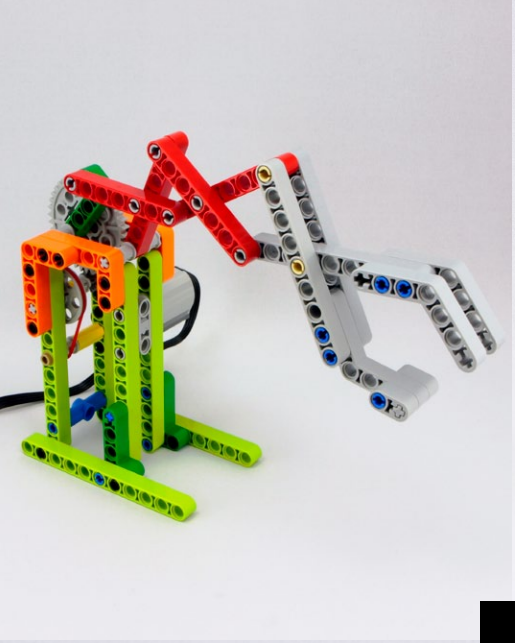
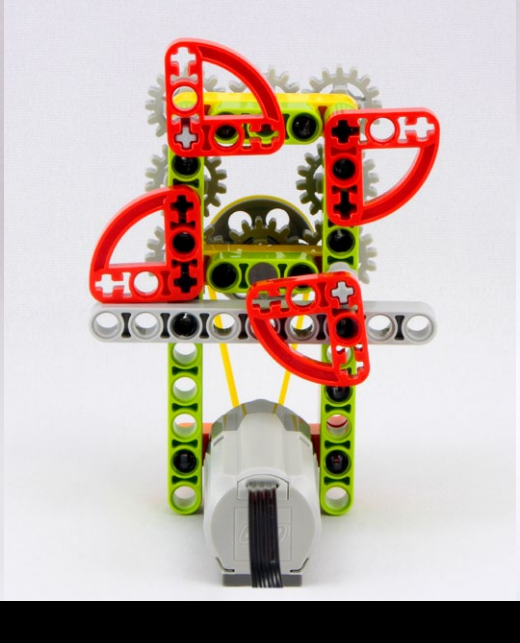
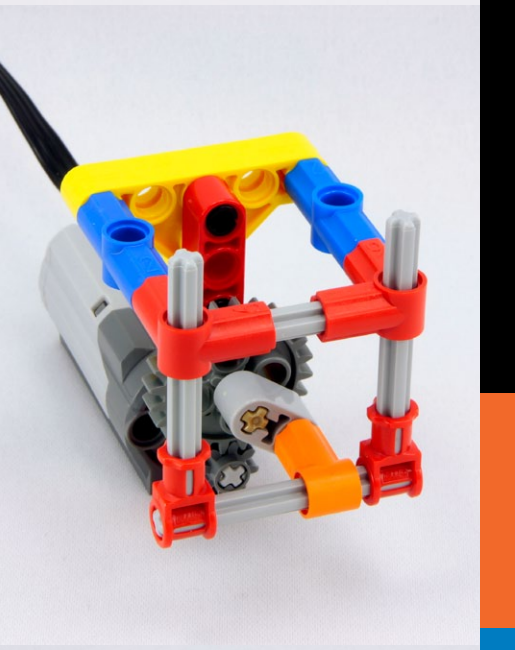
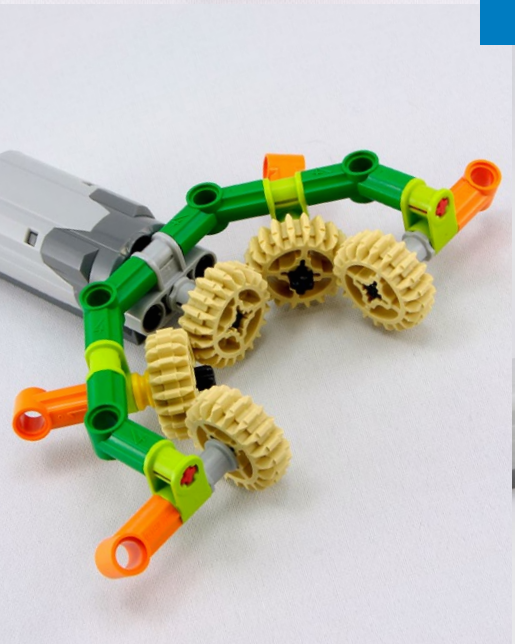
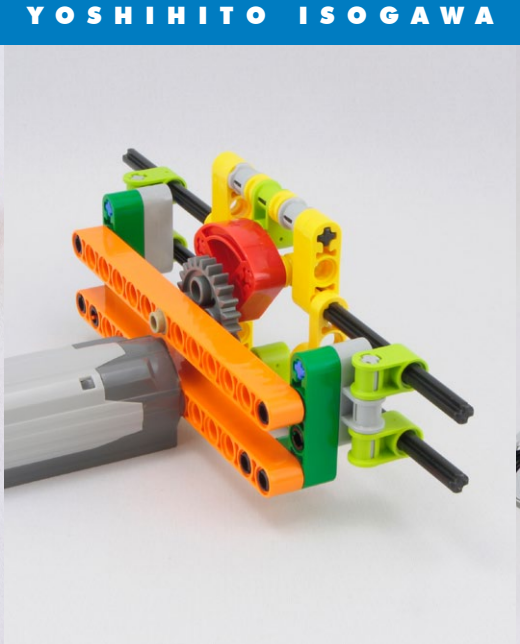
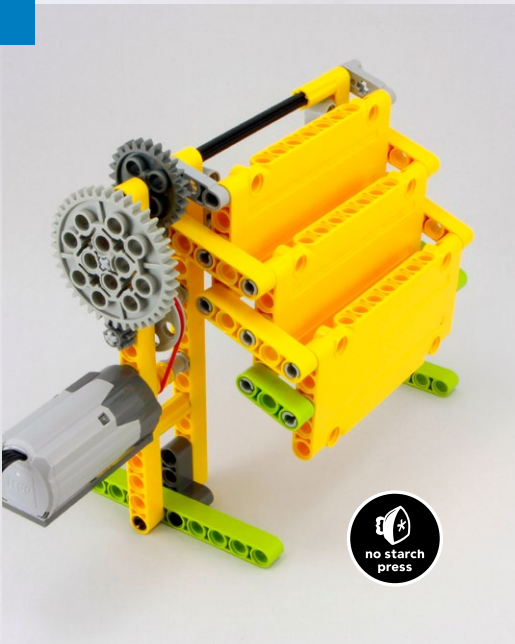




THE LEGO® POWER FUNCTIONS IDEA BOOK

MACHINES AND MECHANISMS

YOSHIHITO ISOGAWA



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THE LEGO® POWER FUNCTIONS IDEA BOOK
MACHINES AND MECHANISMS

VOLUME 1

THE LEGO® POWER FUNCTIONS IDEA BOOK

MACHINES AND MECHANISMS

YOSHIHITO ISOGAWA

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Contents

PART 1 • Basic Mechanisms

PART 2 • Arms, Wings, and Other Movements

Introduction

This is an idea book, offering hundreds of projects and mechanisms you can build with LEGO Technic parts. The book especially focuses on LEGO Power Functions, which is the latest version of the Technic system of motors, lights, and other electric building elements.

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 to build 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.

The Use of Color

The examples in this book are made with parts of various colors to make it easier for you to see the individual bricks' shapes. But you don't need to use the colors I've chosen in your models; use whichever colors you want to make the projects your own.

Substituting Parts

The parts used in this book were selected from among the easily obtainable ones as much as possible, but you'll probably still be missing a few.

Try to build as many models as possible using the parts that you already own. If you find that you're missing parts, try to think of ways to substitute other parts for the ones that you're missing.

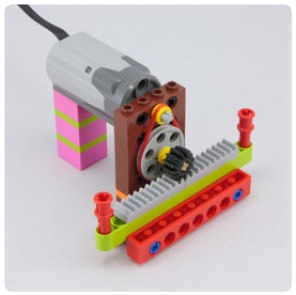
For example, there are many types of LEGO tires. If you don't have the tires shown in a particular project, try using any tires you have that are a similar size. Also, there are several types of Power Functions motors. In this book, the commonly available Medium (M) motors are used most frequently. It's relatively easy to replace the M motor with the Large (L) motor or older motors from earlier systems, so use whatever you have available.

The Parts List in the back of the book will help you find the pieces you need.

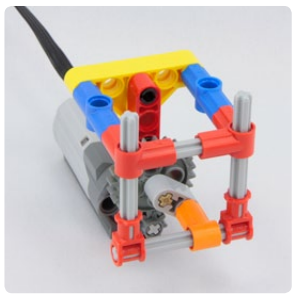
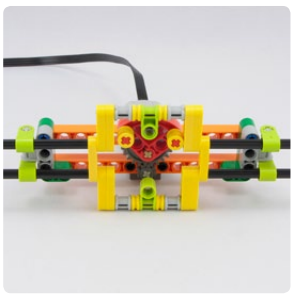
You Are the Creator

Look at the models you build closely. By thinking about how they move and why they are designed that way, you will greatly improve your building skills.

This is an idea book; it's about imagination. It is my sincere hope that you make these projects your own, combine them, and evolve them into something even better—your own original models.









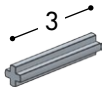
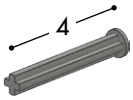
PART 1

Basic Mechanisms

Transmitting rotation

#1



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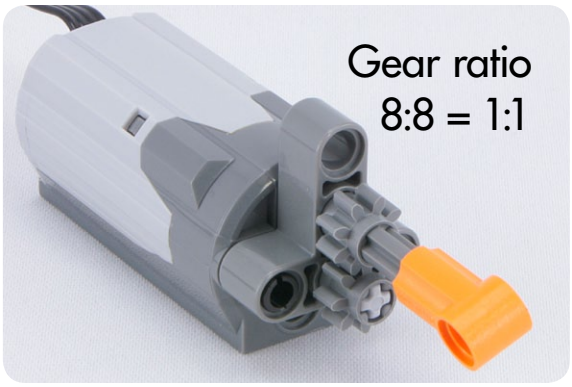
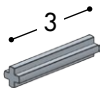

Gear ratio
8:8 = 1:1

#2

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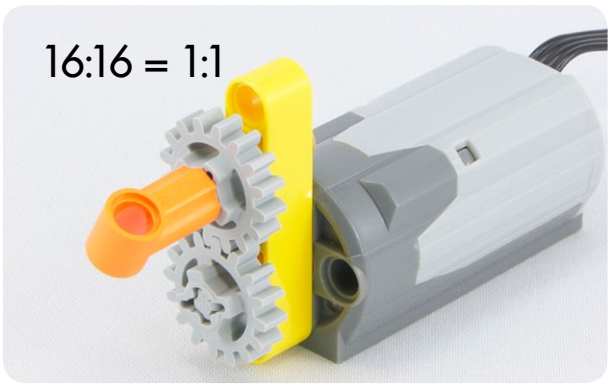
16:16 = 1:1

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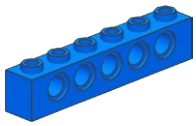

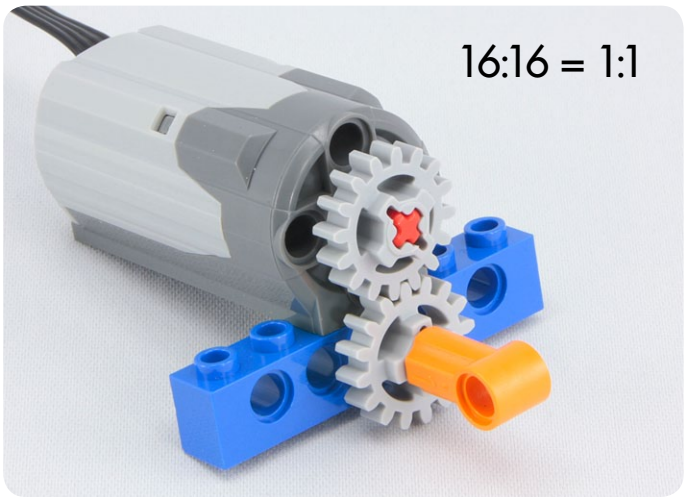

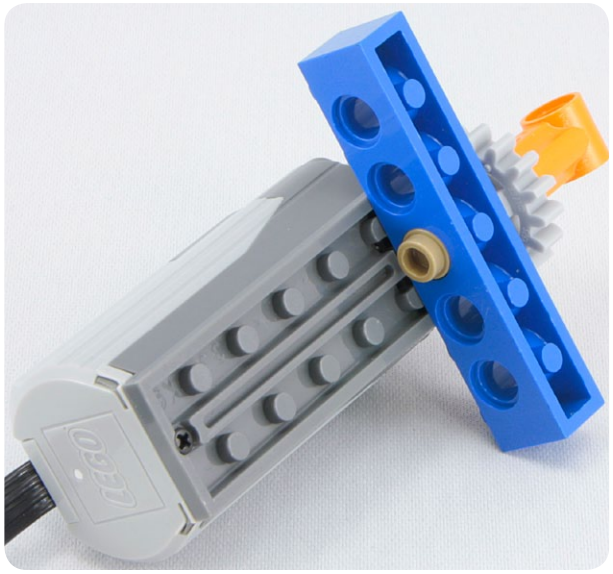

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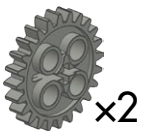

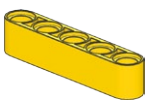

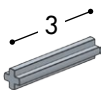

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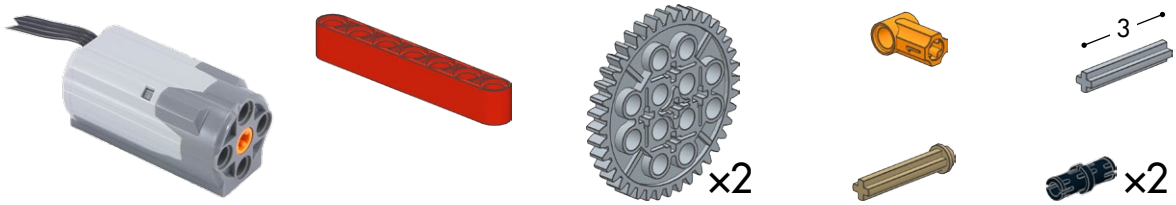

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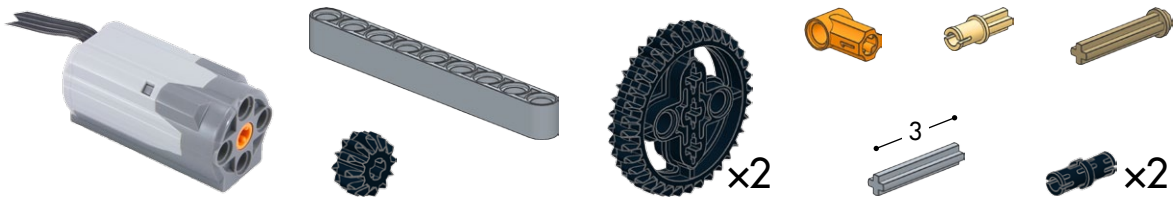

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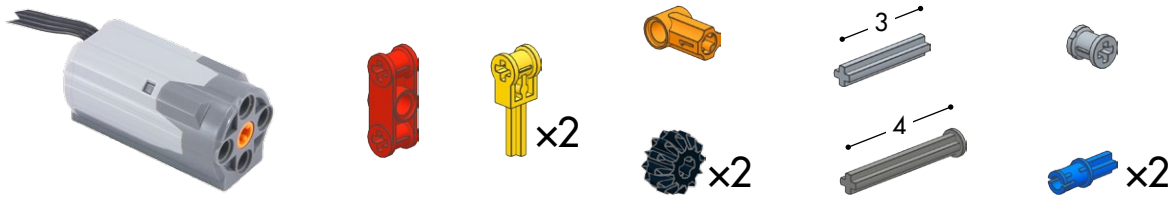

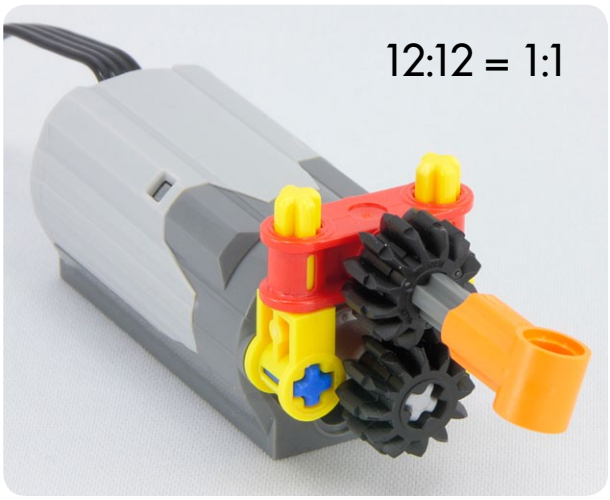

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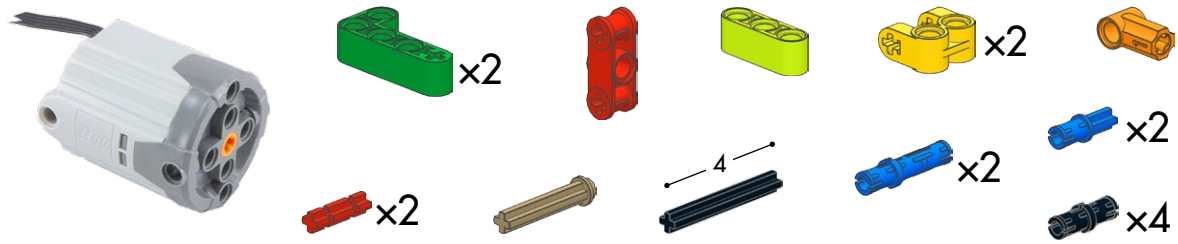

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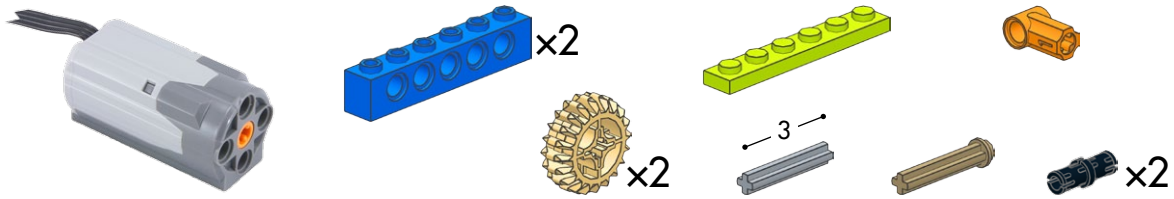

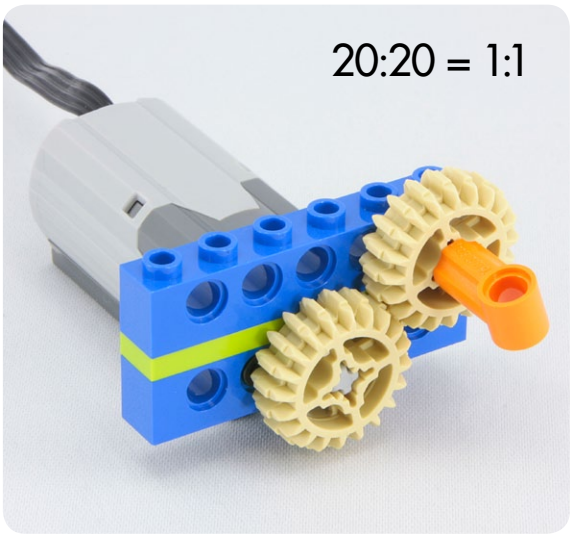

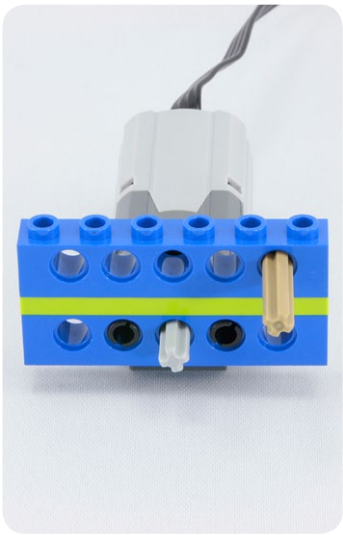

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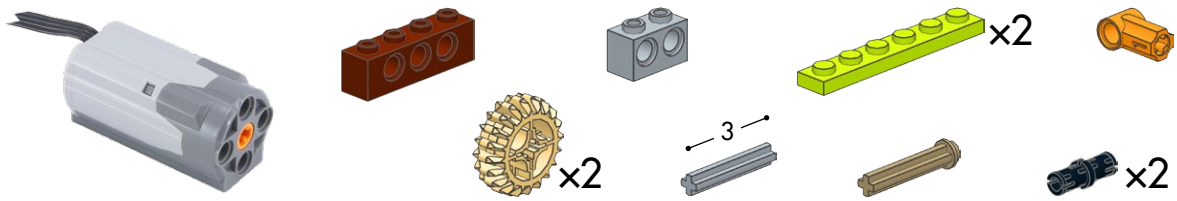

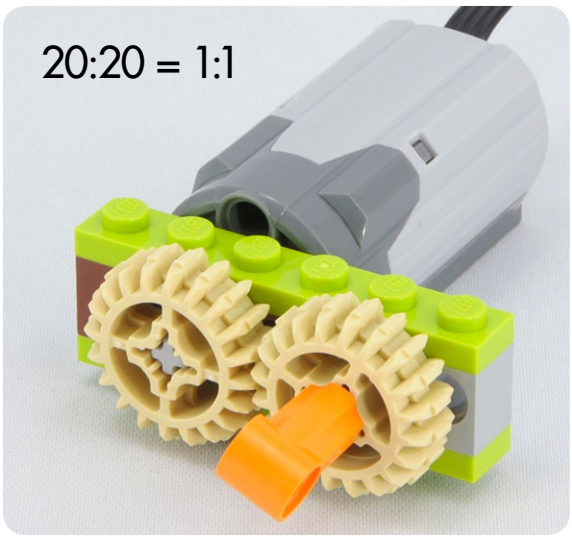

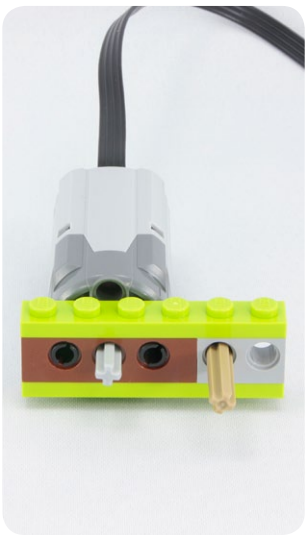

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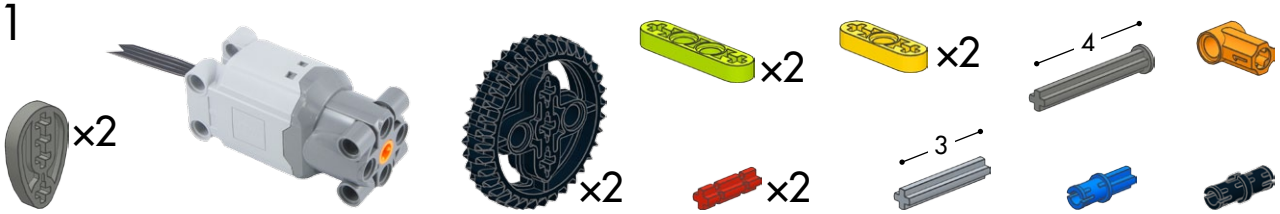

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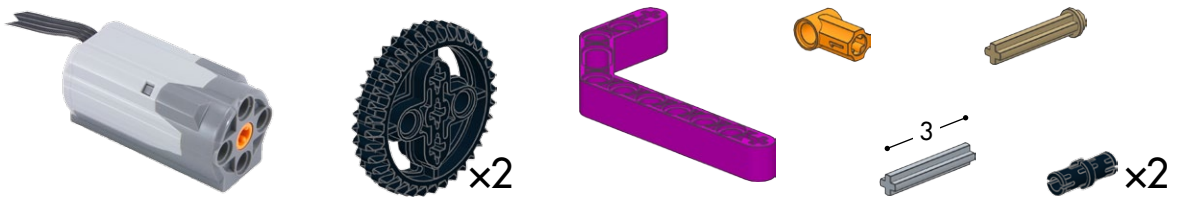

Gearing down (powering up)

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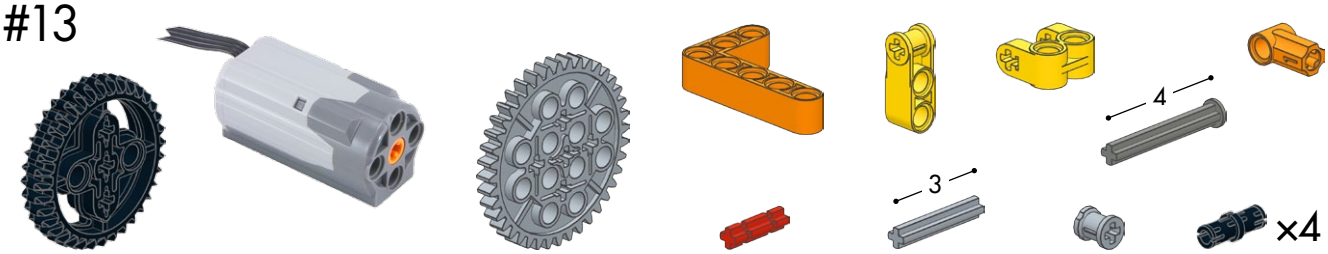

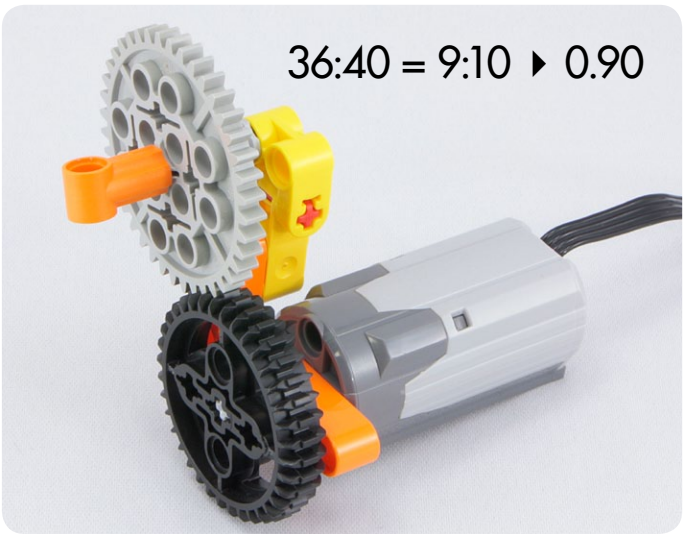

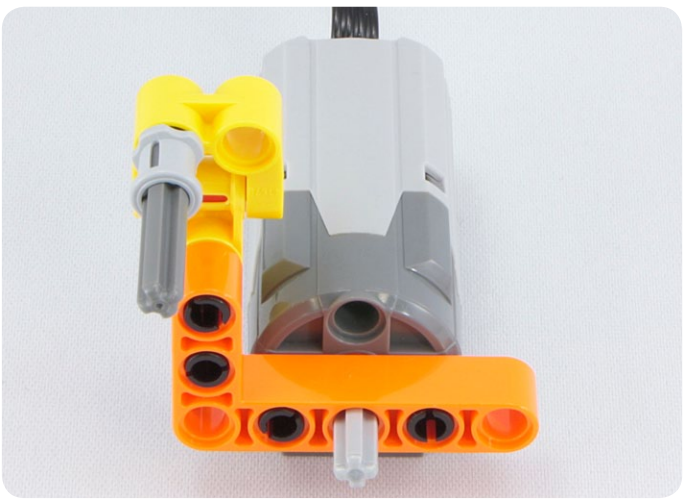

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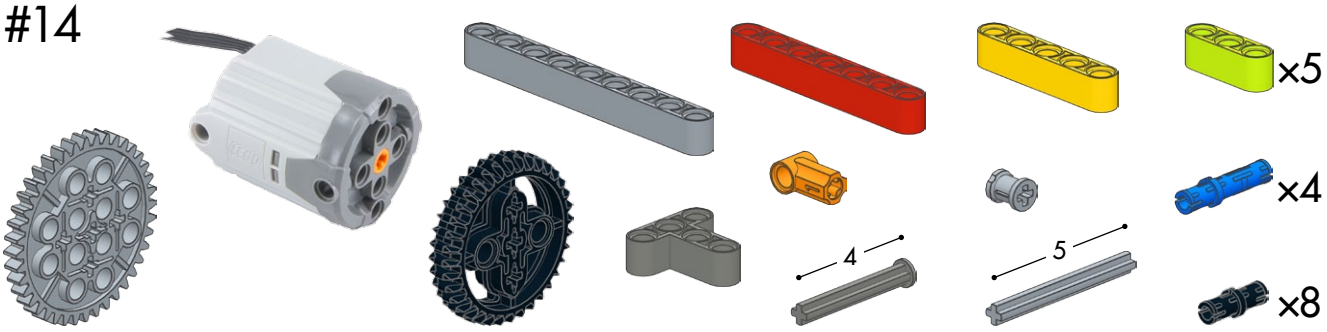

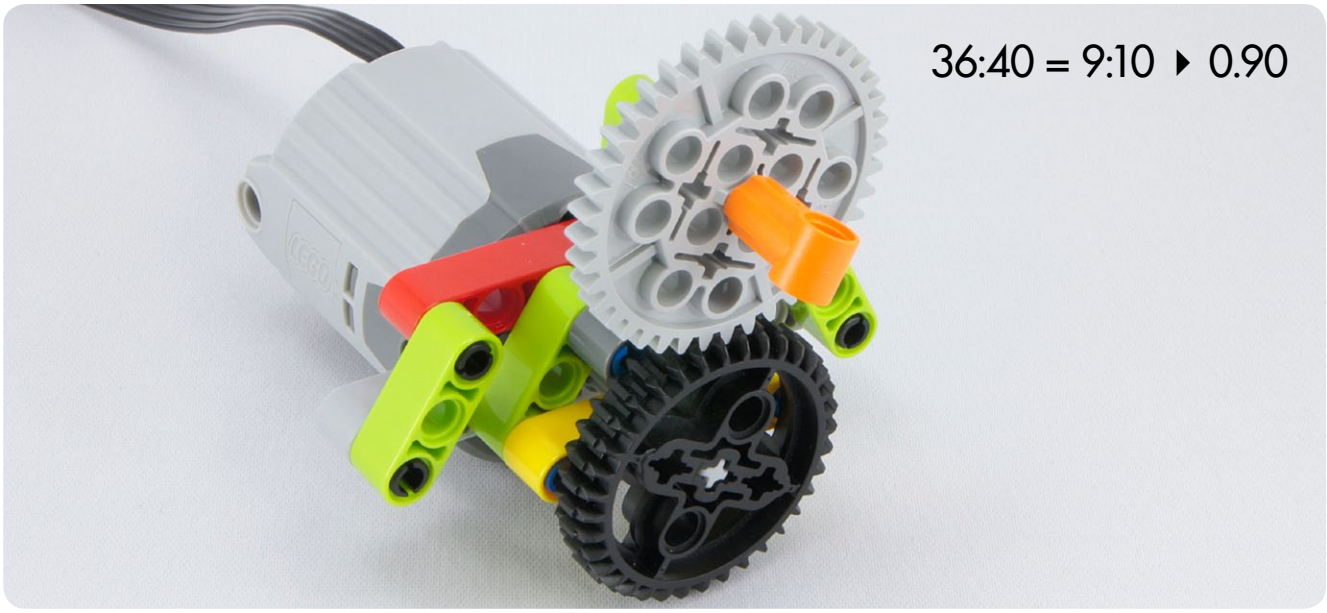

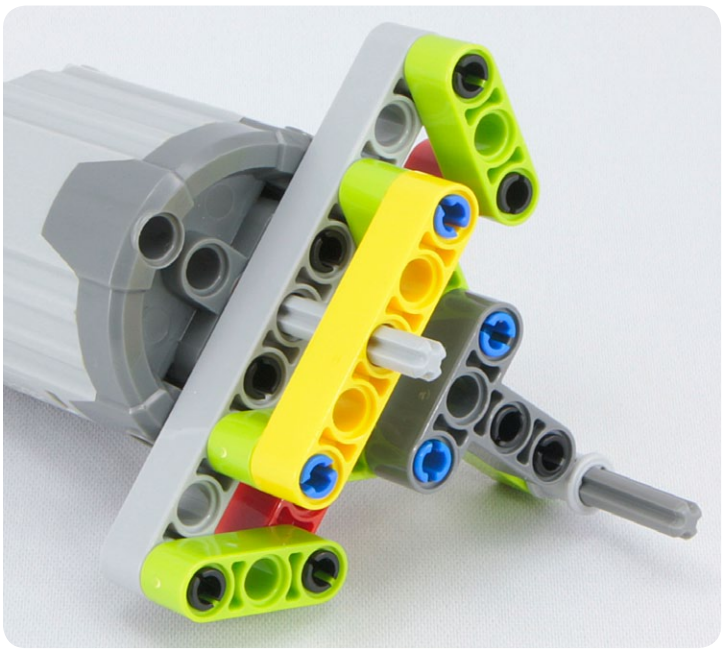

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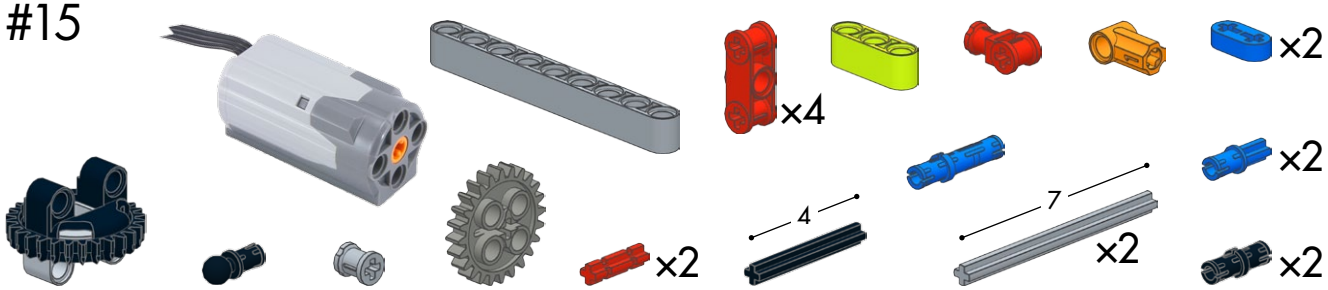

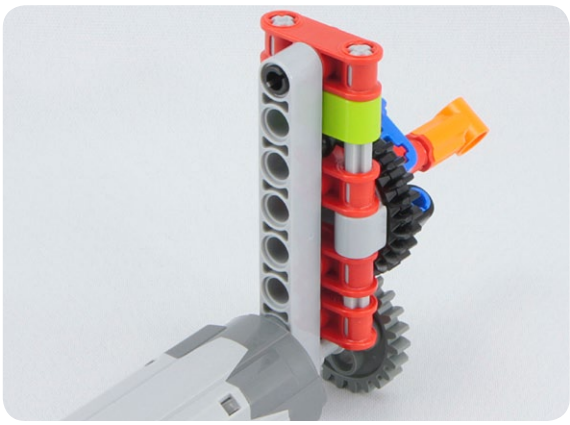

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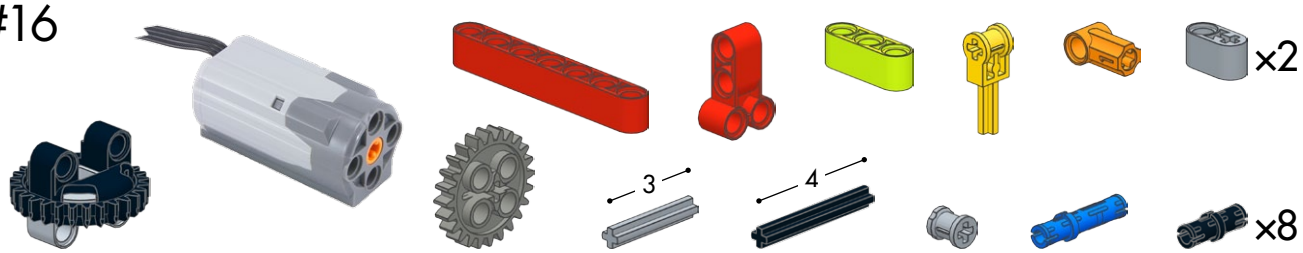

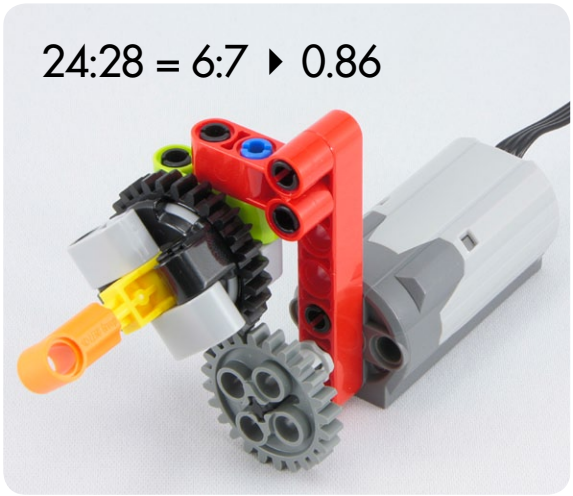

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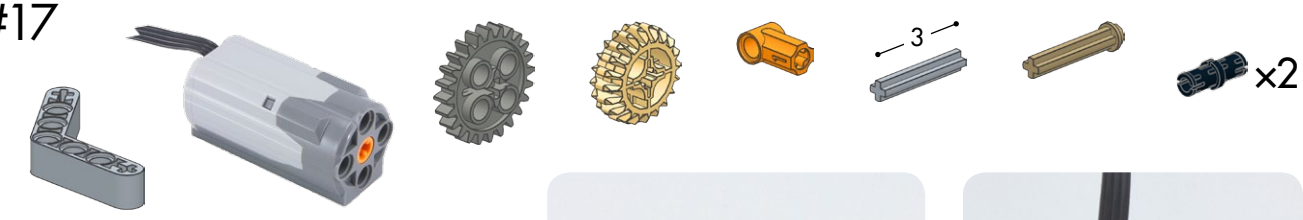

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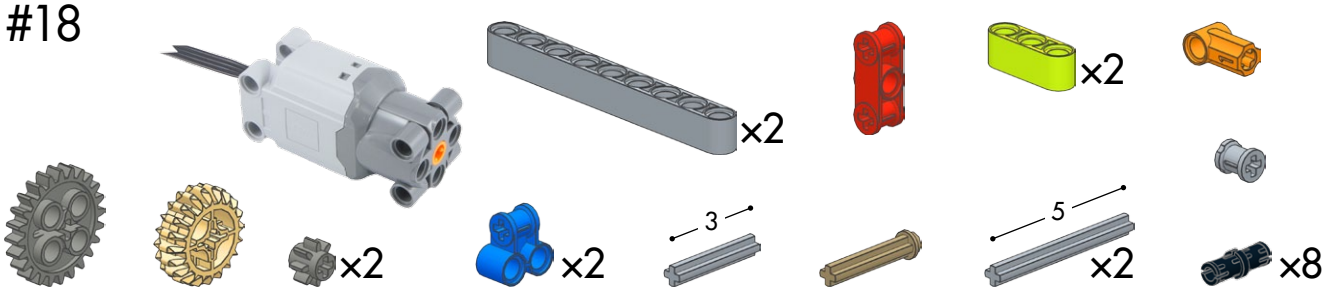

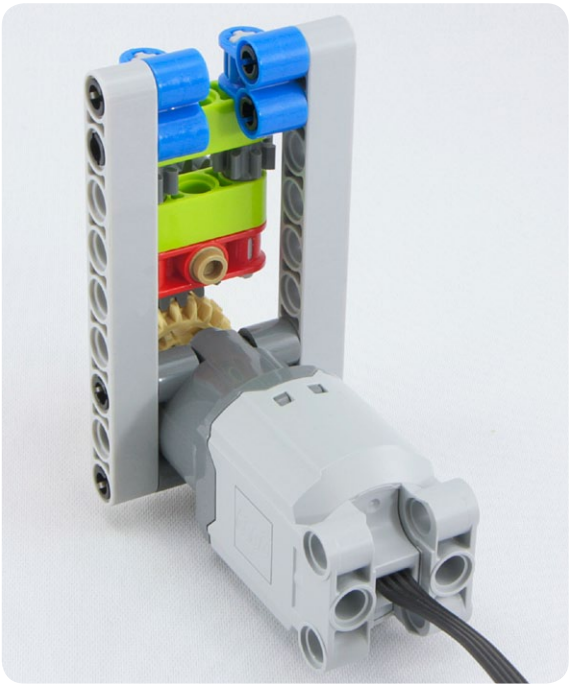

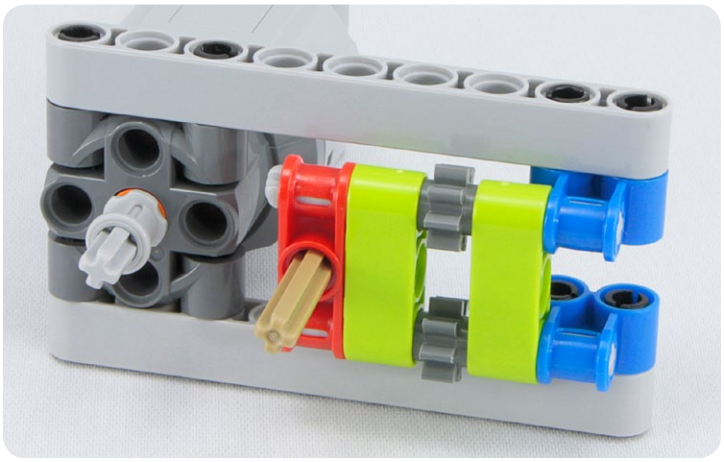

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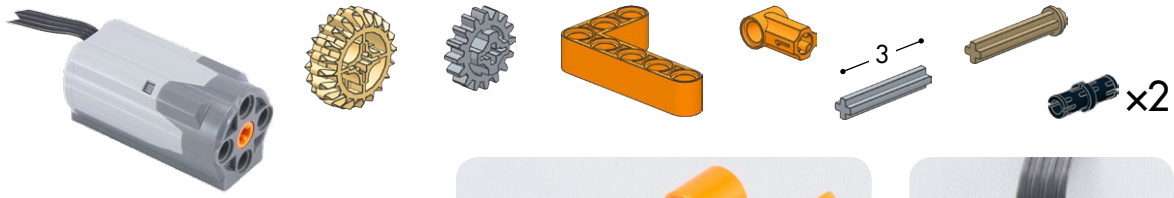

