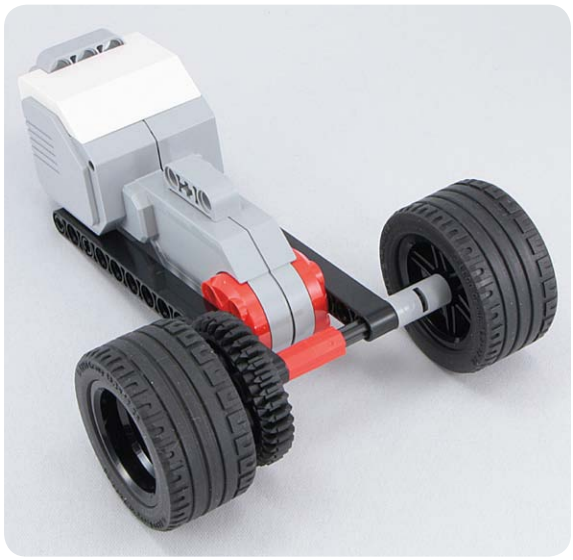

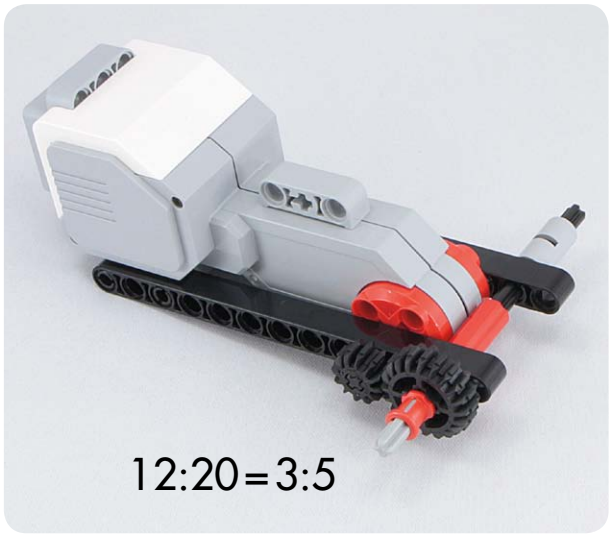

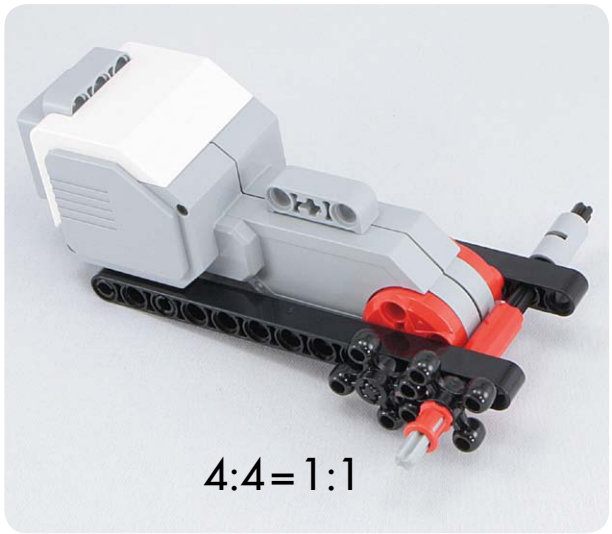

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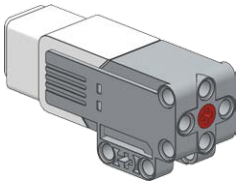

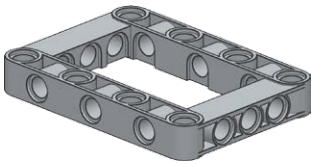

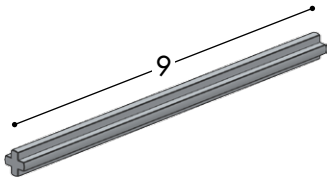

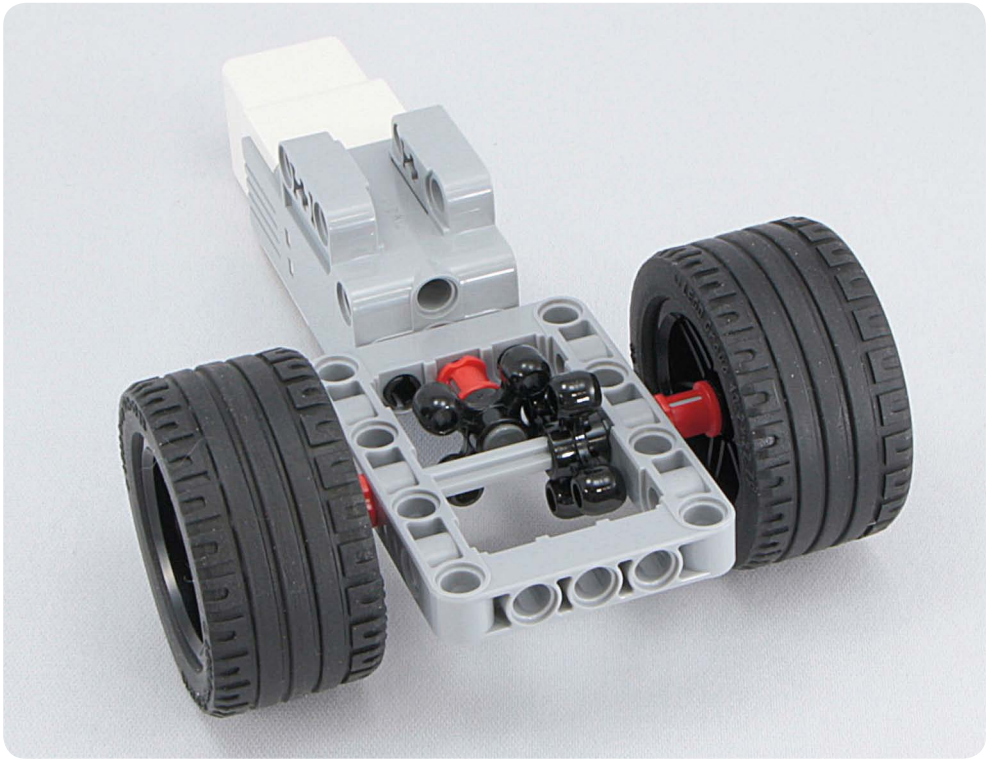

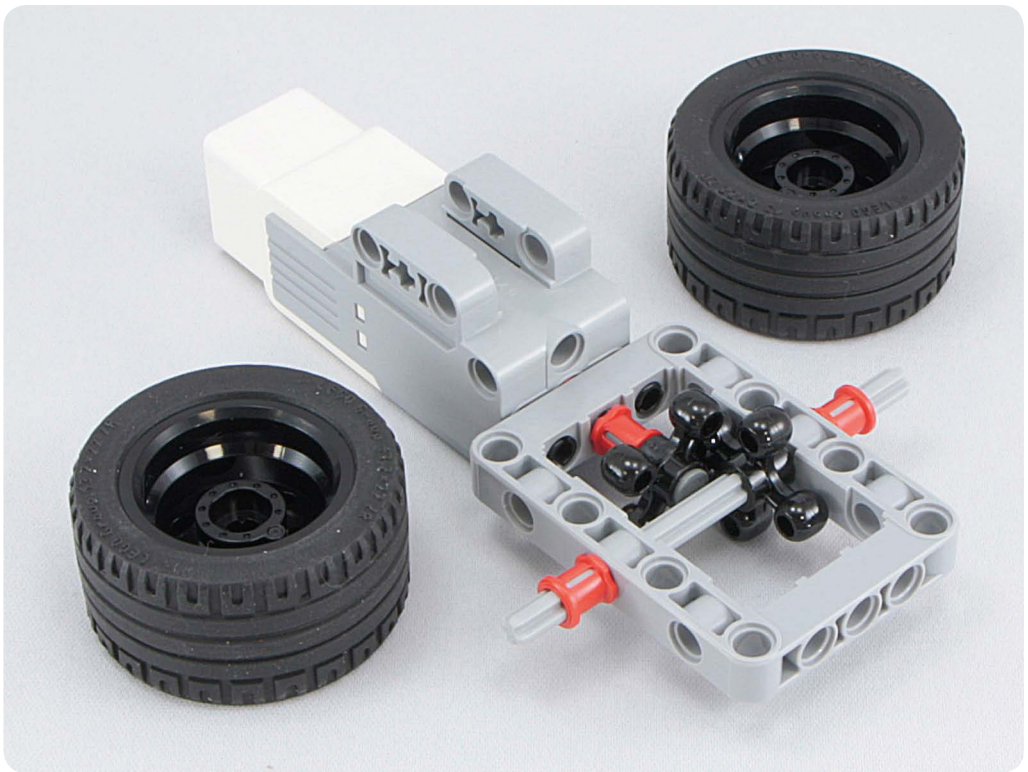

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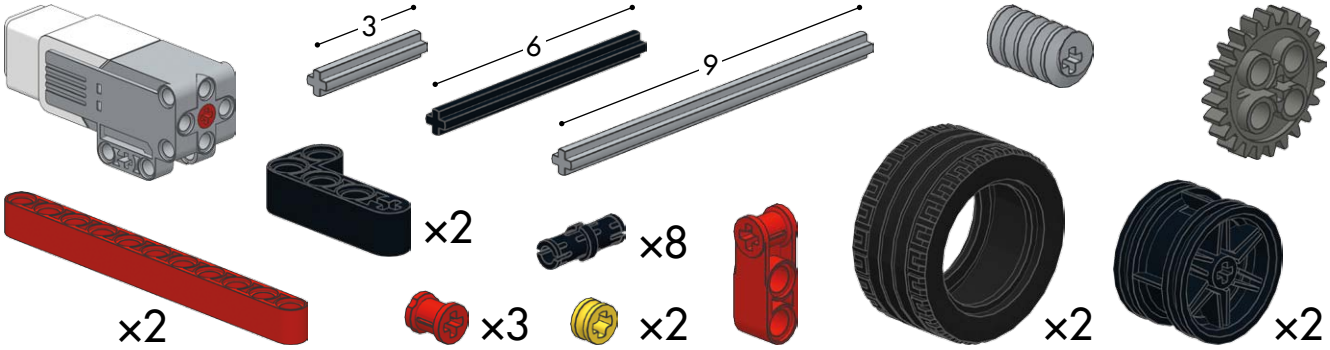
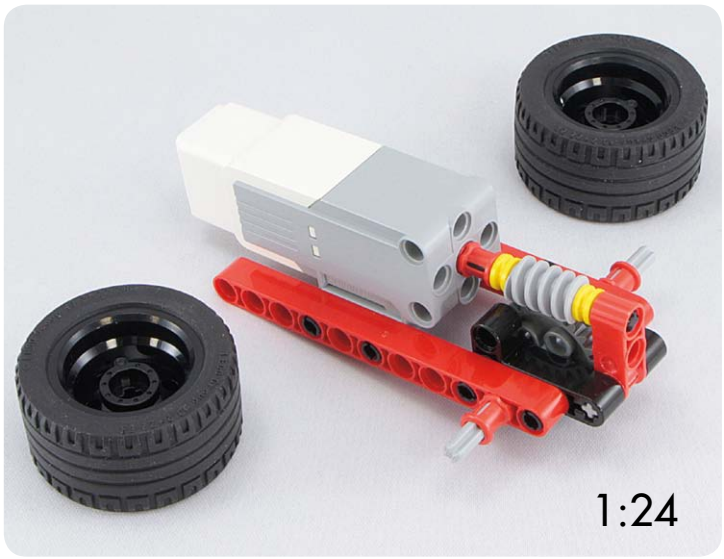
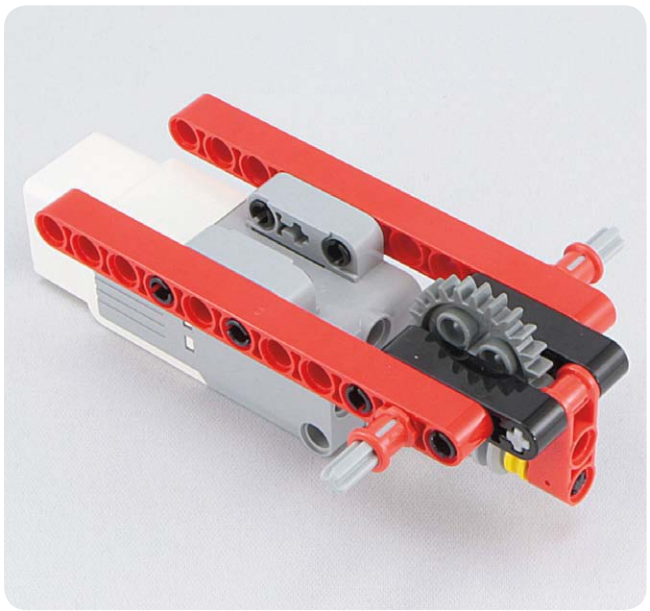
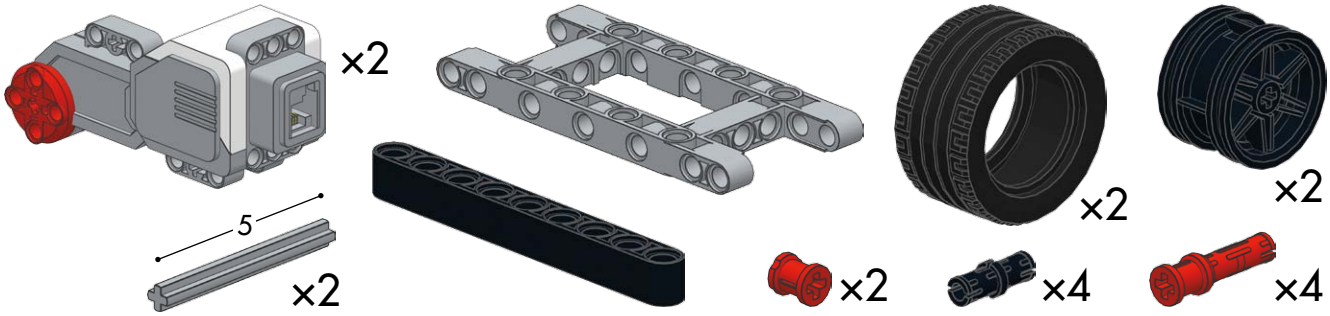


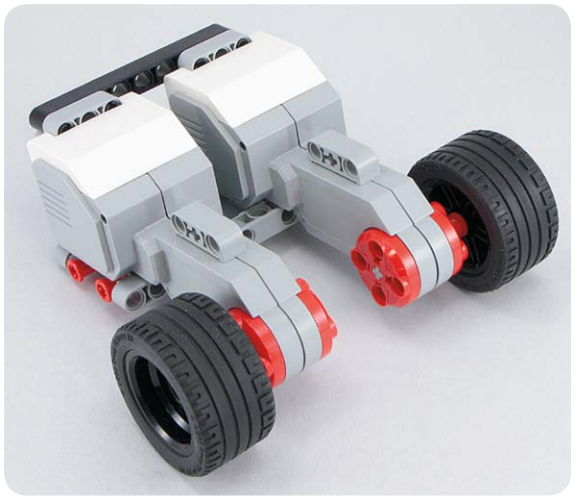


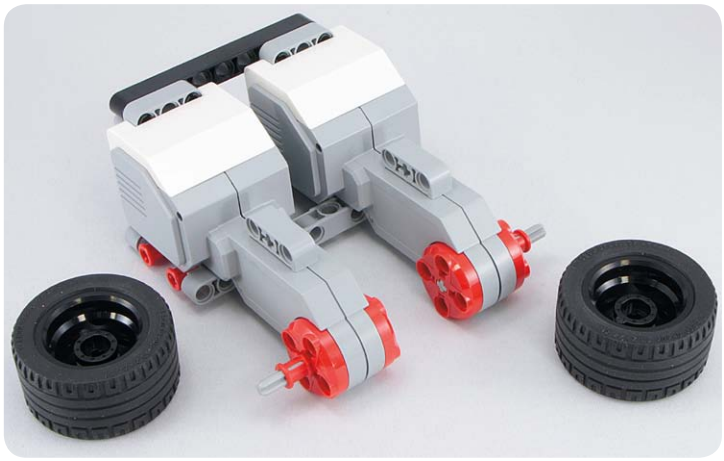


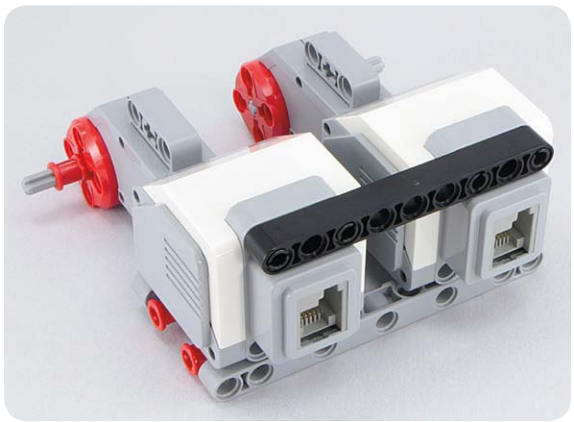
Driving wheels with two motors

#106









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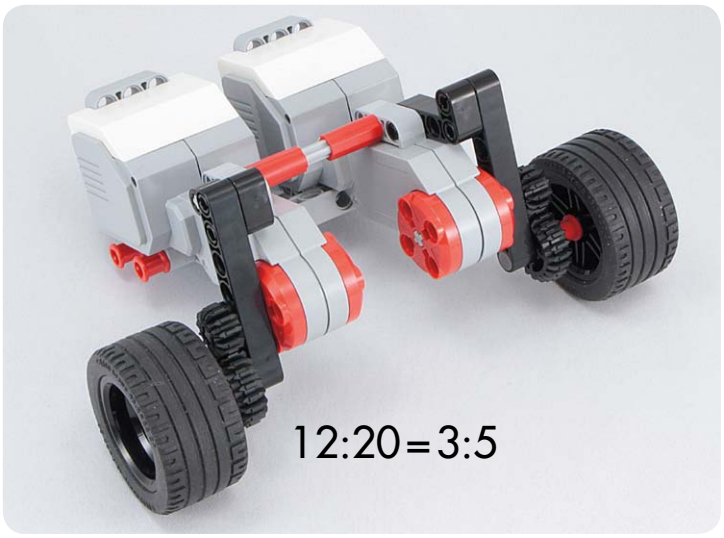

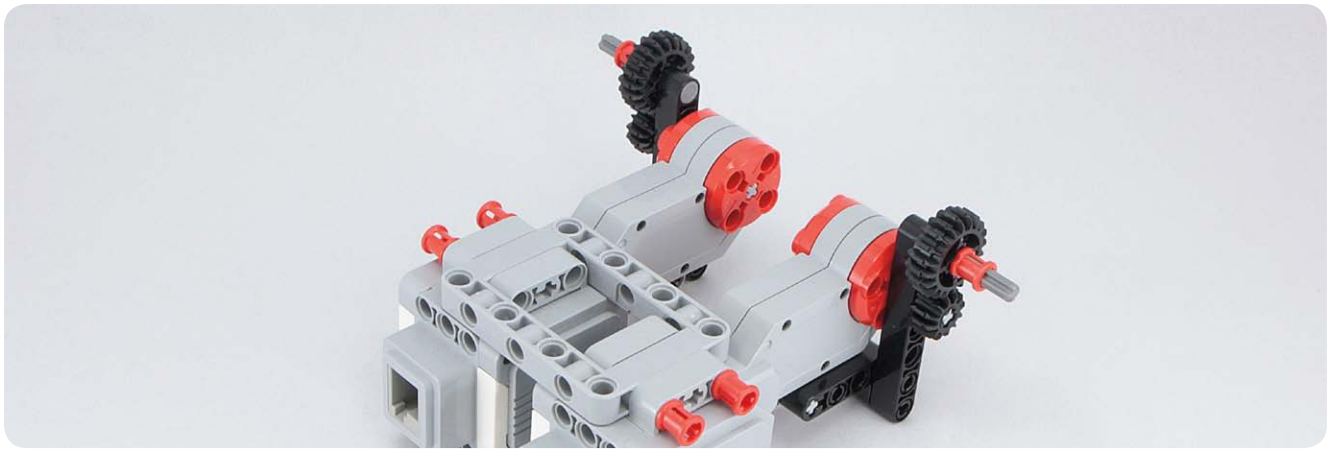

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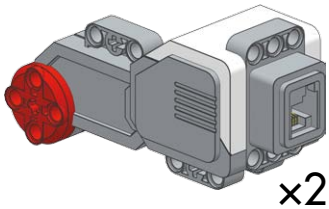
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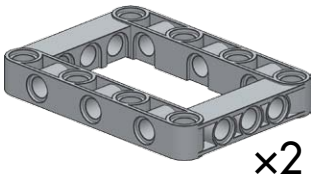
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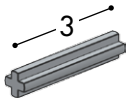

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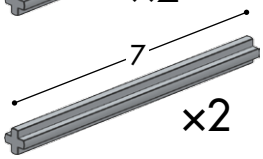

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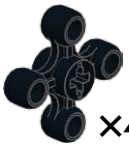
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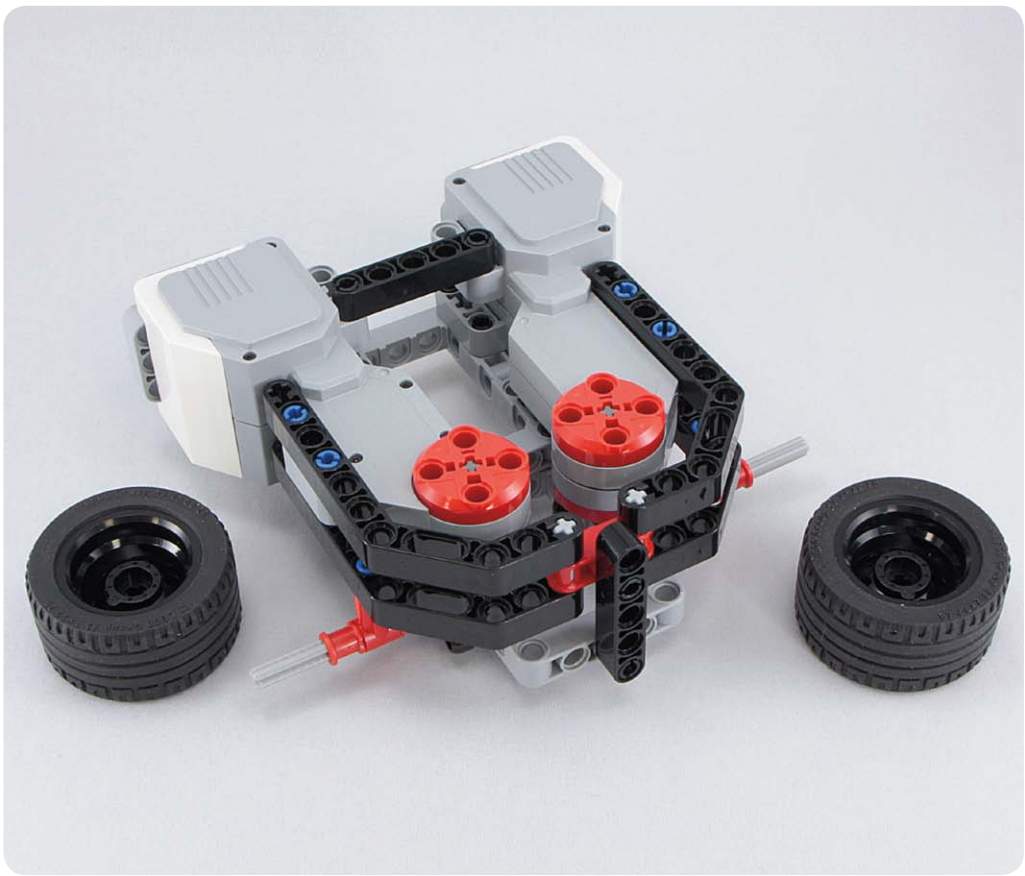

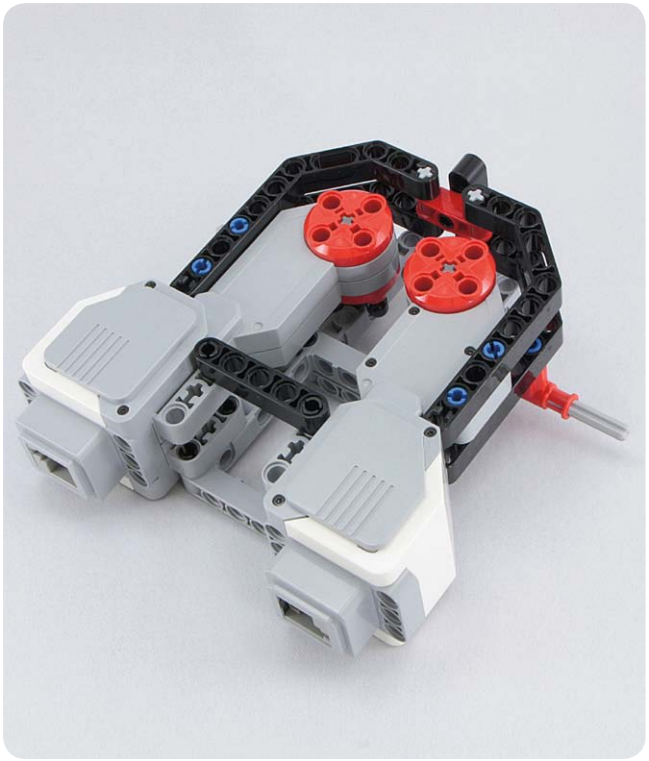

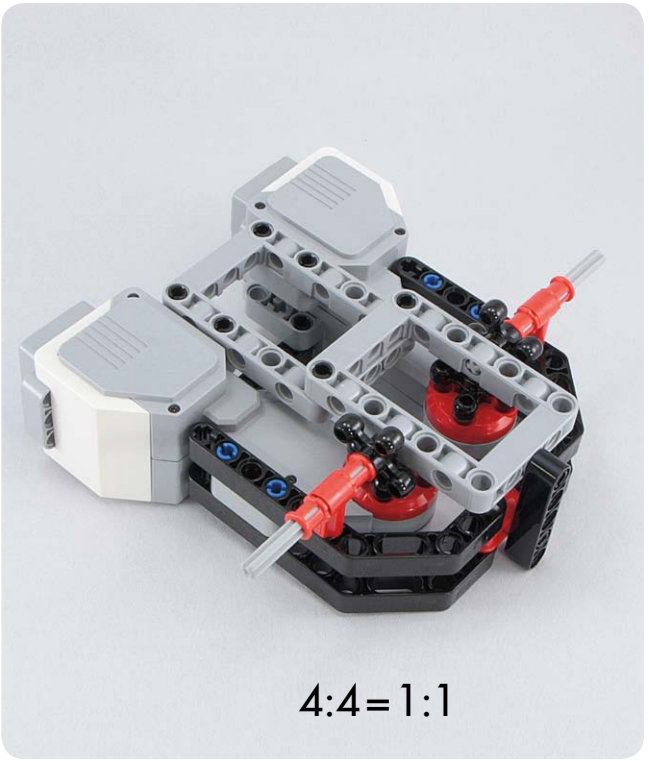

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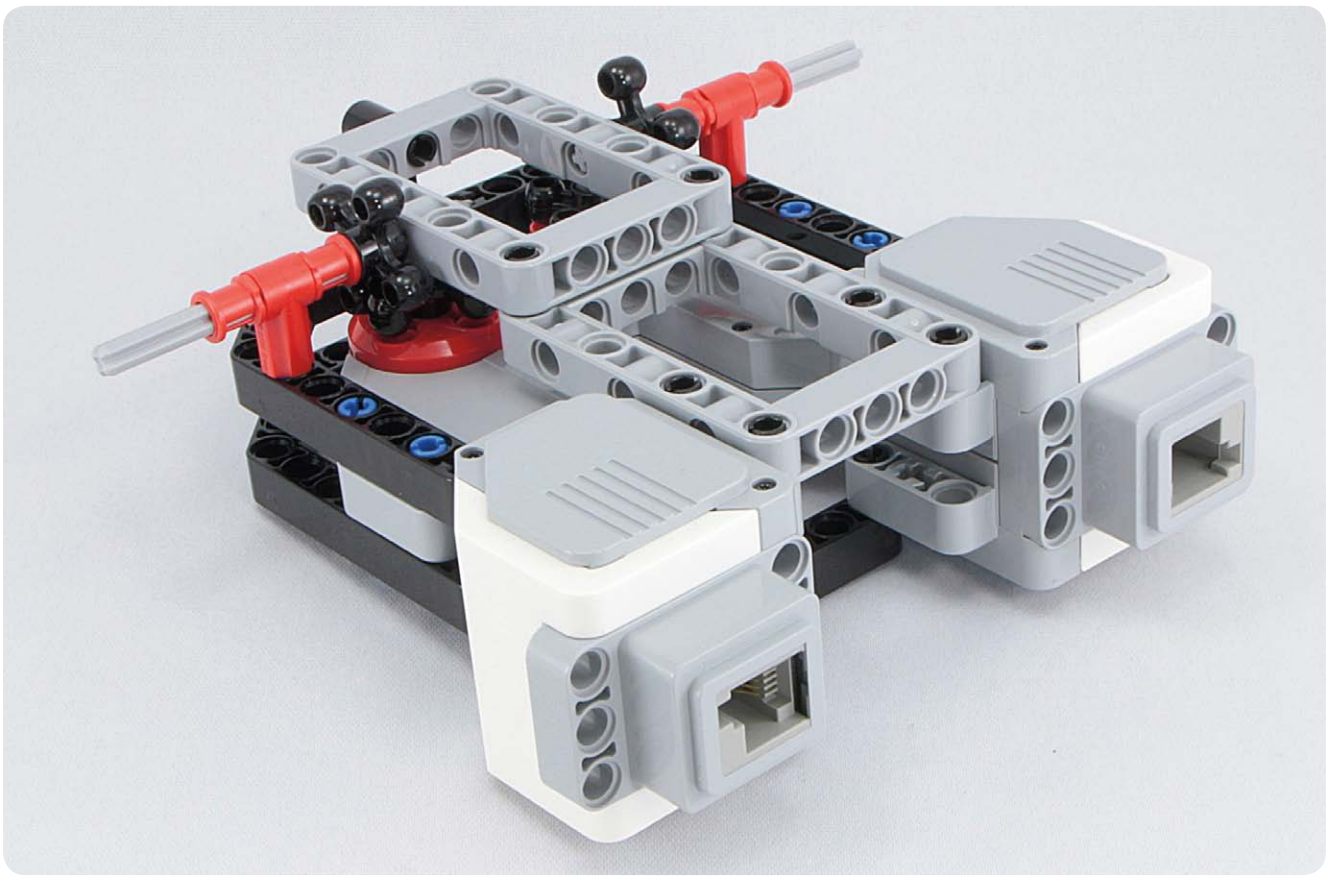

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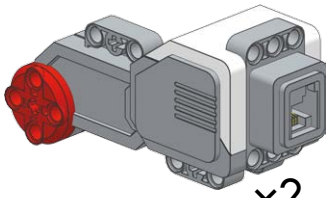
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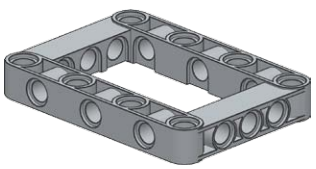


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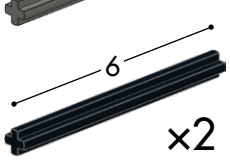

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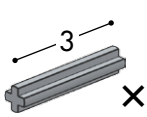

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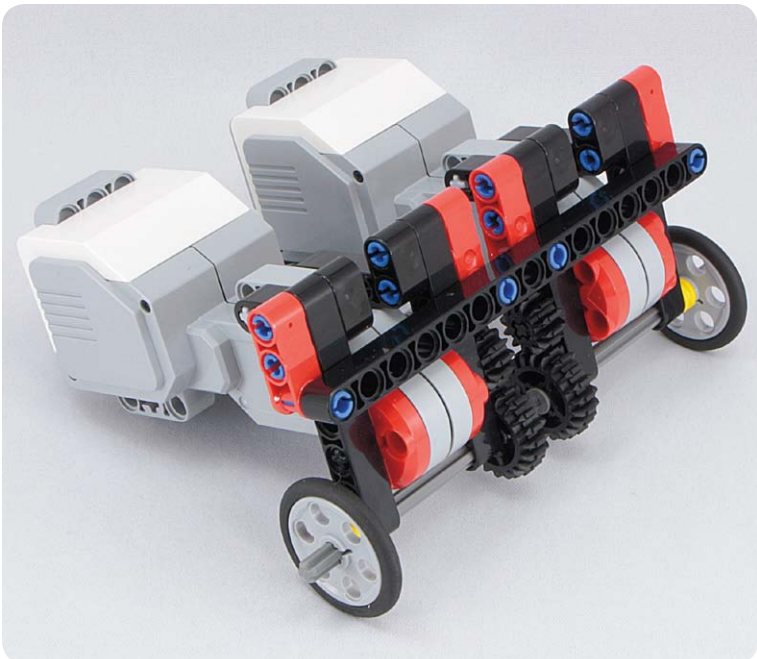

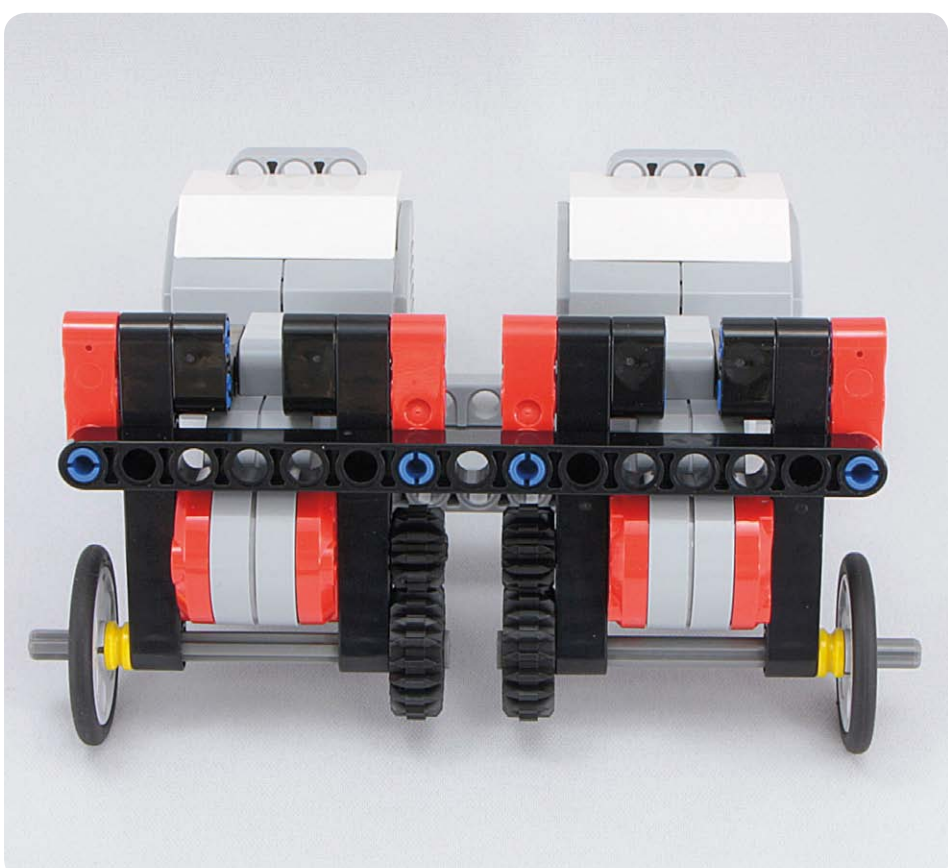


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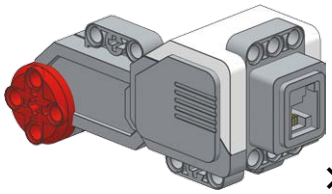

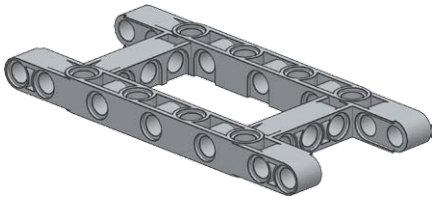

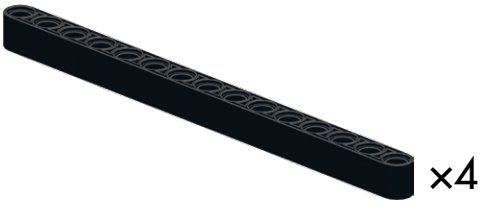

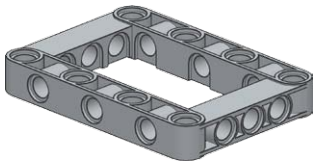

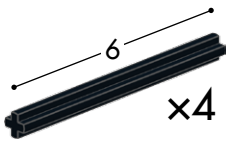

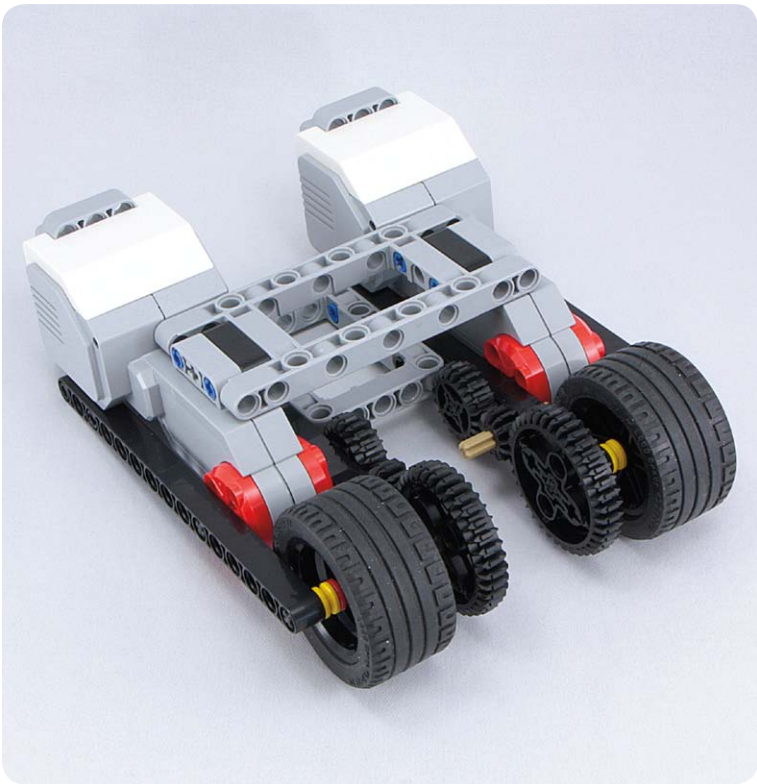

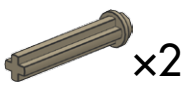

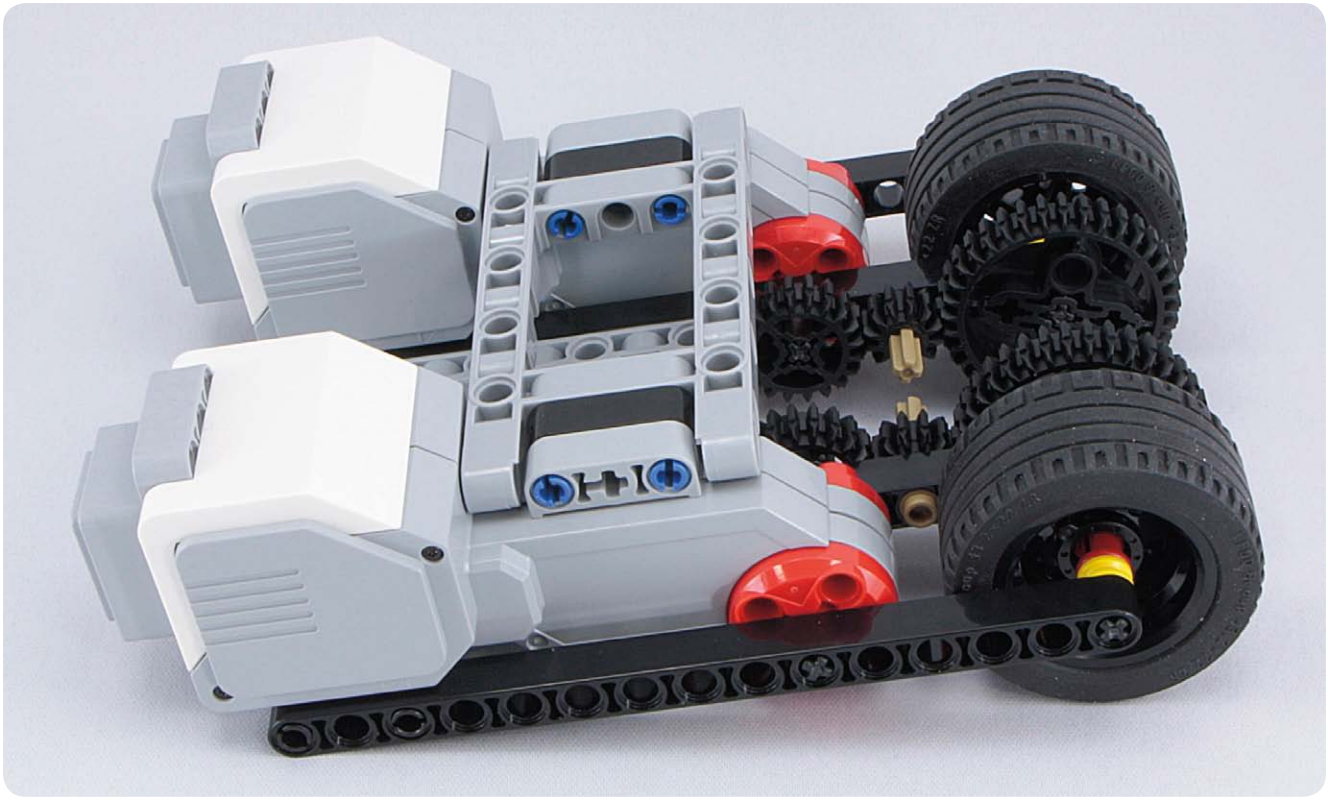


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Caster wheels

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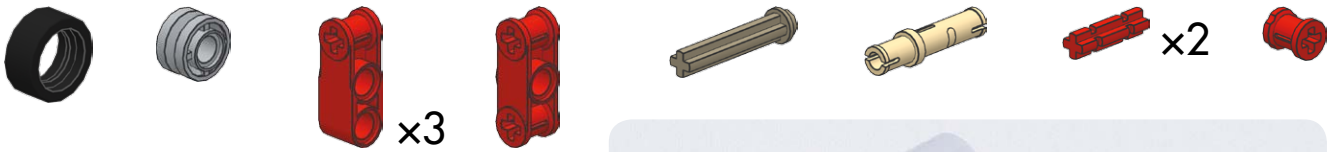

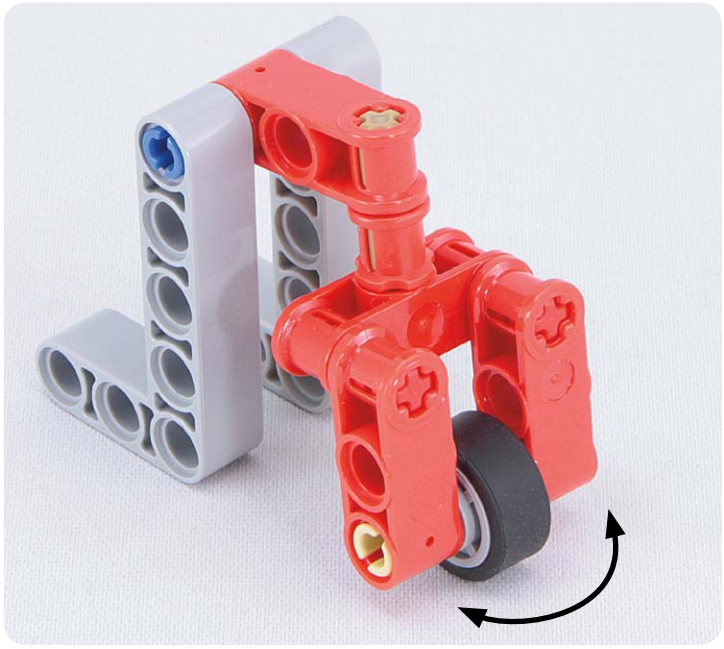

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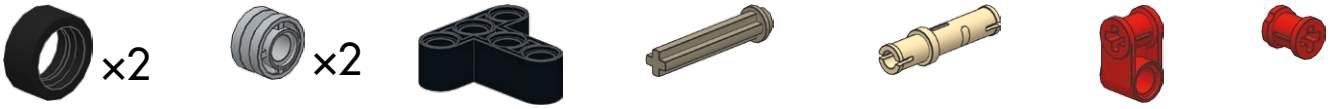

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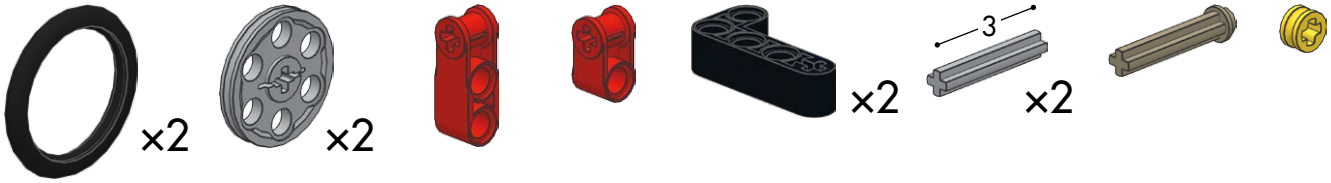

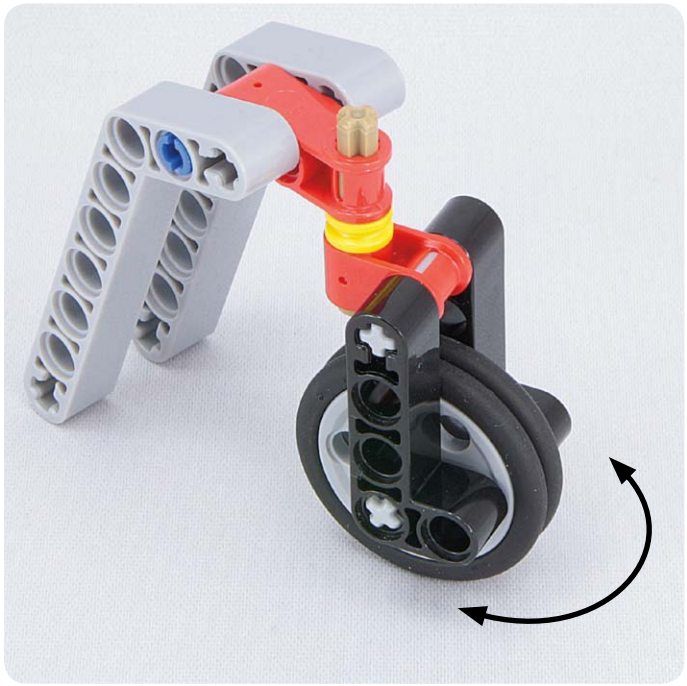

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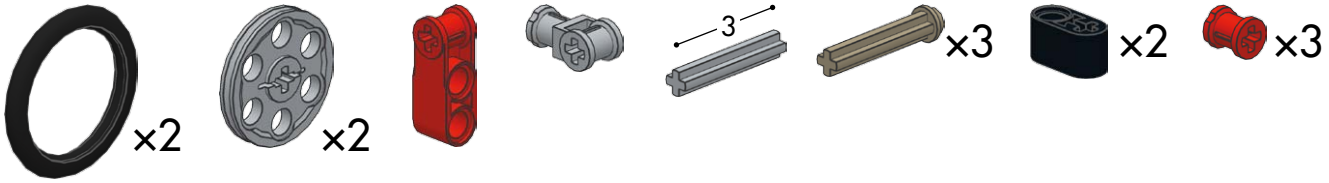

Crawlers

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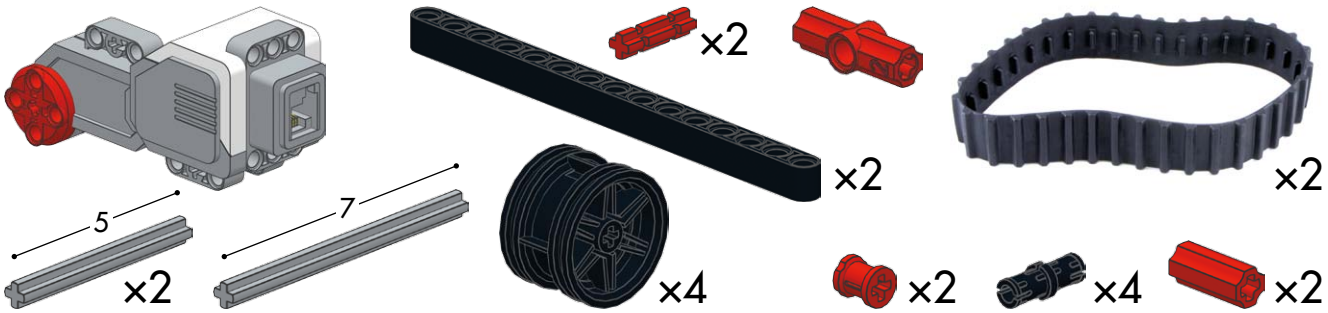

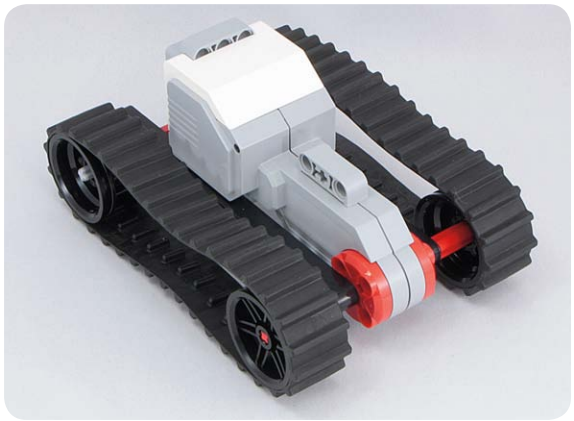

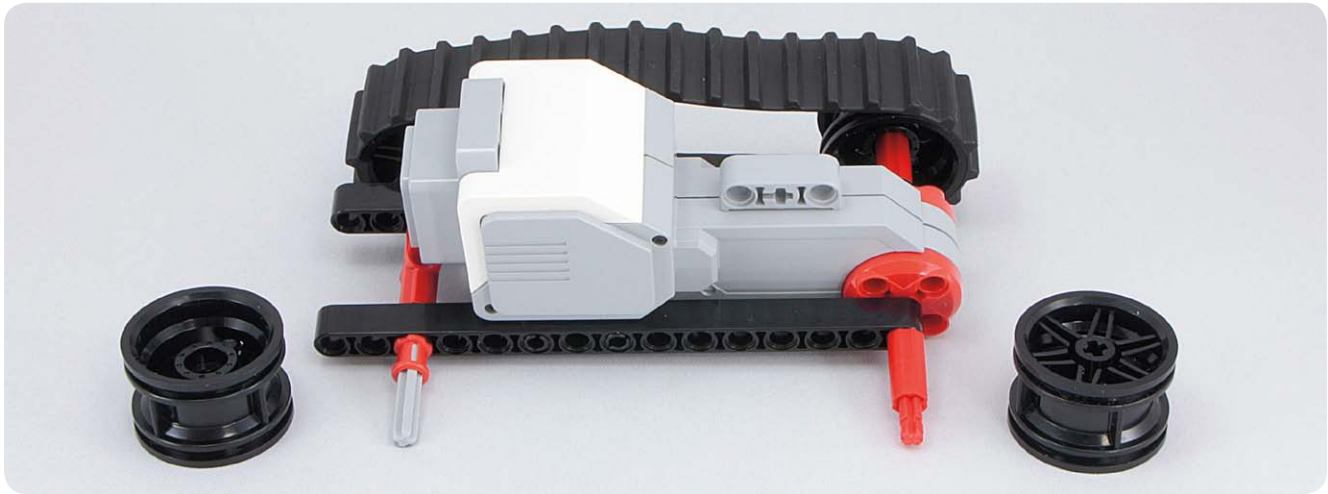

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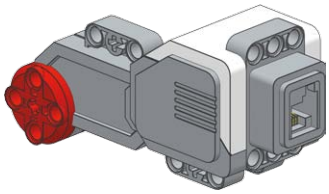

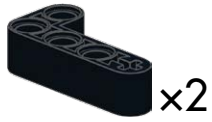

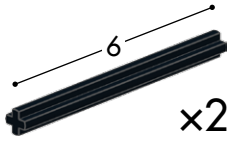

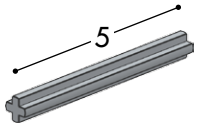

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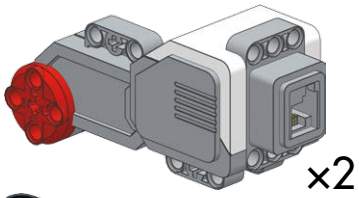
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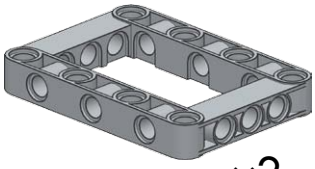
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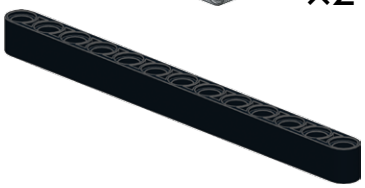
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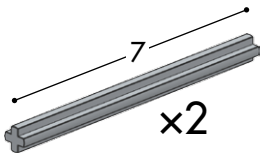

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×4


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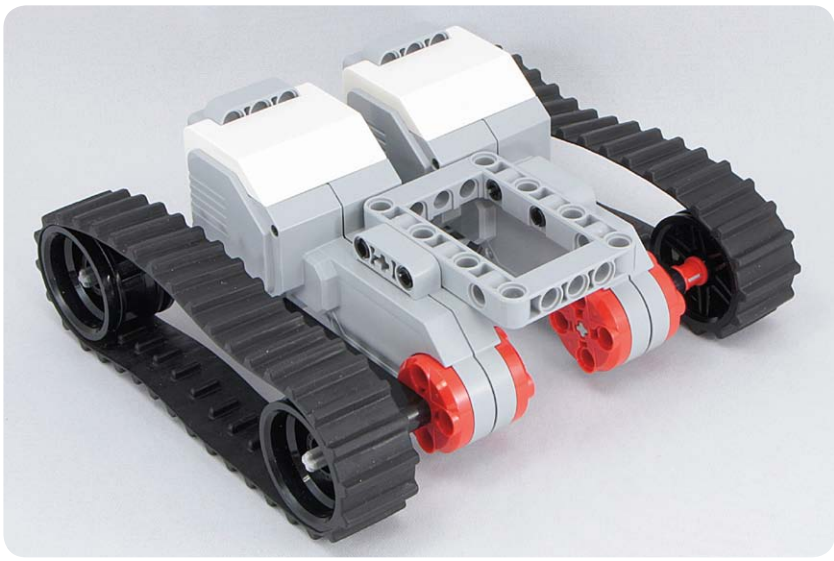
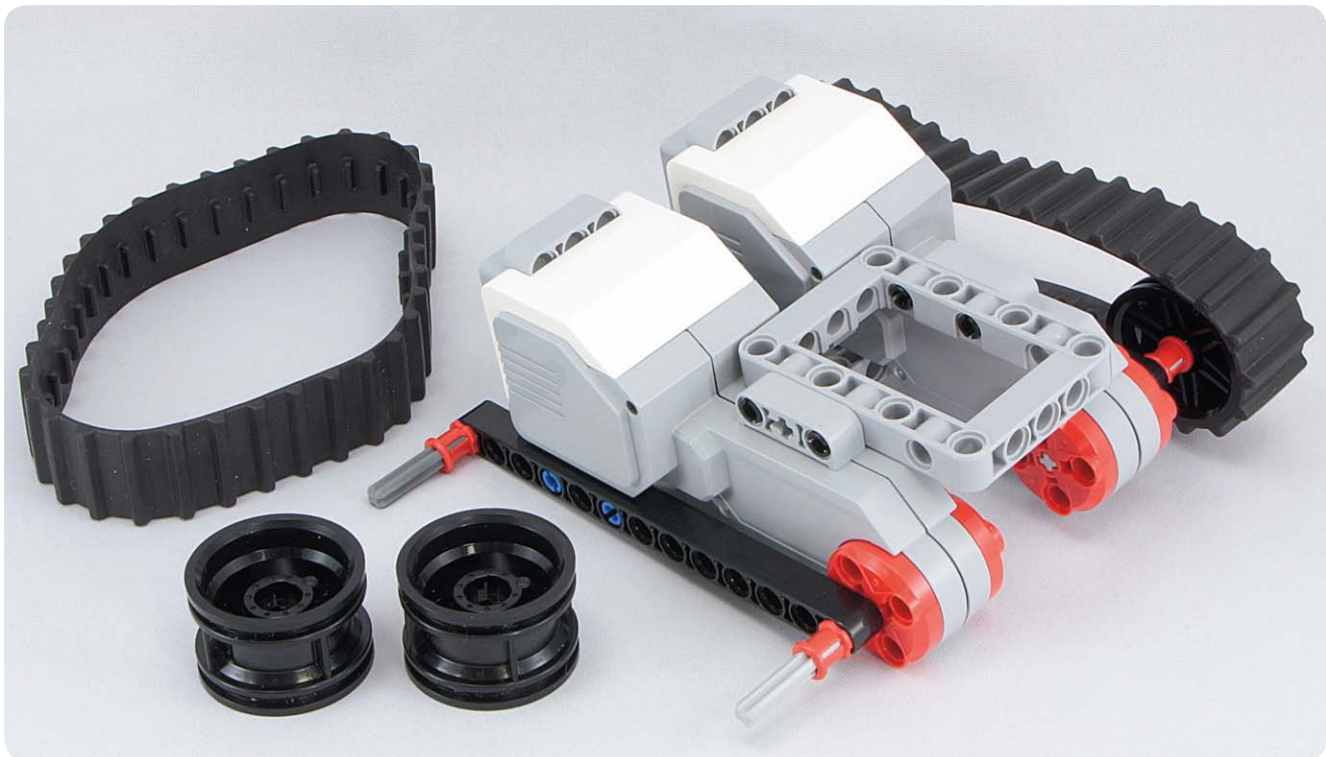
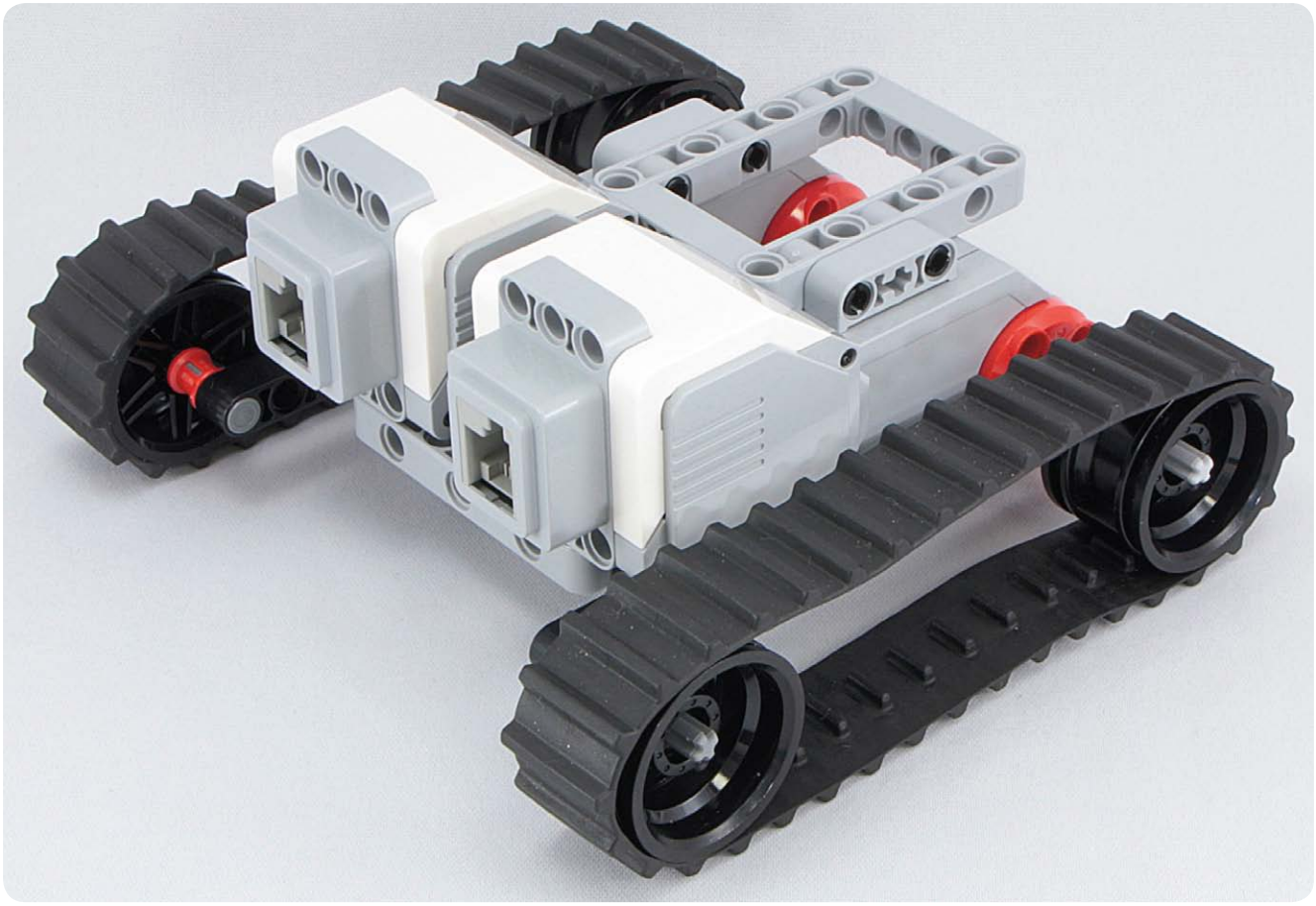
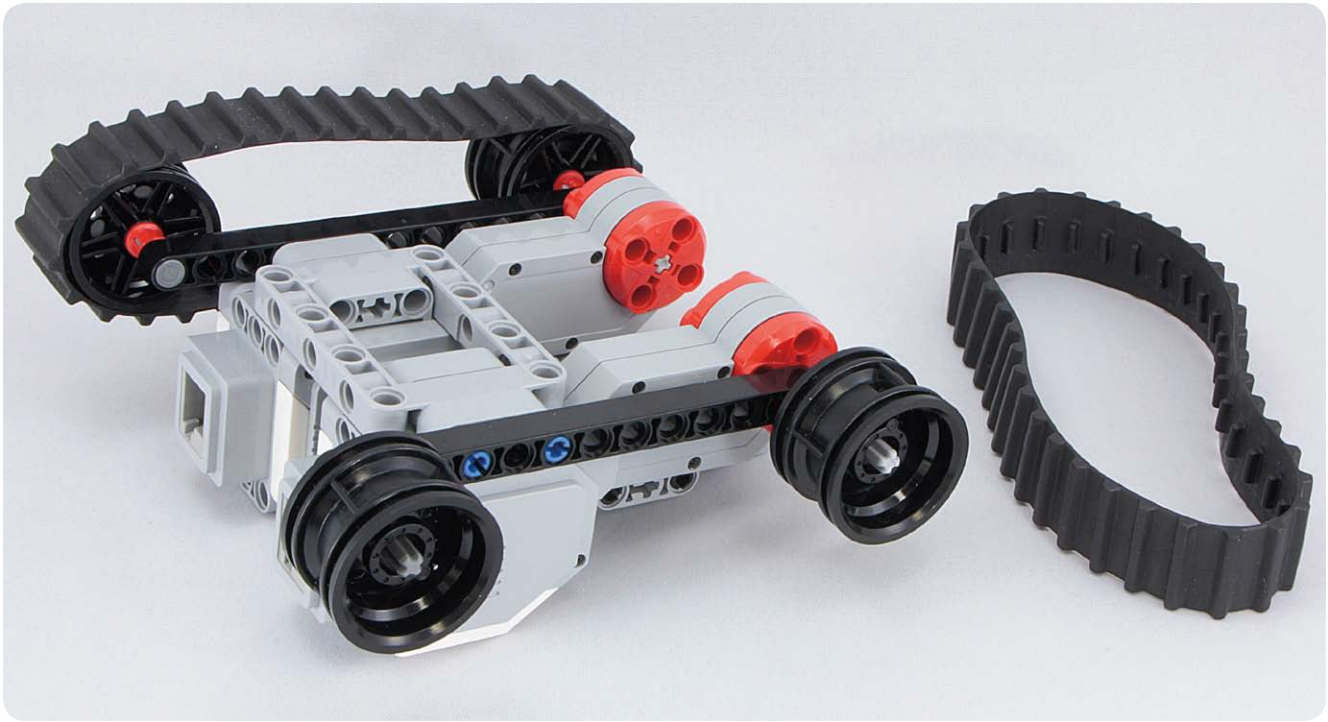
×4









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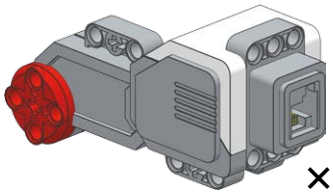
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×2


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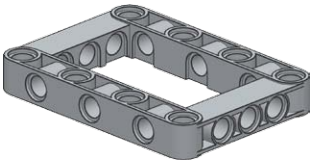

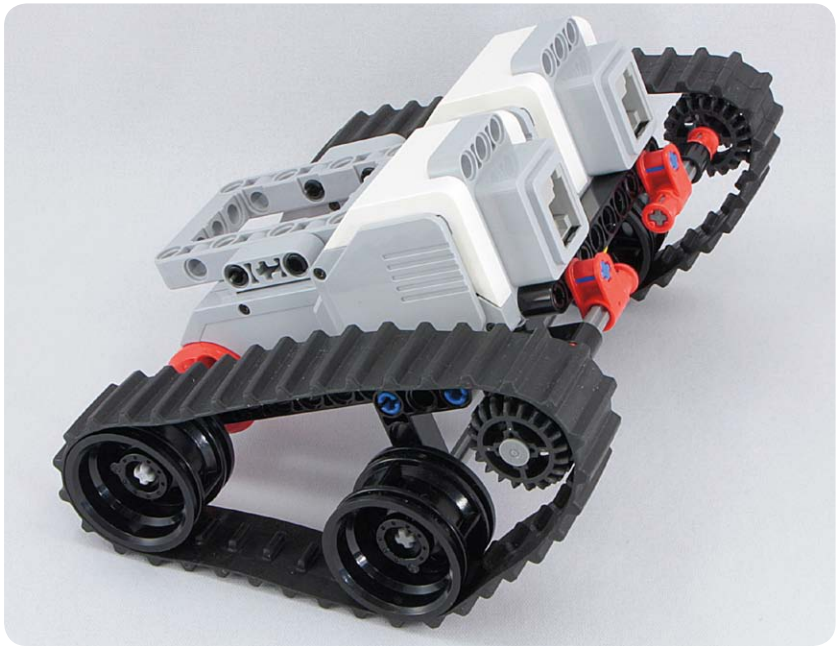

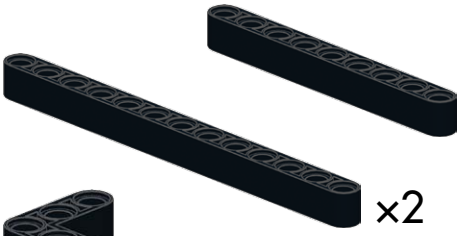
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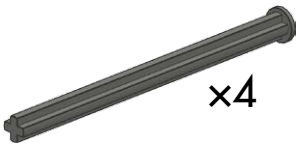
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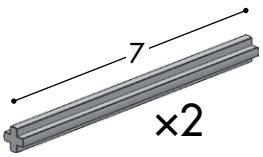
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×2