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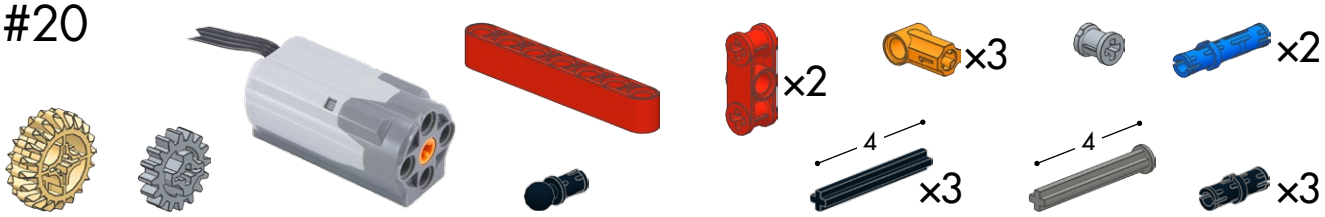

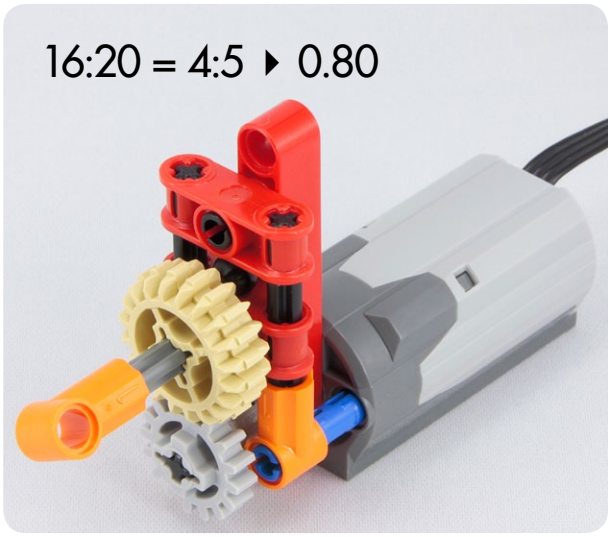

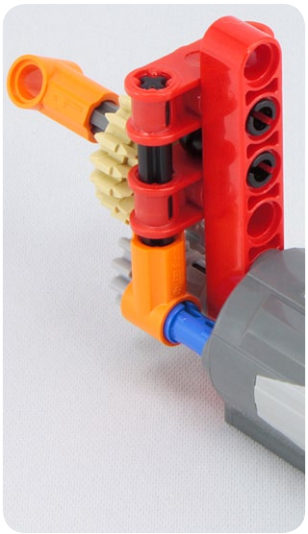

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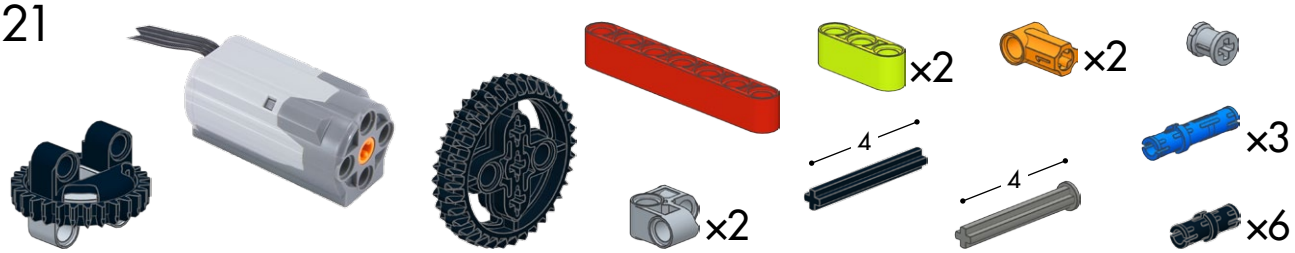

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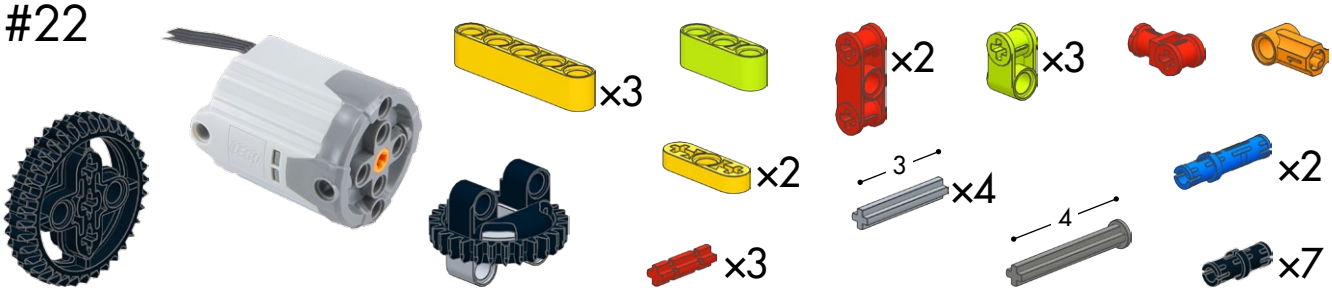

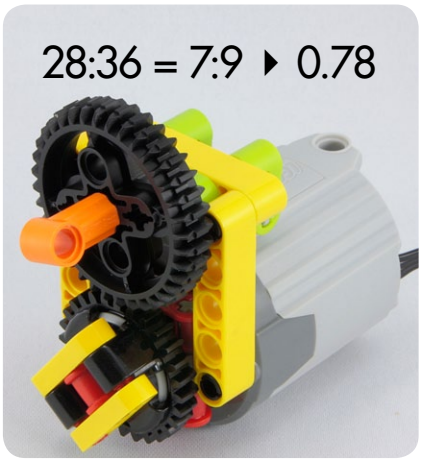

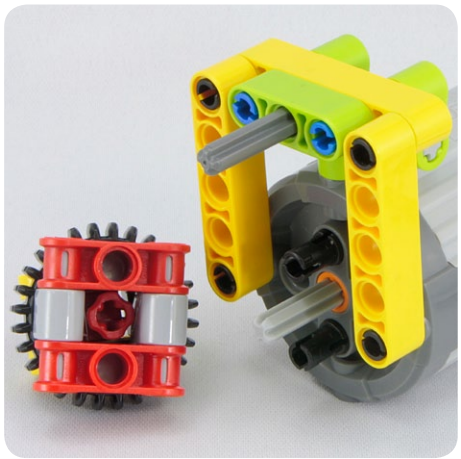

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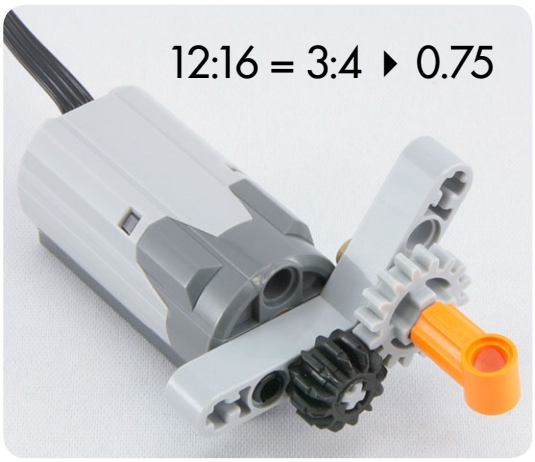

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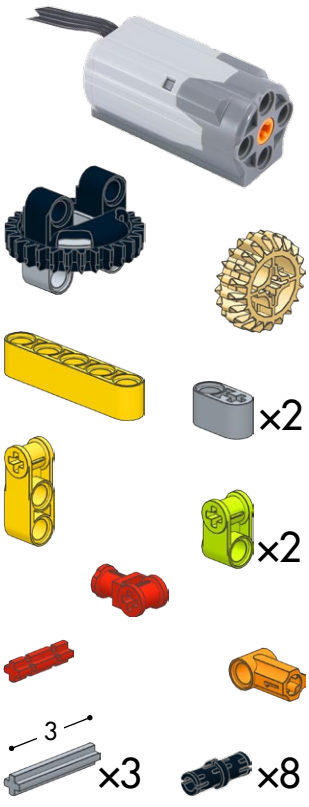

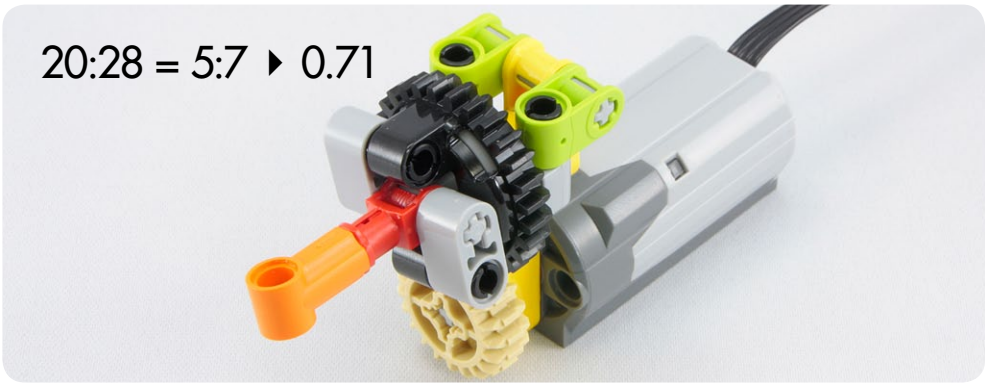

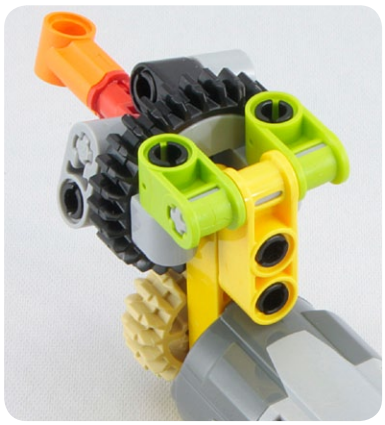

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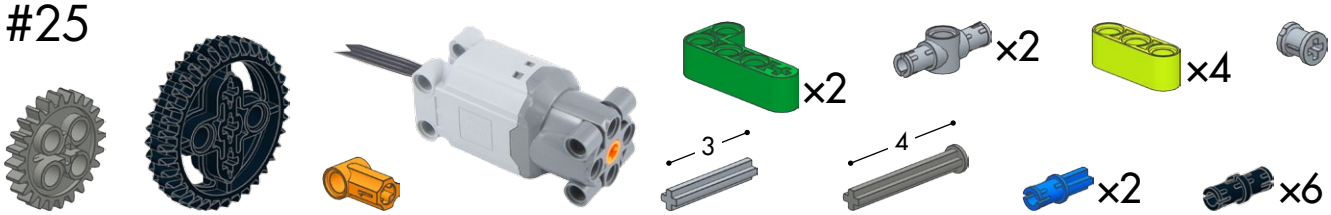

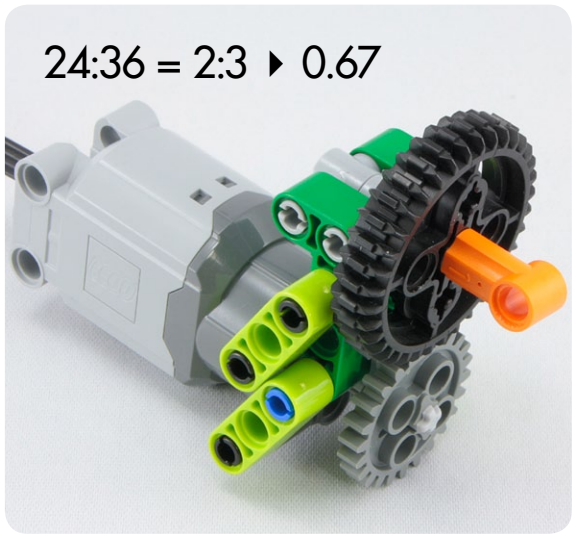

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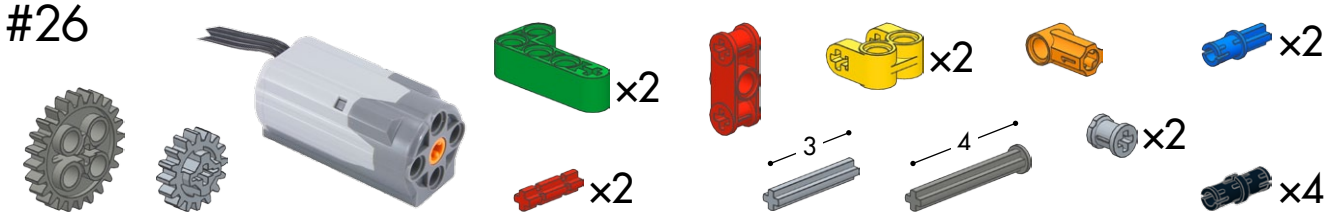

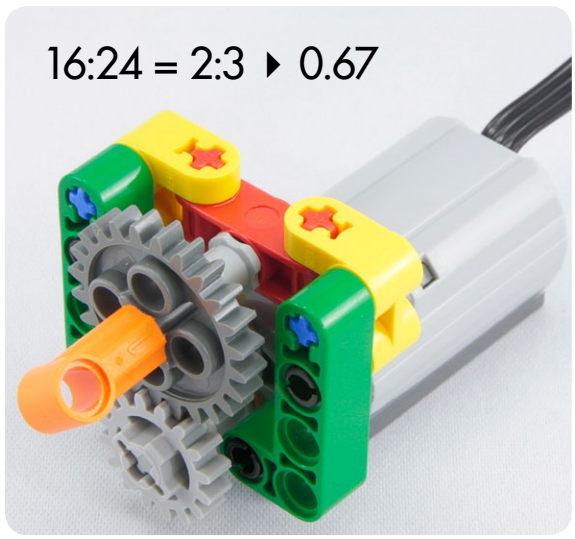

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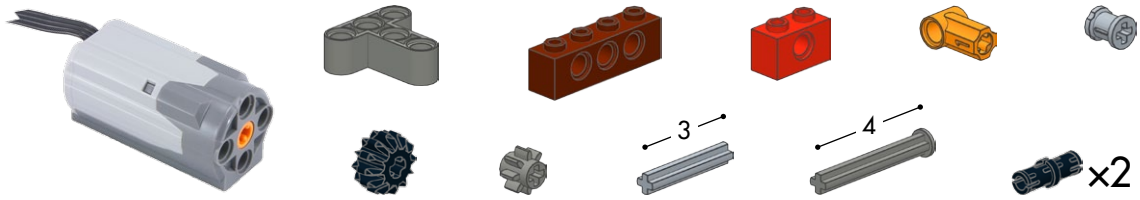

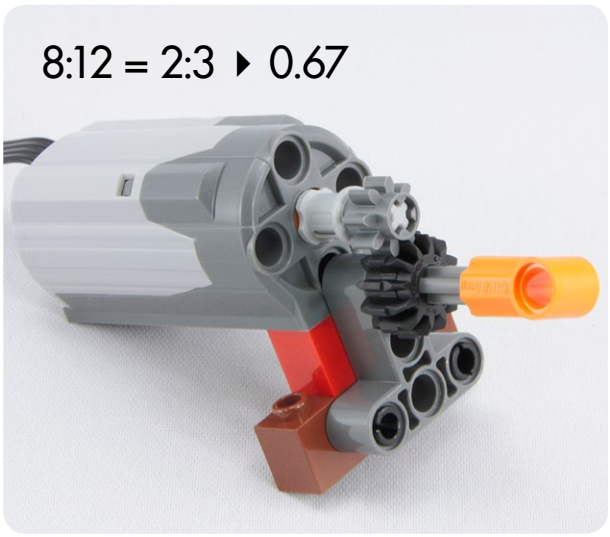

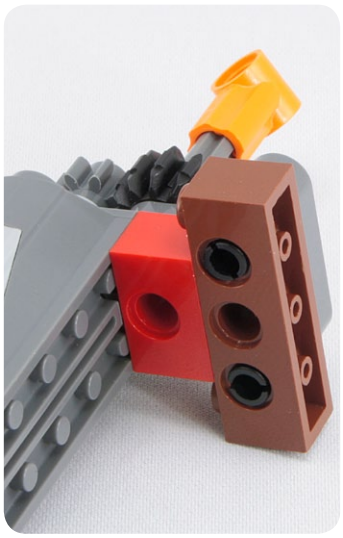

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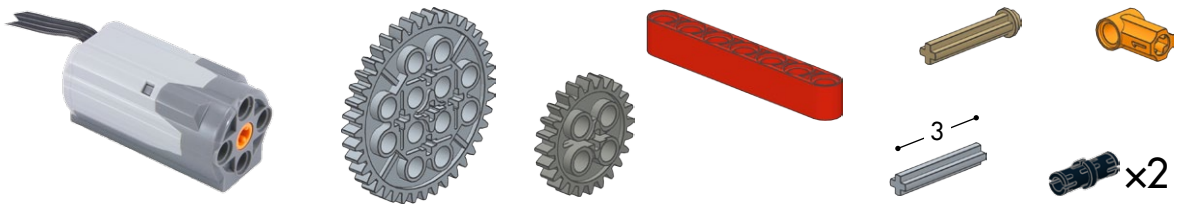

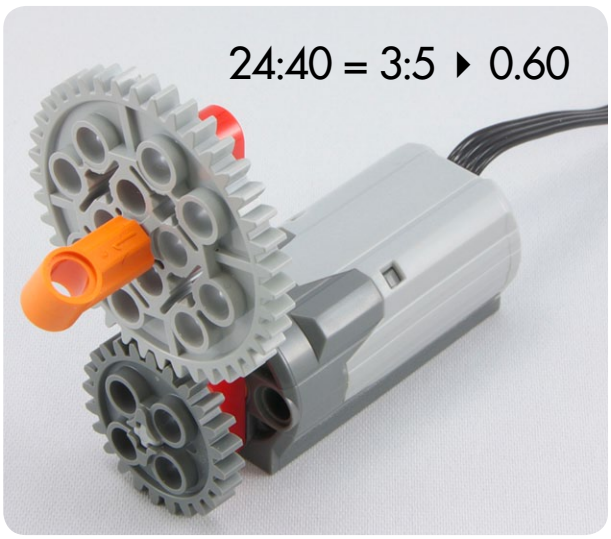

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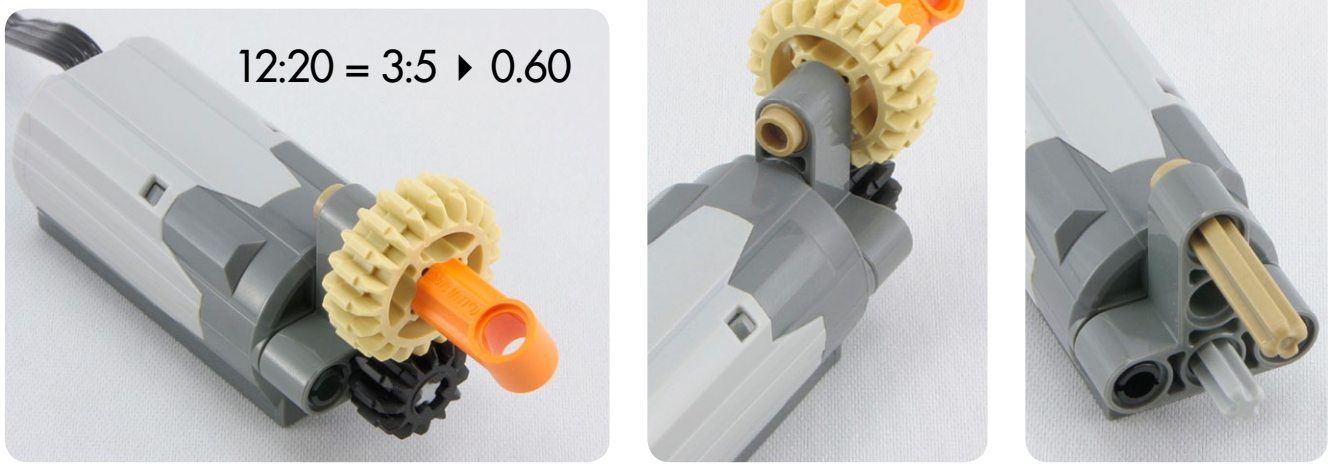

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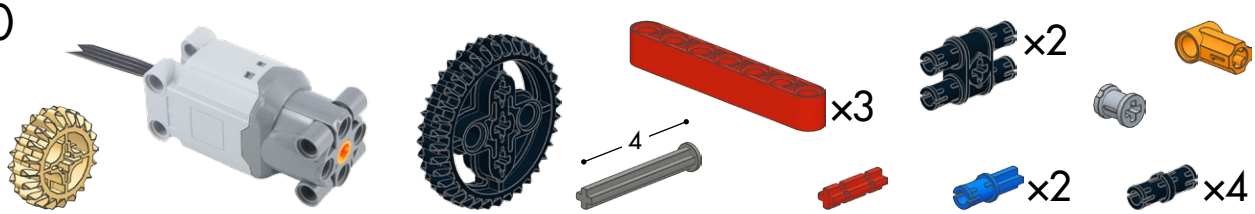

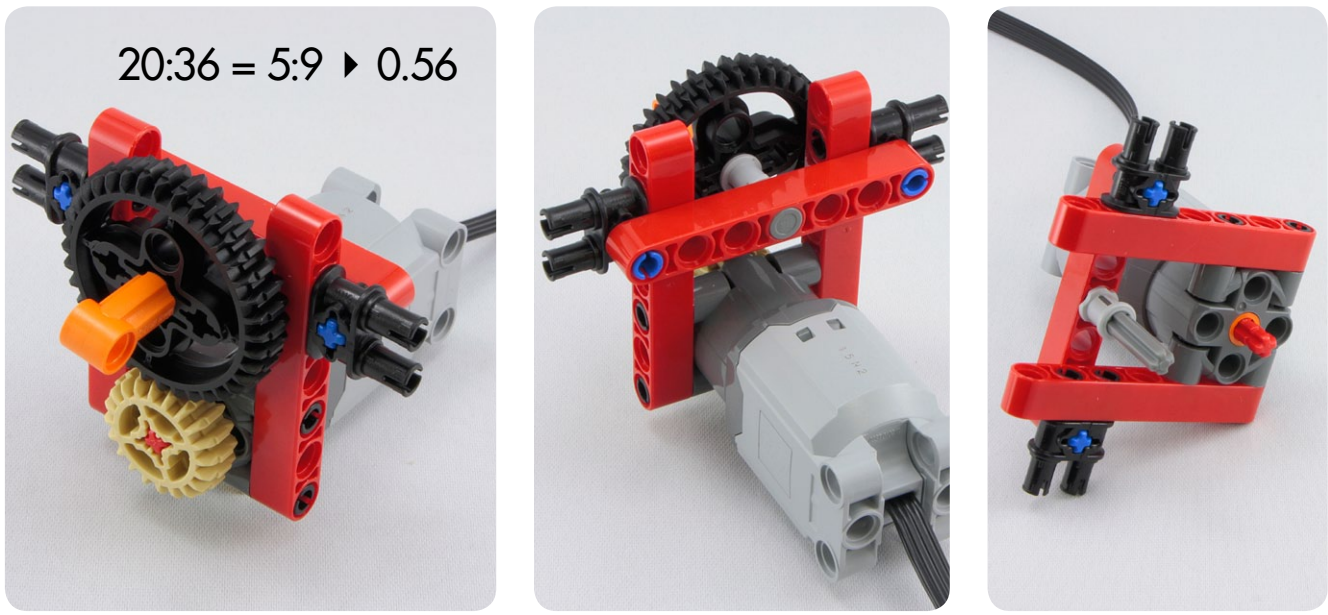

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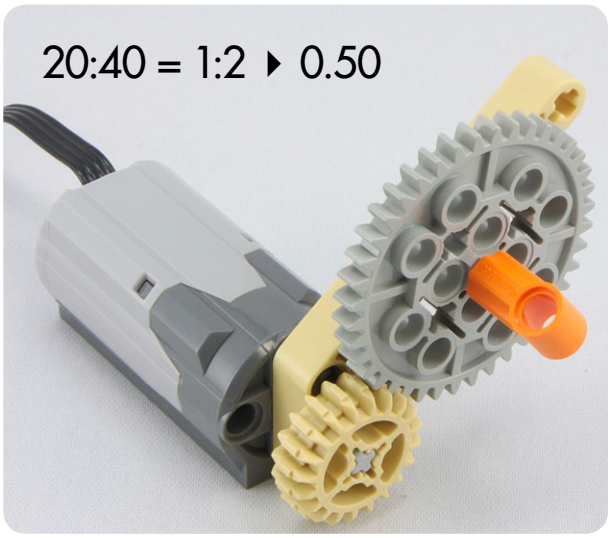

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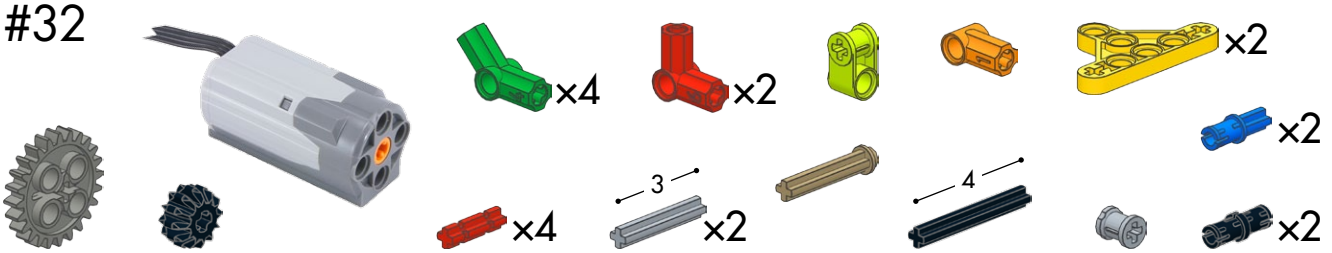

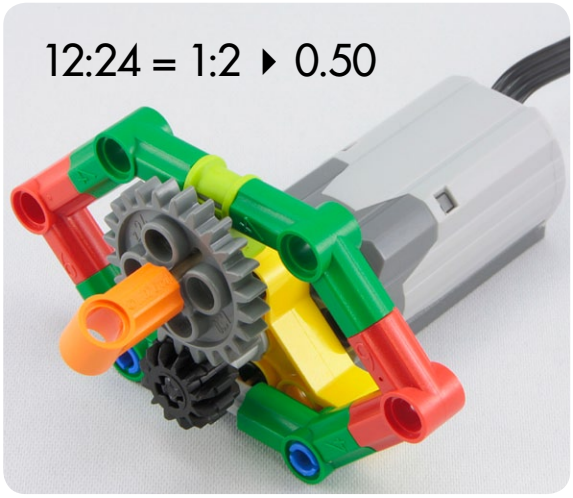

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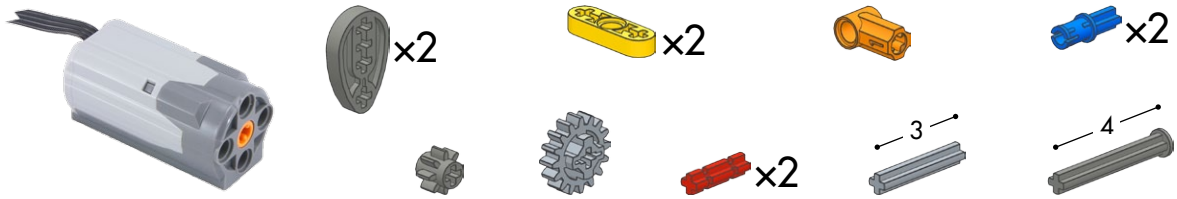

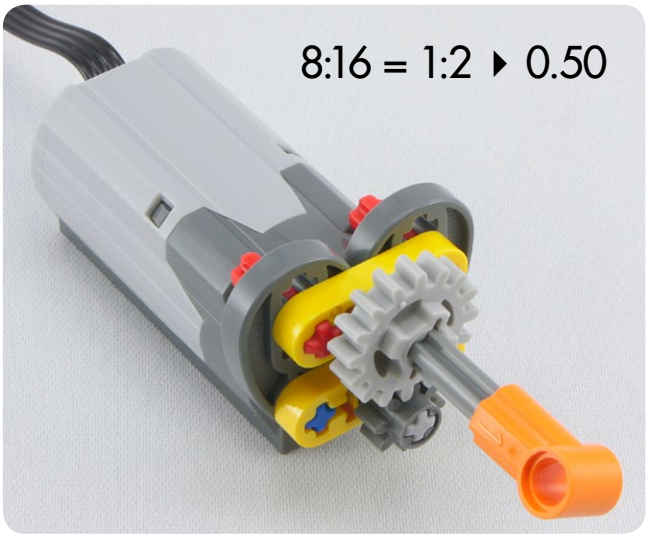

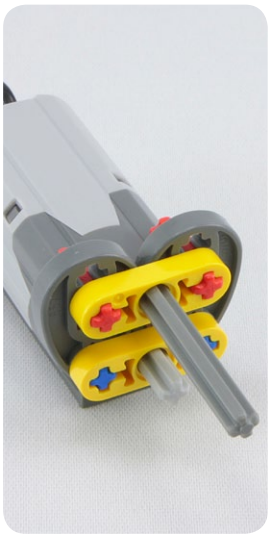

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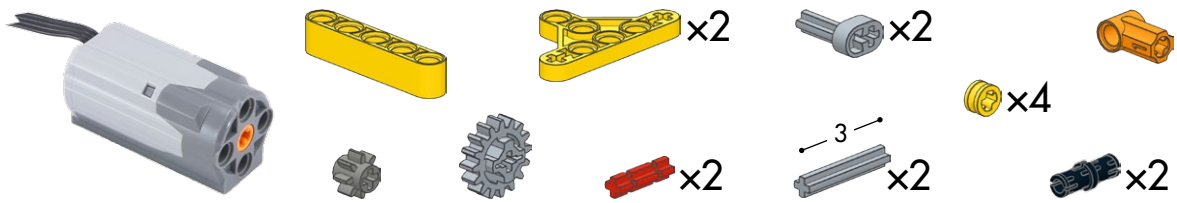

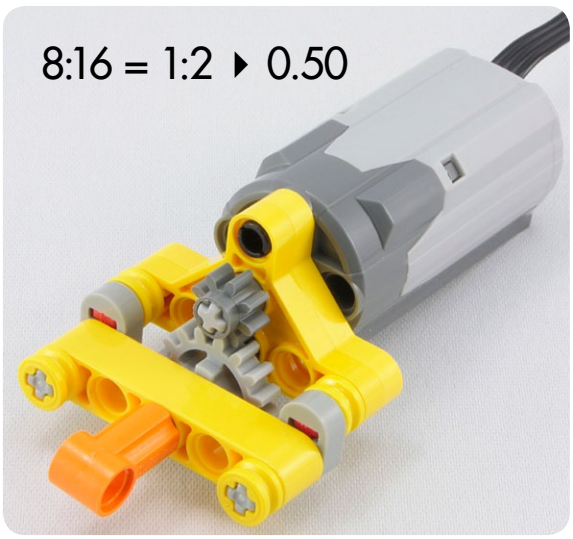

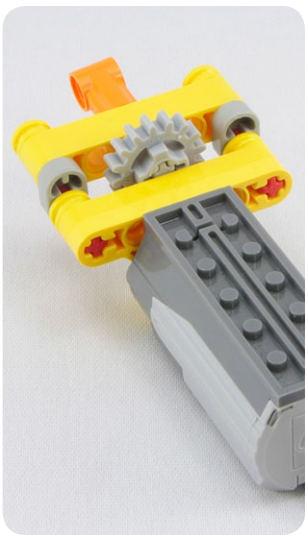

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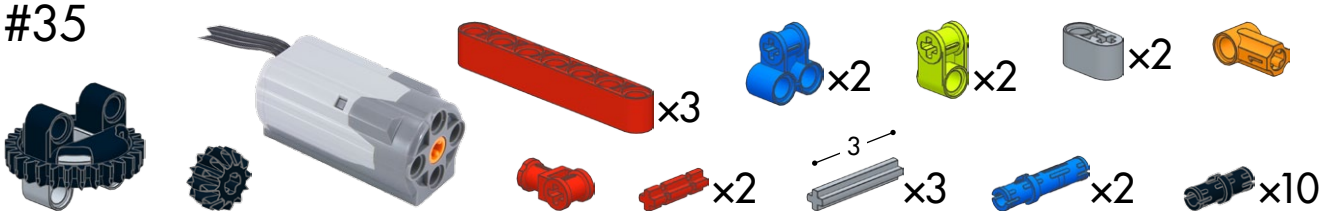

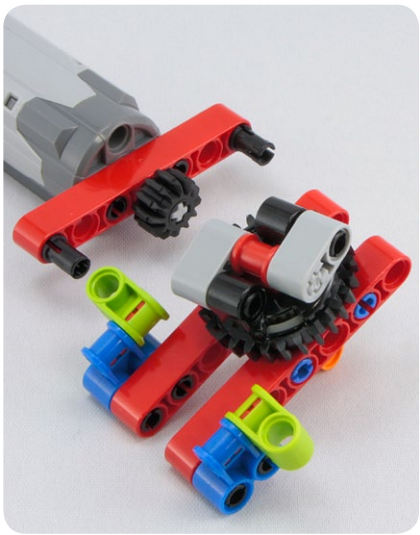

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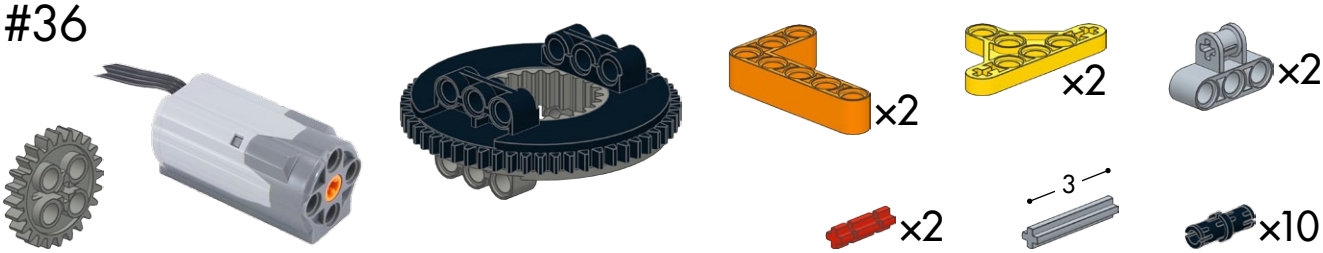

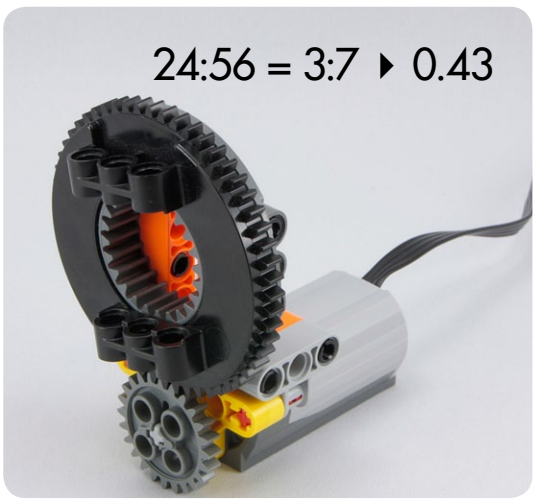

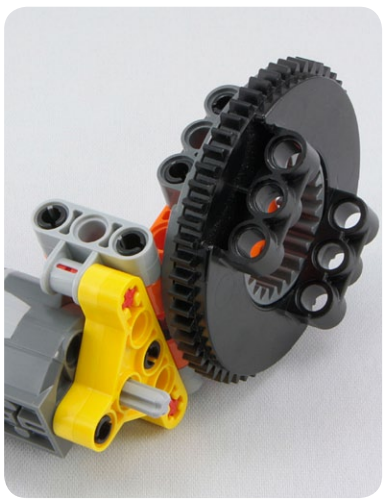

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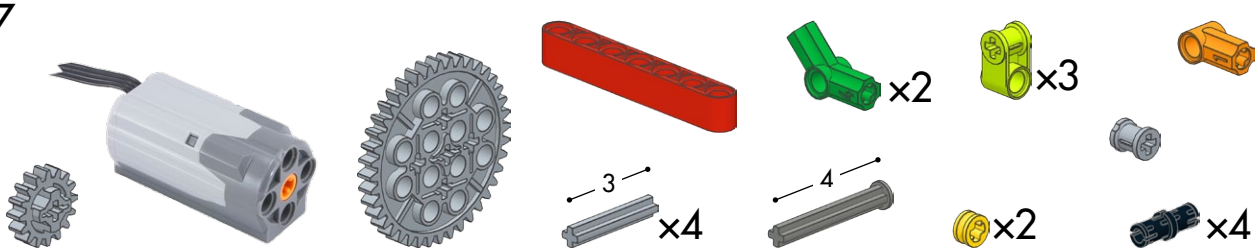

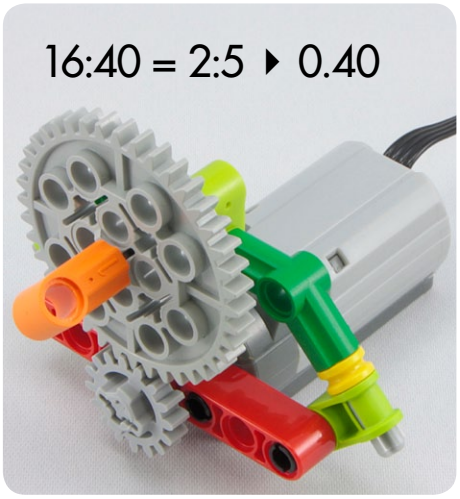

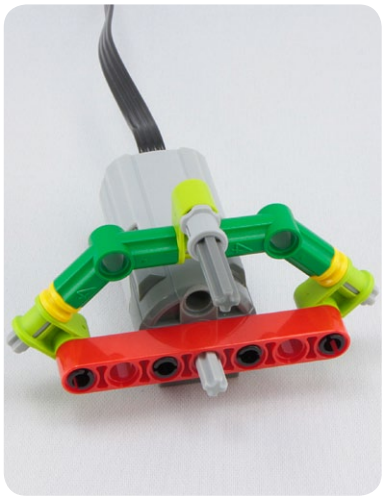

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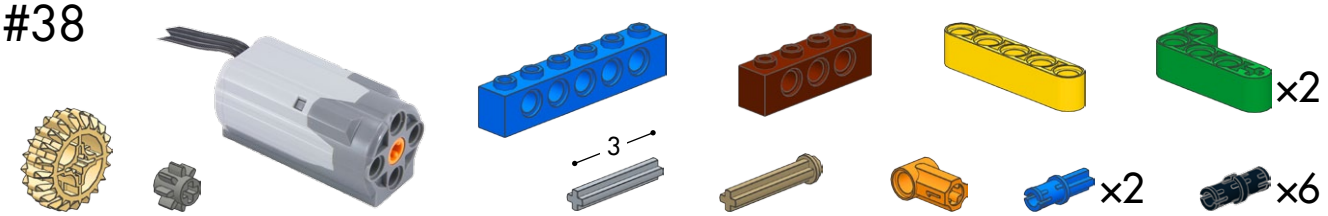

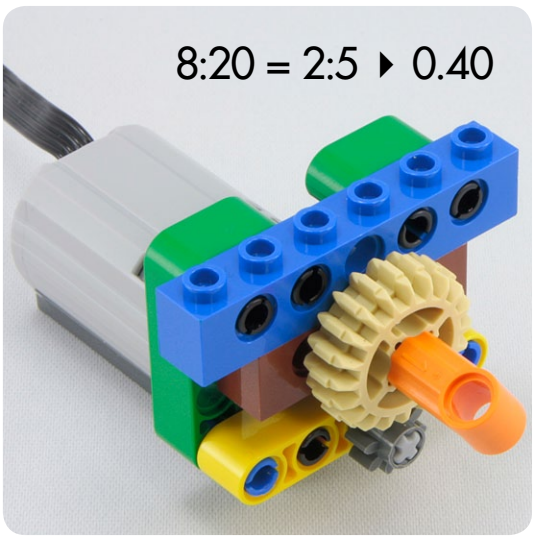

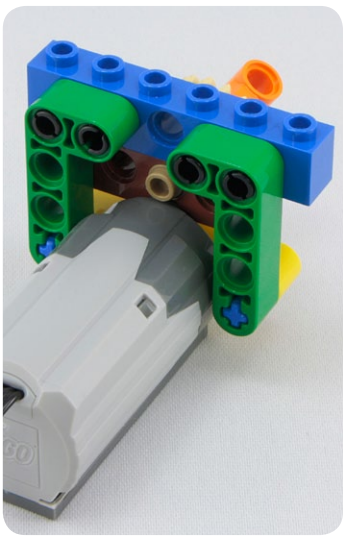

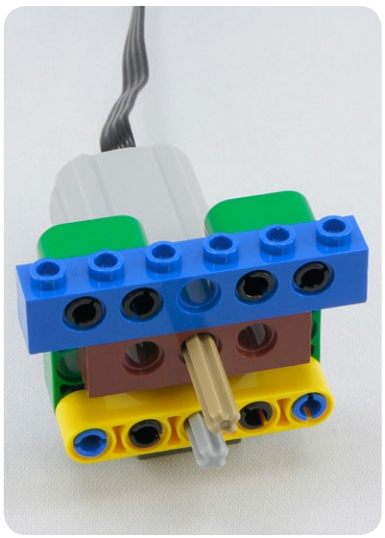

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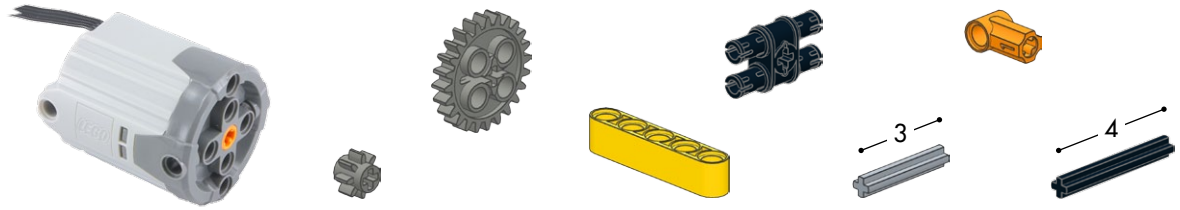

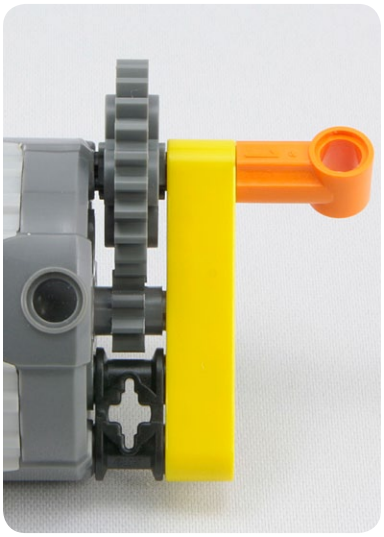

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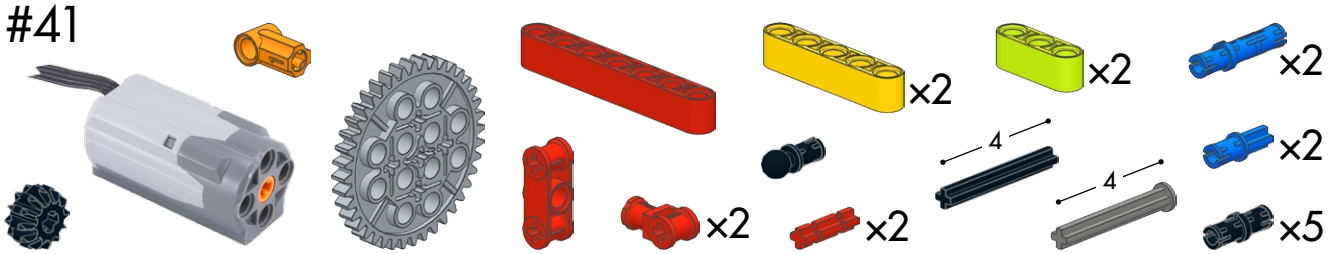

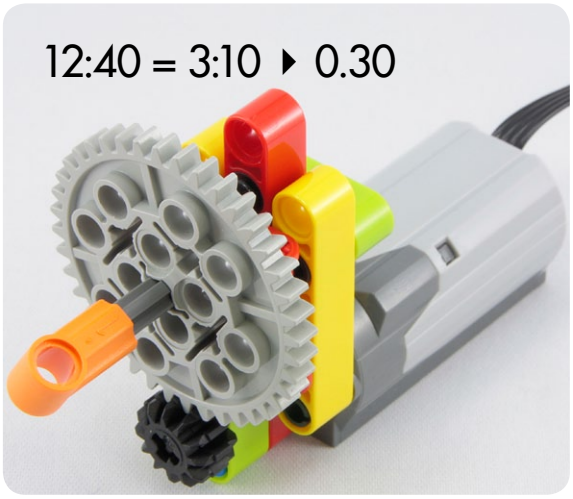

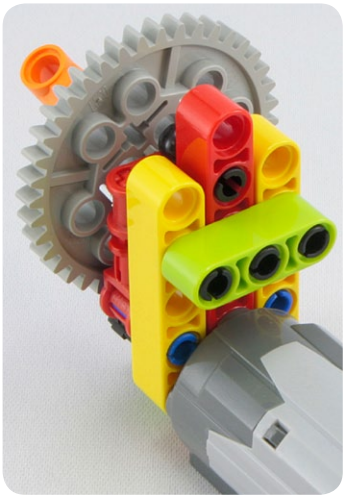

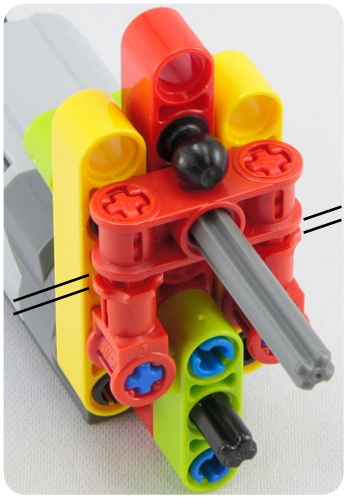

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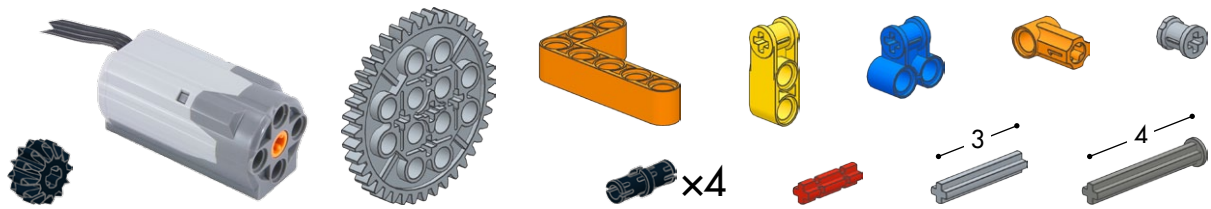

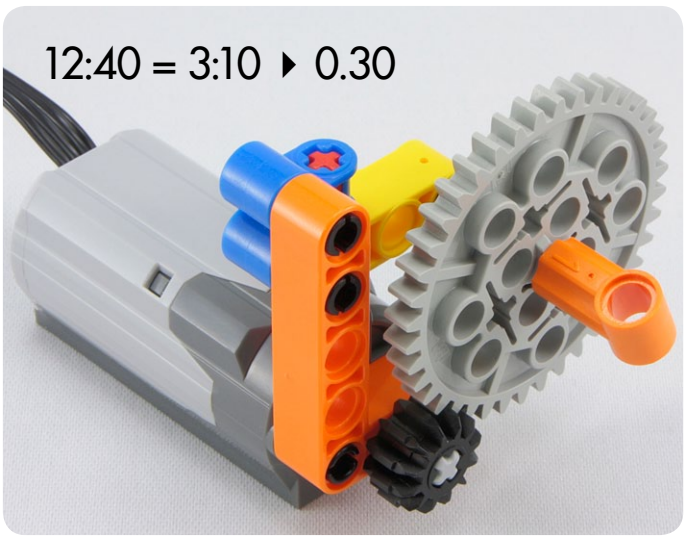

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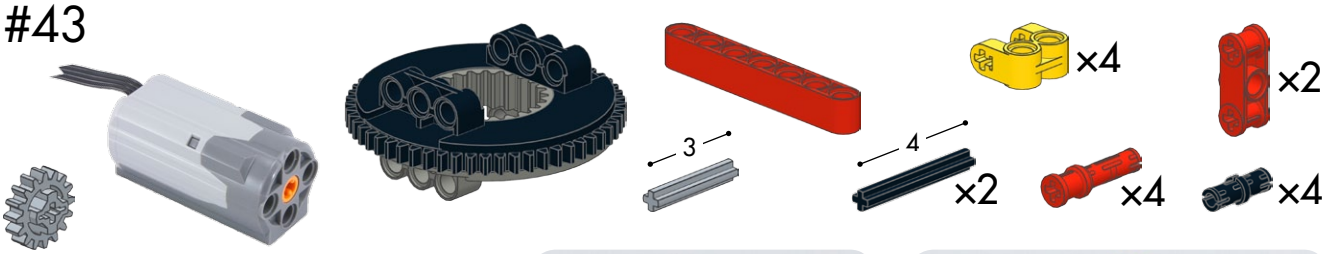

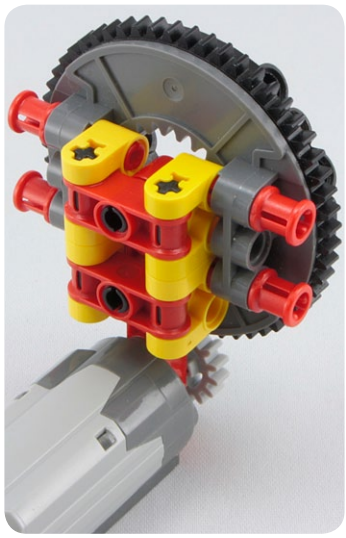

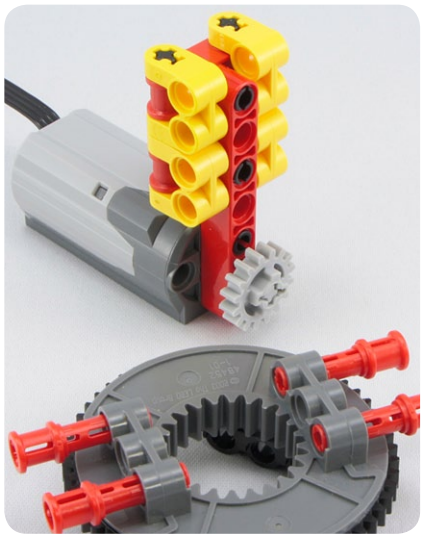

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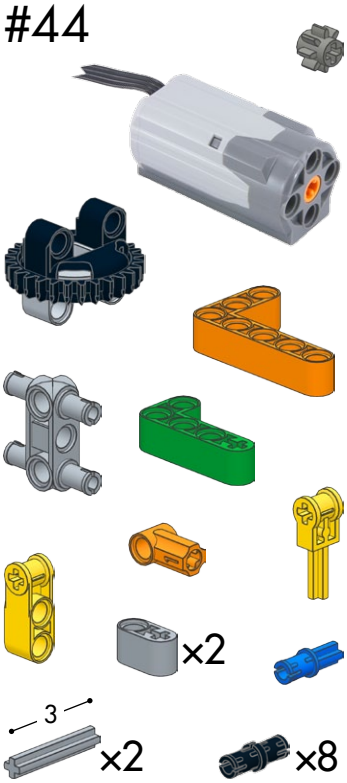

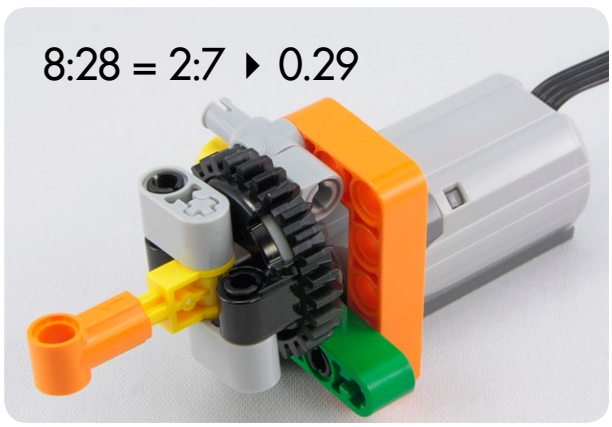

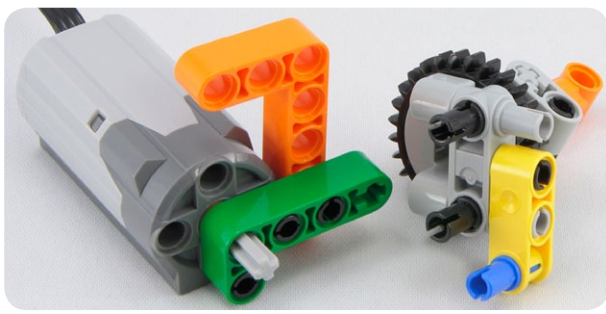

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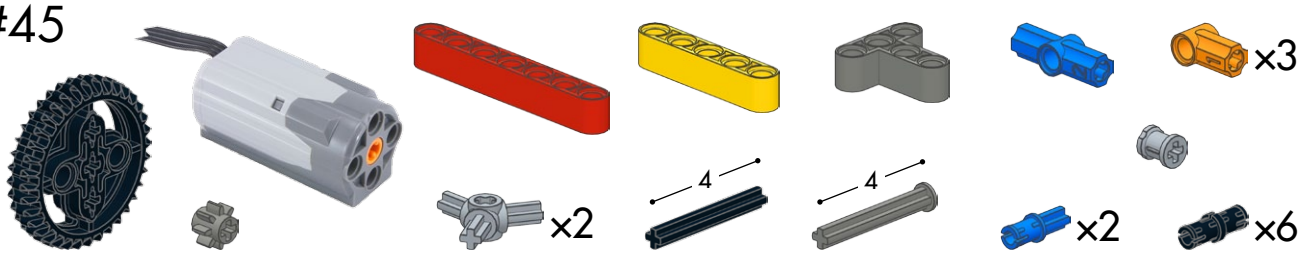

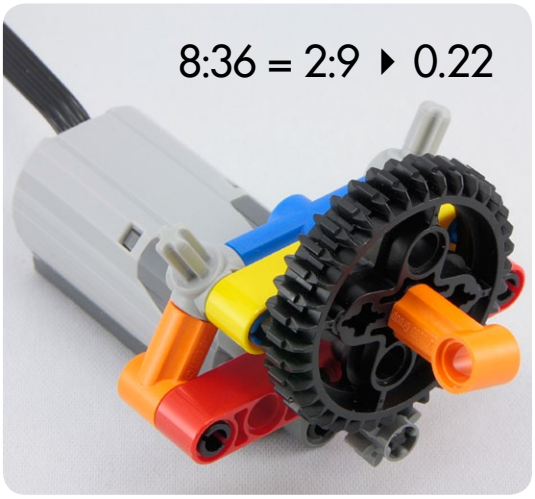

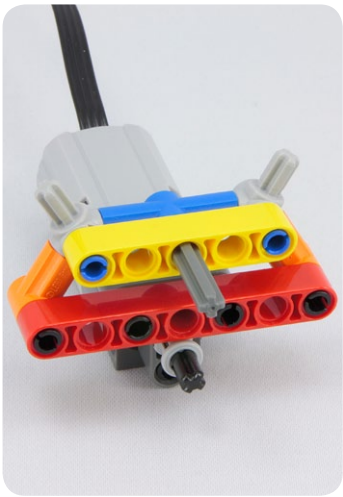

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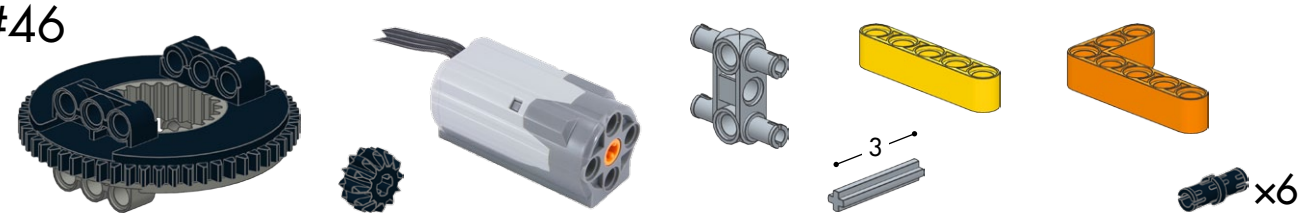

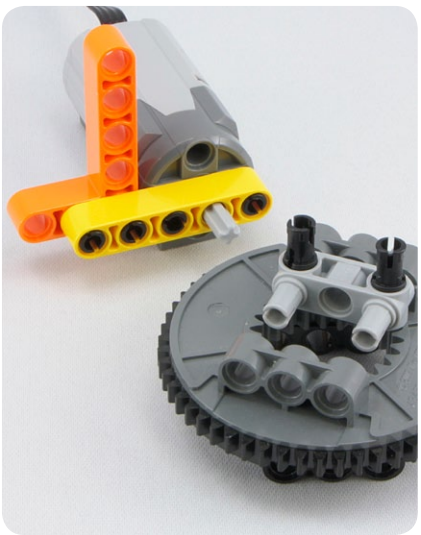

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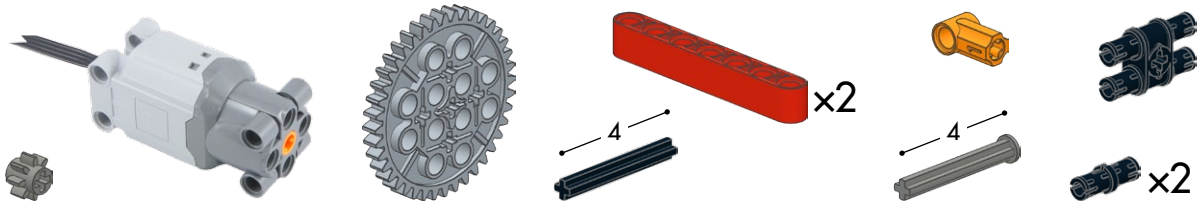

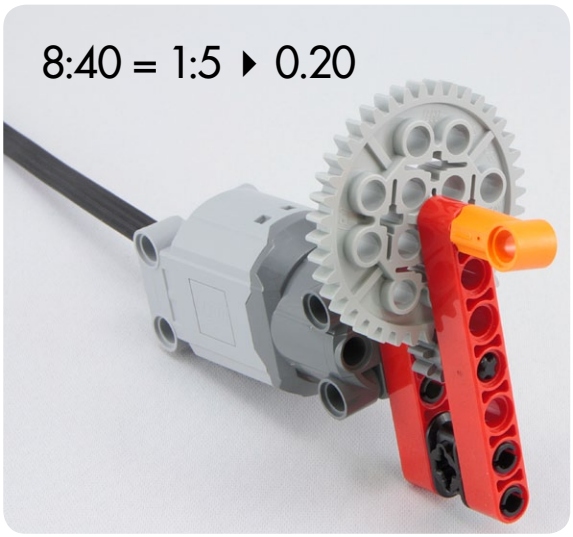

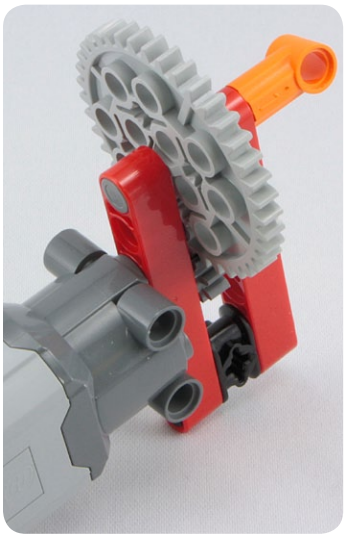

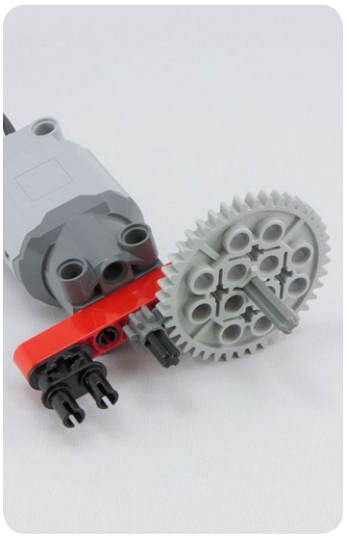

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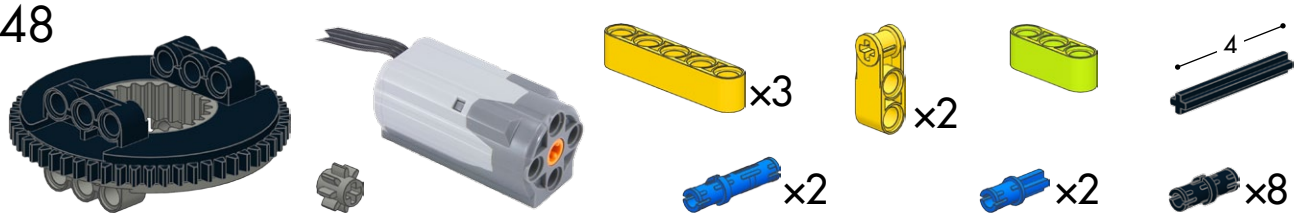
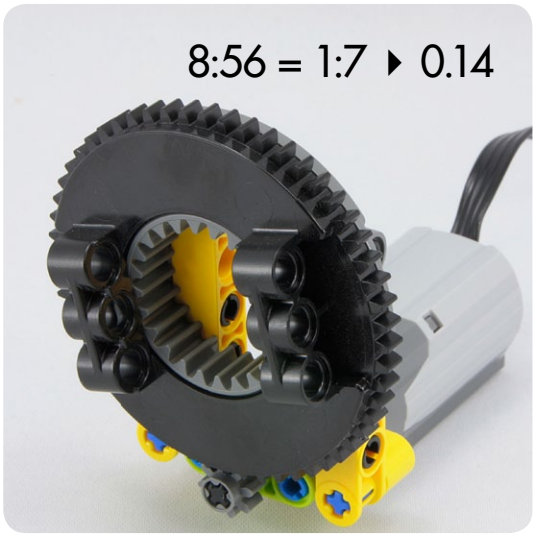
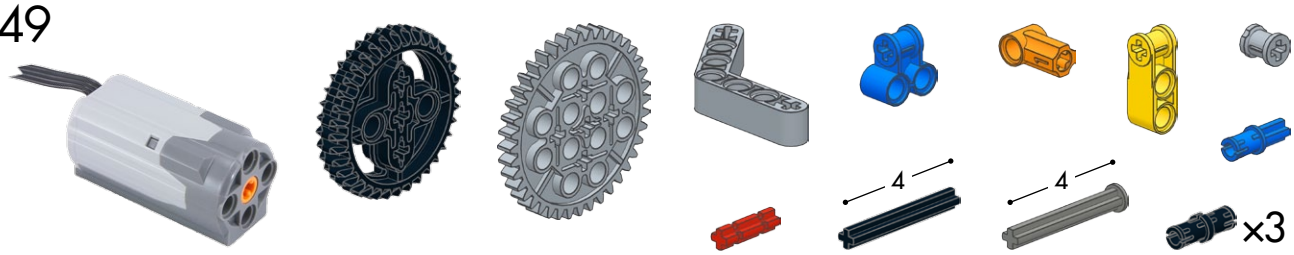


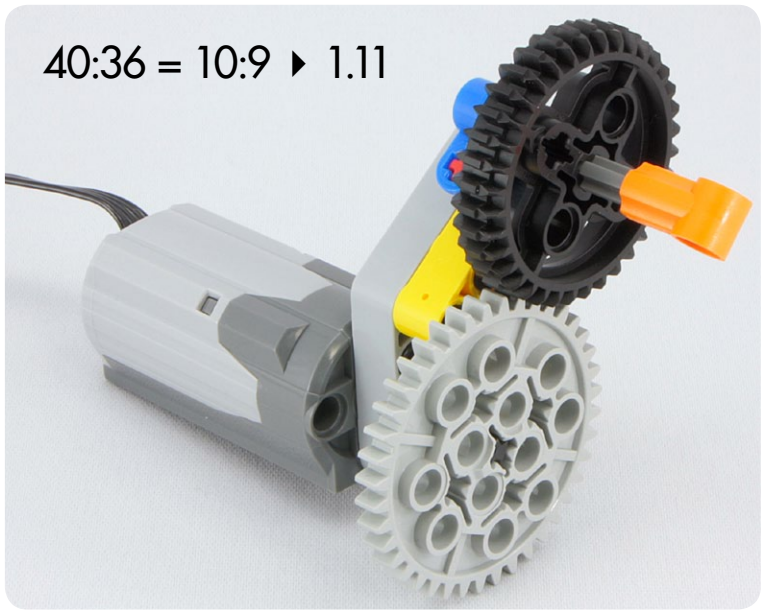


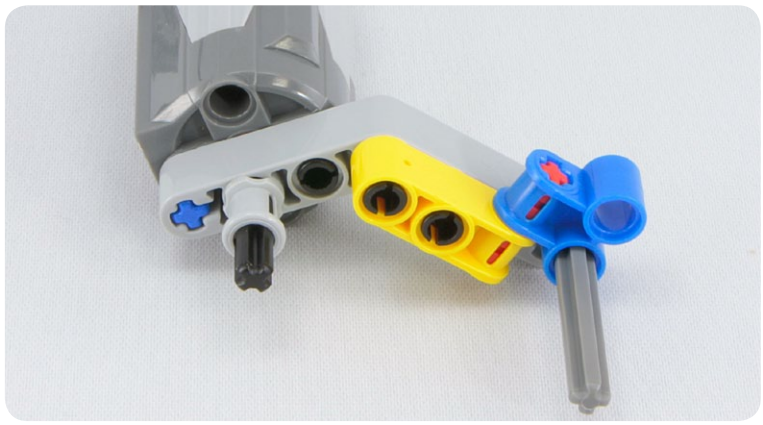
Gearing up (speeding up)

#49



40:36 = 10:9 ▸ 1.11





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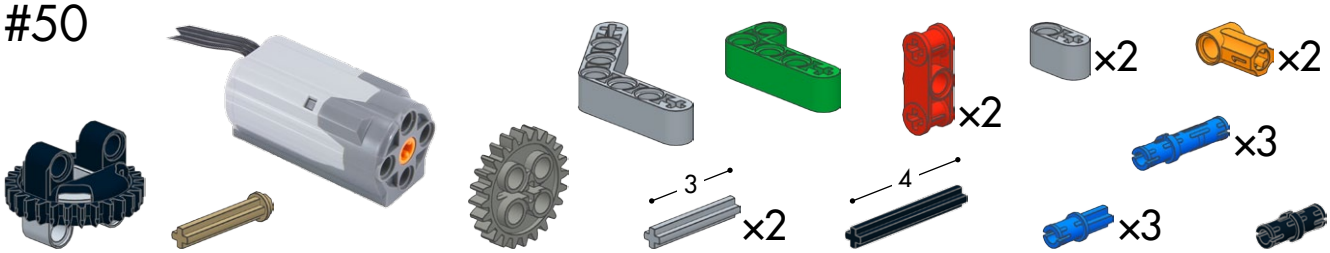

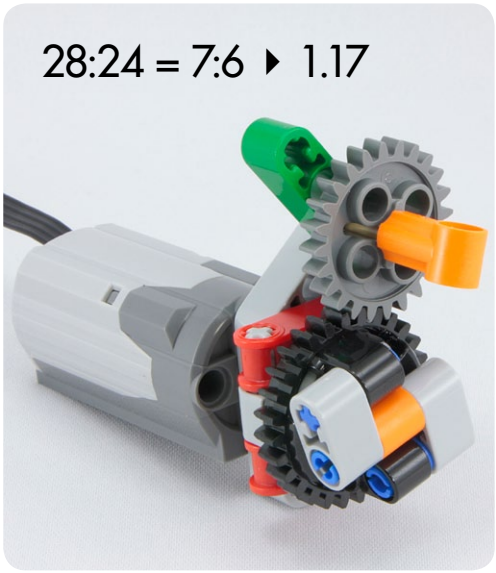

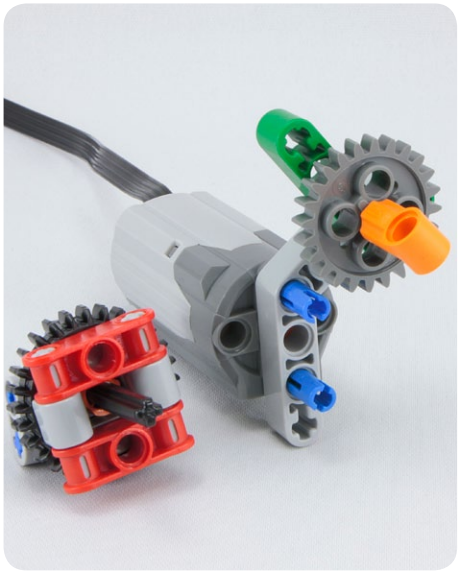

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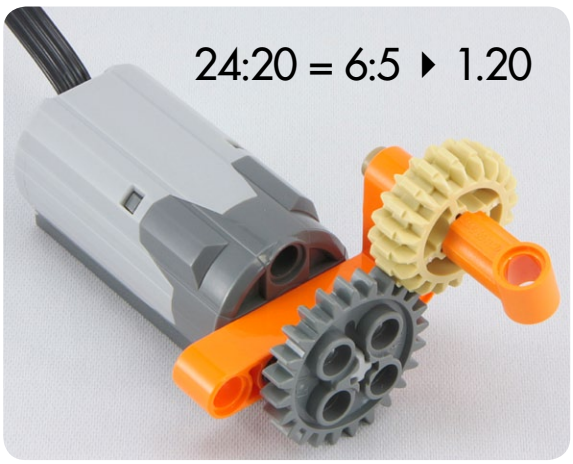

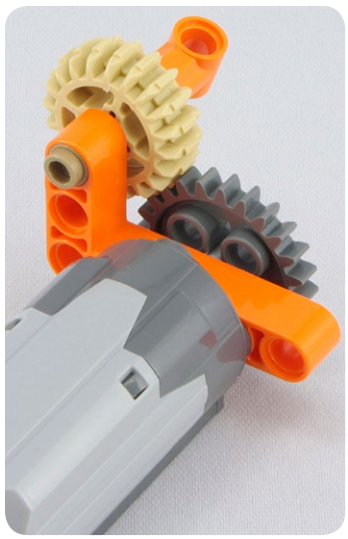

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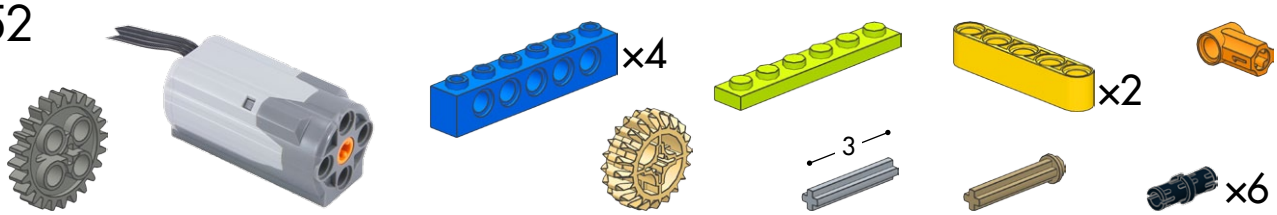

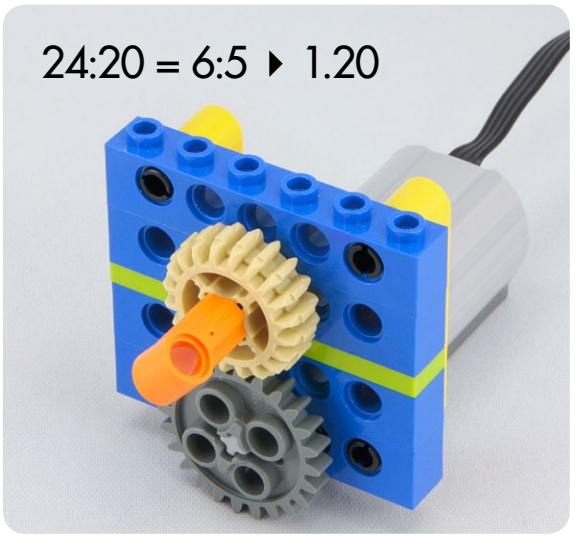

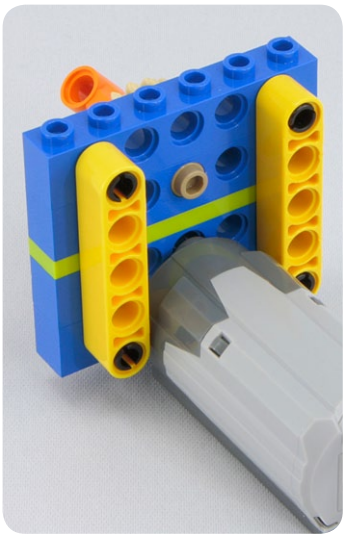

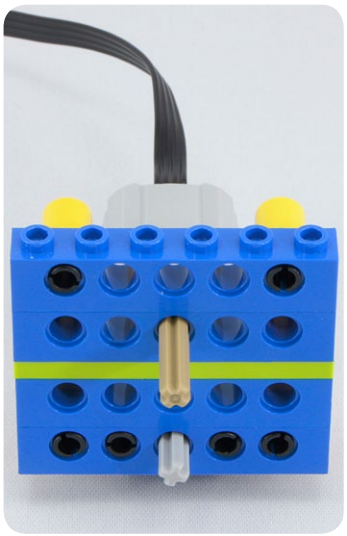

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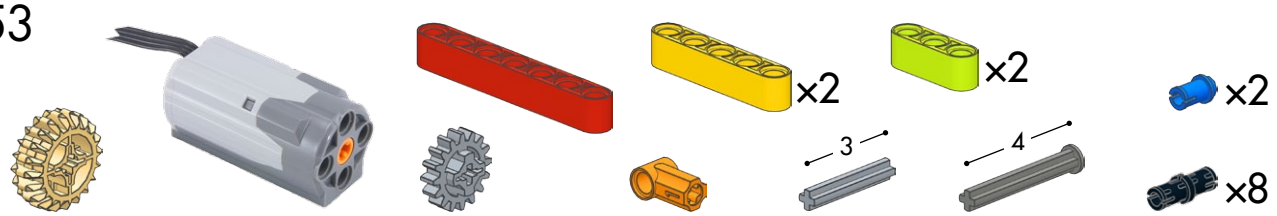

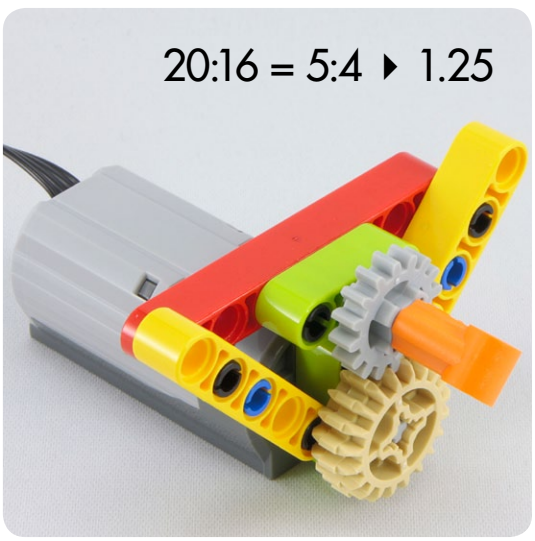

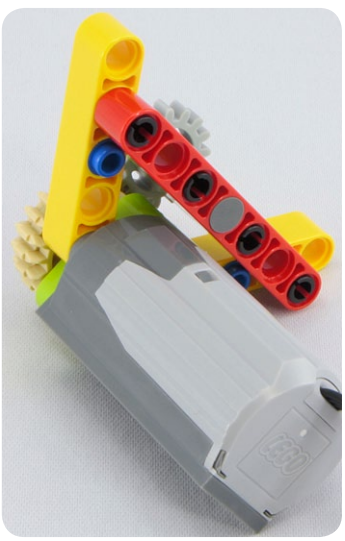

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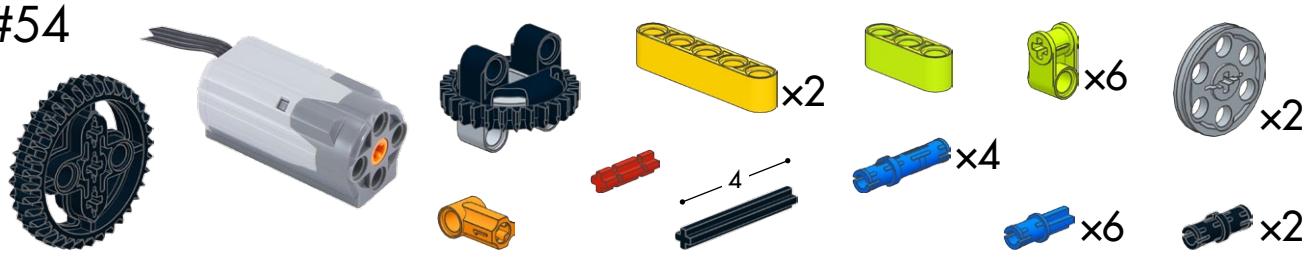

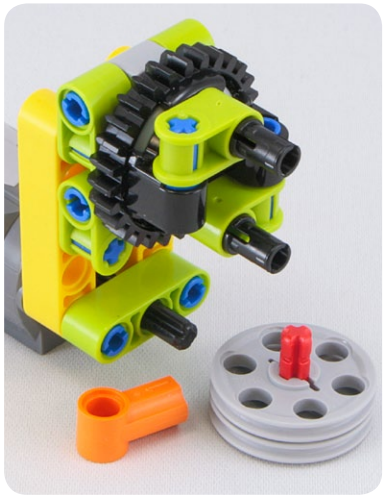

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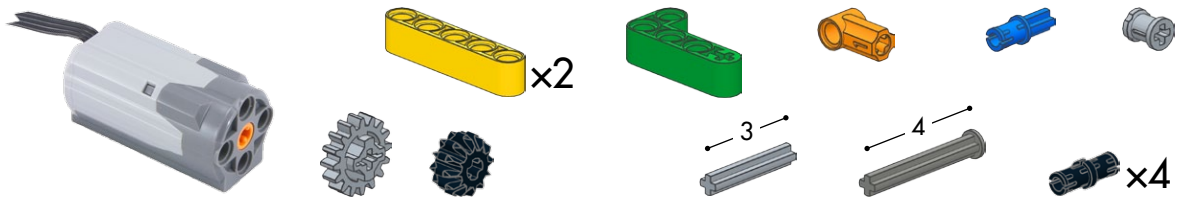

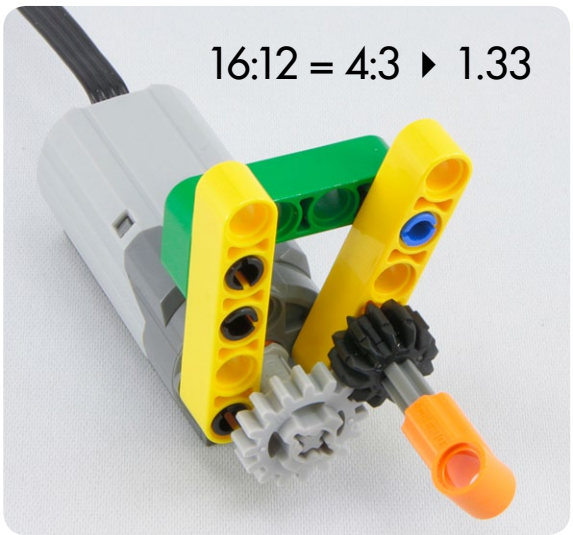

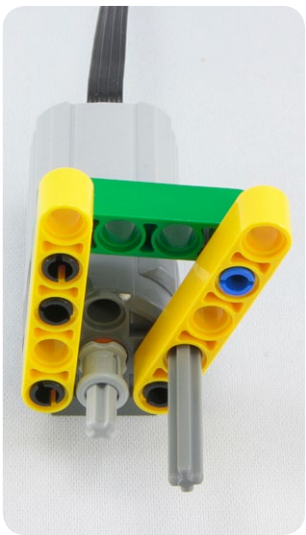

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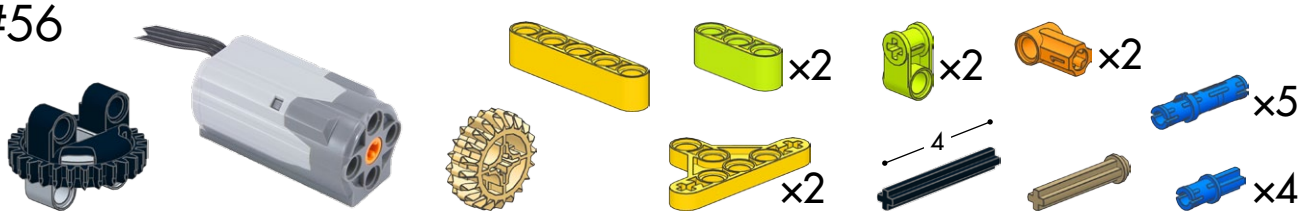

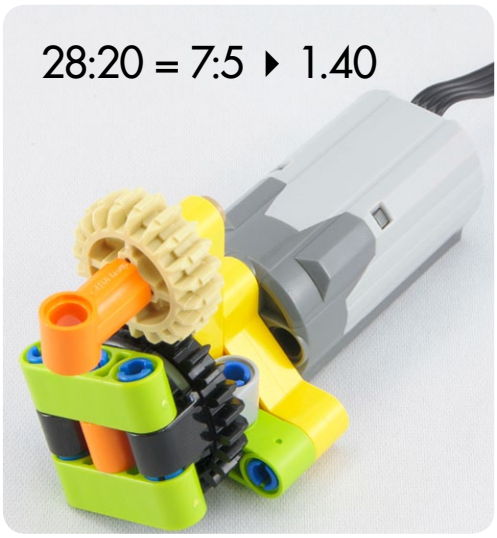

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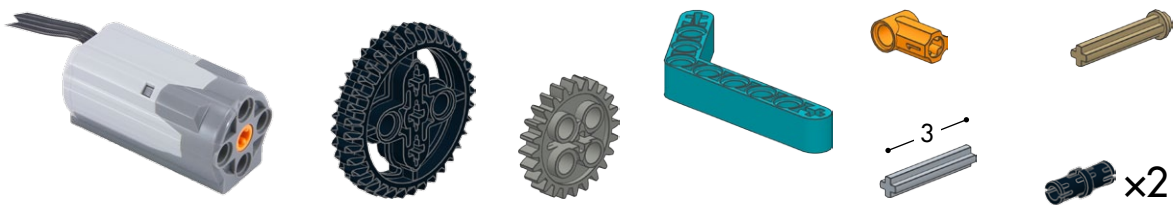

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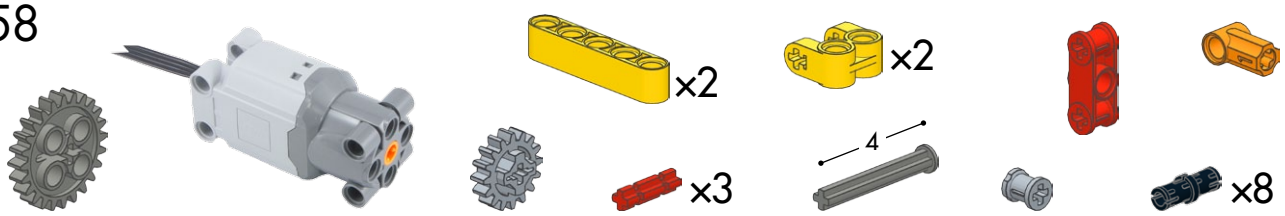

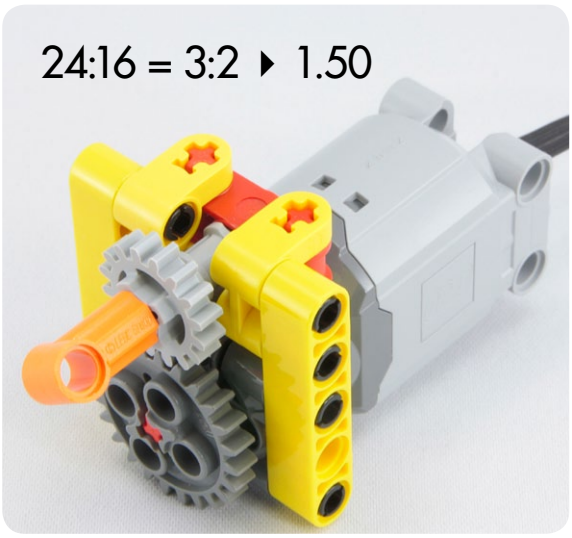

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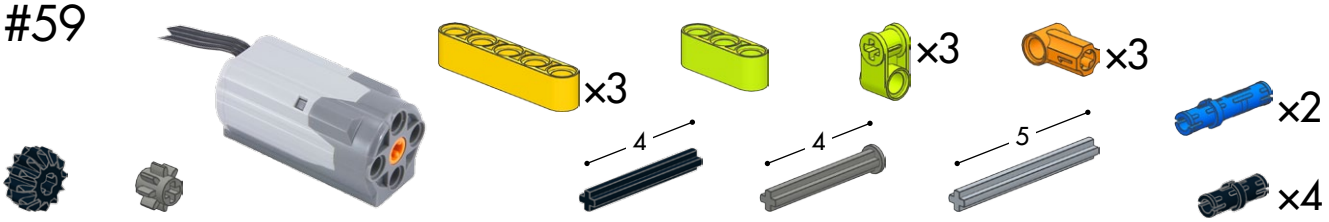