×4


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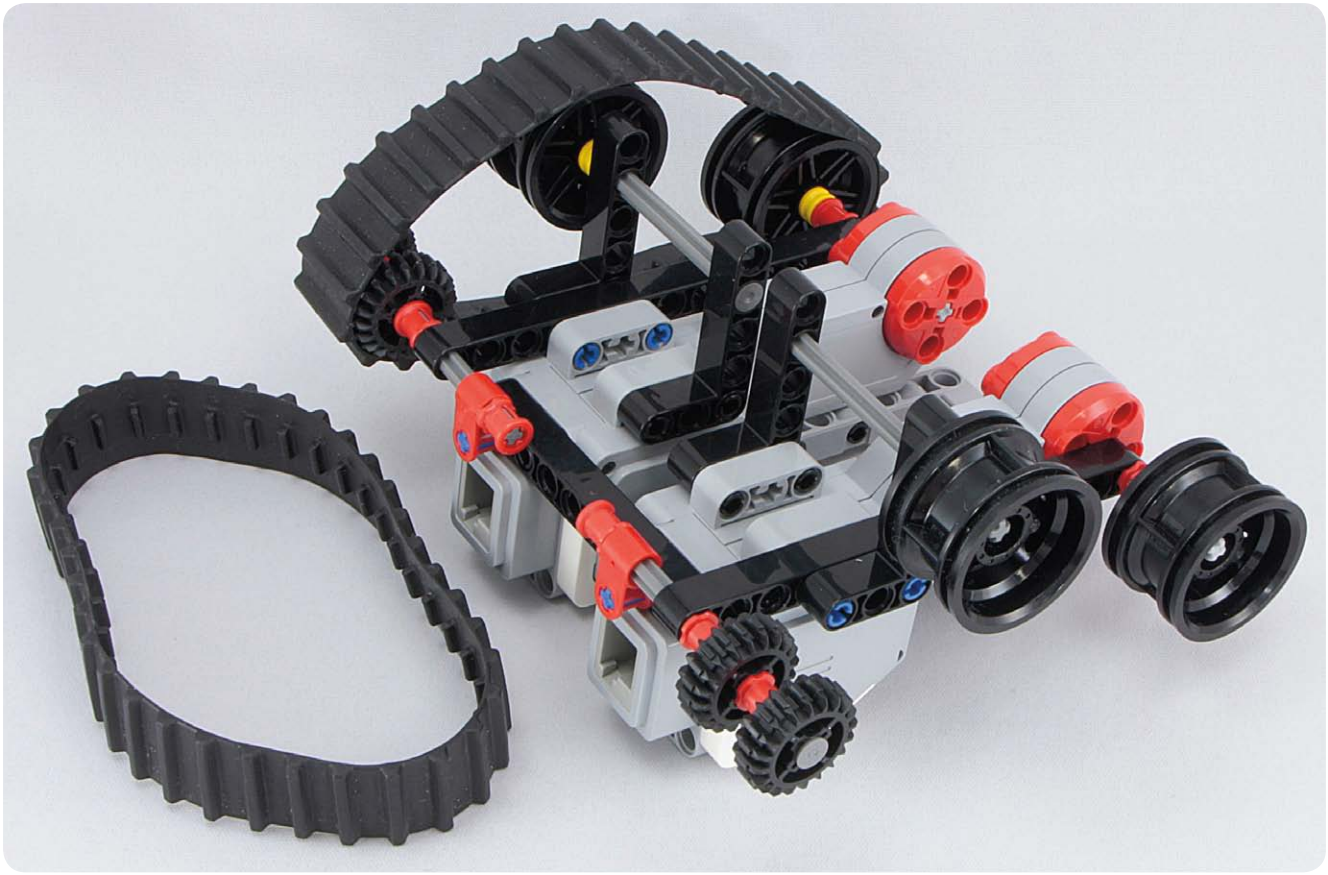
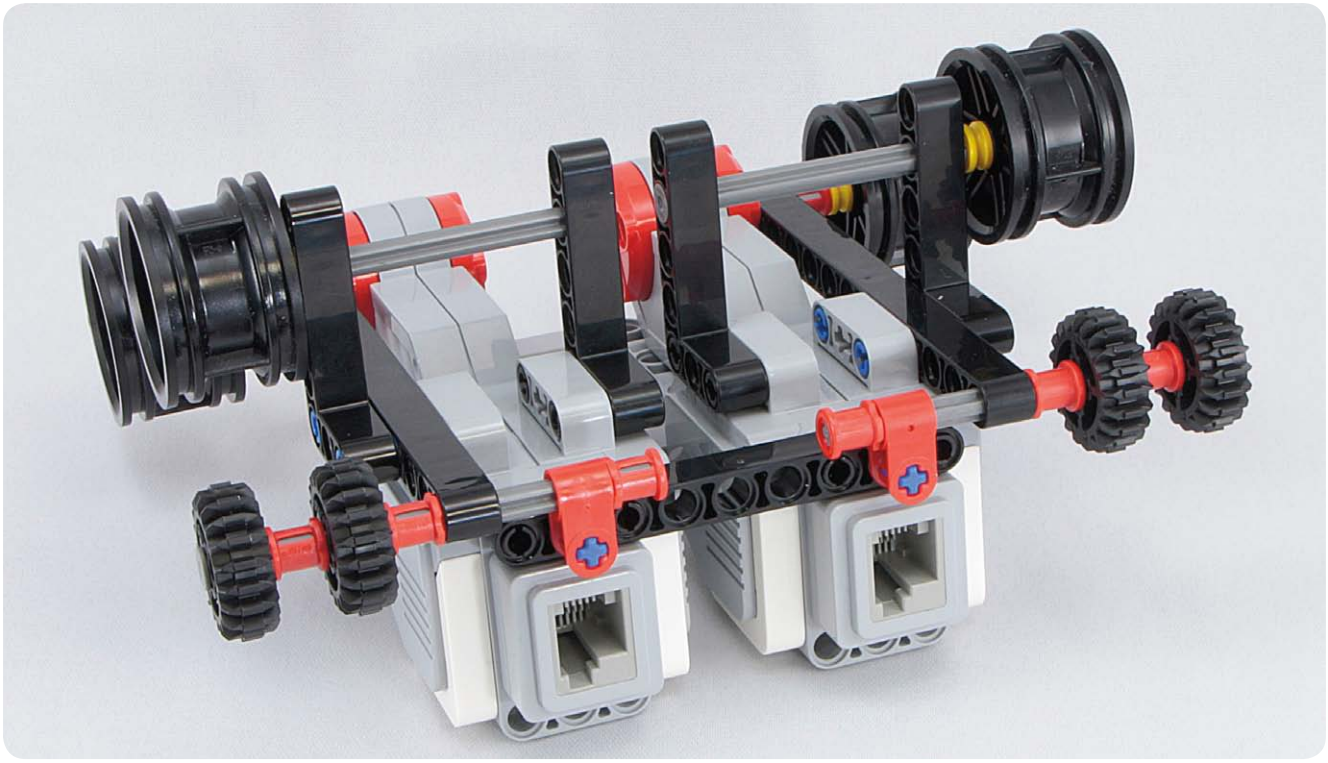
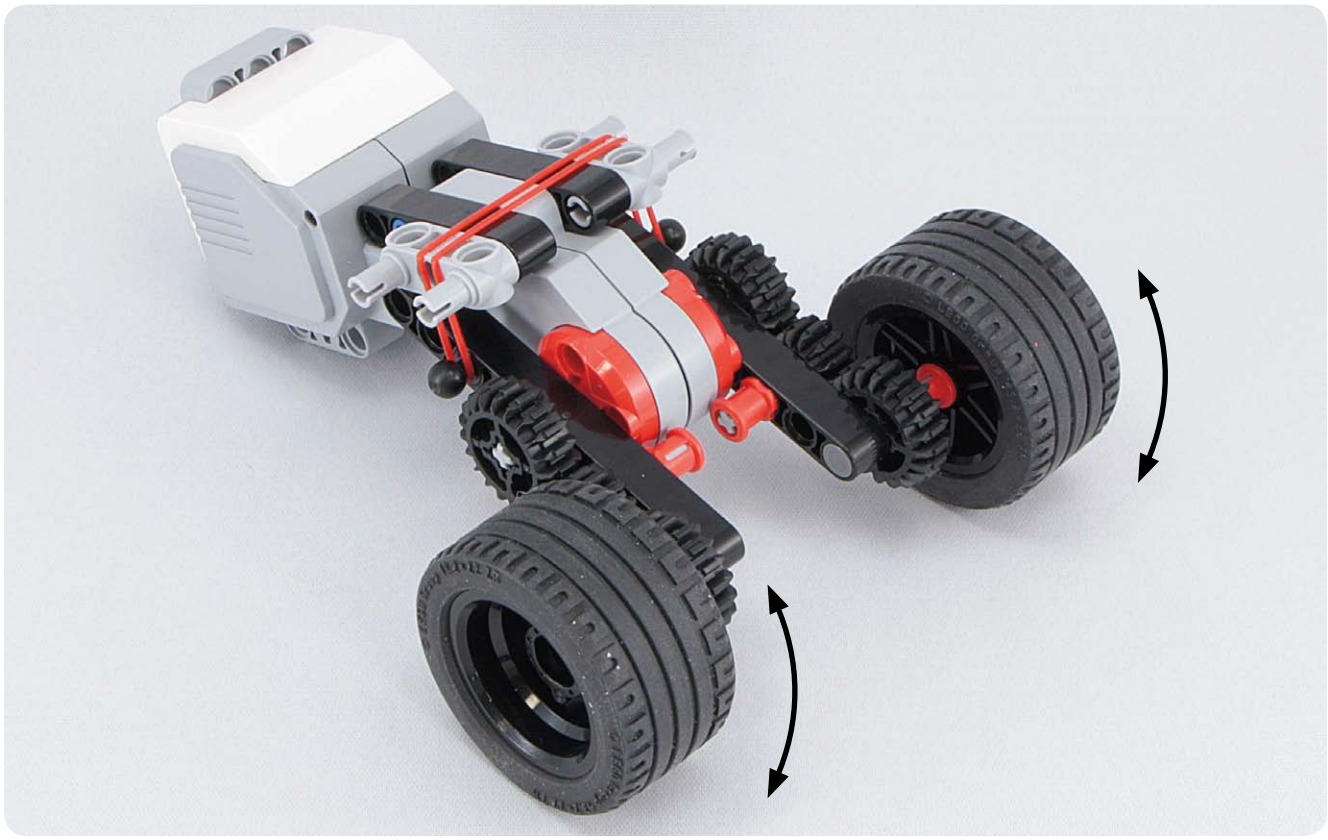
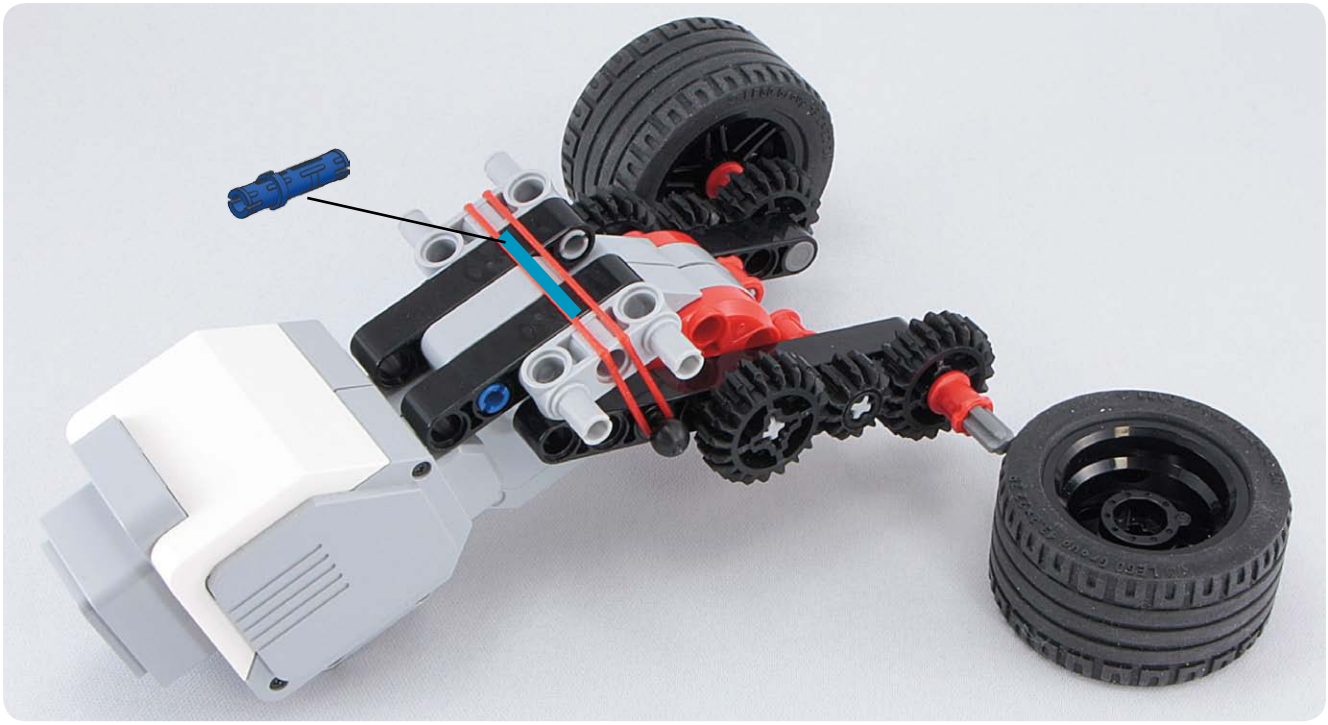


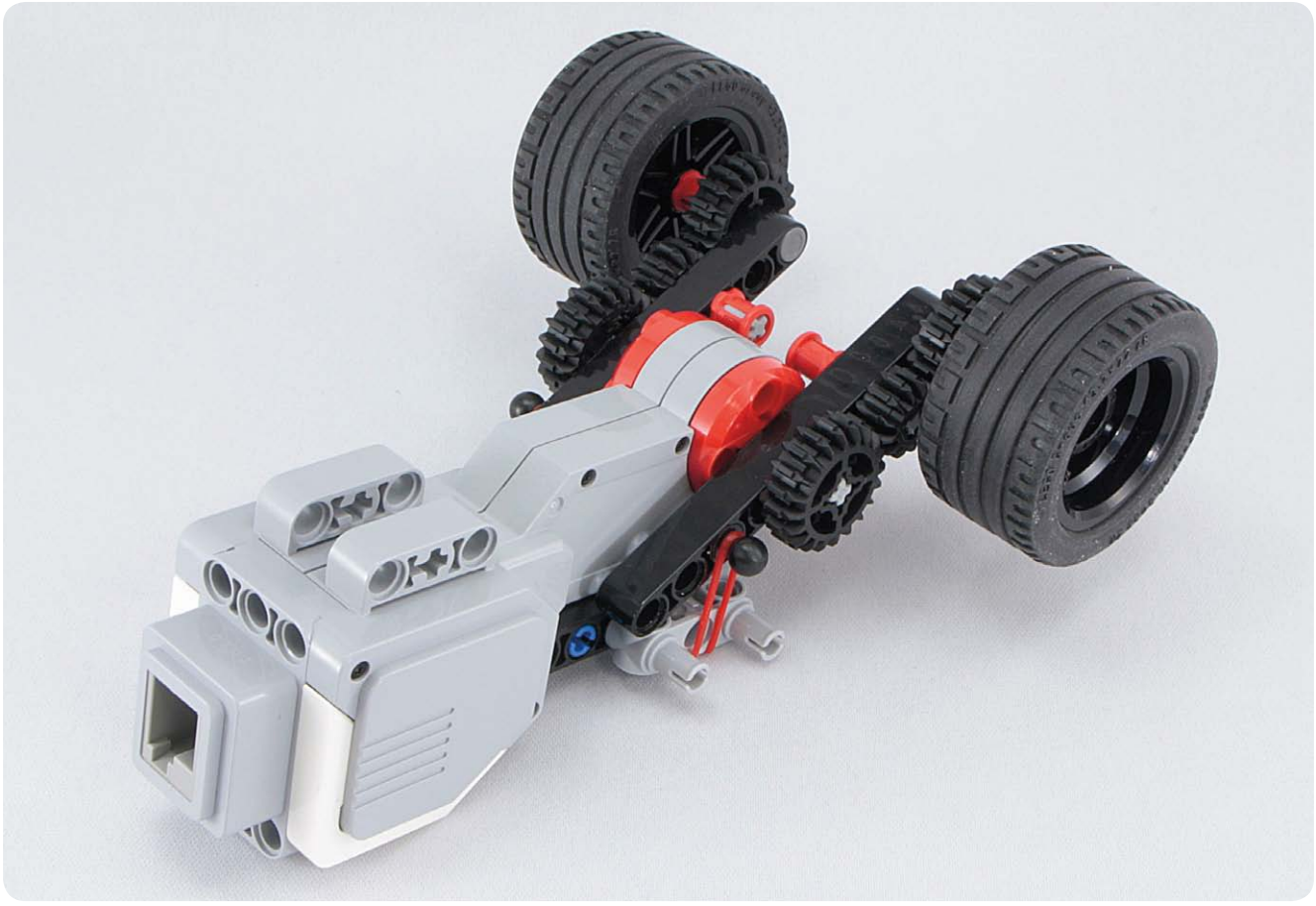


Suspended wheels

#119







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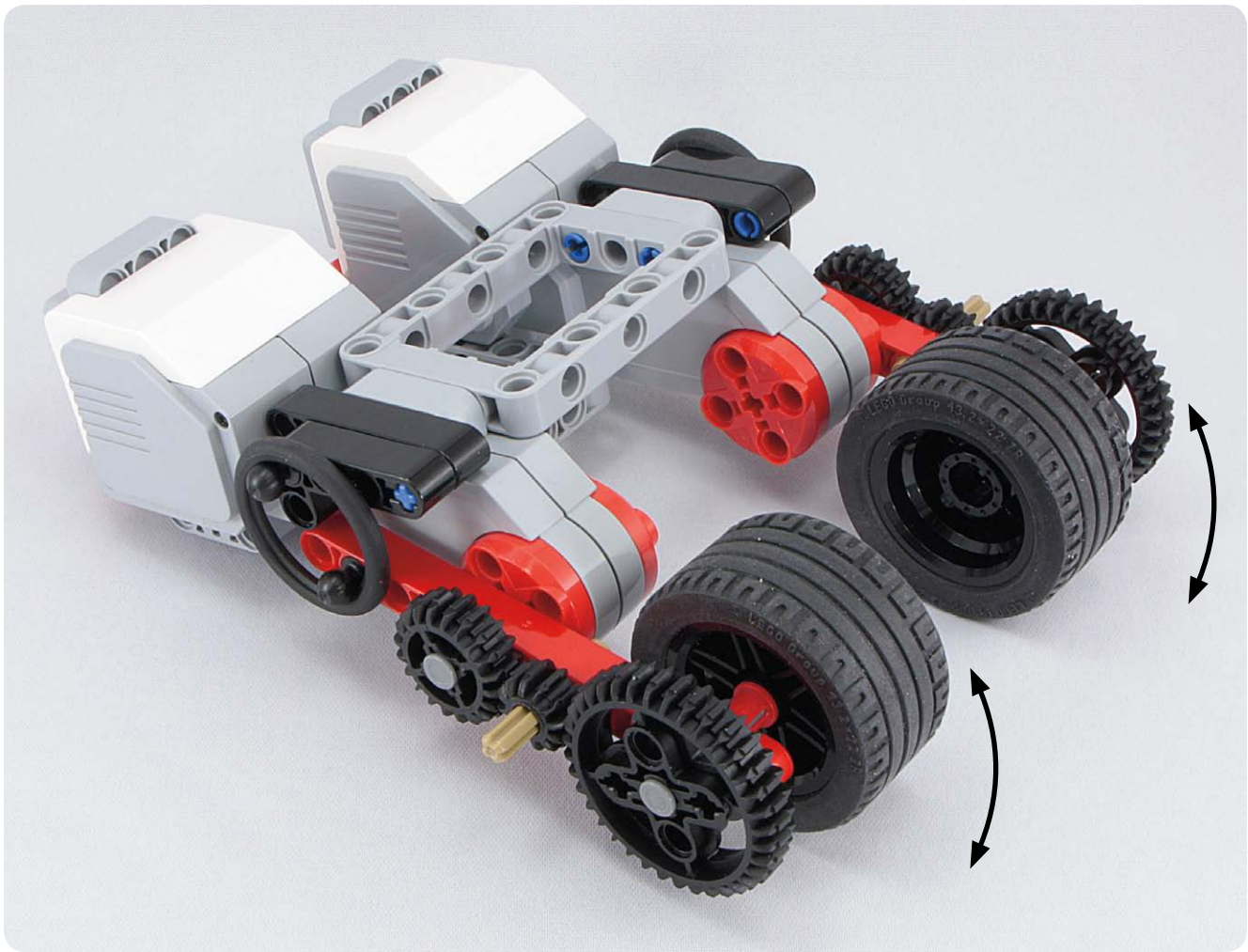

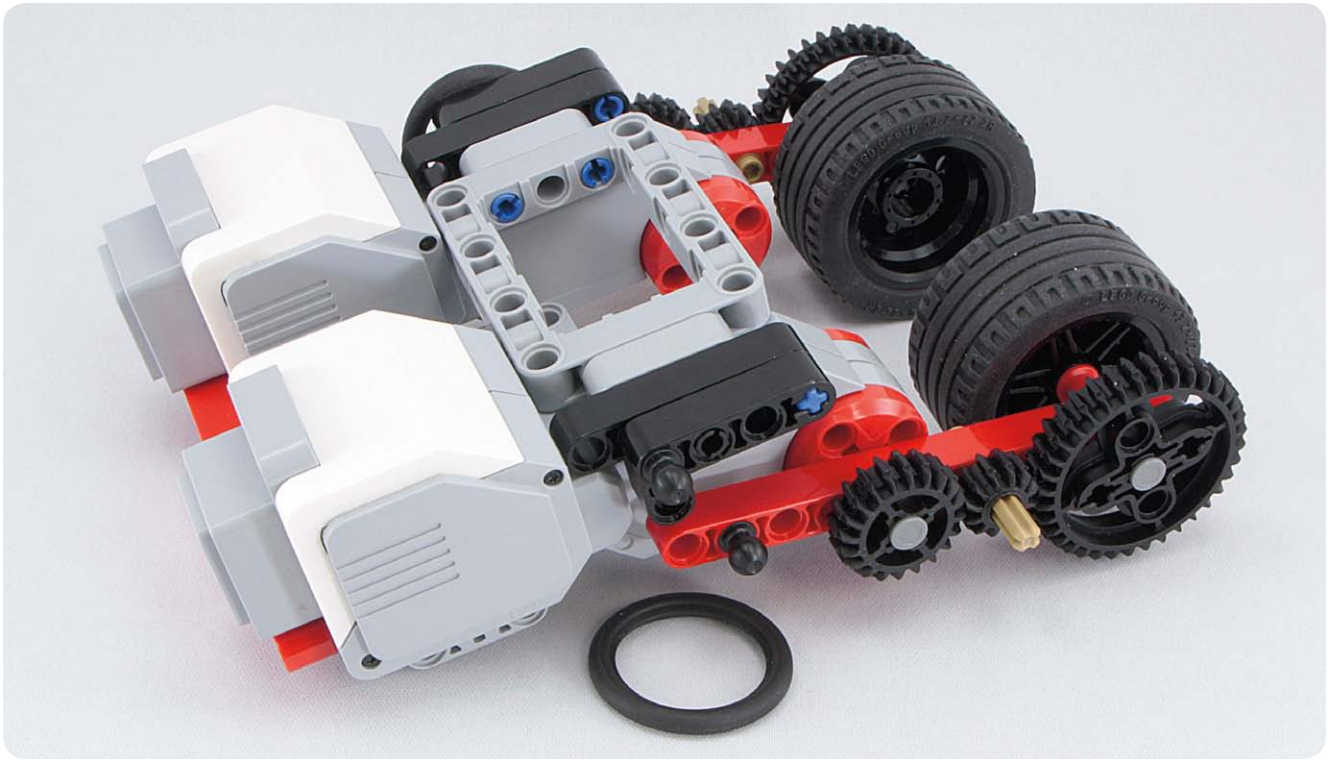

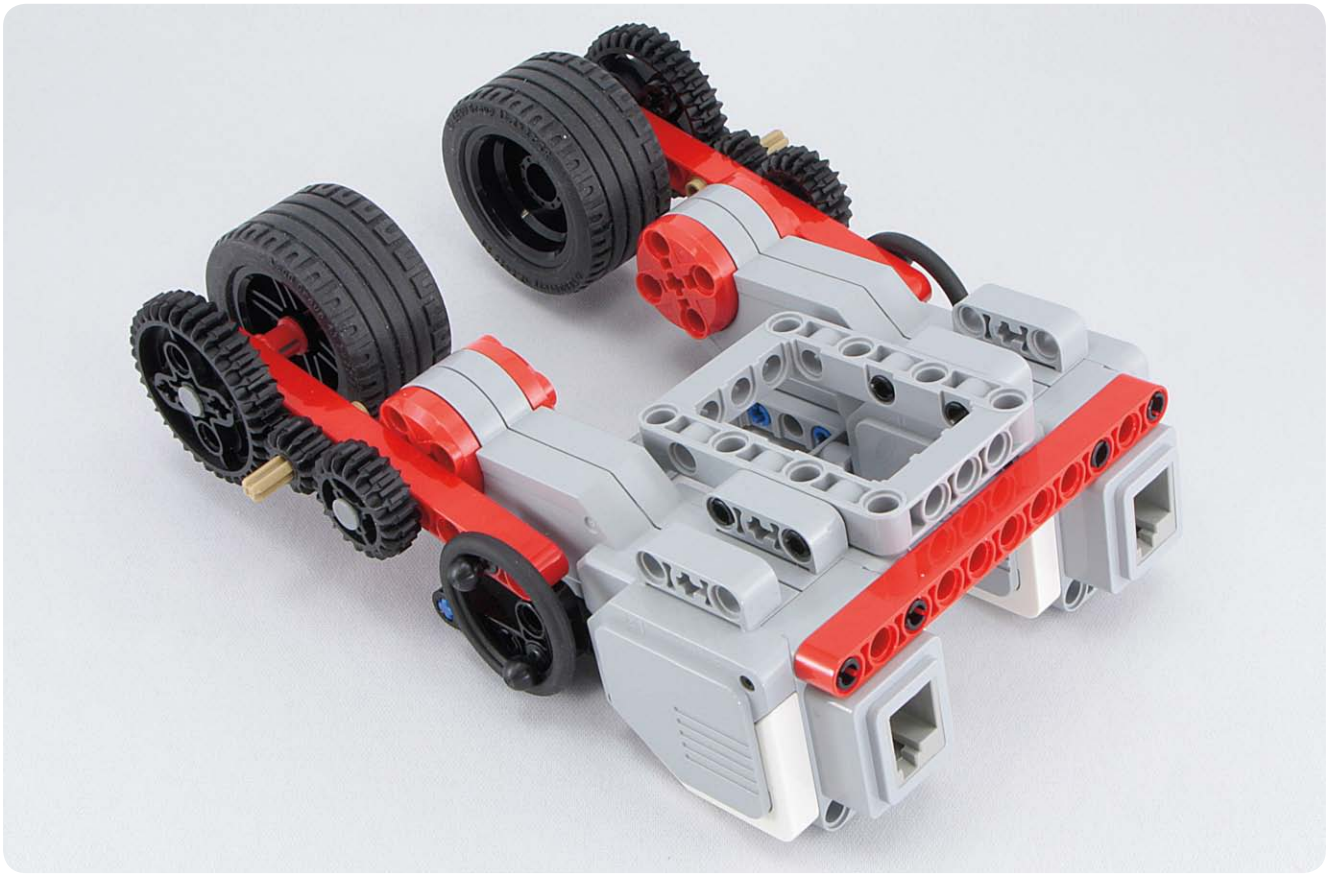

Steering

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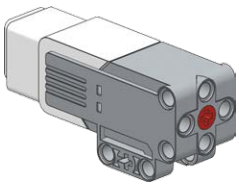
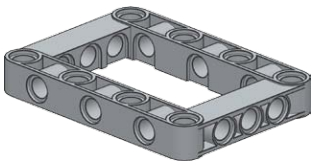
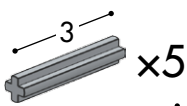
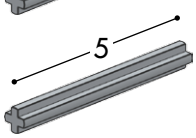
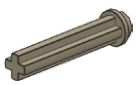
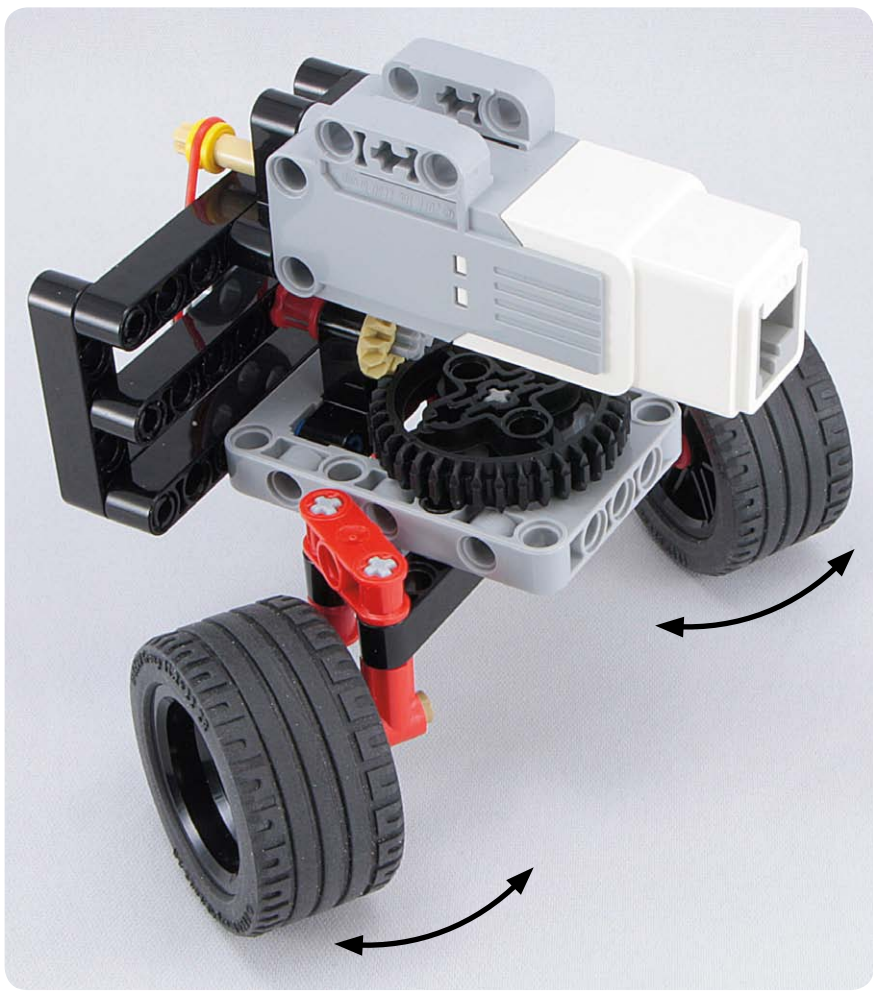


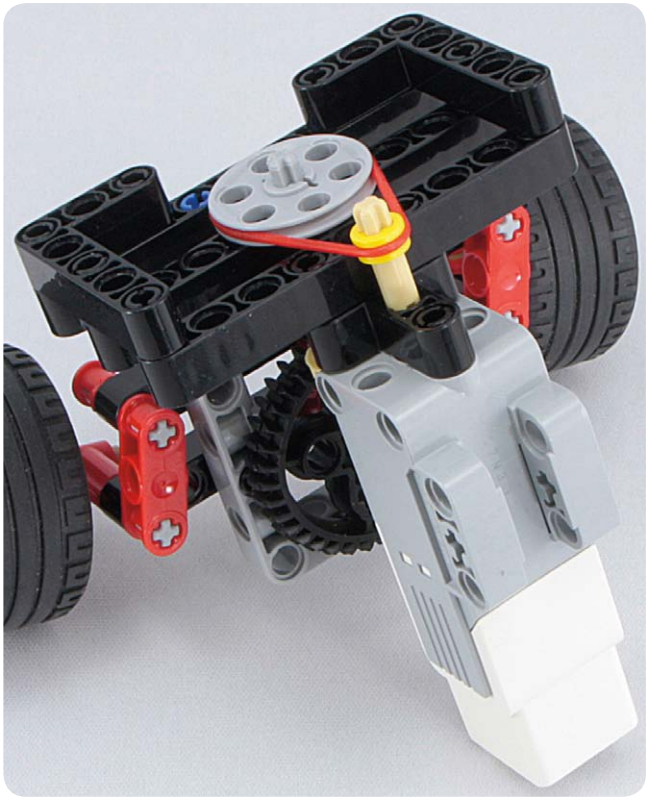






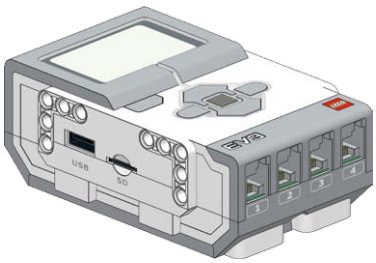







EV3


EV3

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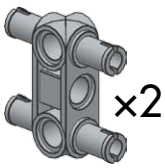
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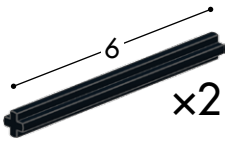
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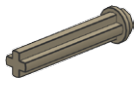
×2

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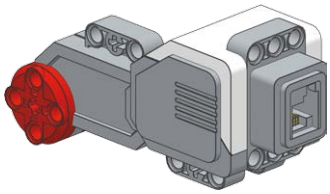


×2
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×2


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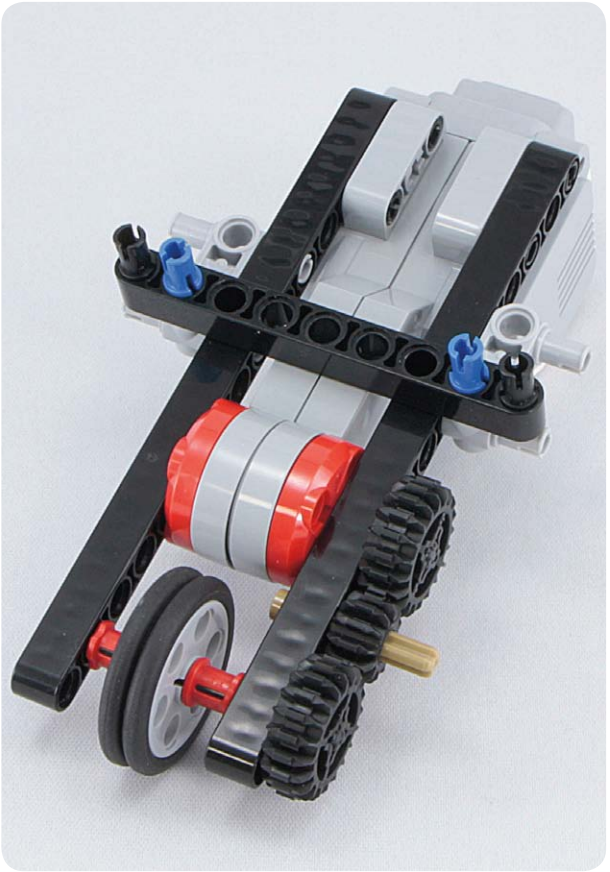
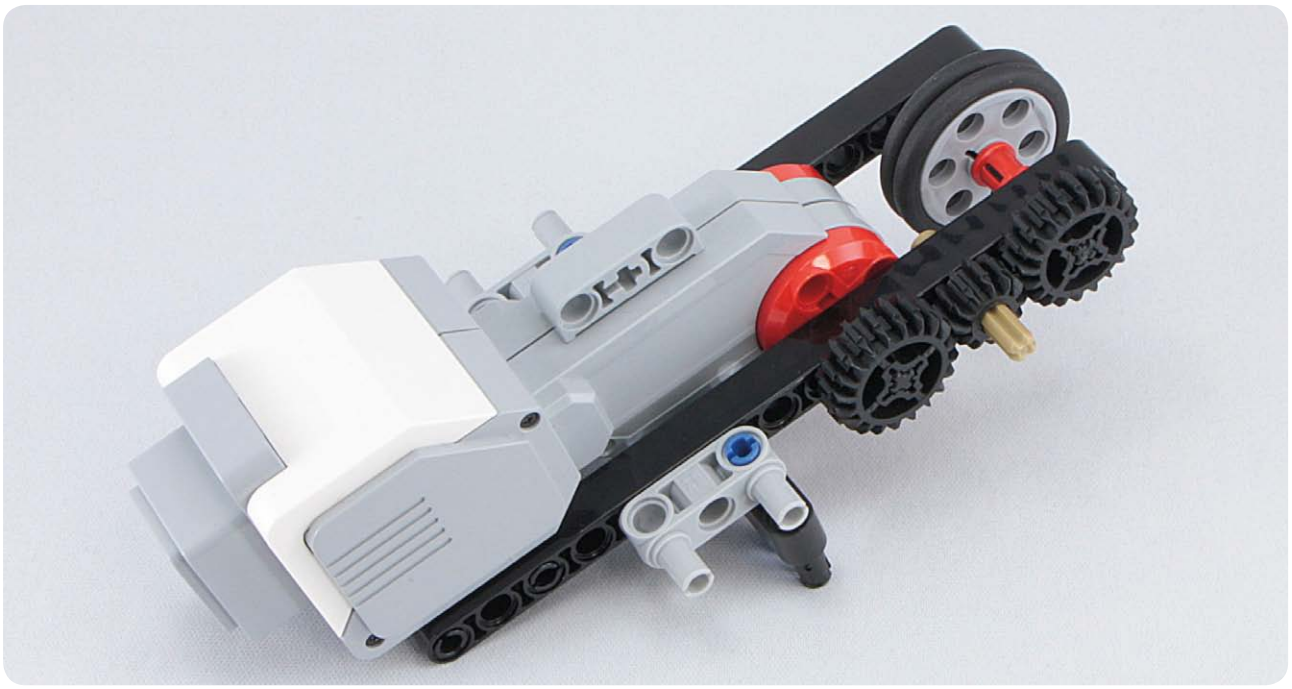
USB
SD
EV3









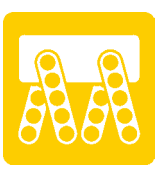







PART 3

Moving Without Tires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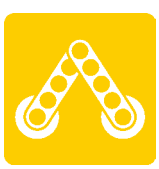
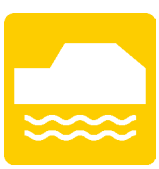
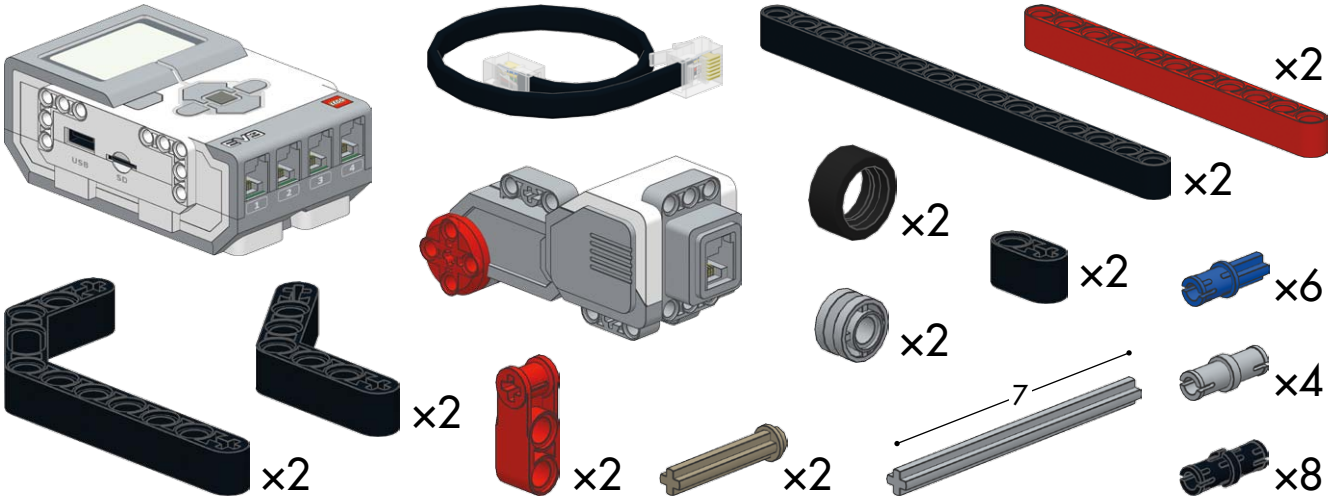
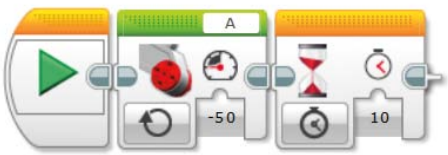

122


126

Walking machines

#122

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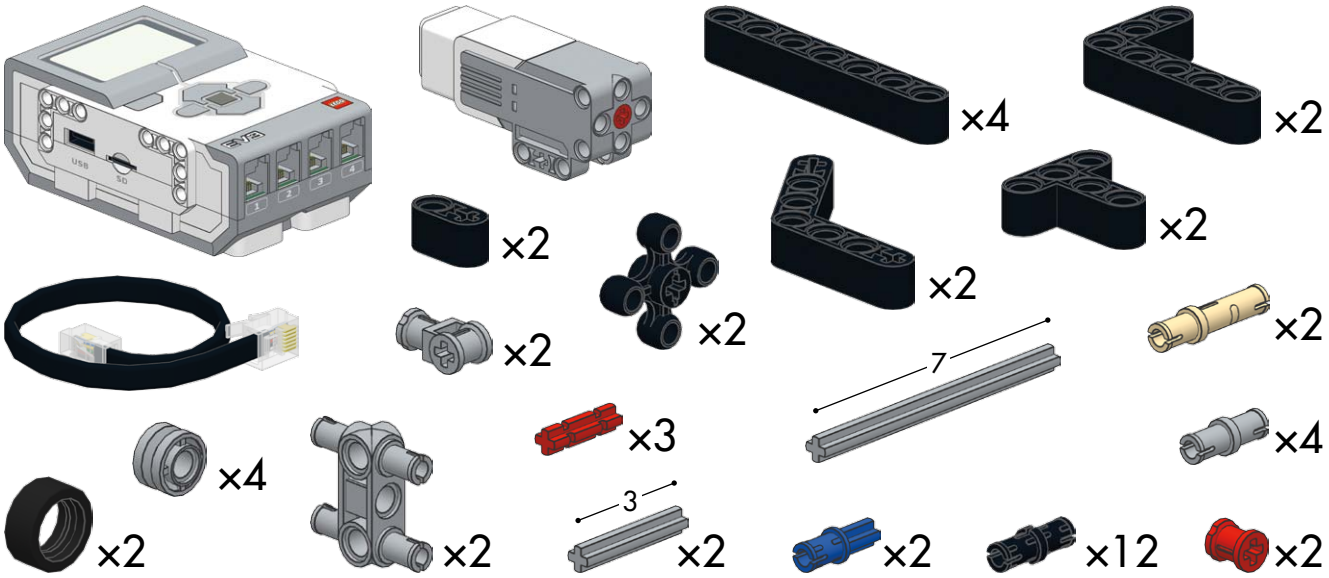
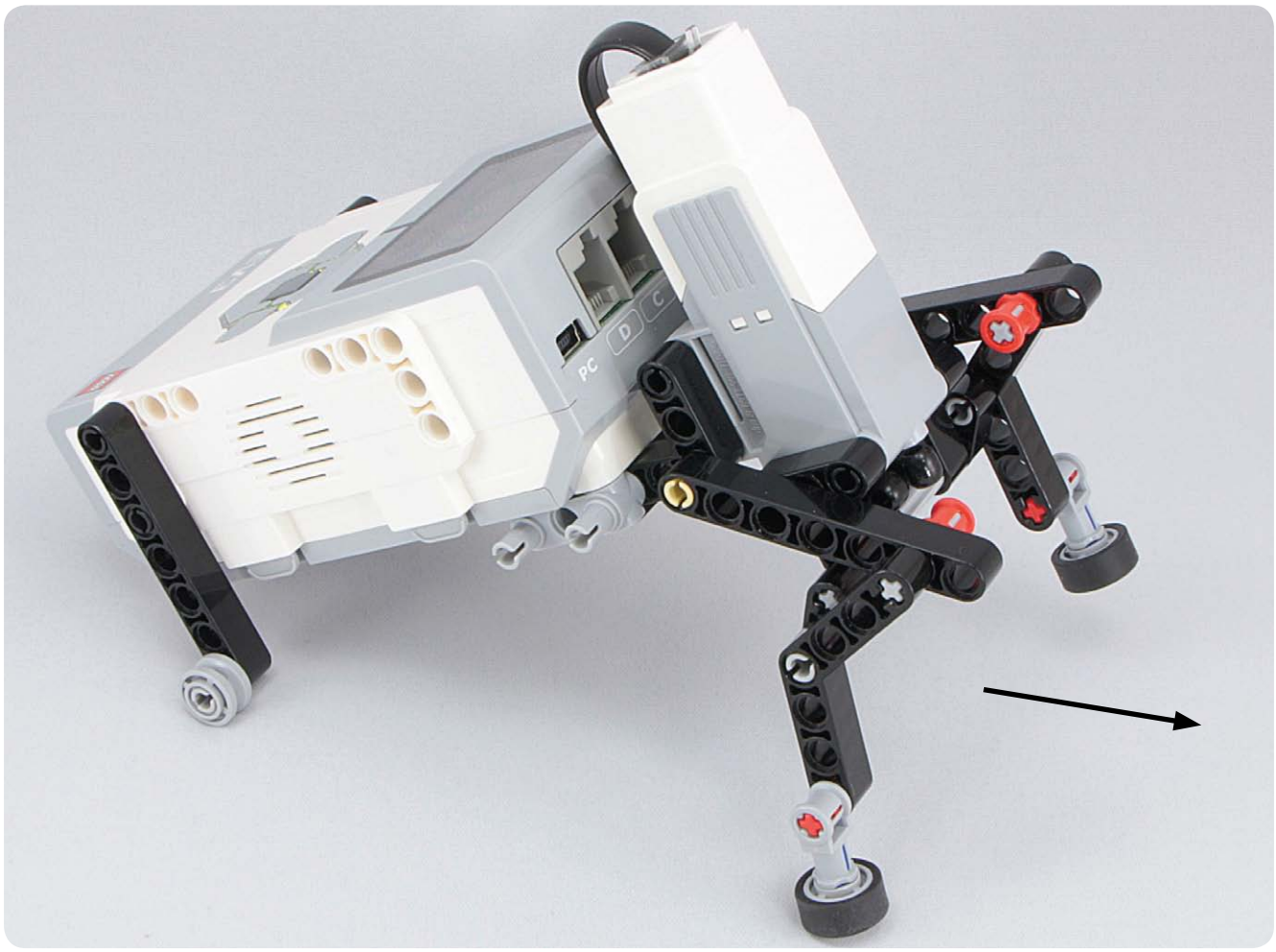
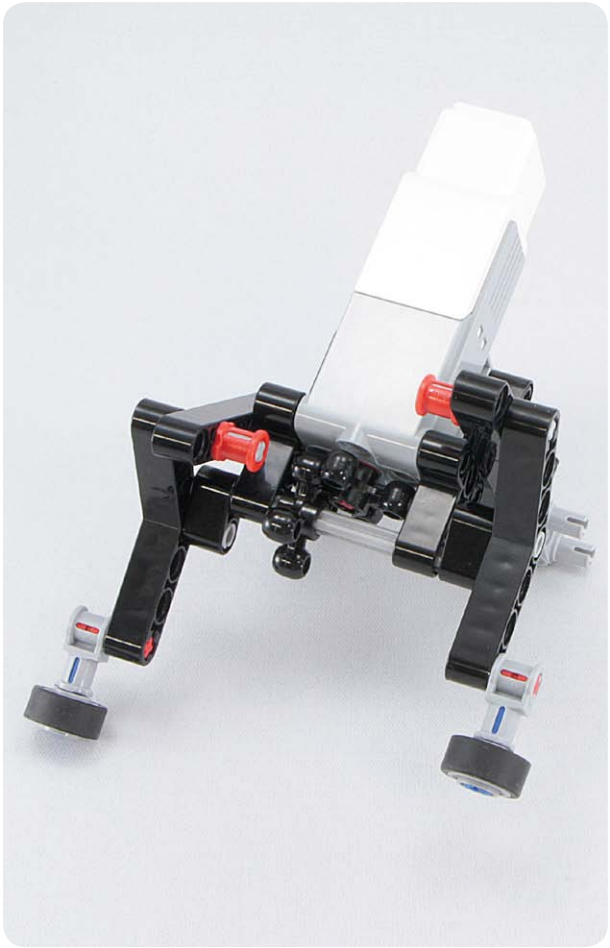
10

#123






EV3
1
2
3
4



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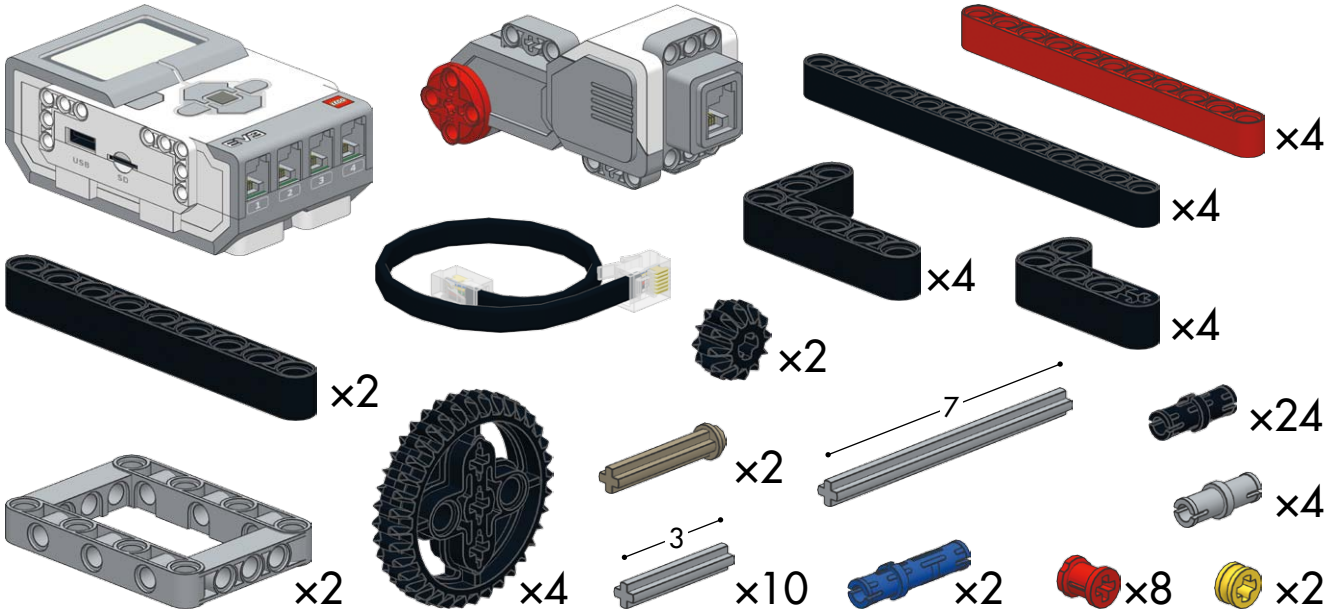
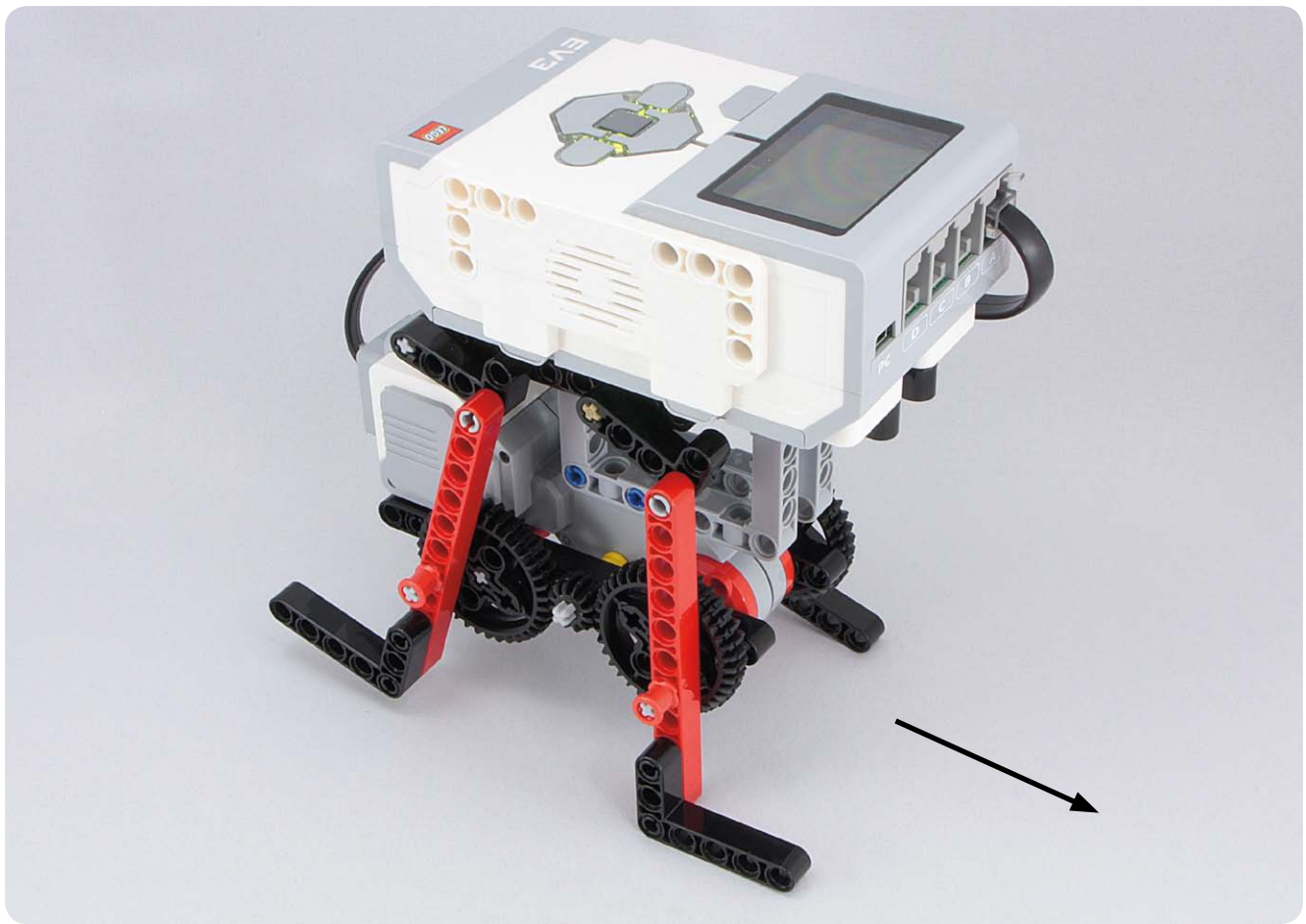
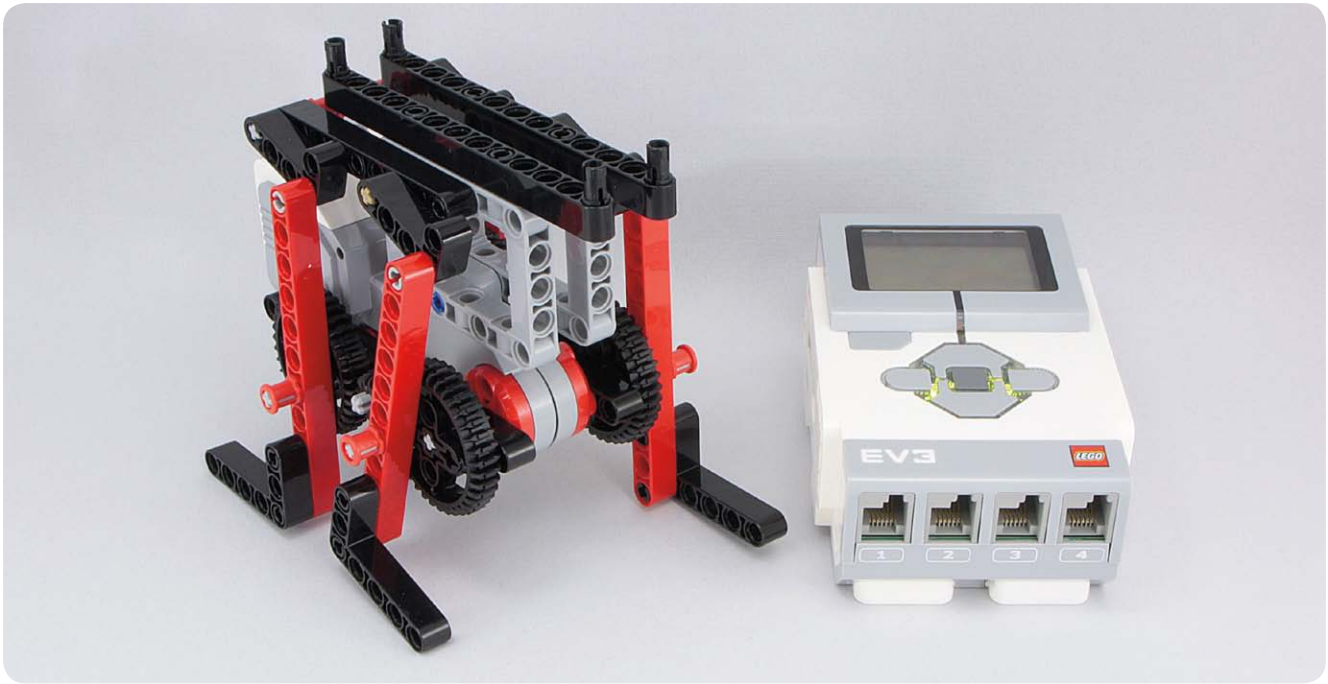
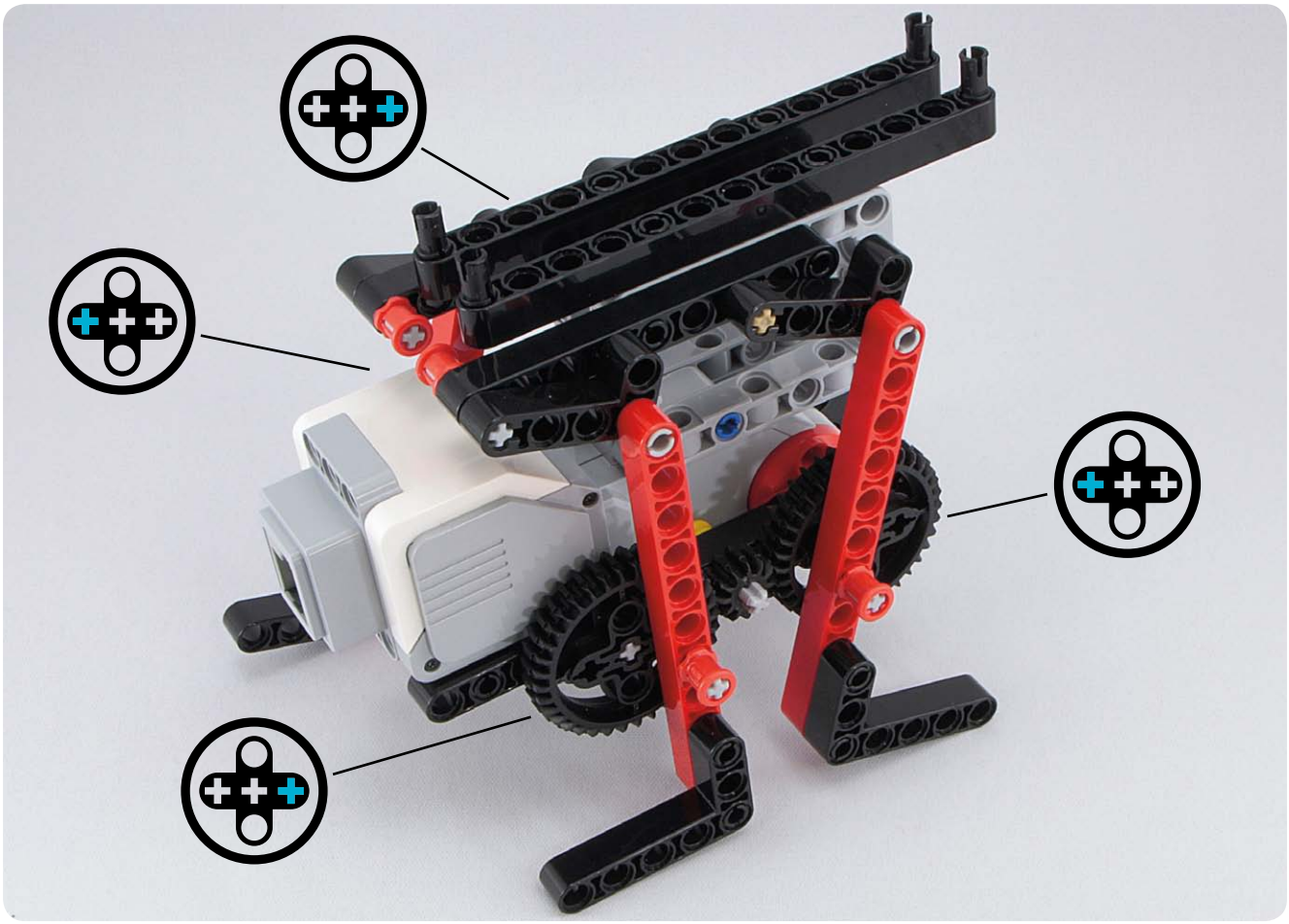
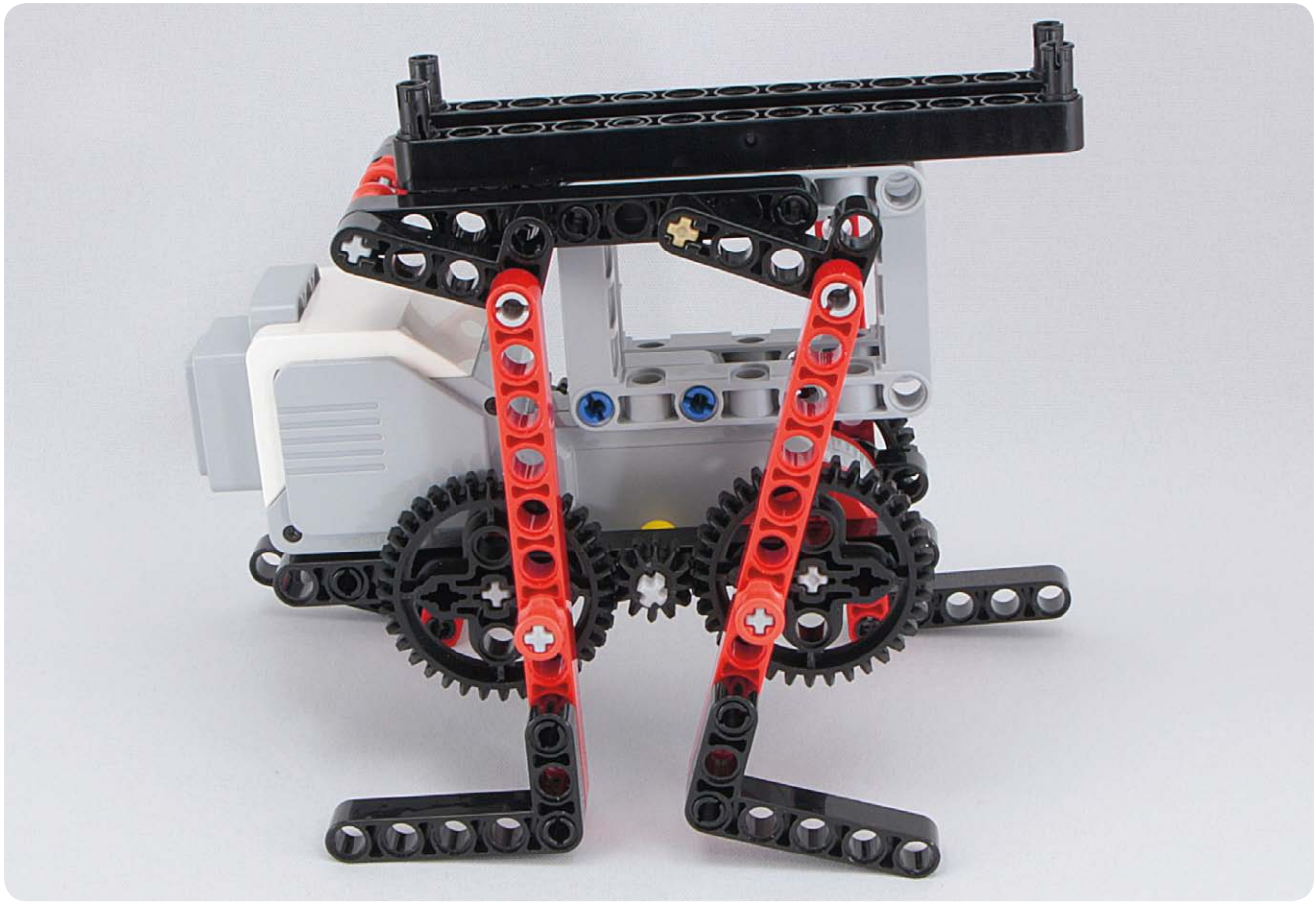
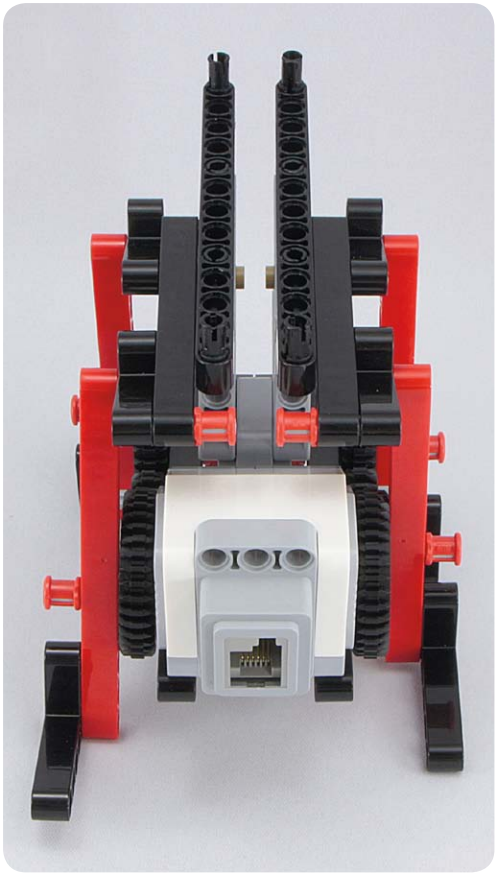