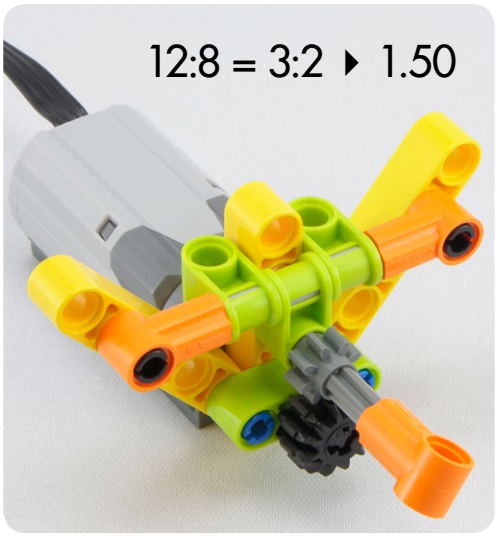

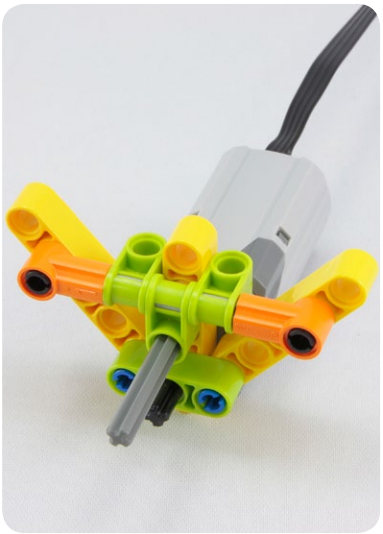

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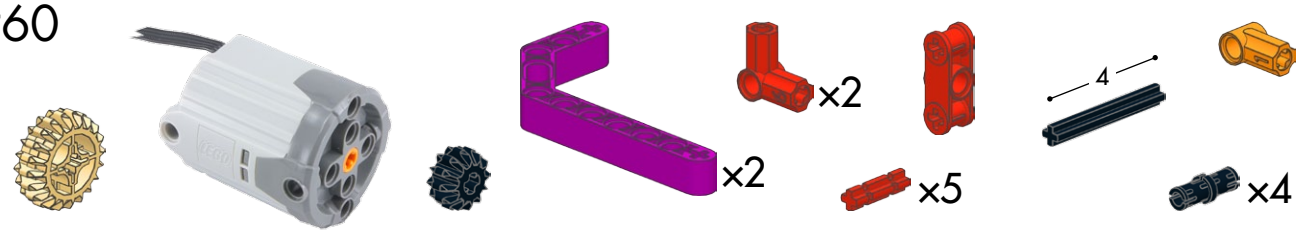

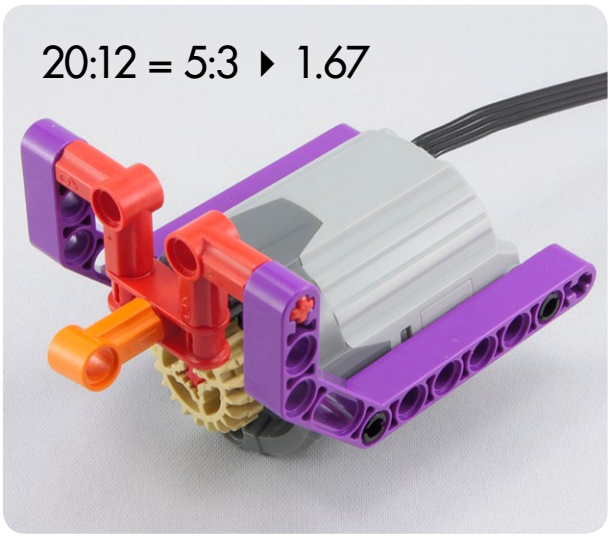

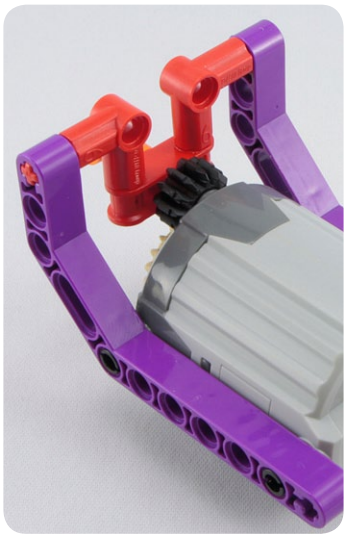

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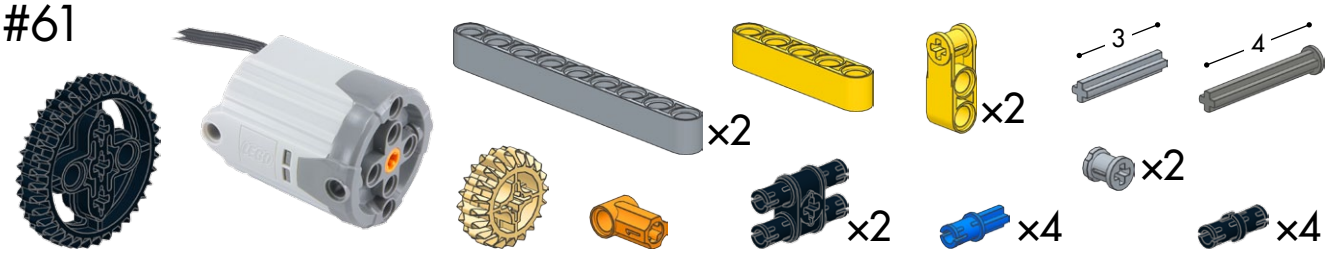

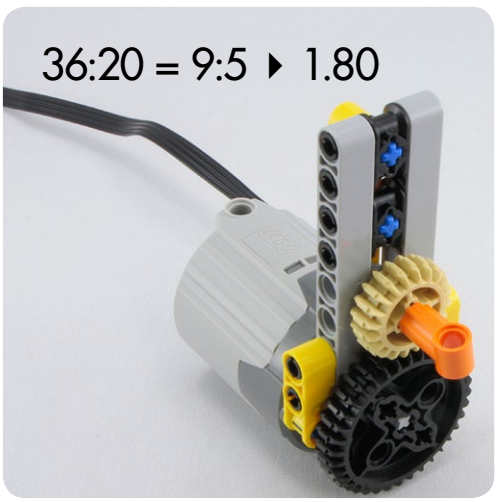

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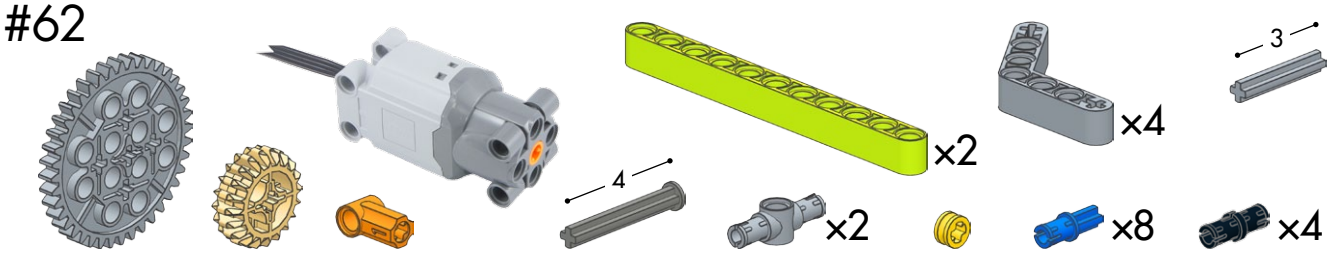

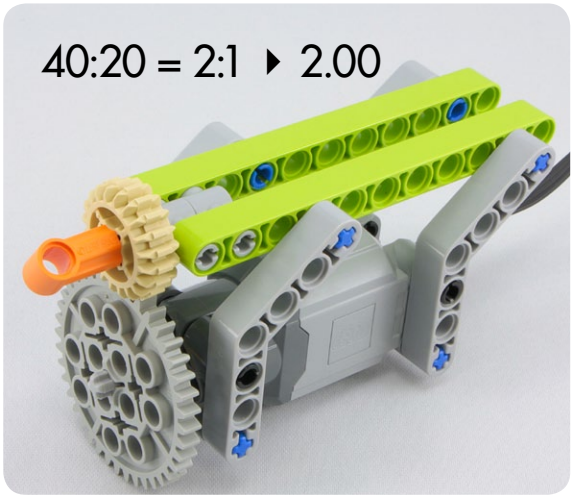

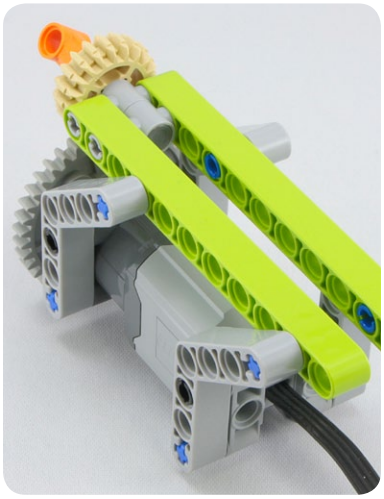

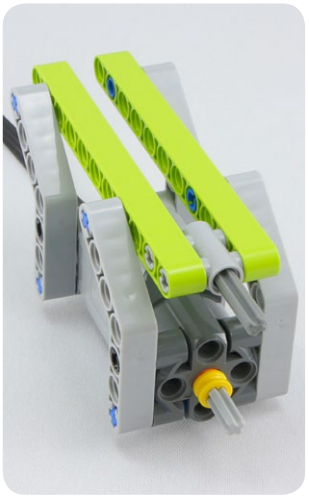

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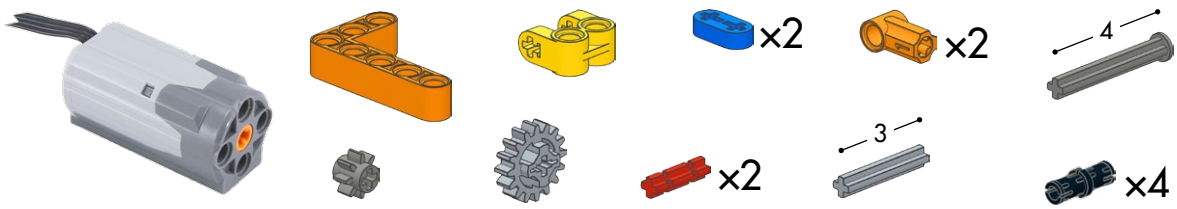

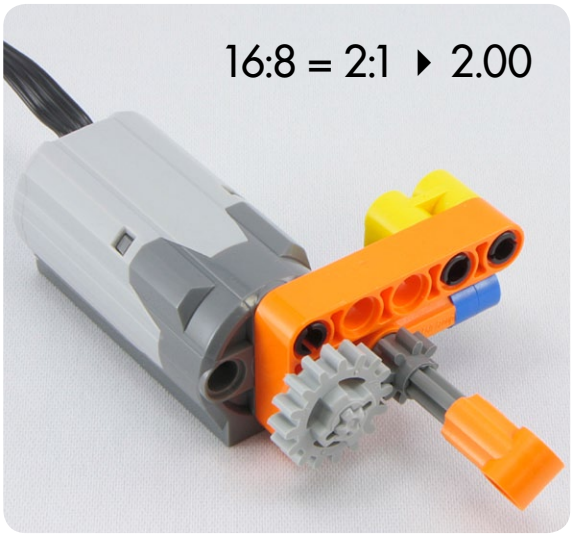

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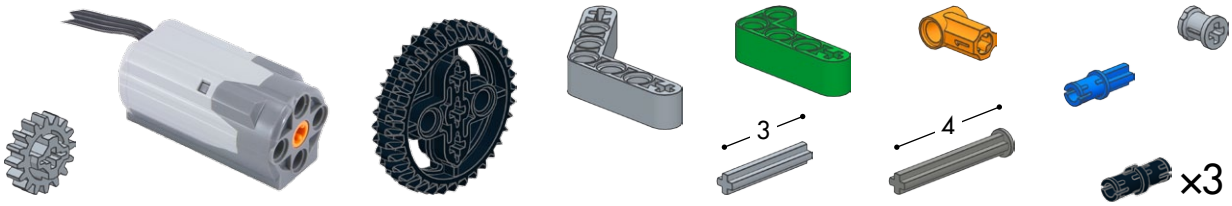

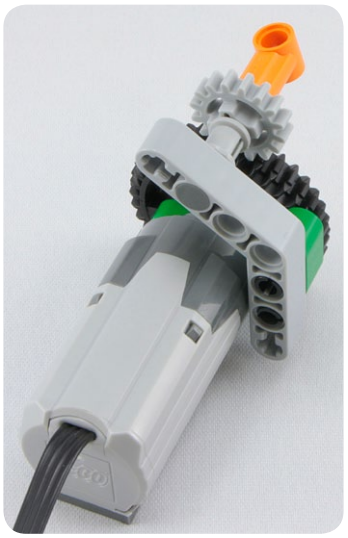

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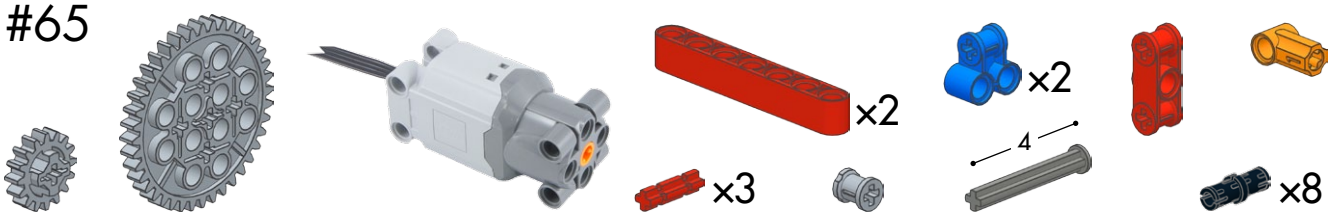

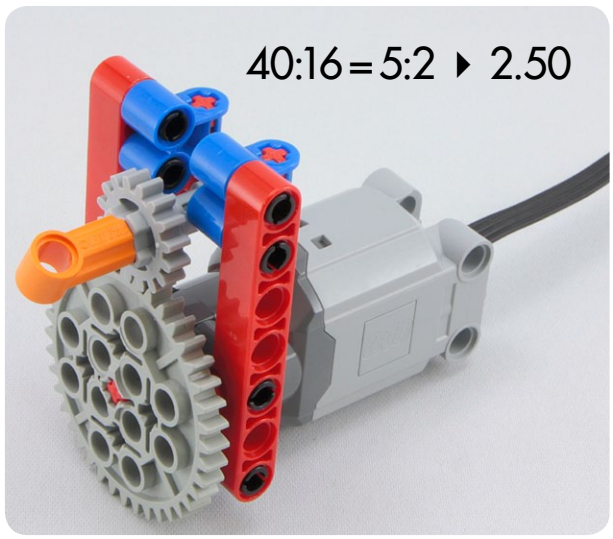

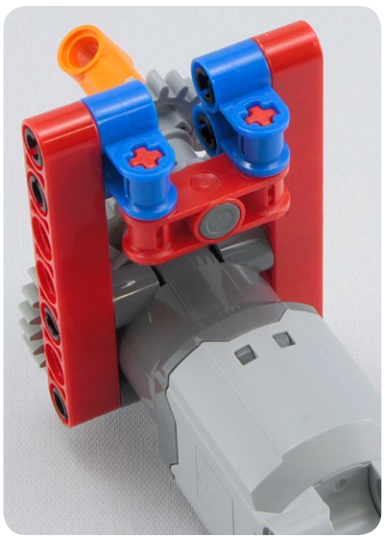

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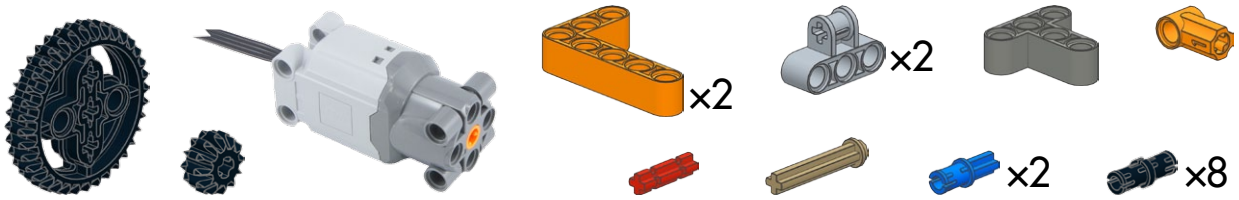

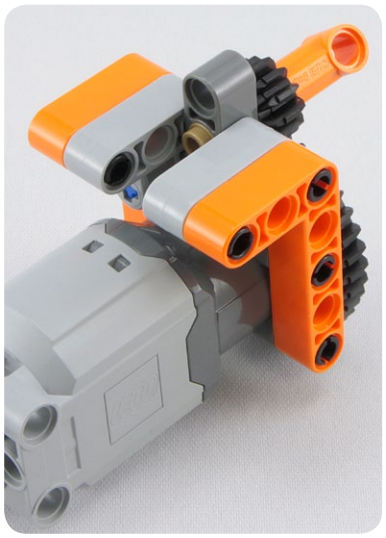

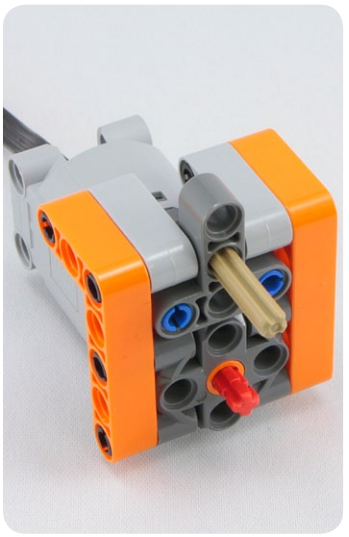

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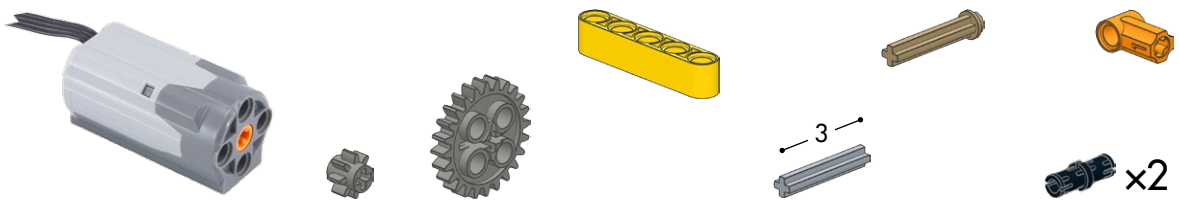

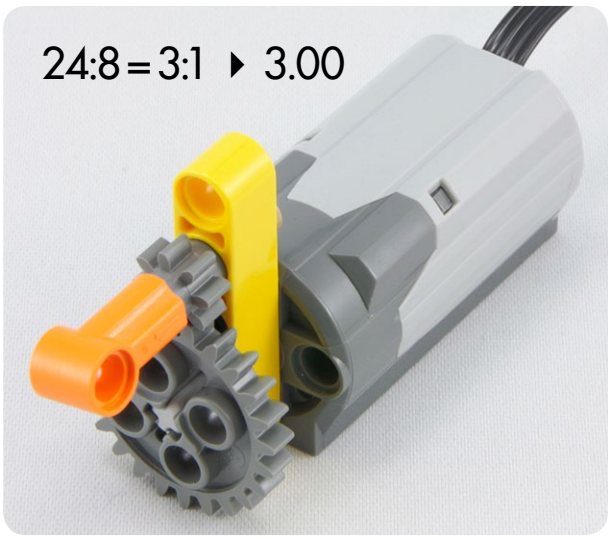

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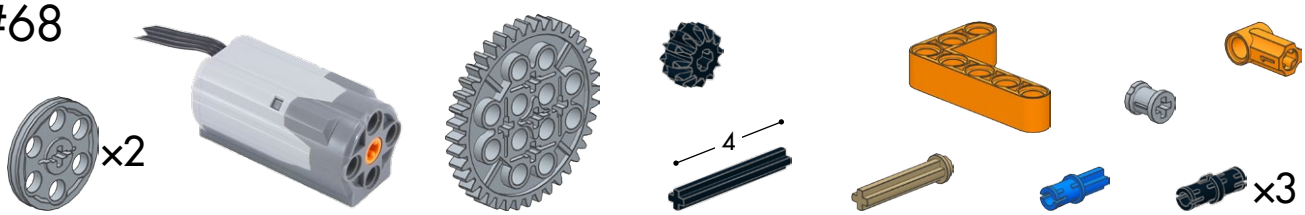

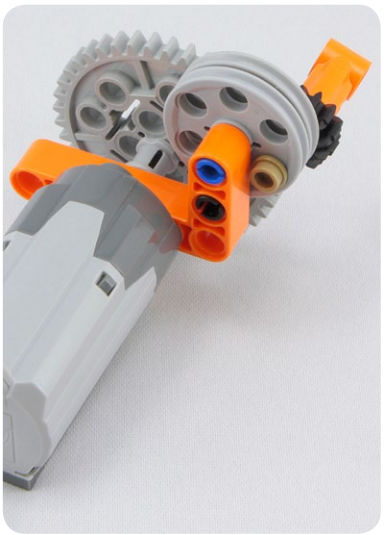

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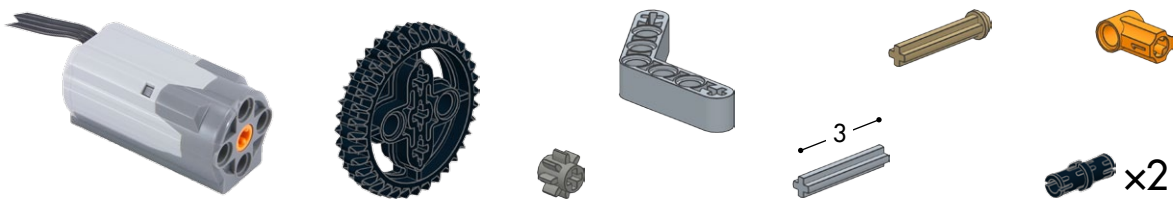

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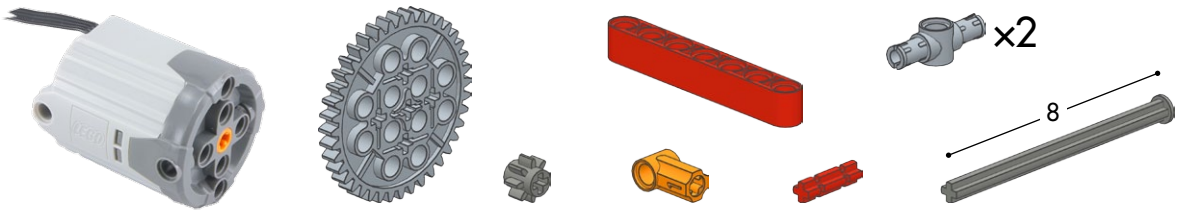
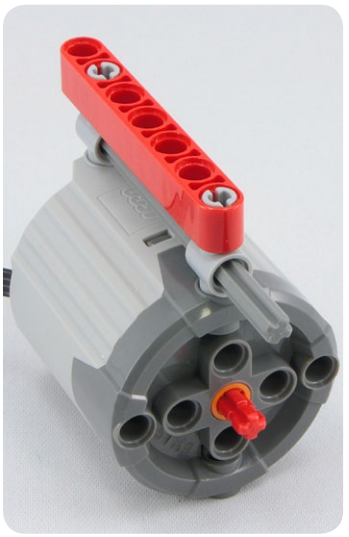
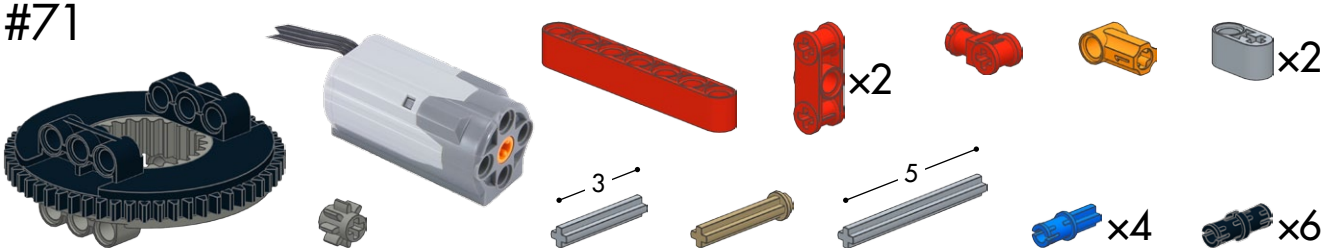
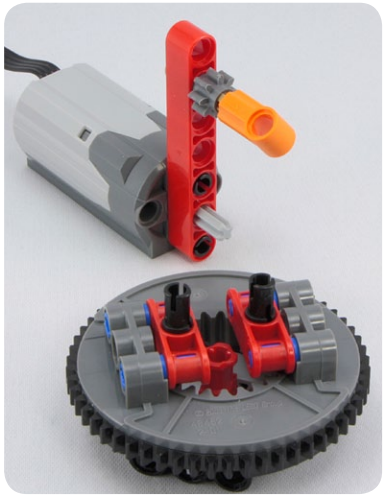




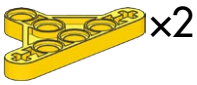
#71

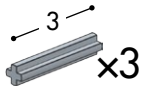


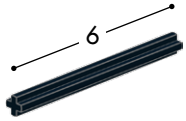


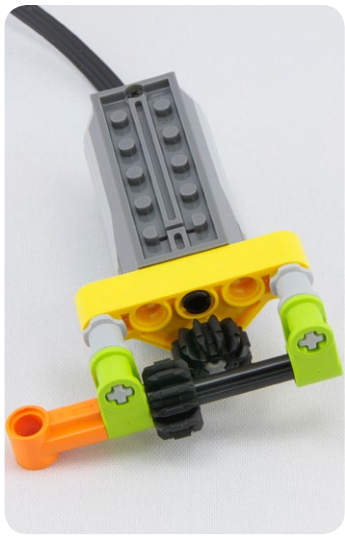
Changing the angle of rotation

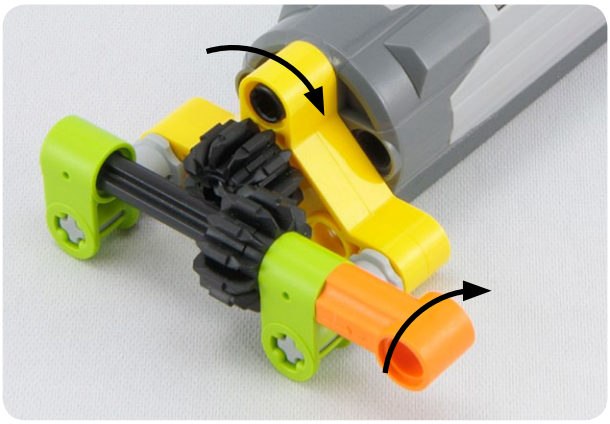
#72

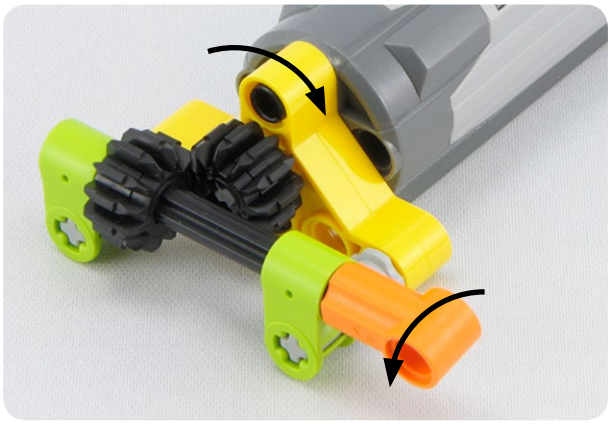











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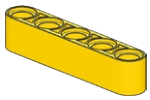

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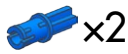
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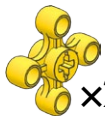
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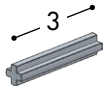
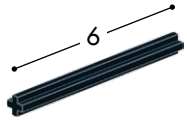




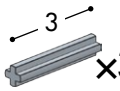

×2


#74



×2



×2


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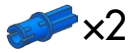
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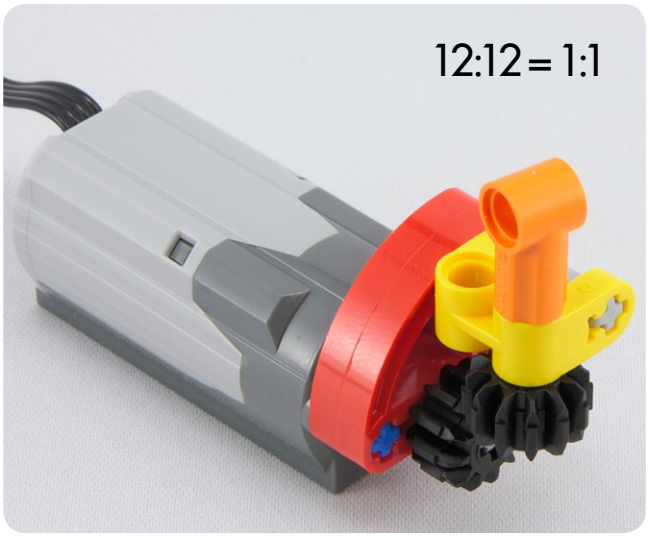


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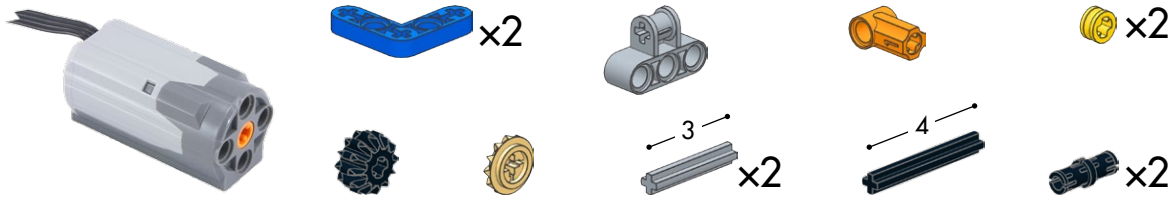

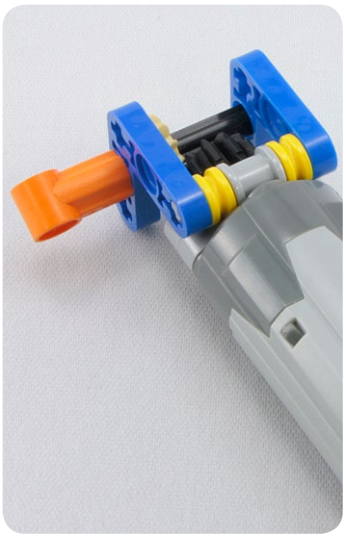

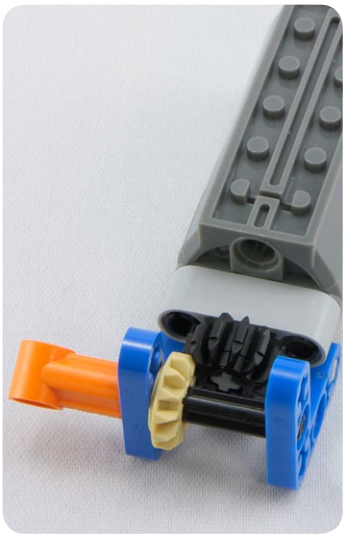

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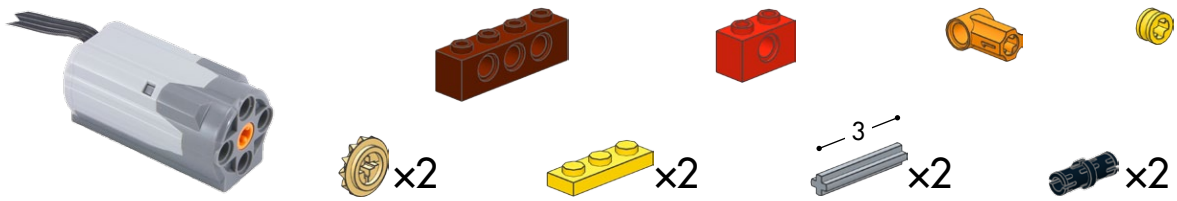

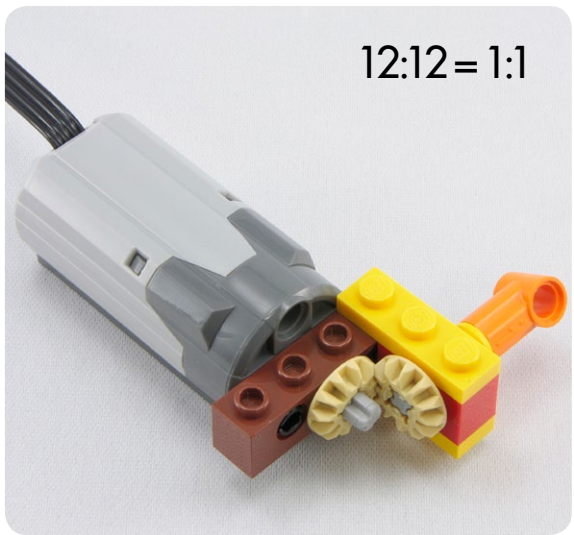

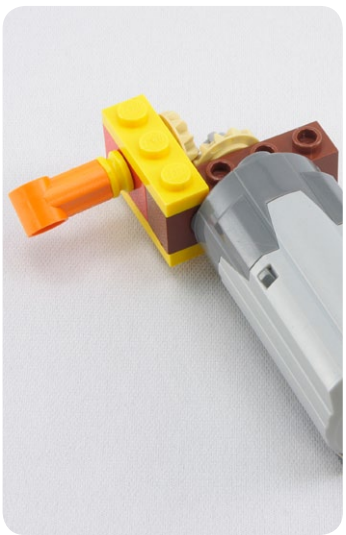

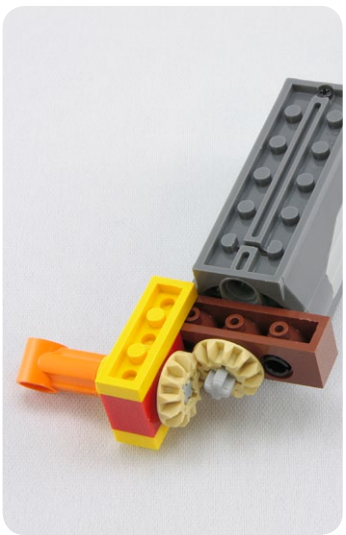

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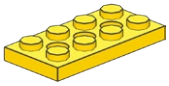

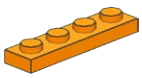

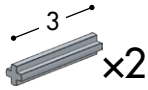

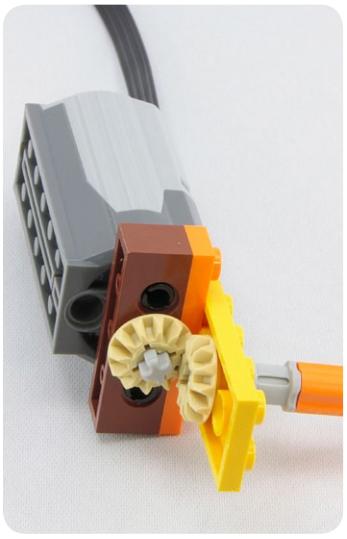

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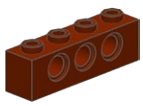

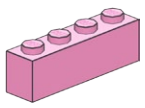

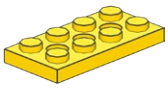

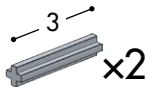

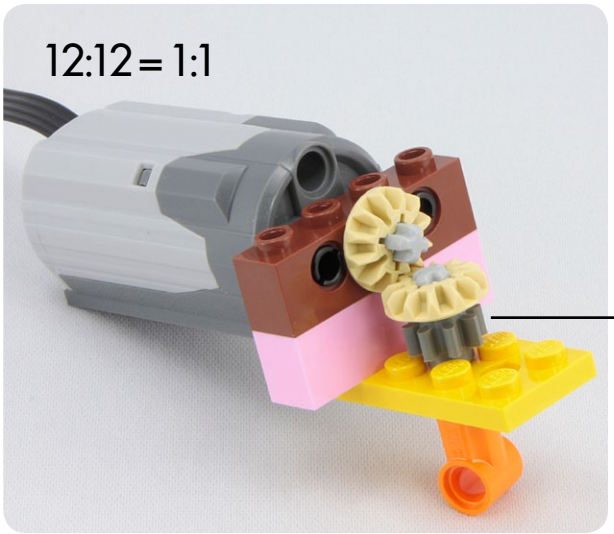

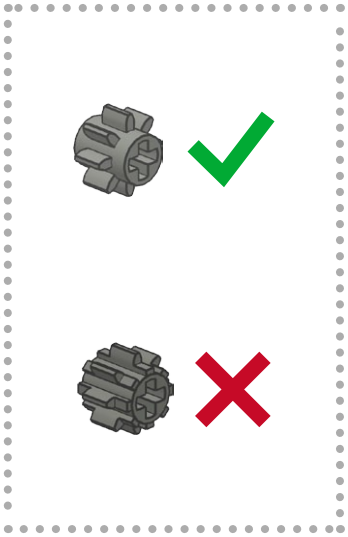

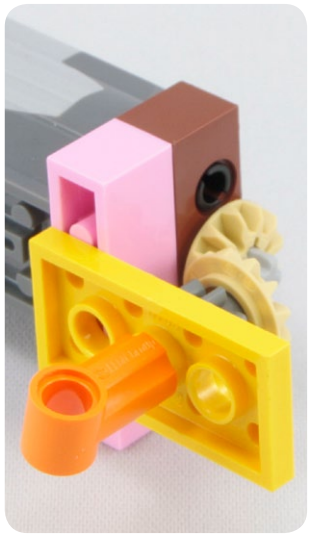

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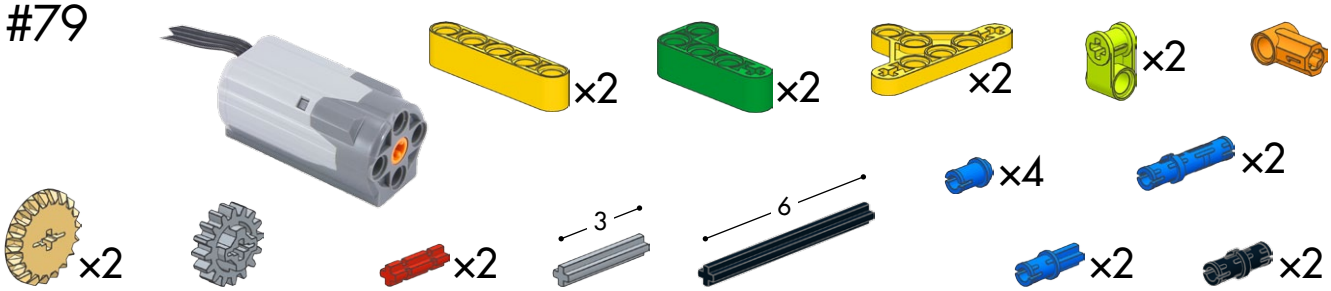

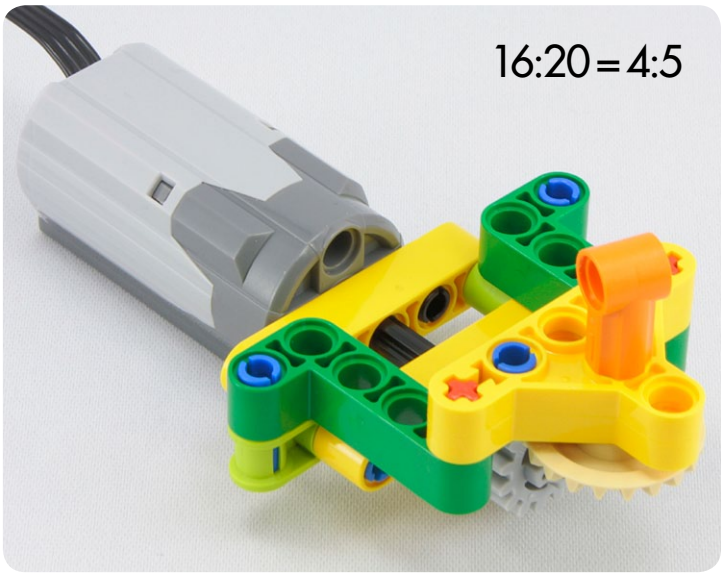

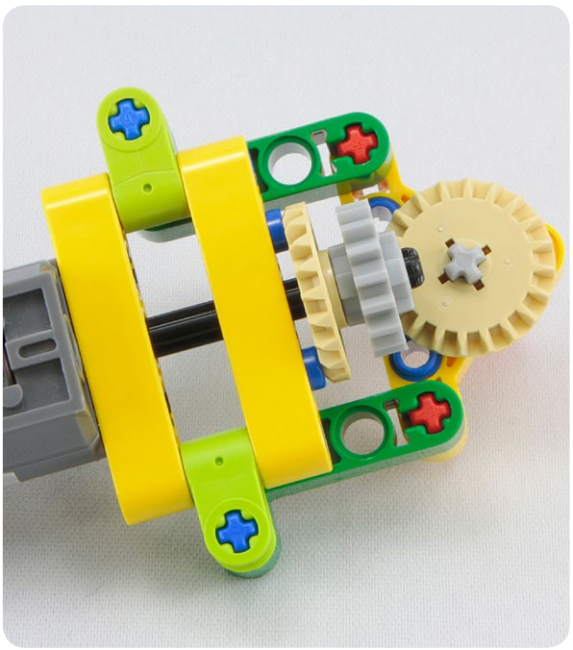

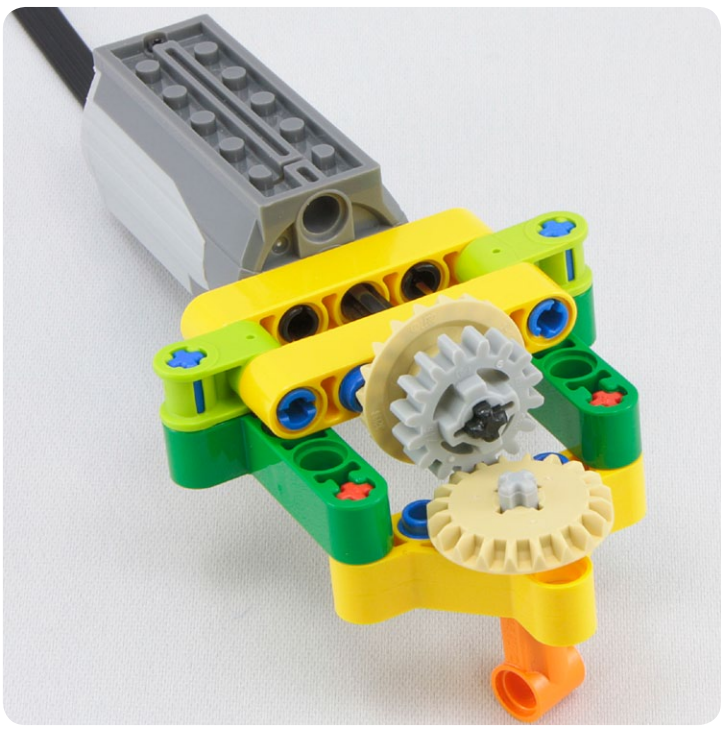

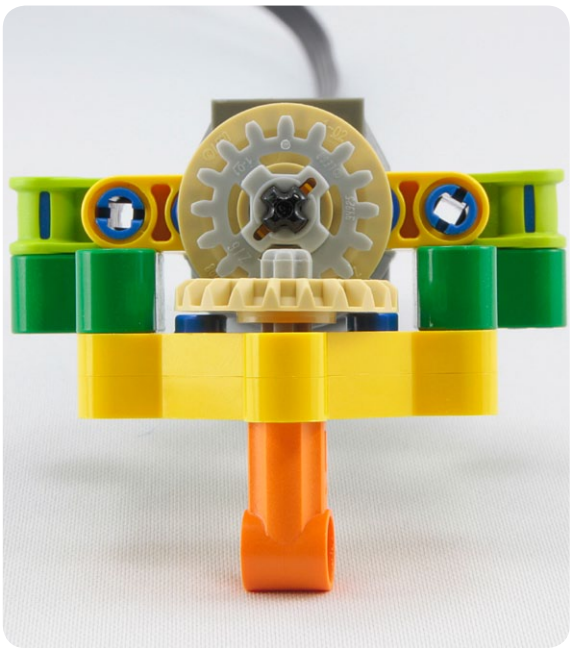

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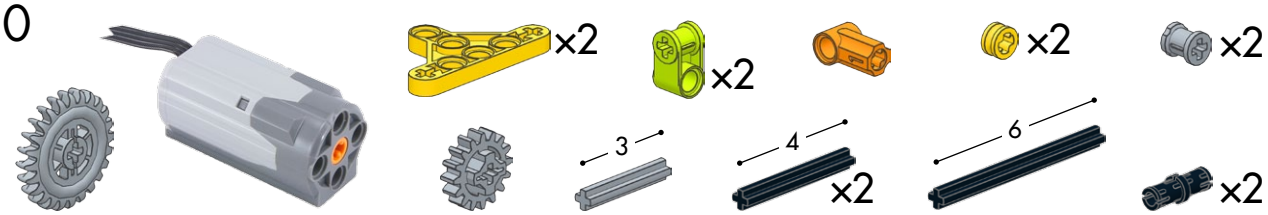

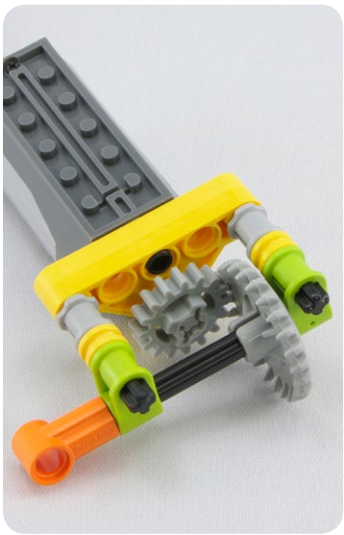

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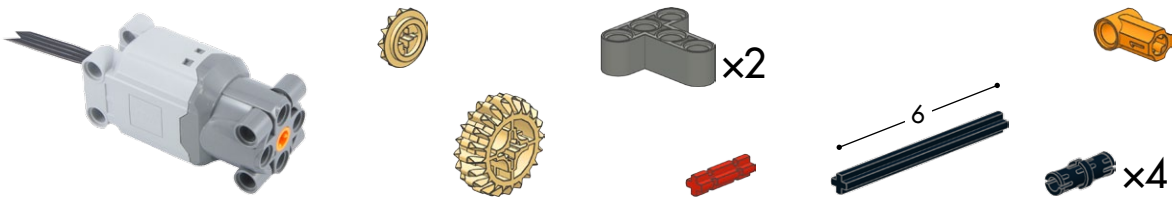

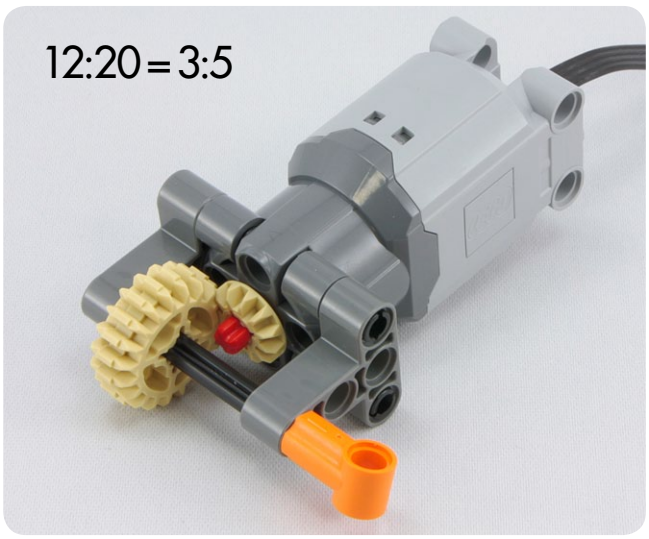

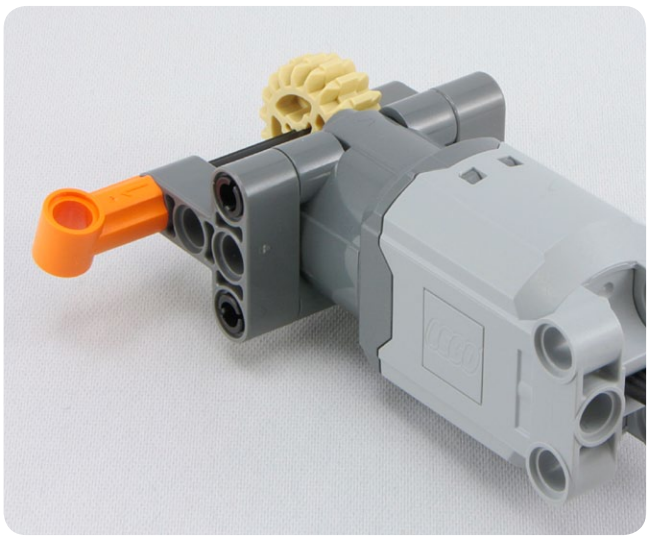

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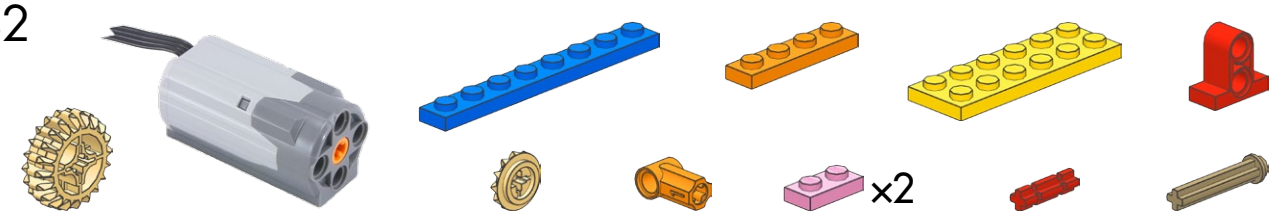

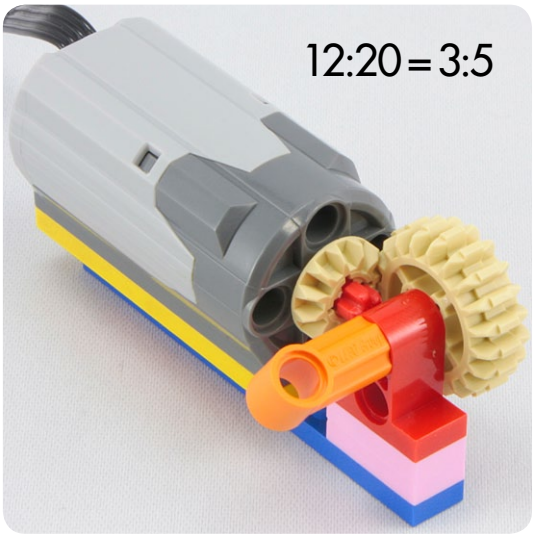

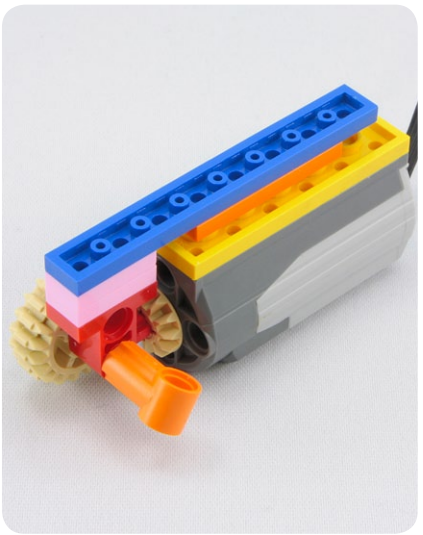

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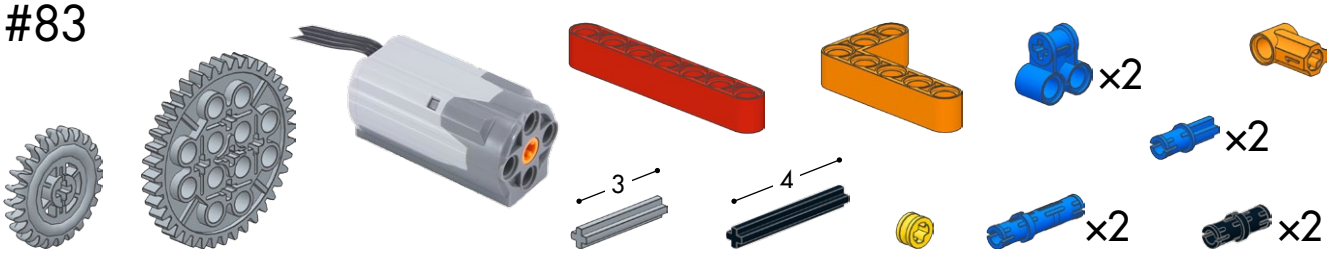

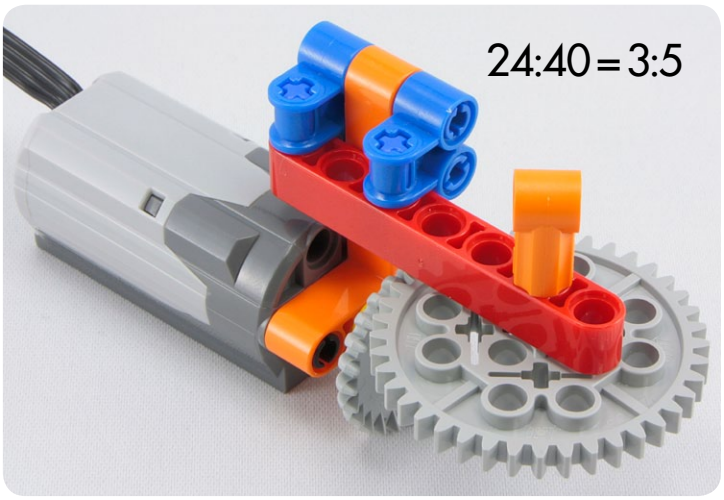

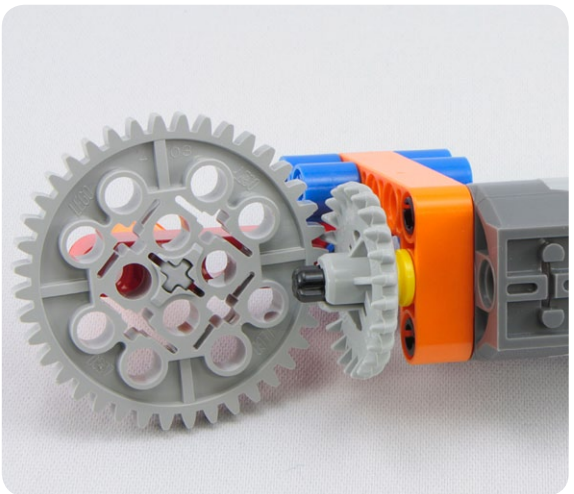

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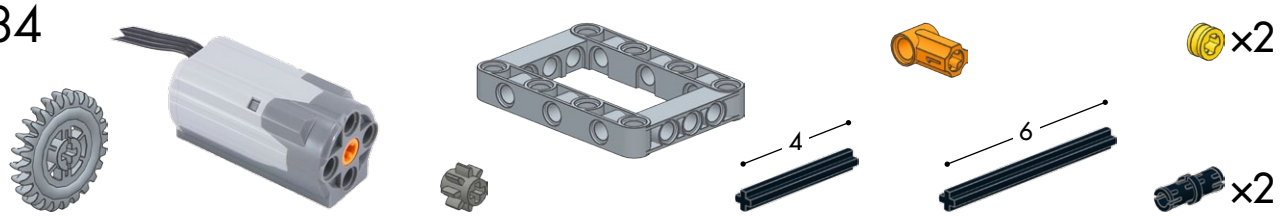

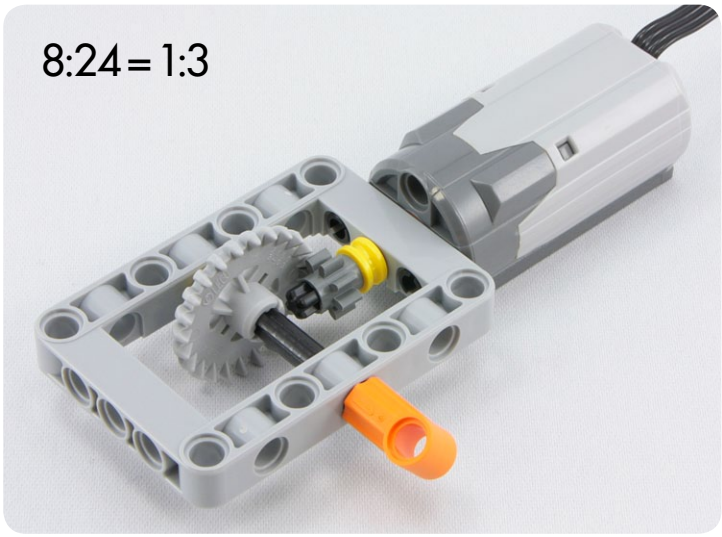

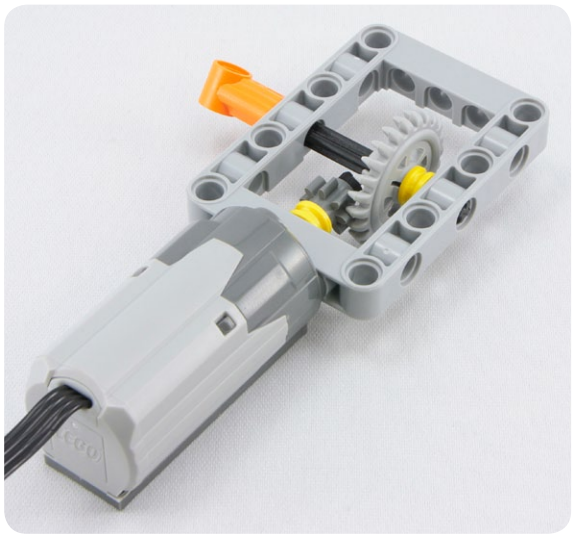

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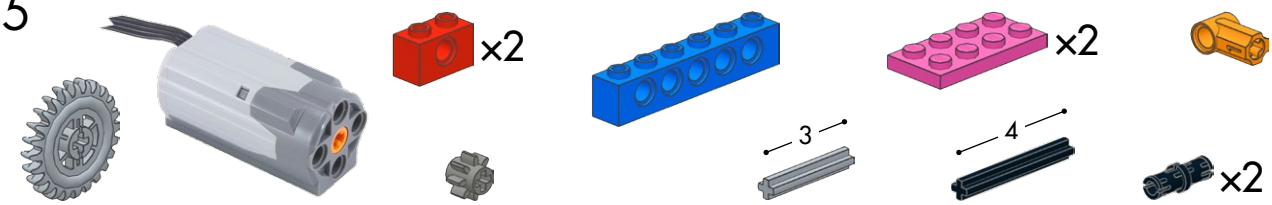

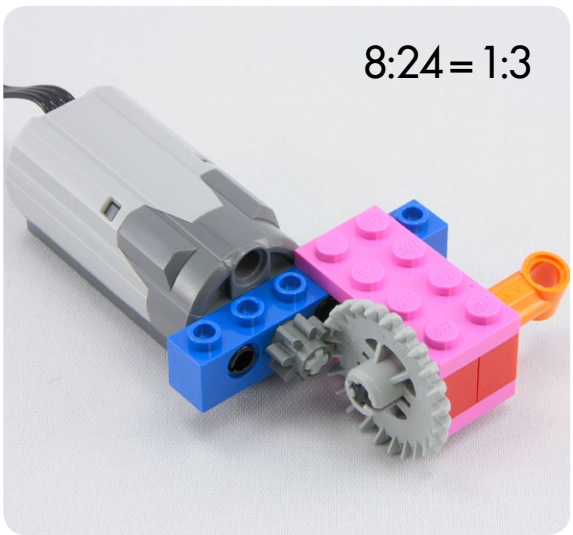

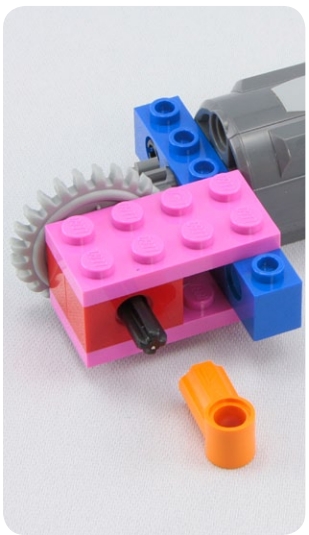

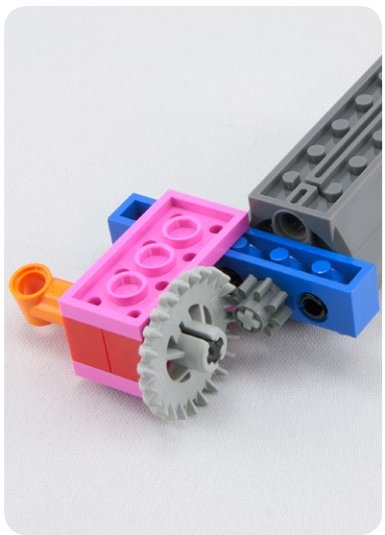

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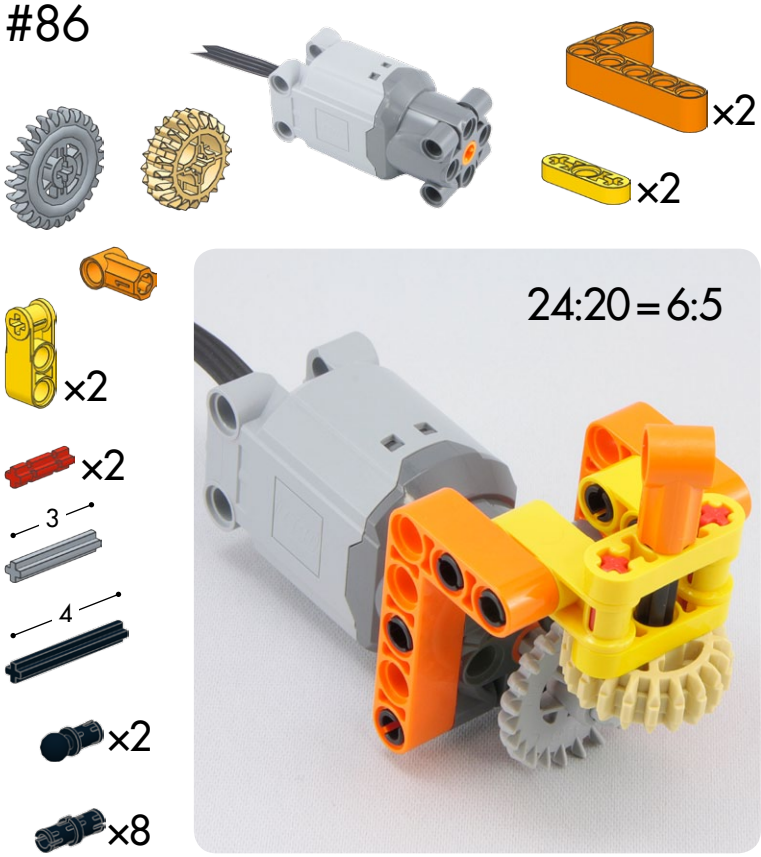

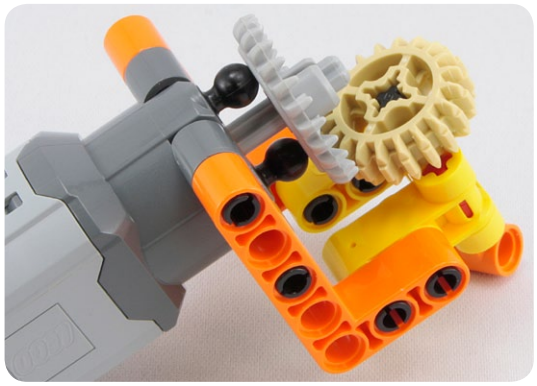

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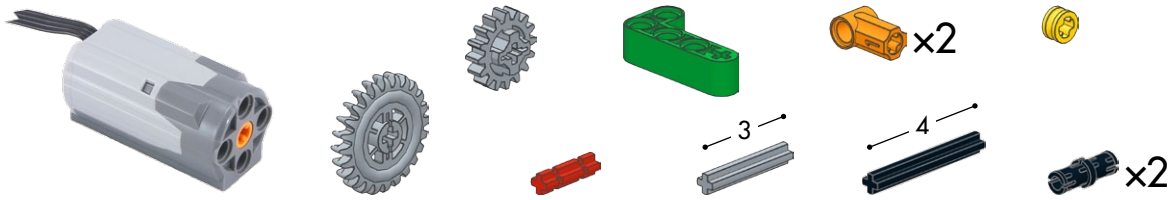

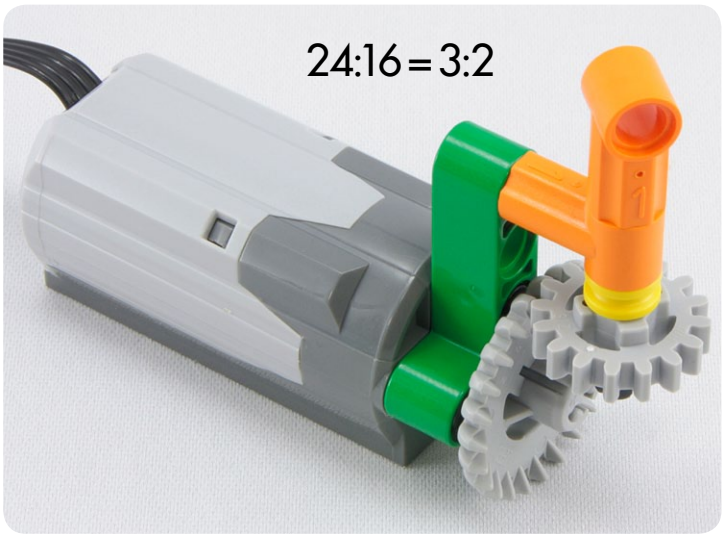

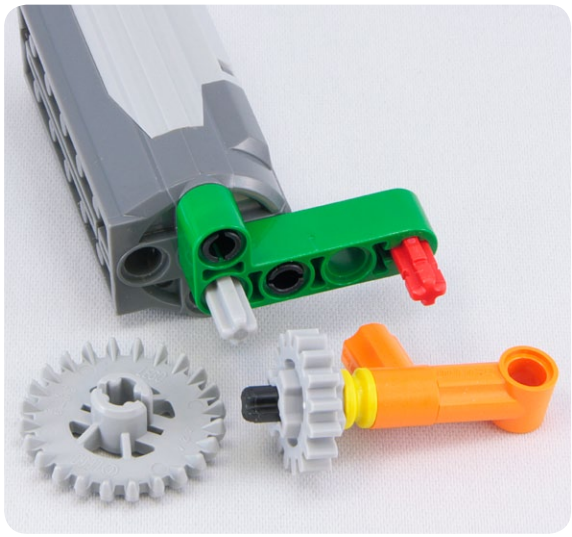

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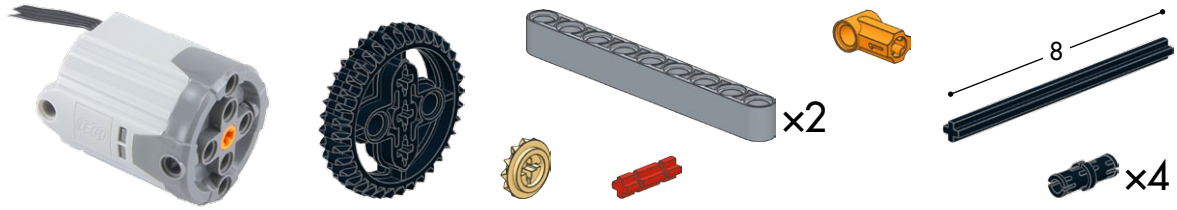
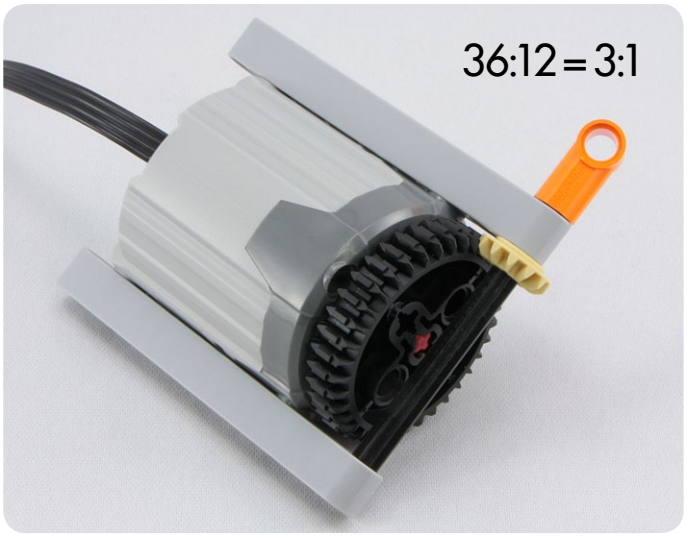
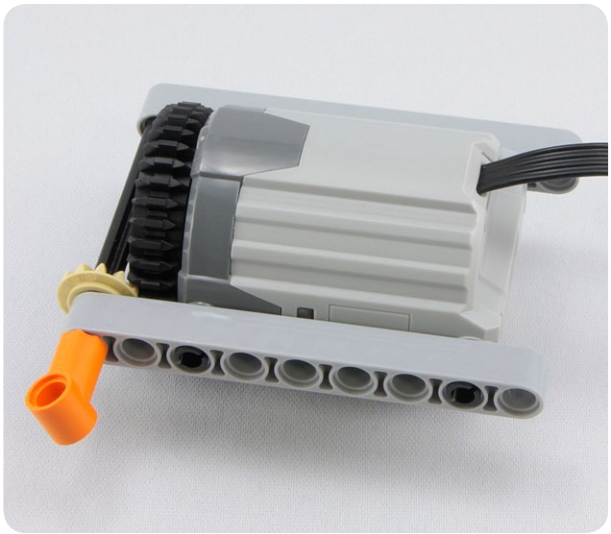
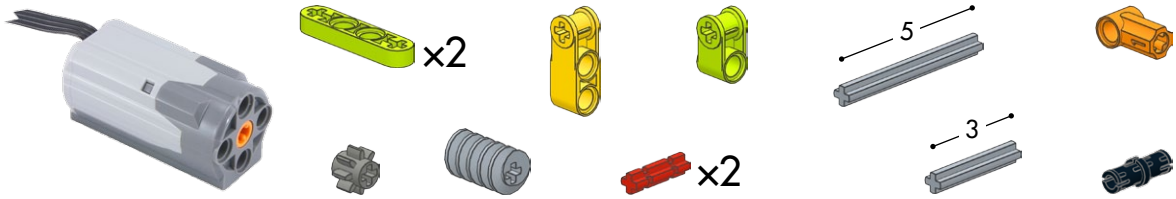






Powering up with worm drives

#90



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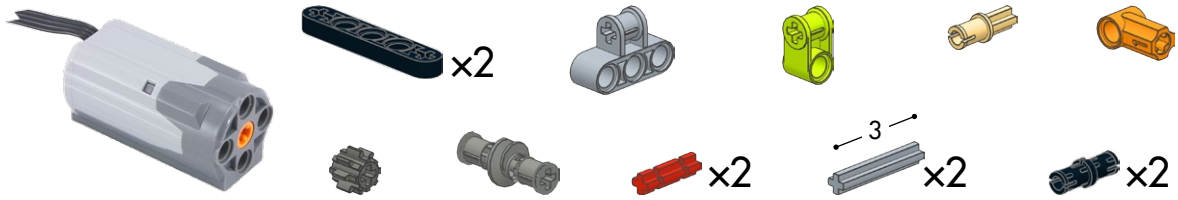

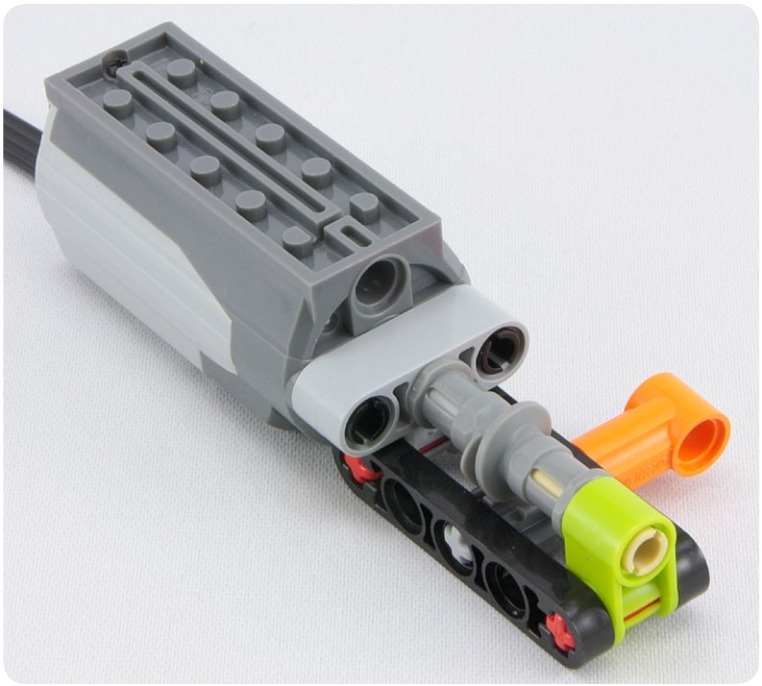

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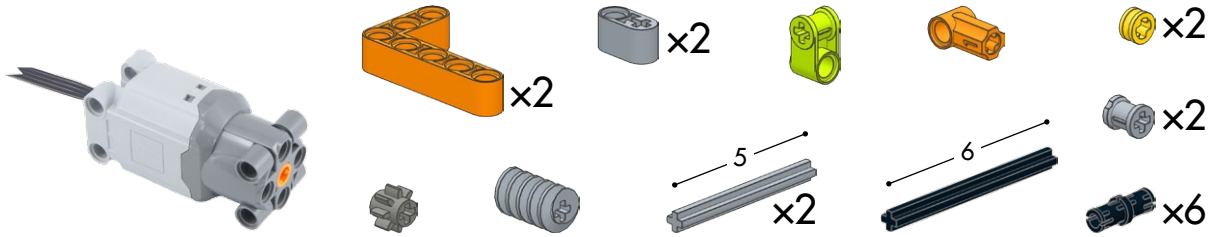

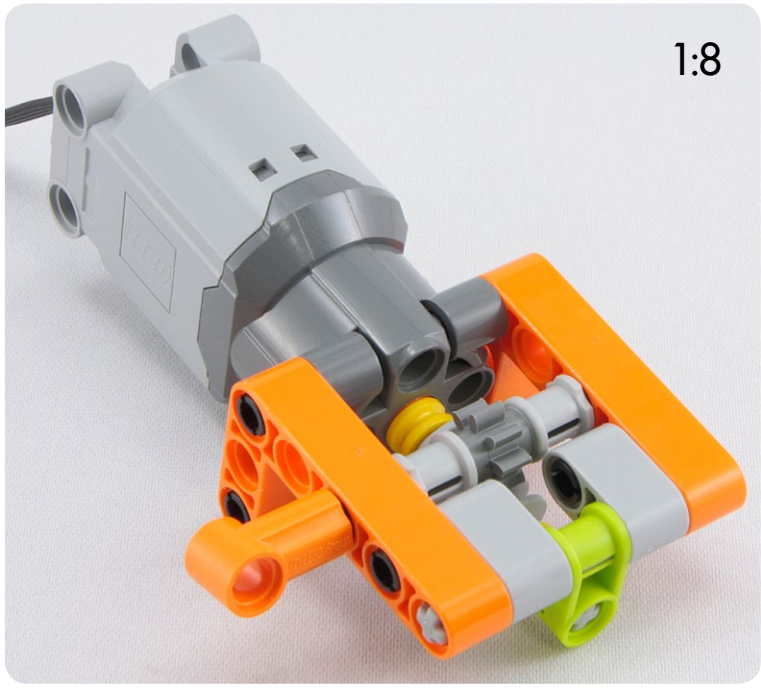

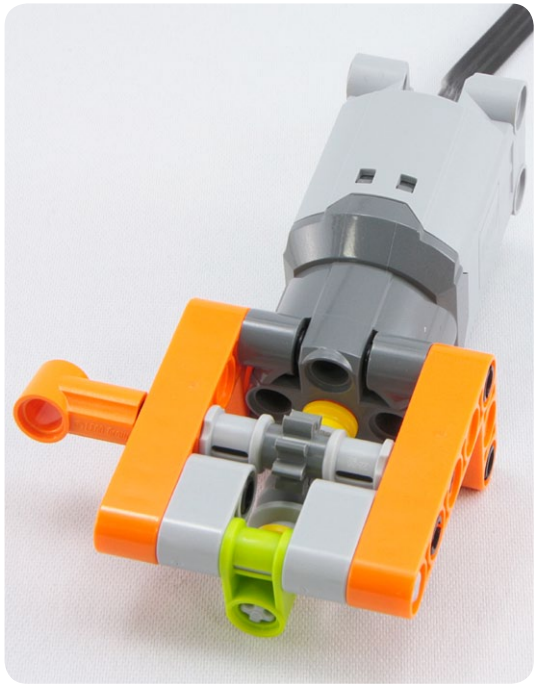

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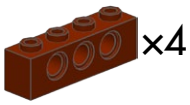





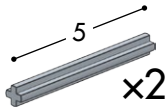

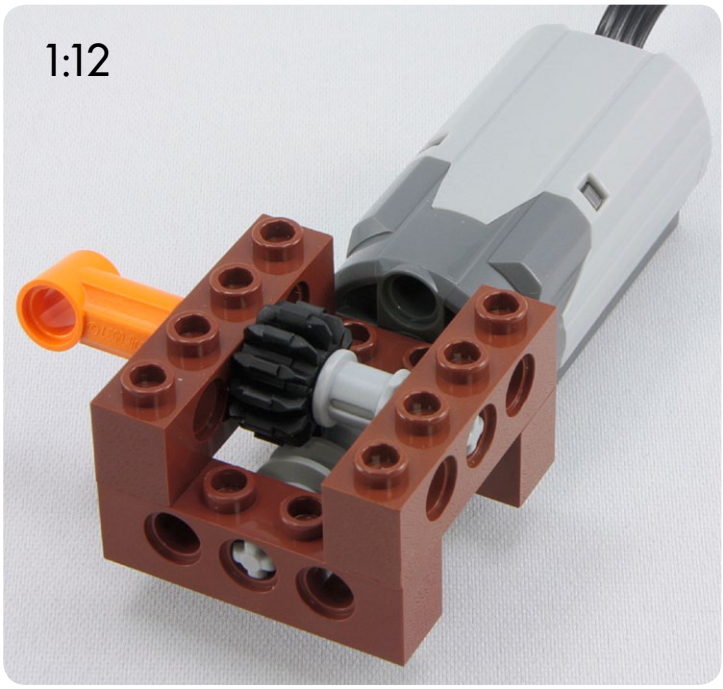

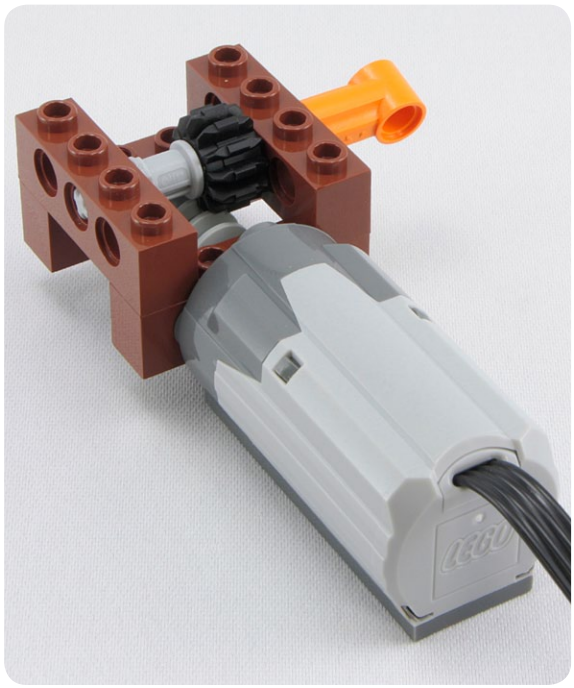

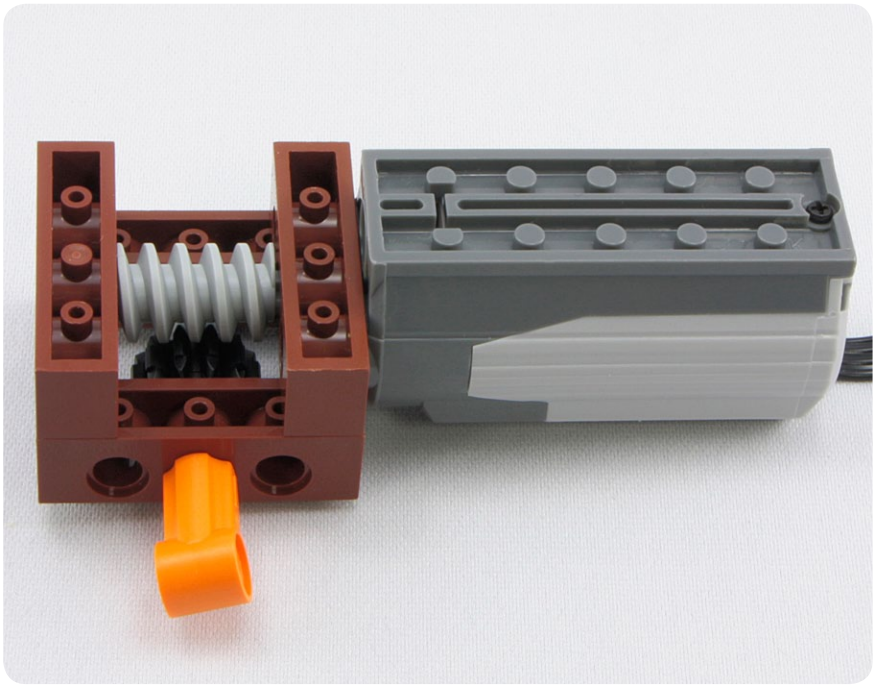

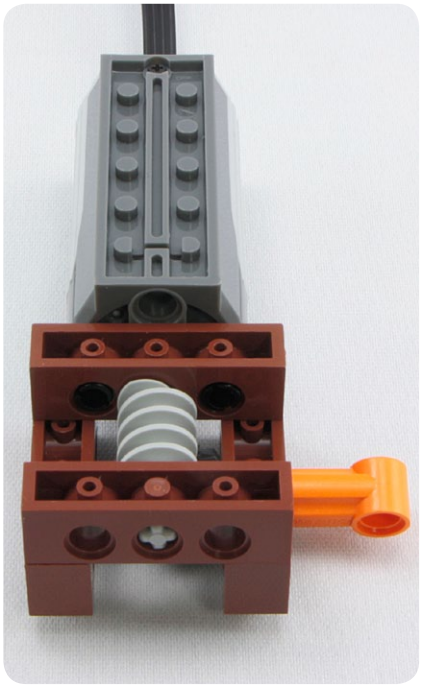

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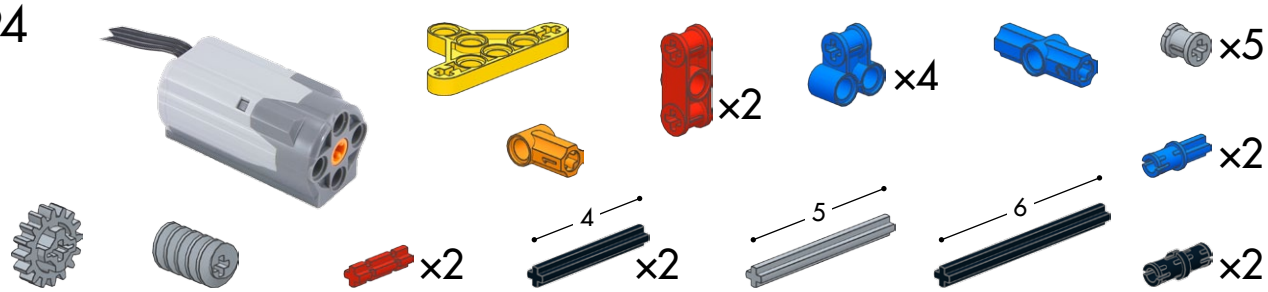