EV3
1
2
3
4







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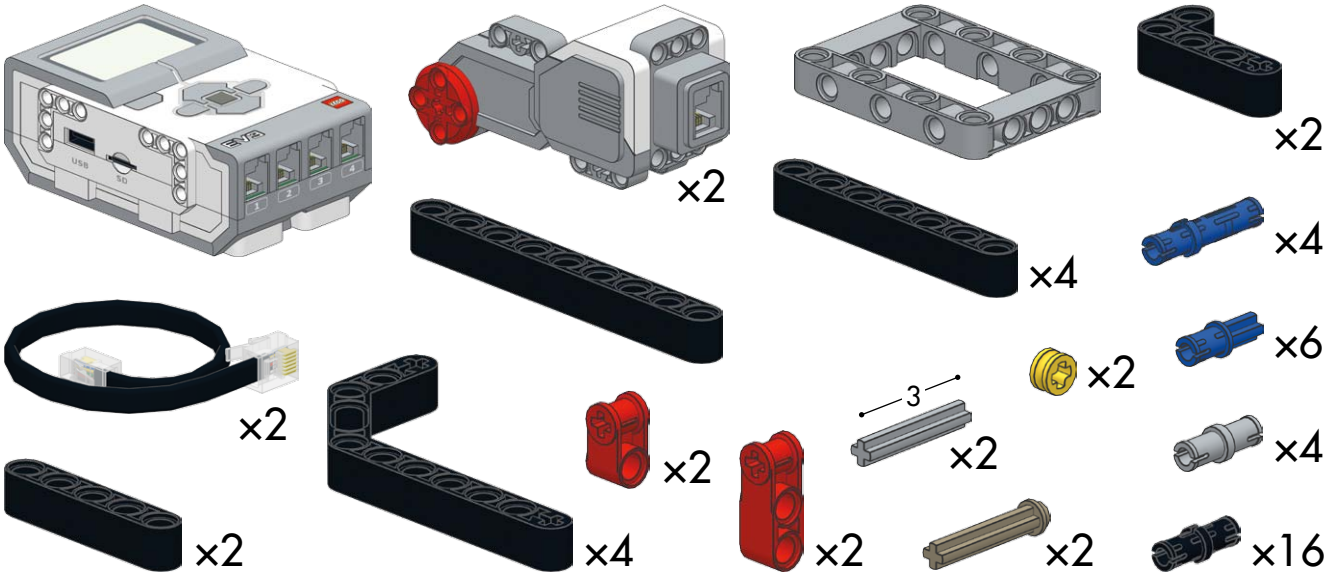
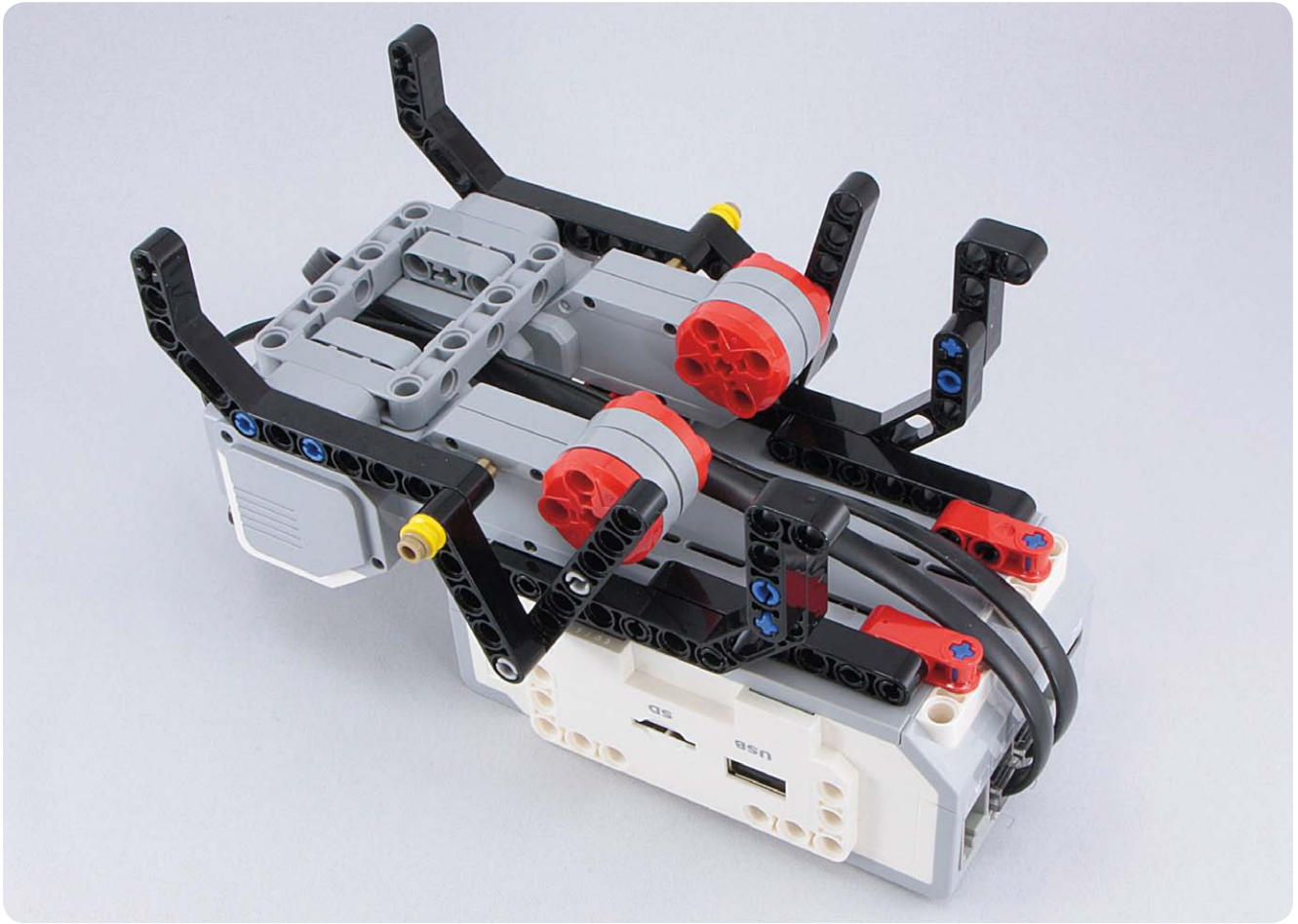
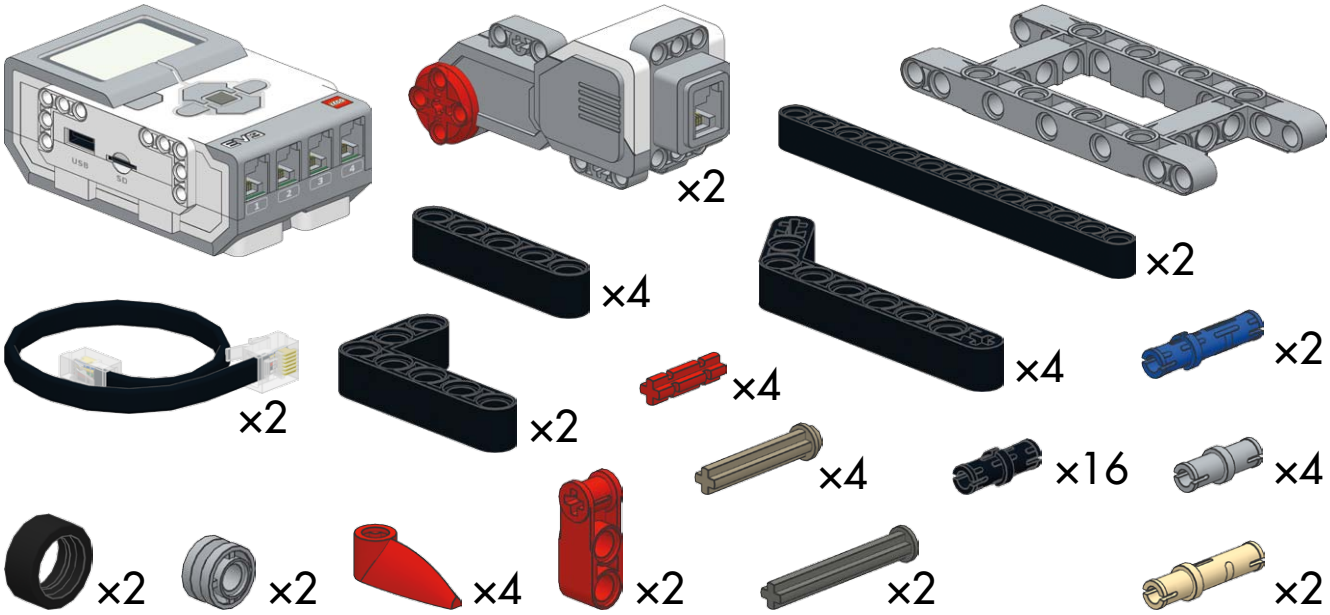
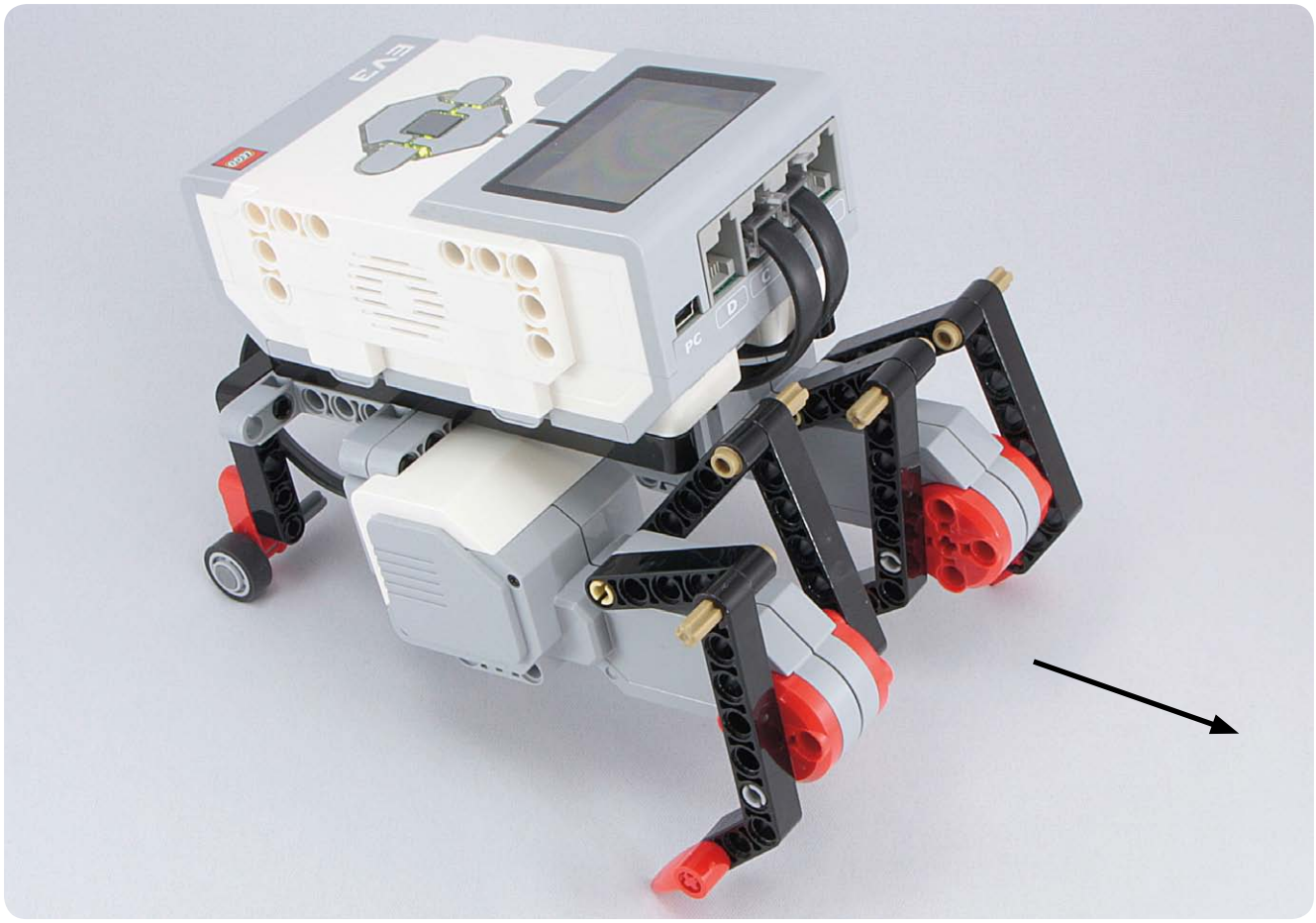


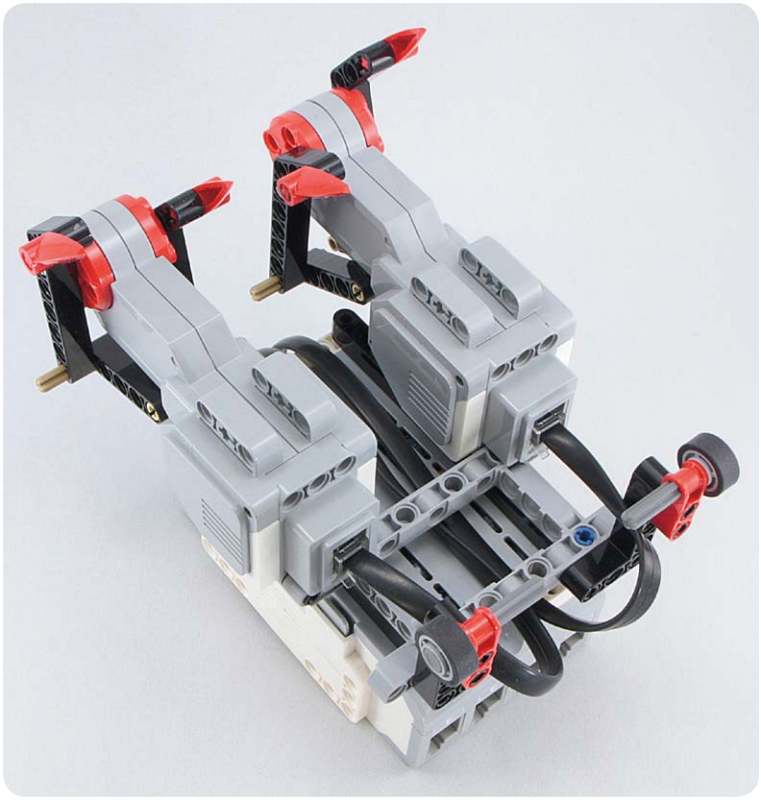

EV3

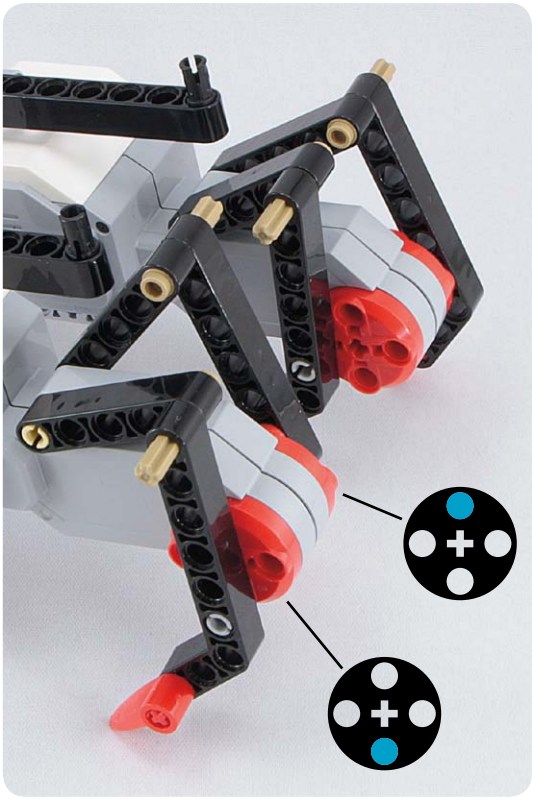

SD
USB

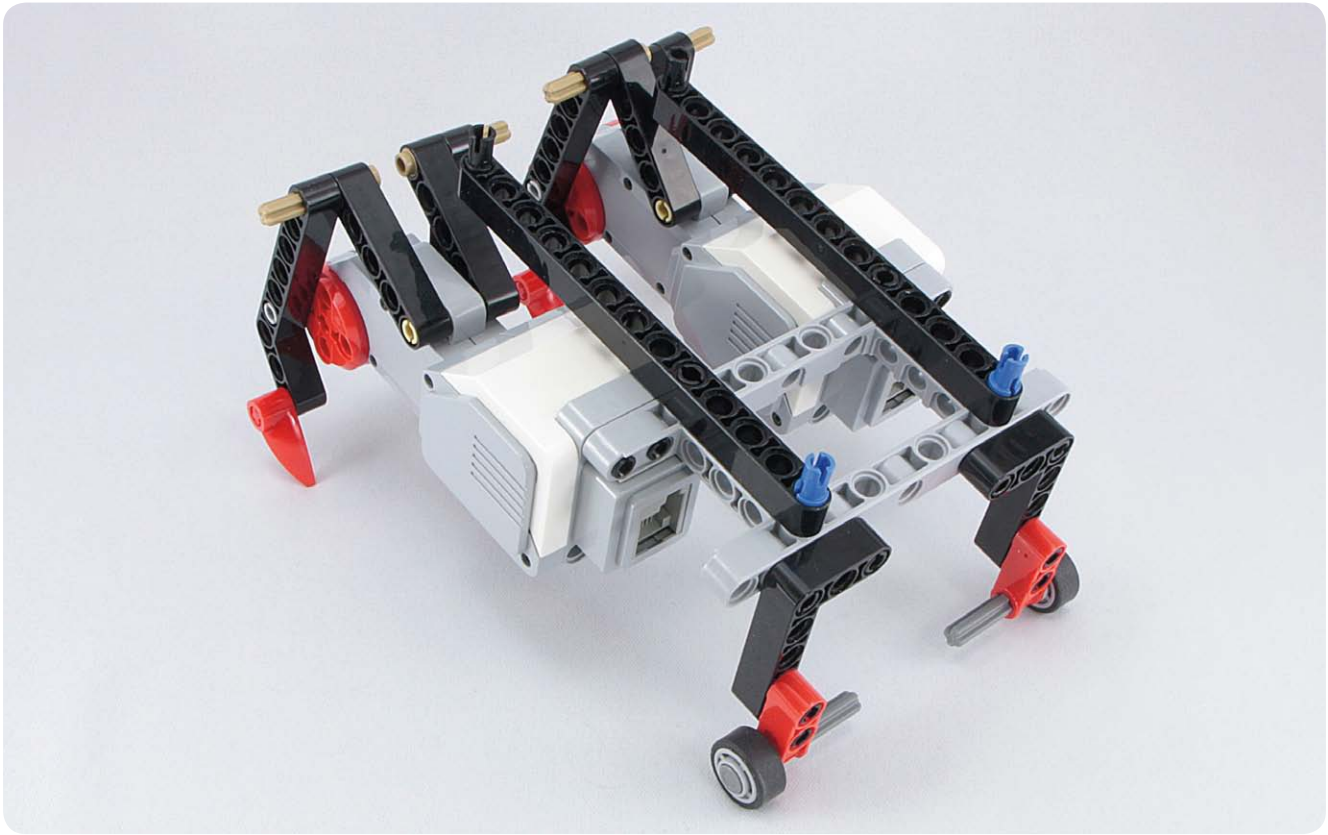
#126





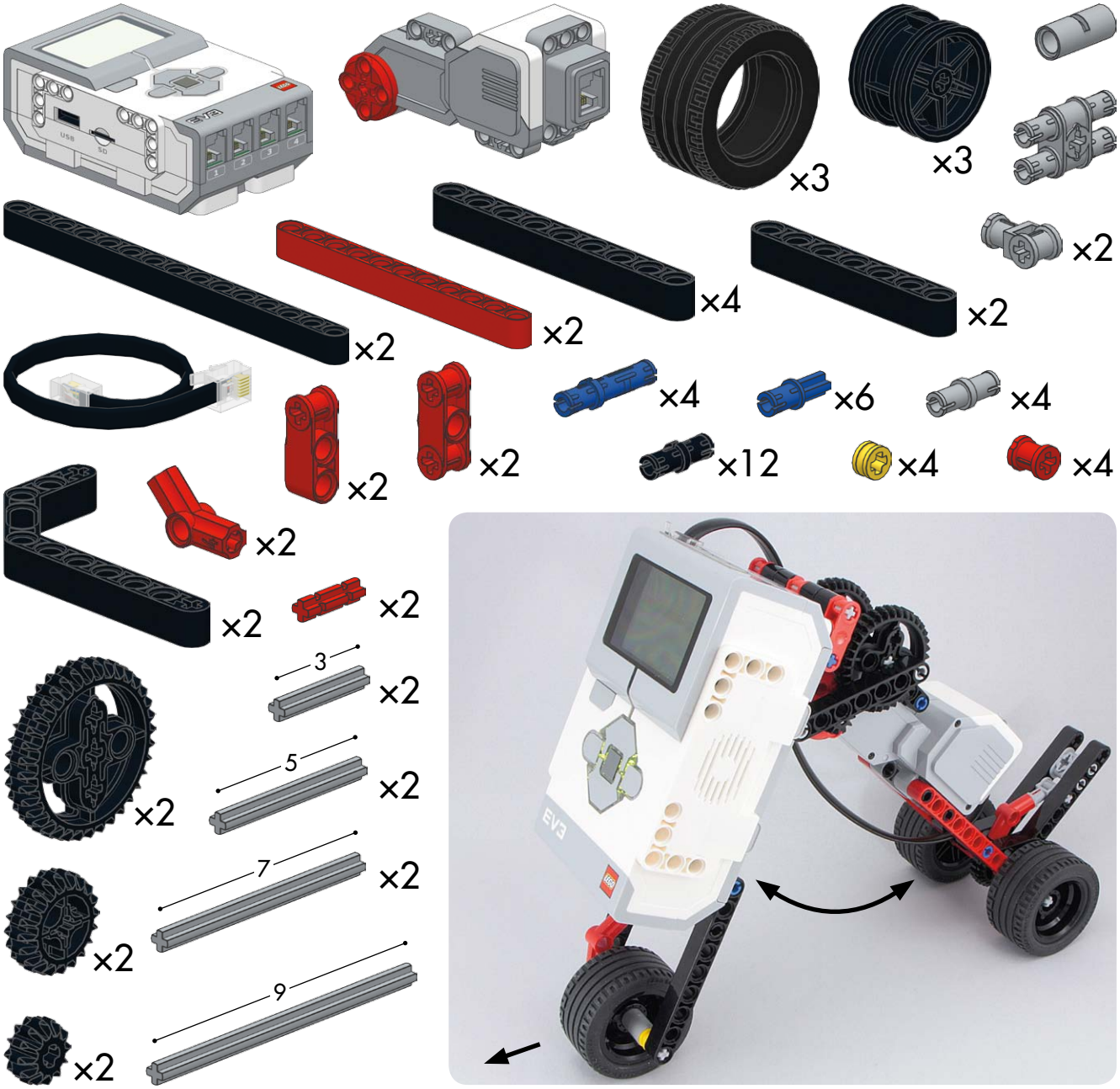






Moving like an inchworm

#127




PC
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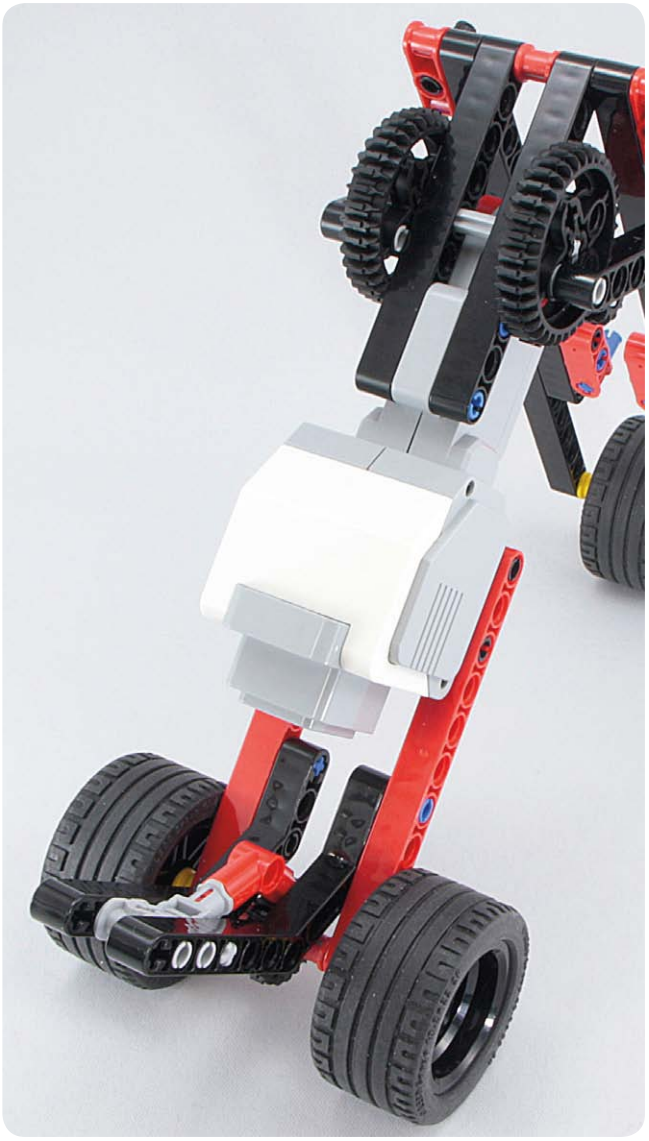
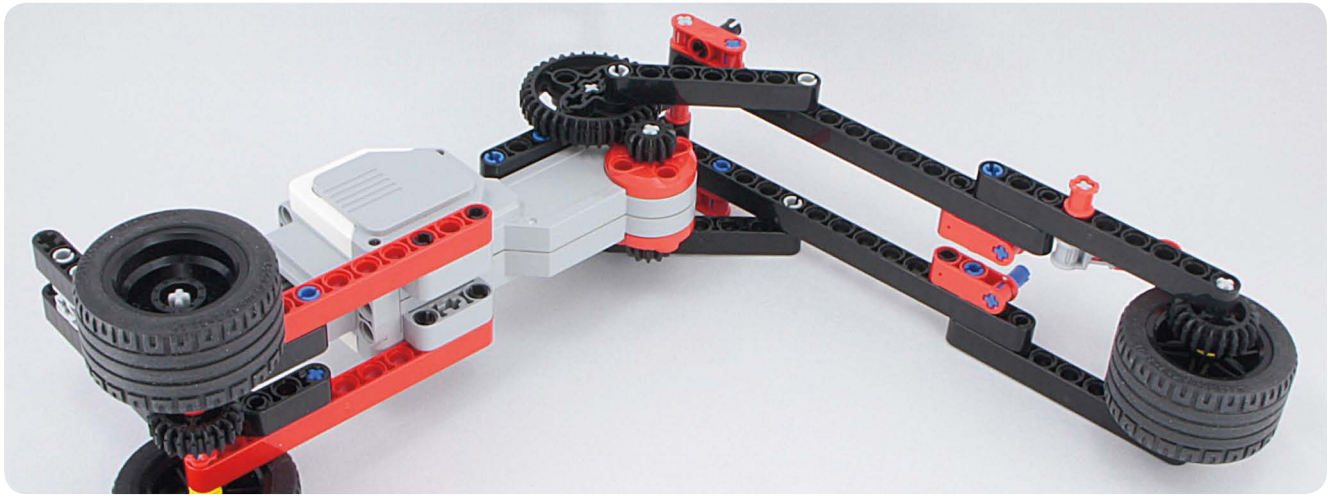
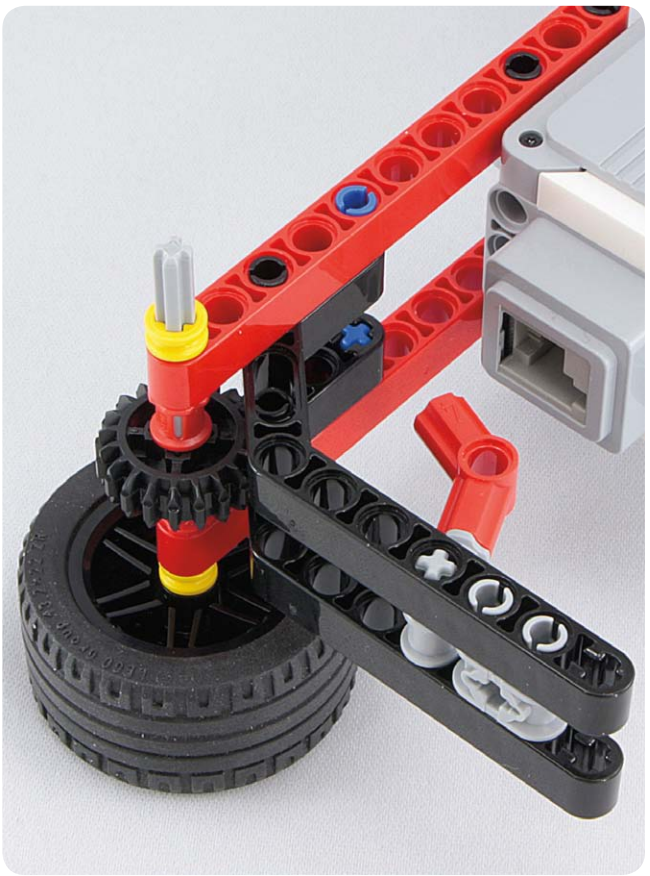
USB
SD

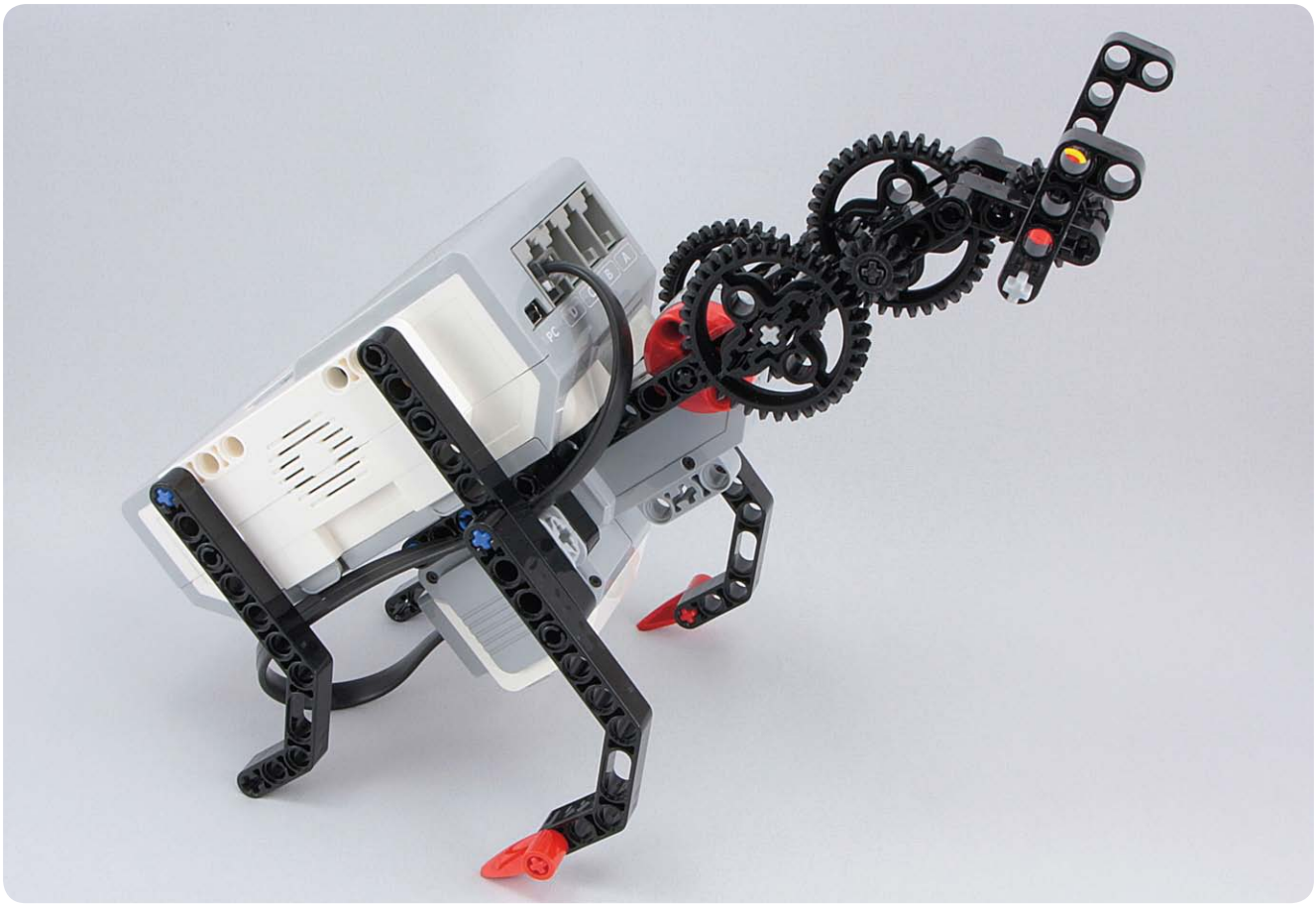


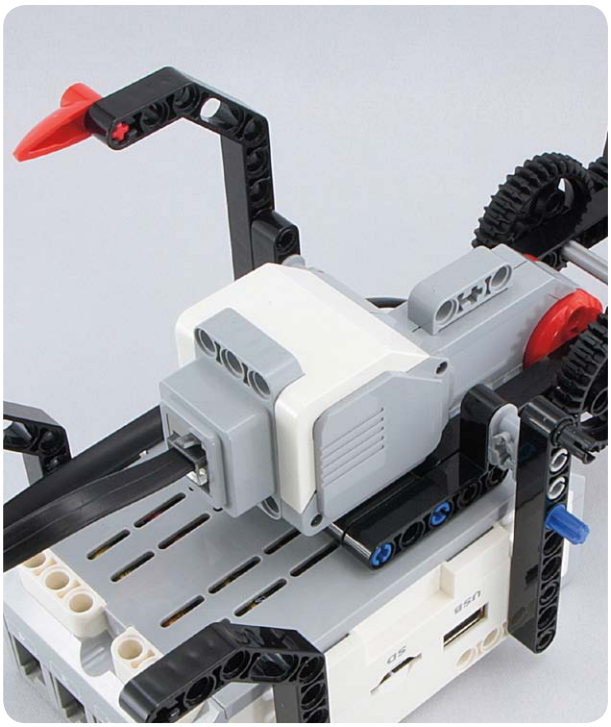




Moving through vibration

#128









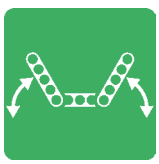







PART 4

Arms, Wings, and Other Movements


130


158


180

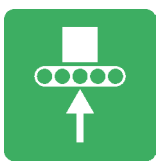

194


140


168


184


198

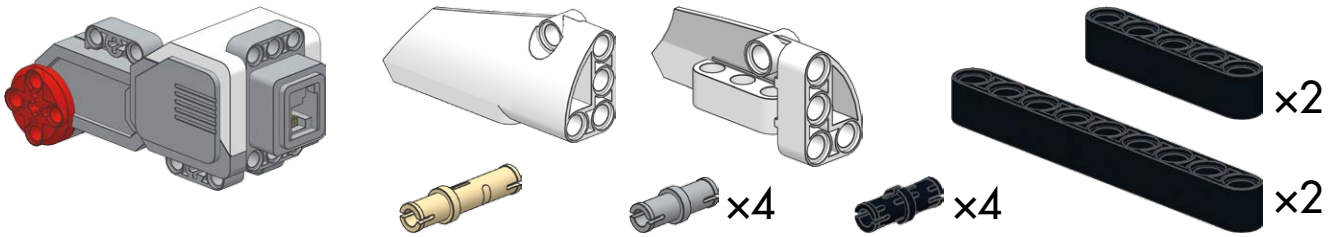

152


176


188

Flapping wings

#129



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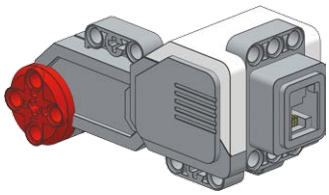
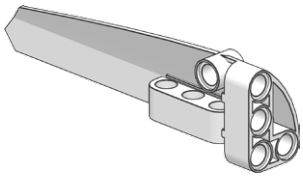
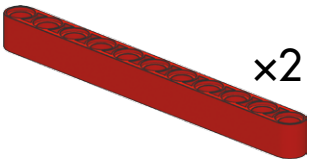
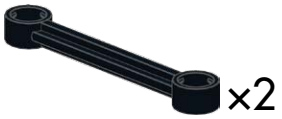
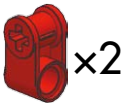
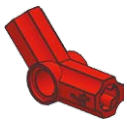


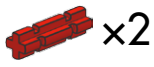


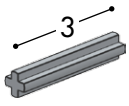


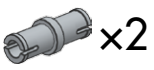


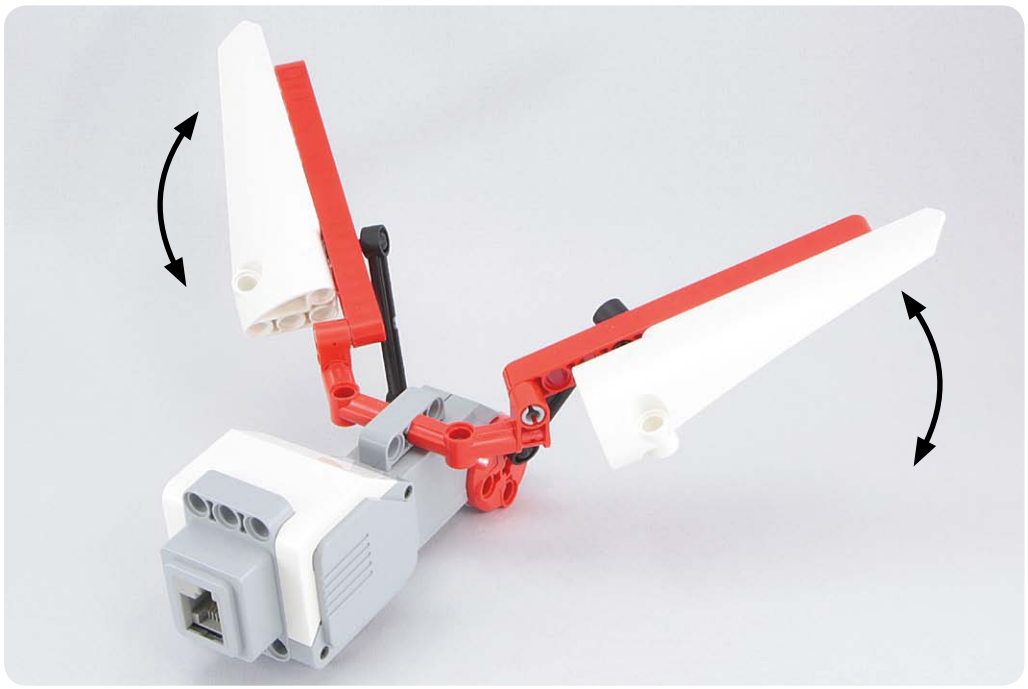




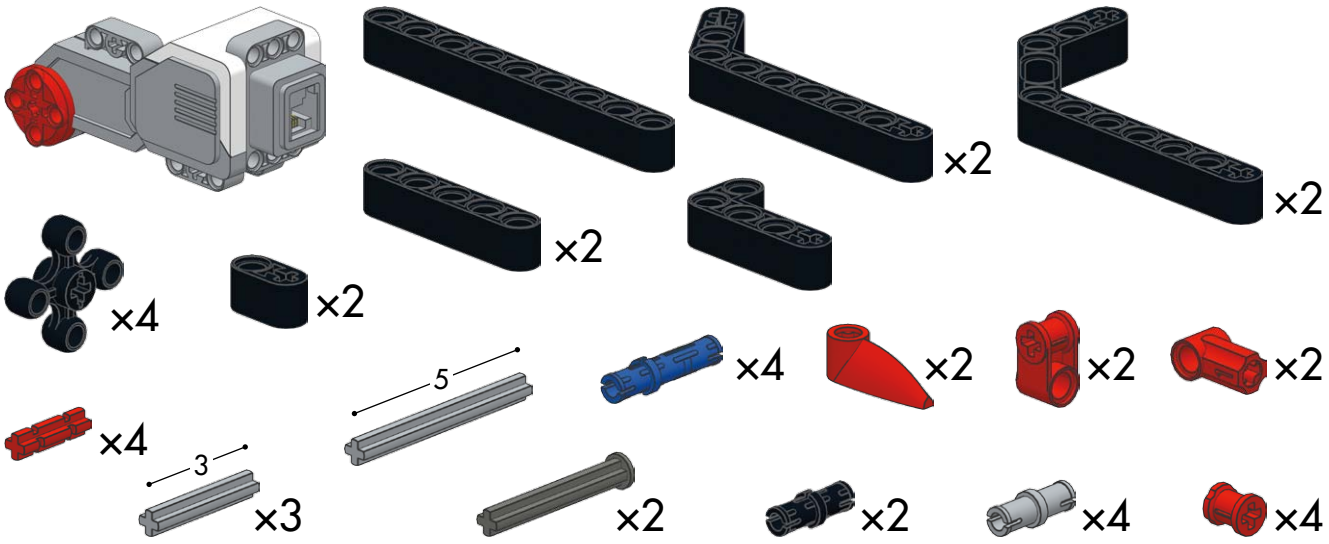


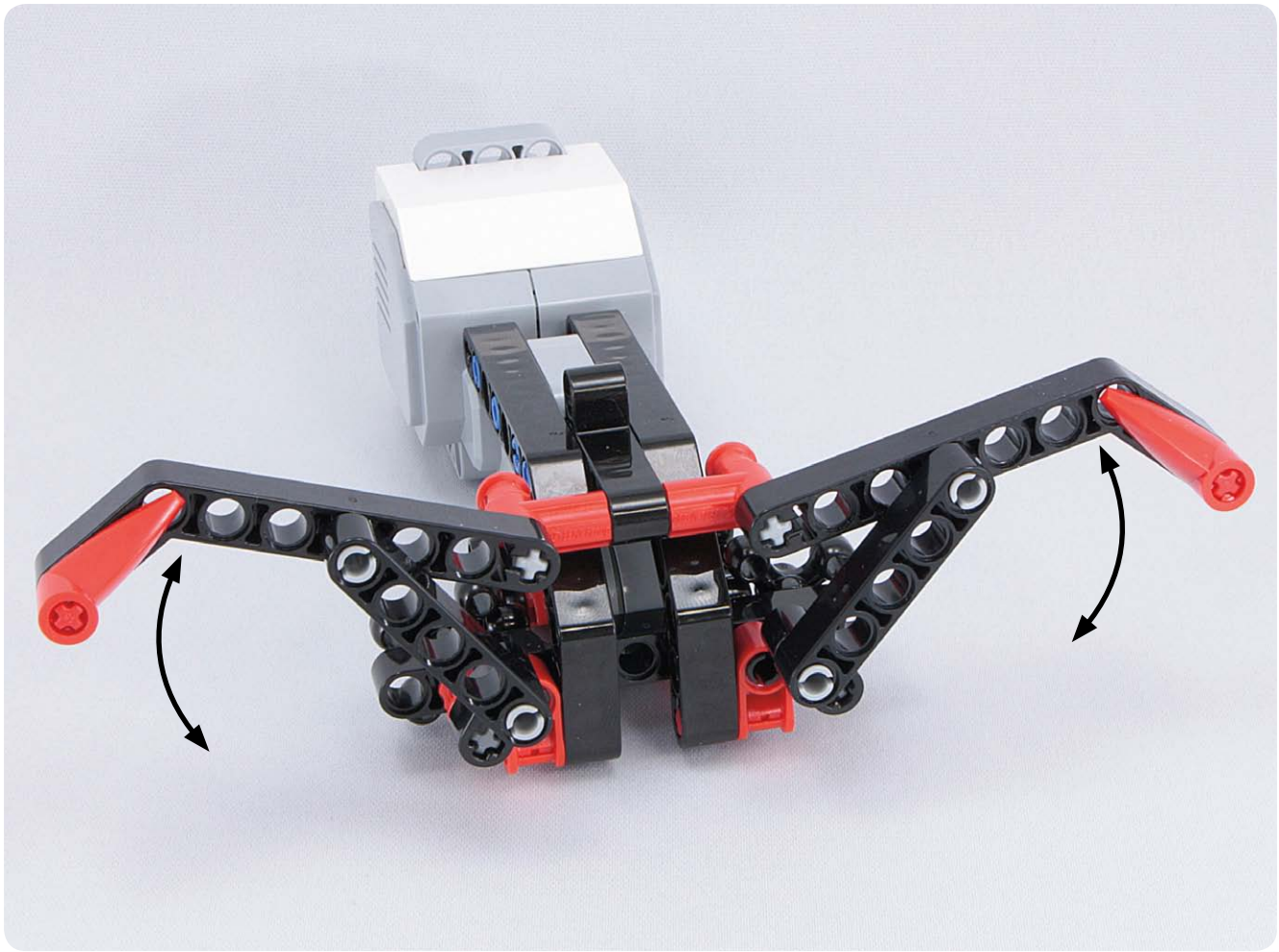






#131





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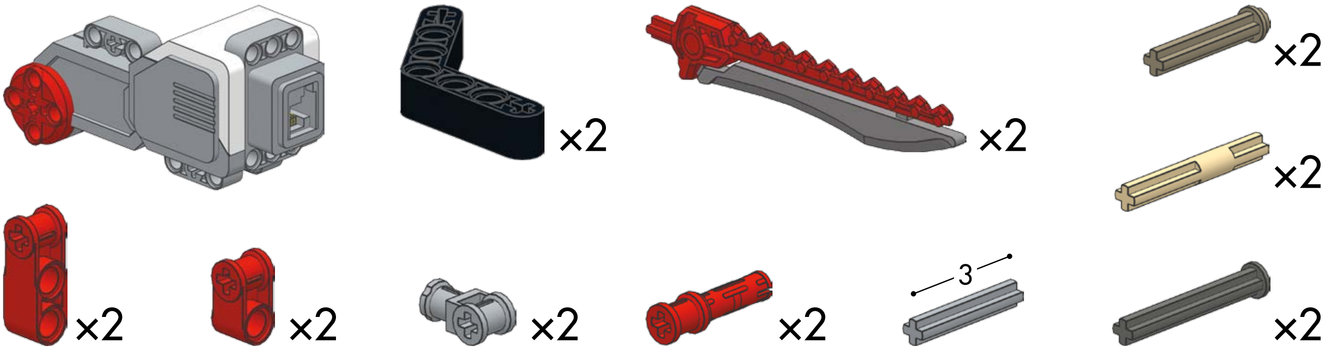
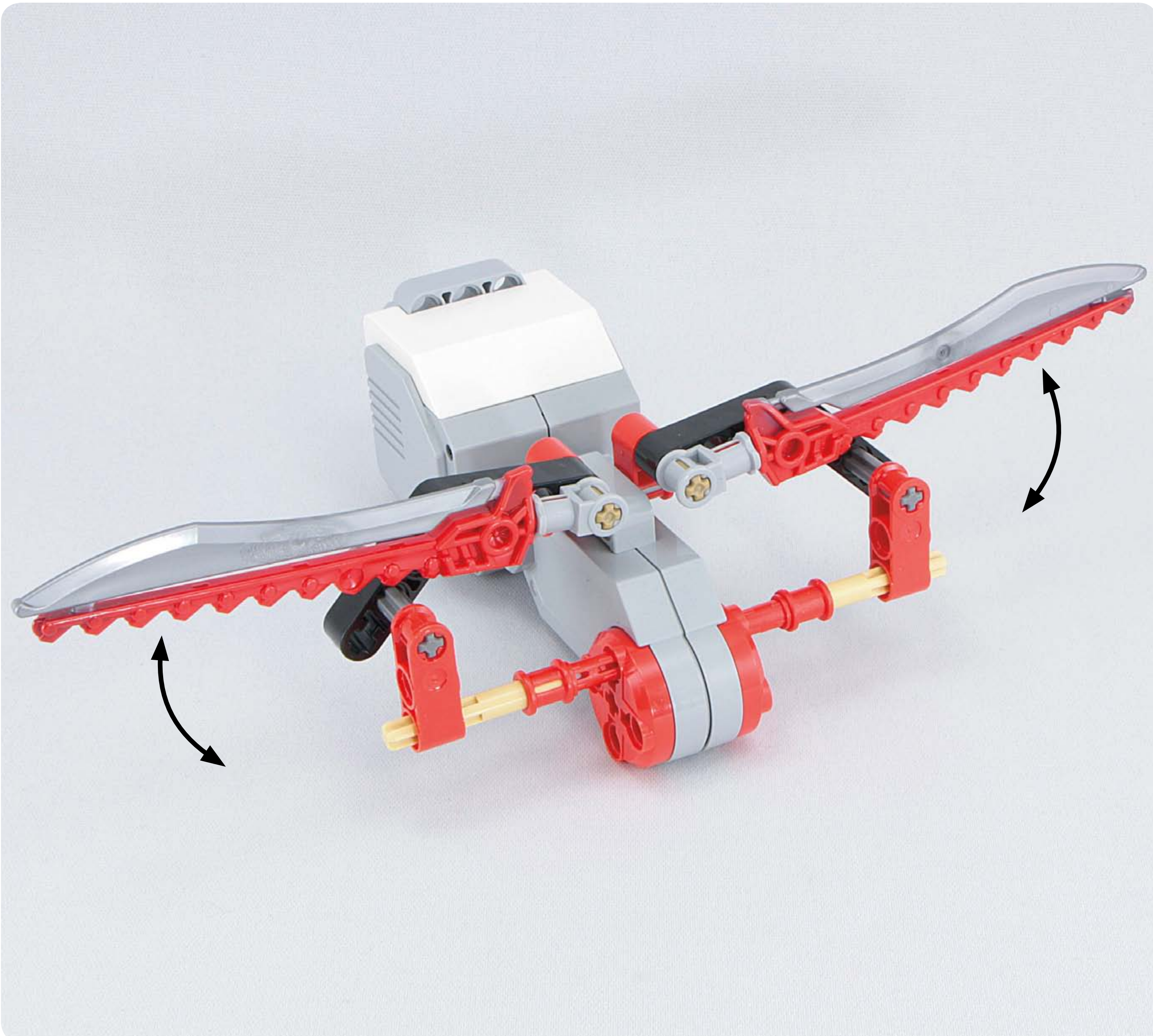
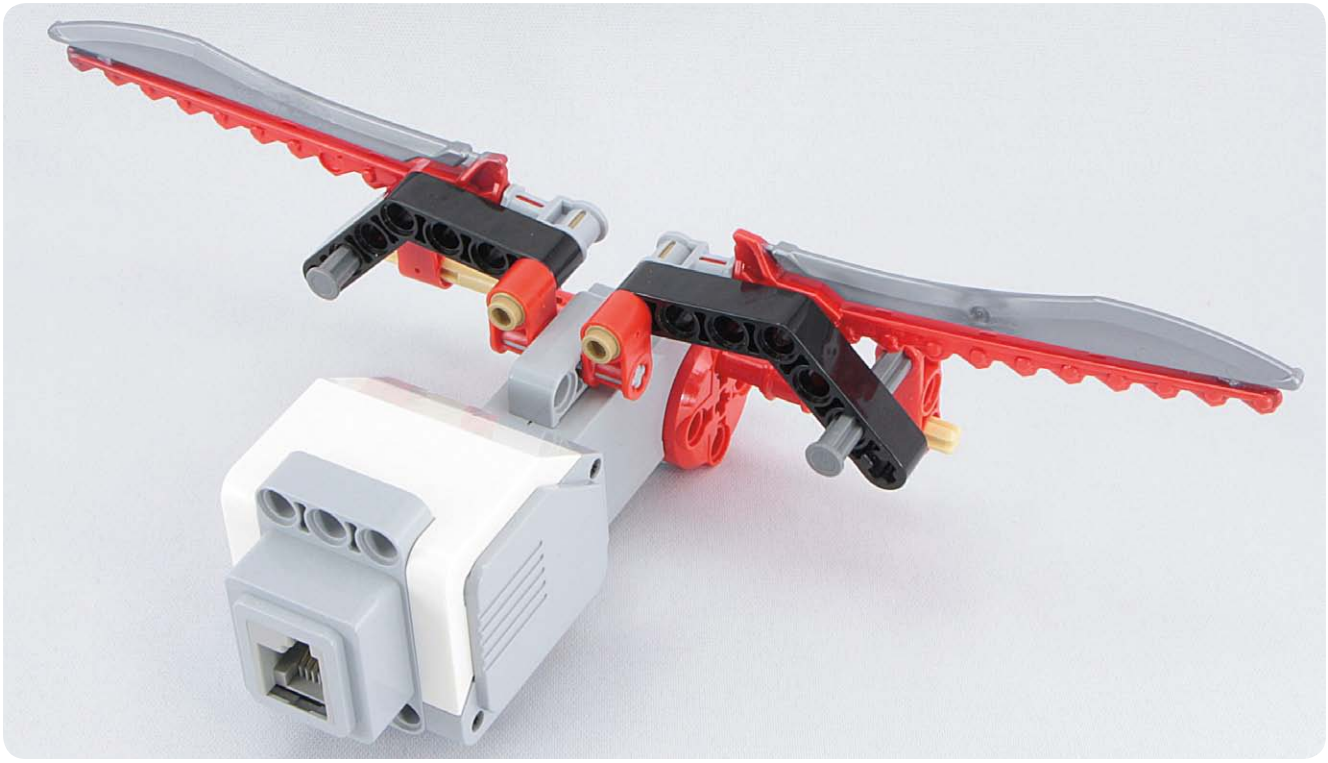
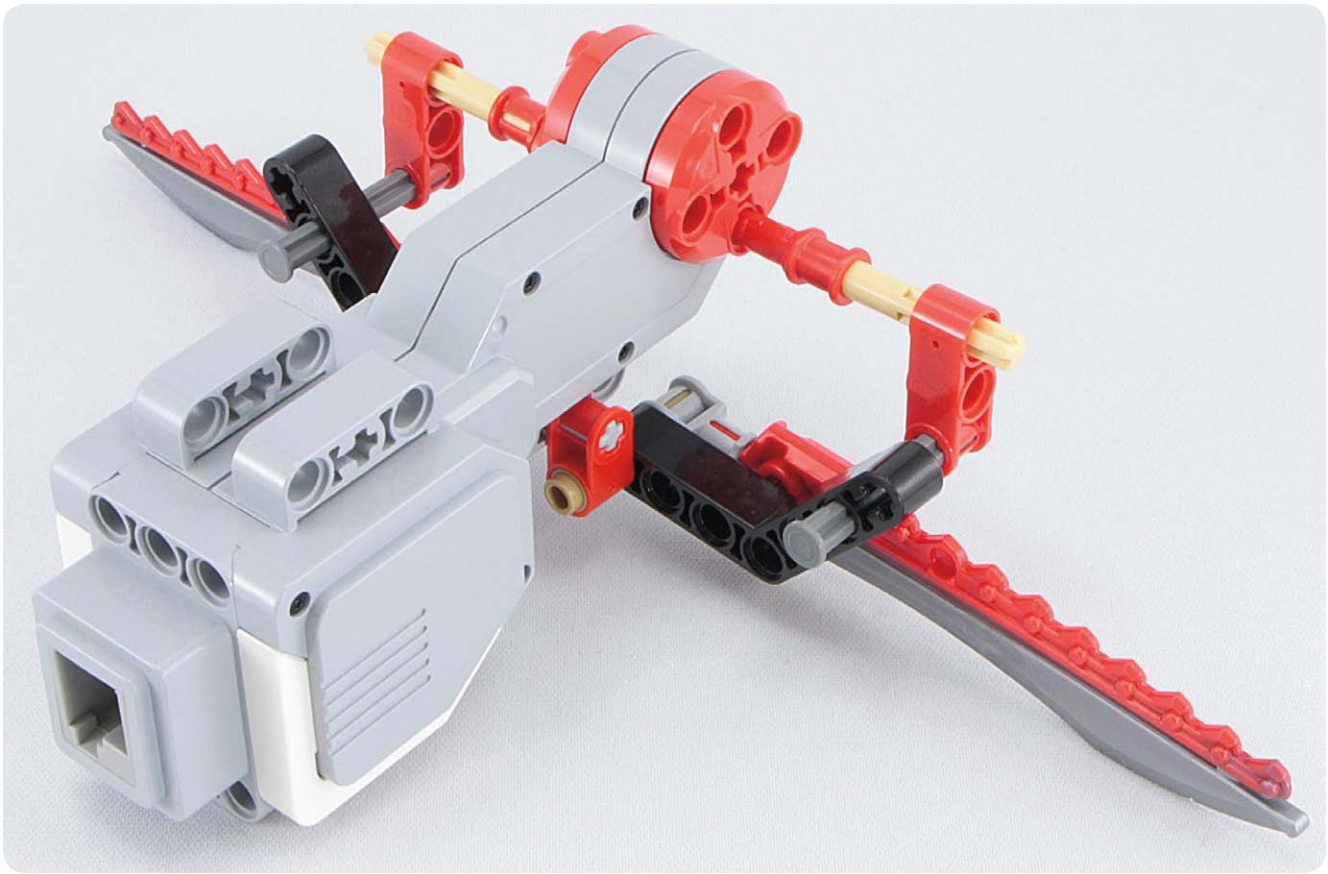
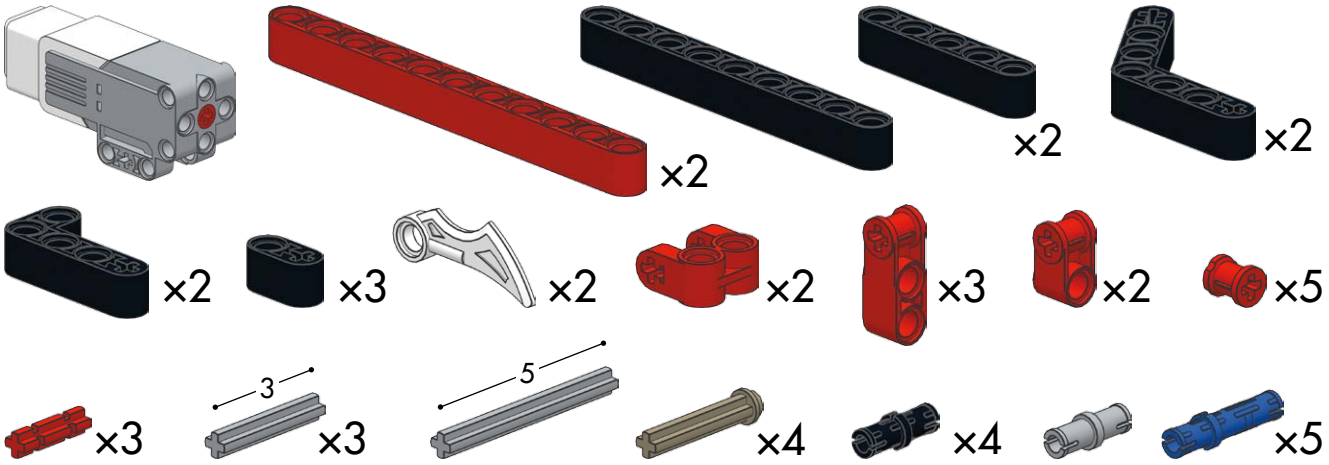