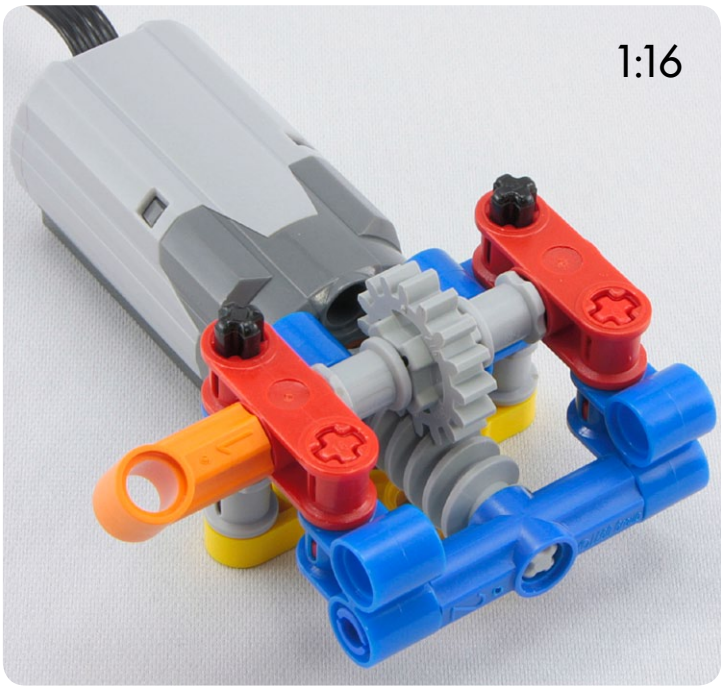

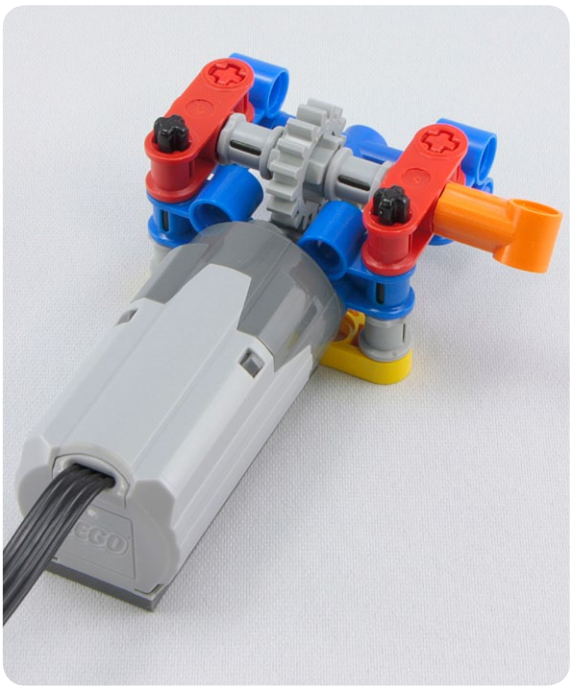

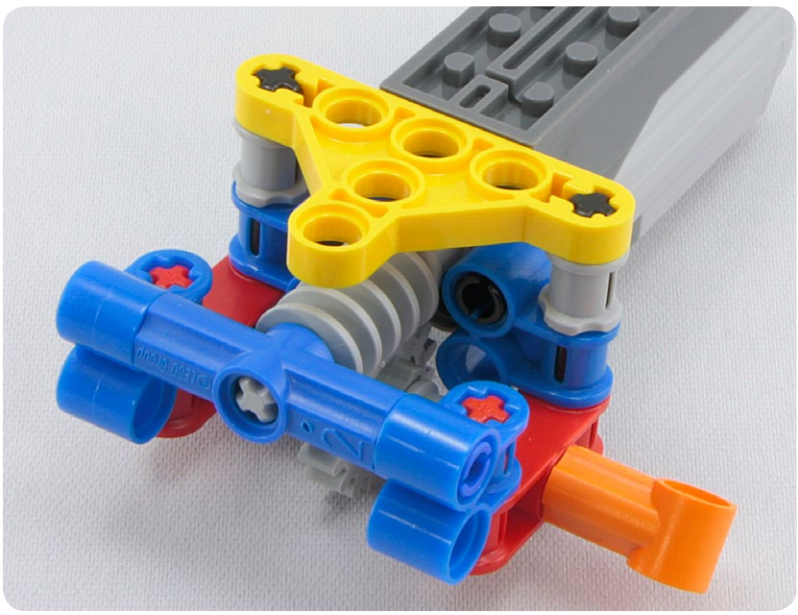

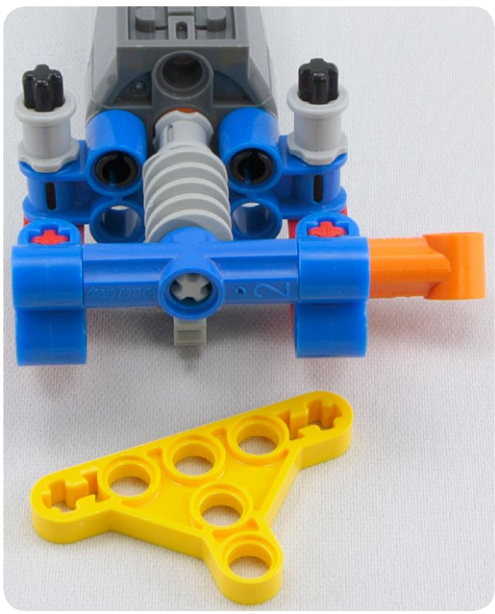

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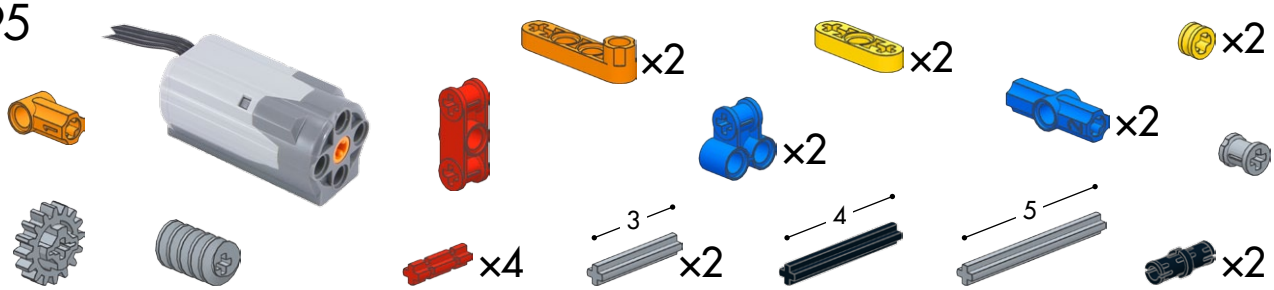

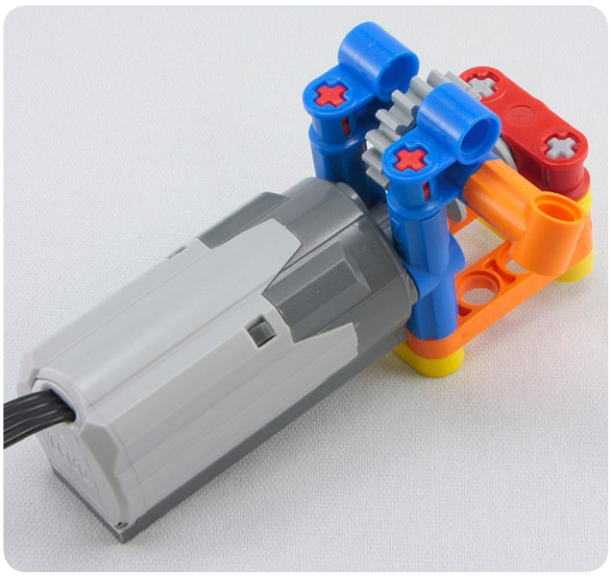

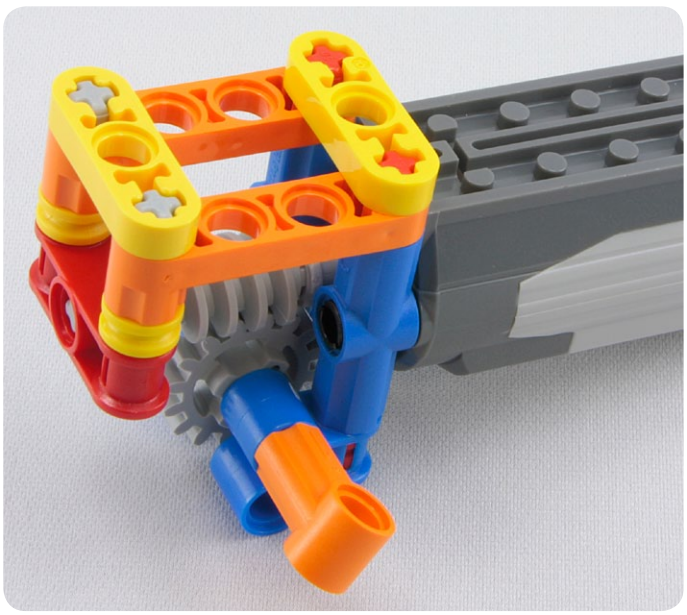

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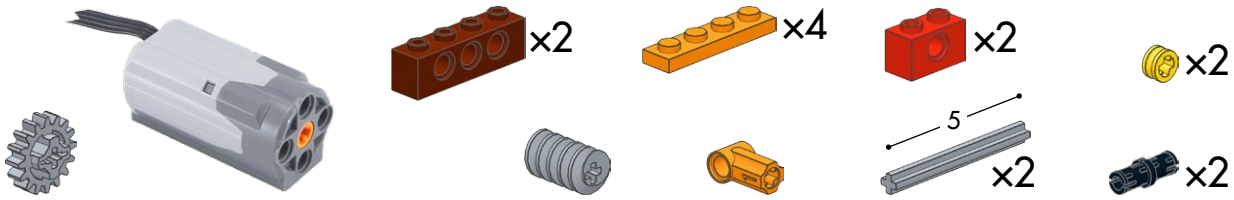

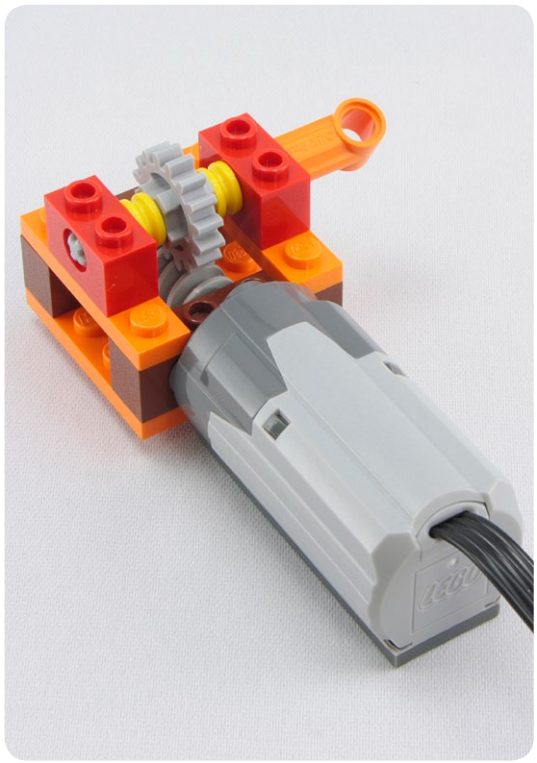

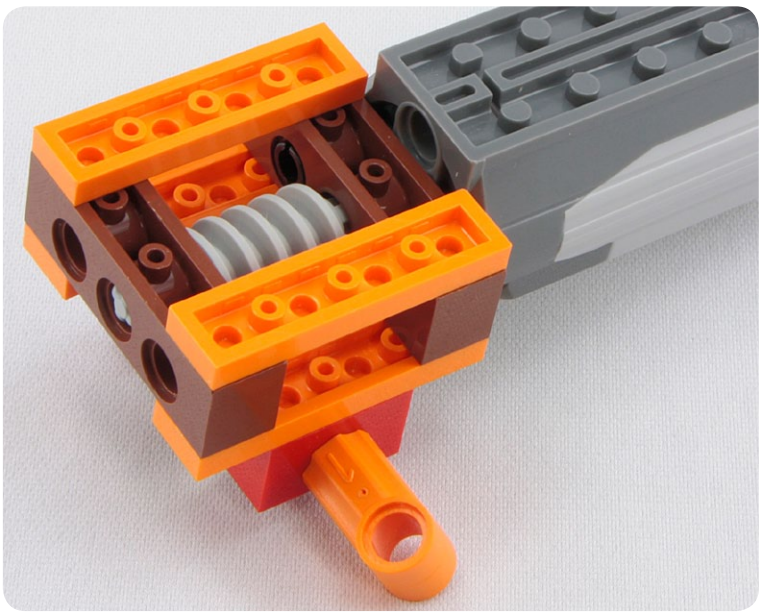

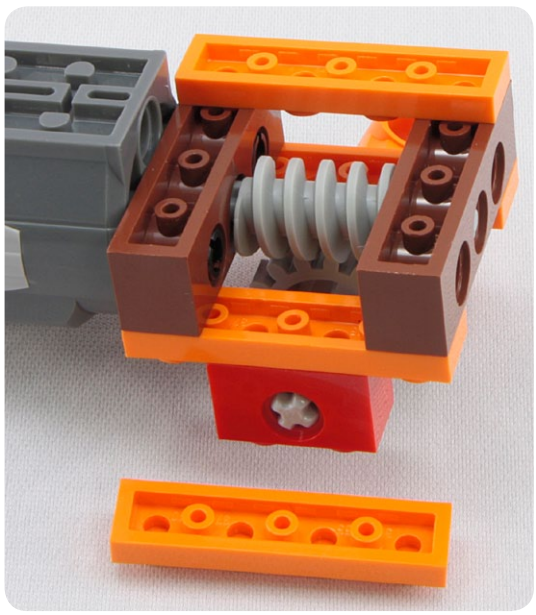

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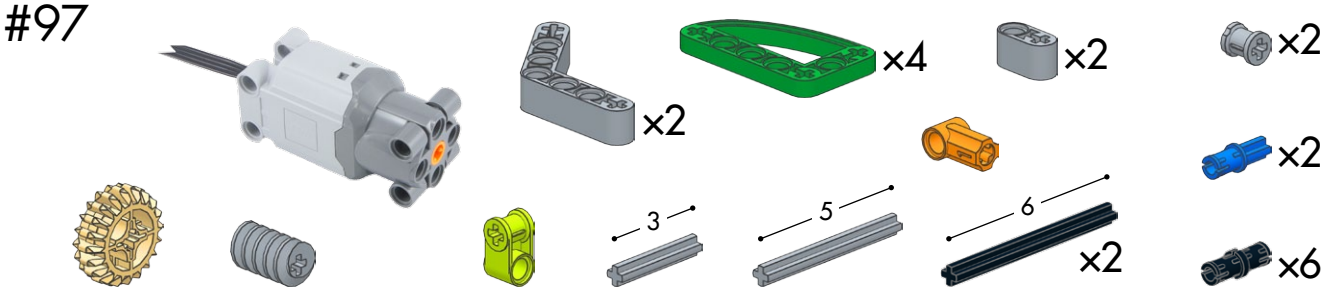

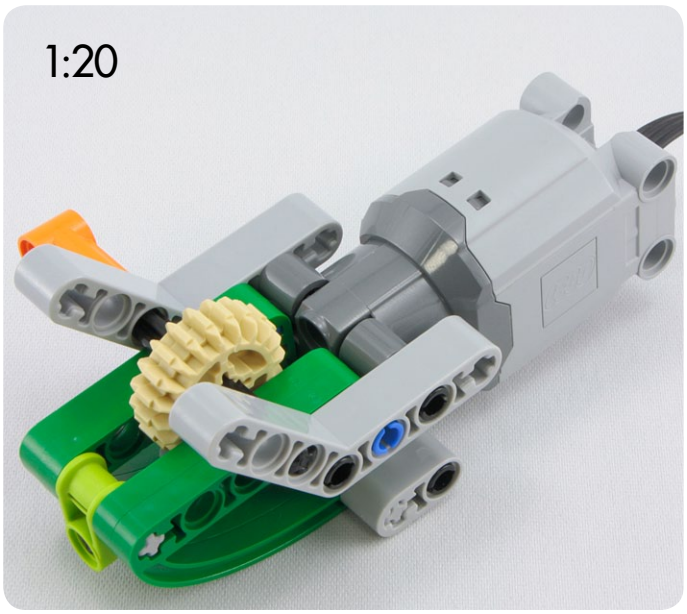

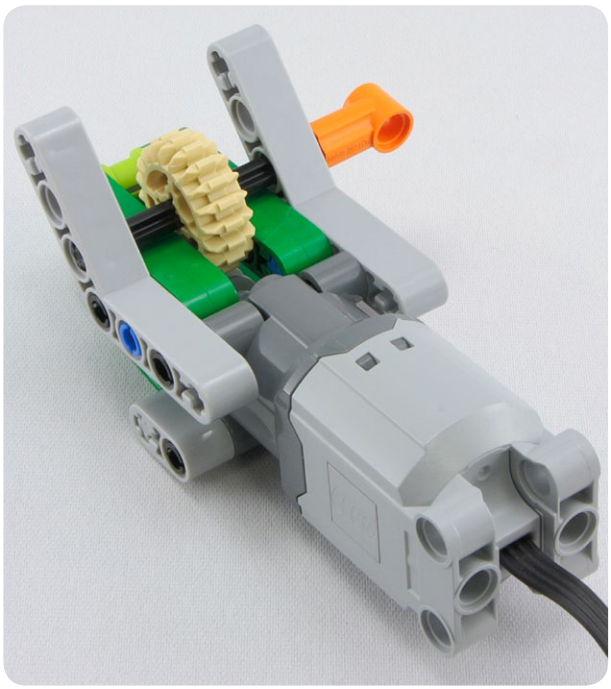

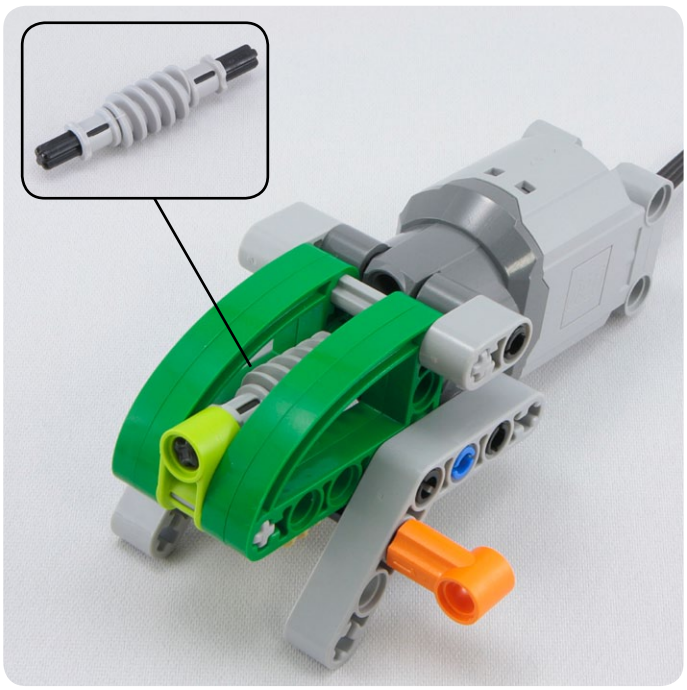

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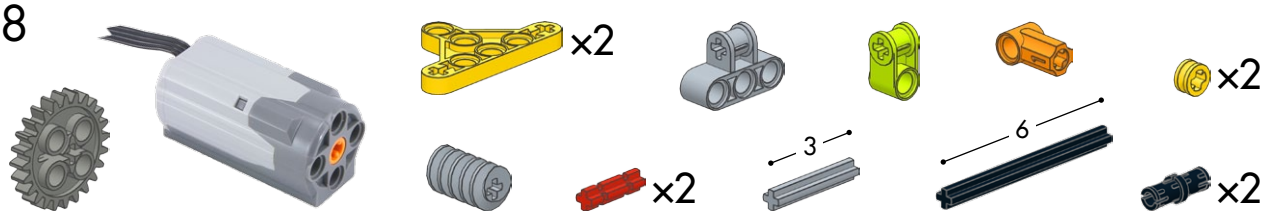

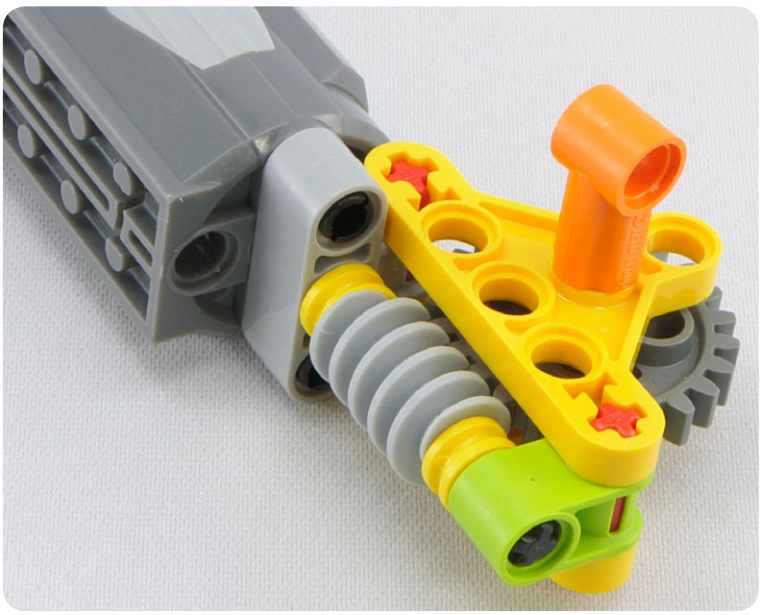

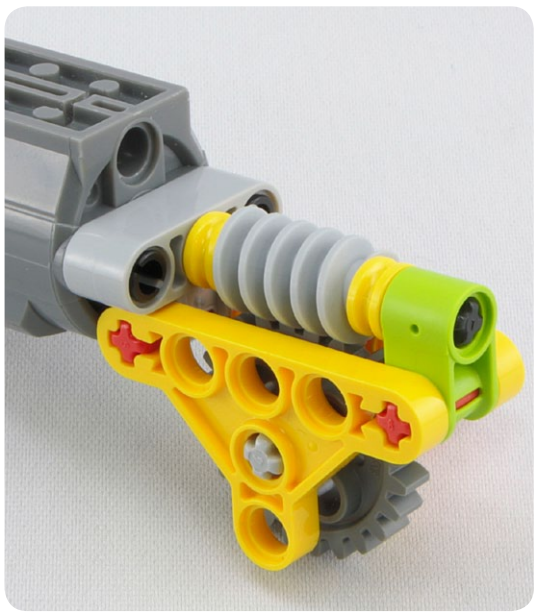

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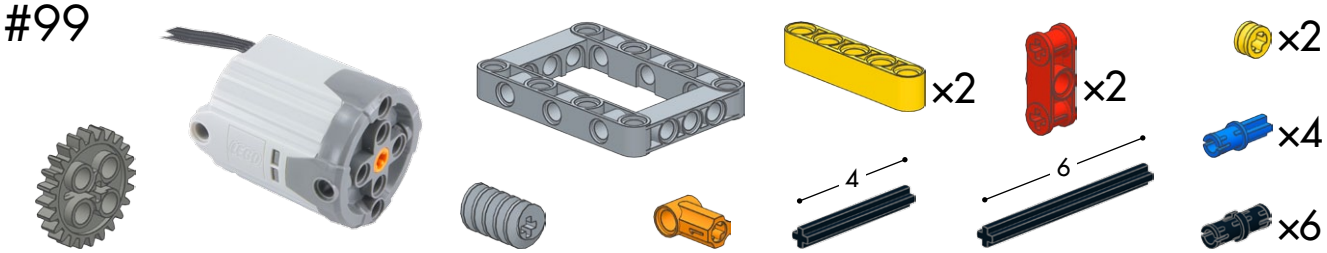

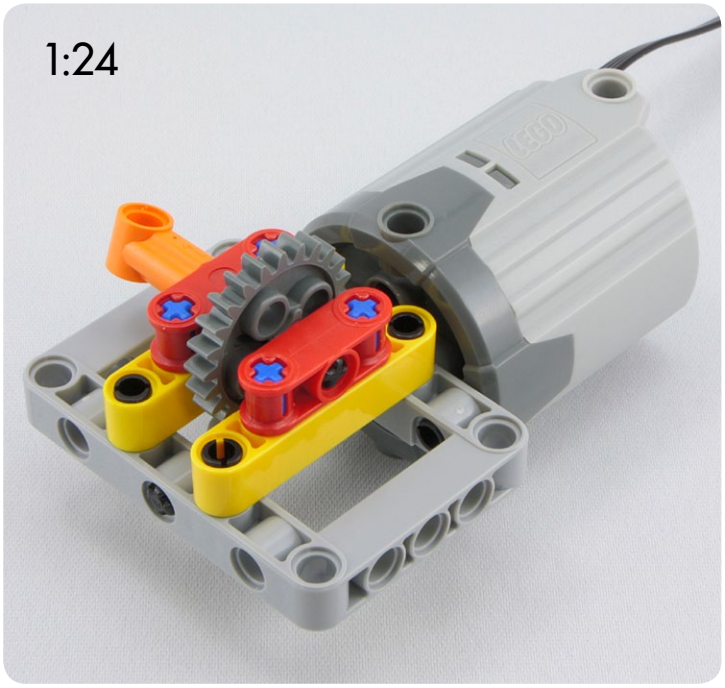

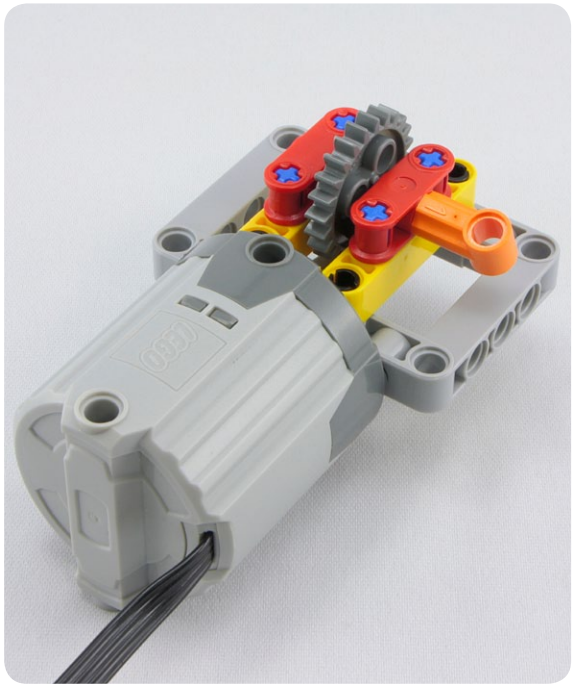

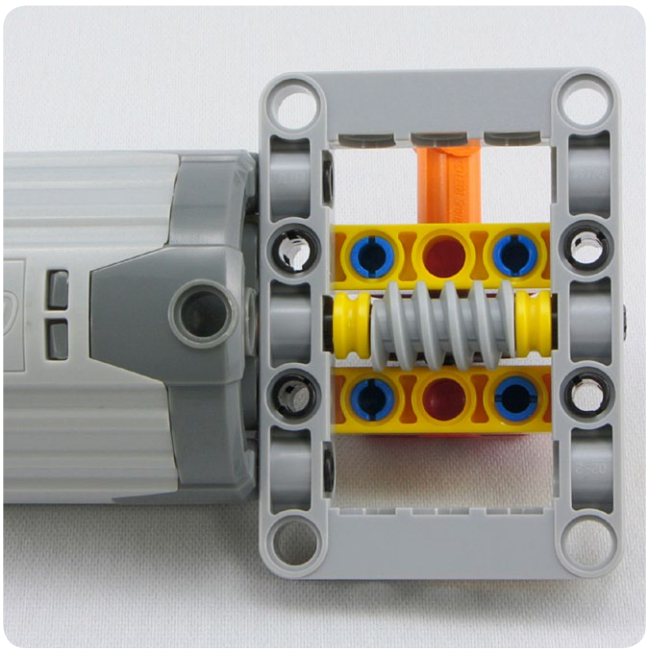

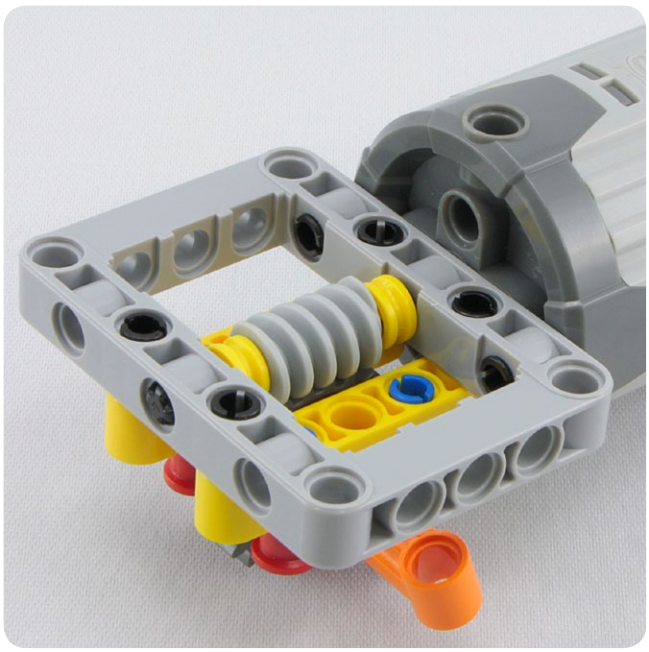

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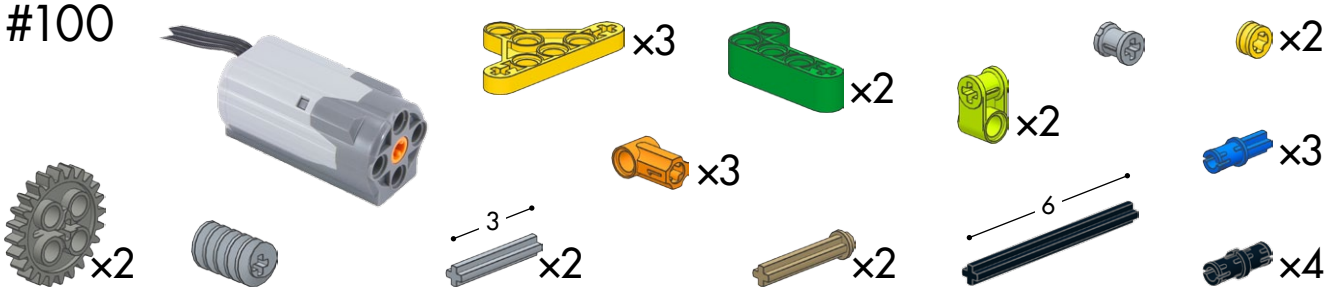

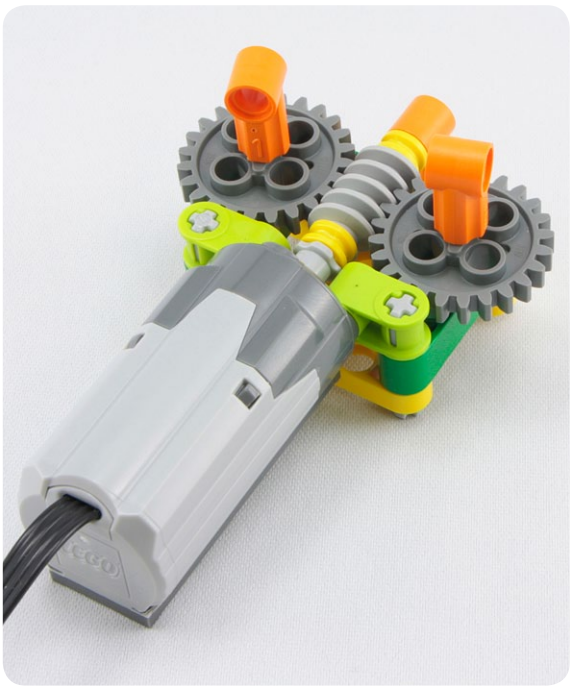

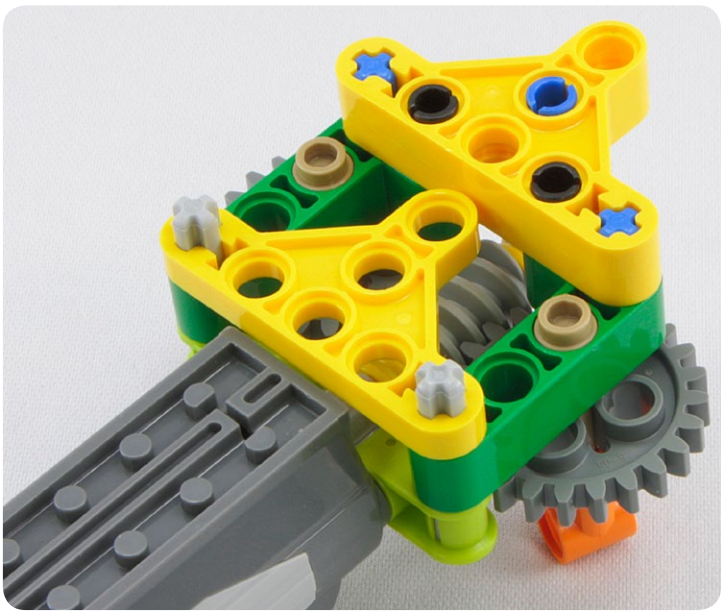

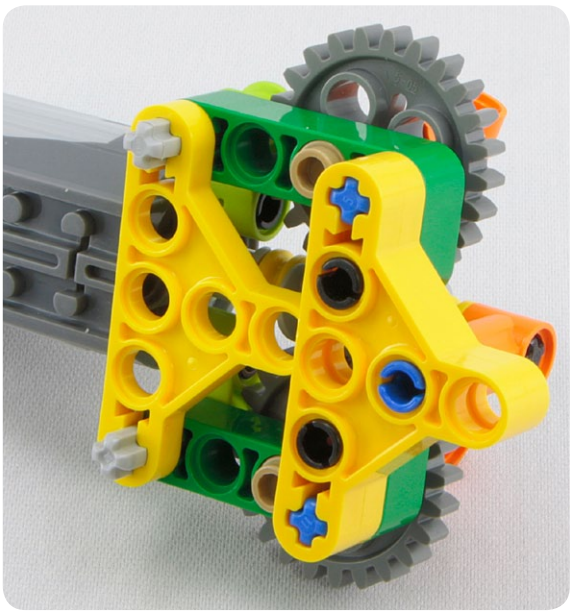

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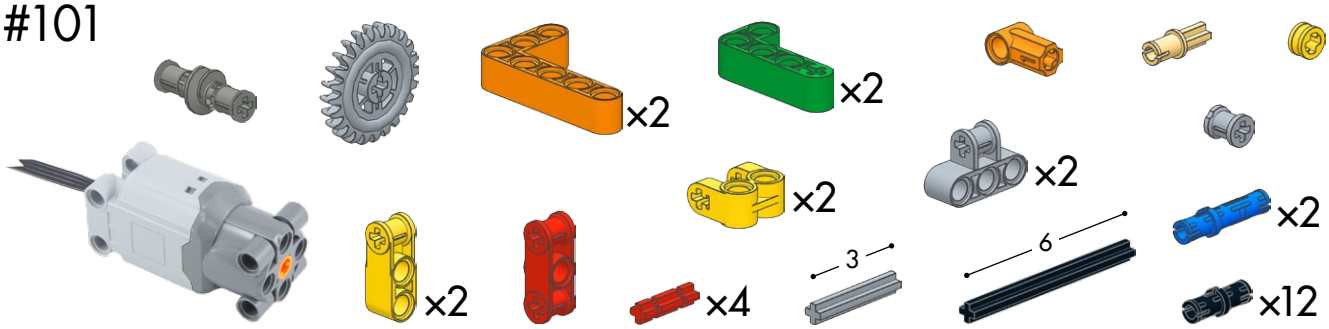

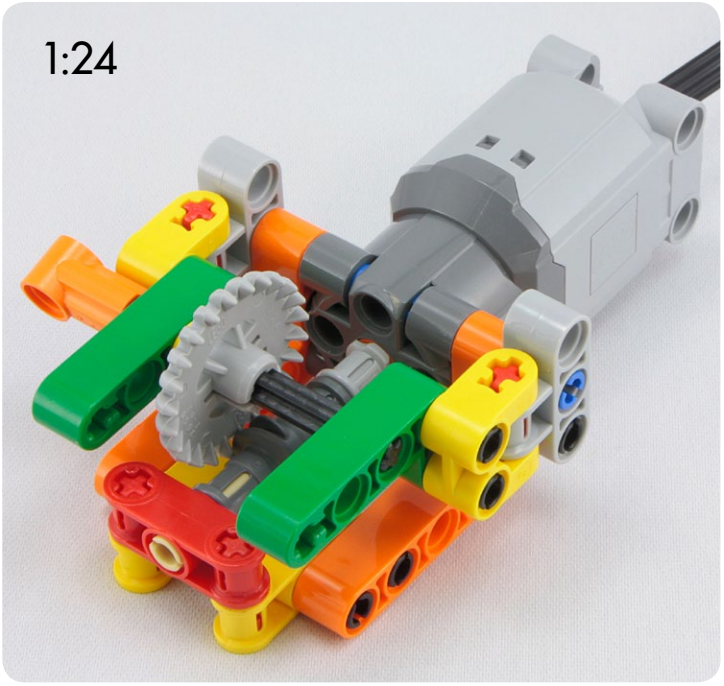

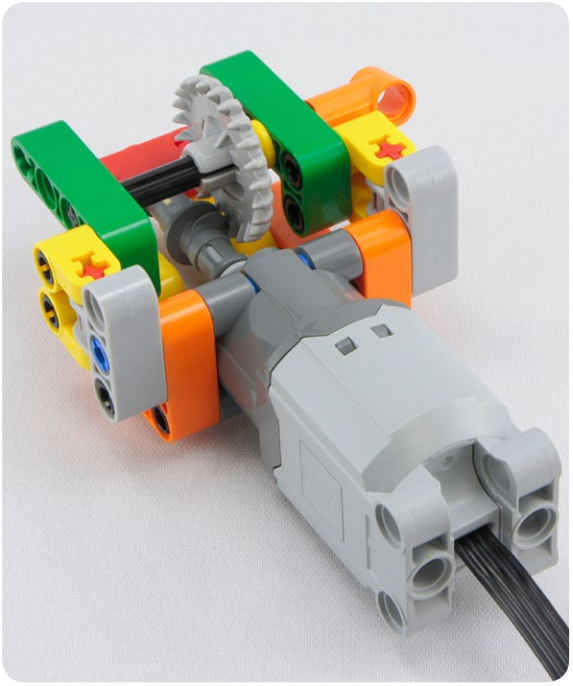

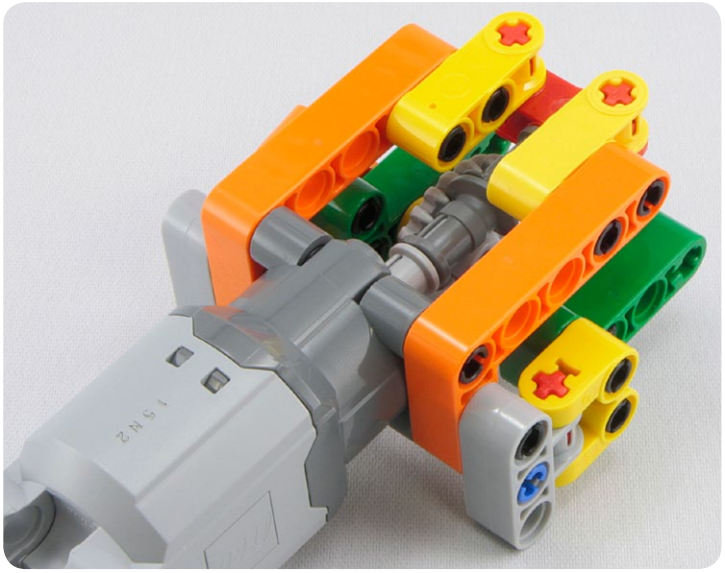

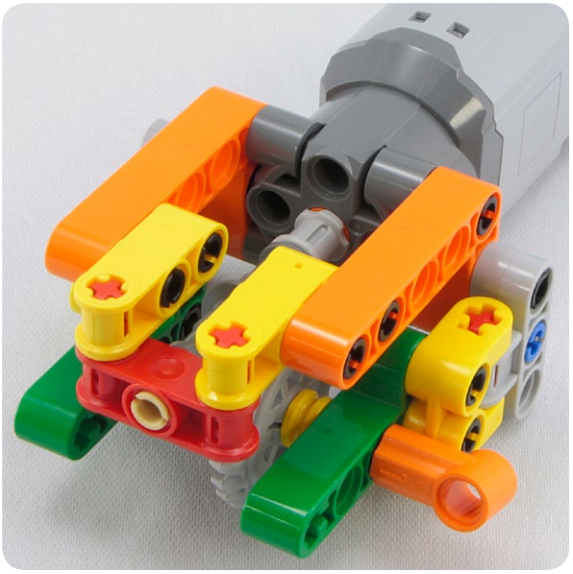

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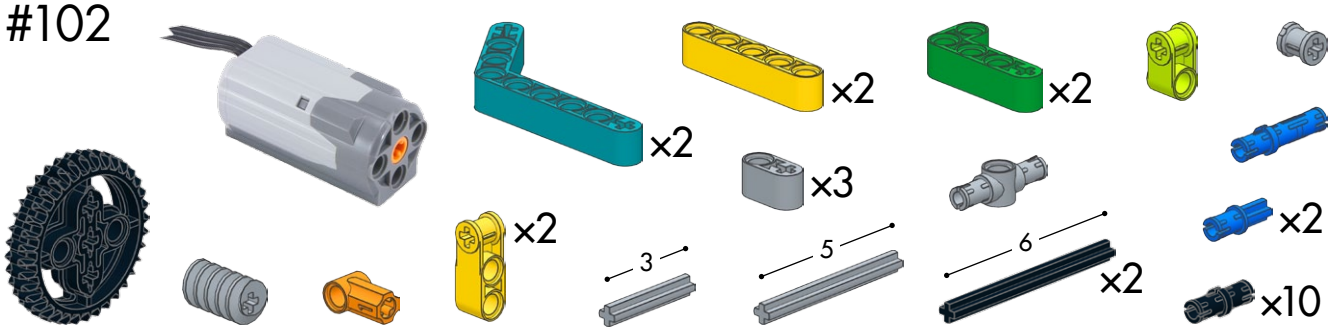

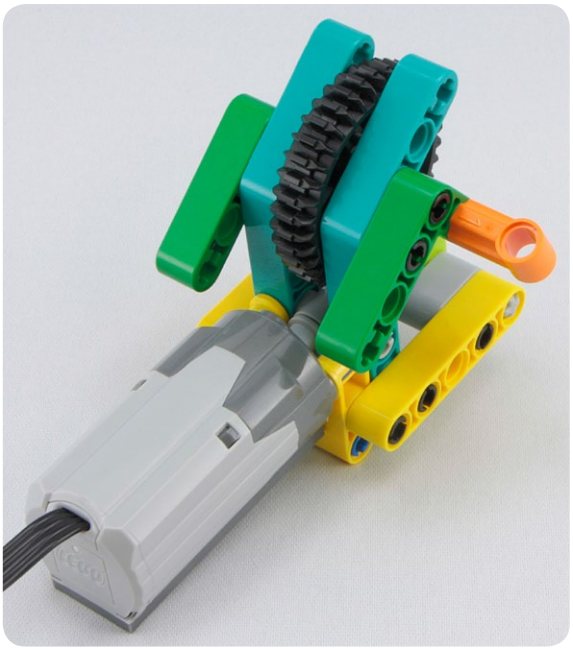

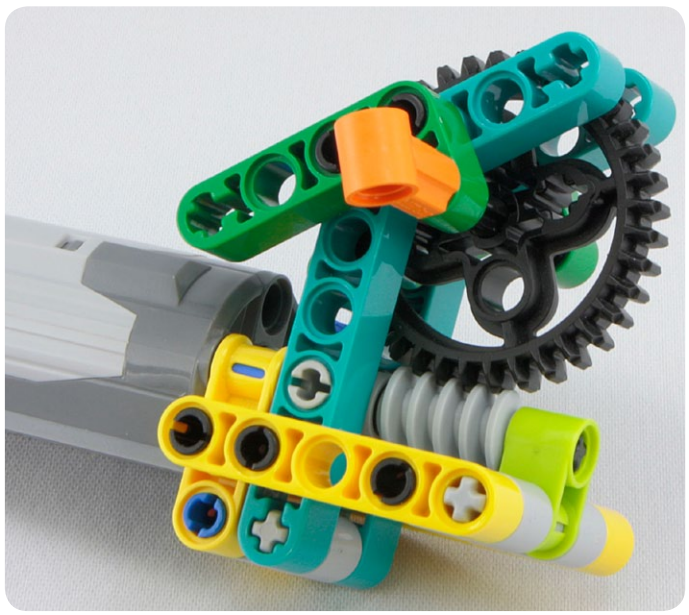

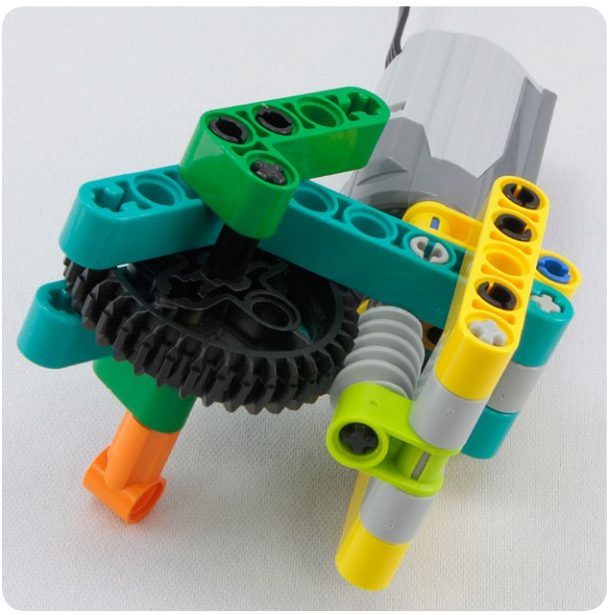

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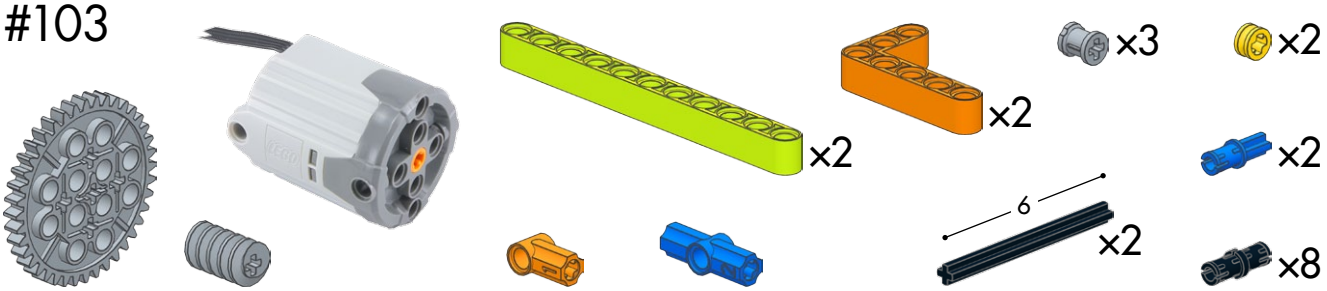
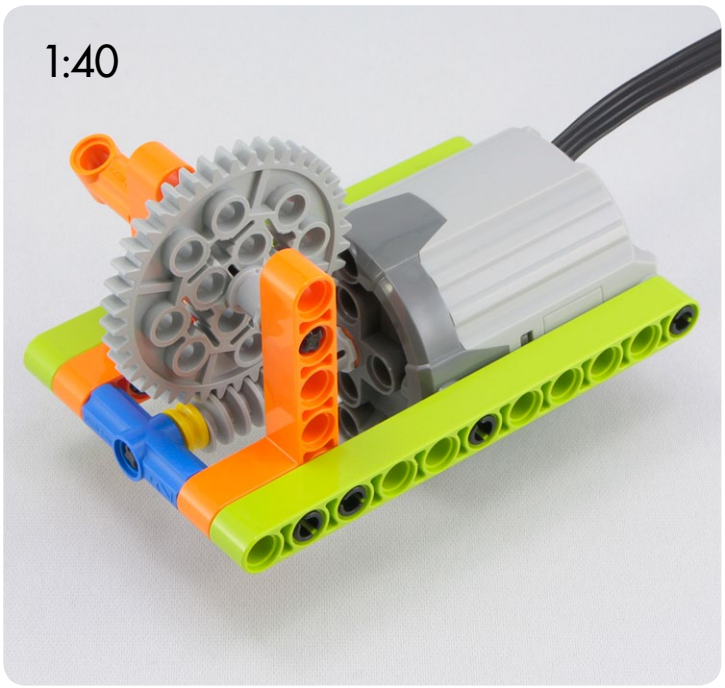
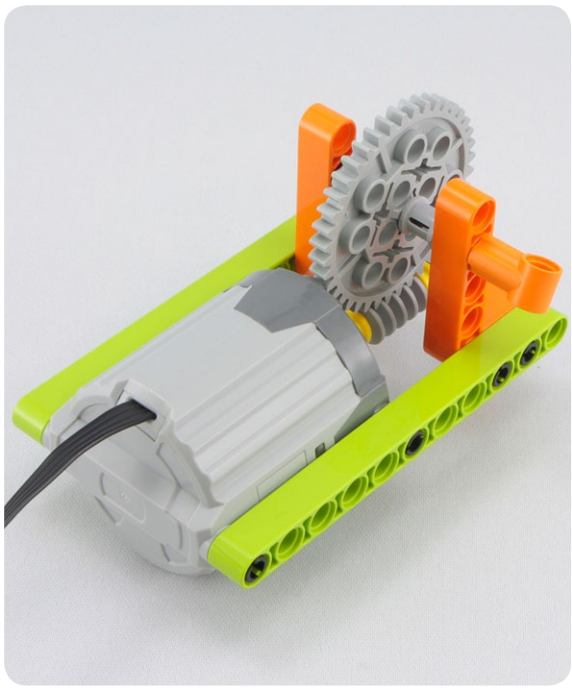
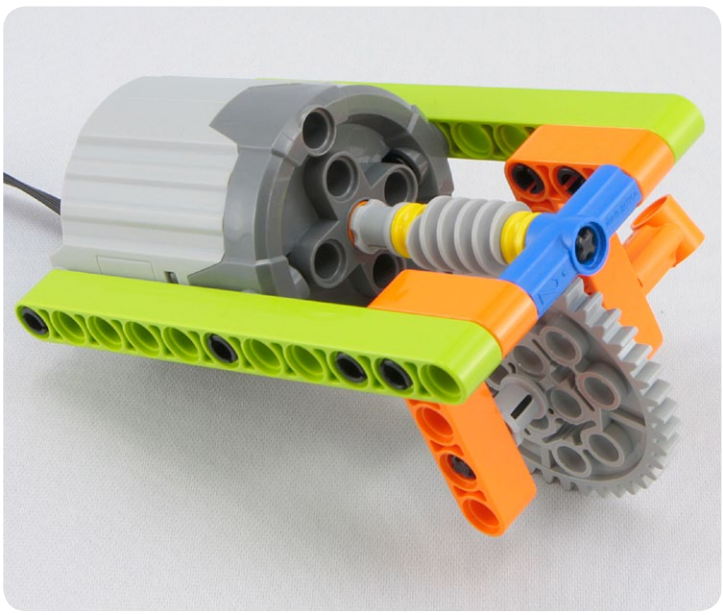
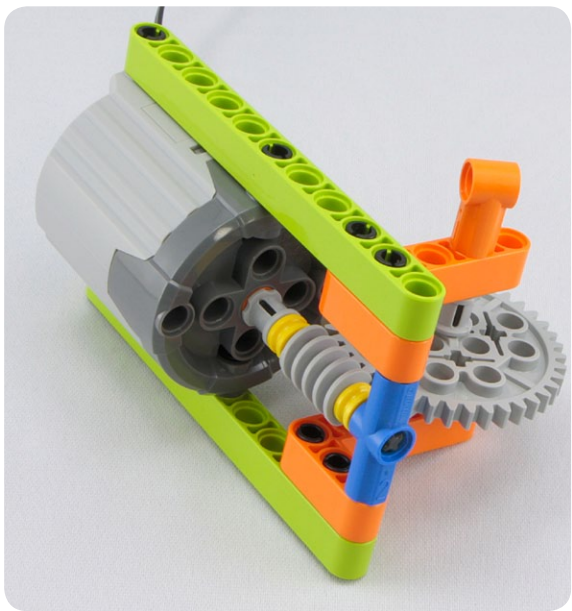




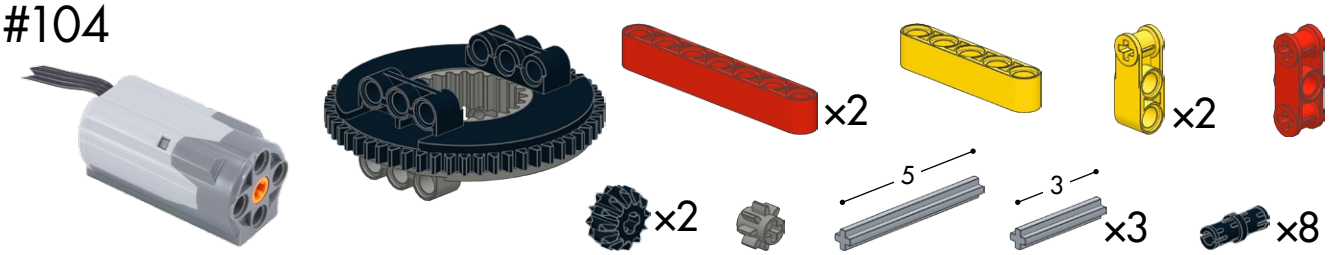


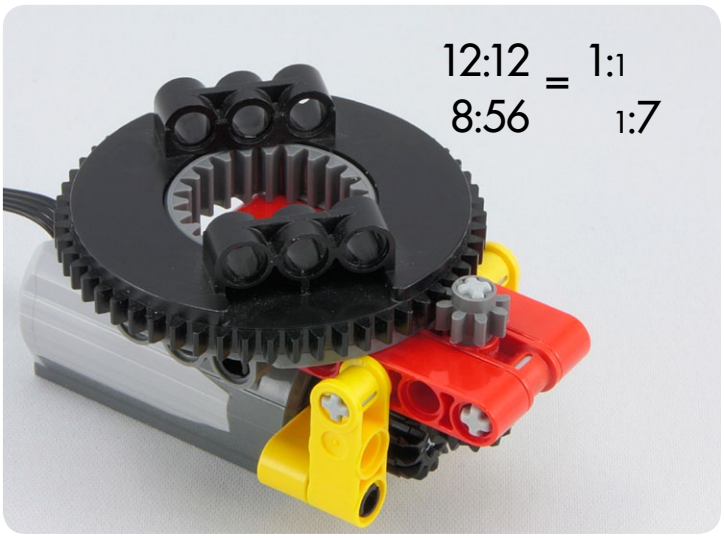


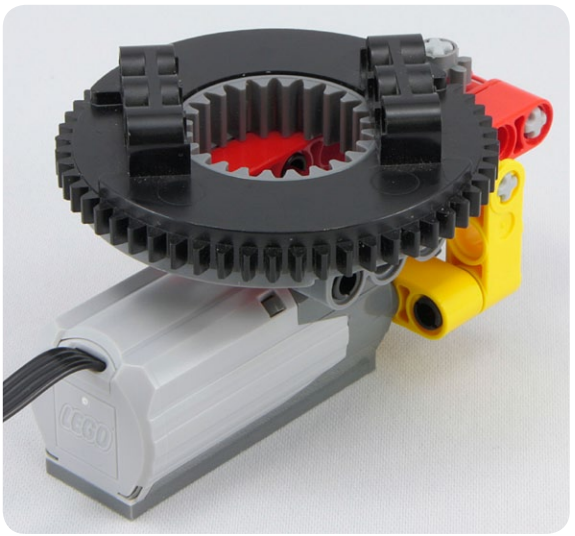


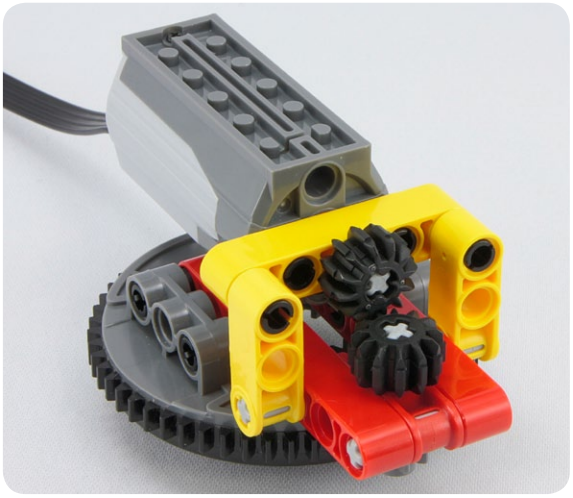
Using turntables

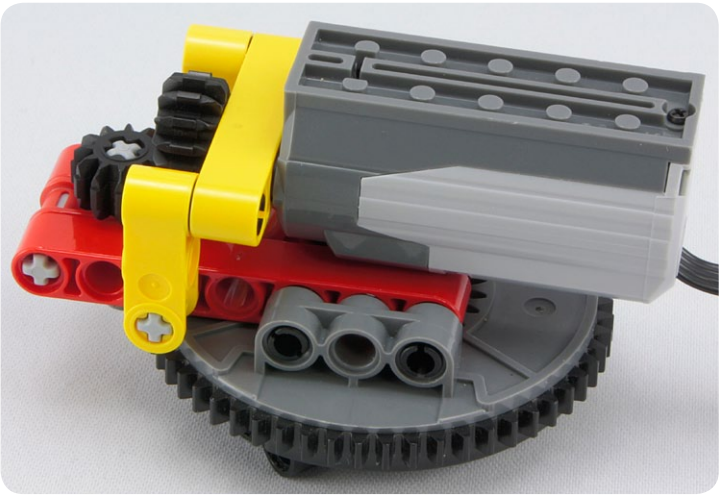
#104











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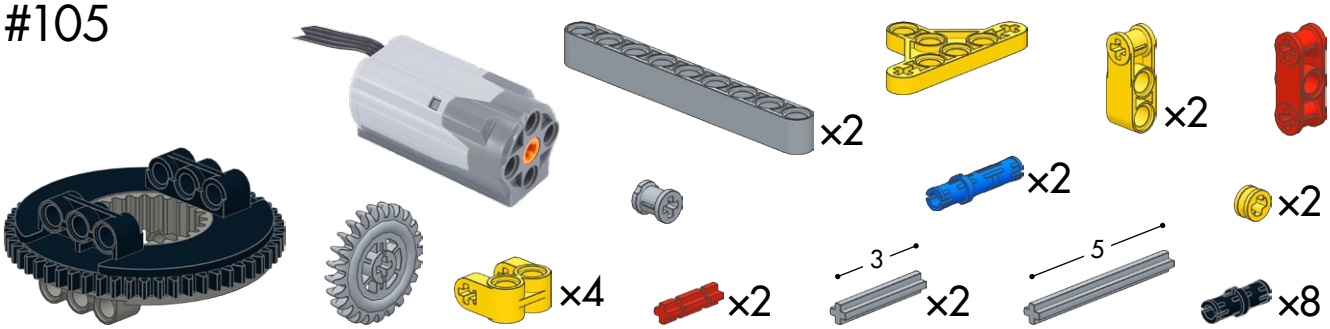

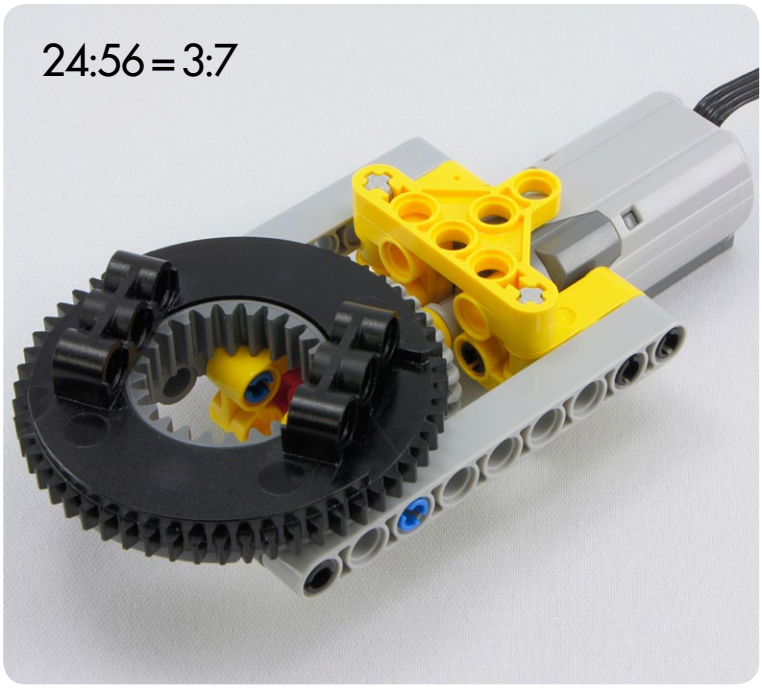

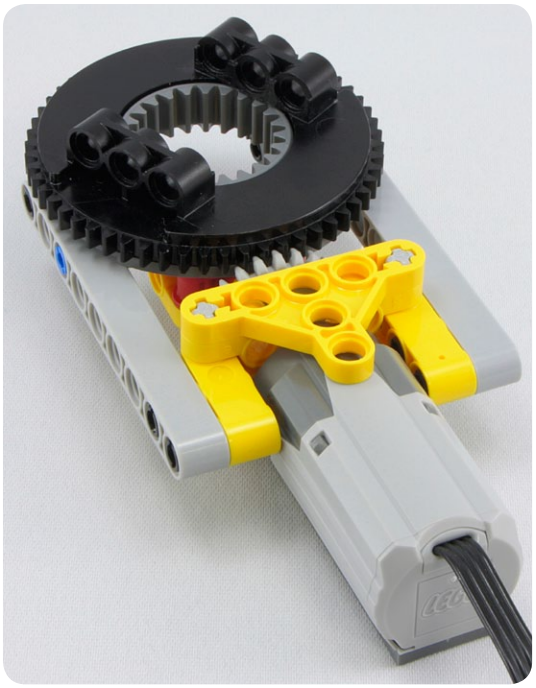

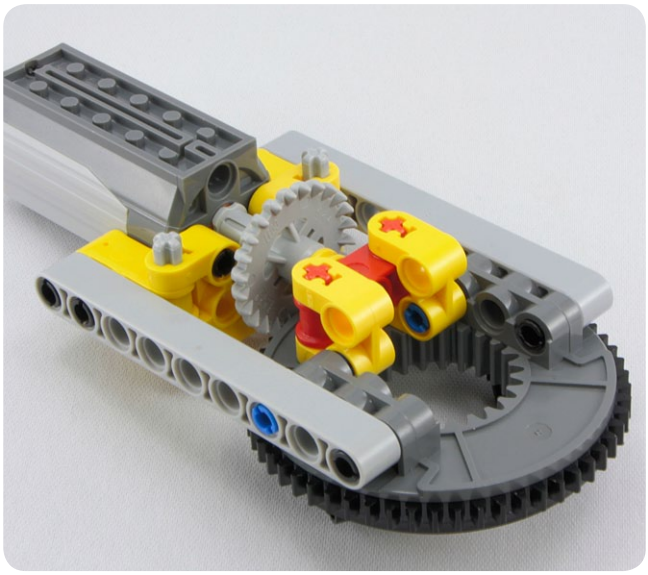

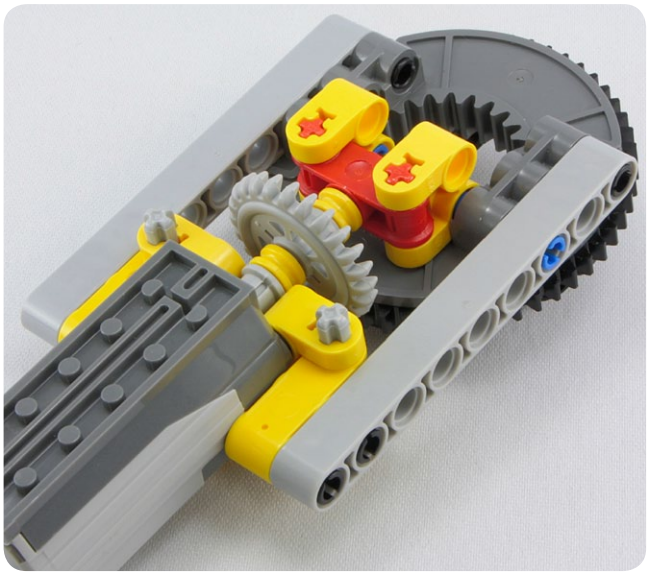

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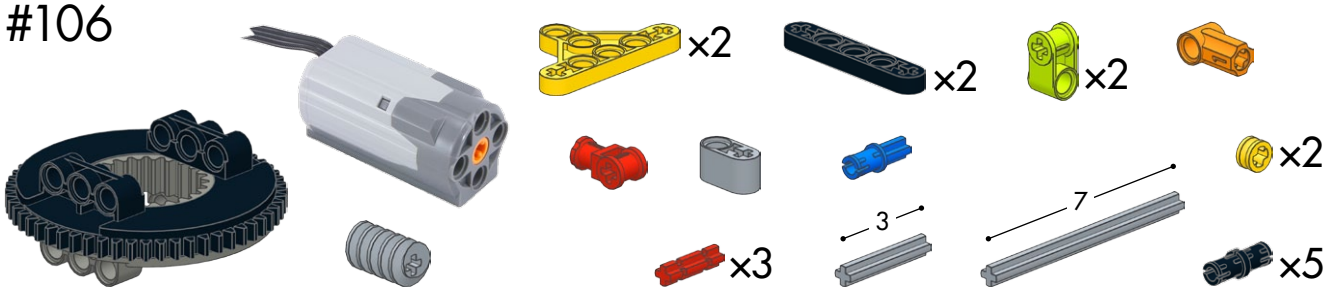

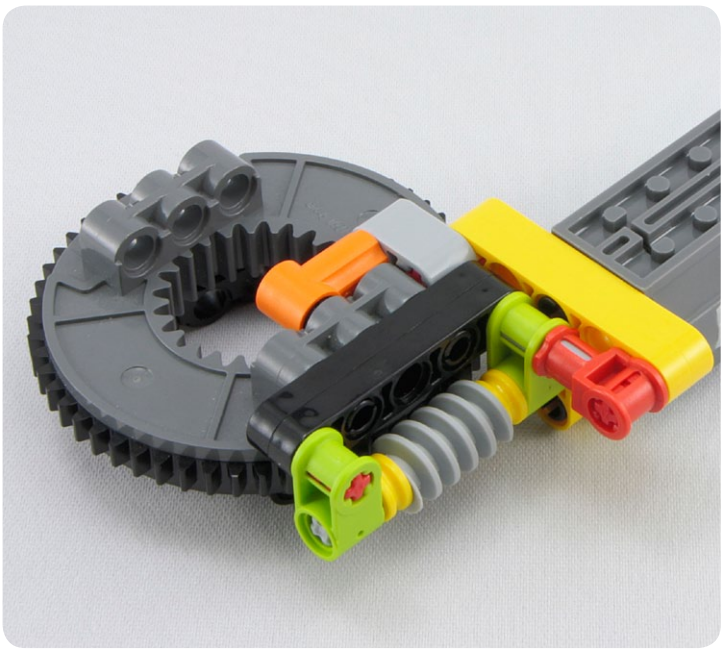

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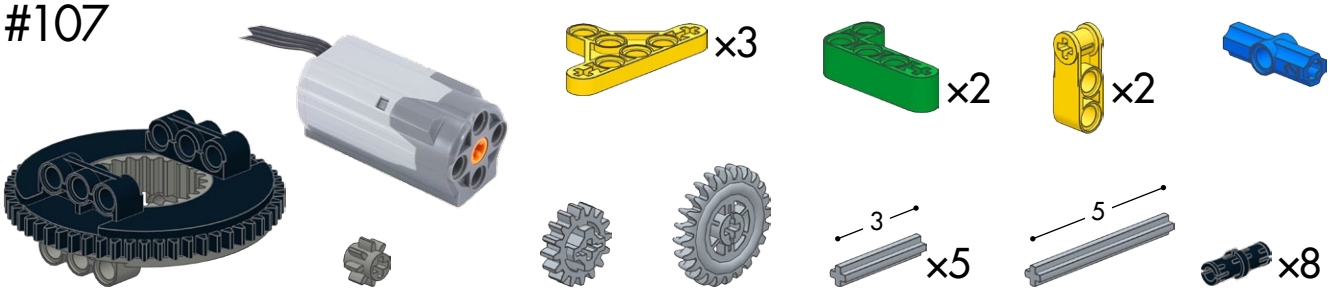

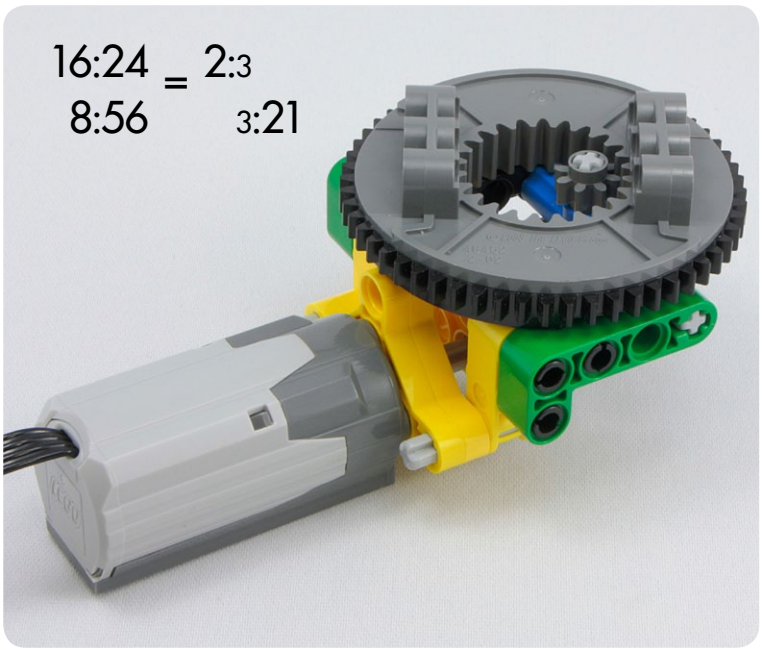

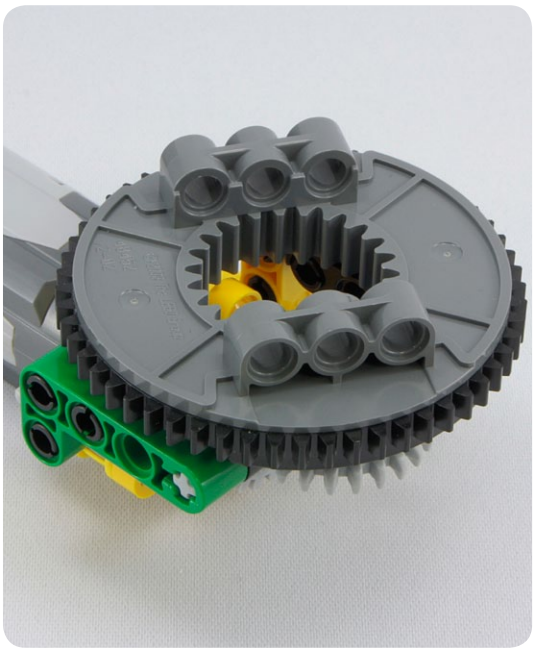

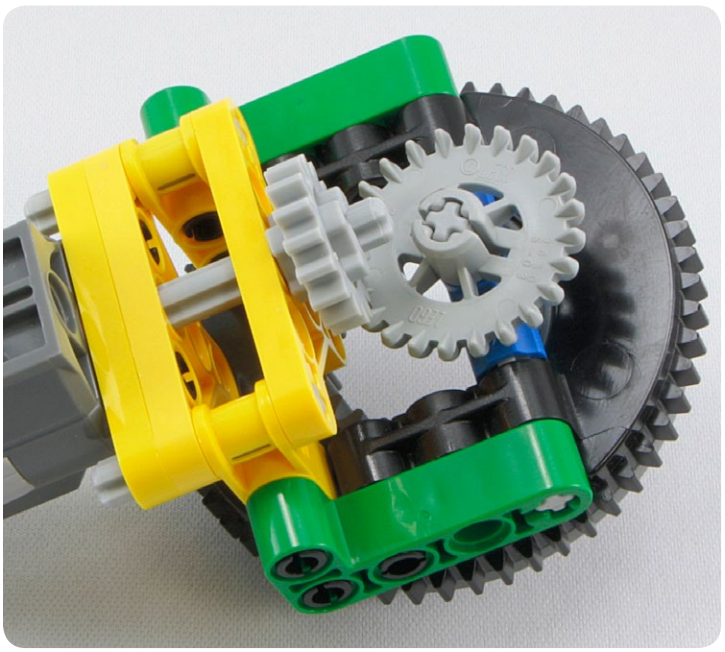

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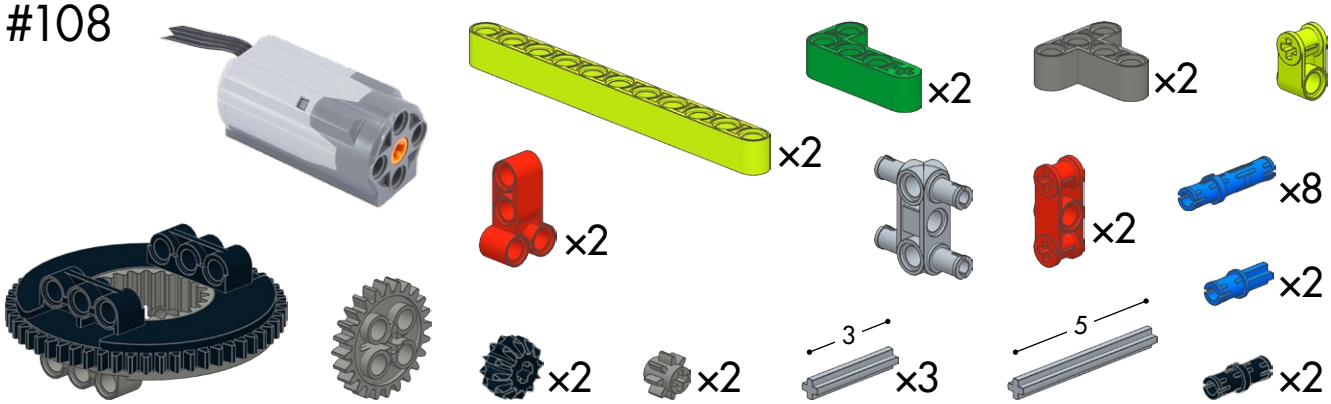

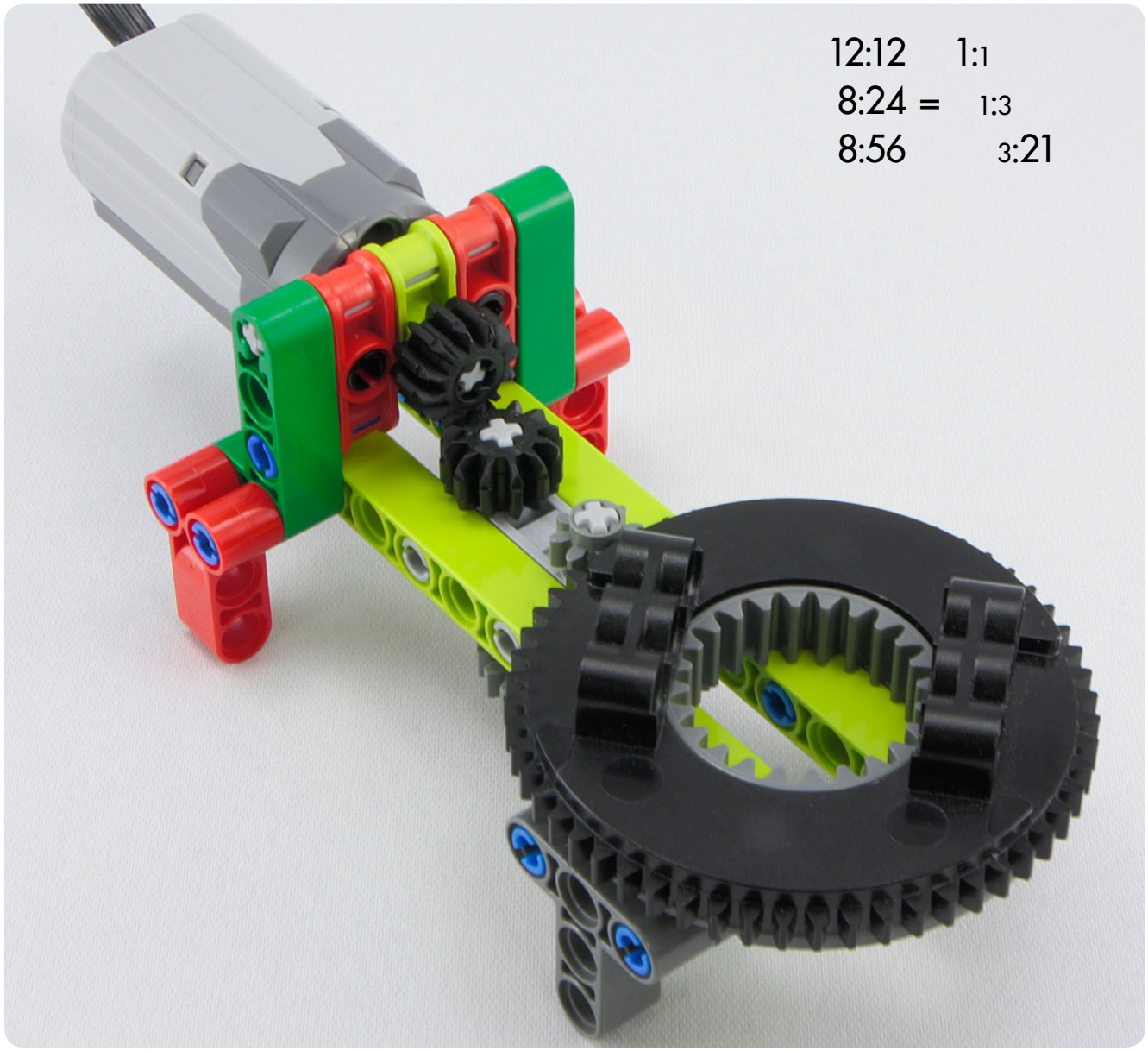

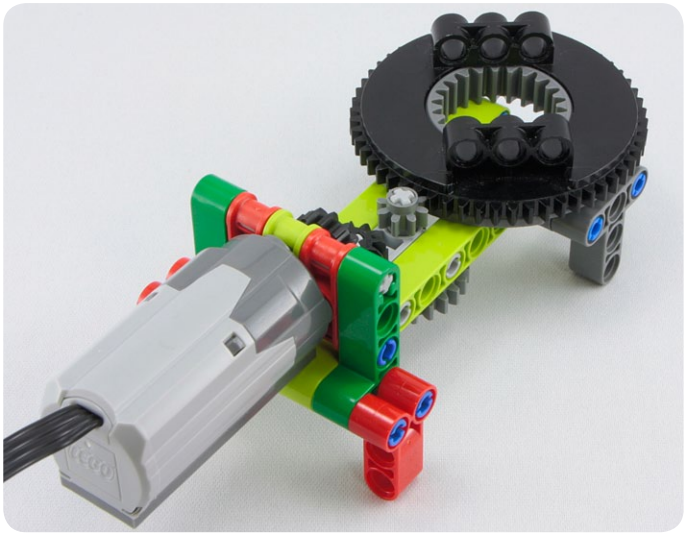

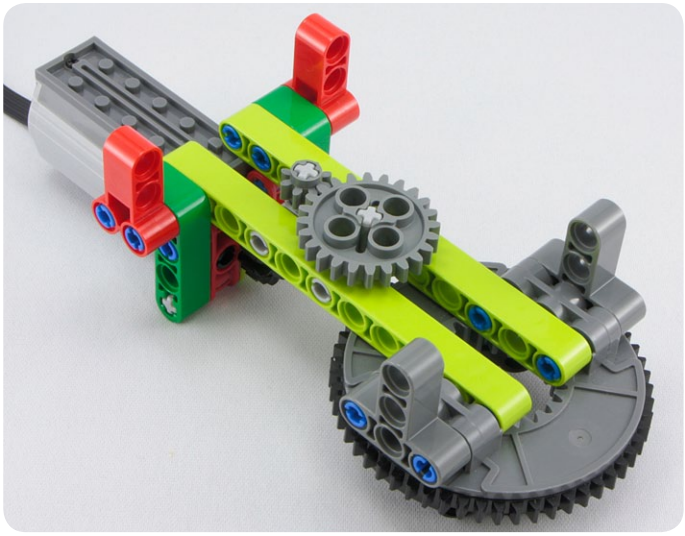

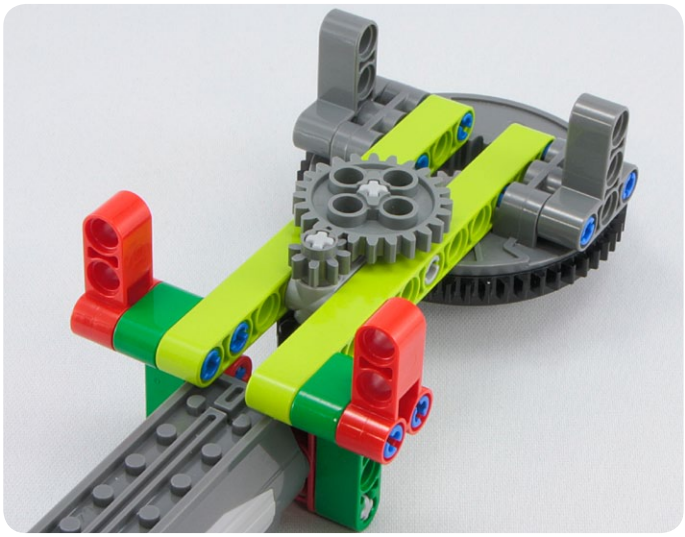

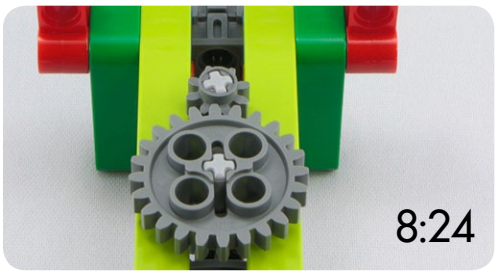
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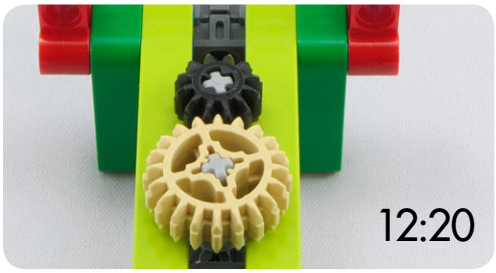
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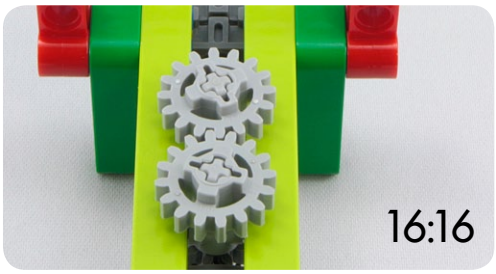
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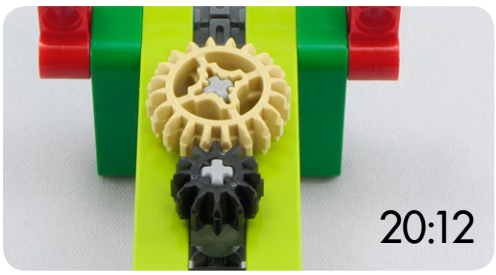
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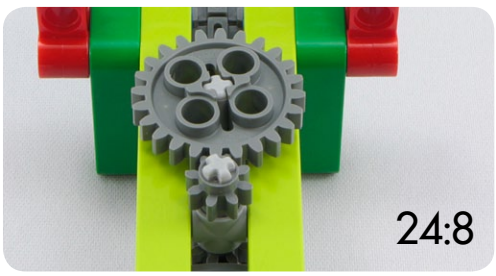
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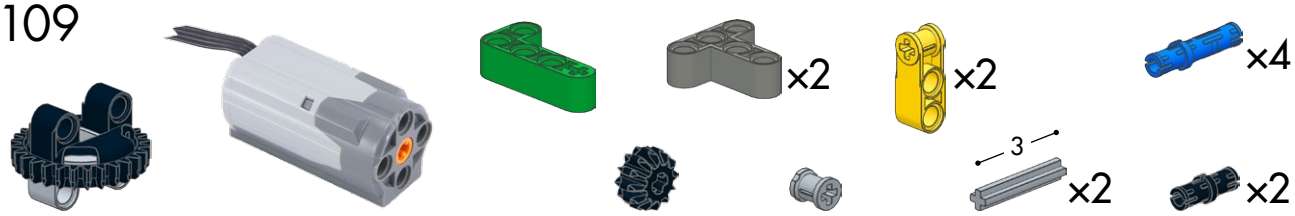