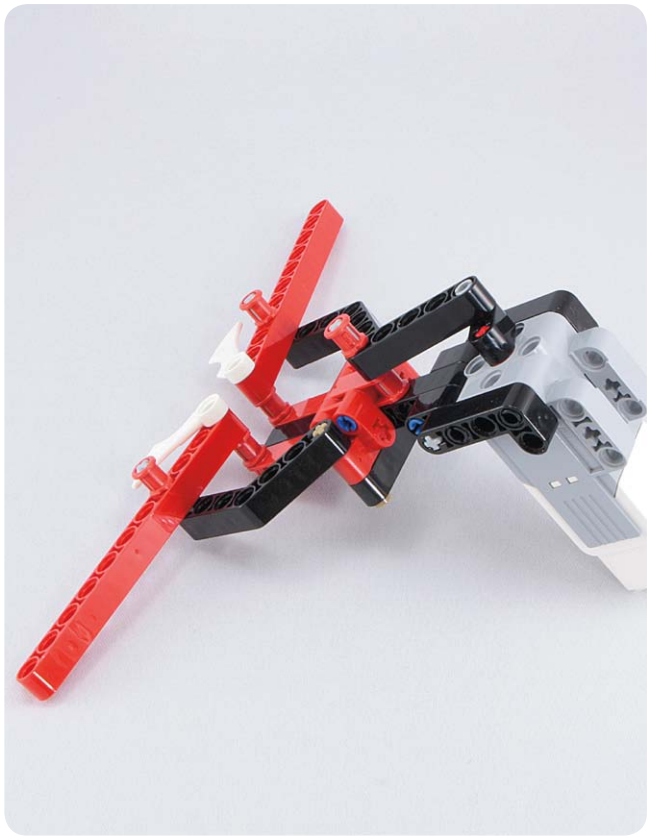


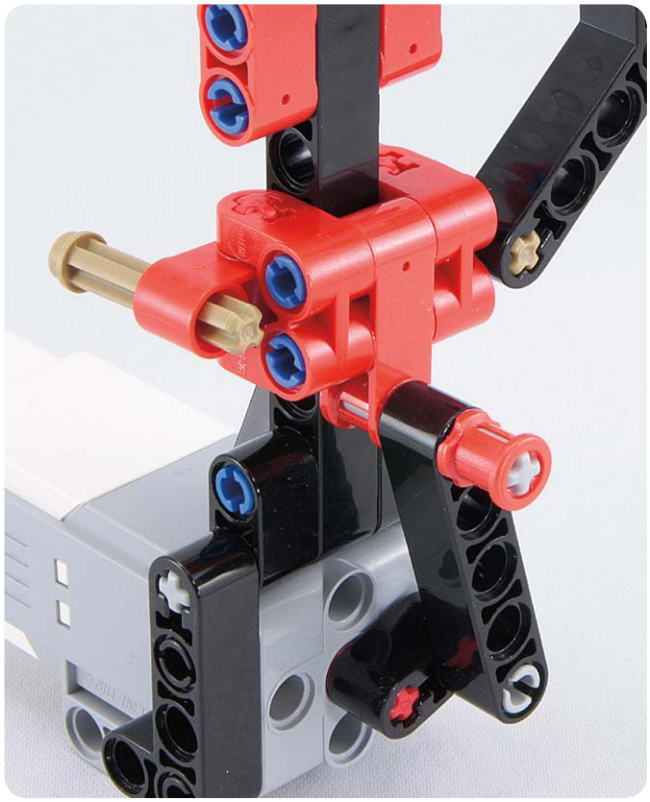




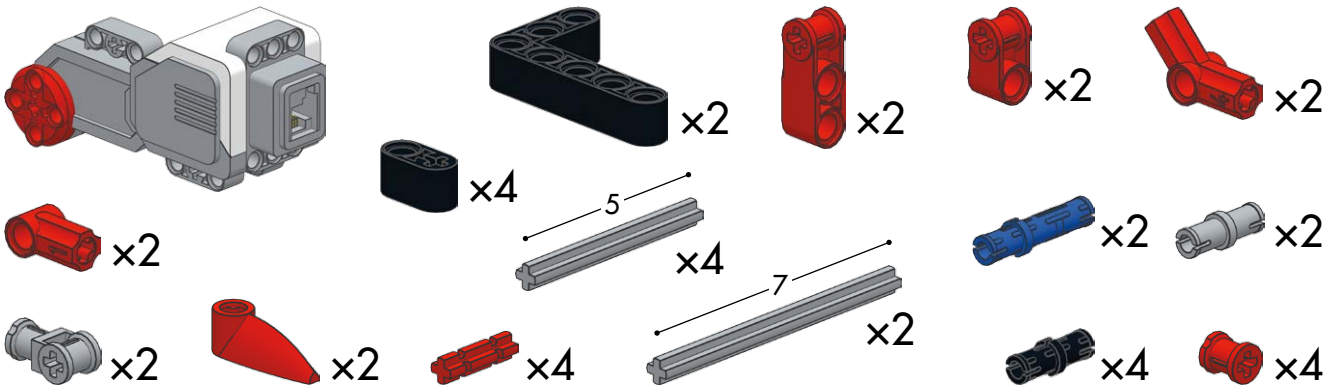
#133

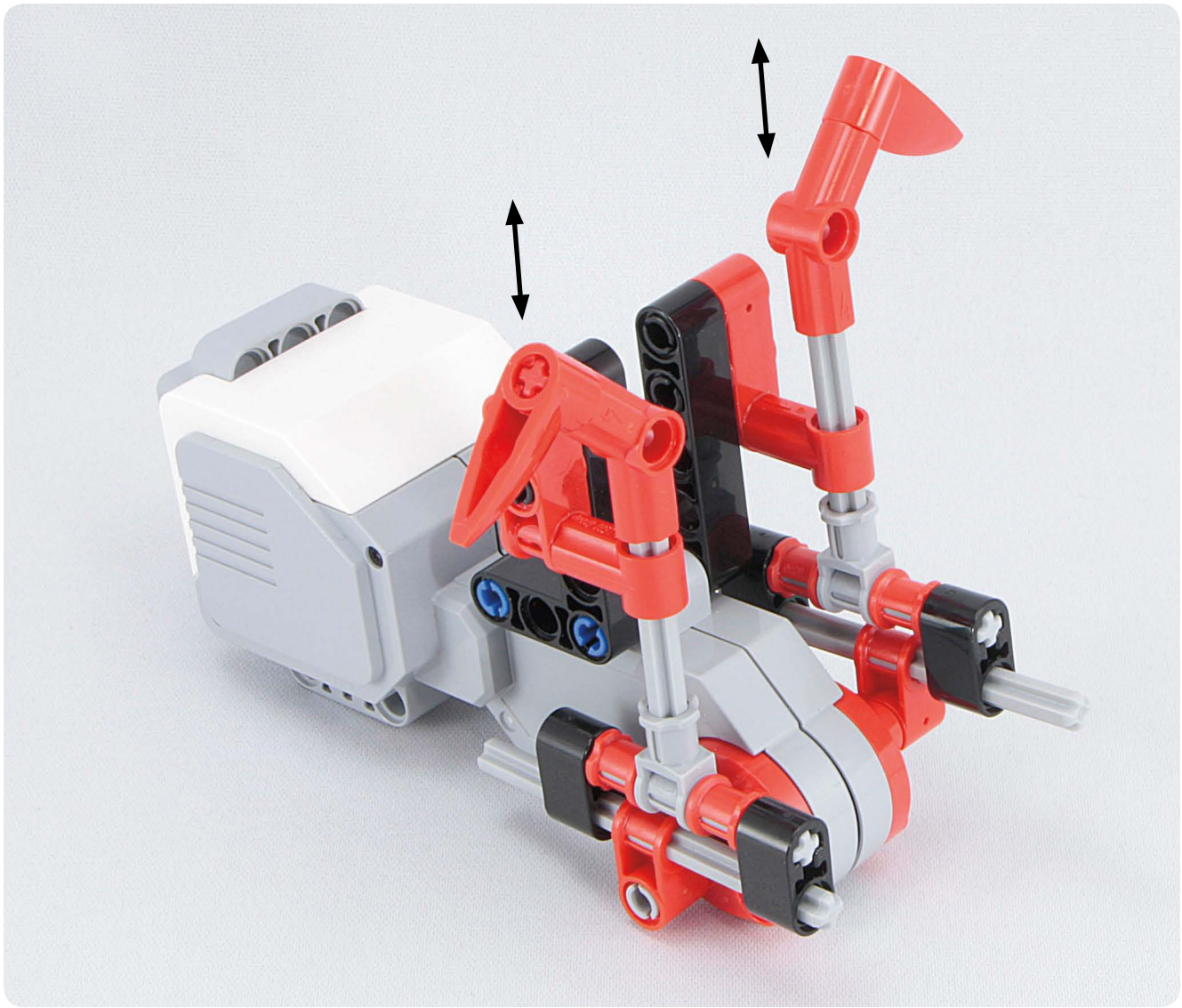


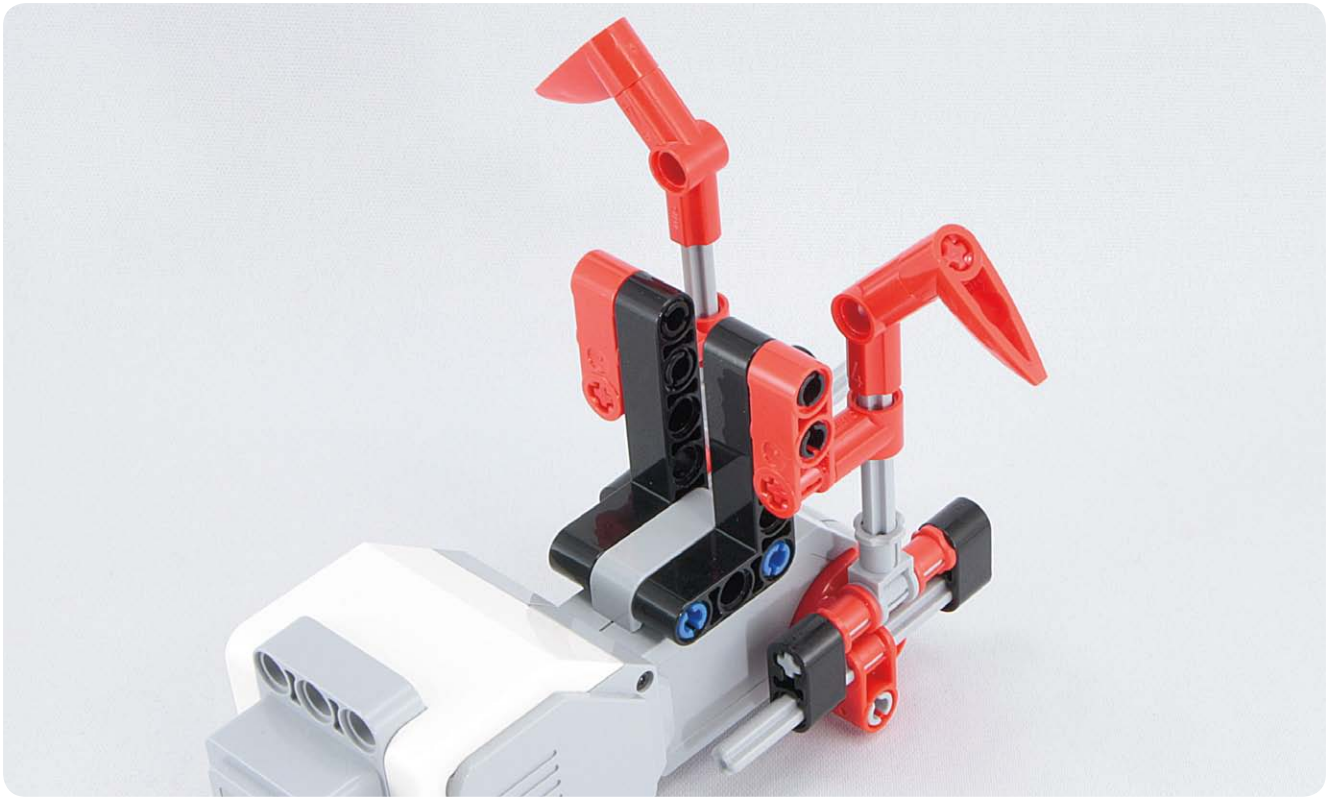


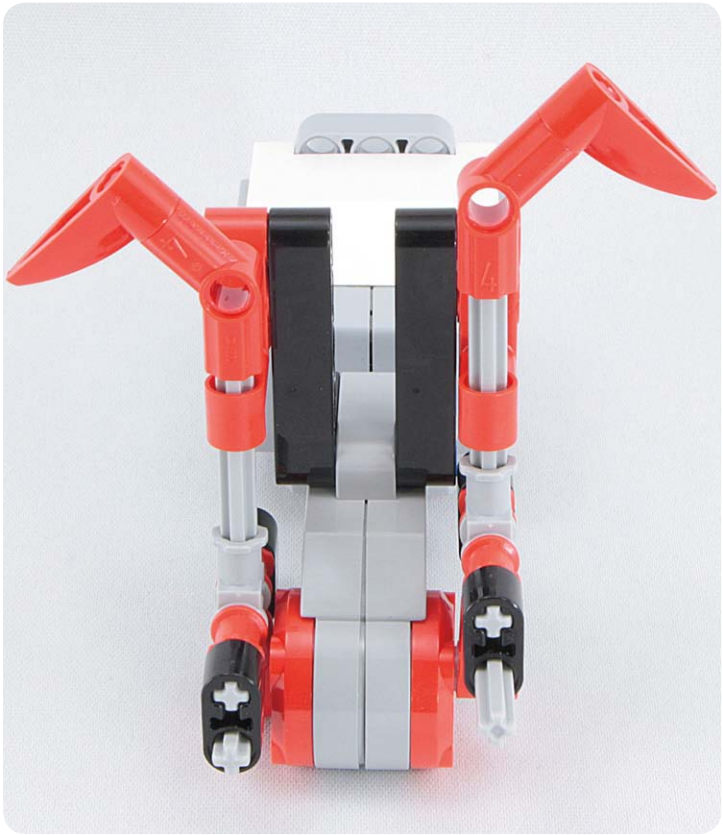


#134



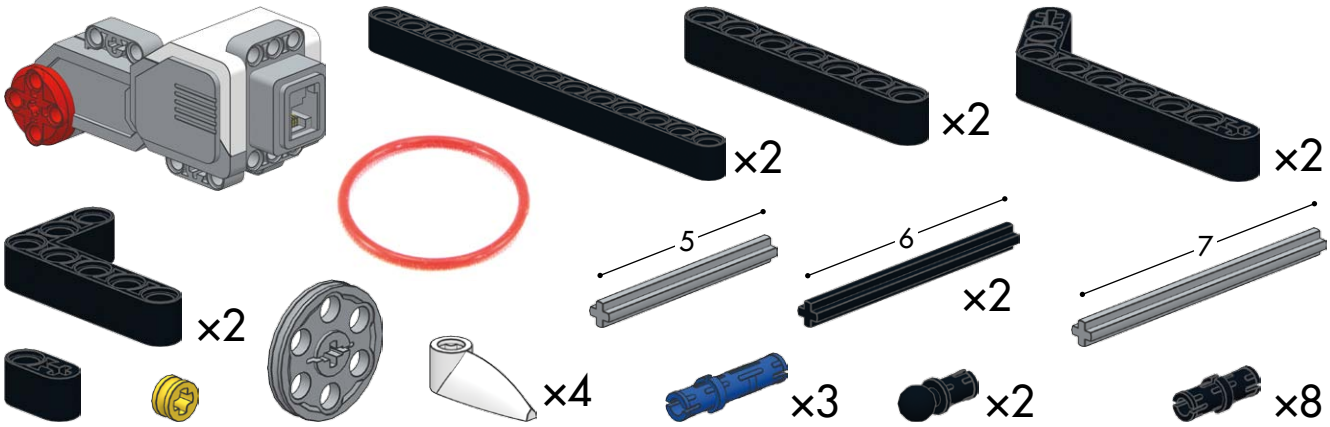


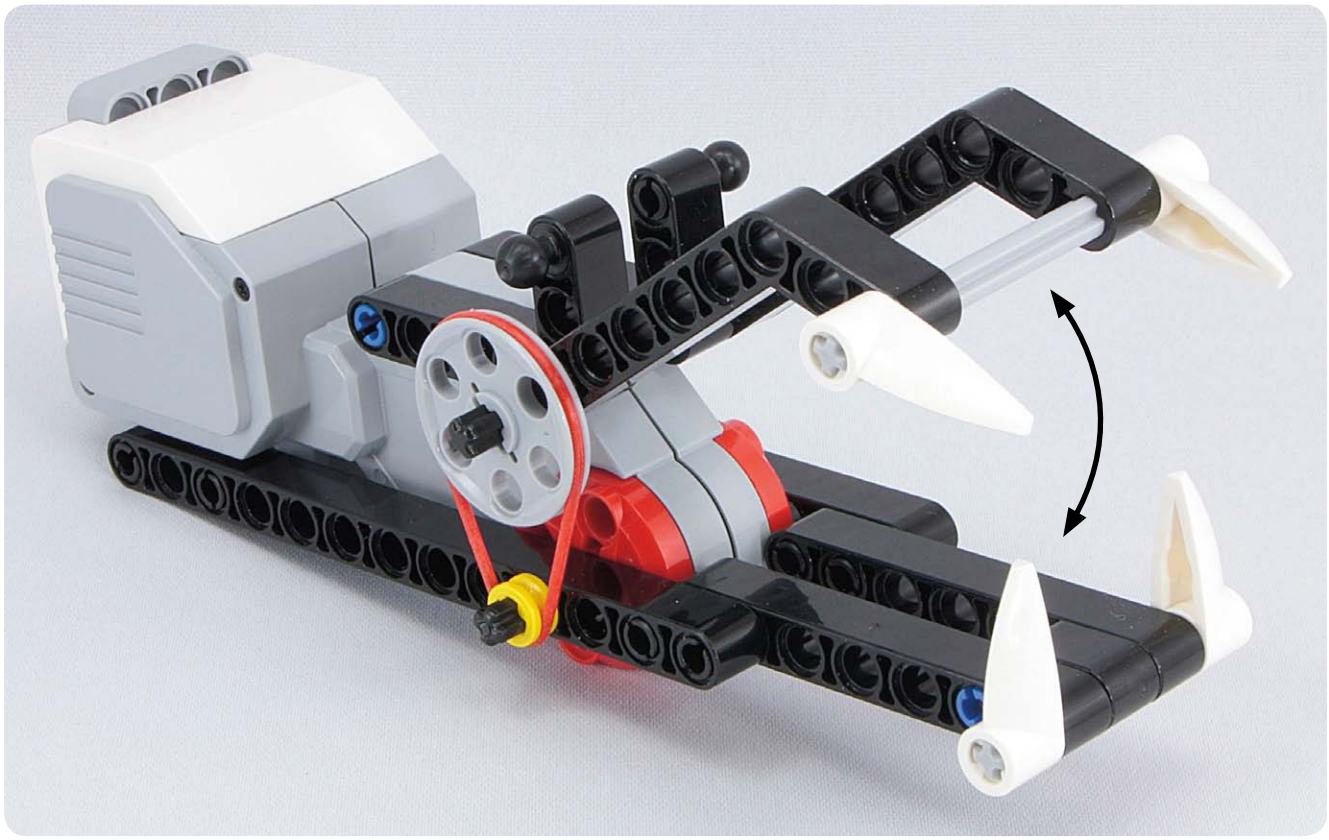


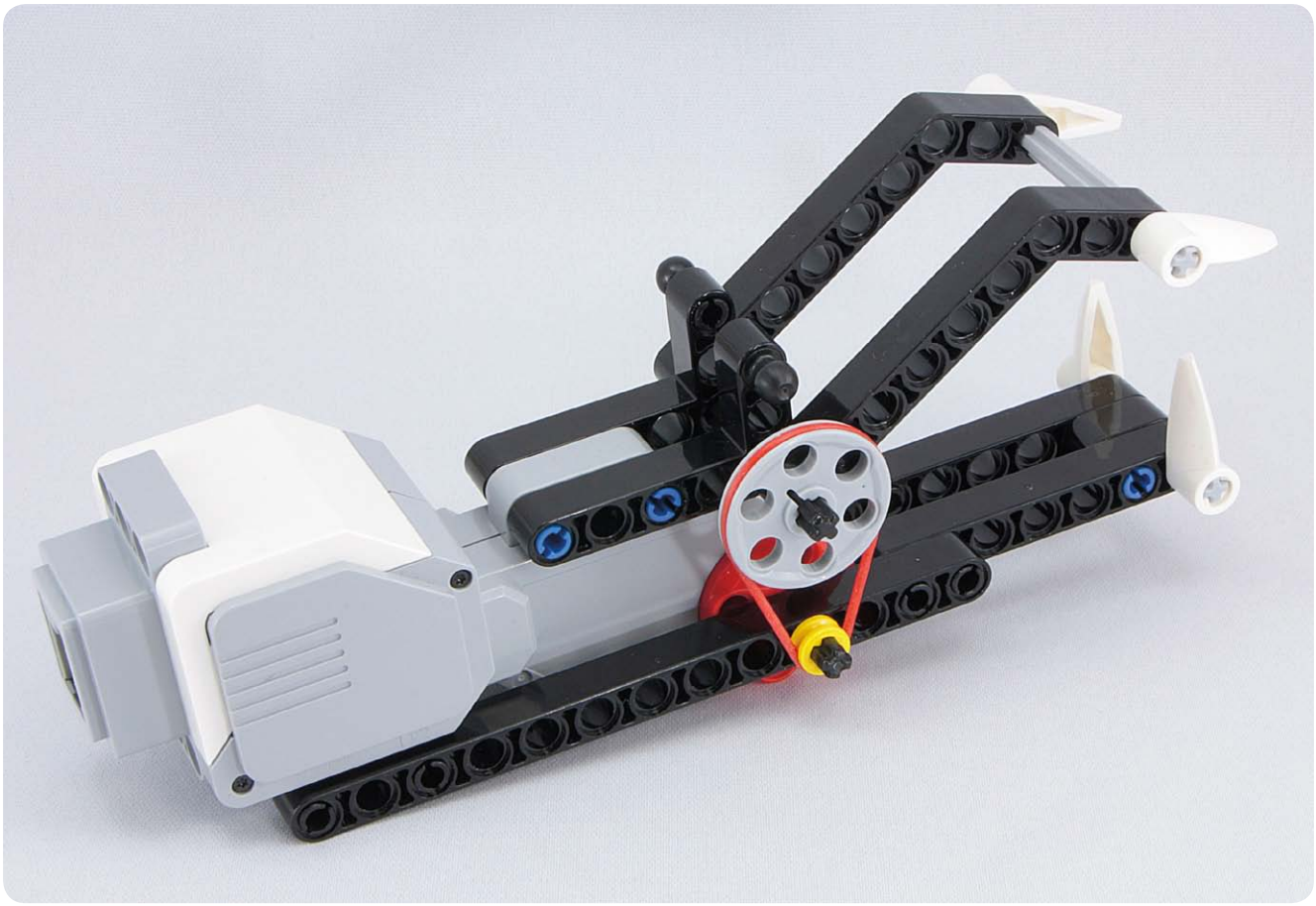


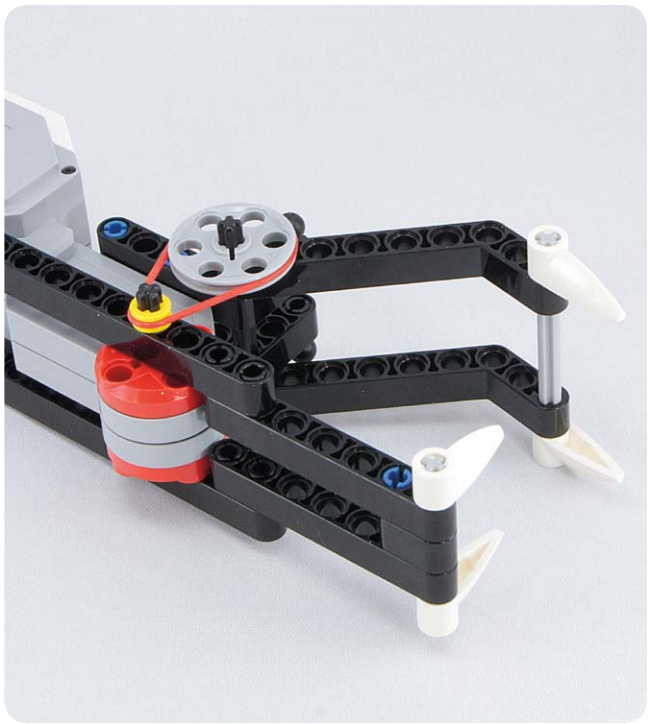
Gripping fingers

#135









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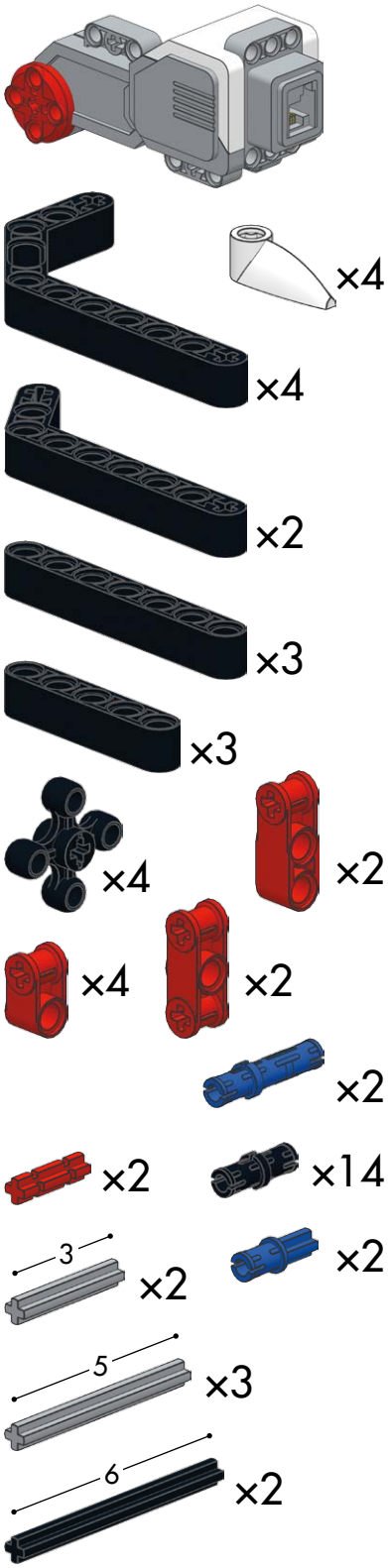
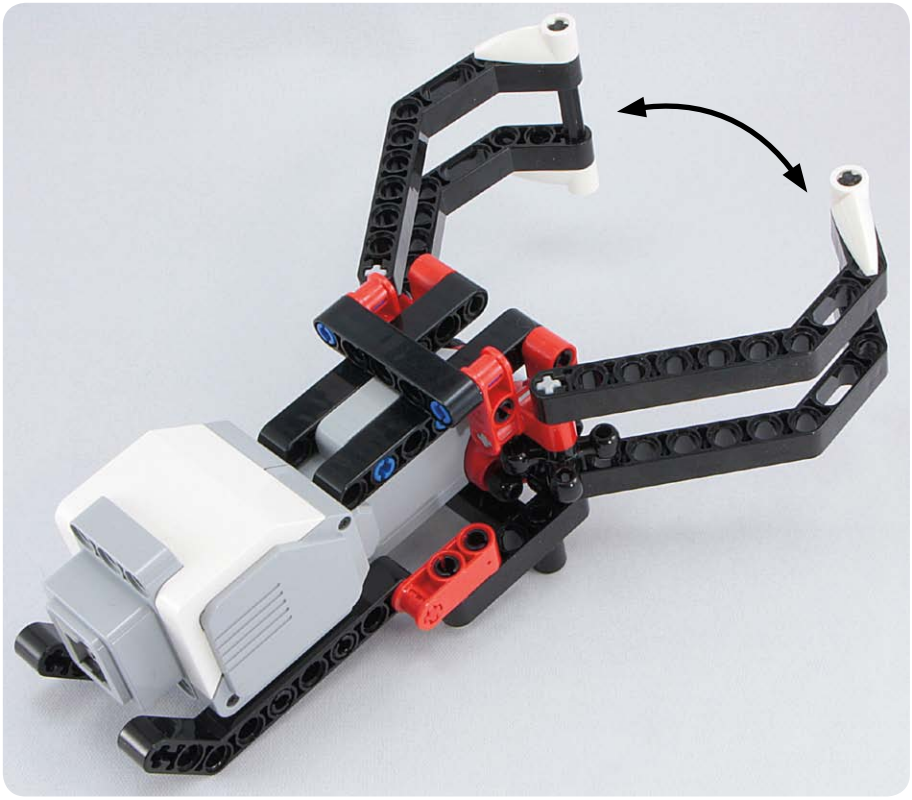
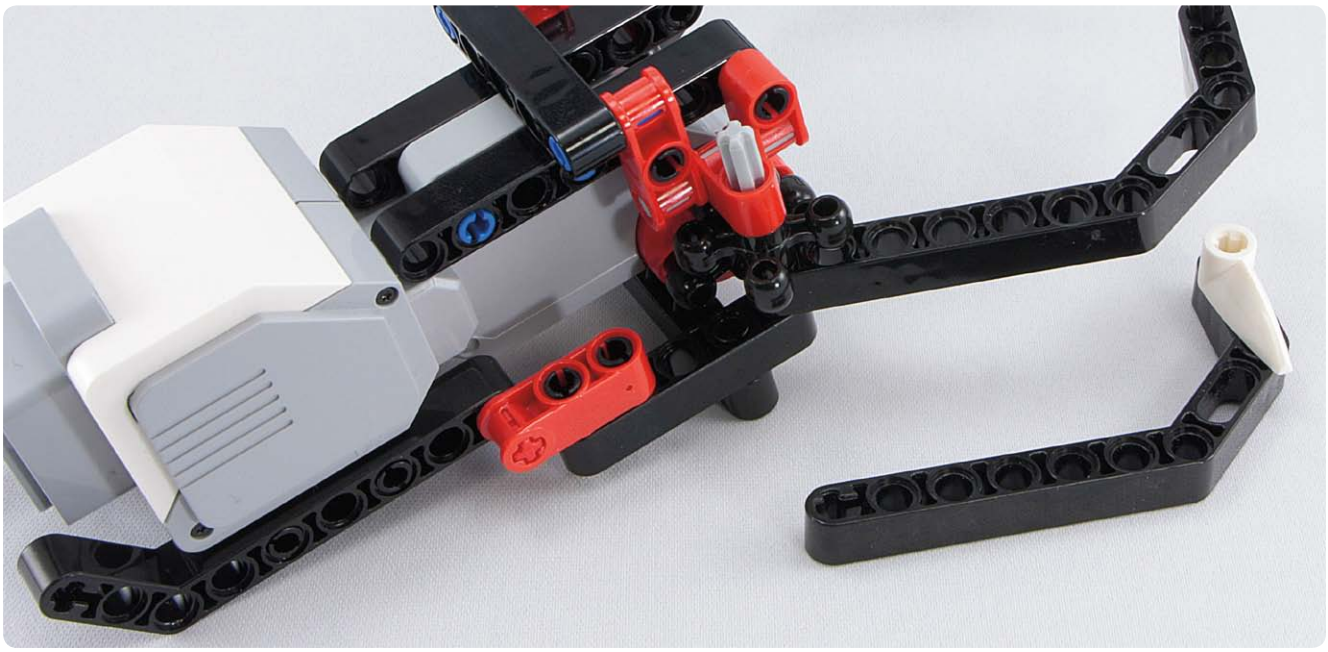
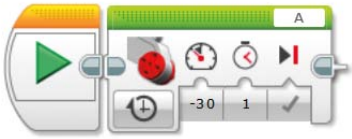
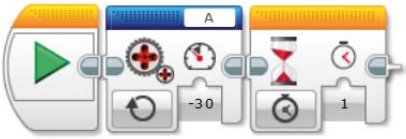




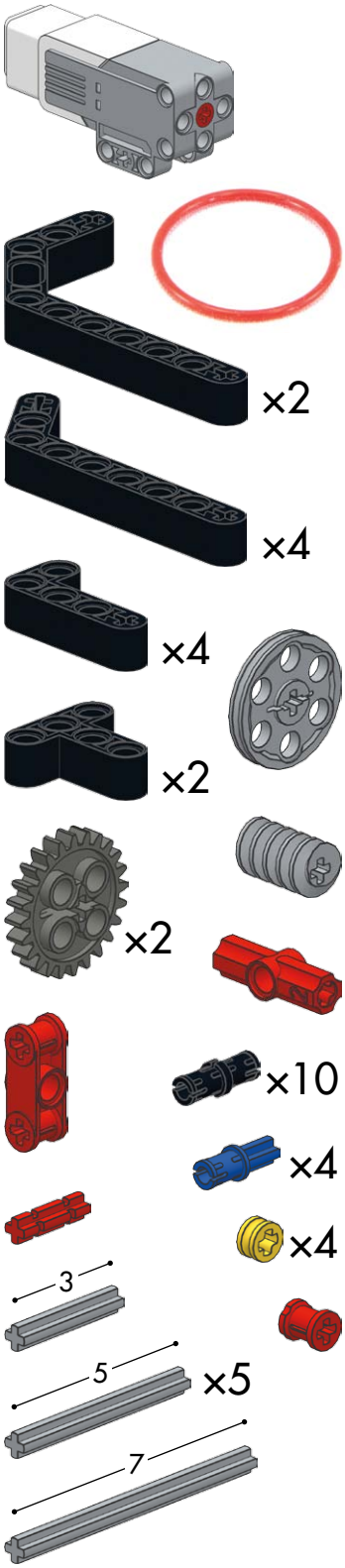


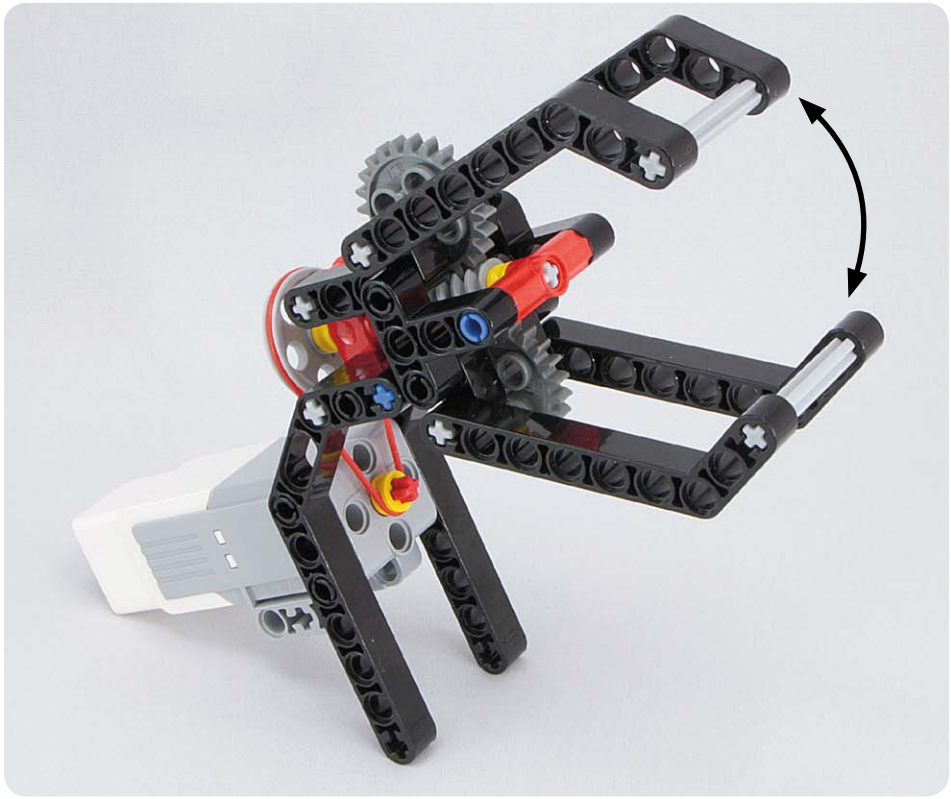


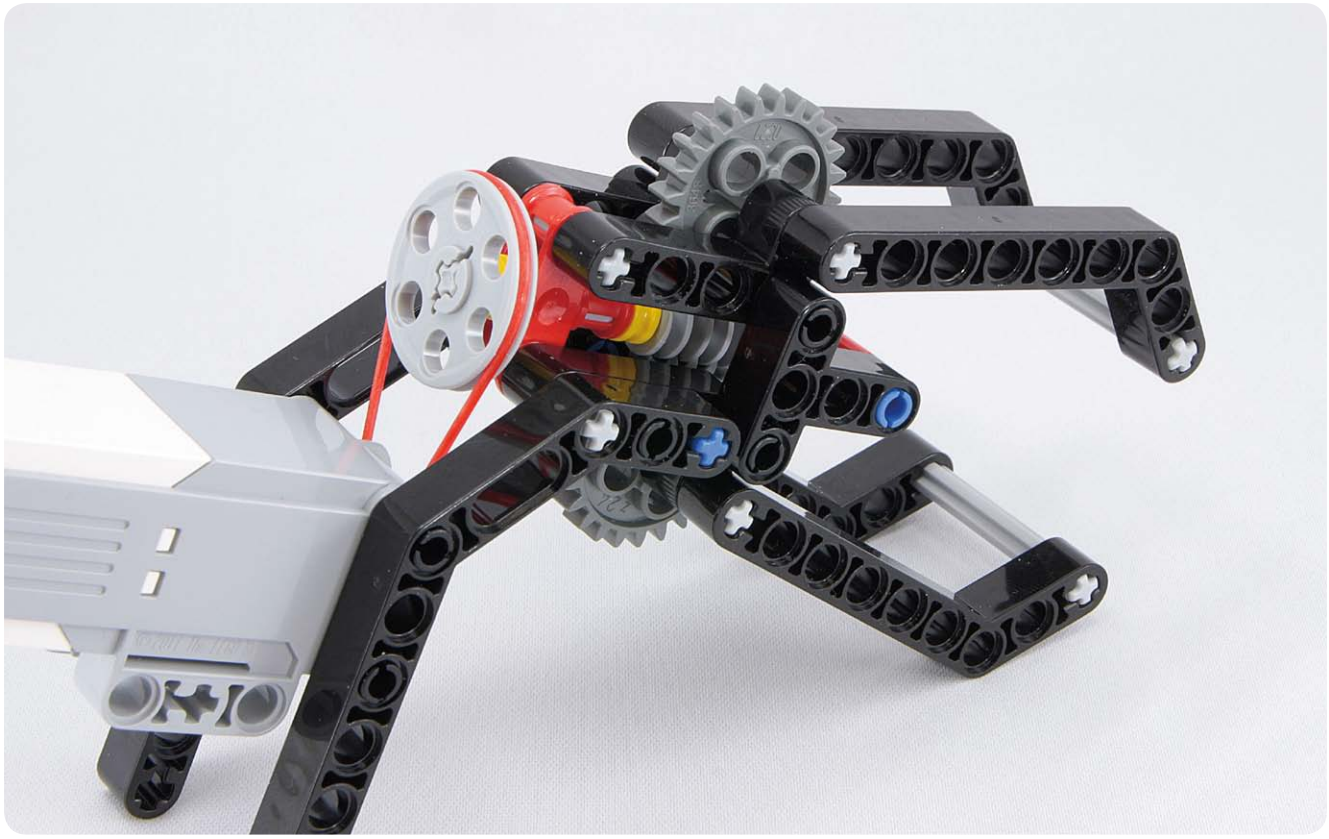


To avoid overextending the mechanism, use this program instead of the standard one.

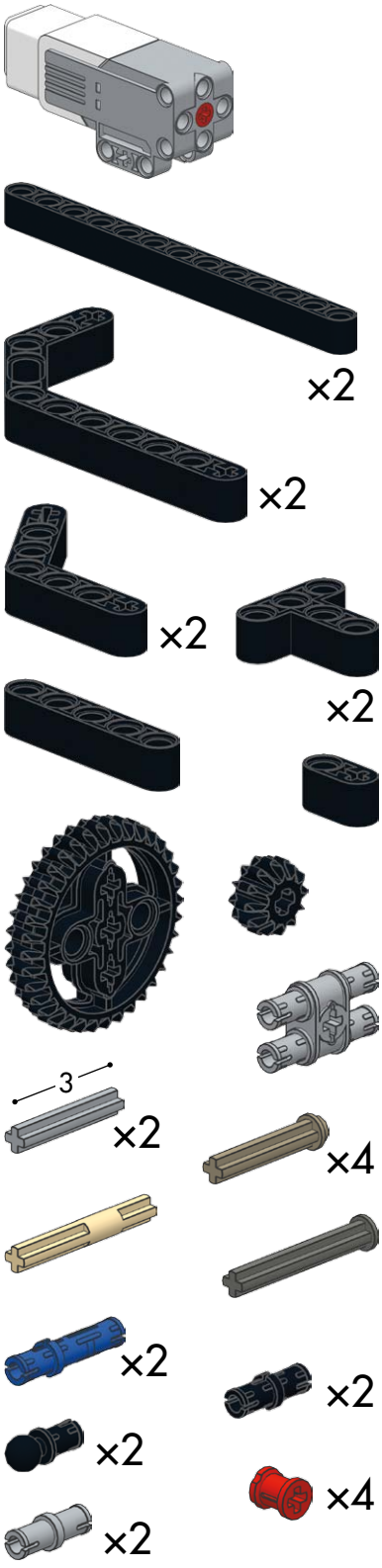
#137

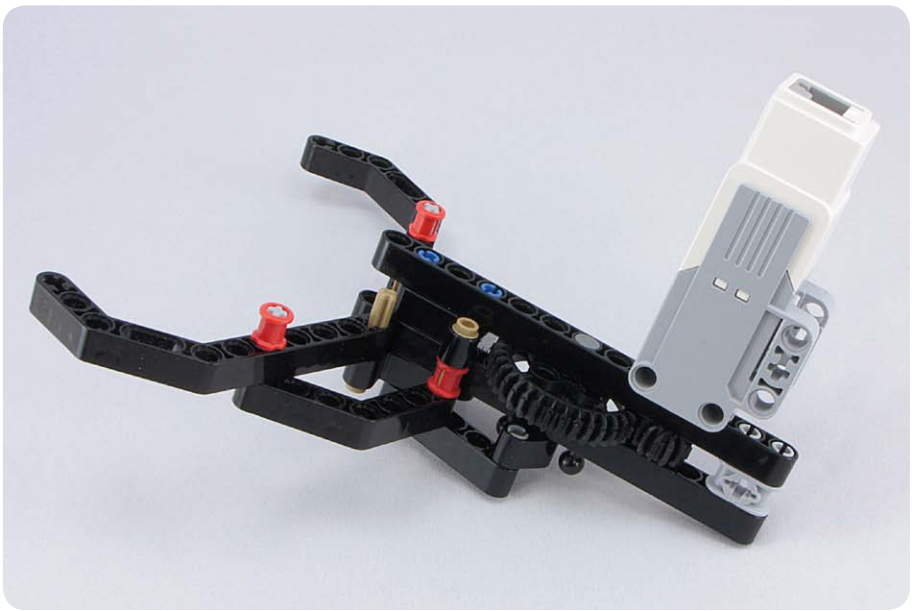


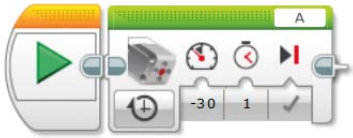




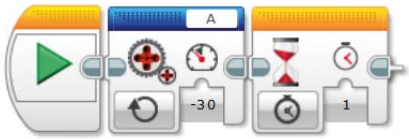
#138

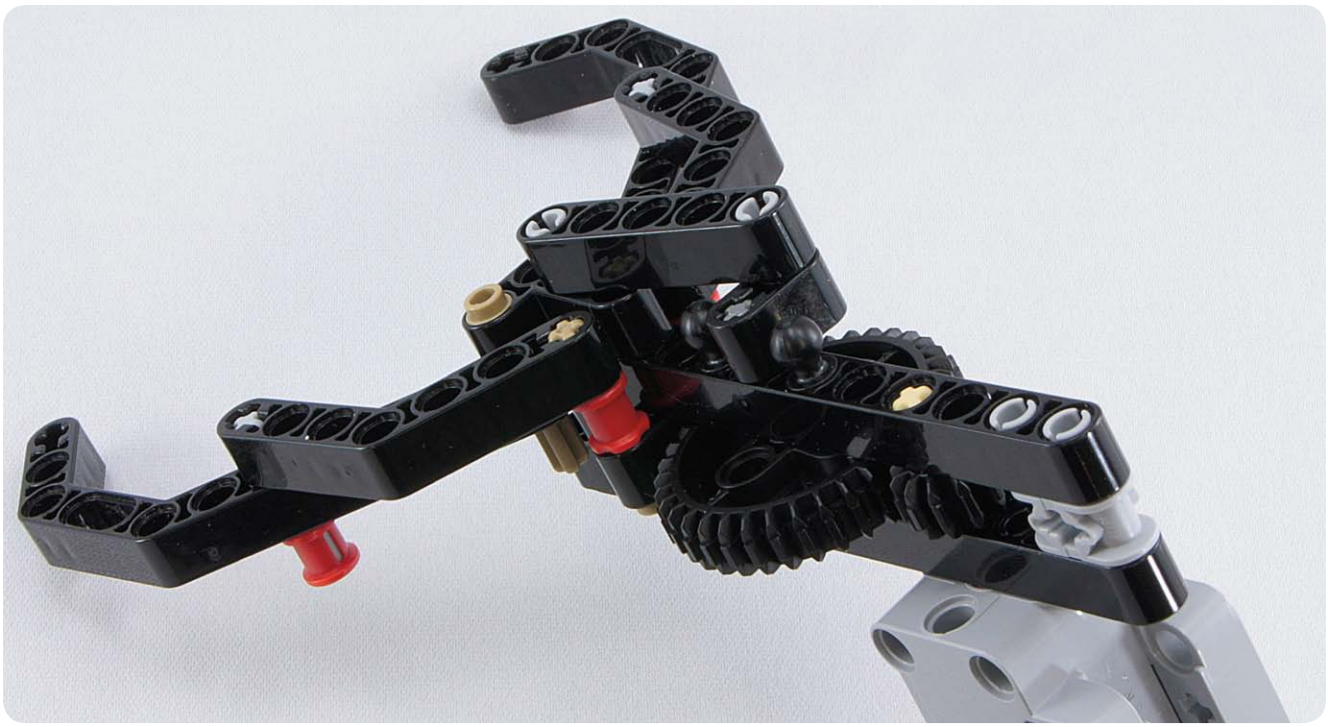




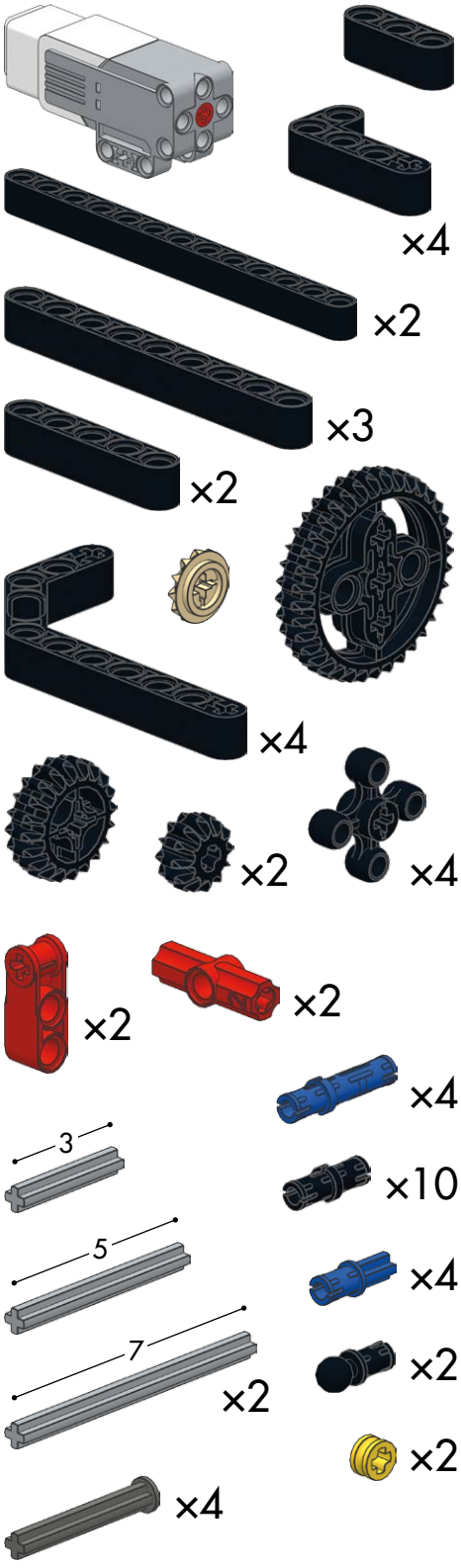


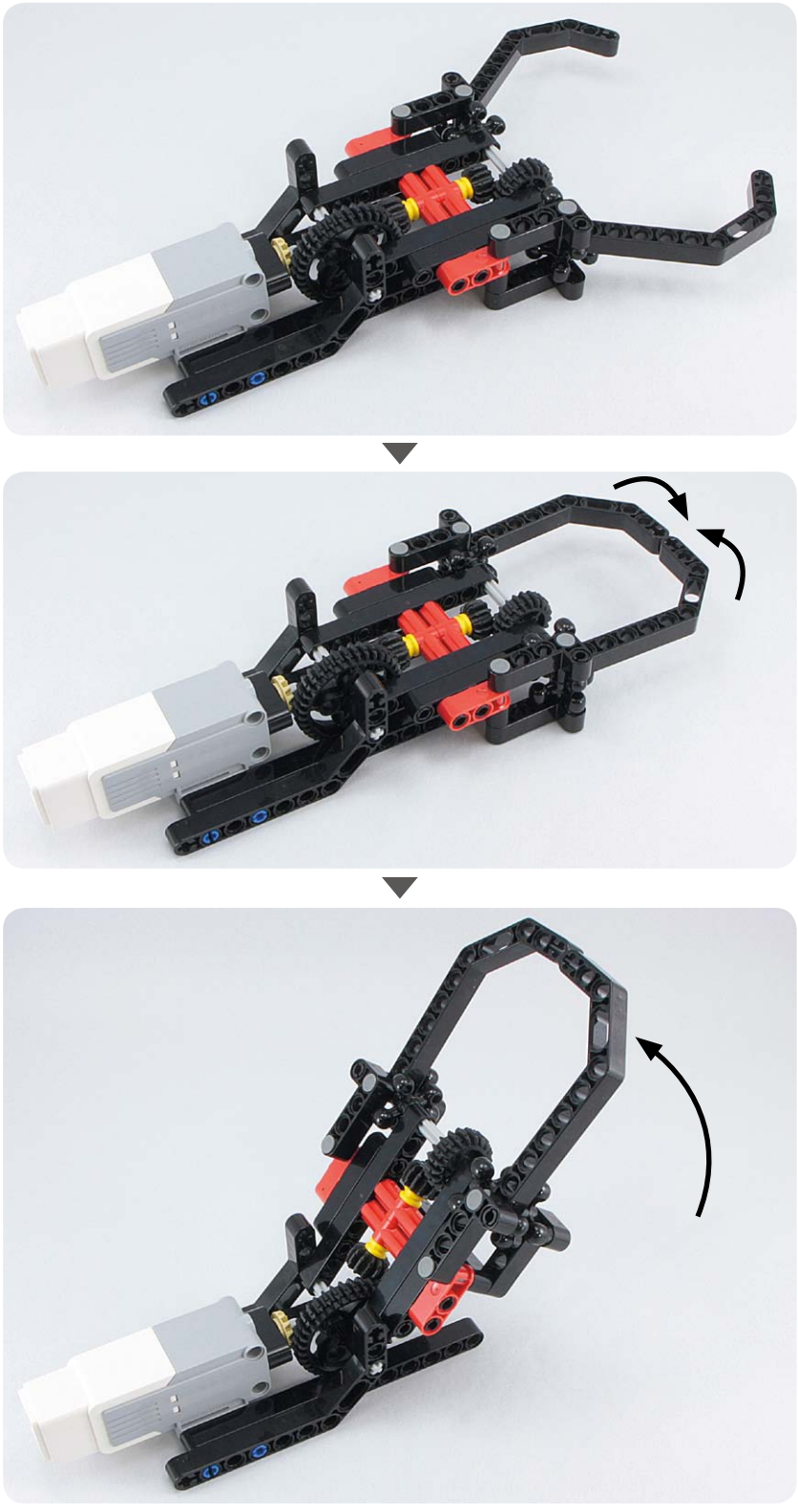
To avoid overextending the mechanism, use this program instead of the standard one.

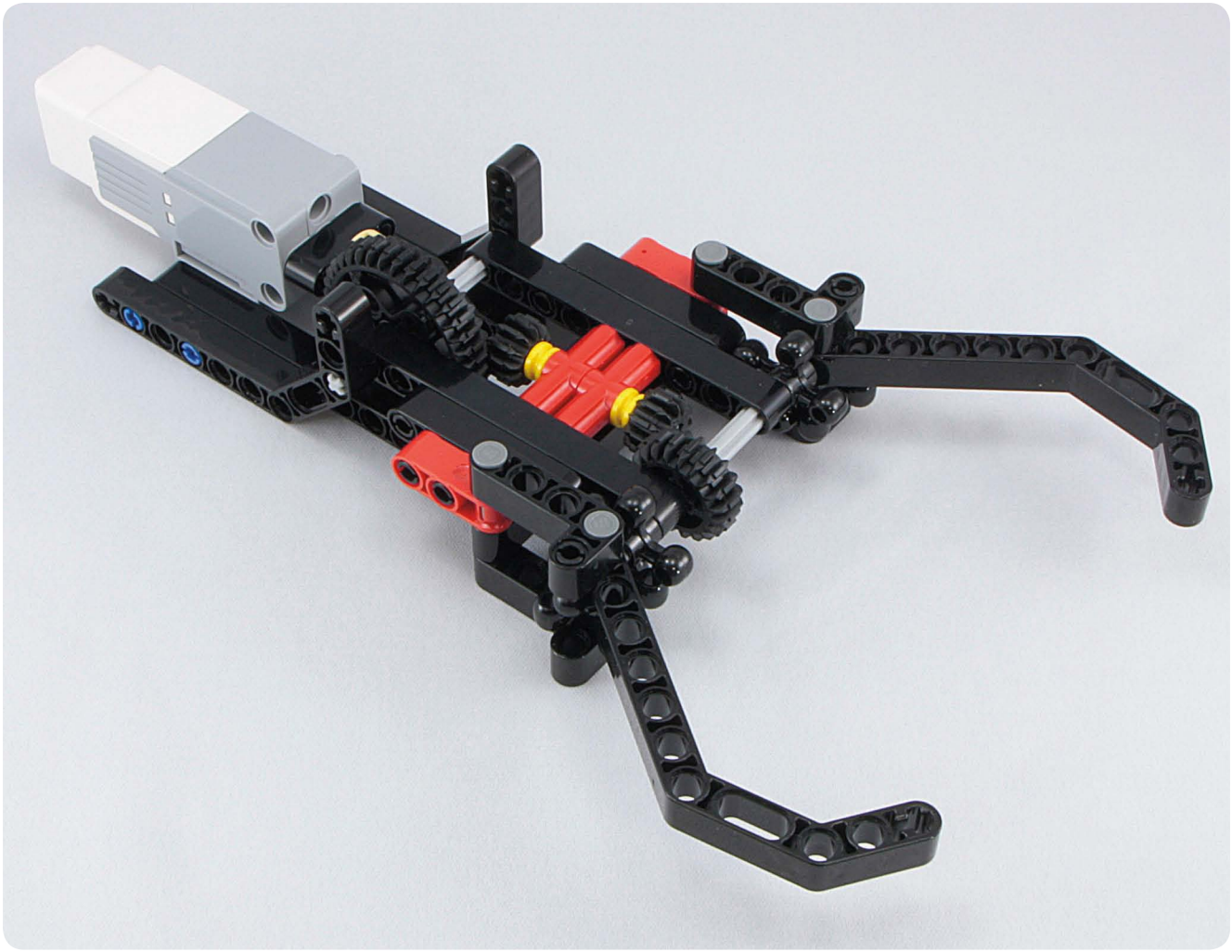


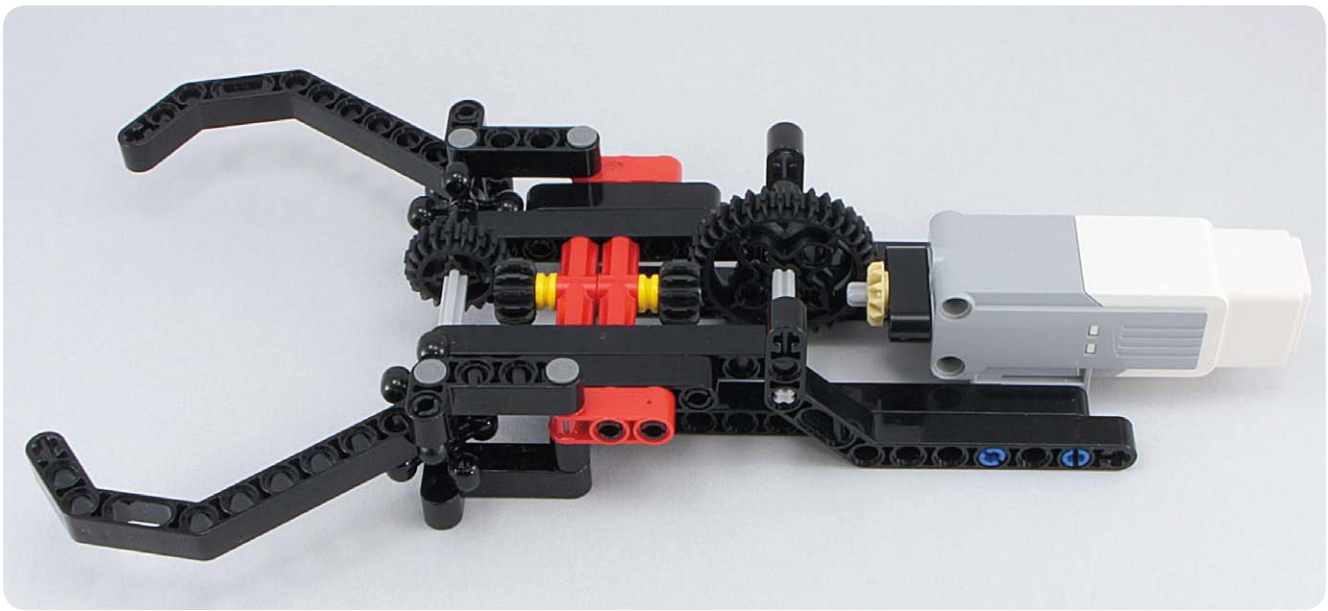


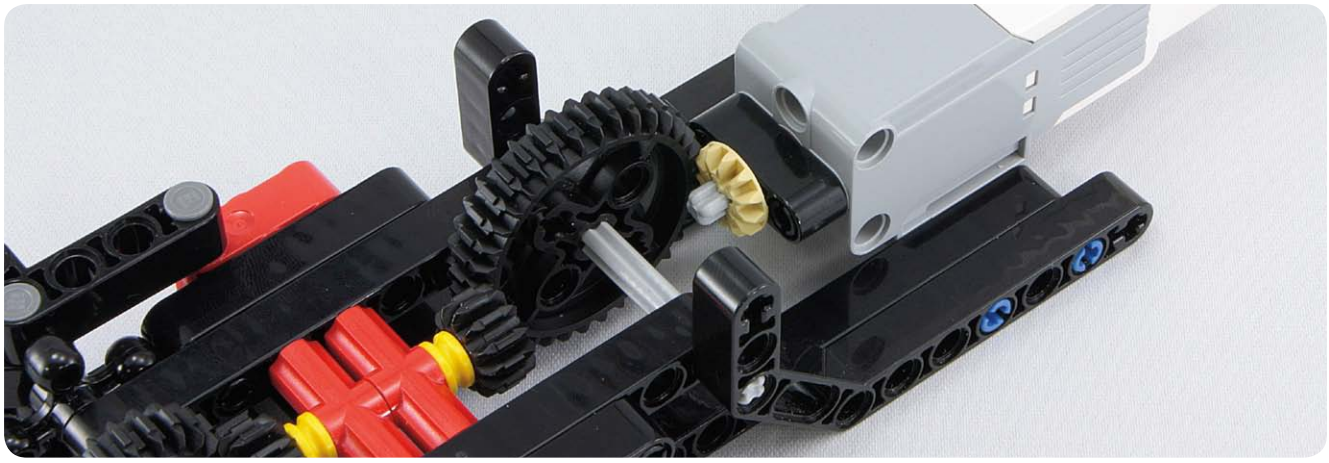
#139

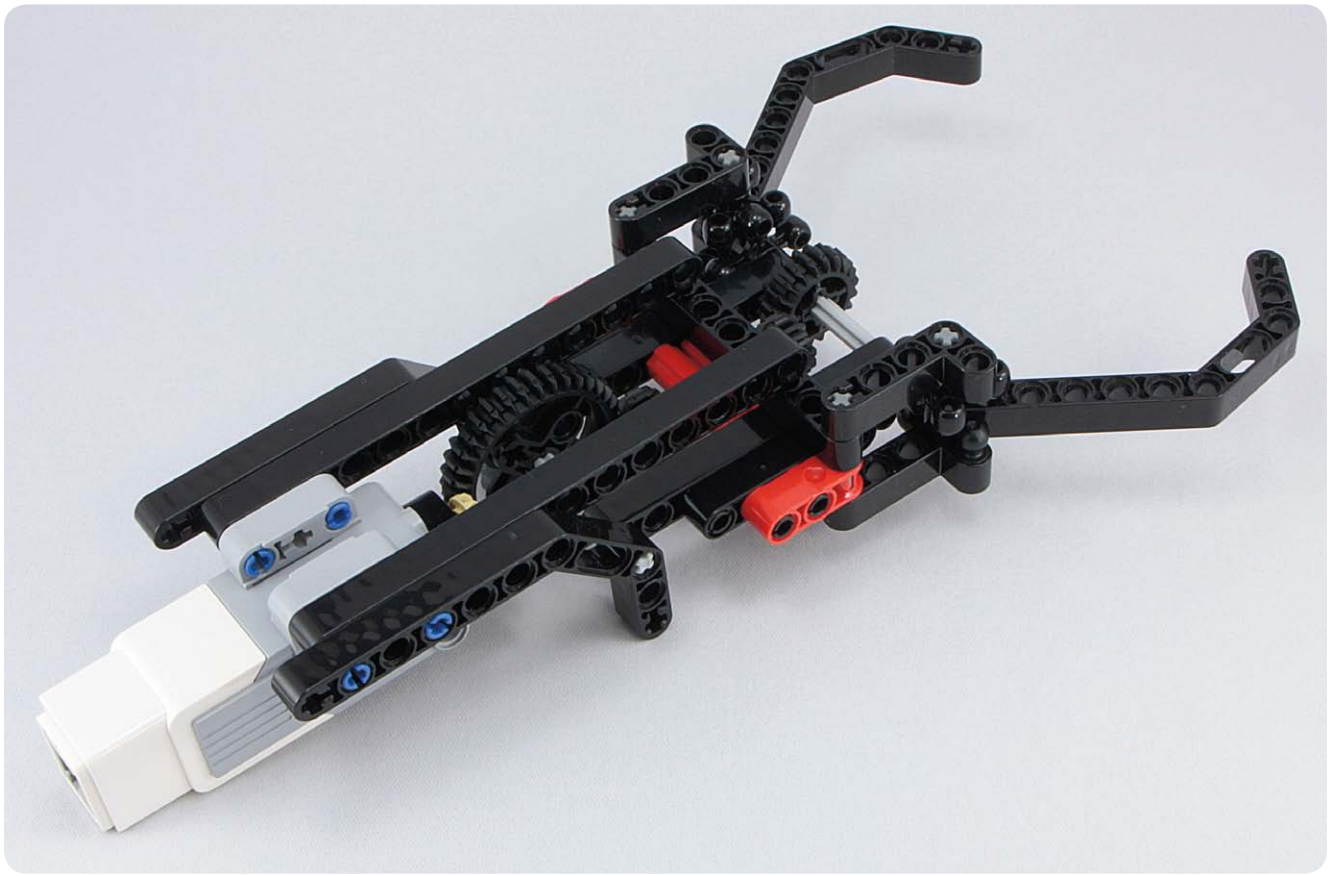




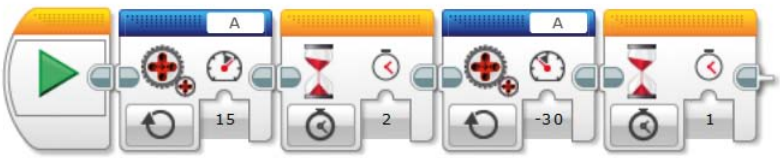






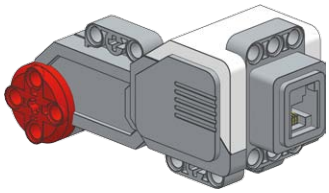


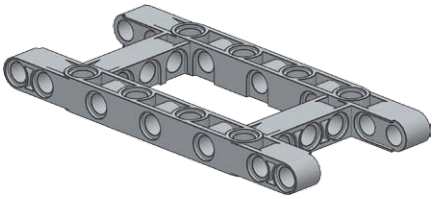
Here's a program for this arm.

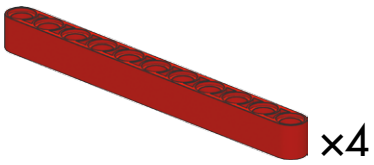


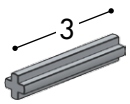
Lifting things

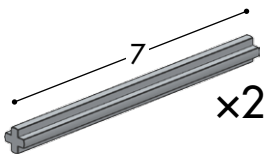
#140

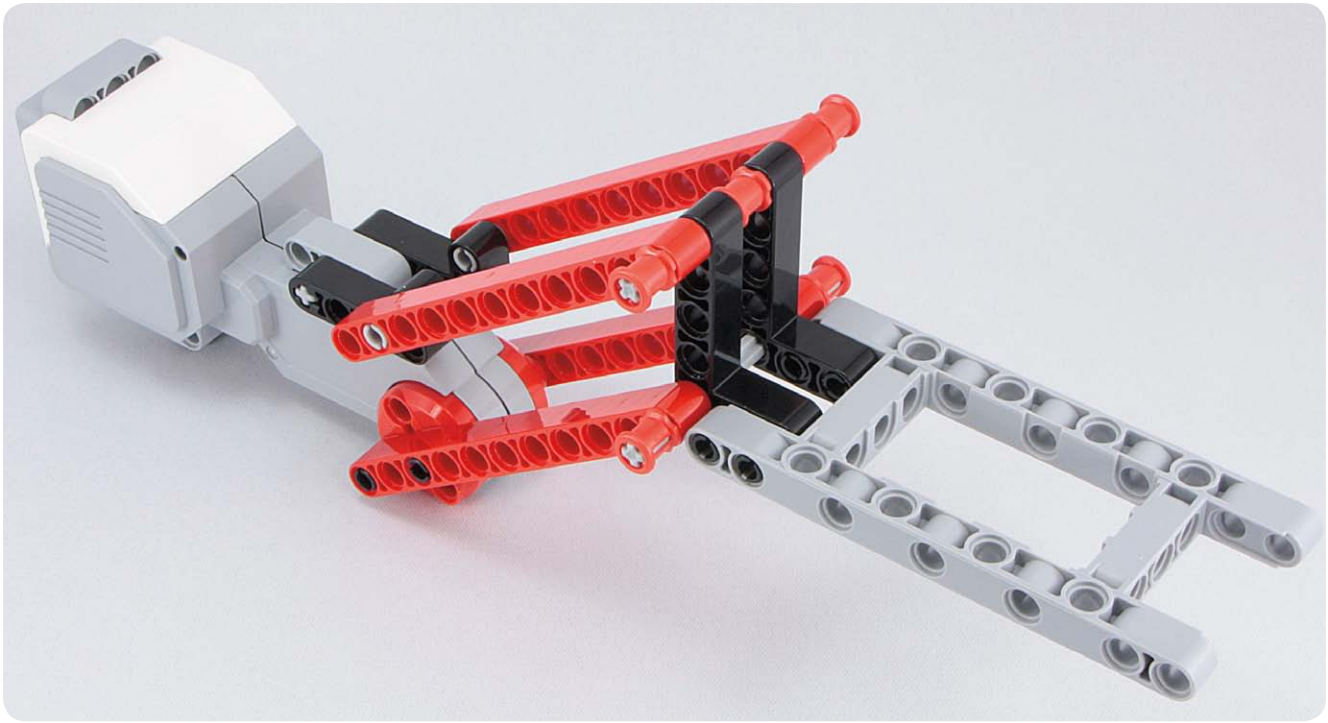


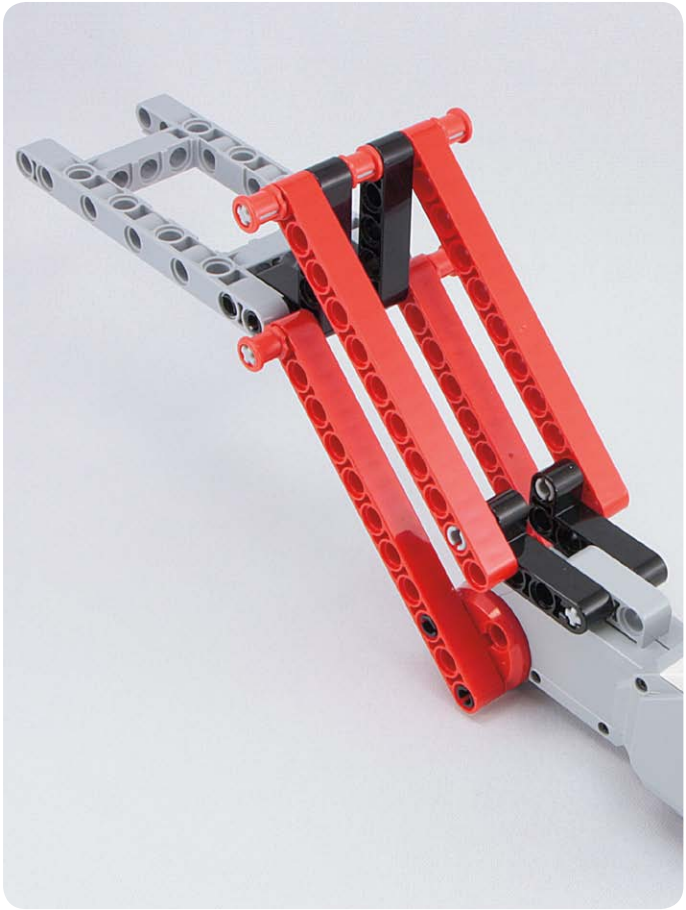


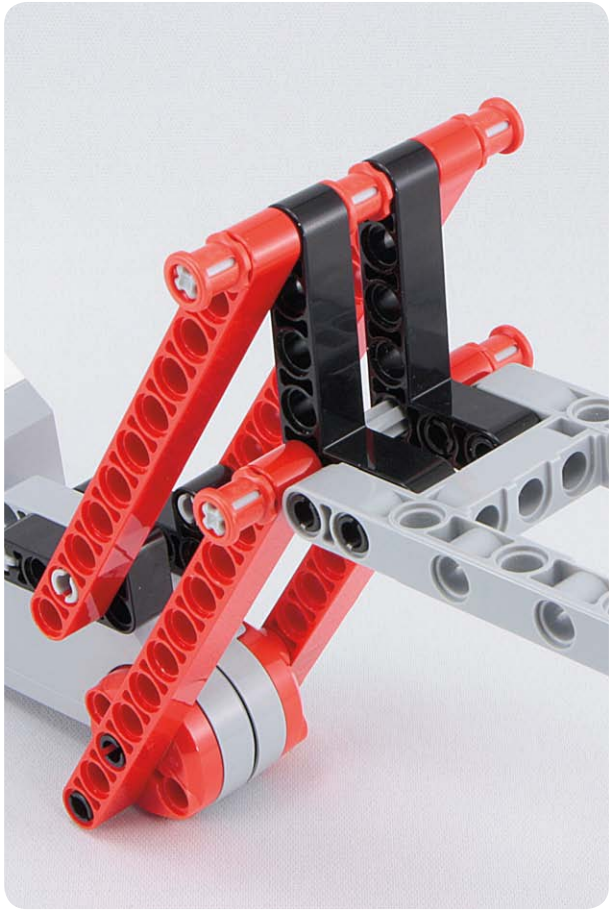




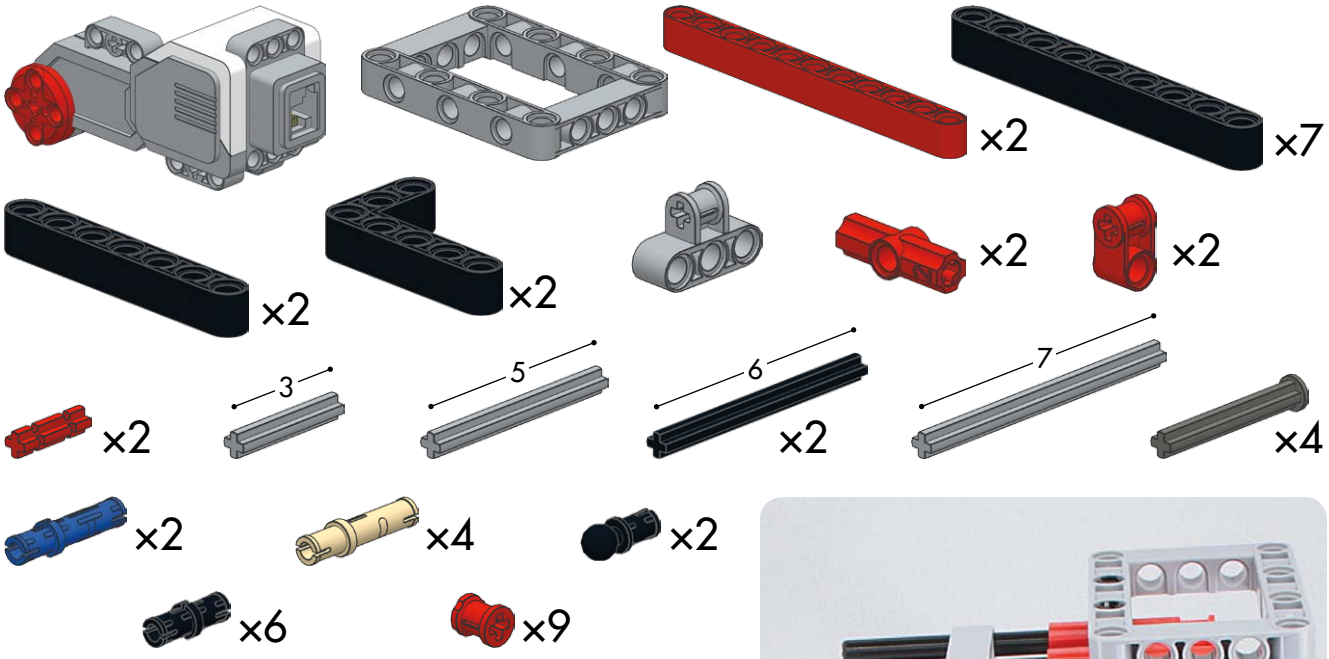


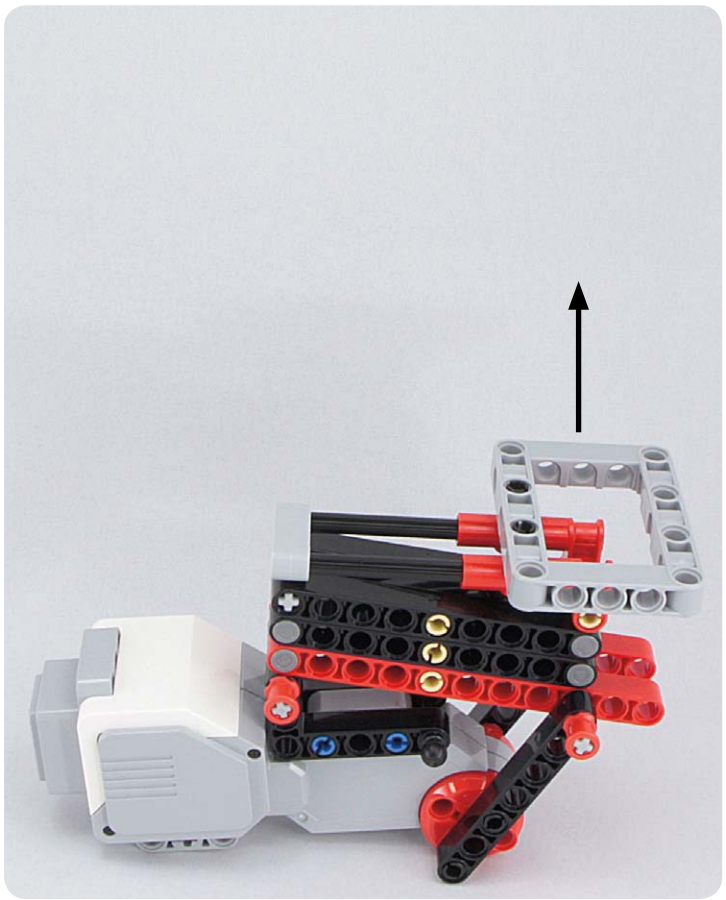


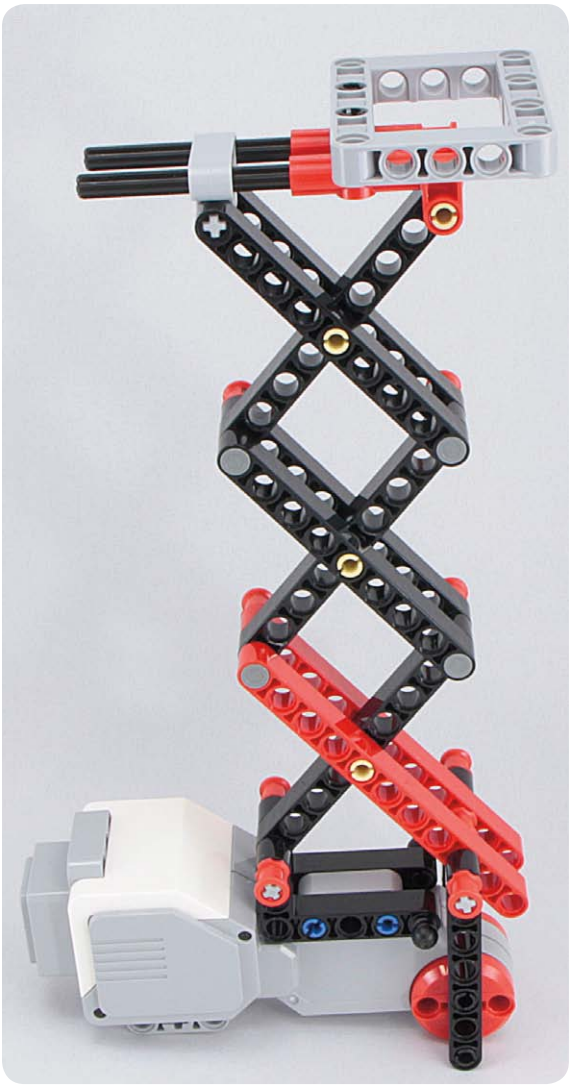


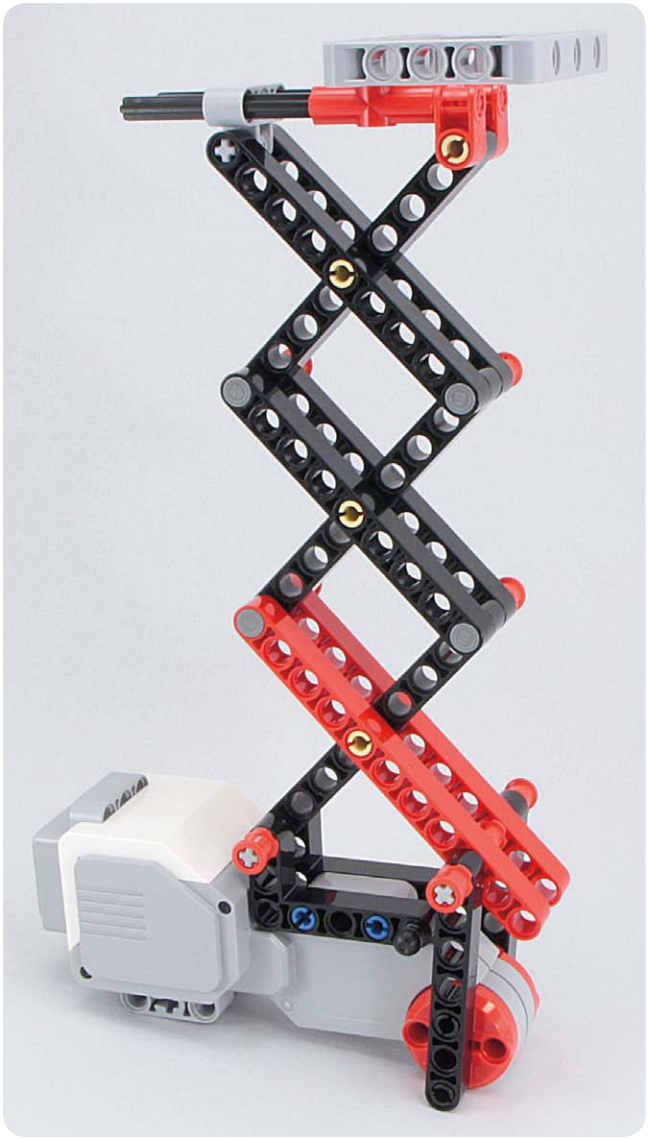


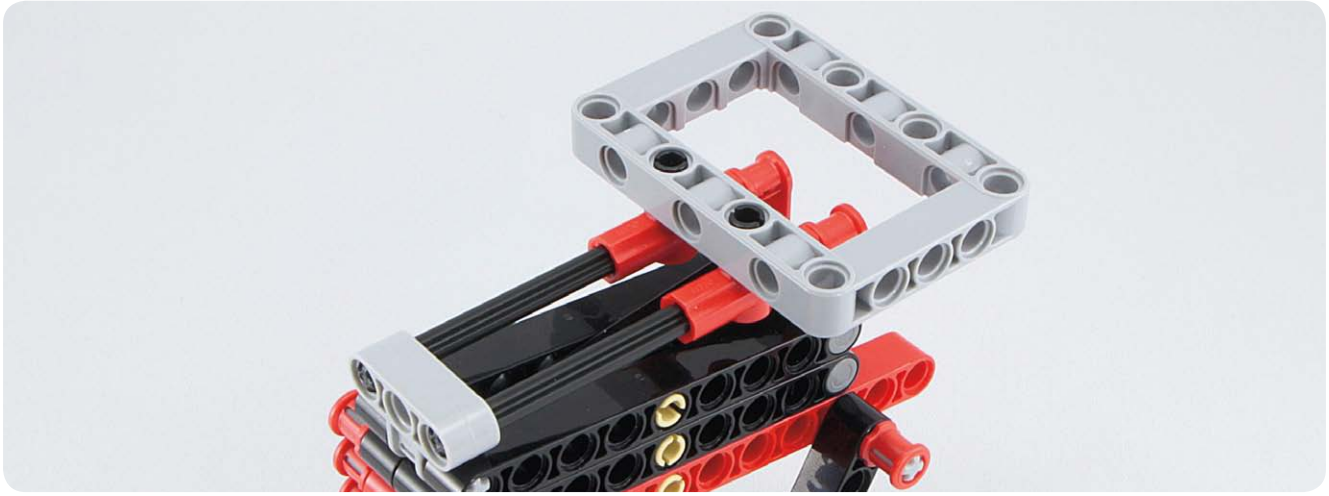
#141



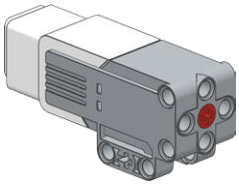


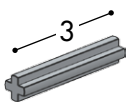


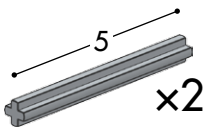


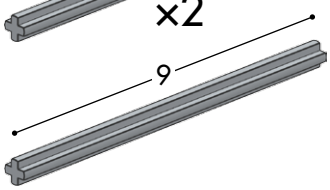


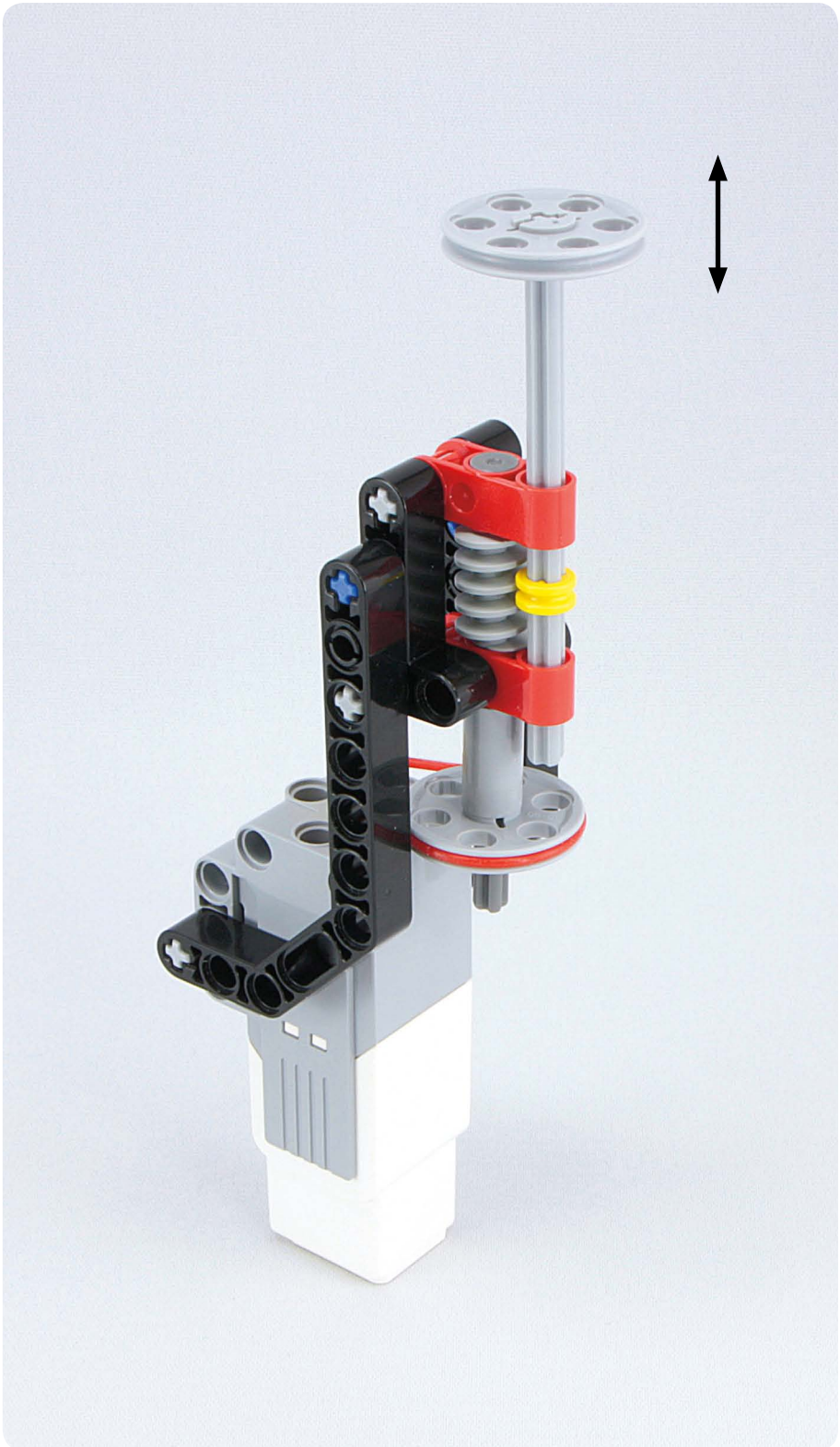
#142

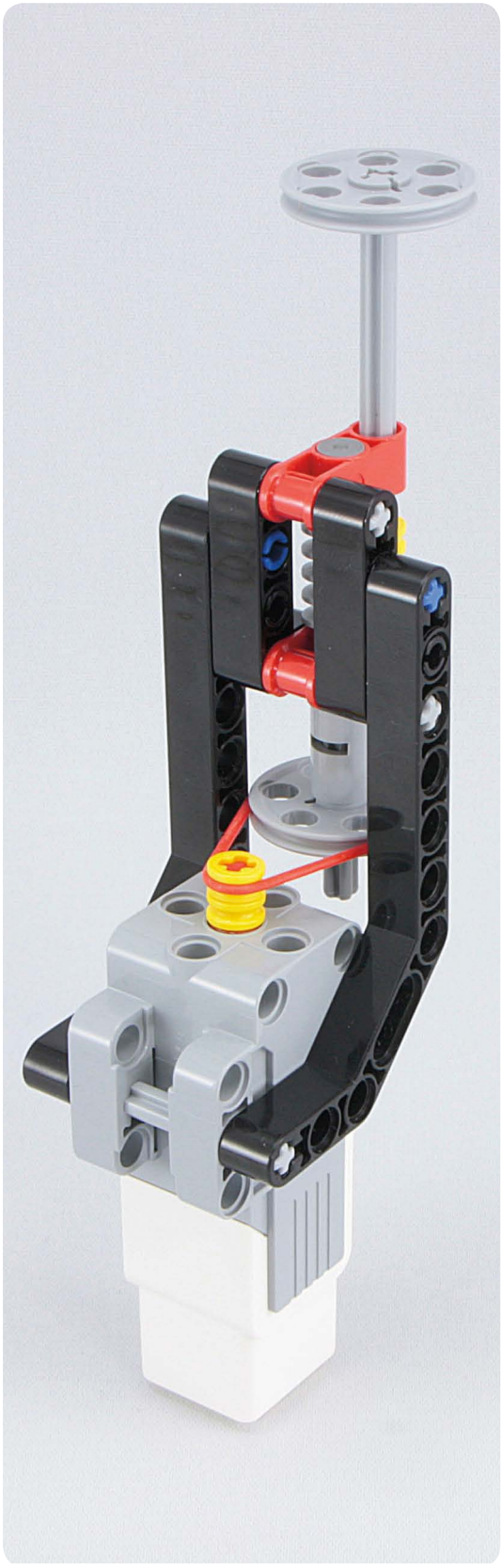






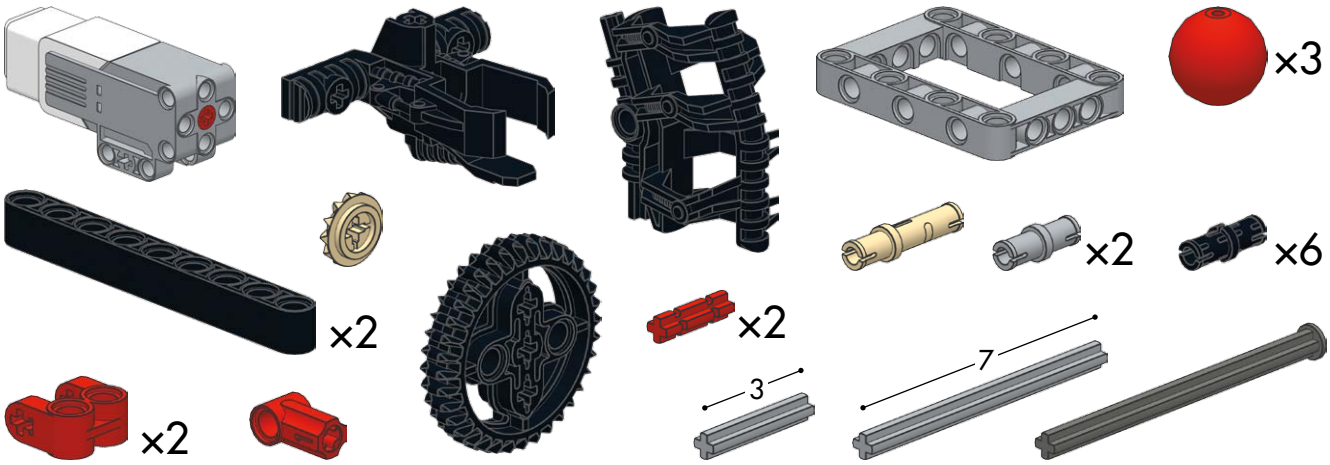


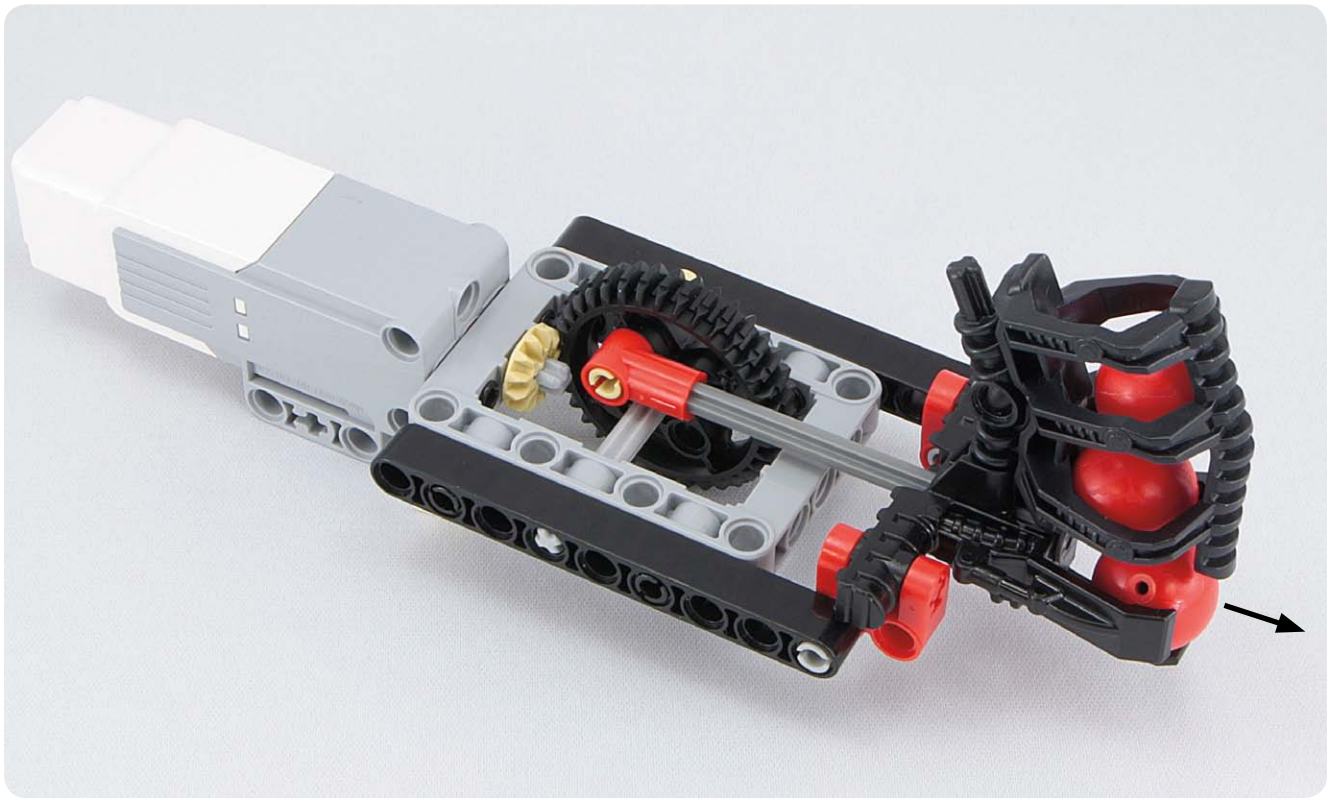


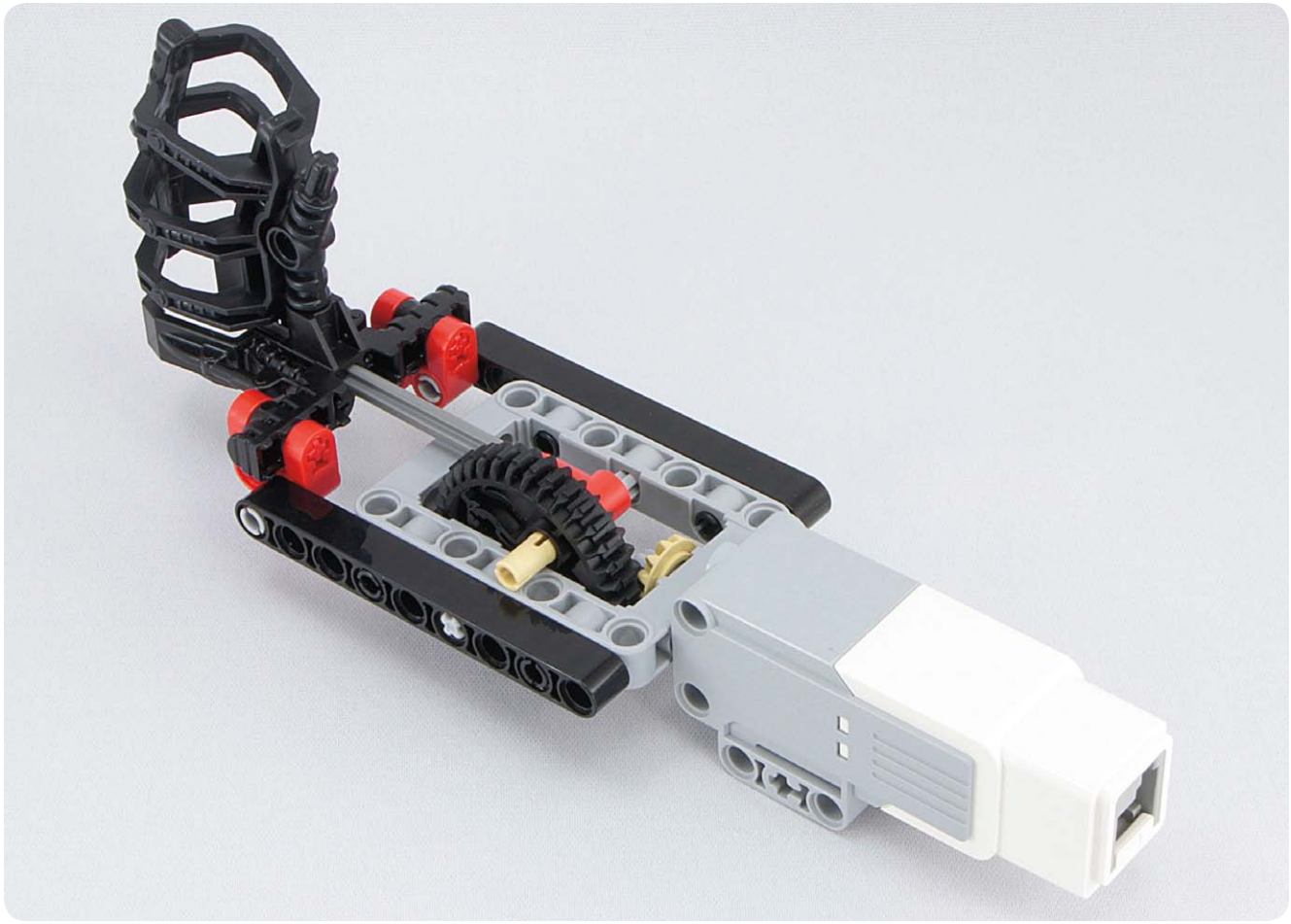


Shooting things

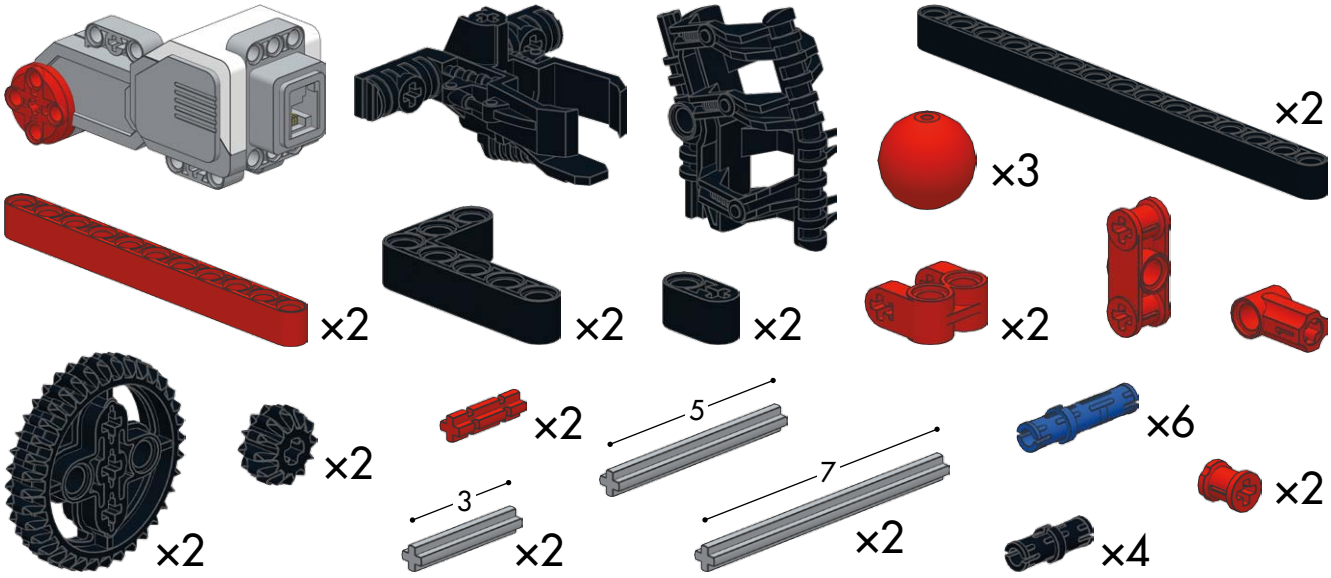
#143

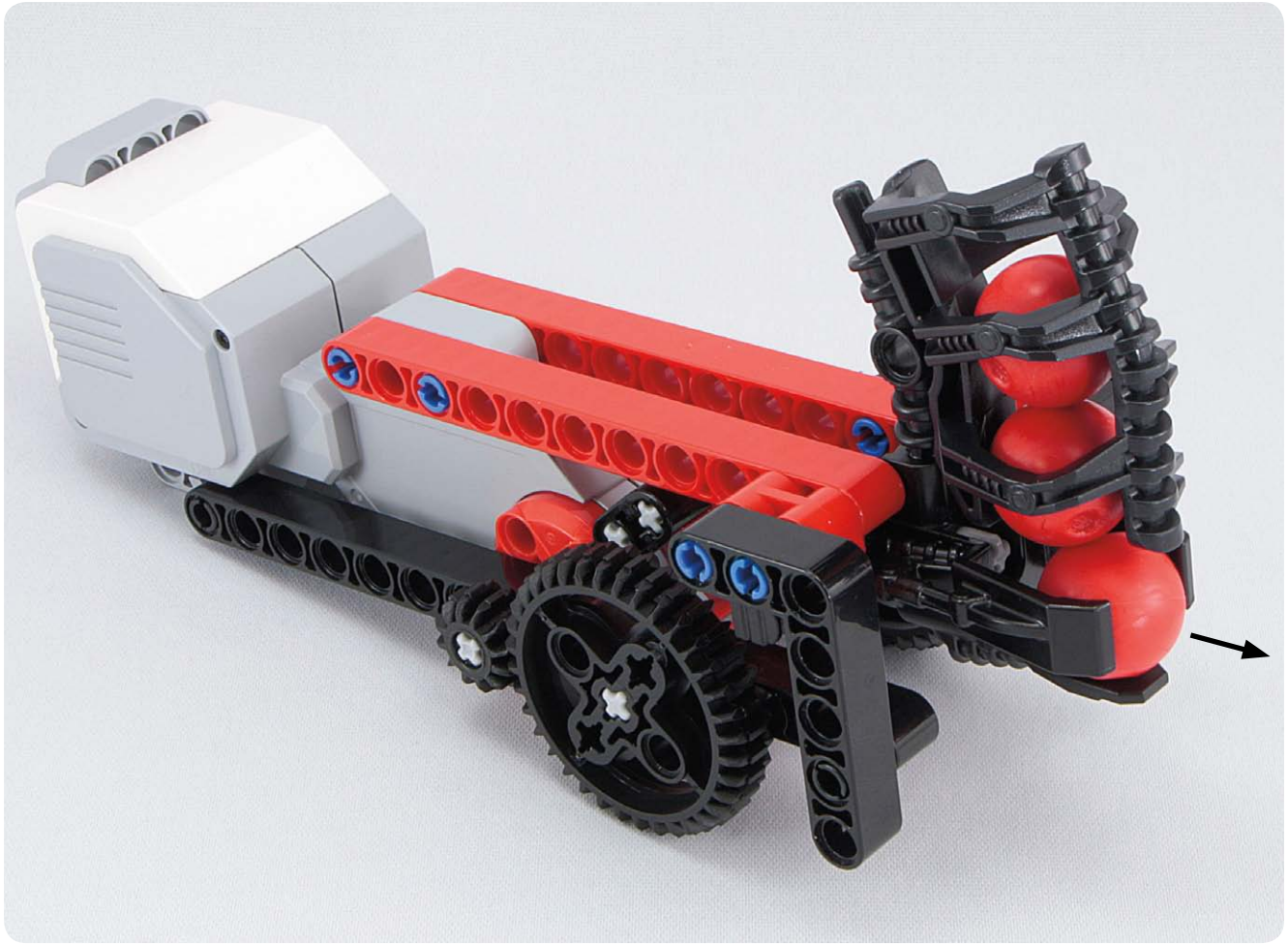


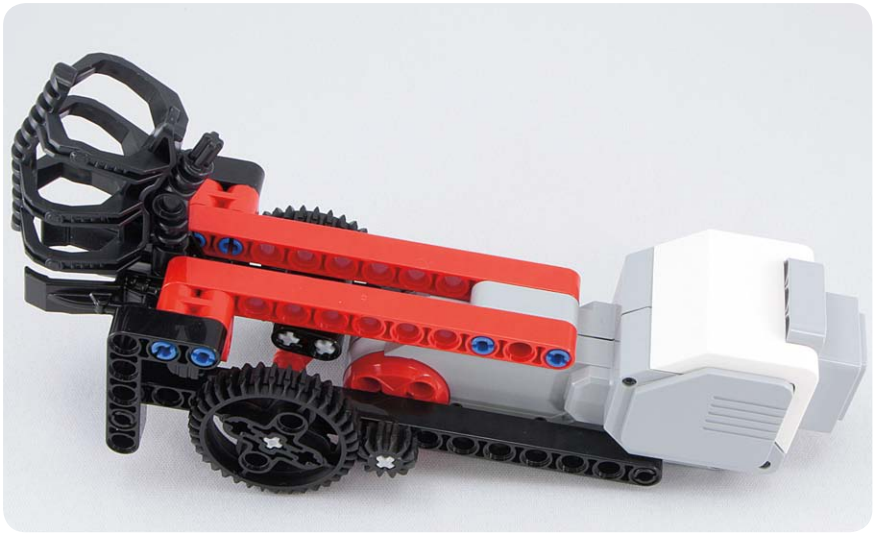


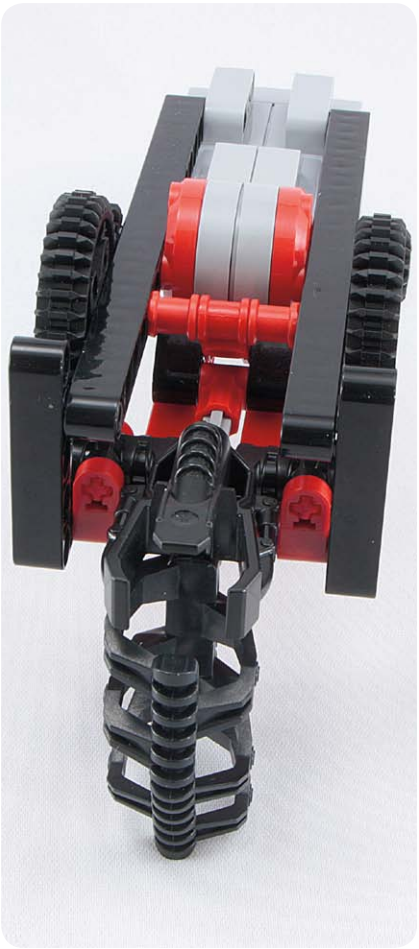


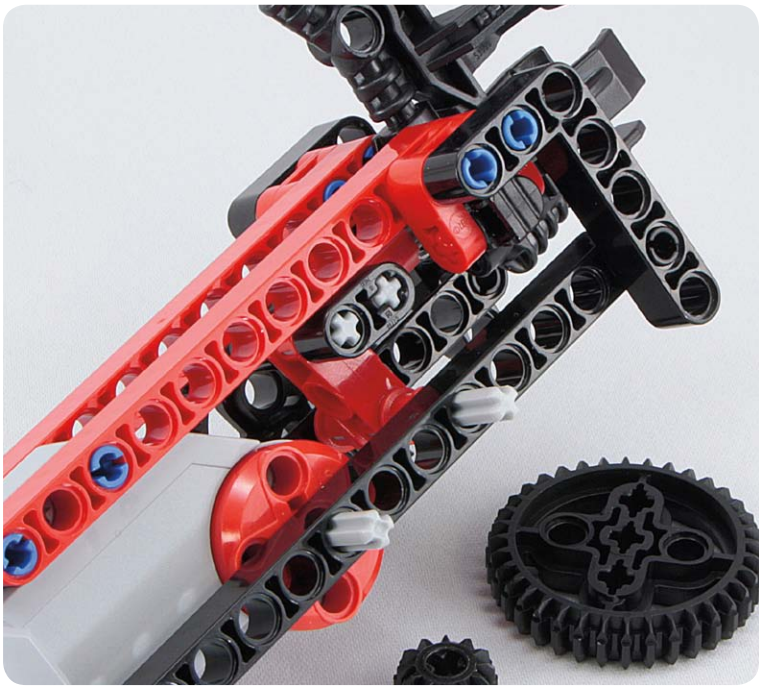
#144











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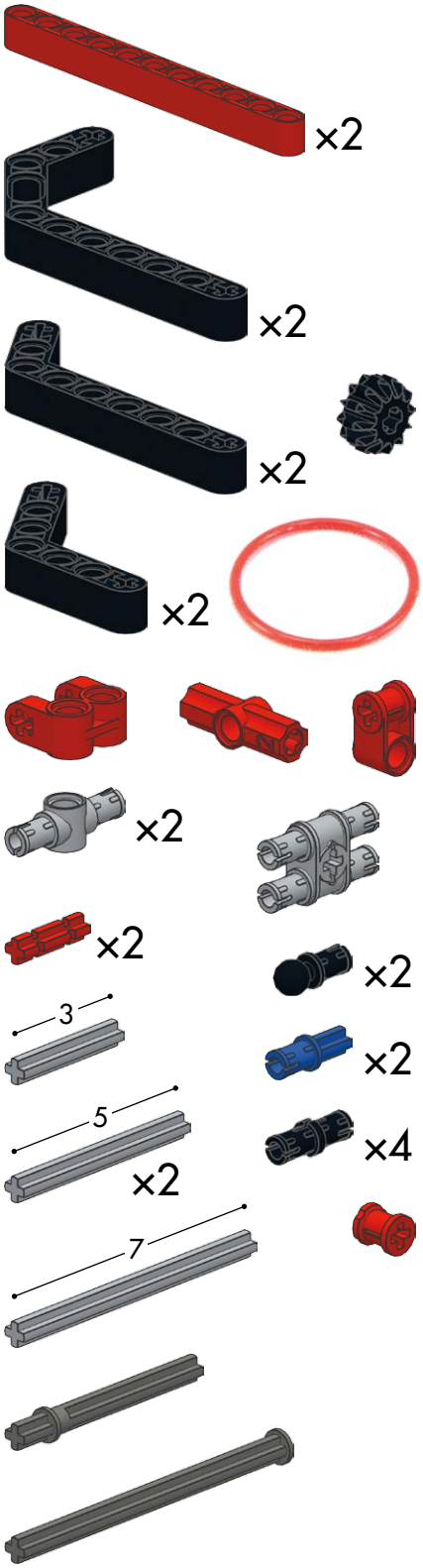
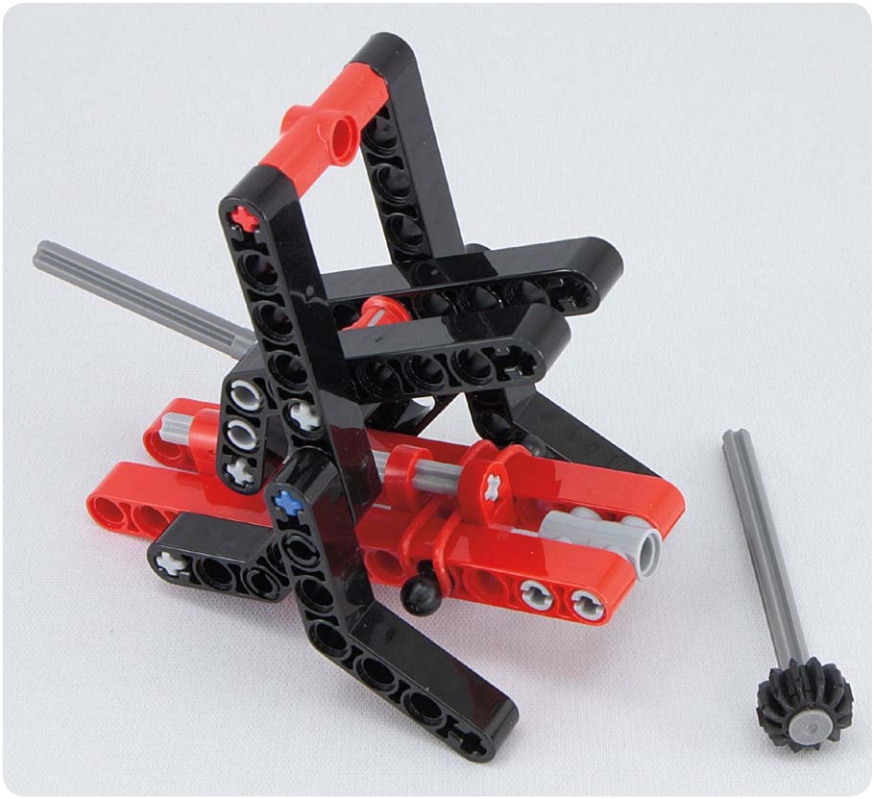
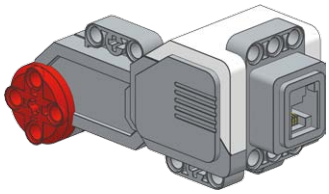
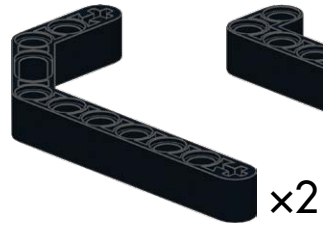
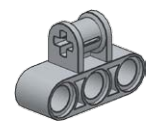


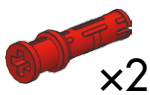


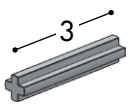
#146

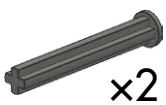


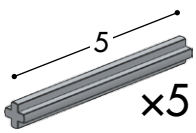


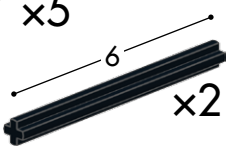












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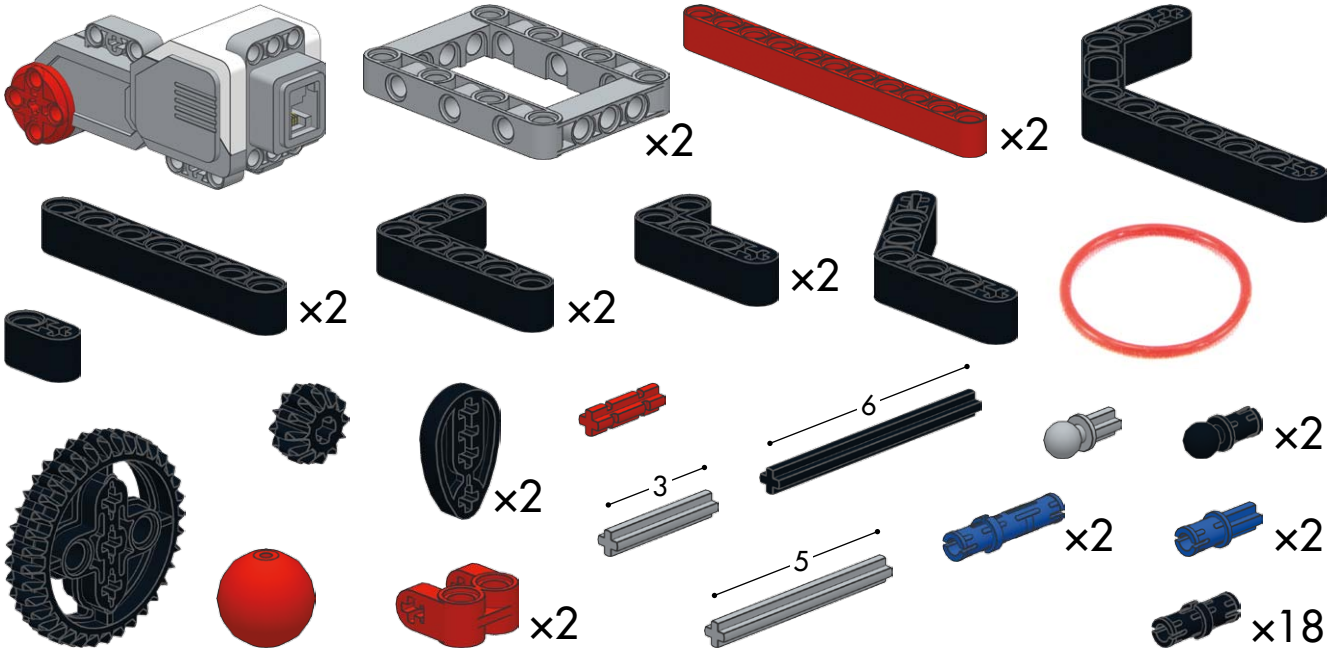
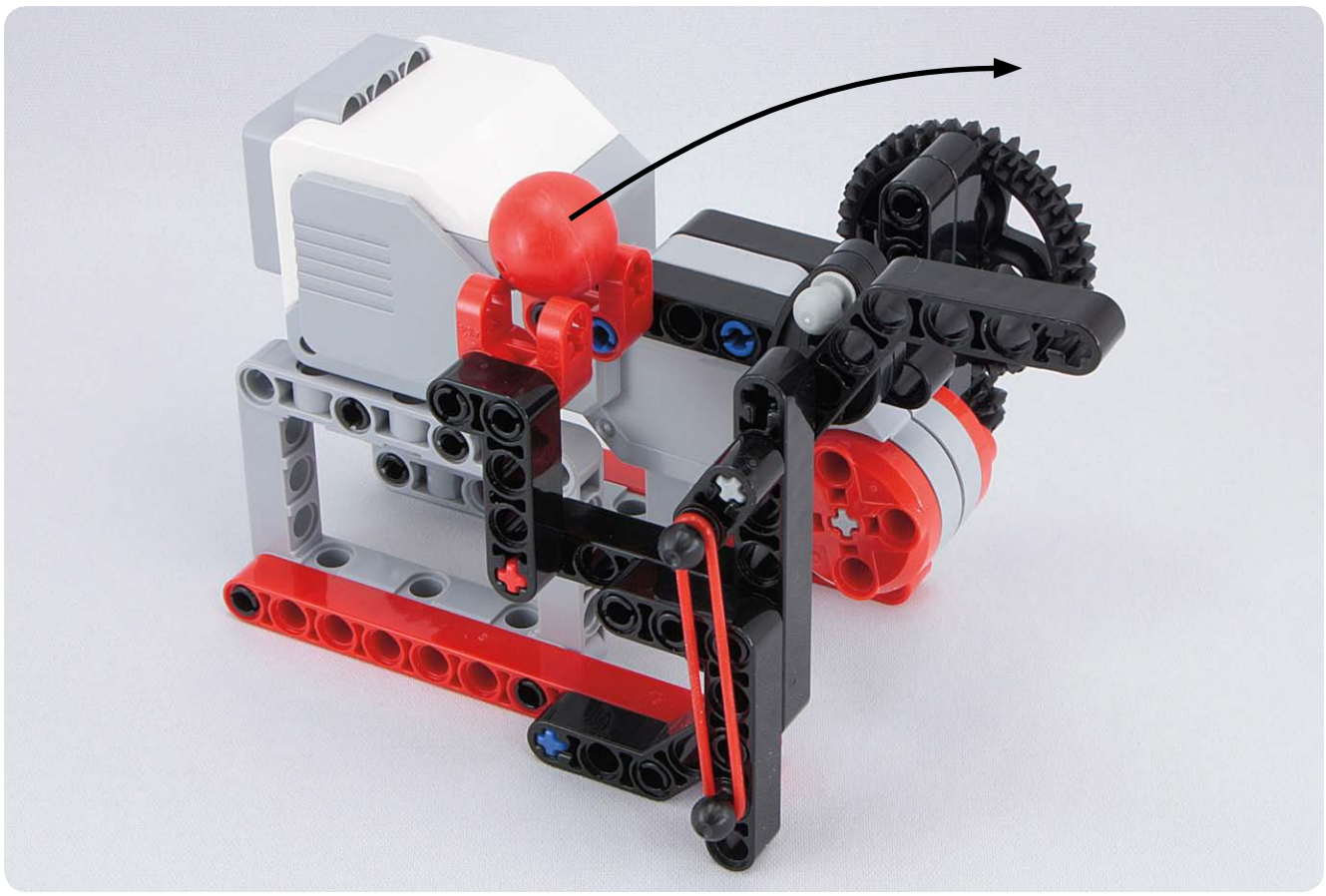
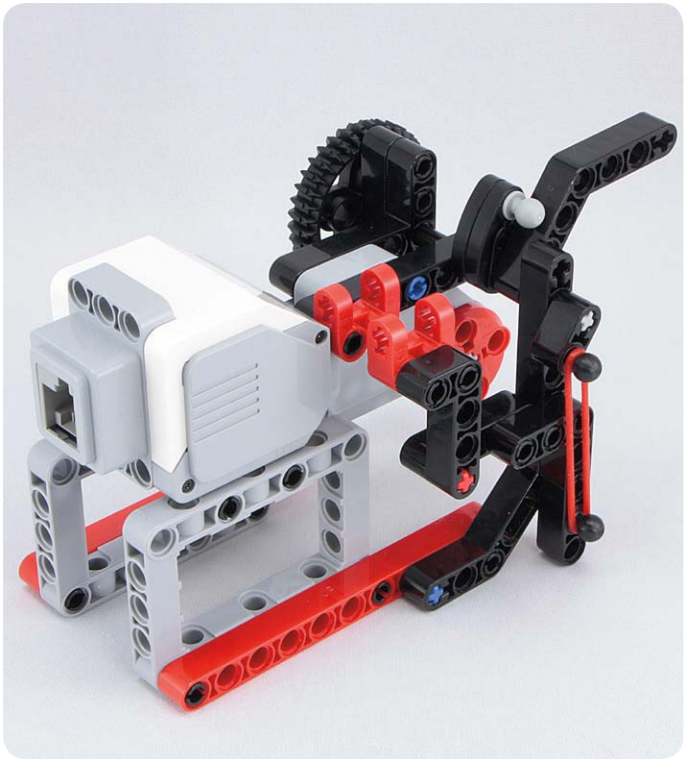
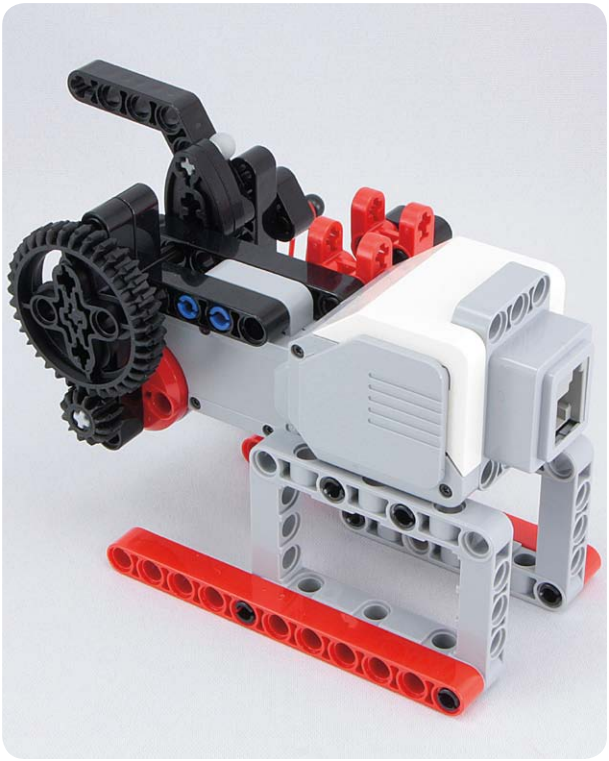
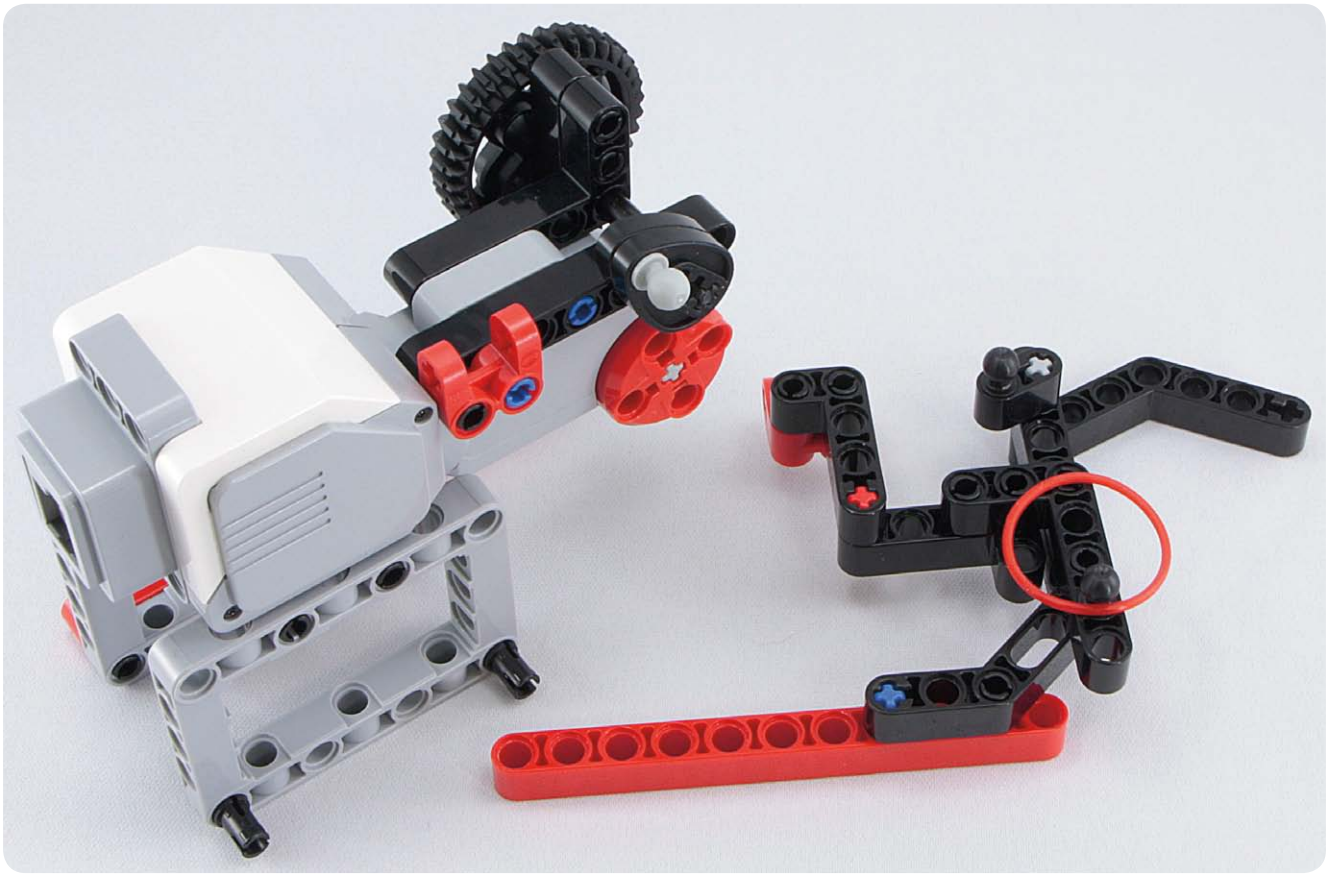




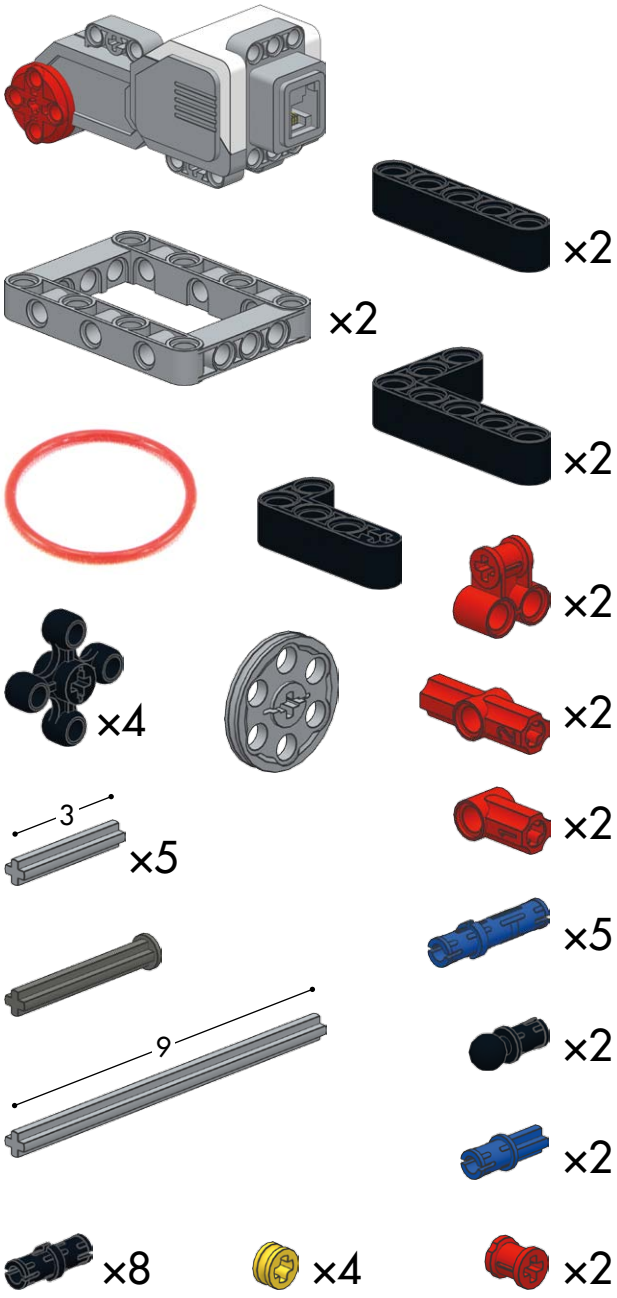


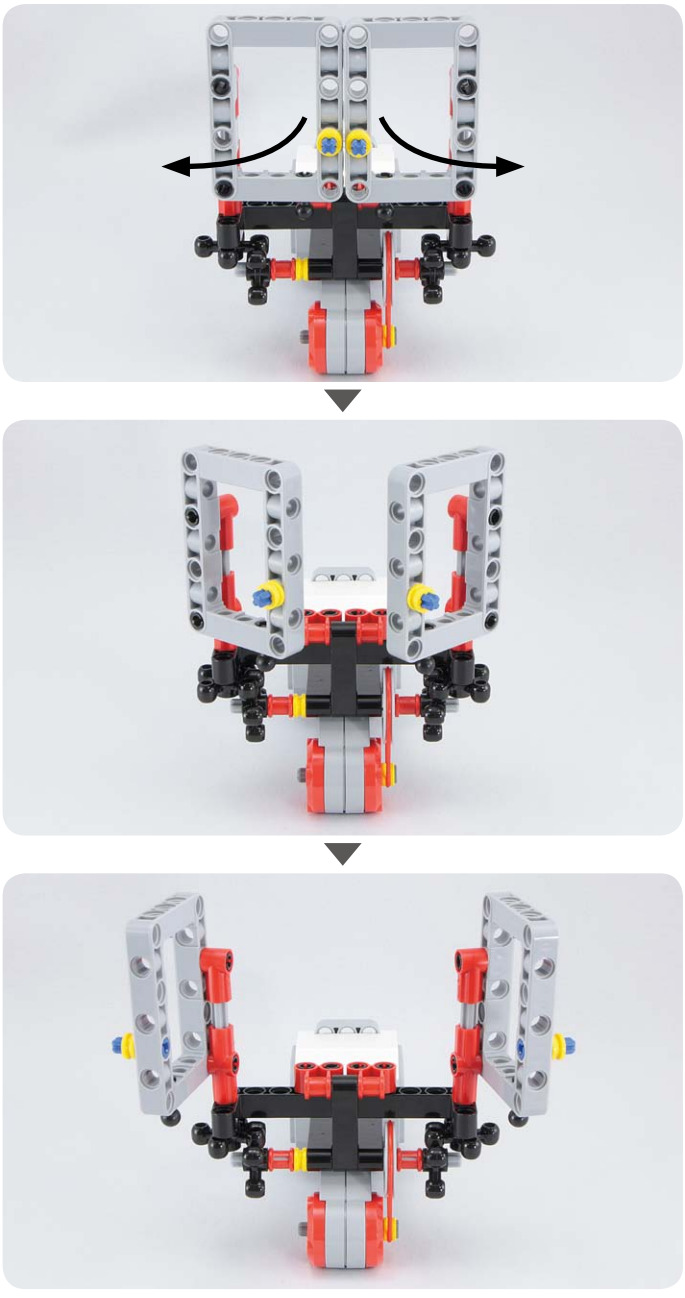


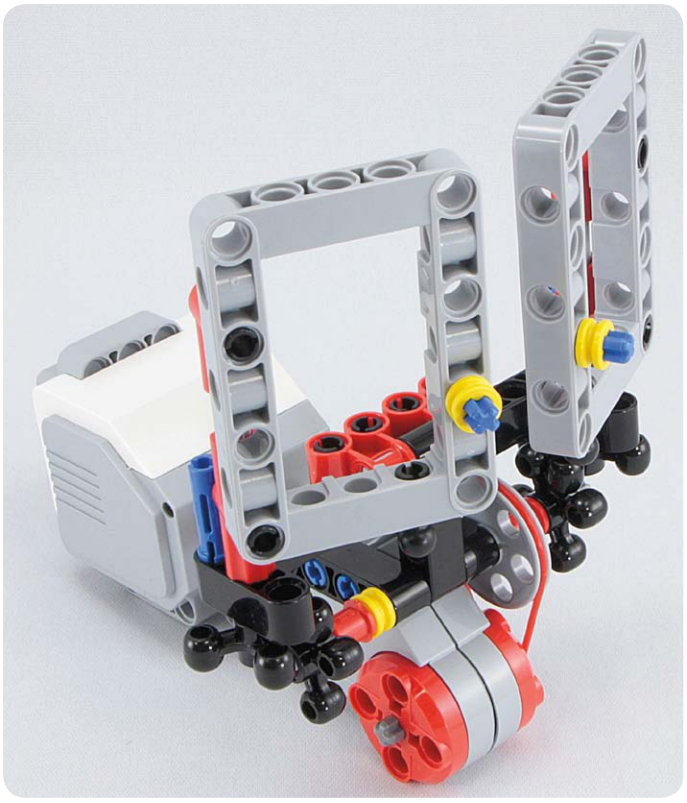


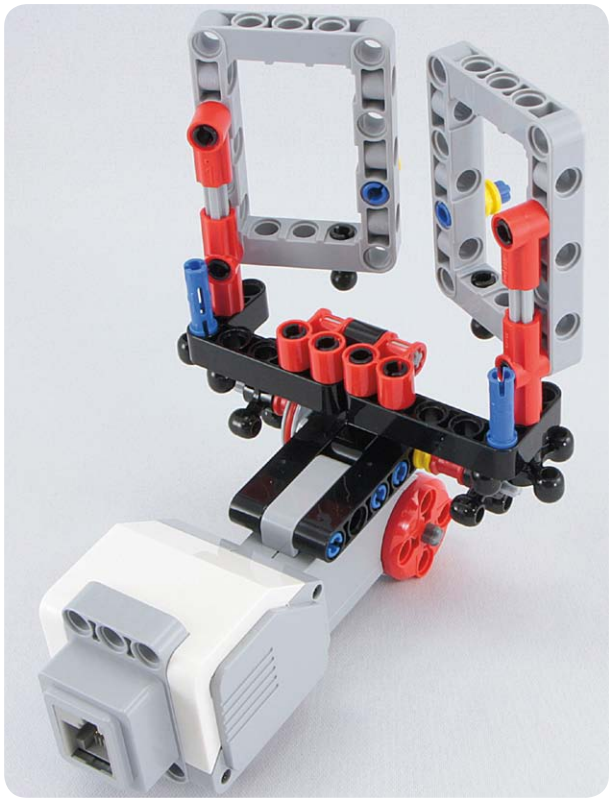
Automatic doors

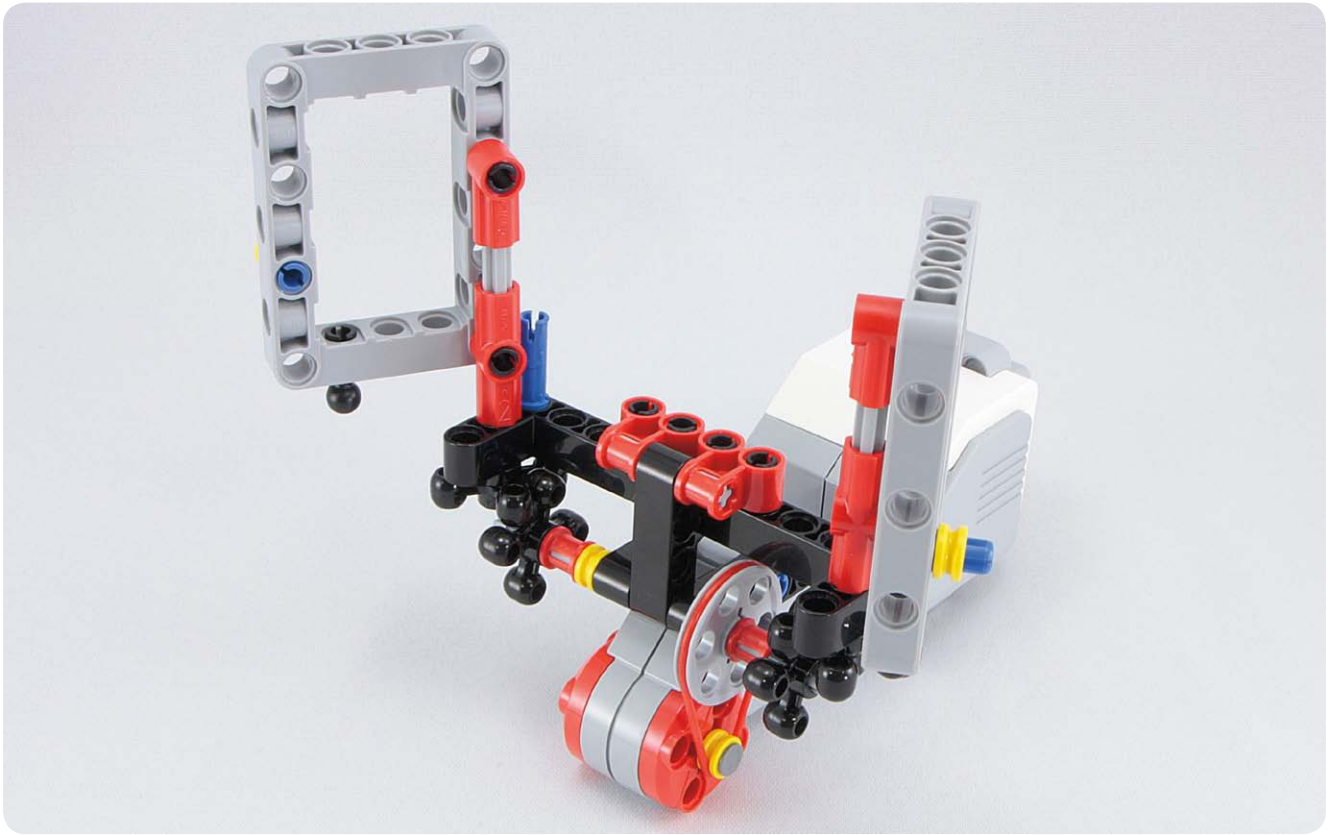
#148



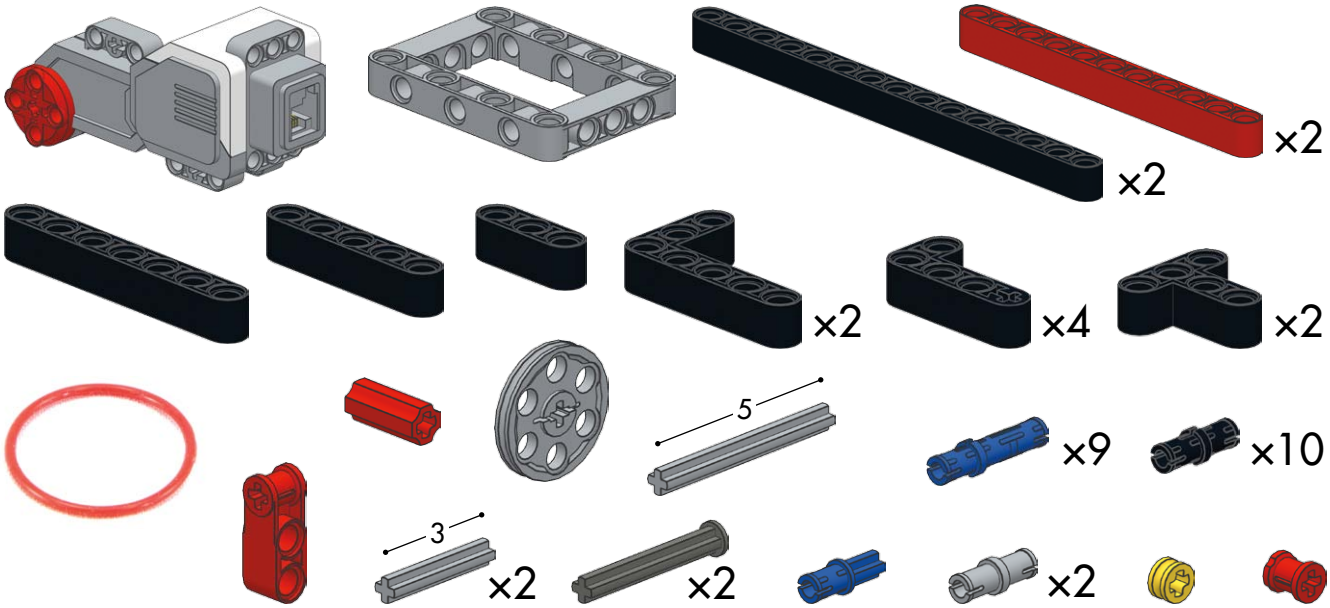


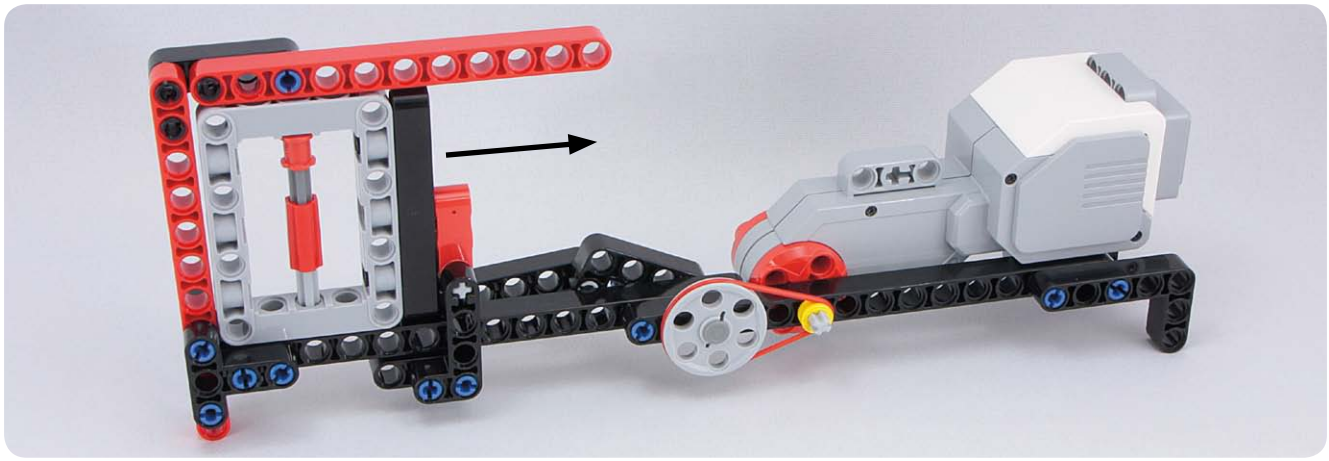


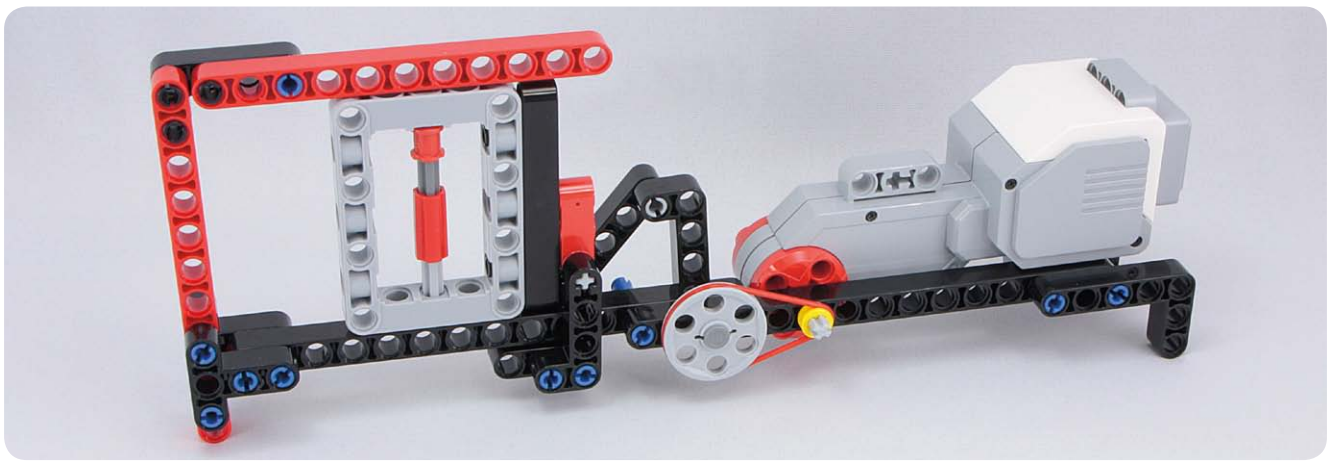


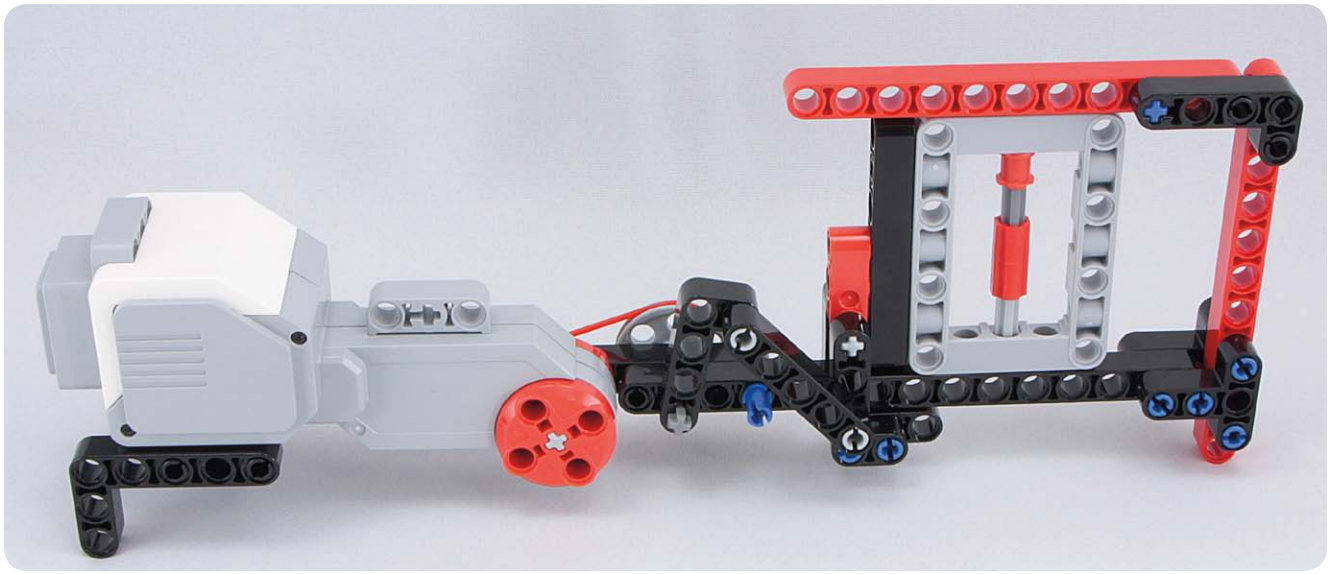


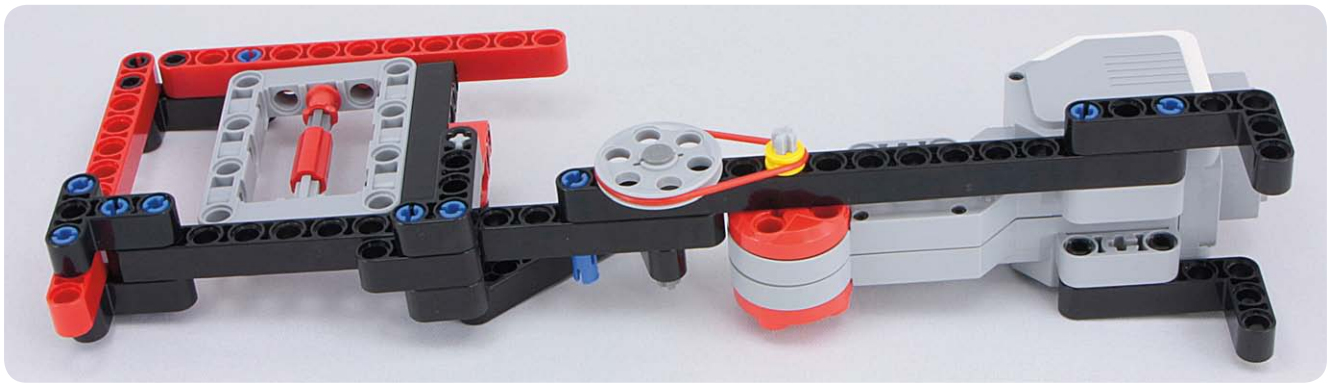
#149

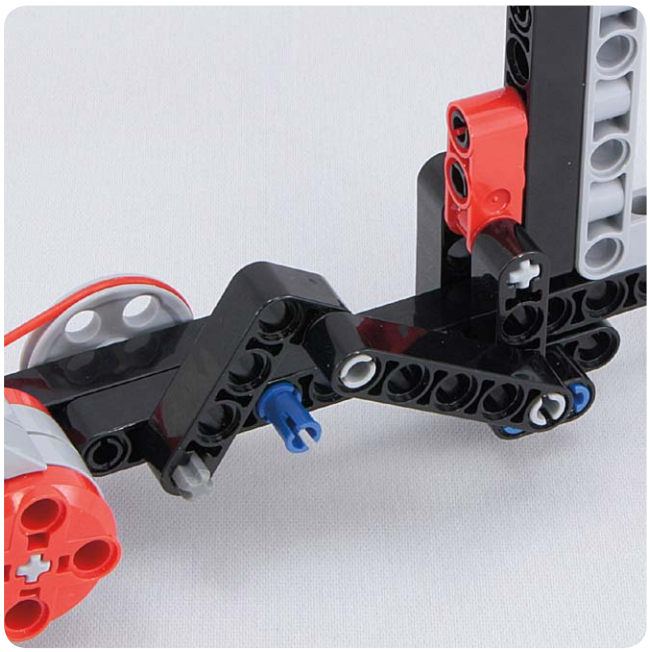




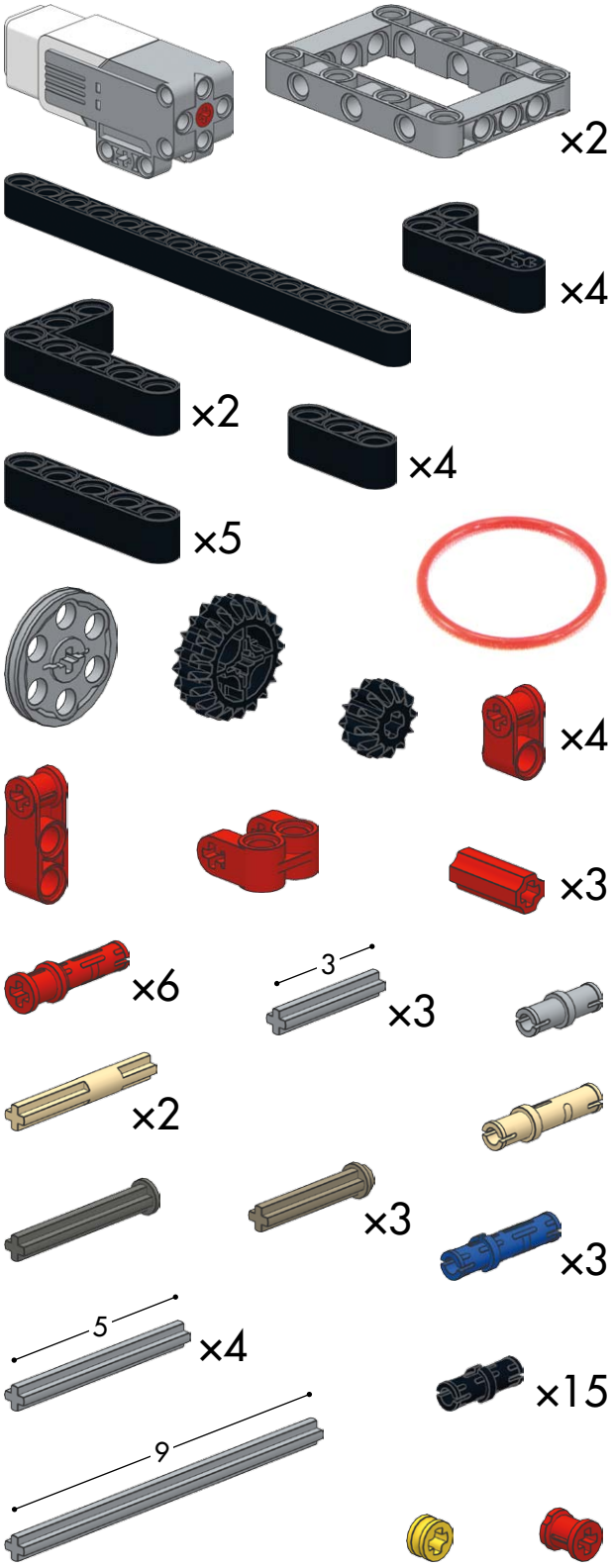


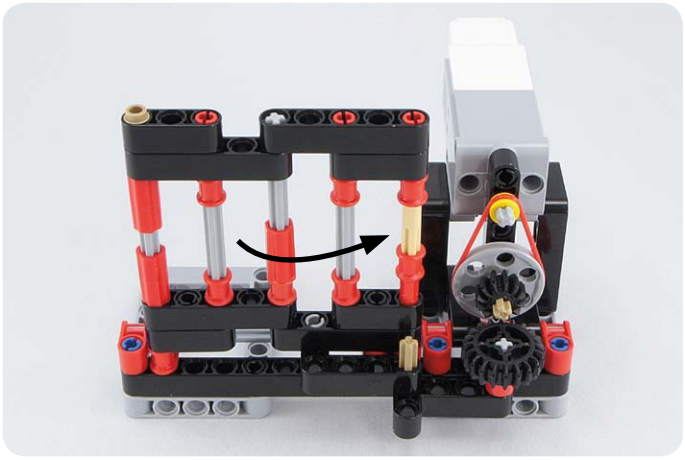


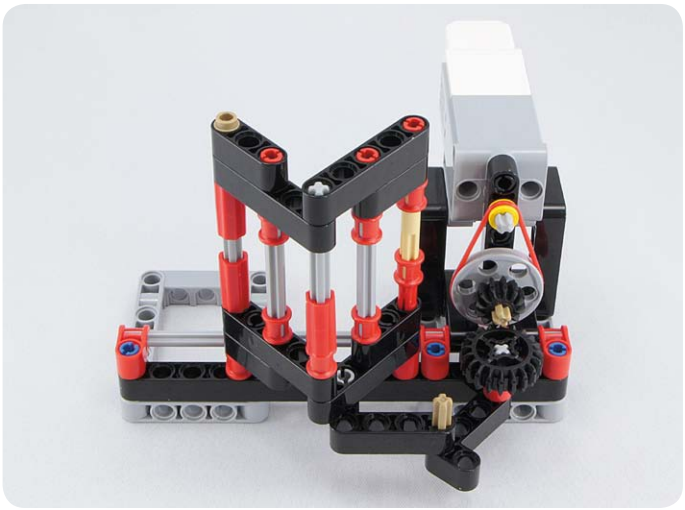


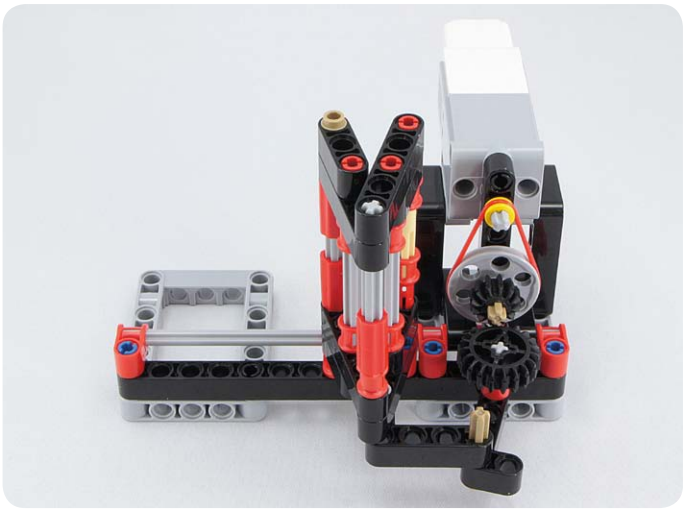


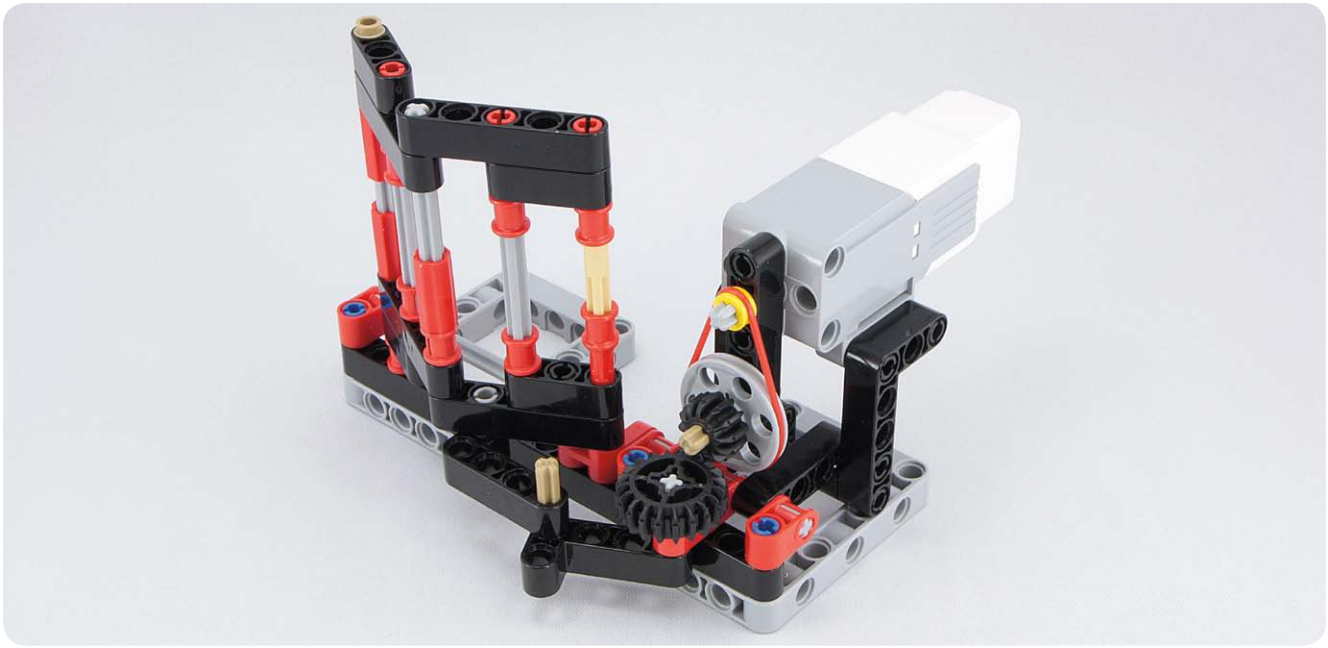
#150

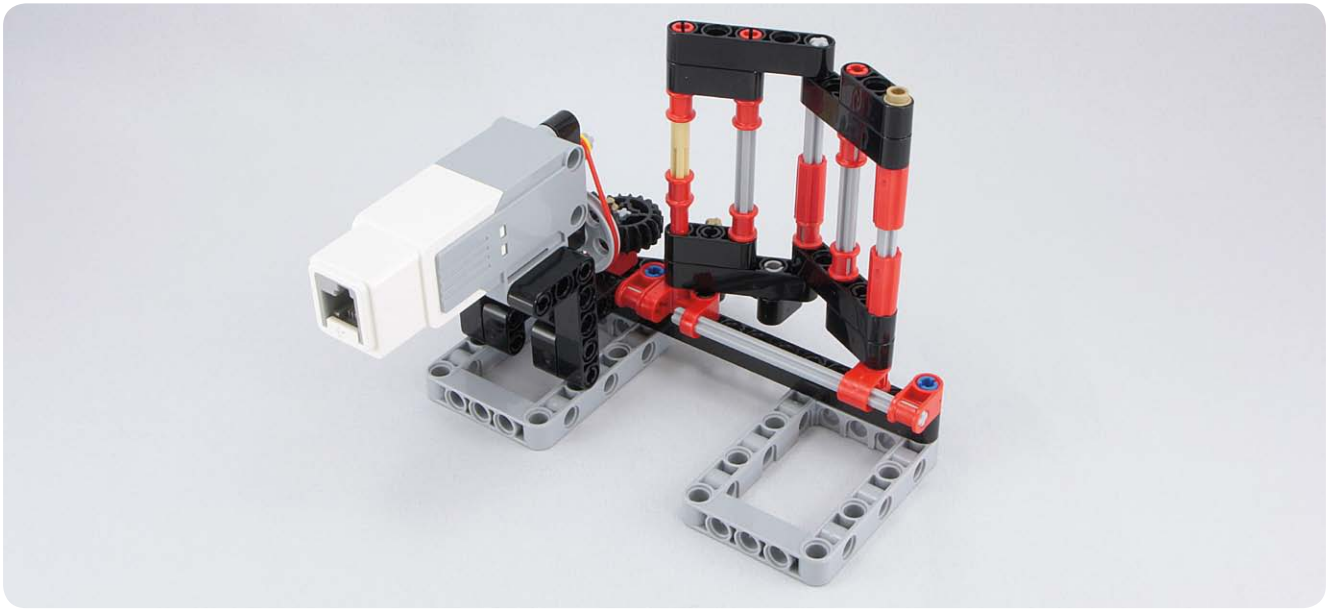


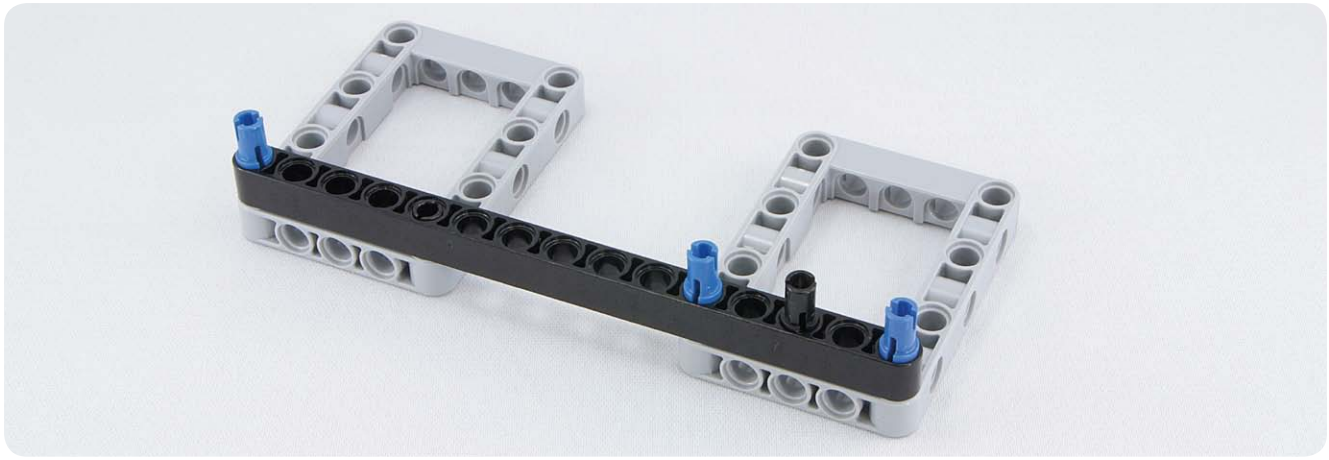


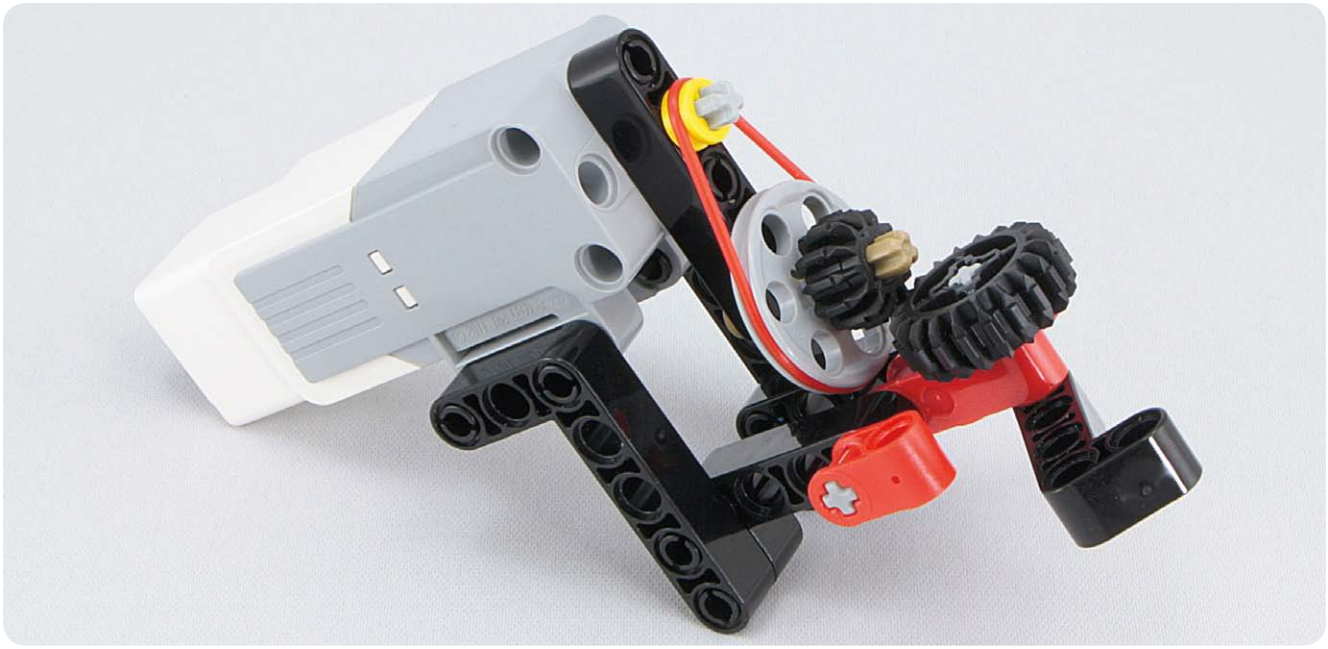


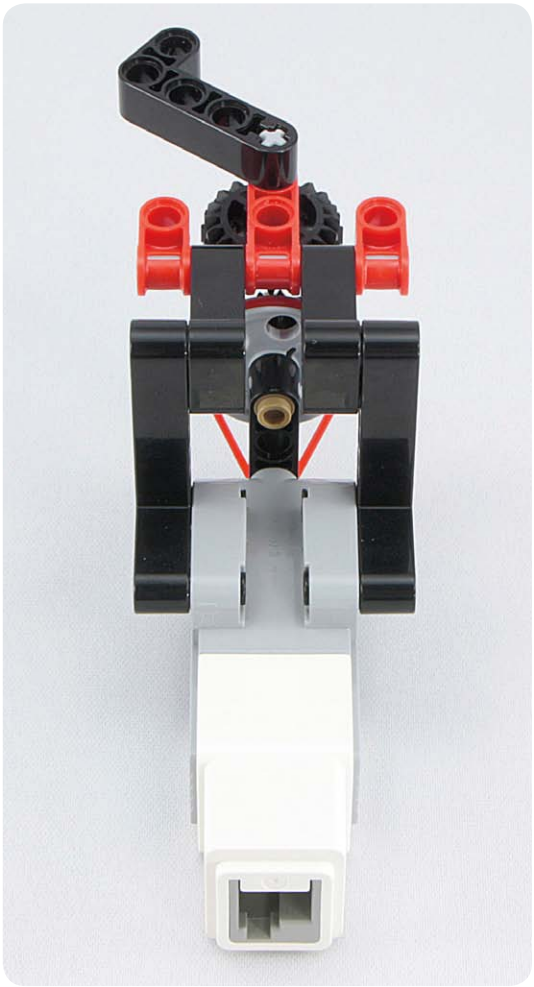






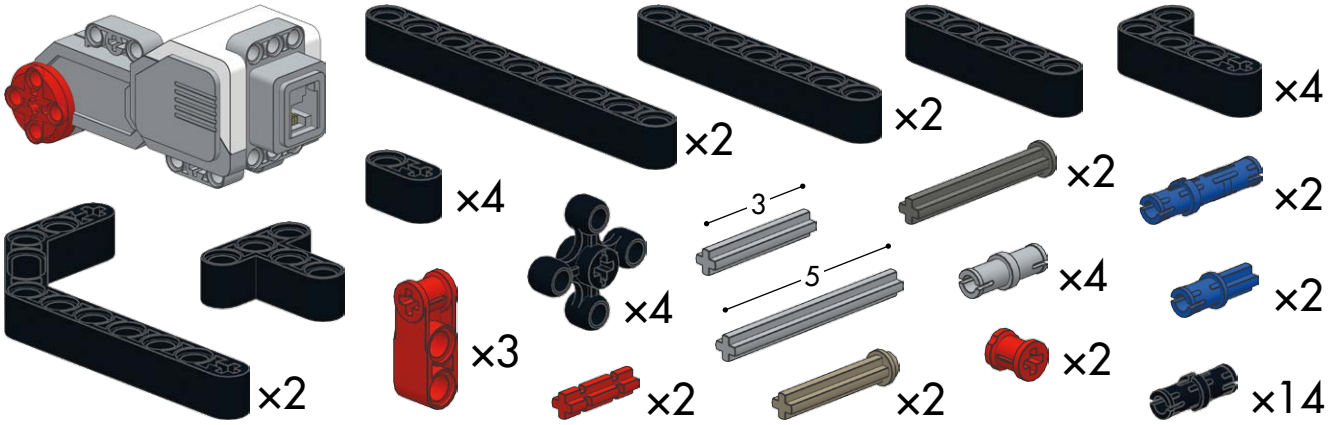


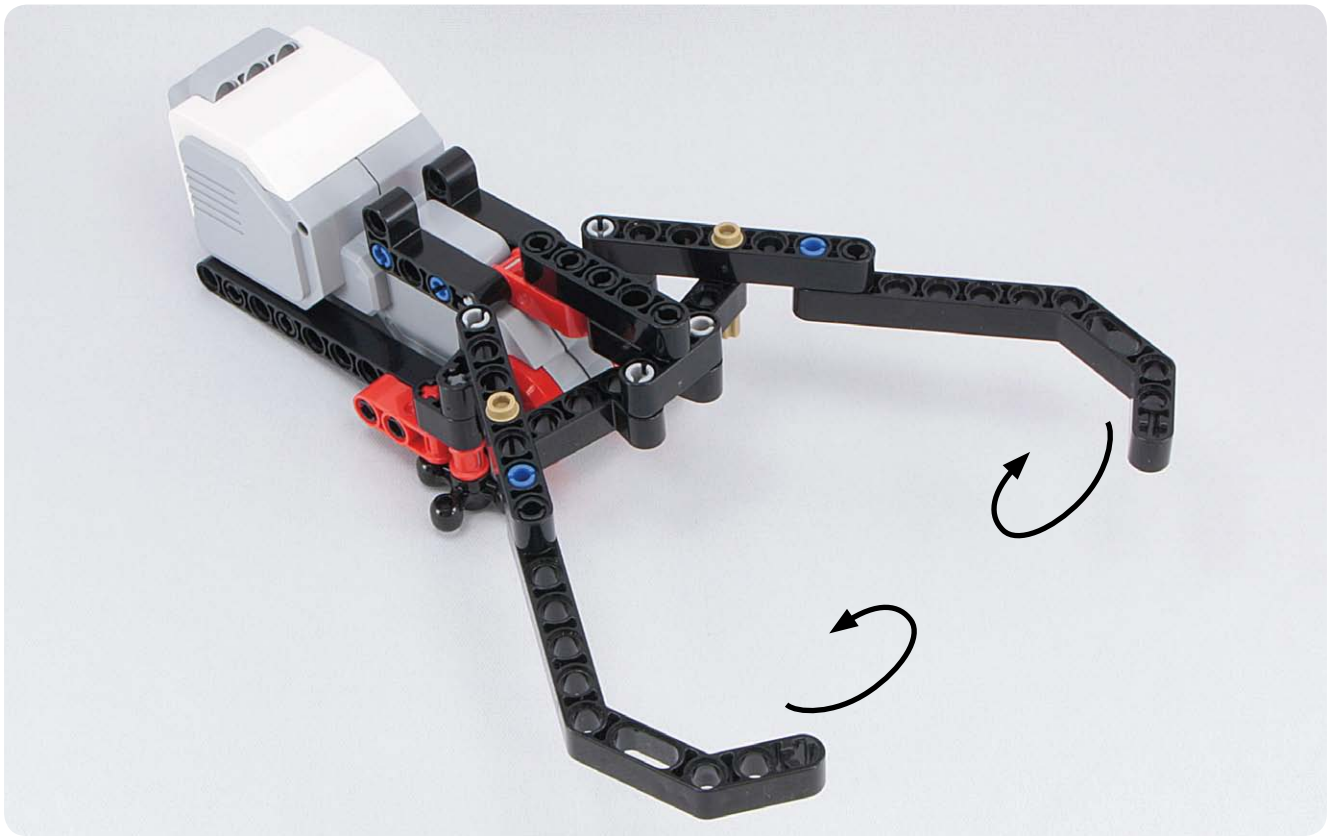


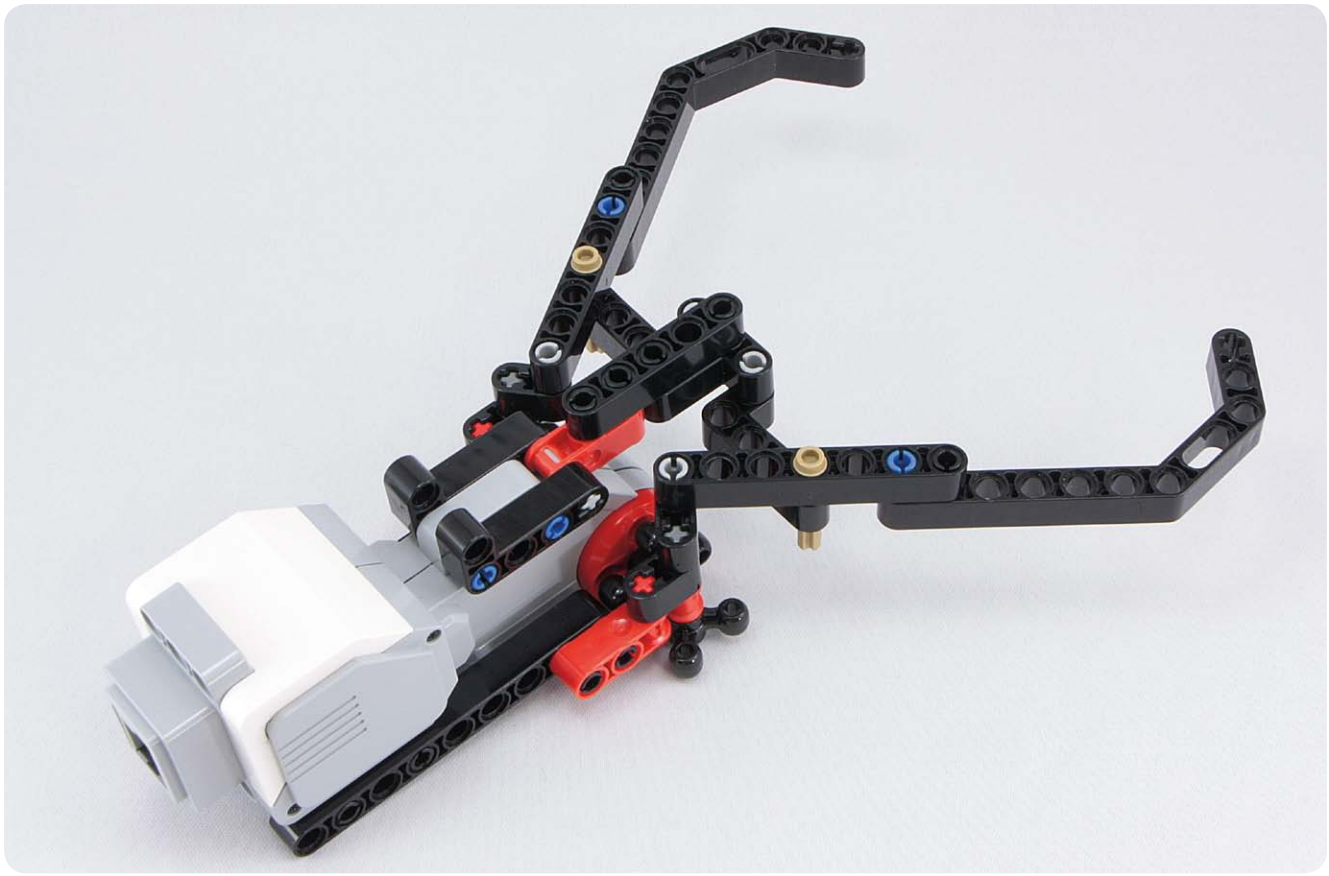


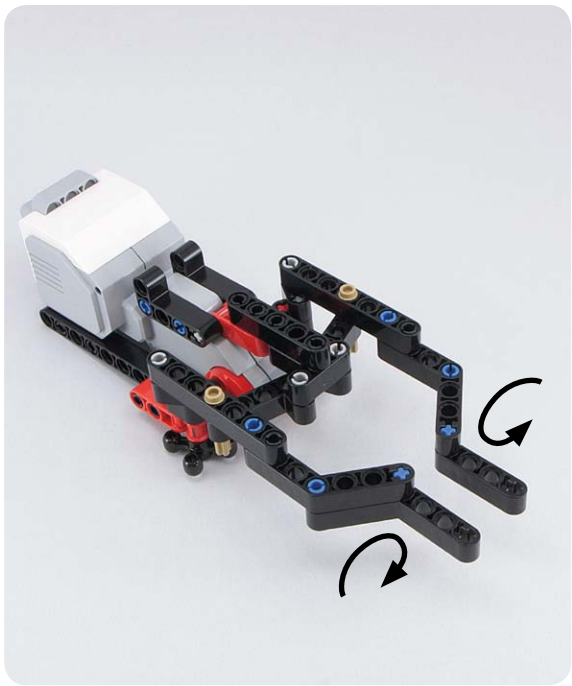
Raking up or out

#151

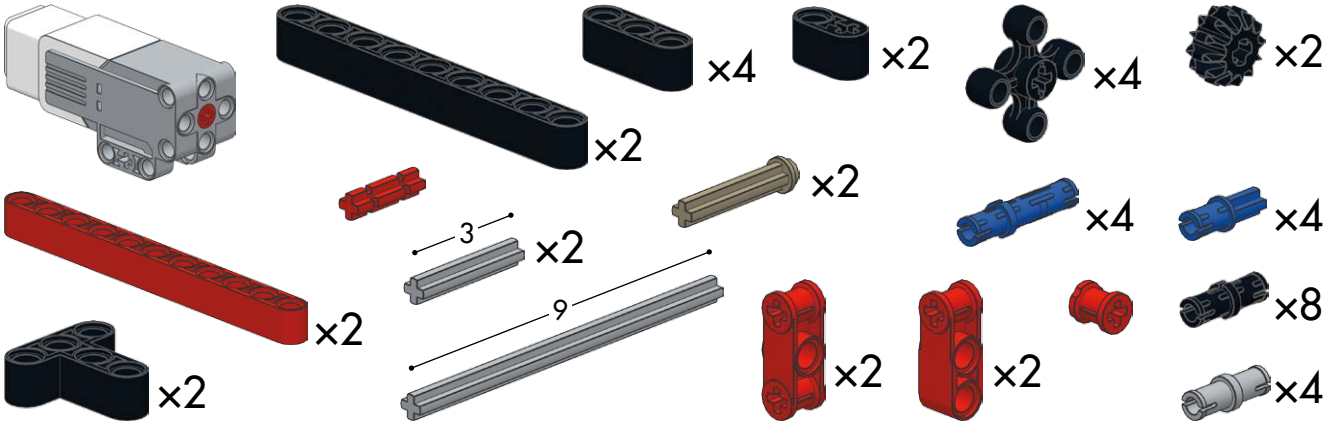


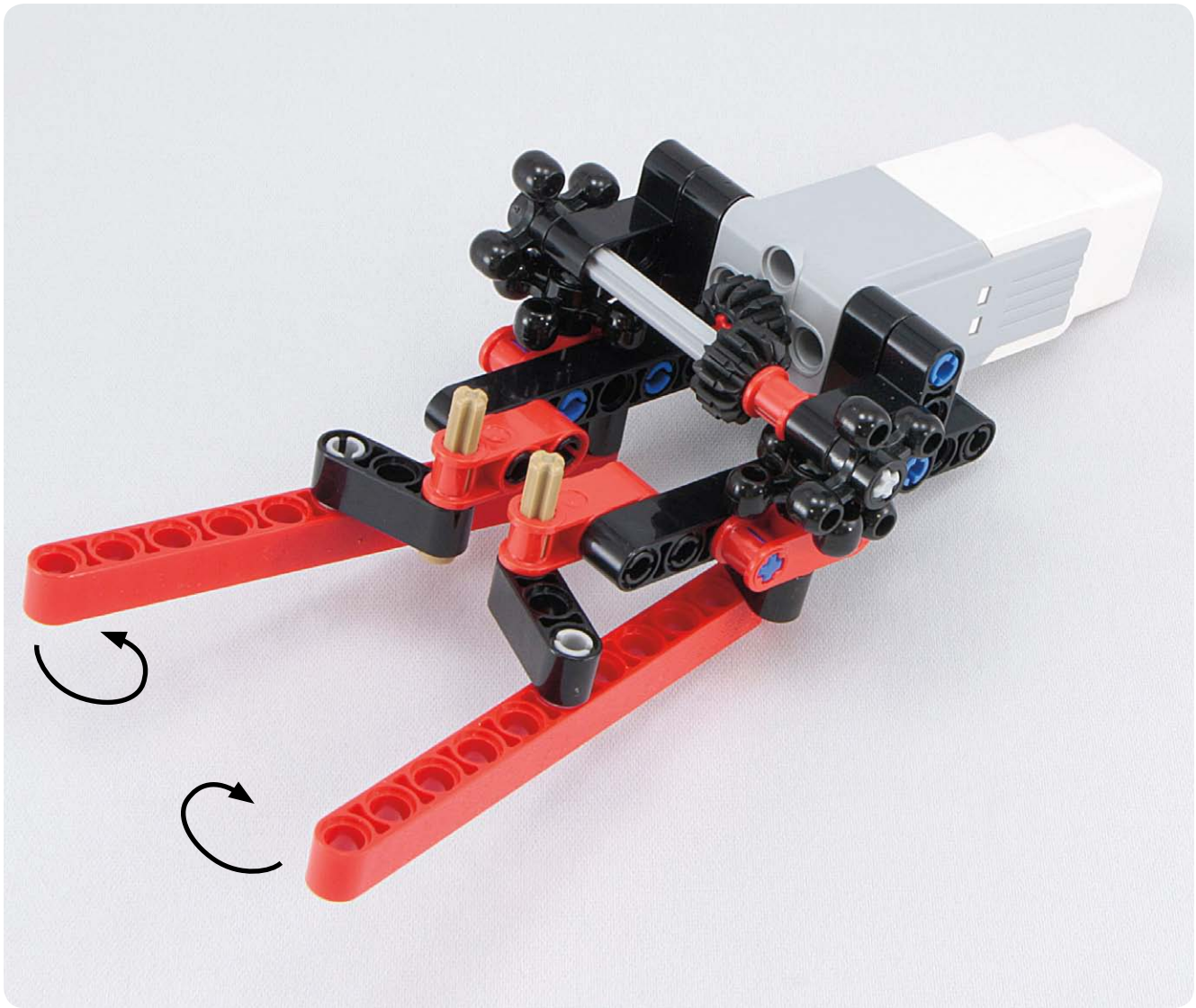


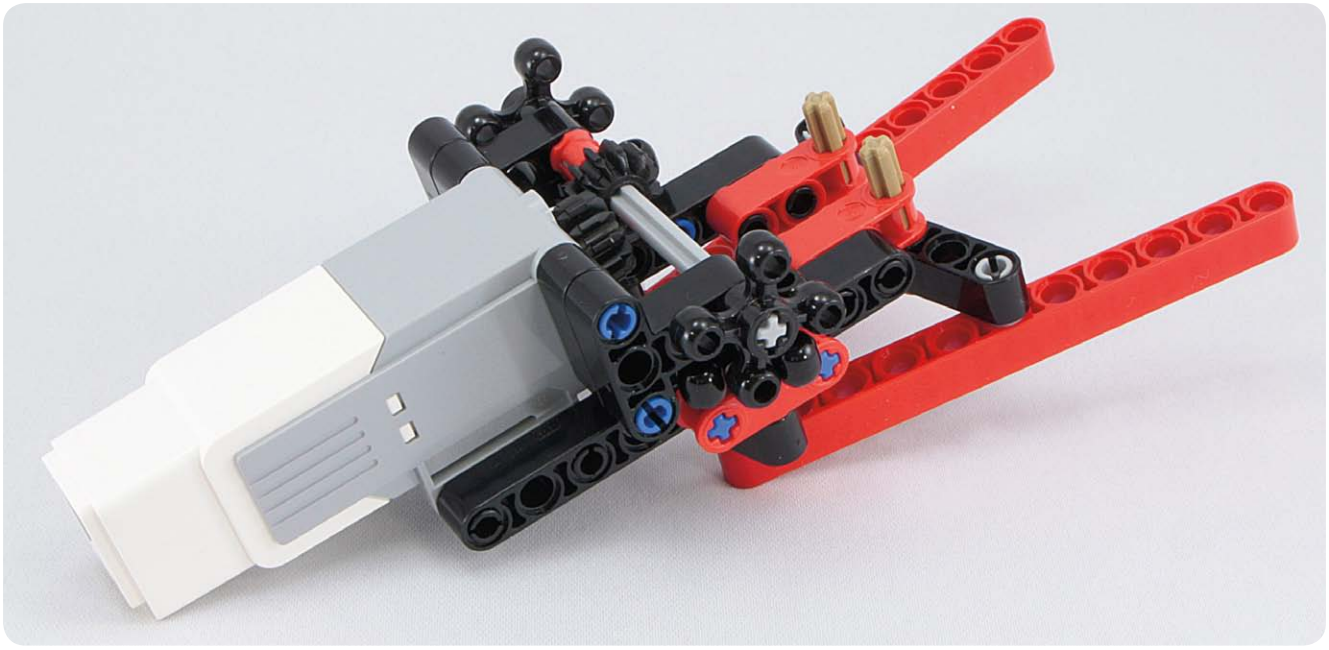


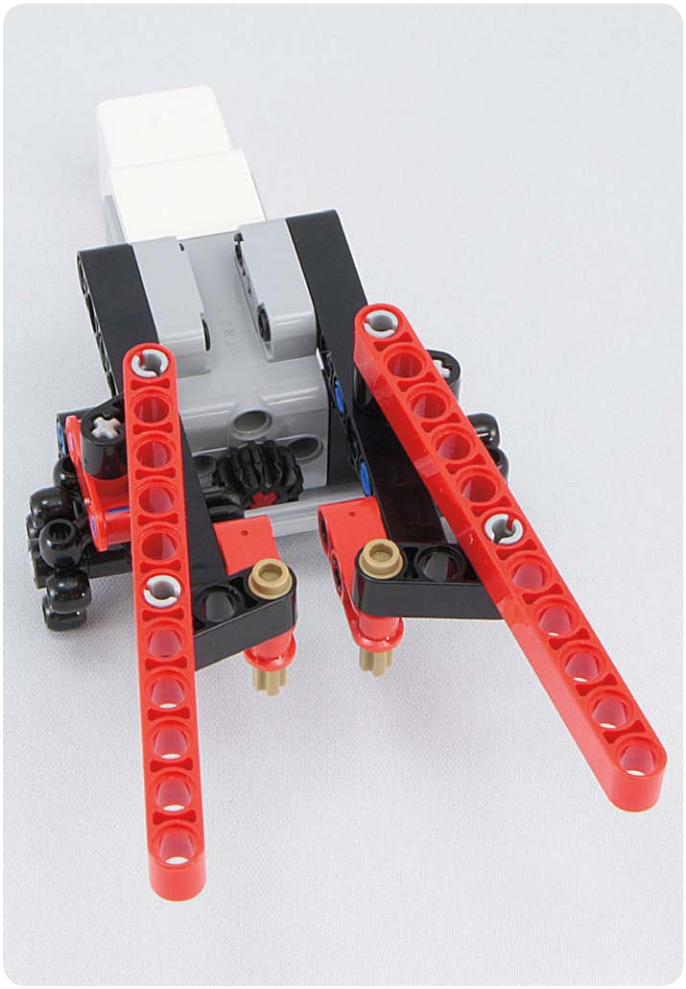


#152



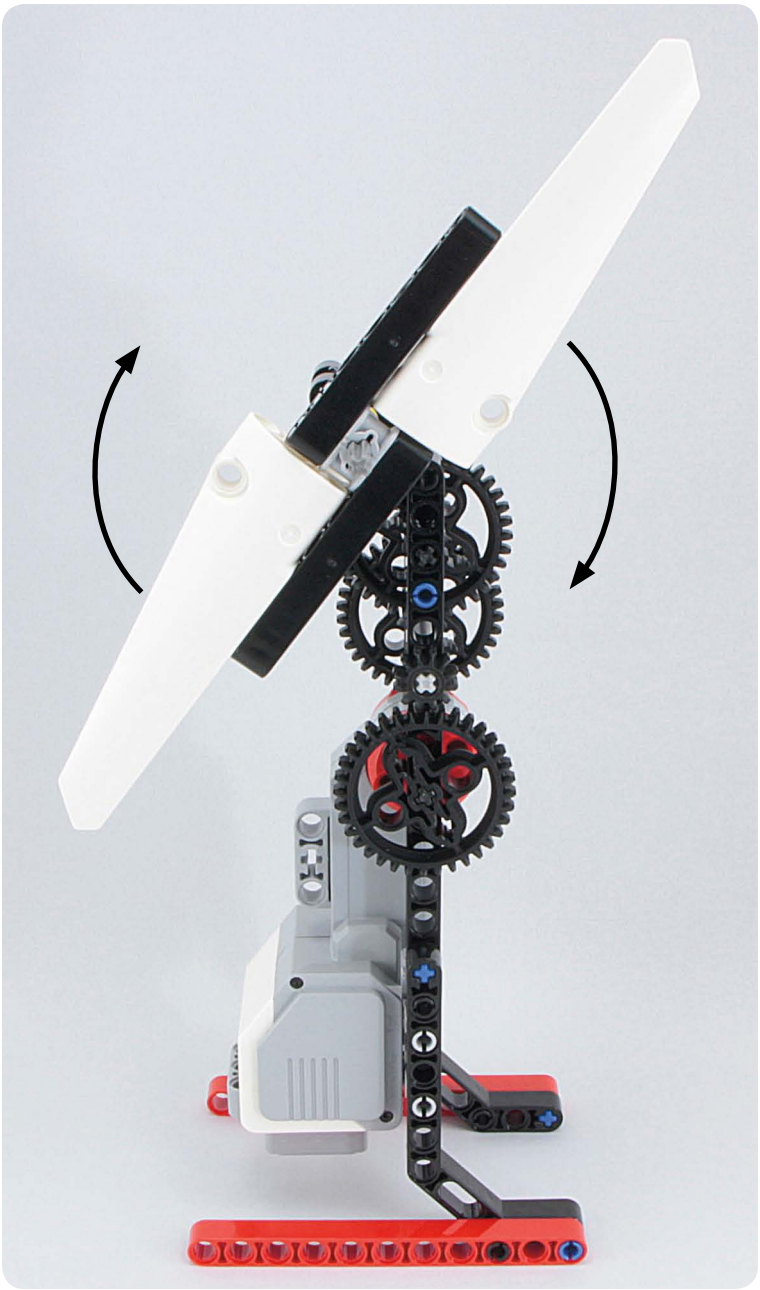


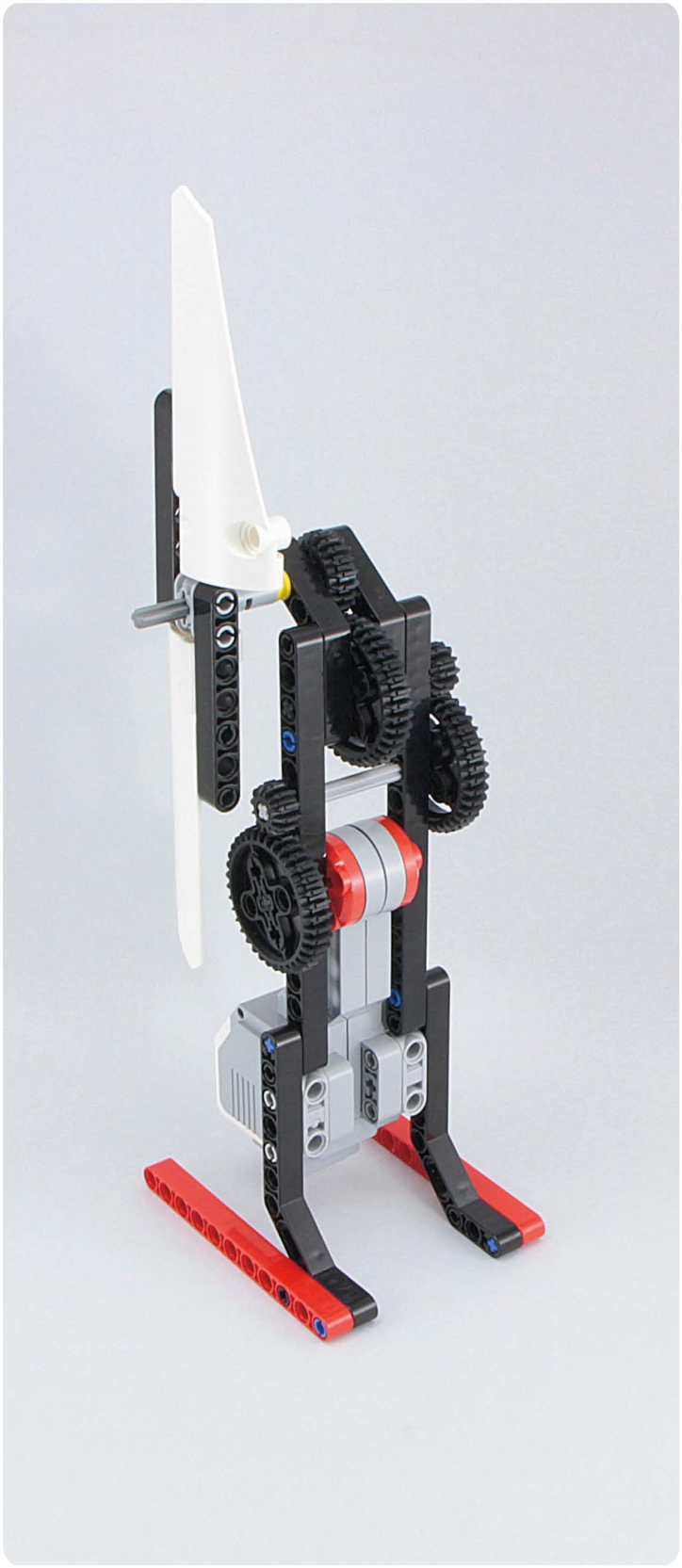


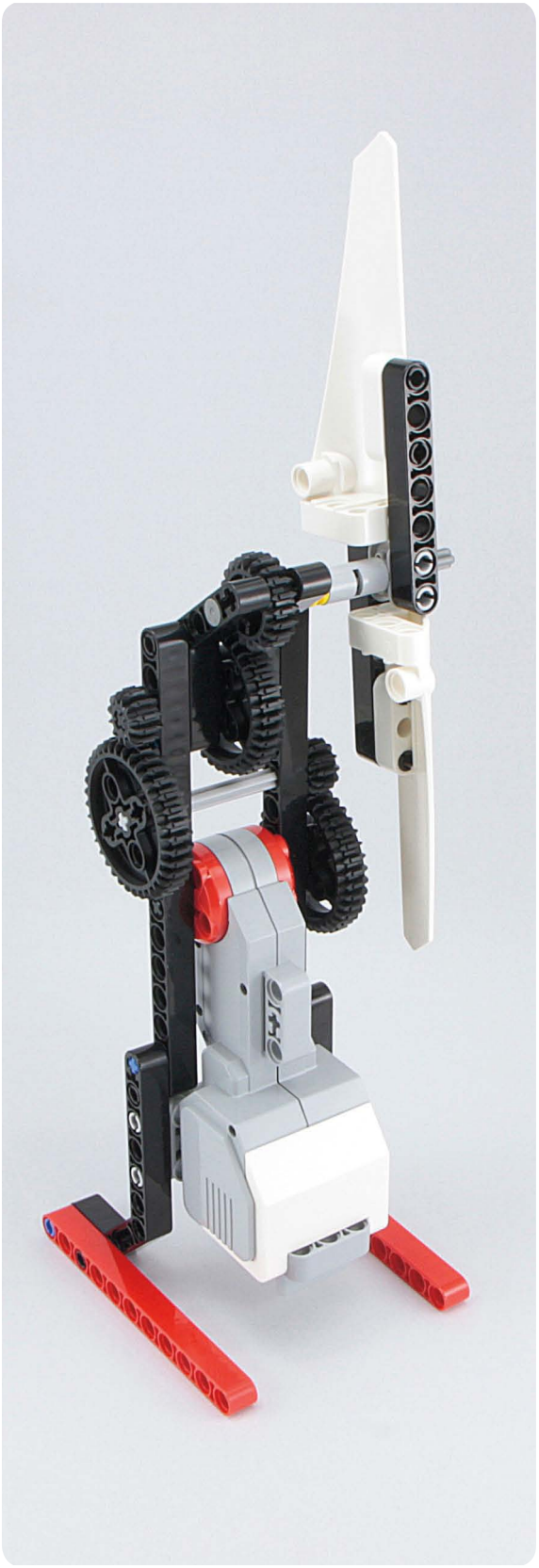


Creating wind

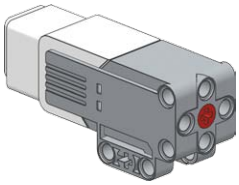
#153

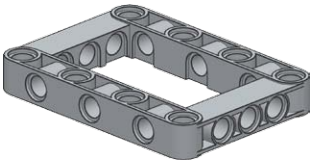


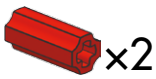


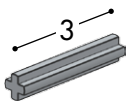


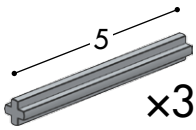
#154

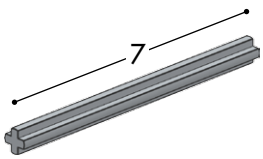


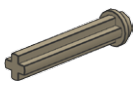


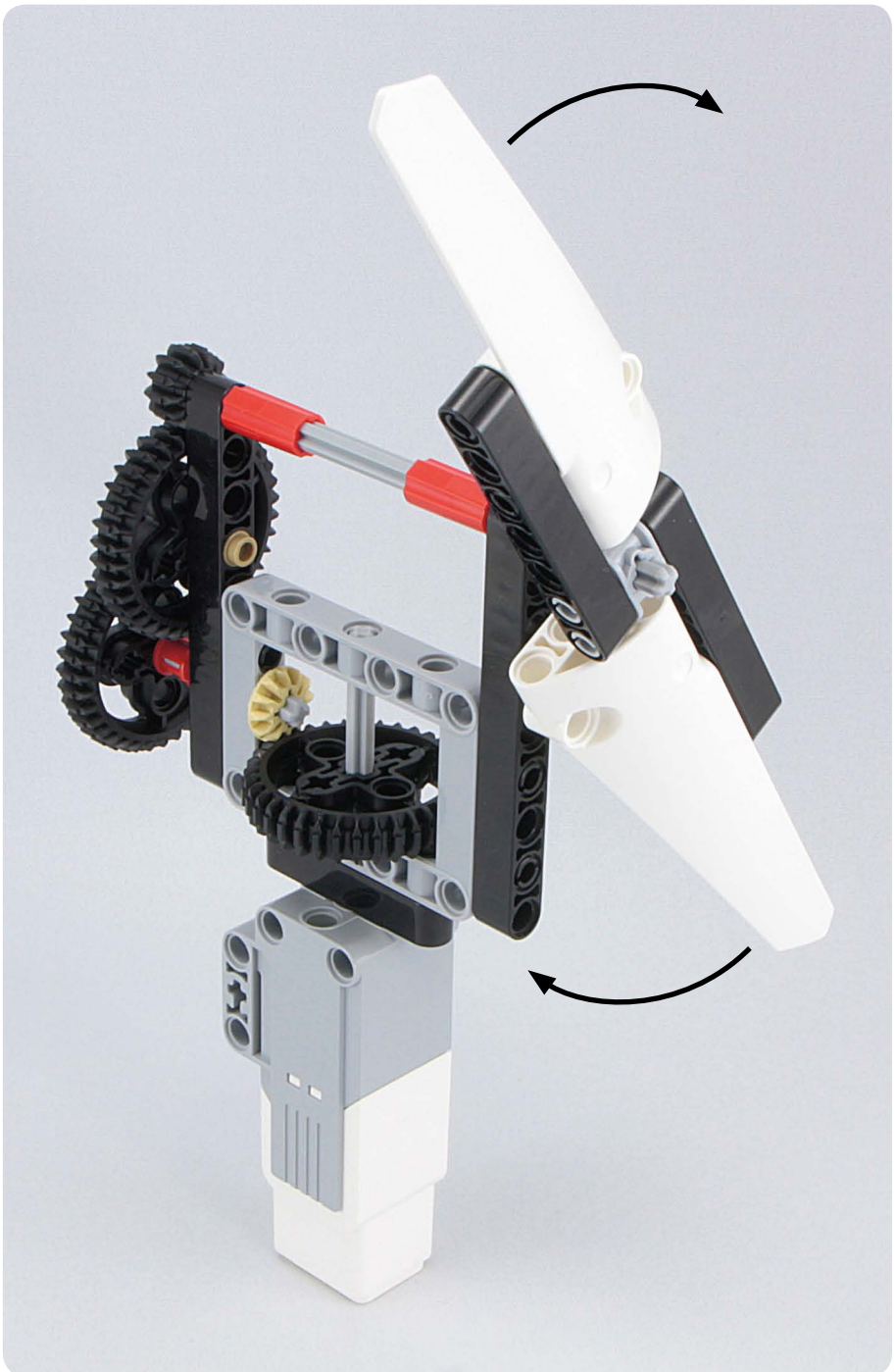


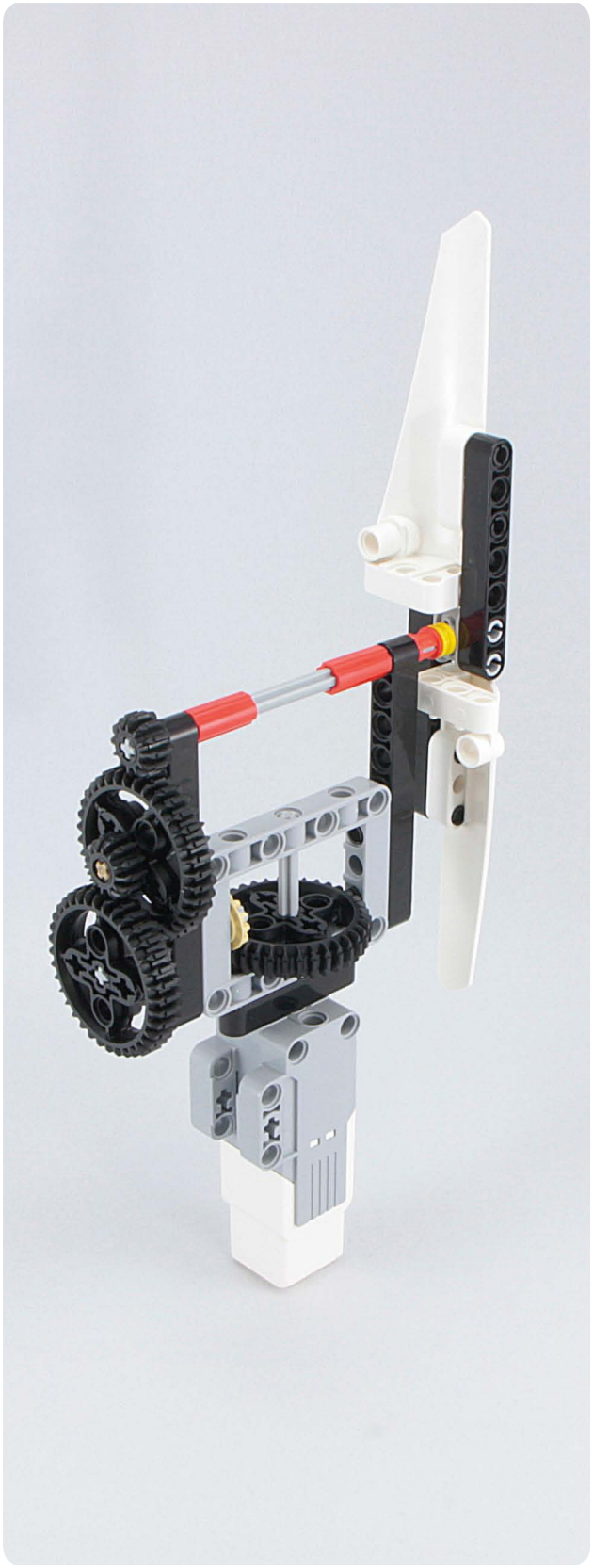


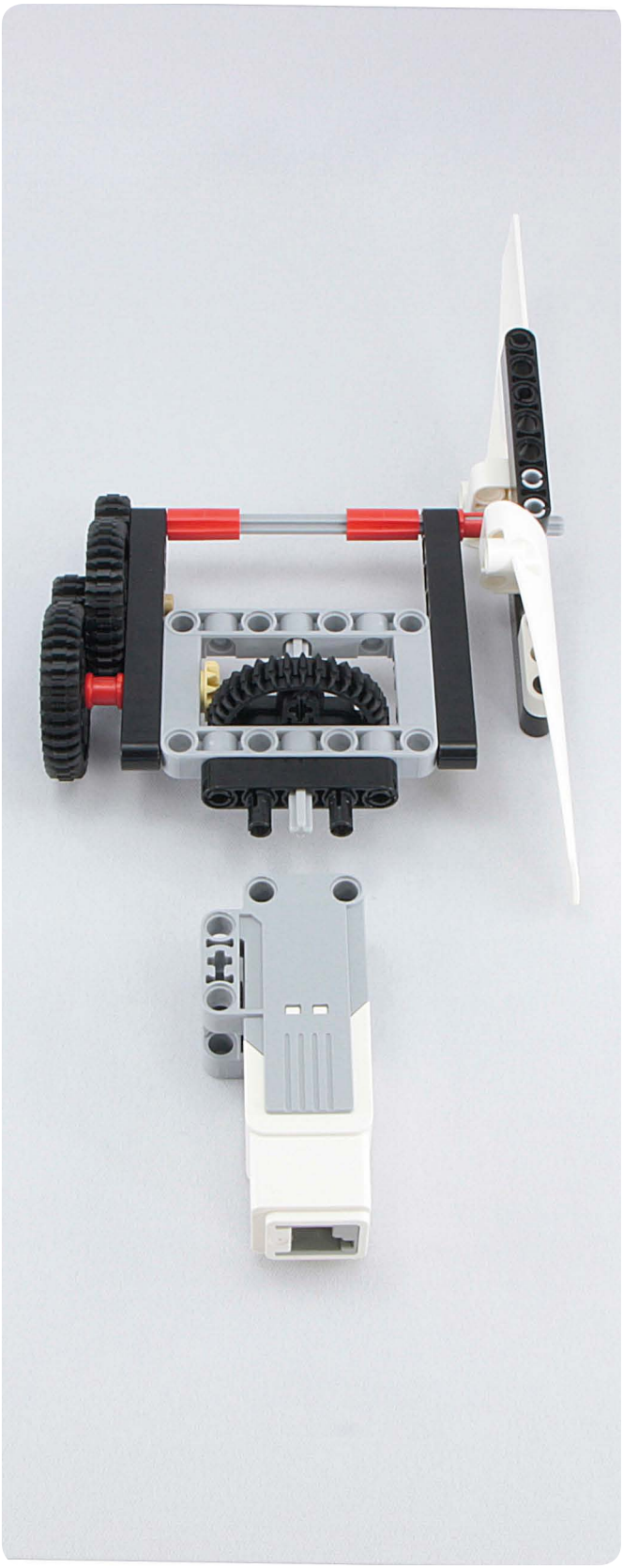






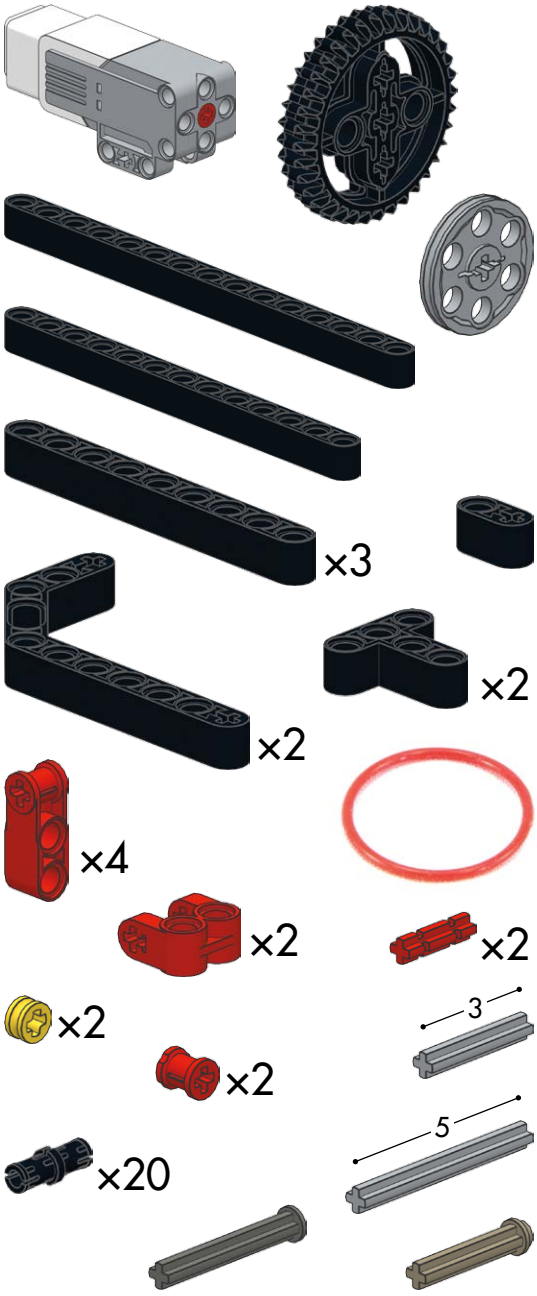


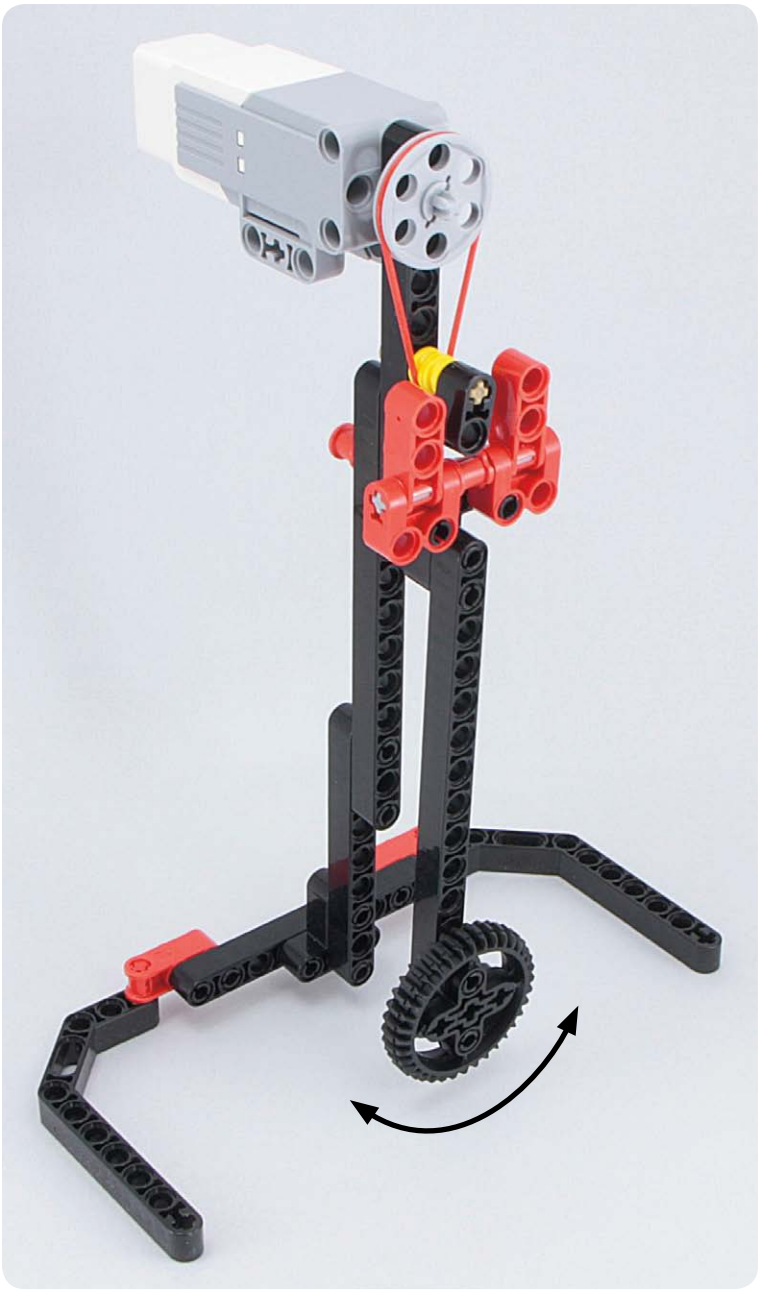


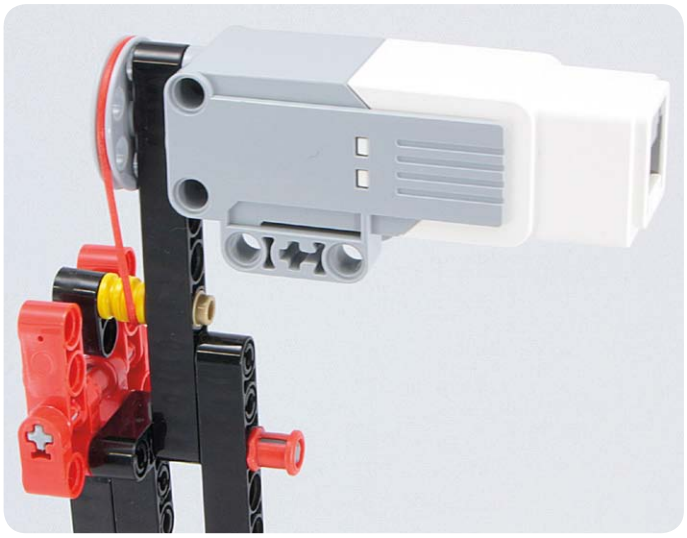


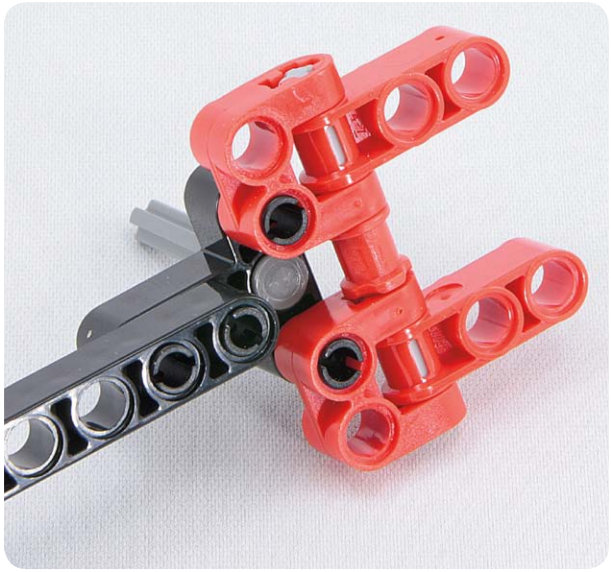
Swinging a pendulum

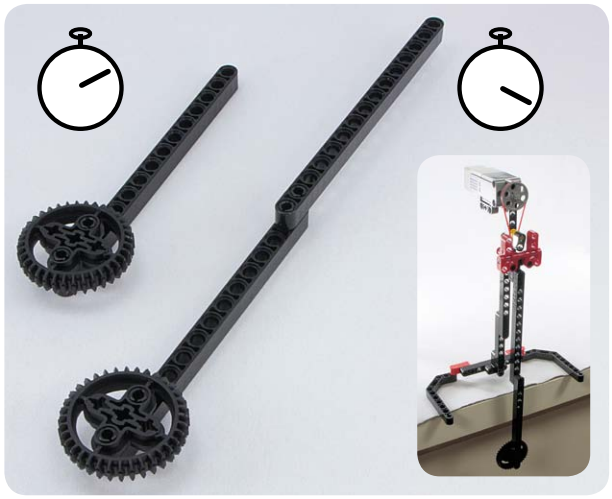
#155



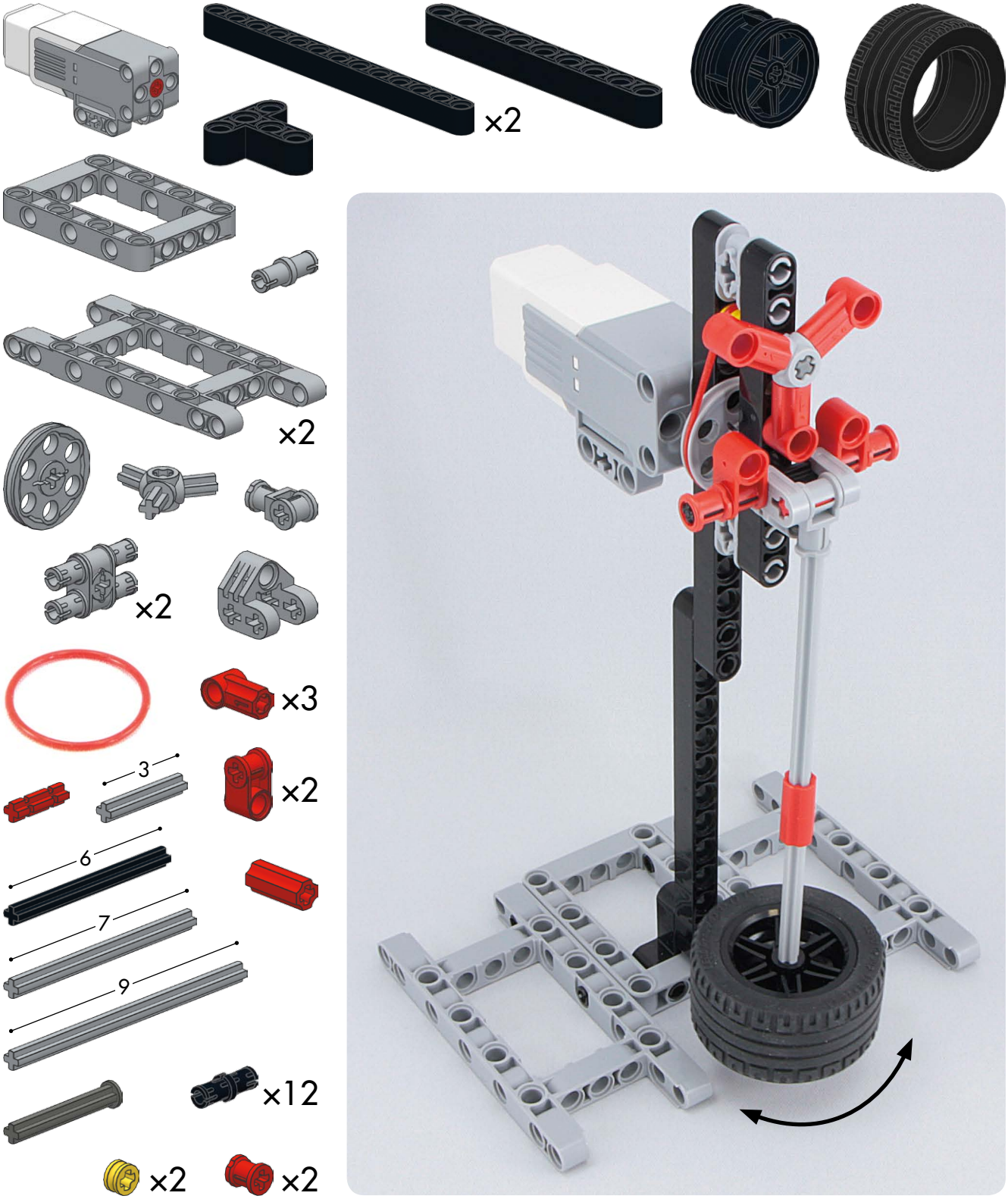


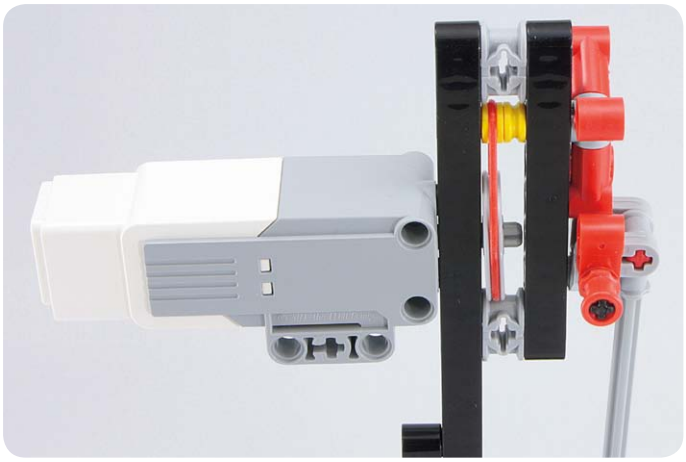


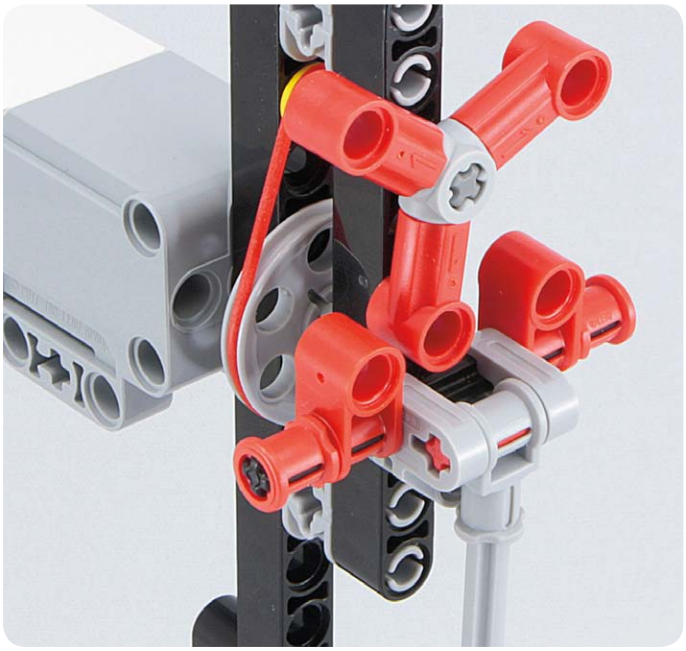


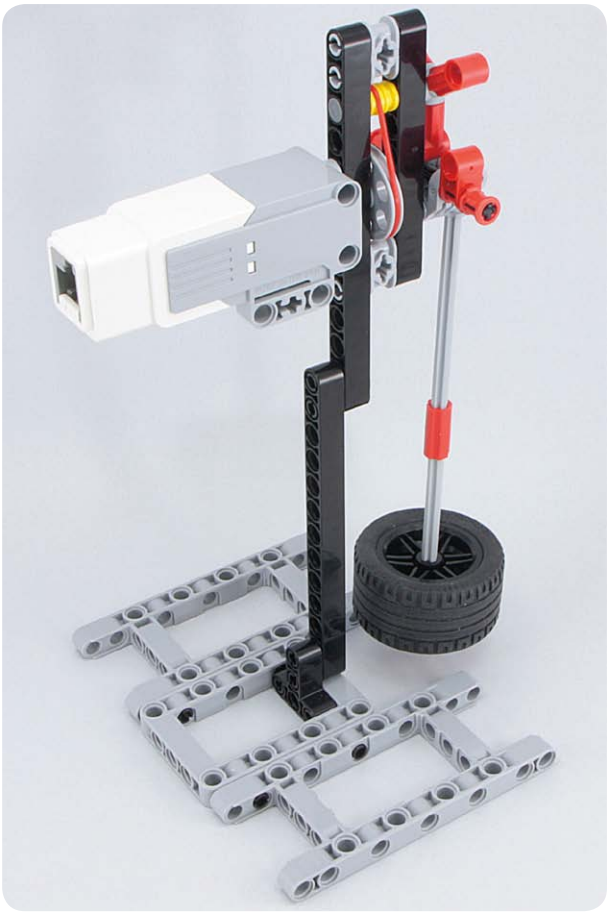


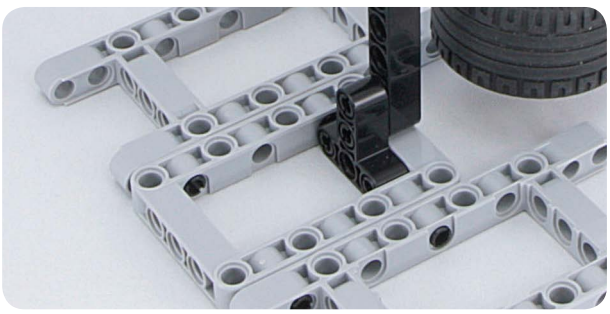
#156





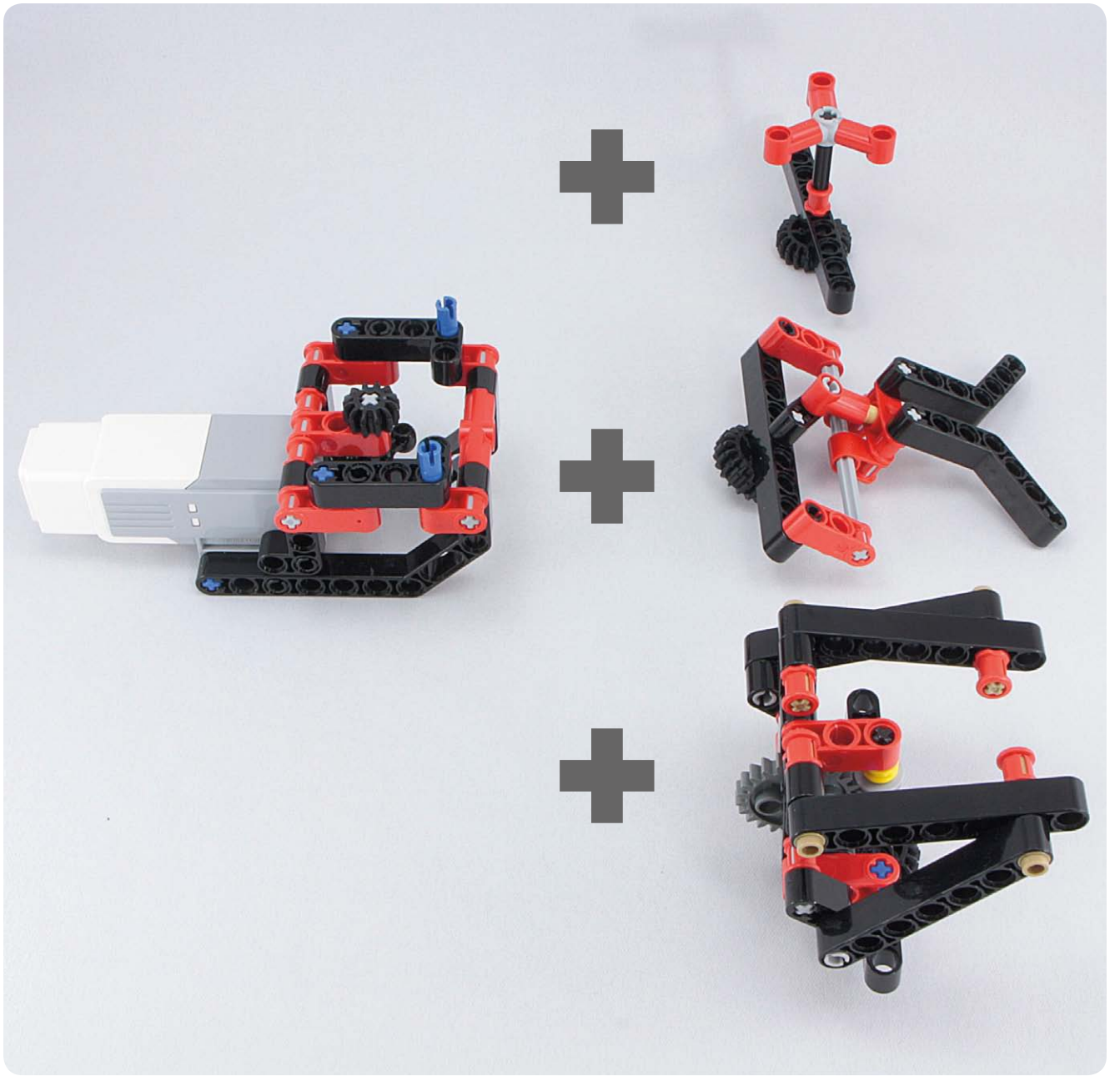


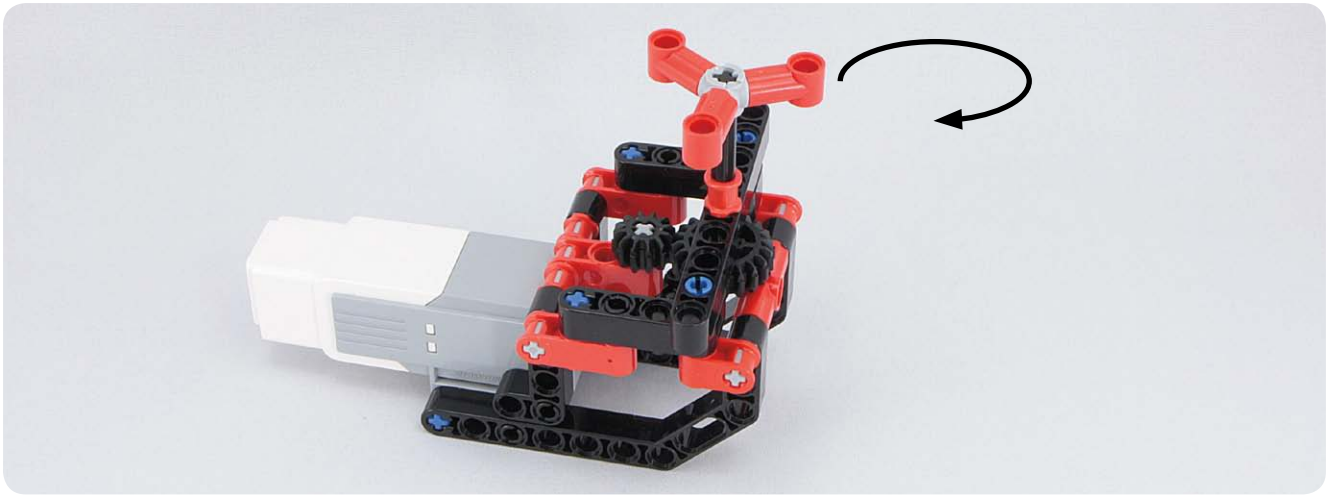


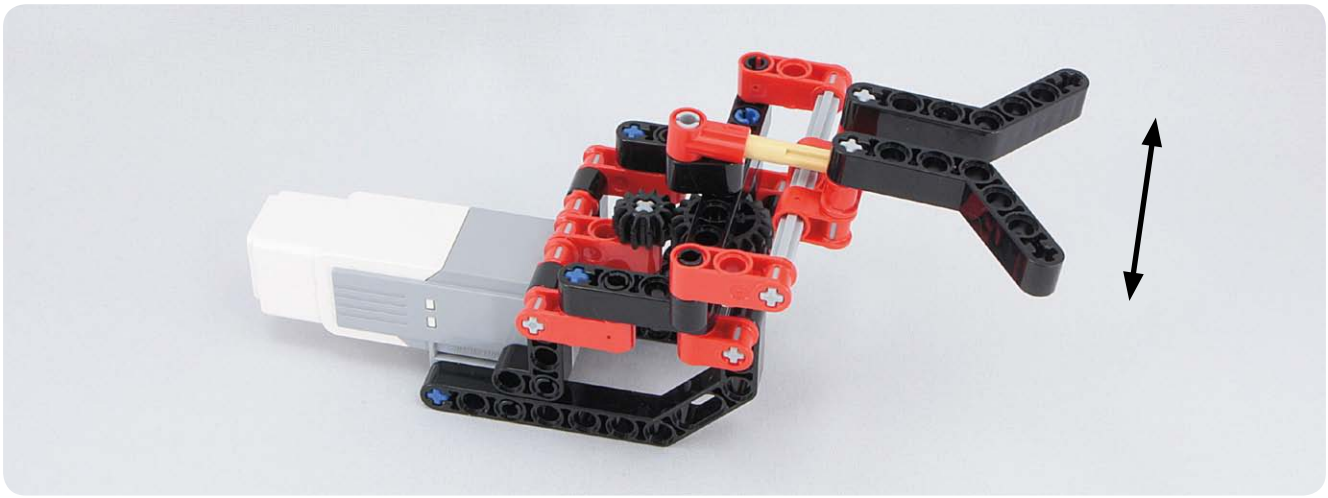


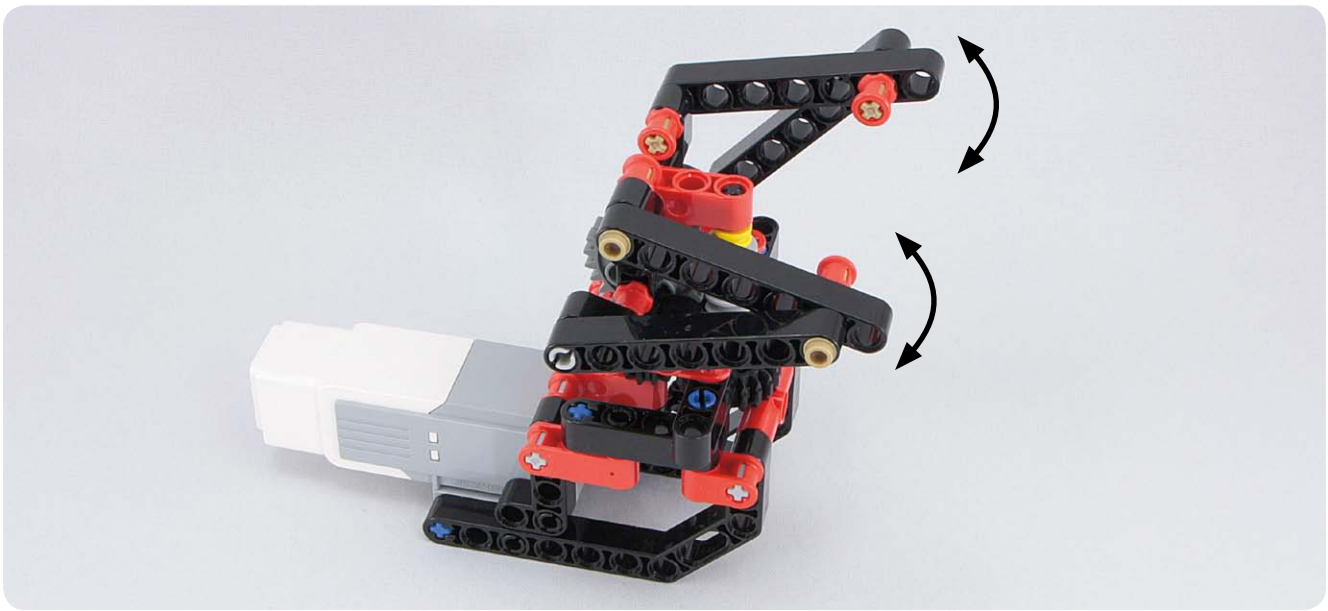
Using attachments to change motion

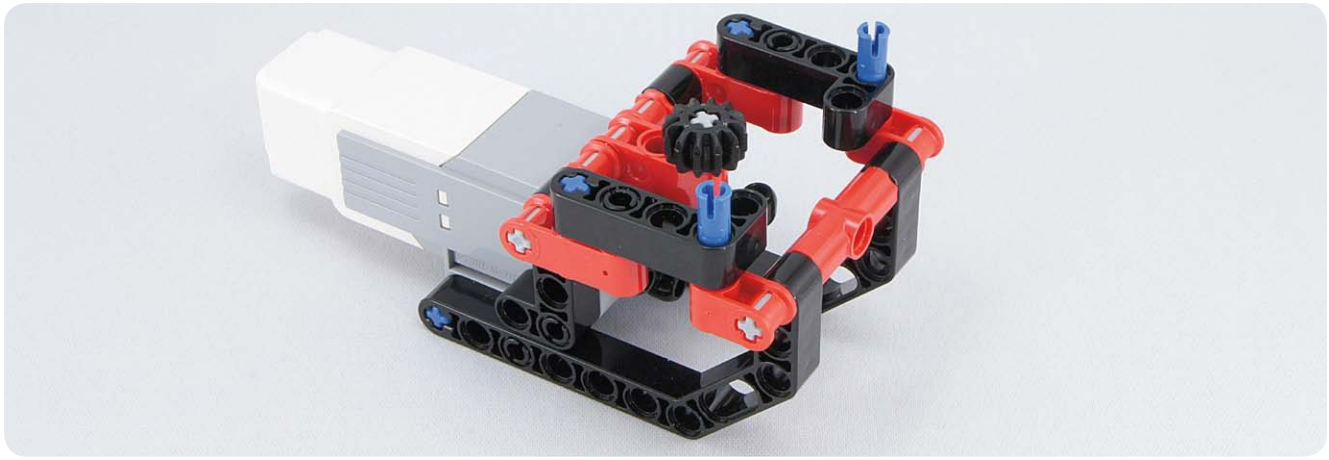
#157

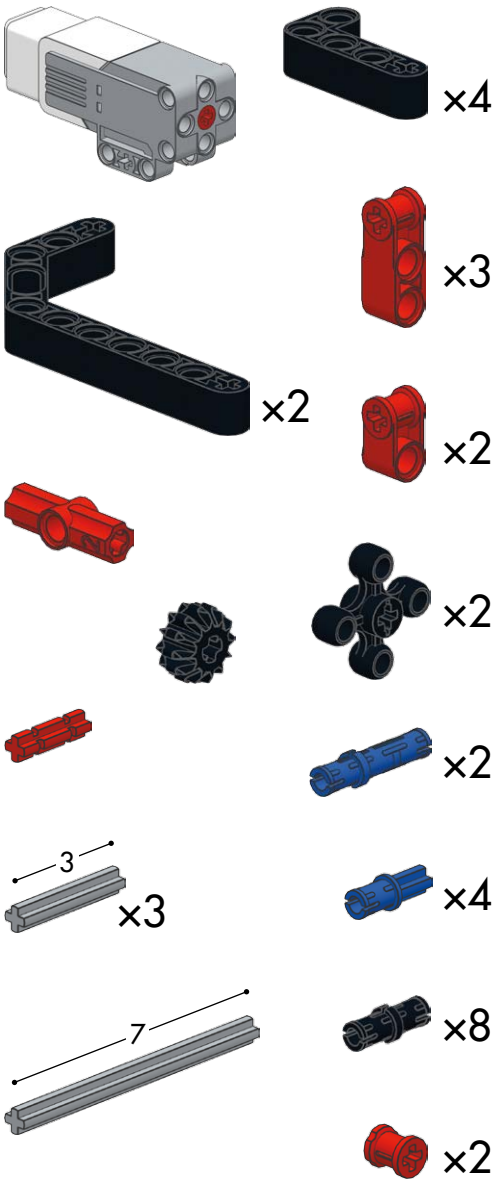


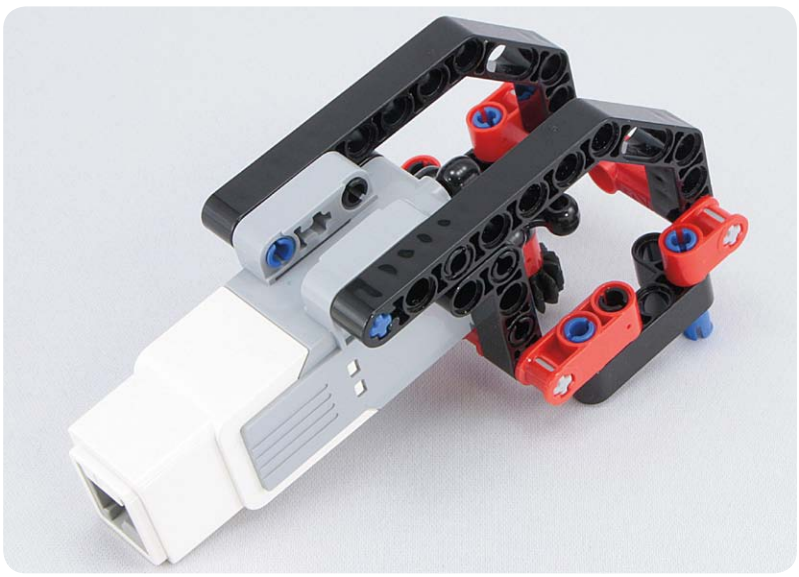


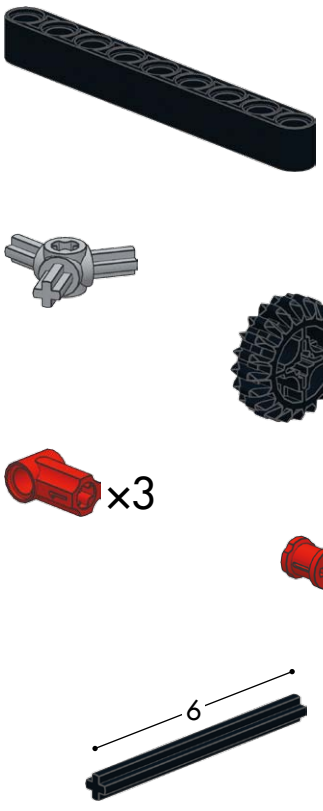


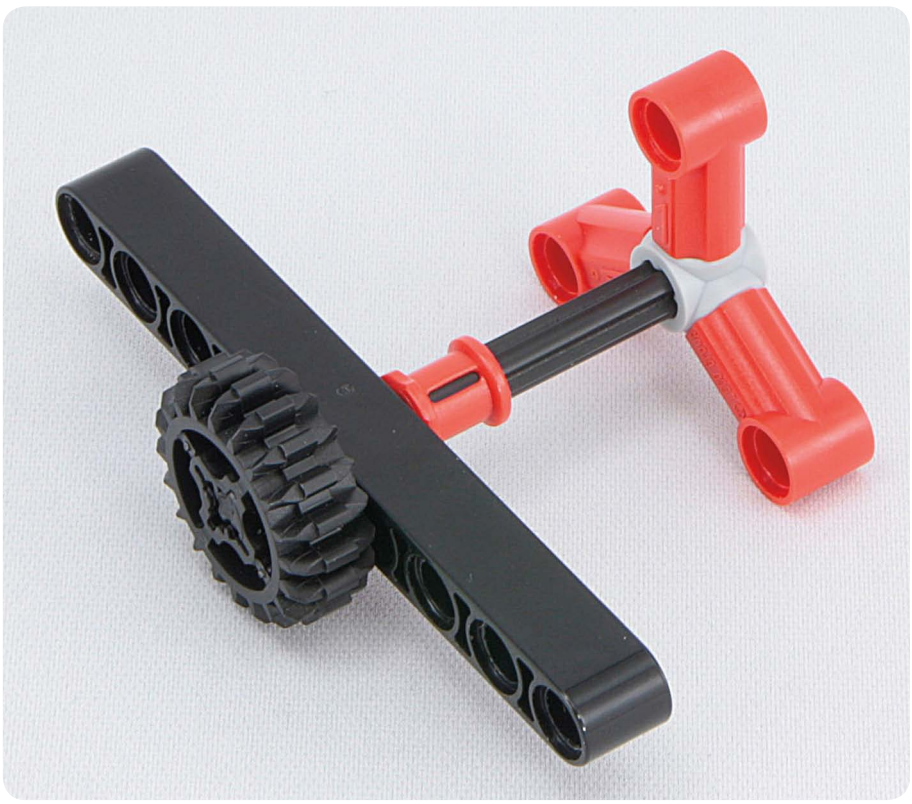


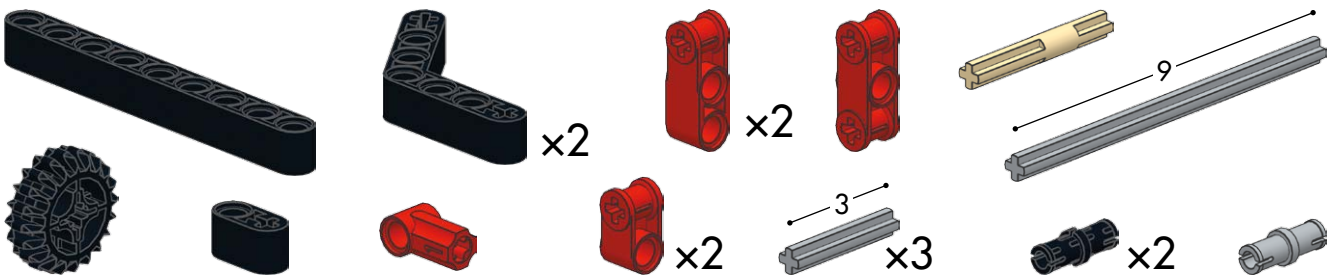


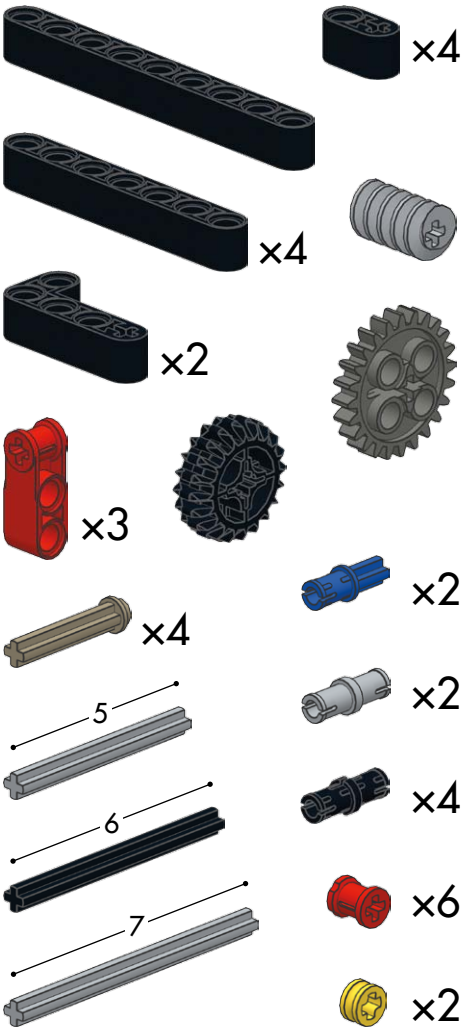

×4
×3
×2
×2
×2
×2
3
×3
×4
7
×8
×2




×3
6




×2
×2
9
3
×3
×2


×4
×4
×2
×3
×2
×4
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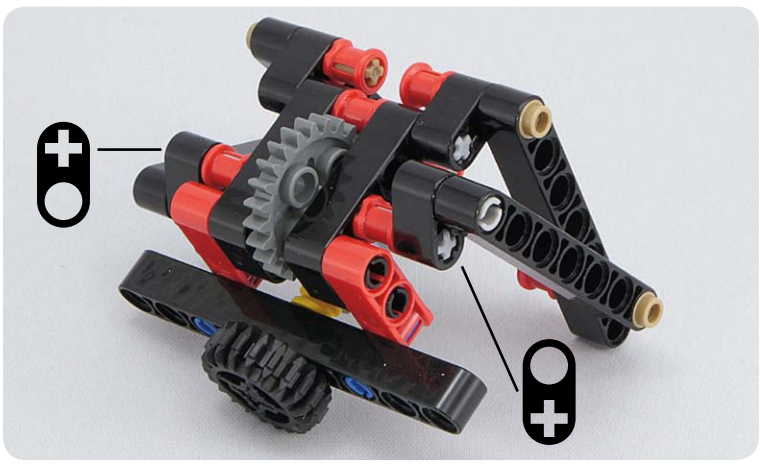
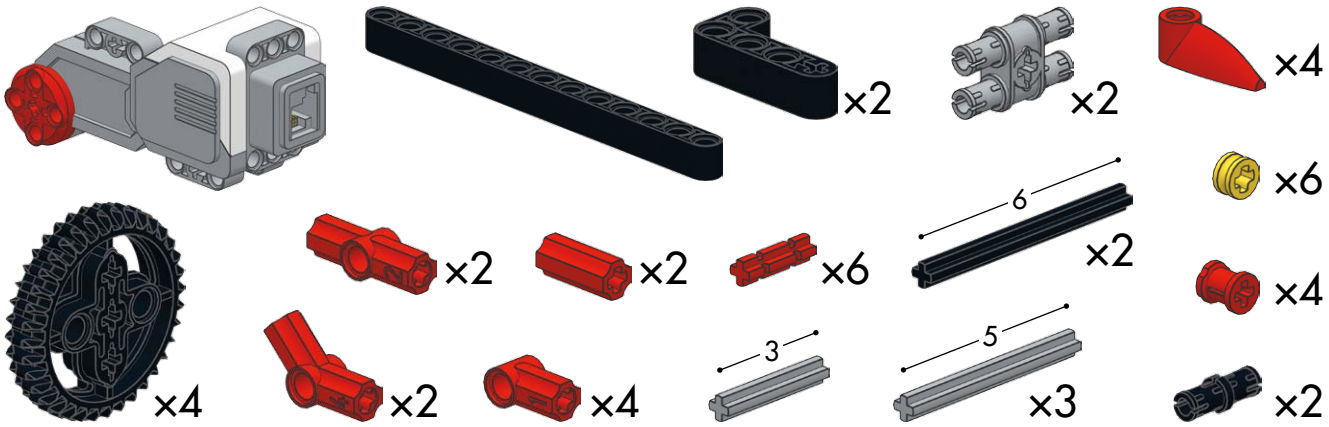
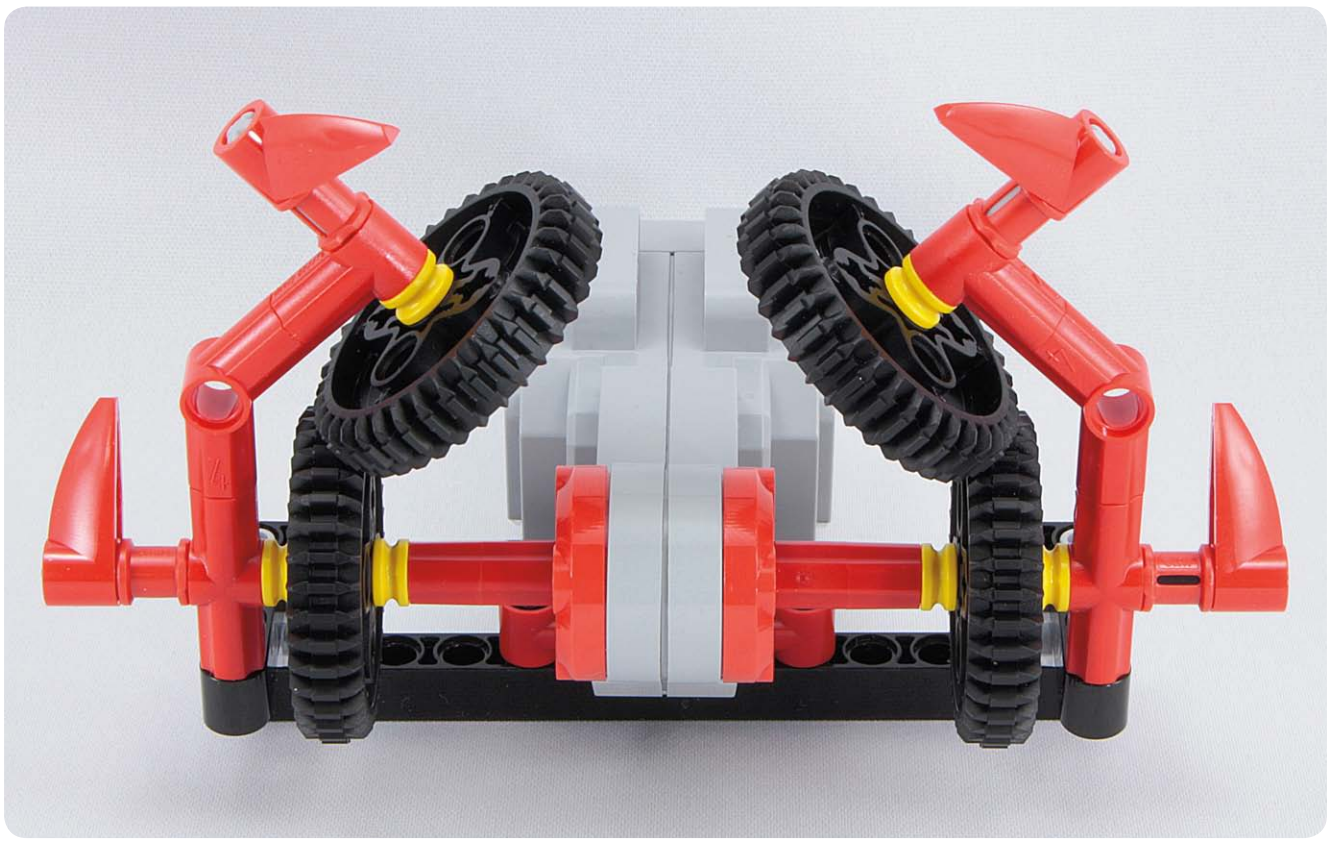
×6
×2

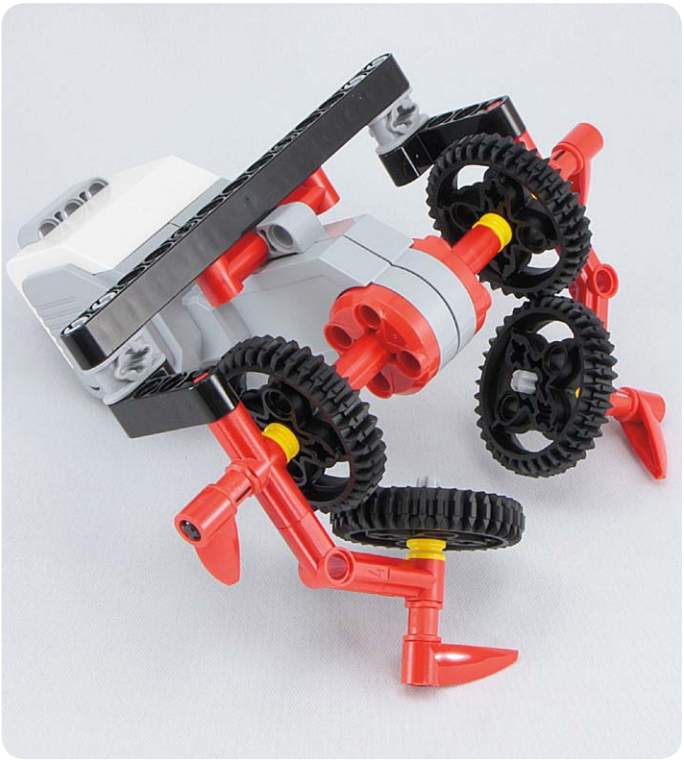


Meshing gears diagonally

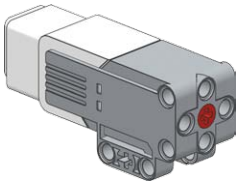
#158

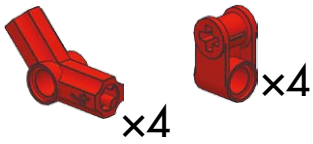


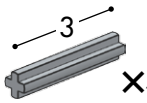


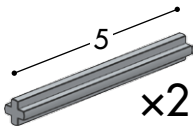


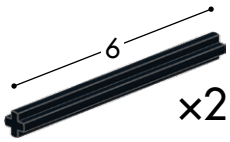
#159

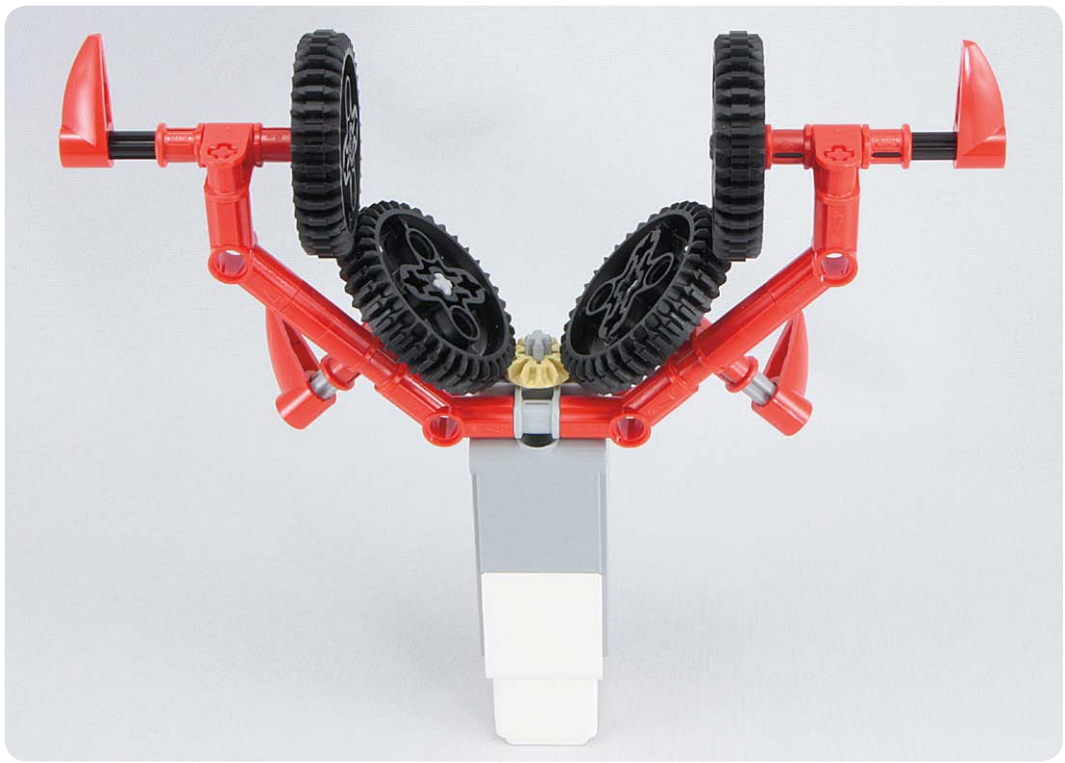




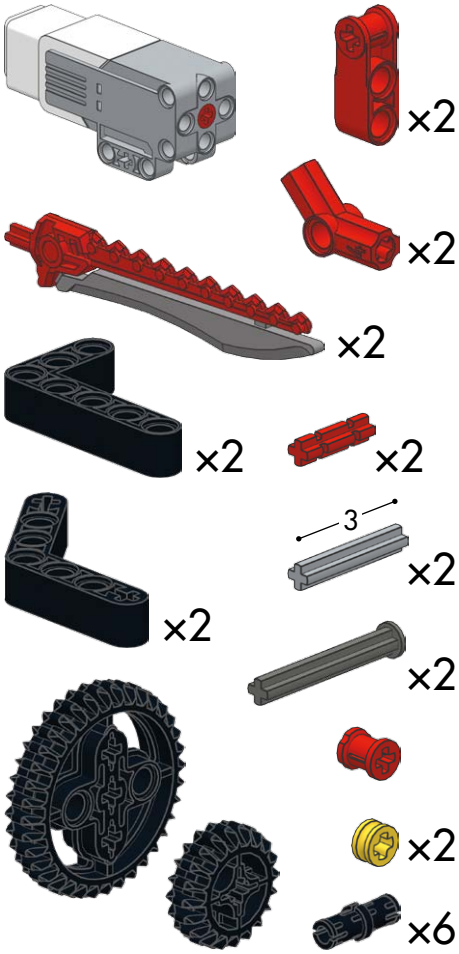


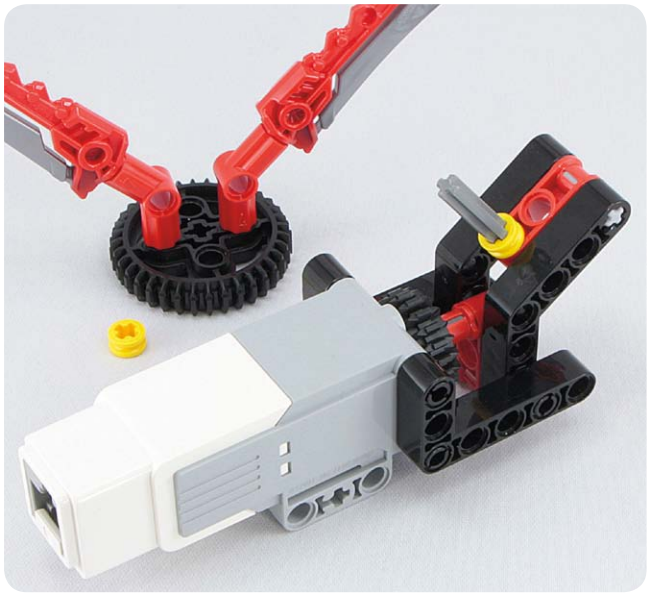


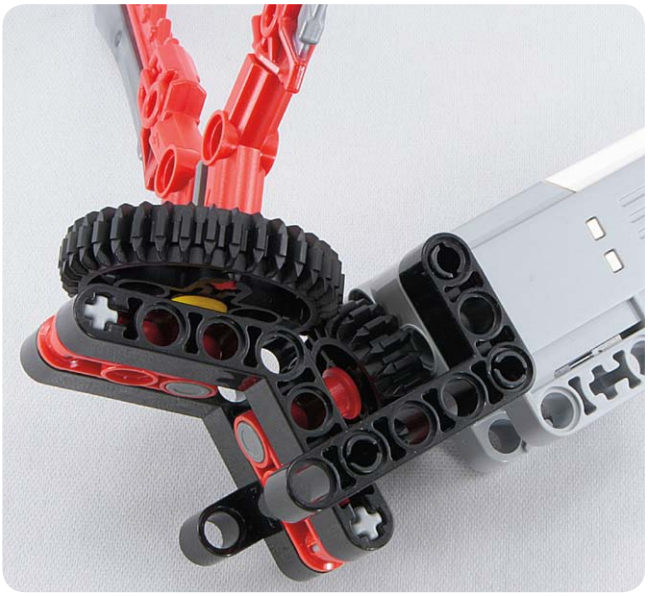




#160

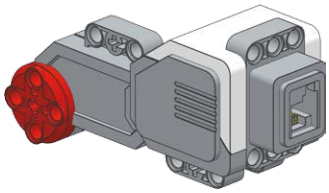


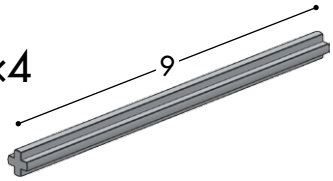


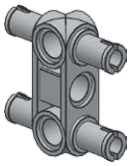


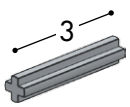
Changing the angle of rotation freely

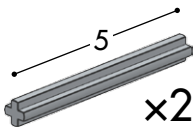
#161

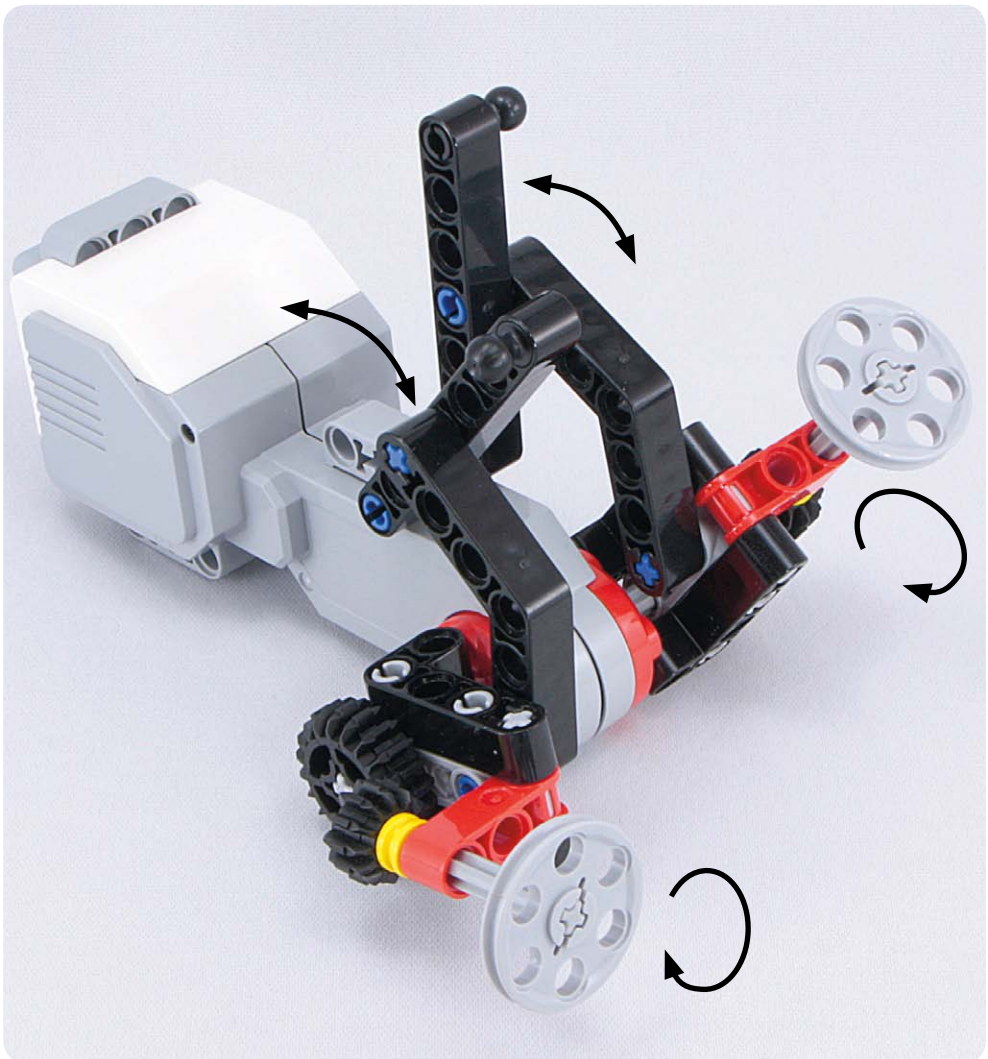


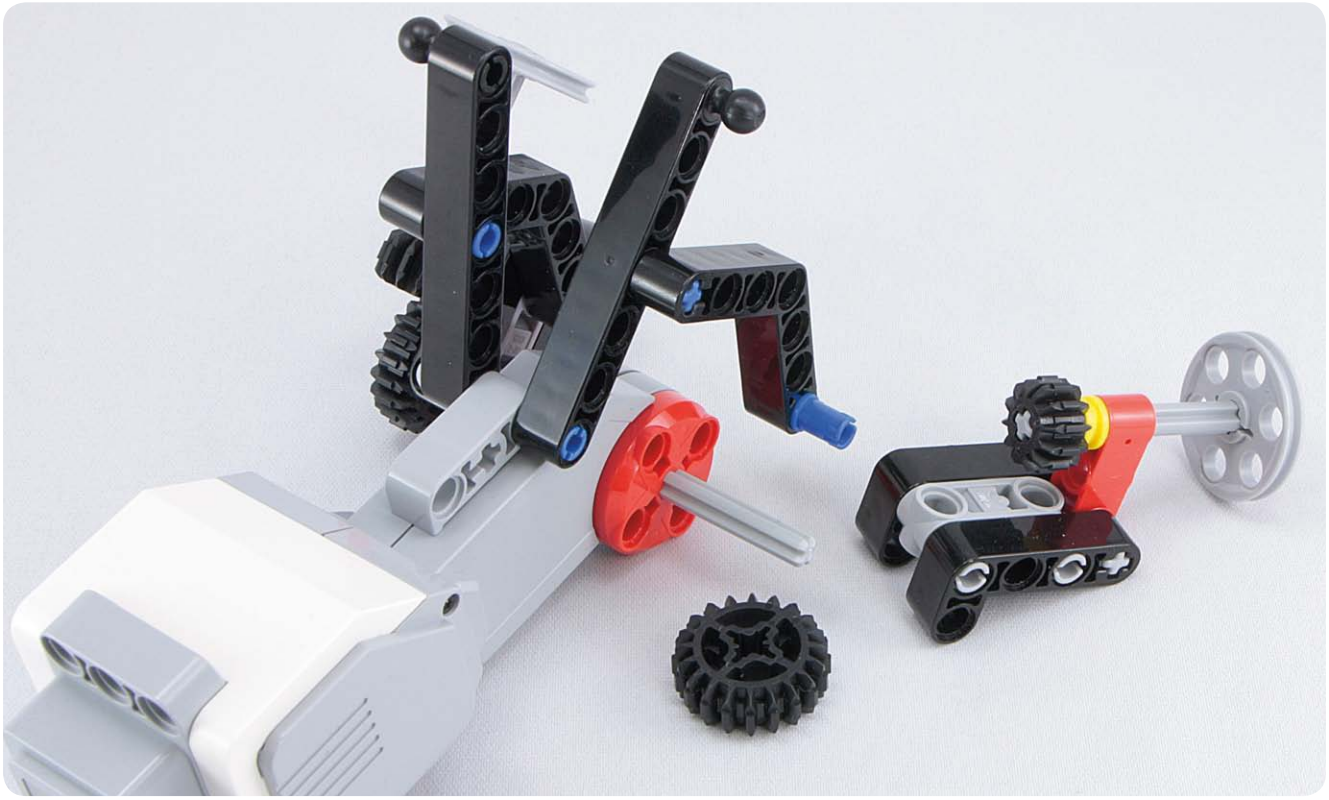












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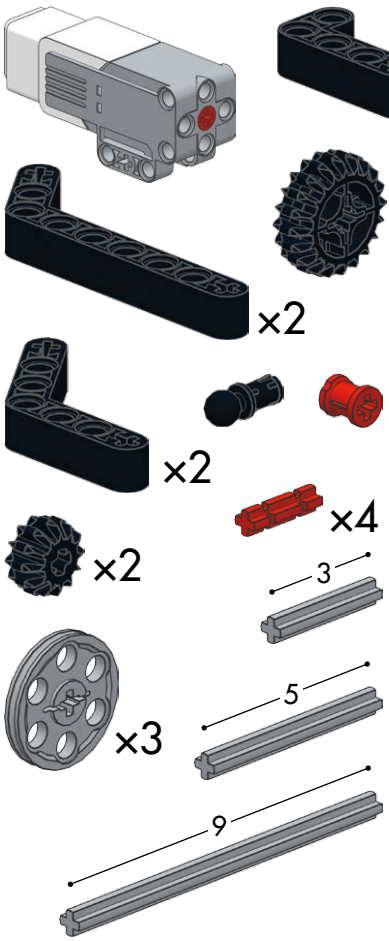

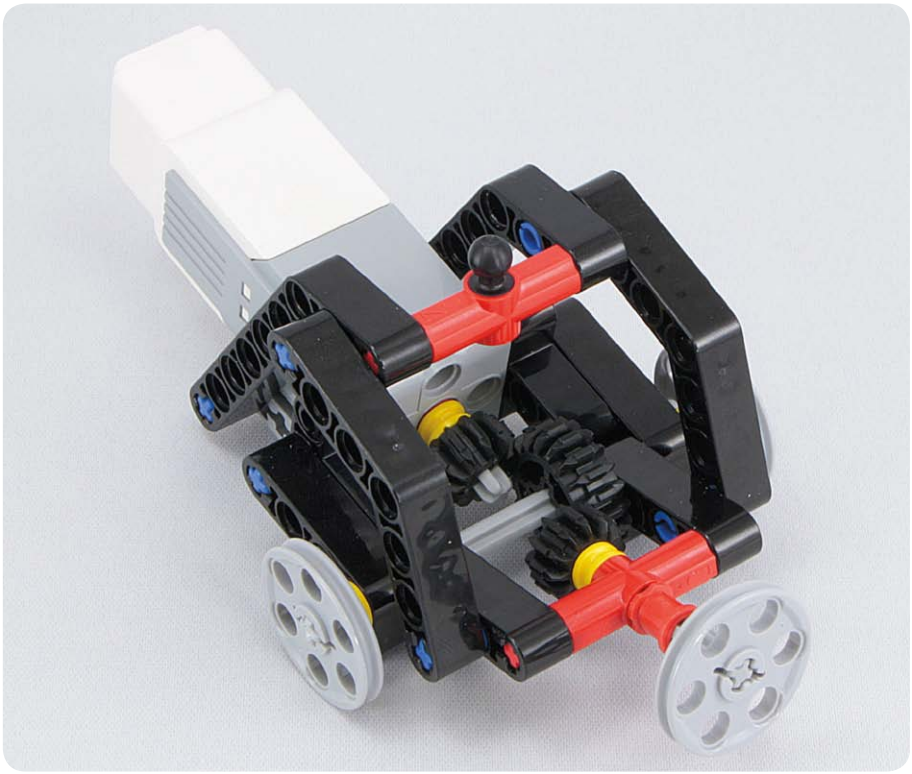

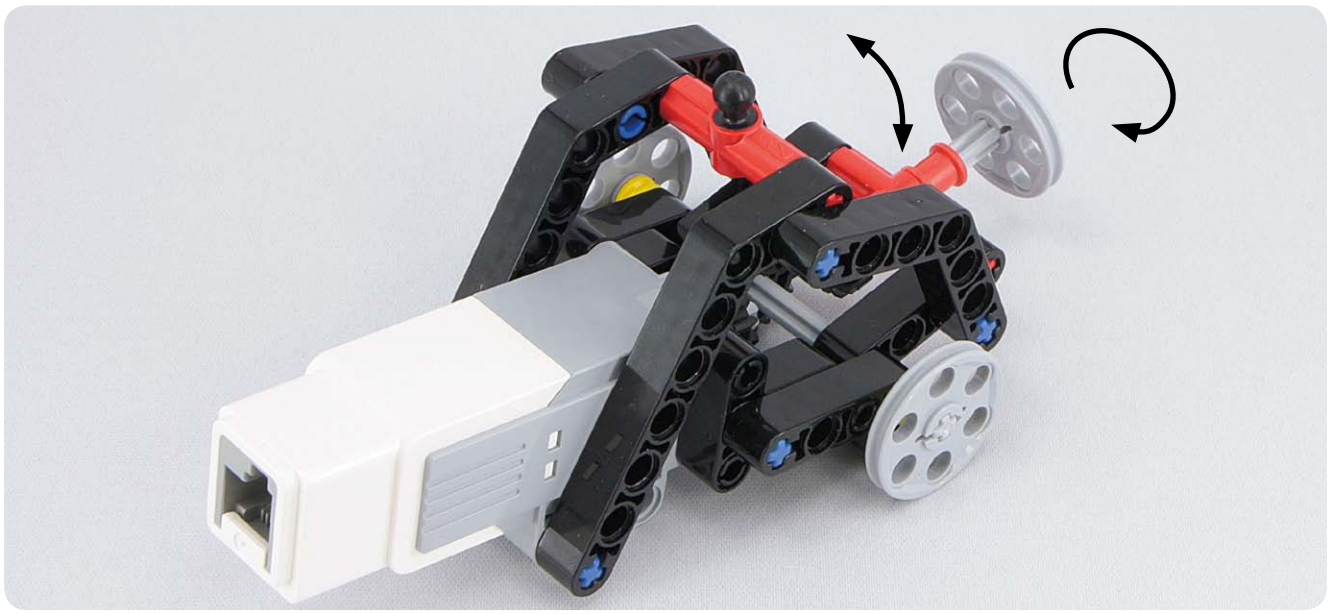

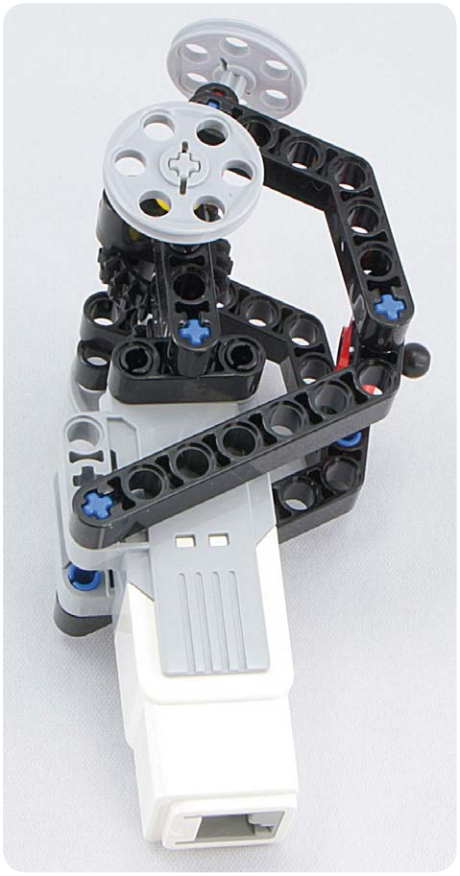

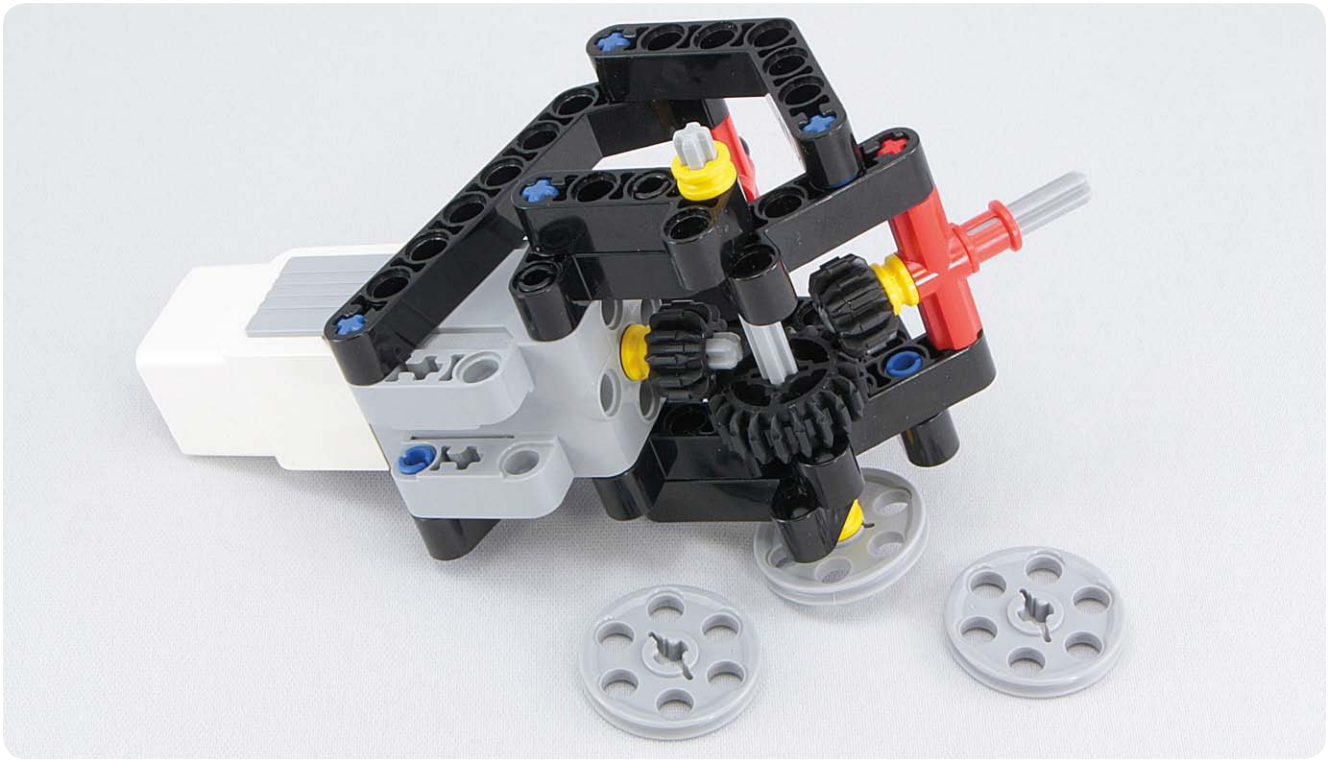

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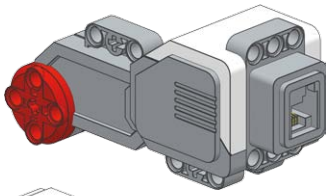

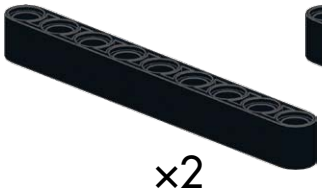

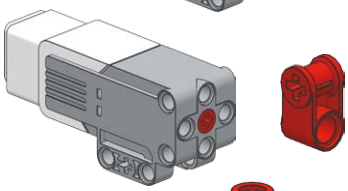

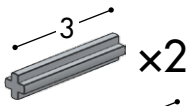

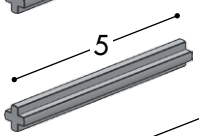

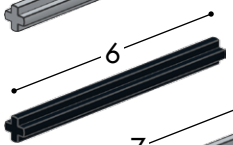

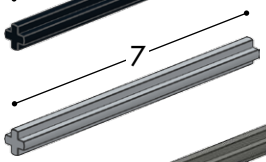

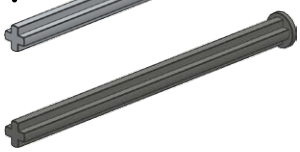

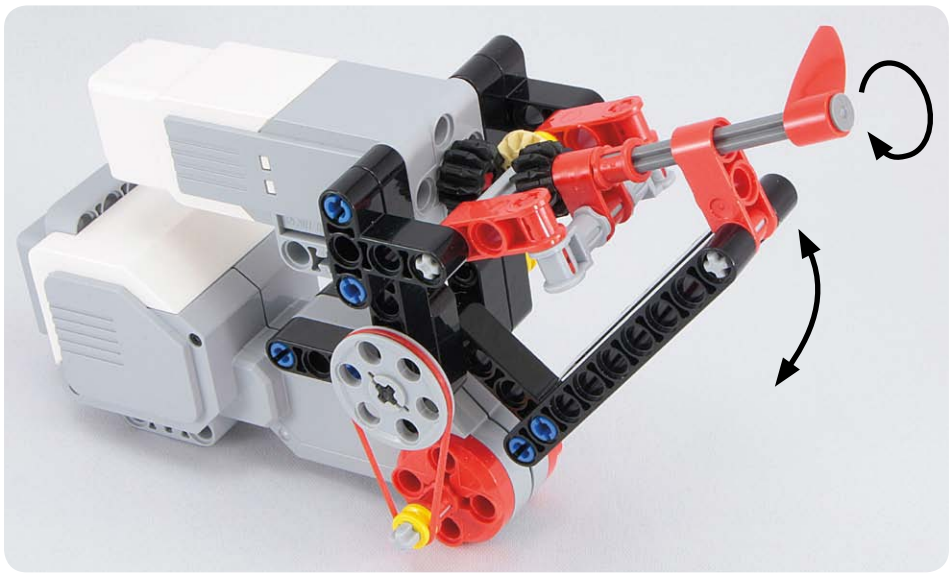

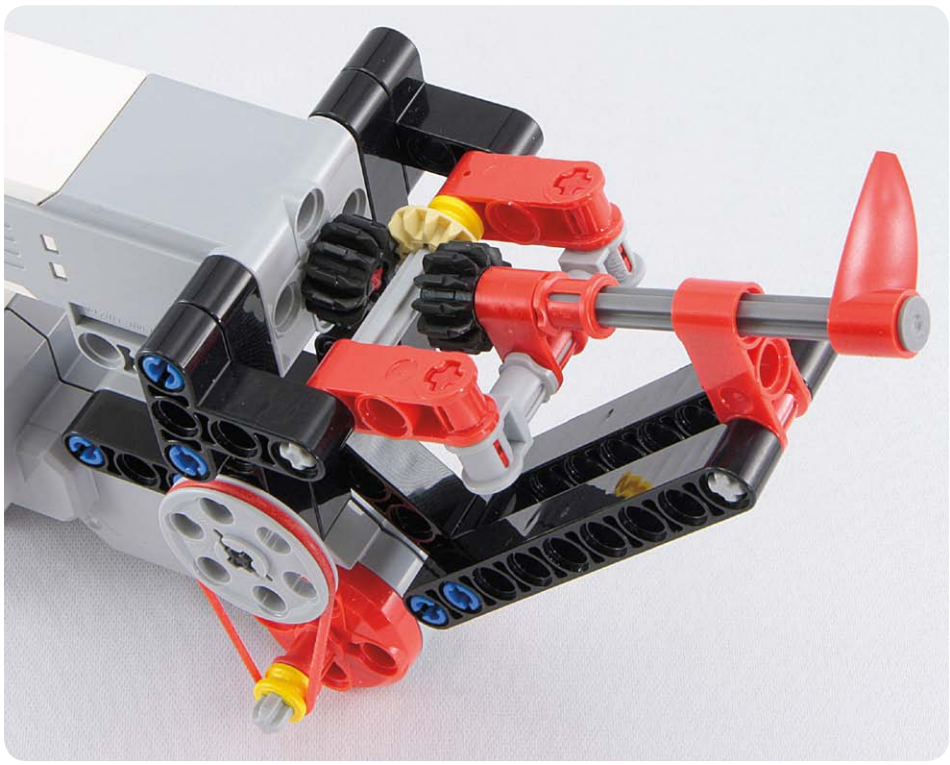

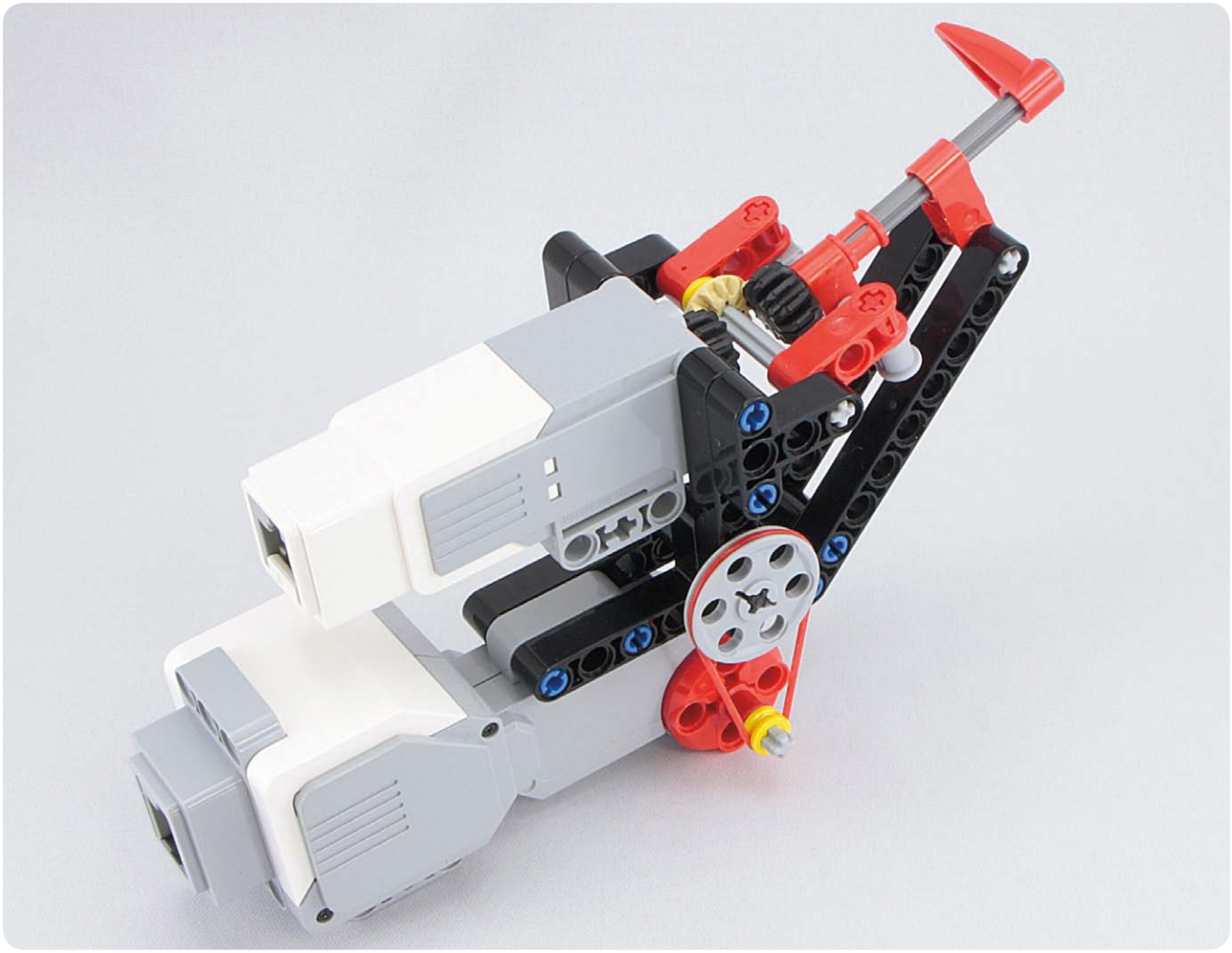

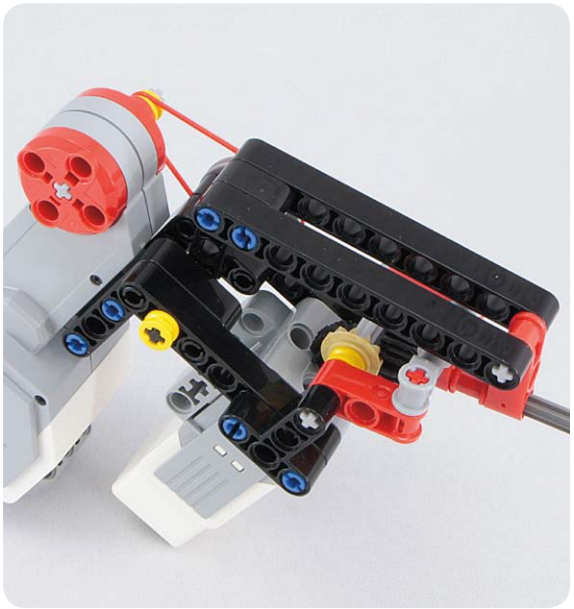

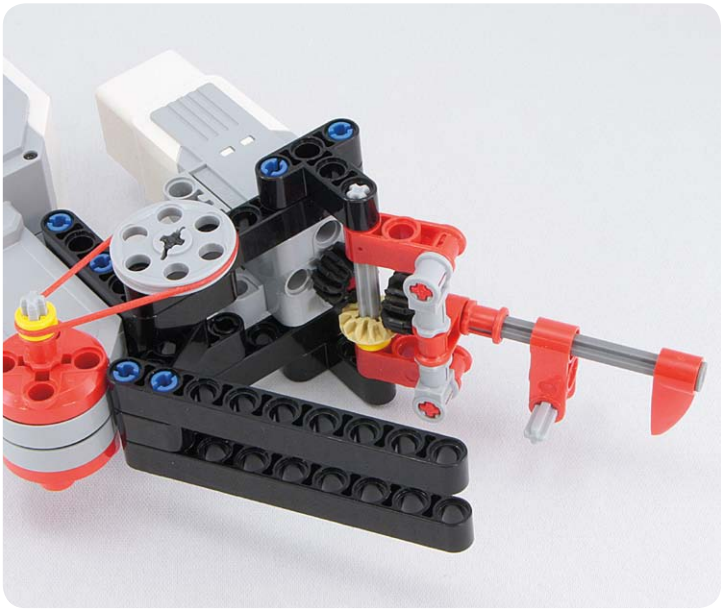












PART 5

Sensors

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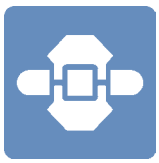
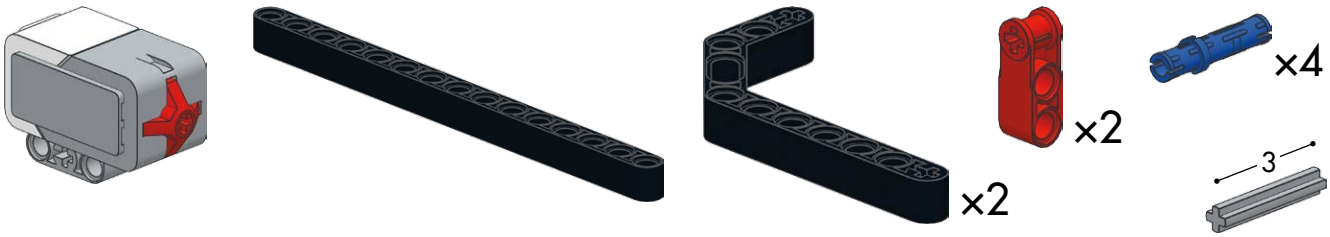


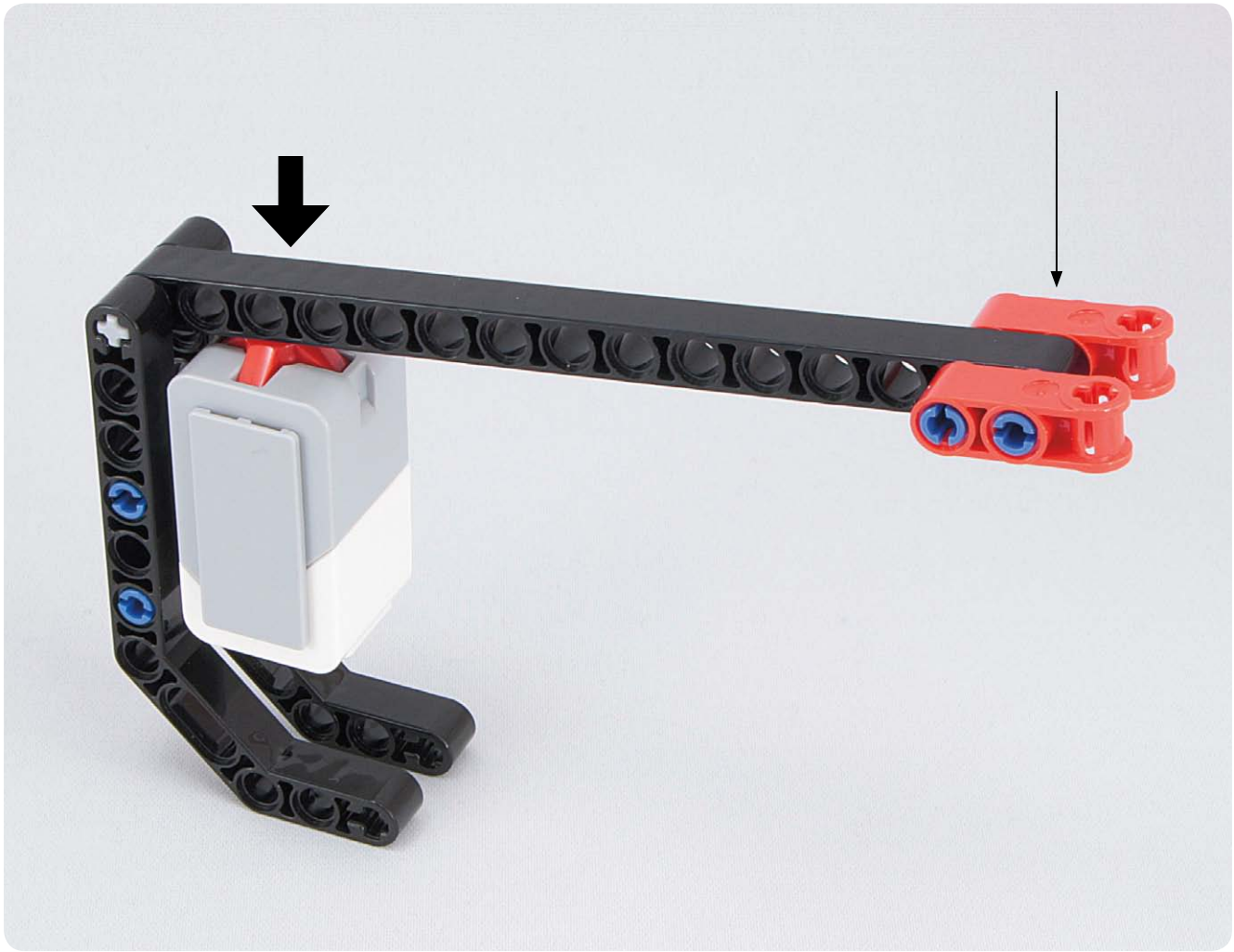
214

216

Ideas for using the touch sensor

#164





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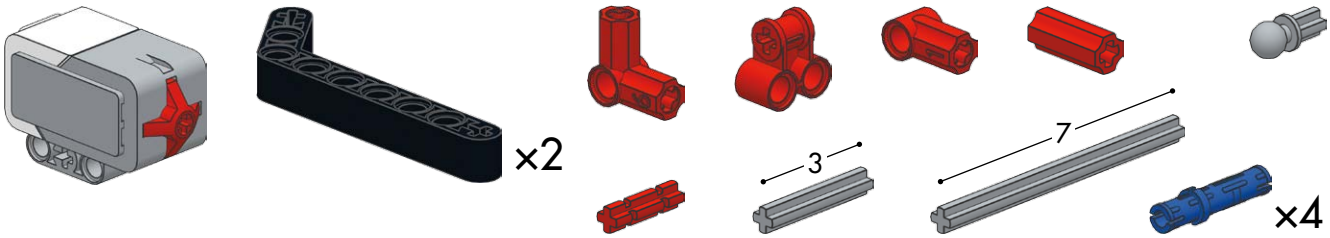

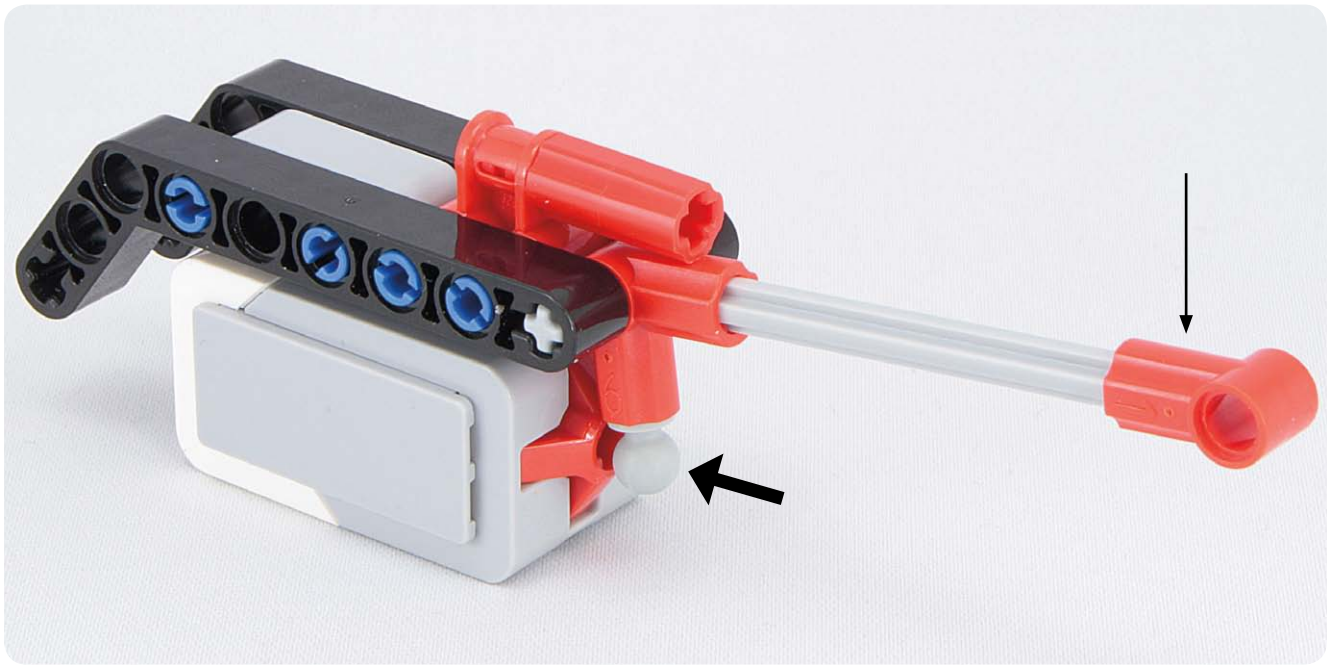

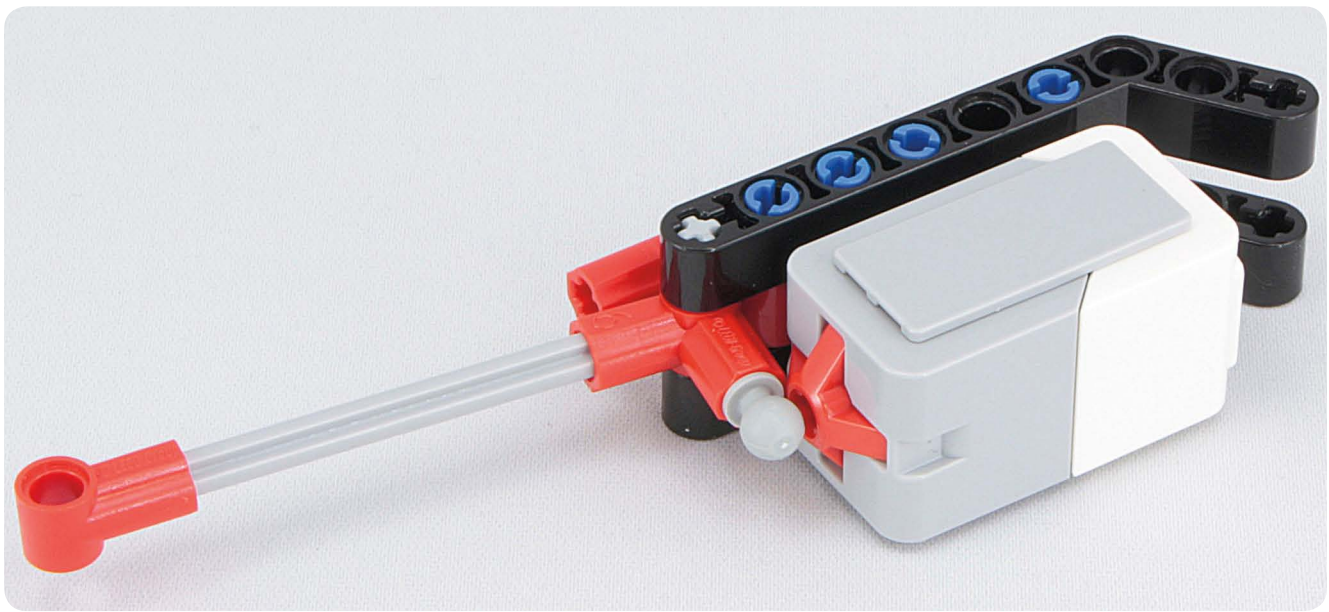

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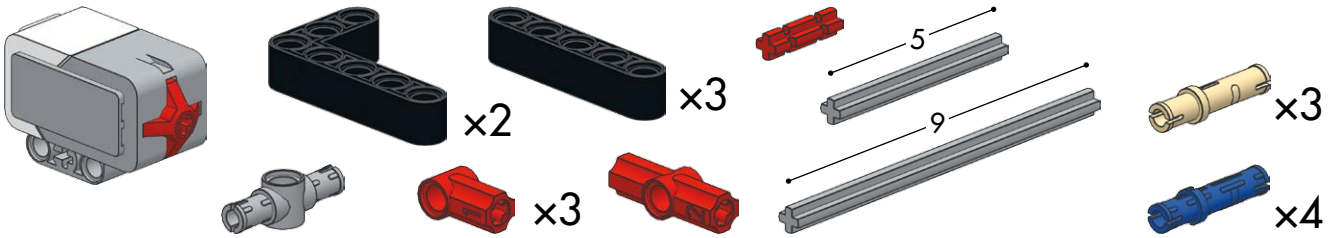

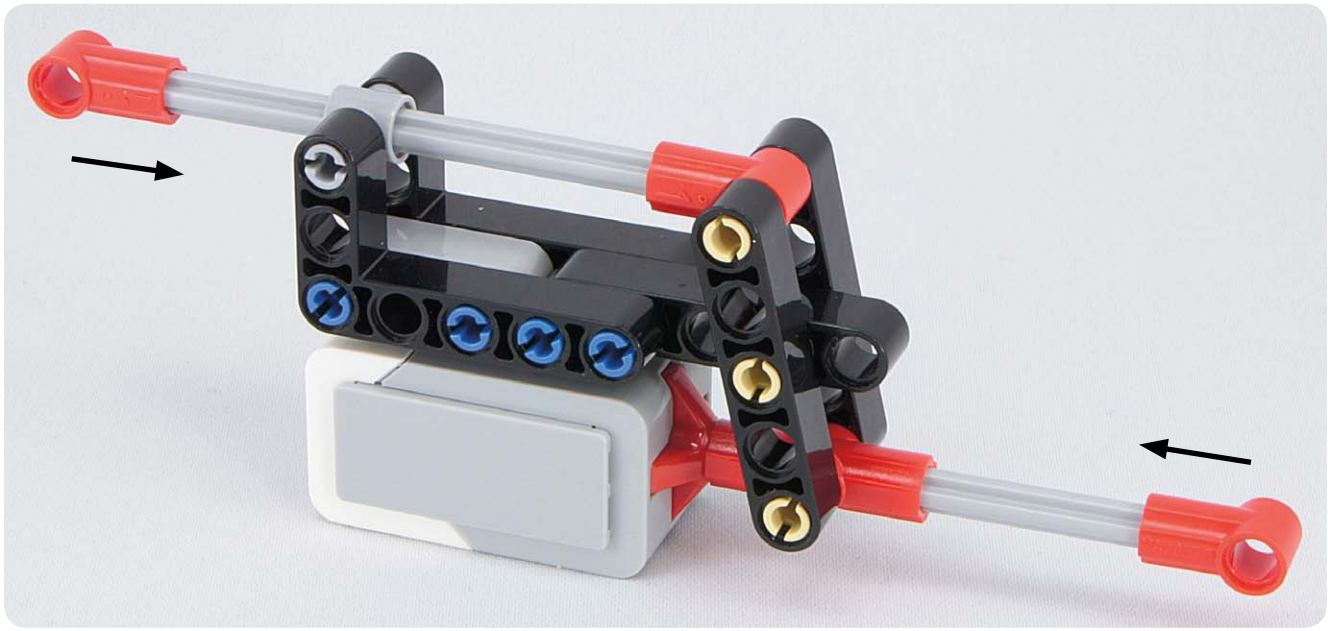

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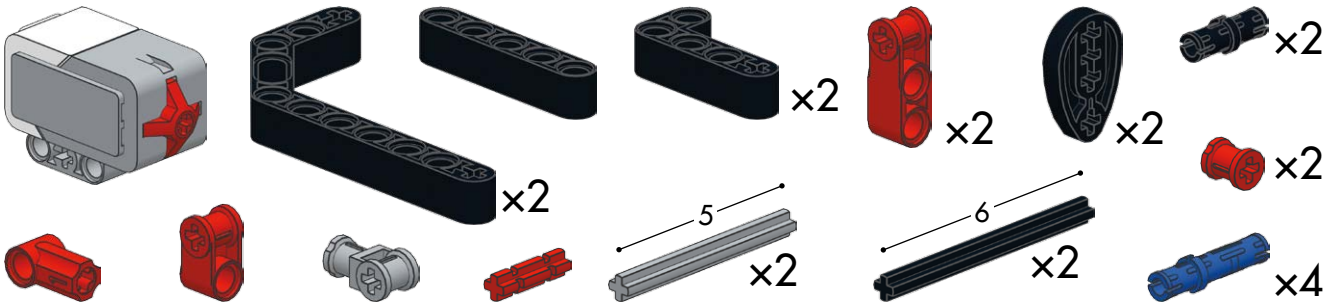

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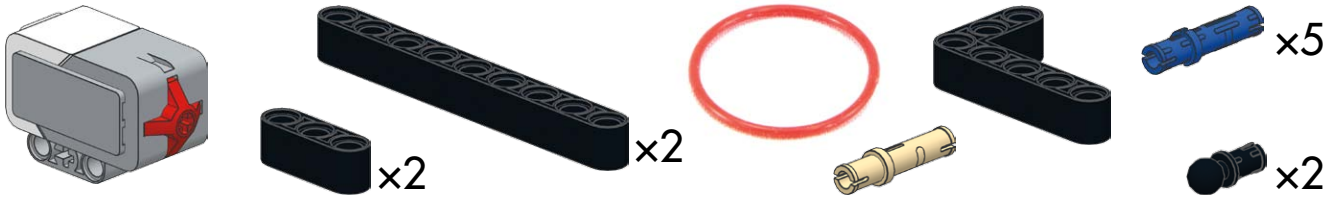

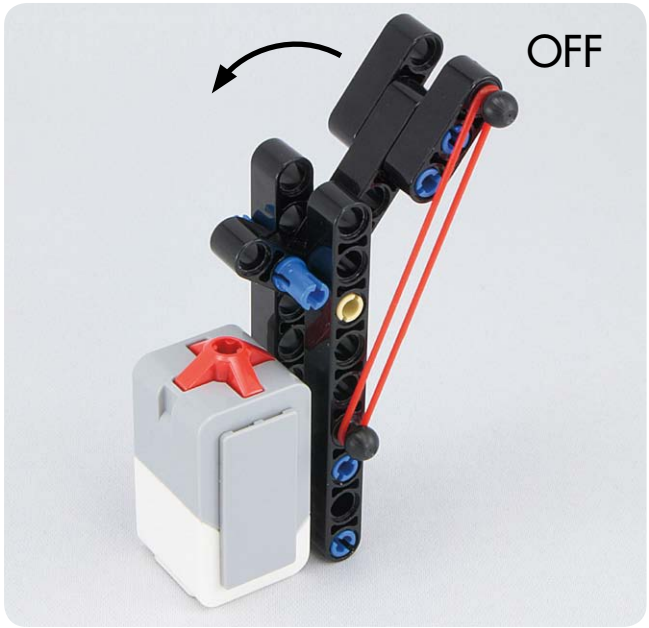

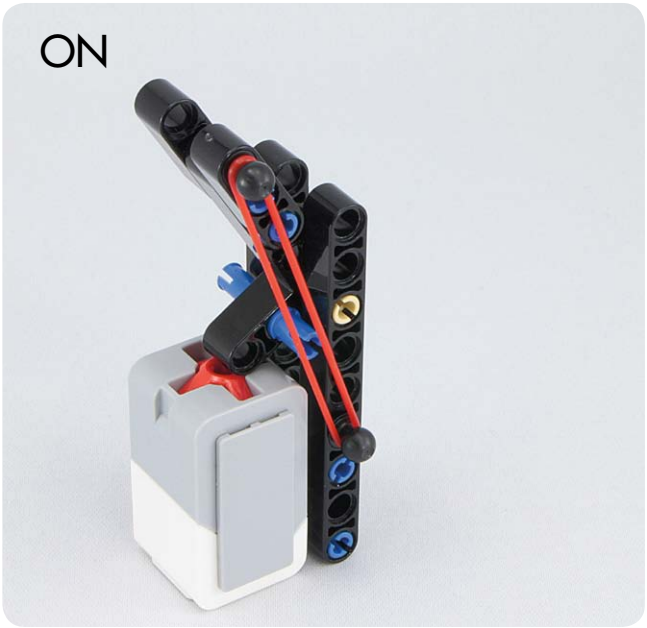

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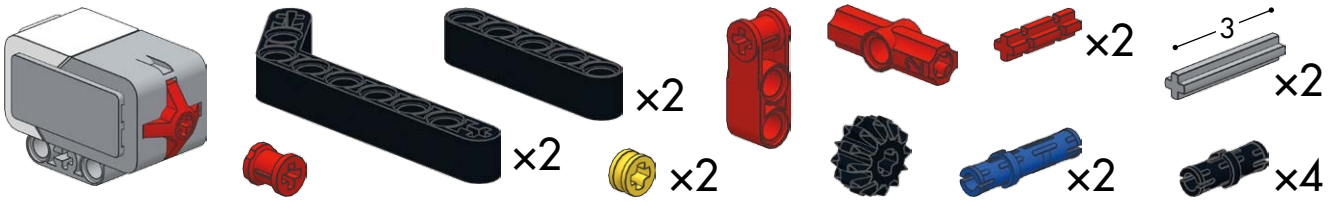

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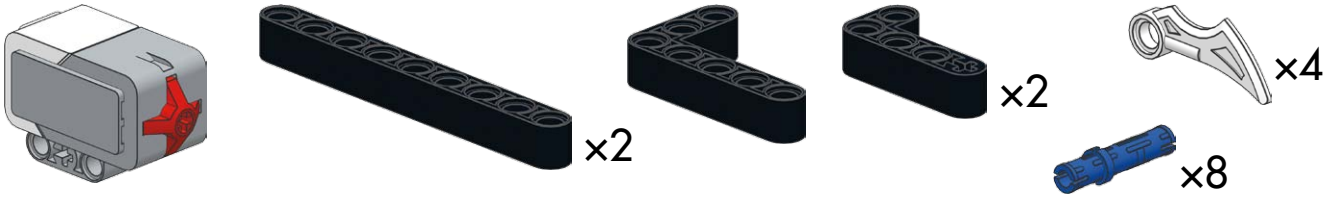

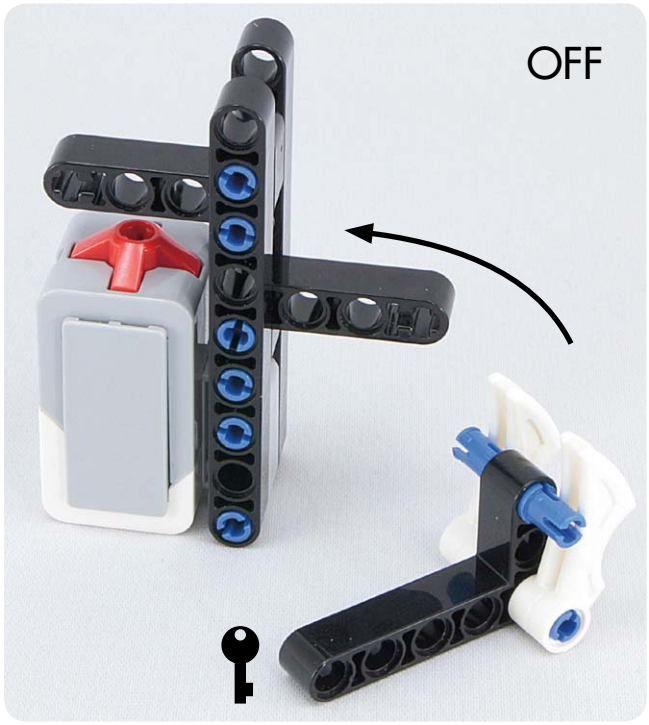

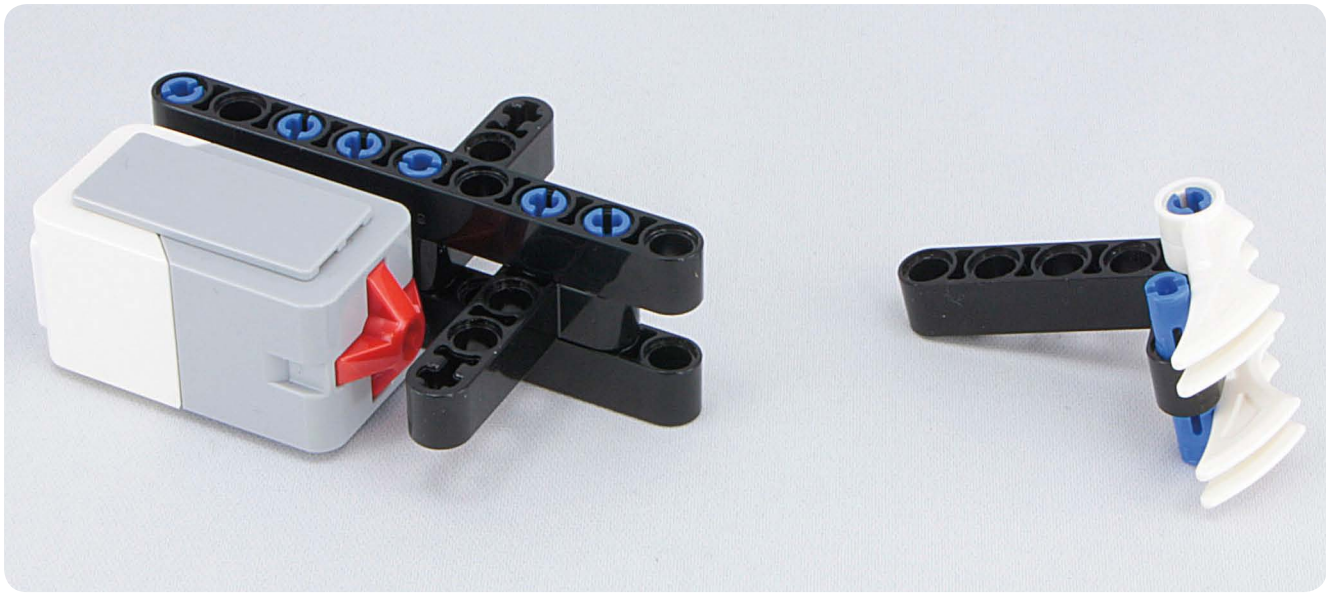

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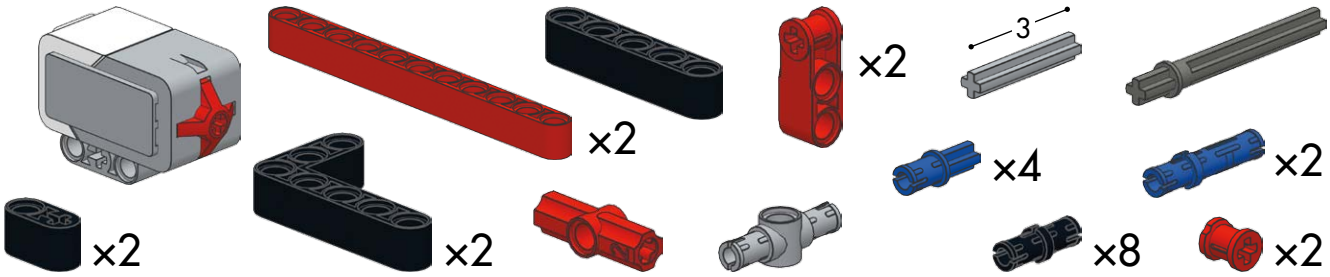
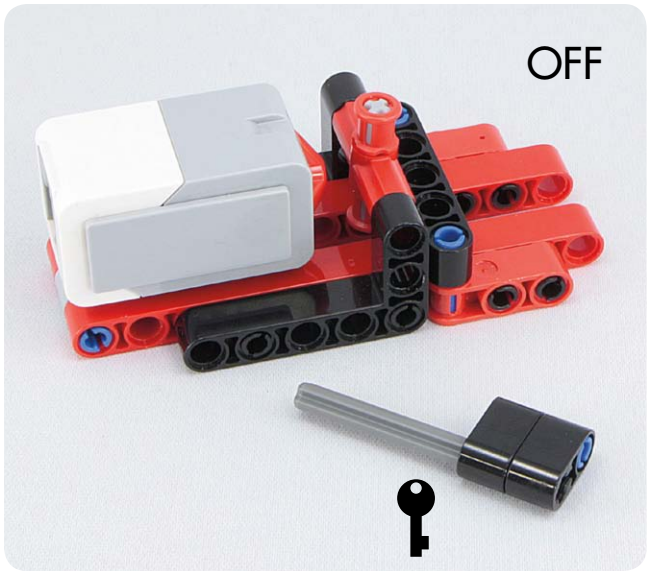
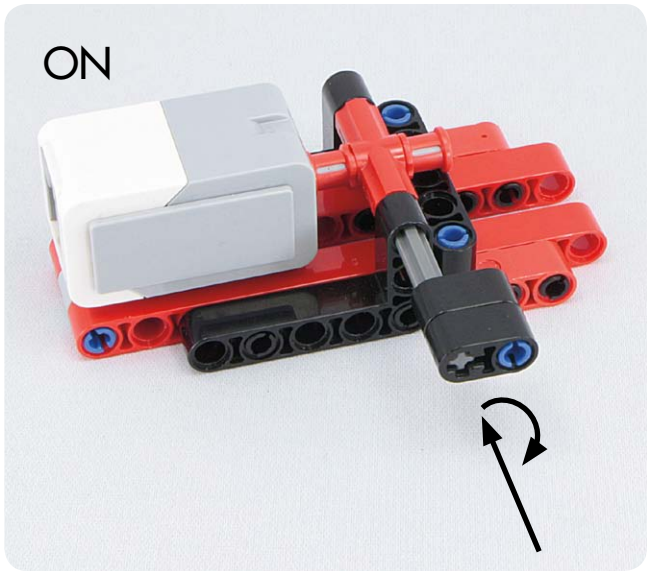
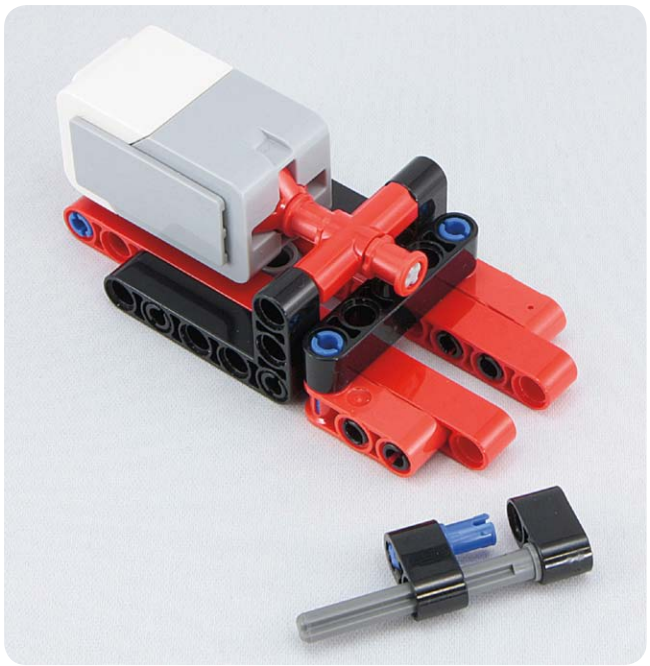


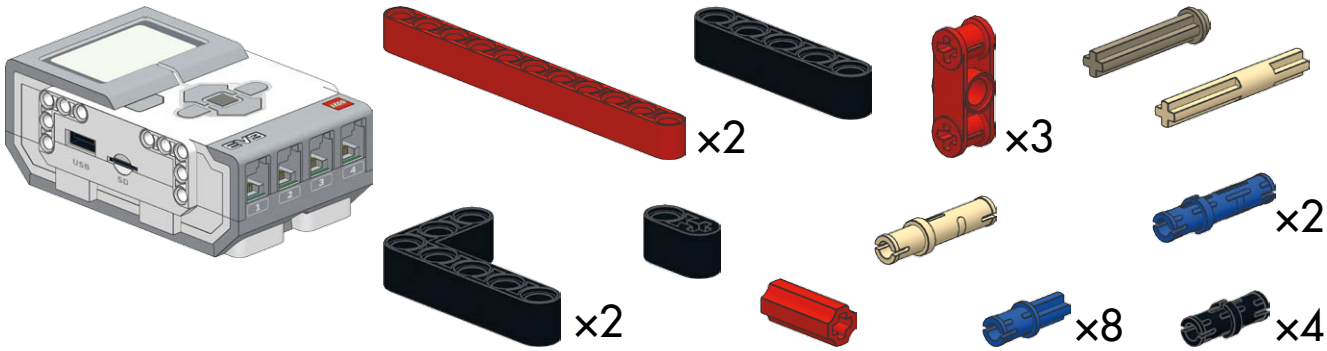


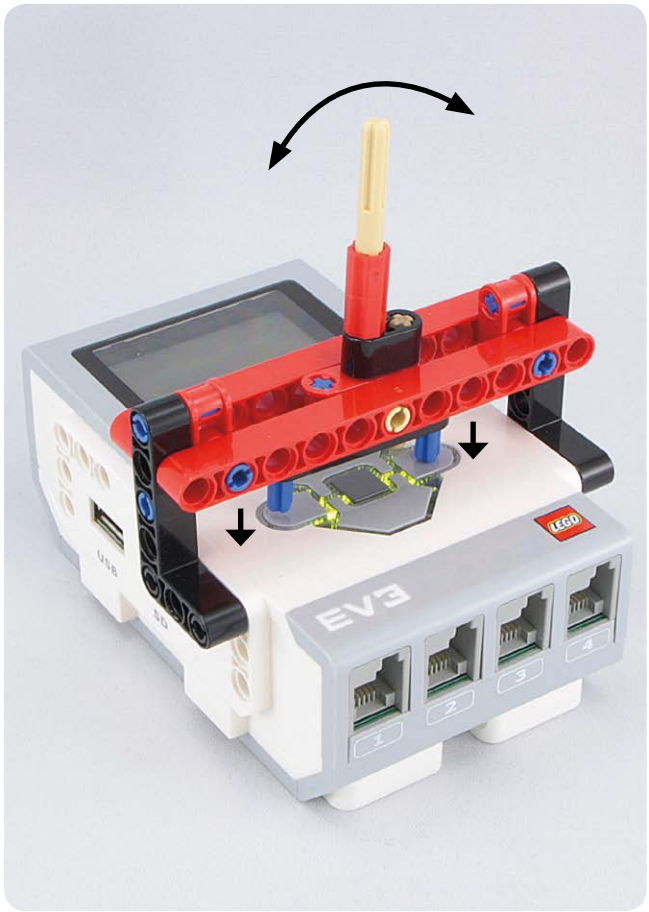


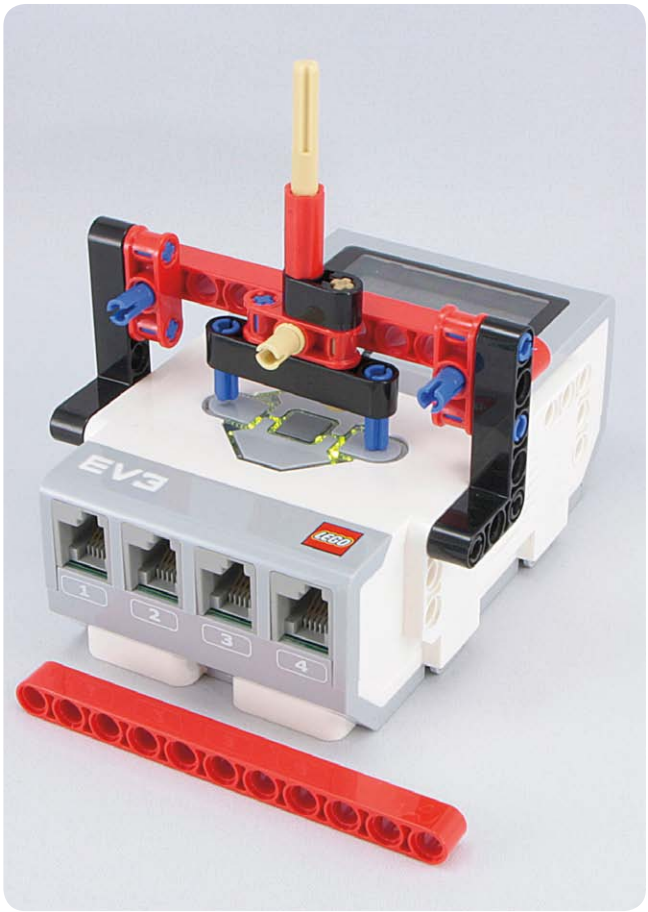


Ideas for using the buttons of the Intelligent EV3 Brick

#172







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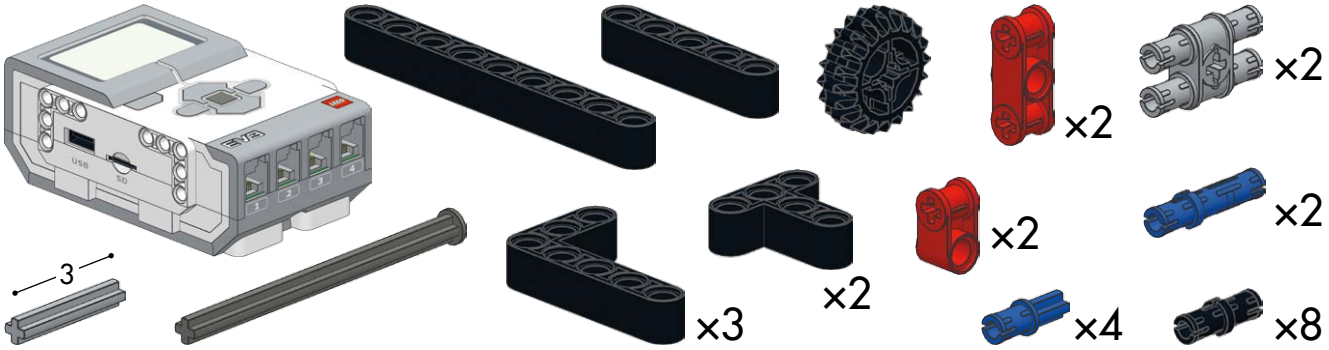
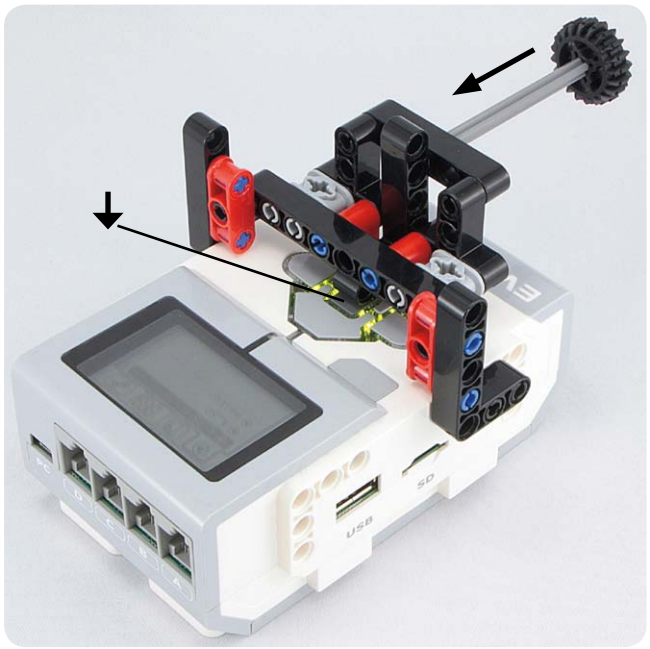
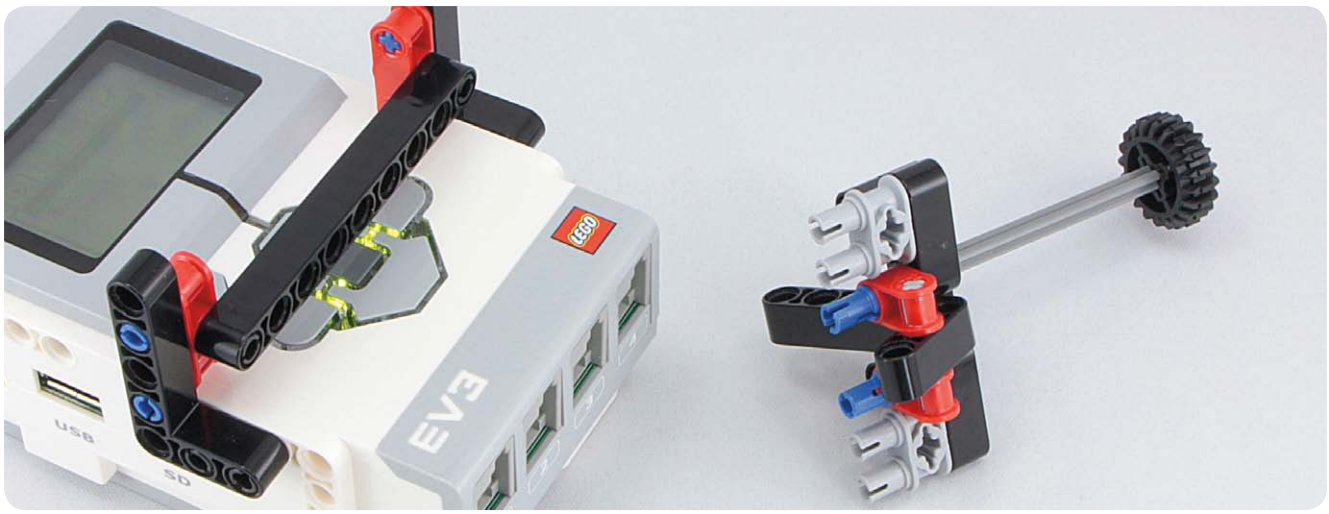
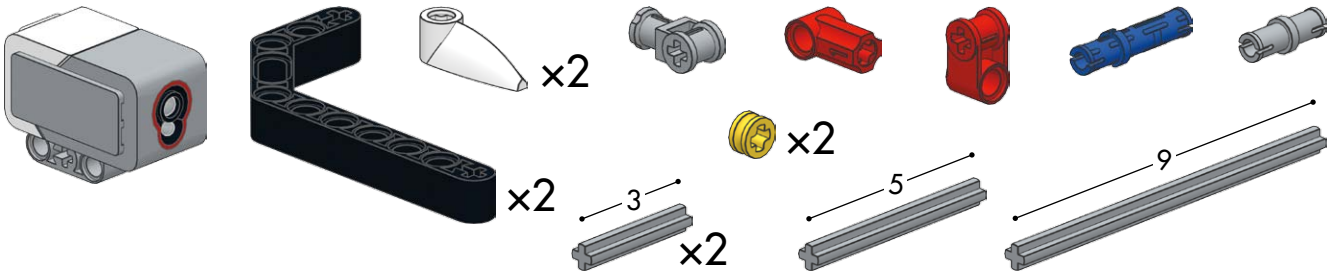


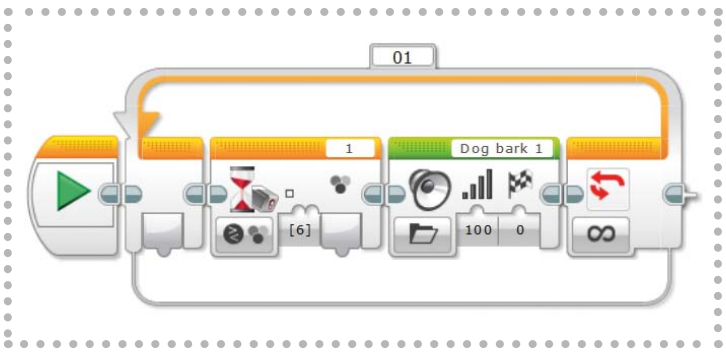




Ideas for using the color sensor

#174





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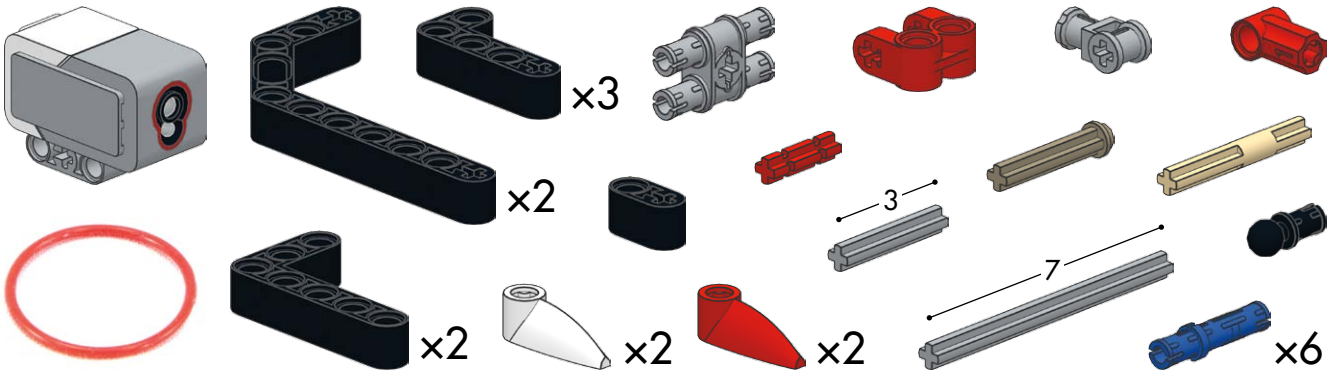
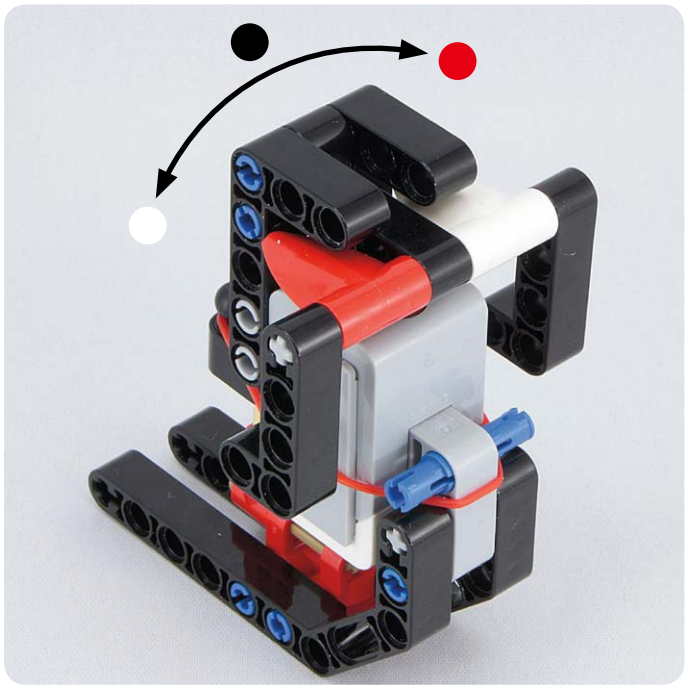
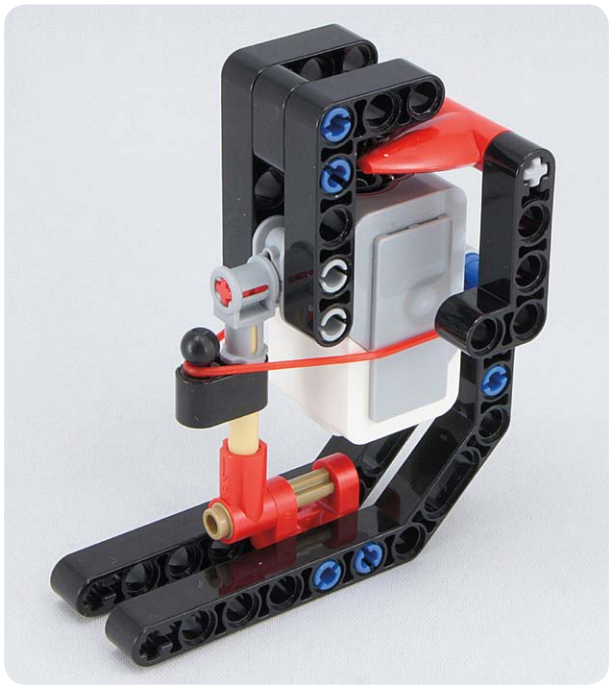
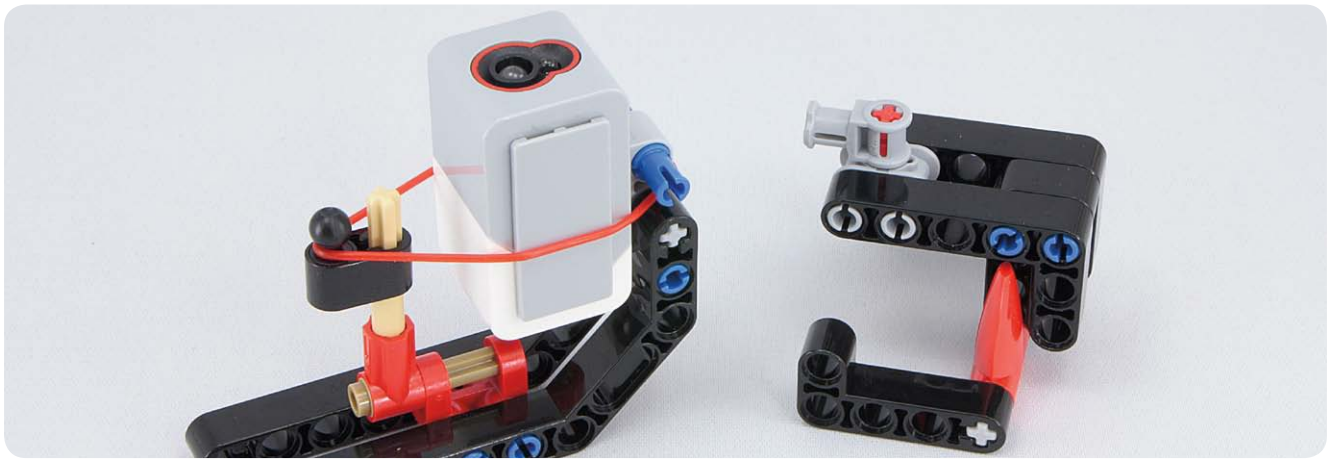
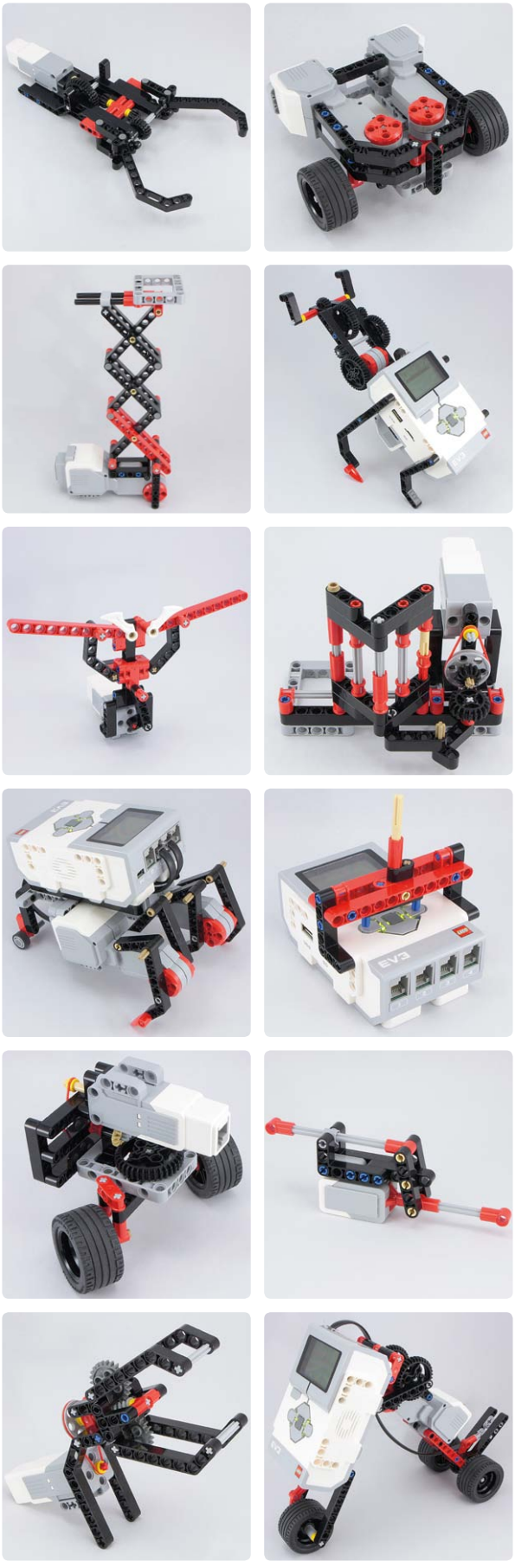




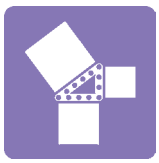


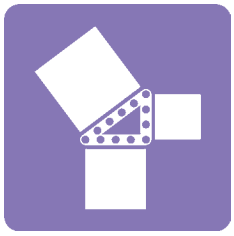




PART 6

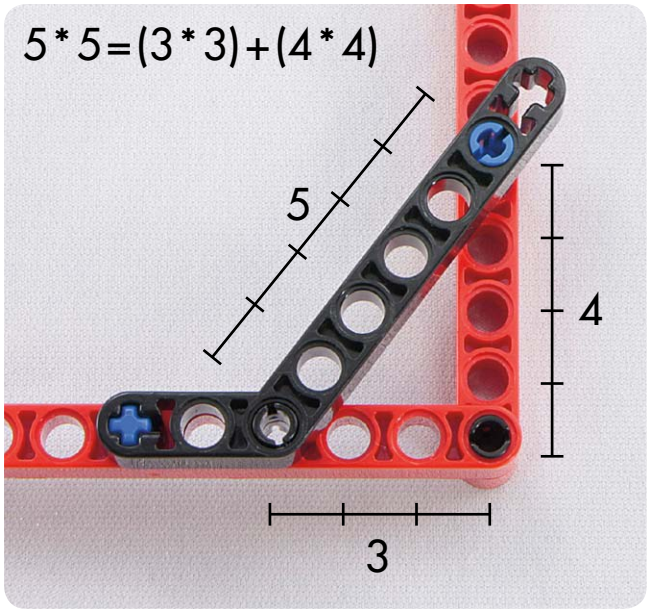
Something Extra





Using the Pythagorean theorem

#176



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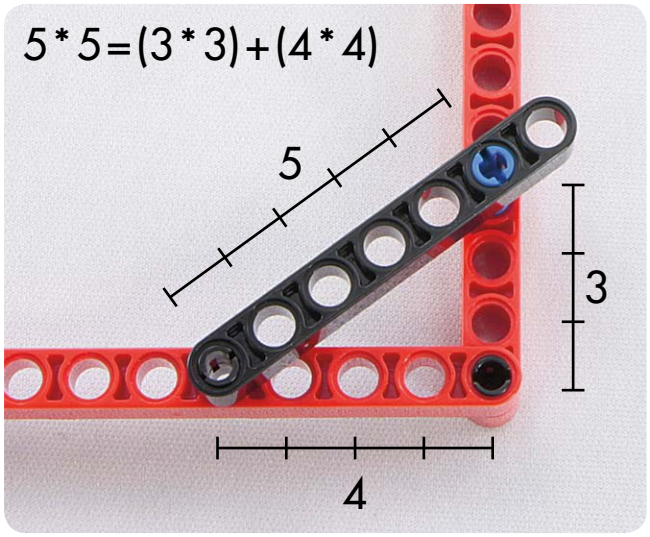

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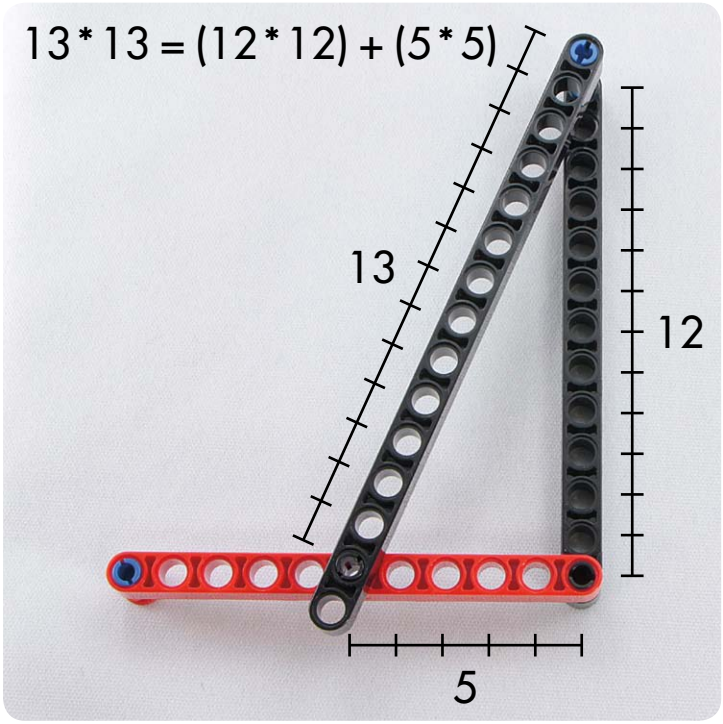

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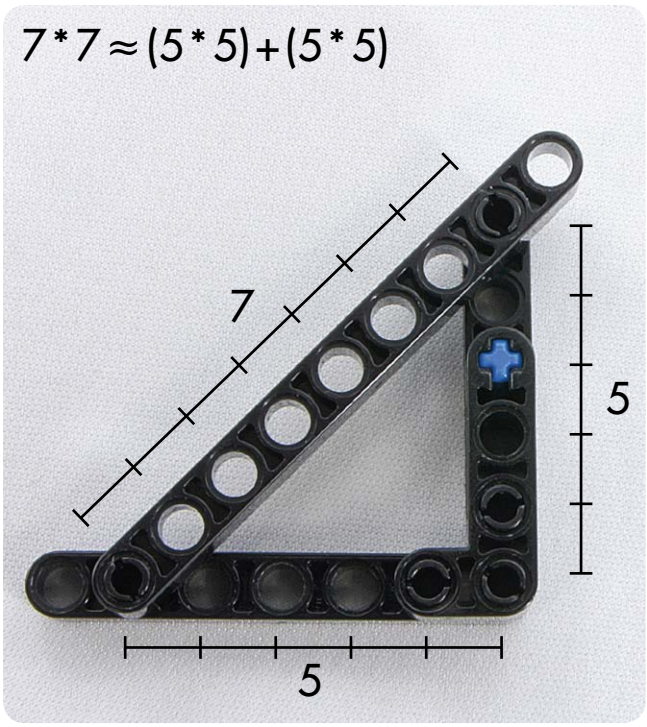

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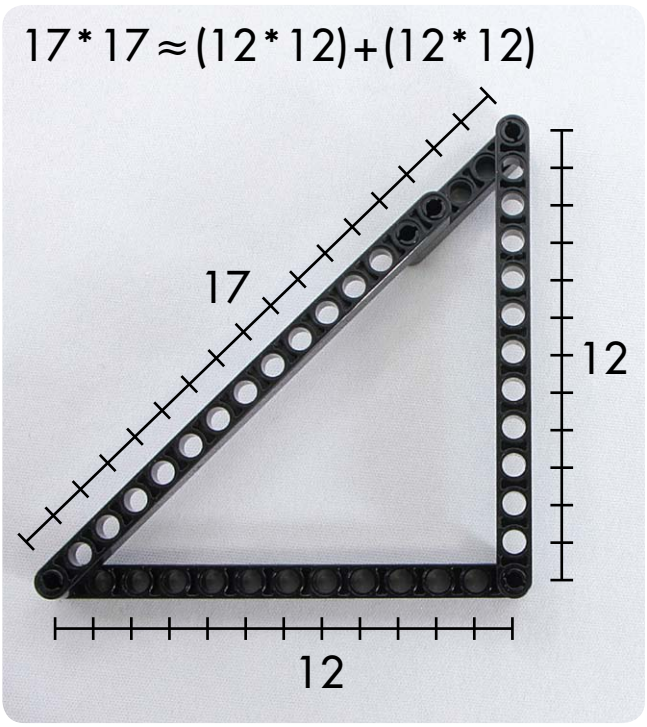

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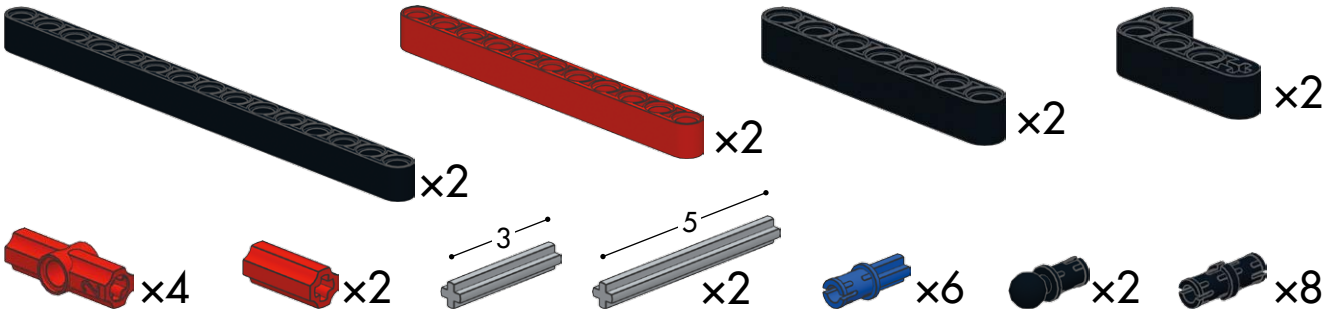

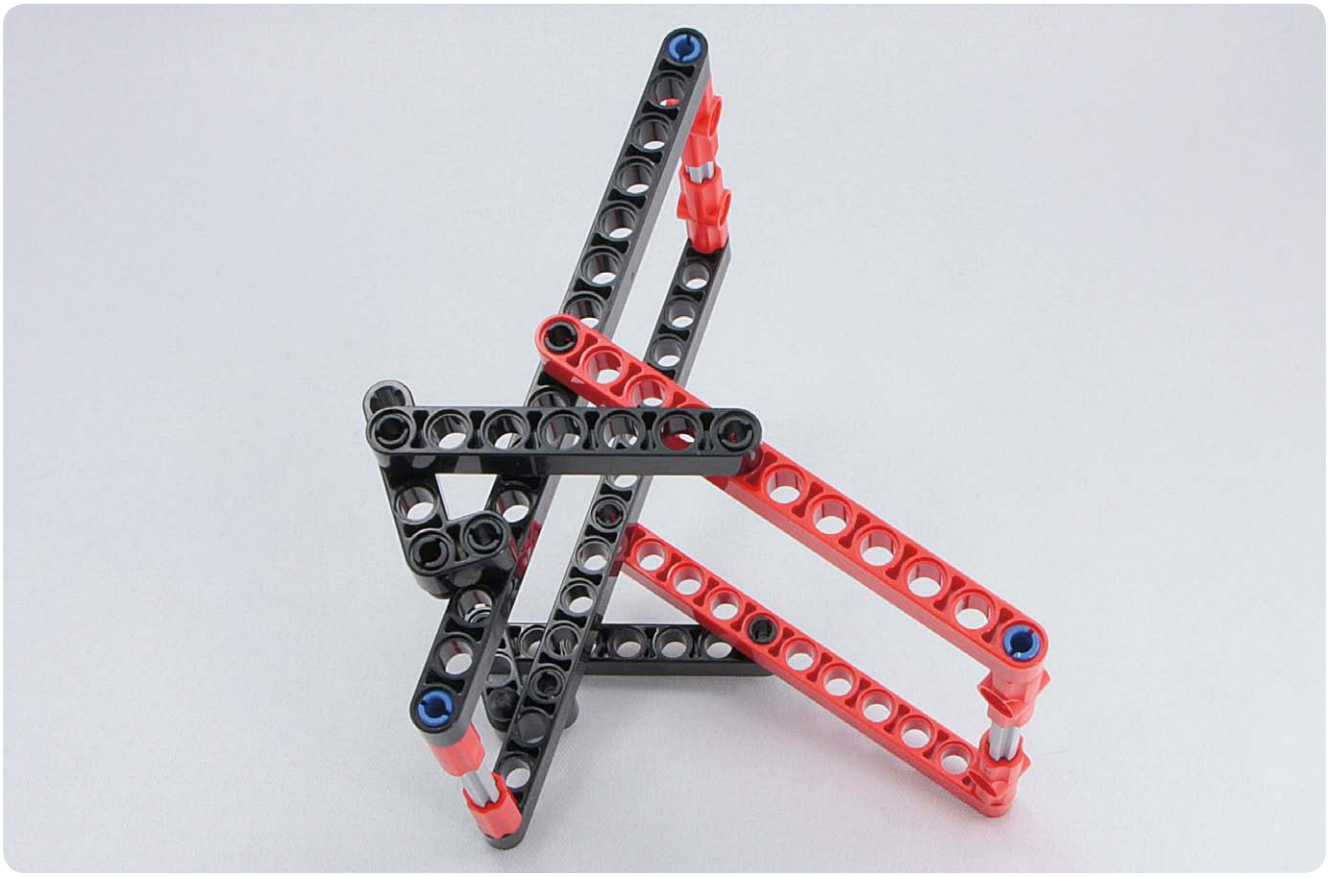

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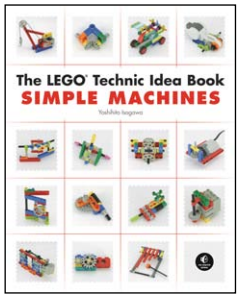

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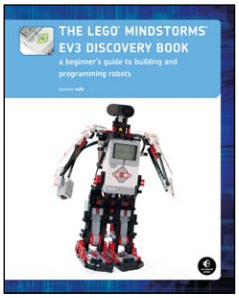

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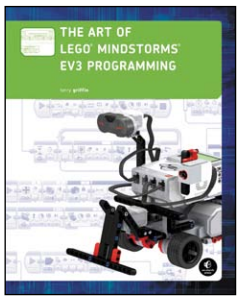

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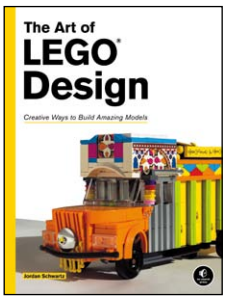

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ABOUT THE AUTHOR

Yoshihito Isogawa is a LEGO luminary with 46 years of building experience. He is the author of the *LEGO Technic Idea Book* series (No Starch Press) as well as many Japanese-language LEGO books.

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