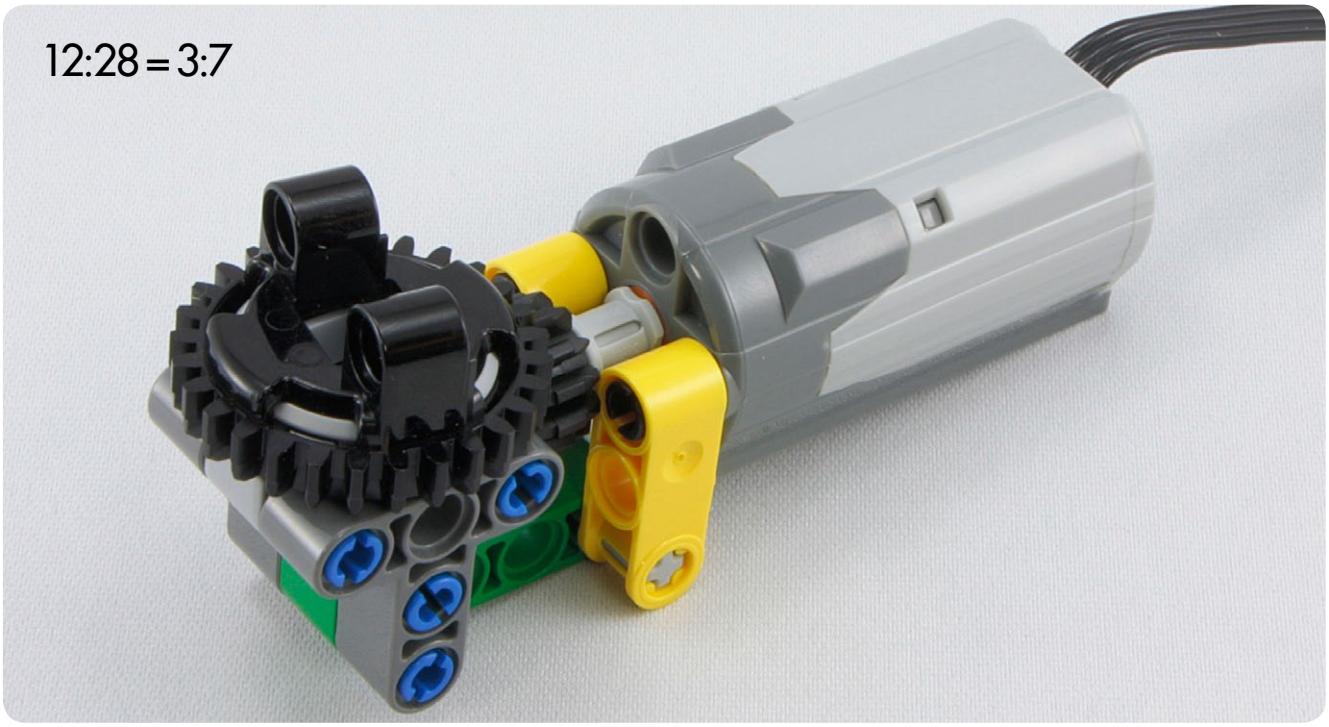

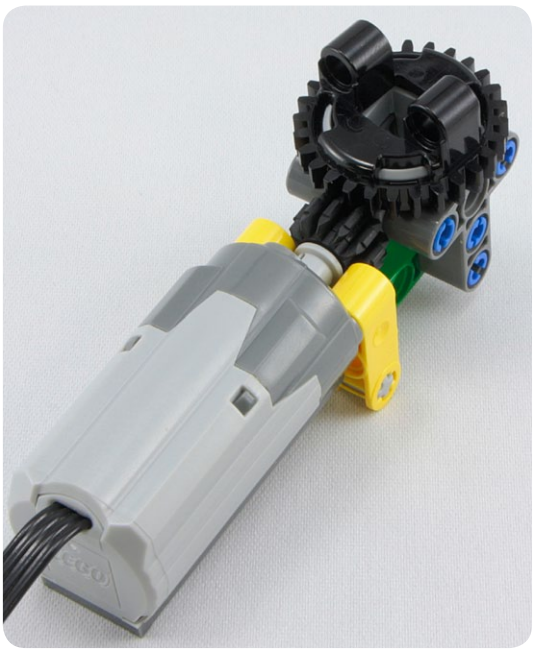

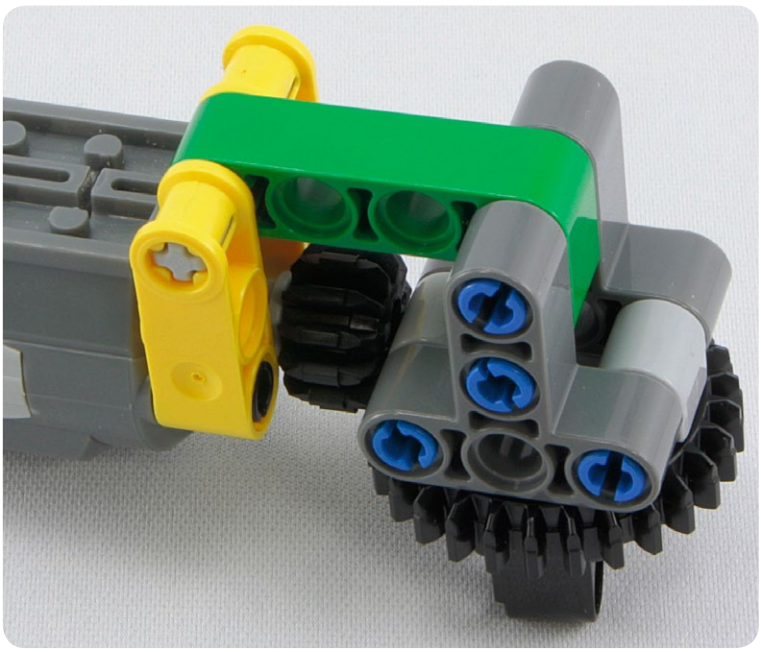

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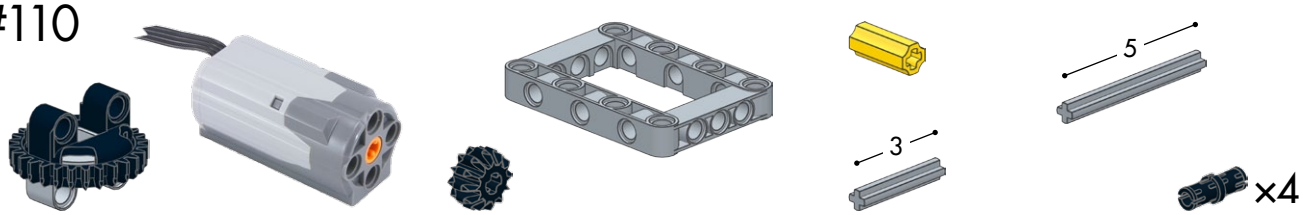

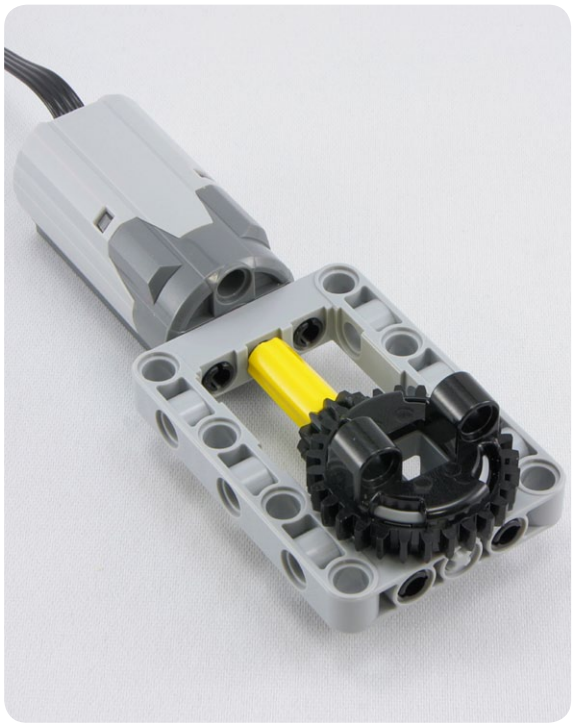

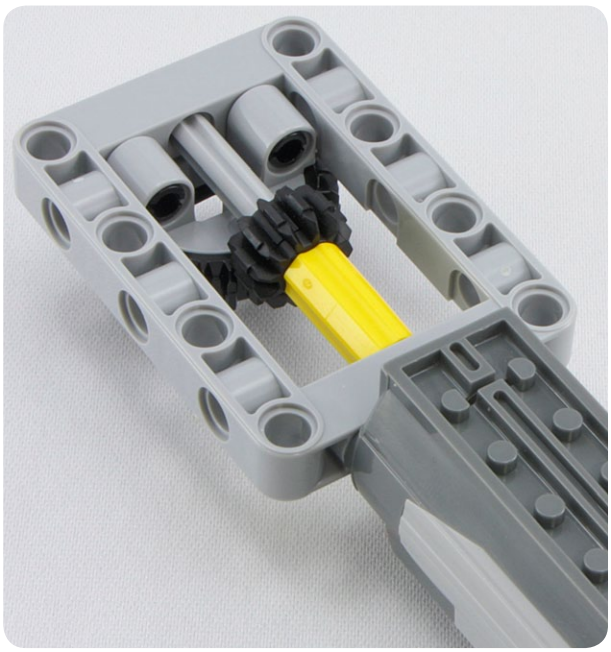

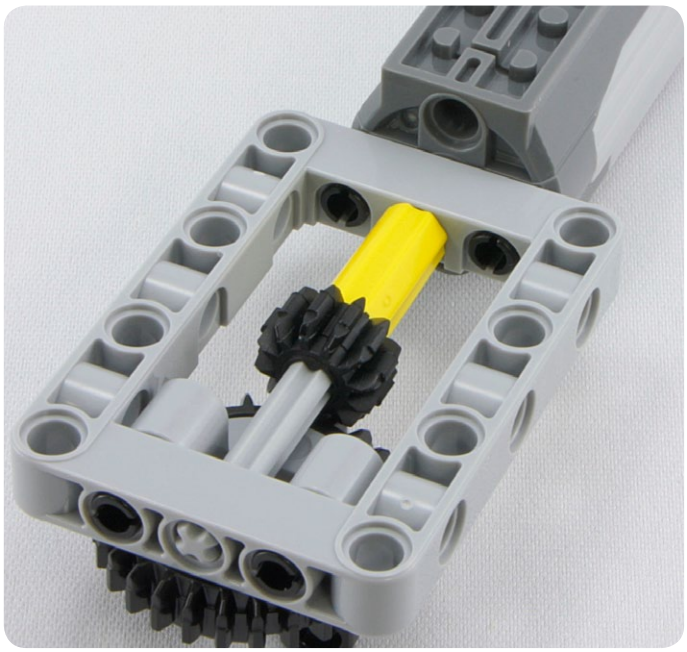

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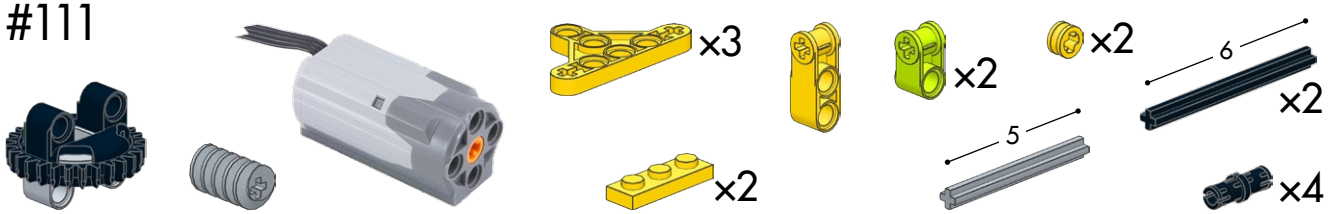

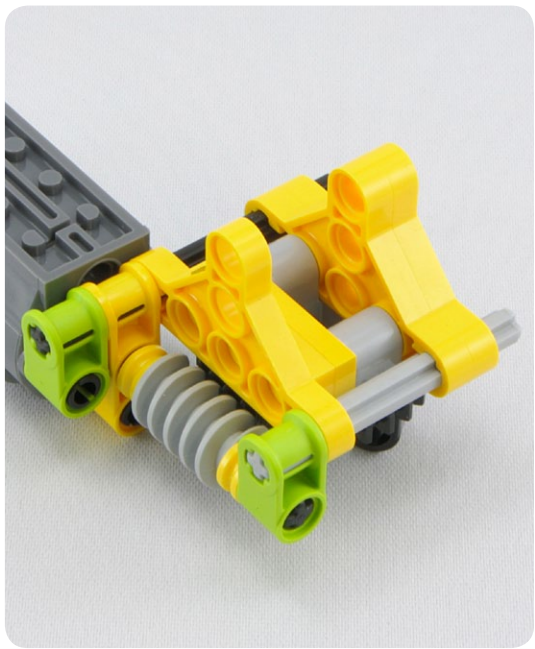

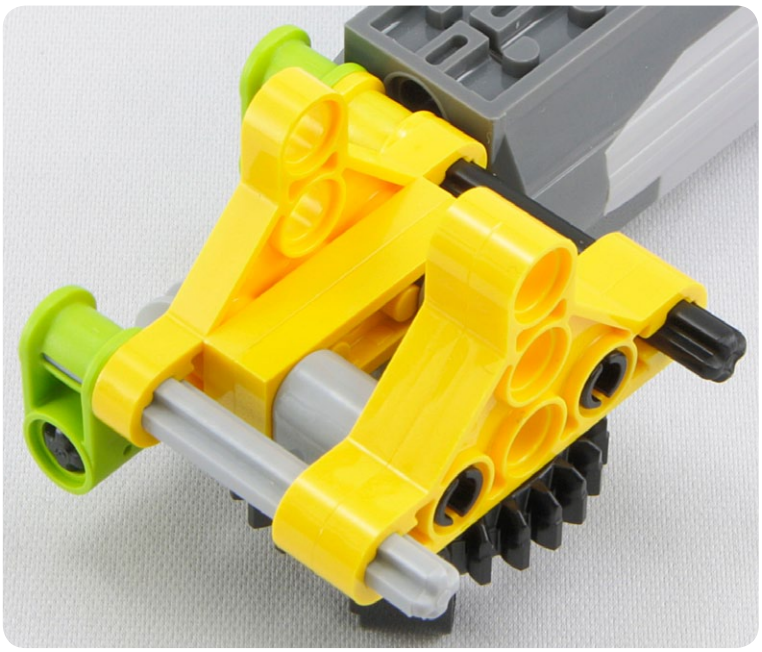

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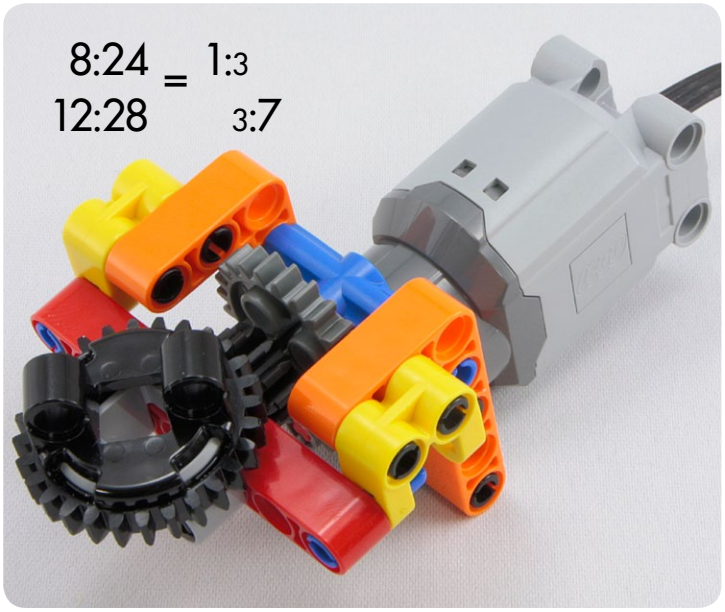
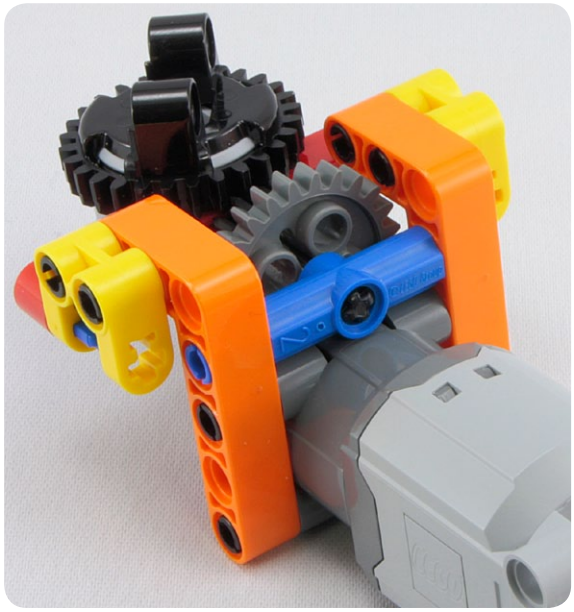
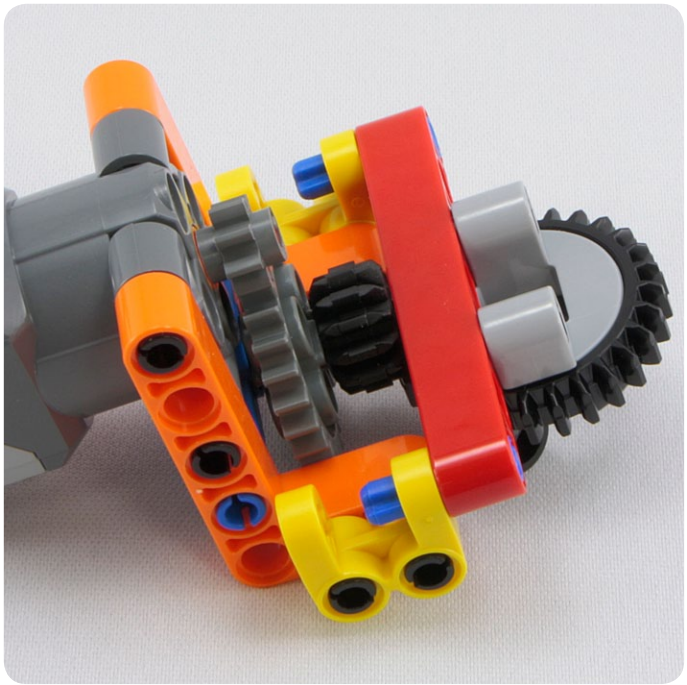
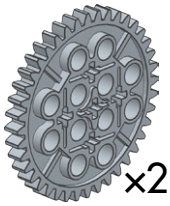


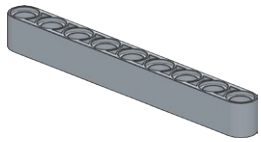




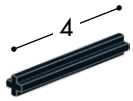
Gear systems

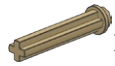
#113







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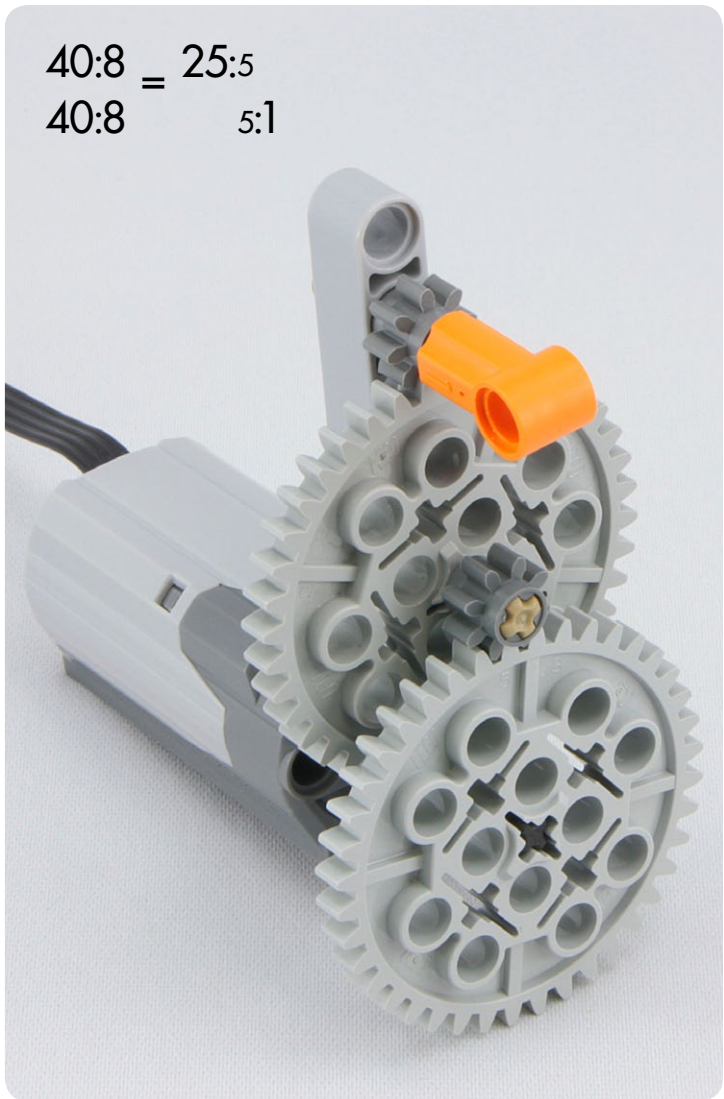
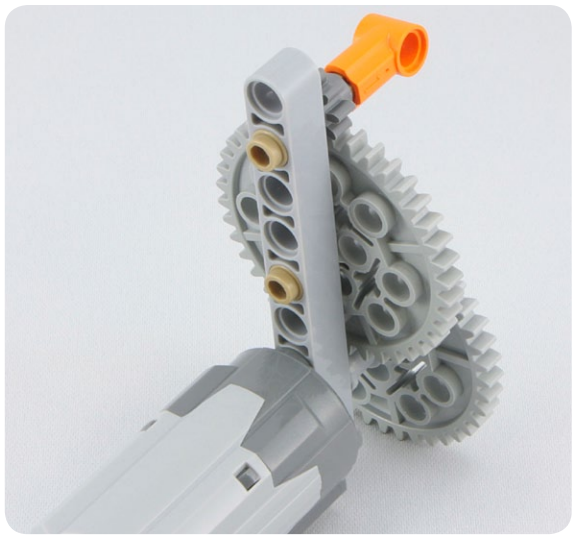
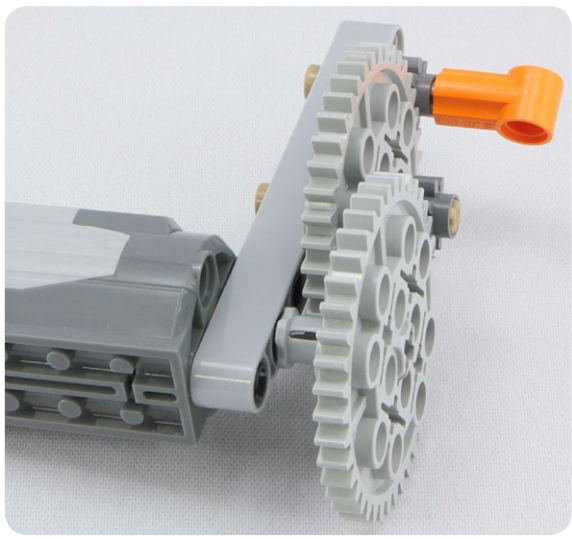
40:8 5:1



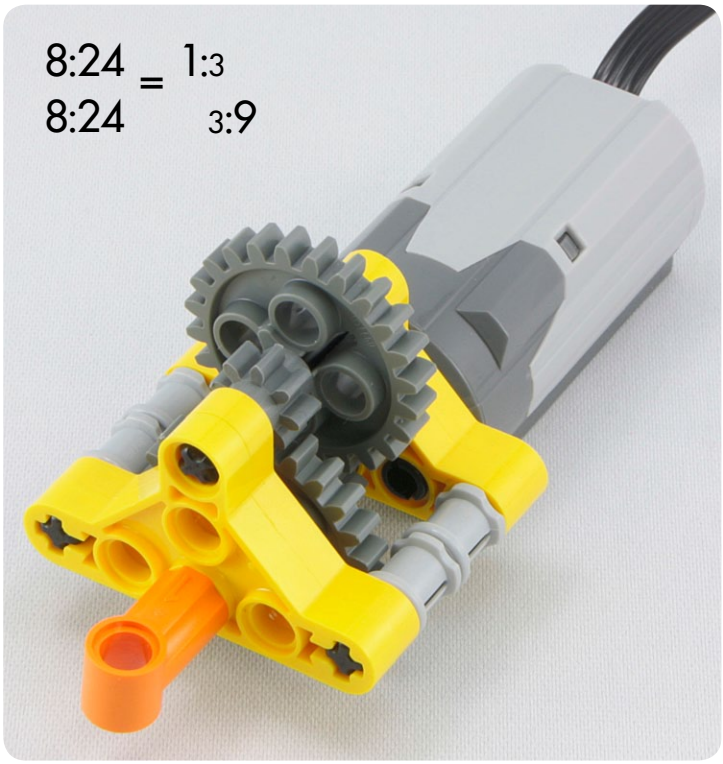


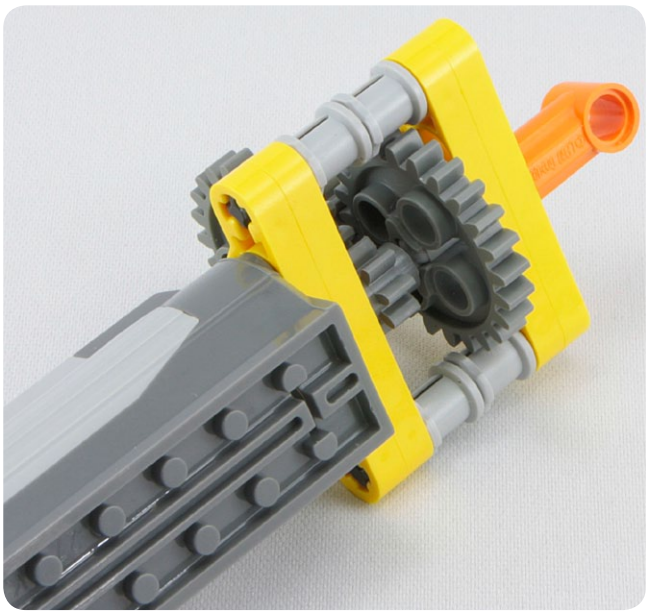


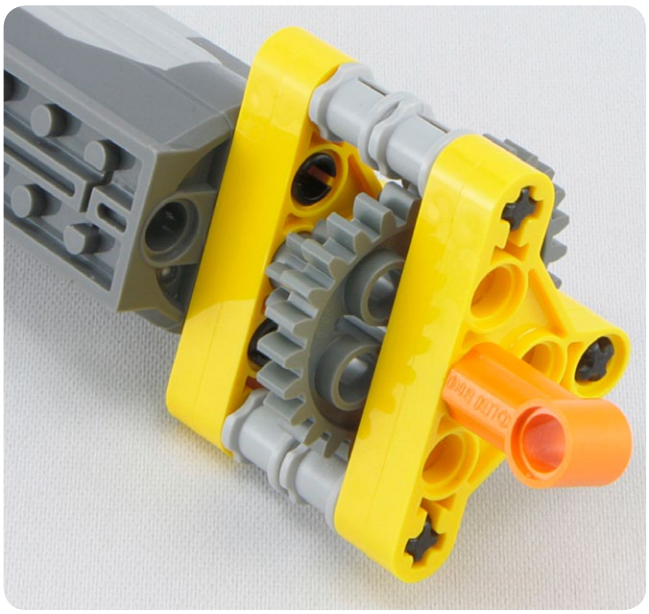
#114

×2 ×4 ×4

×2 3 ×2 4 ×3 ×2







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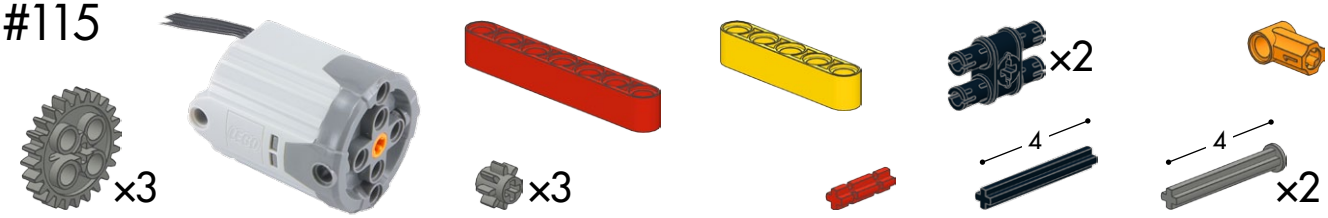

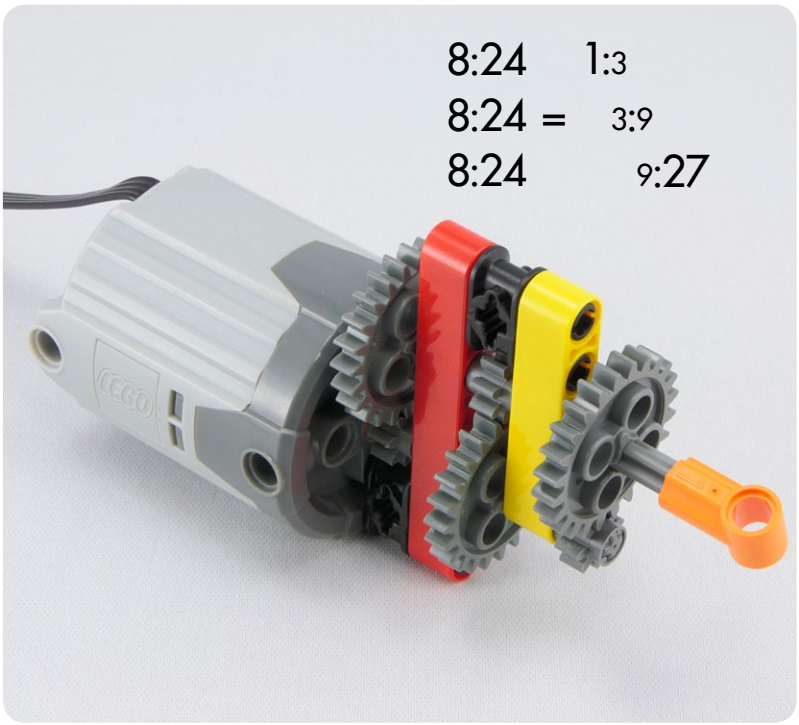

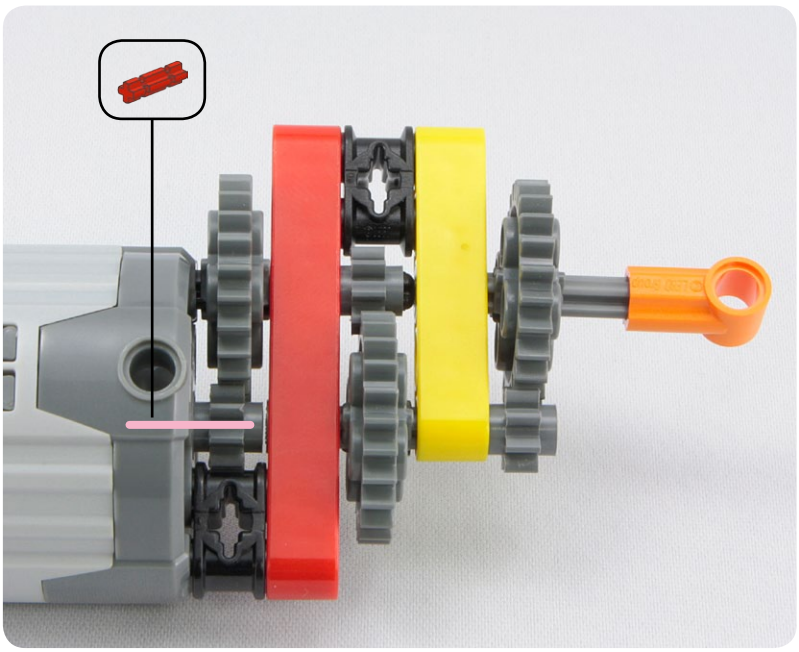

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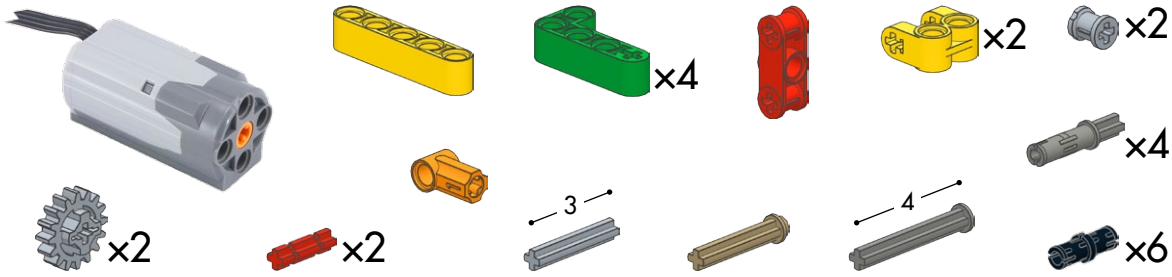

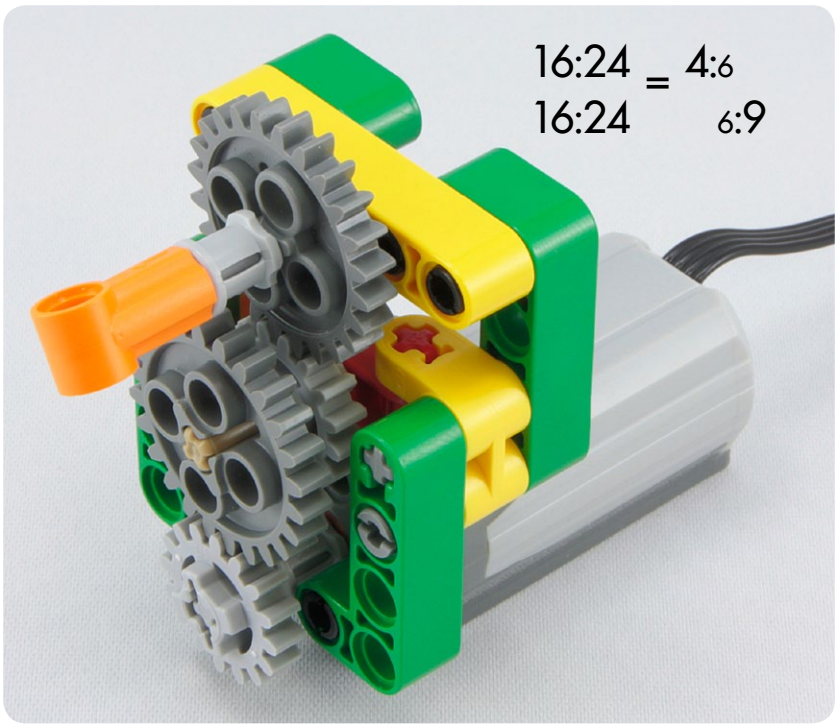

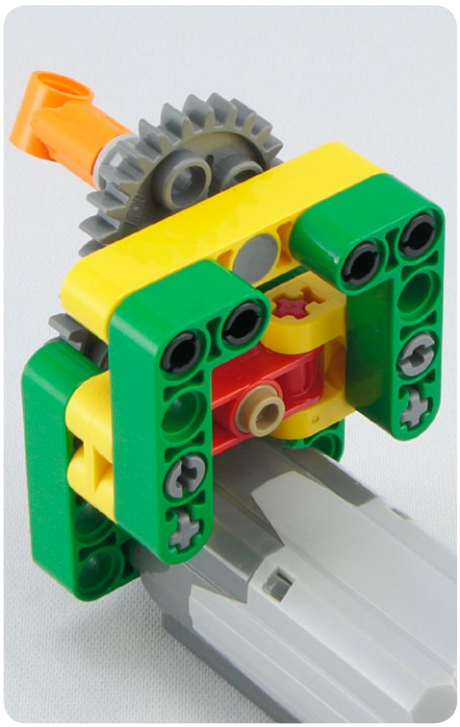

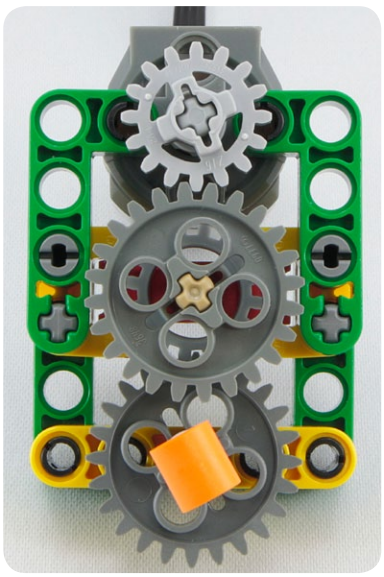

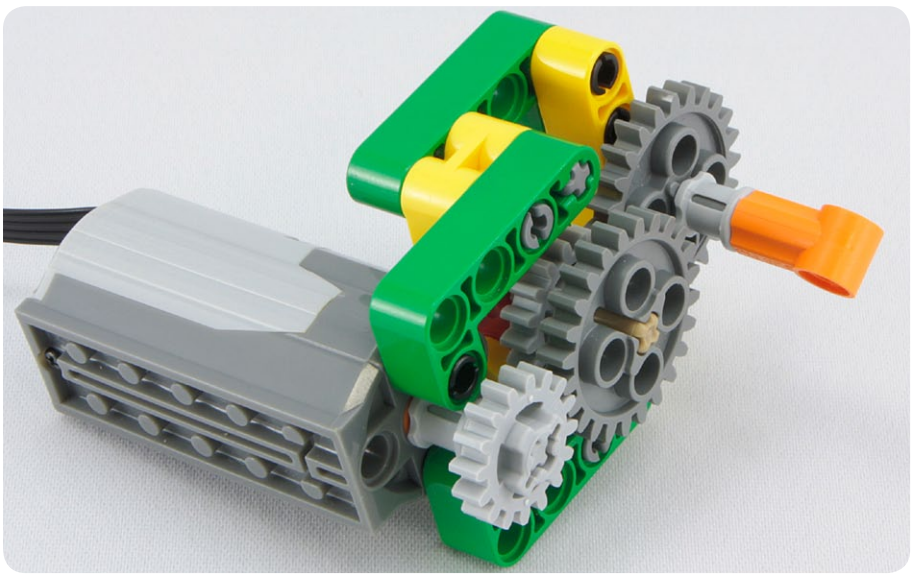

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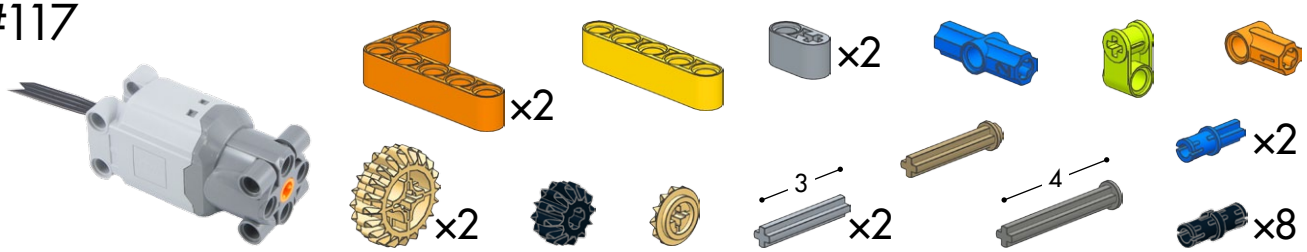

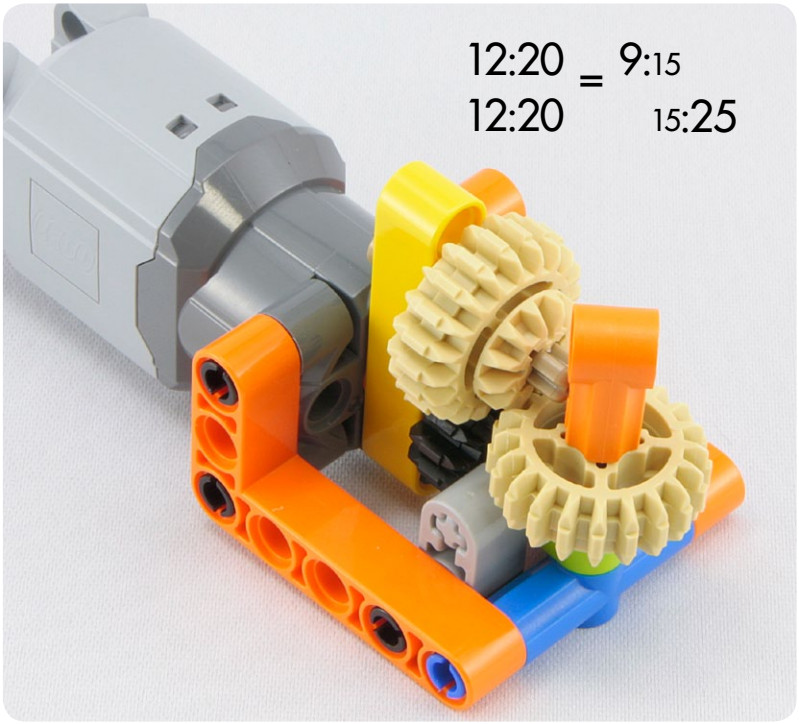

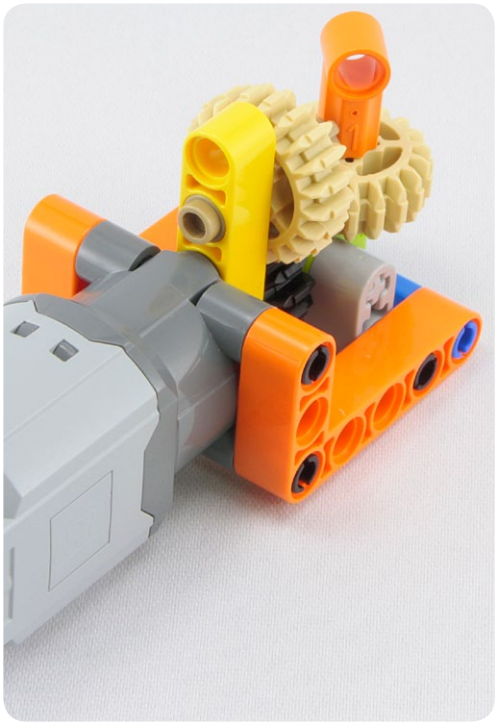

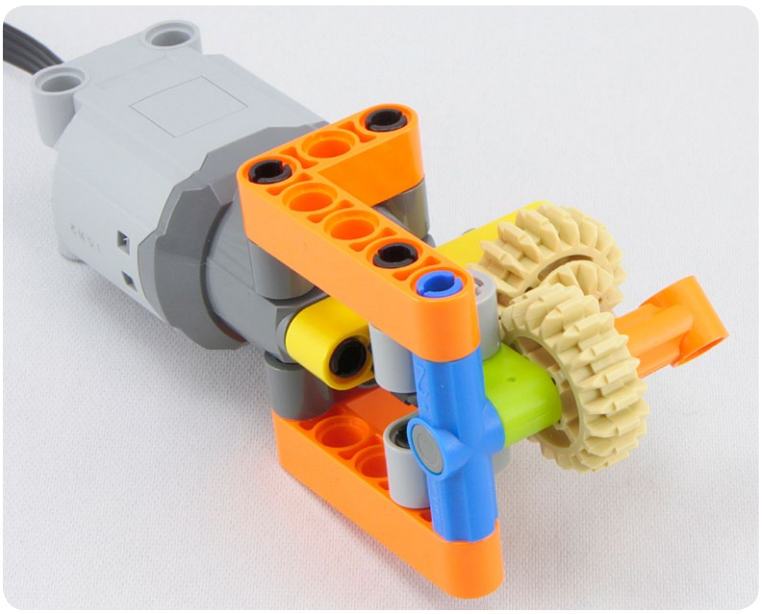

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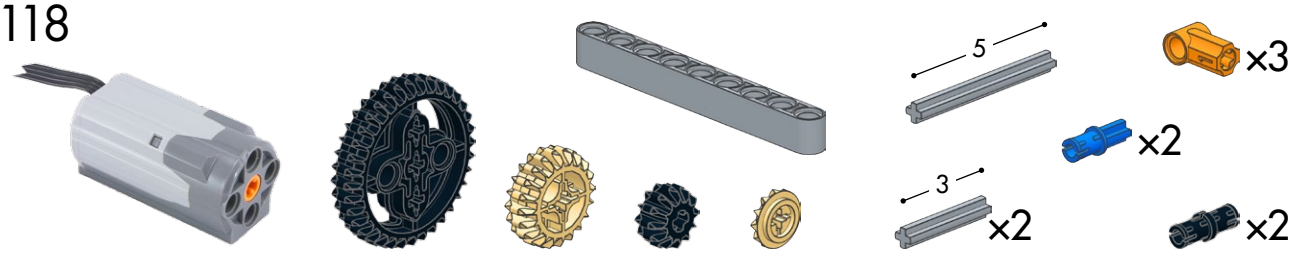

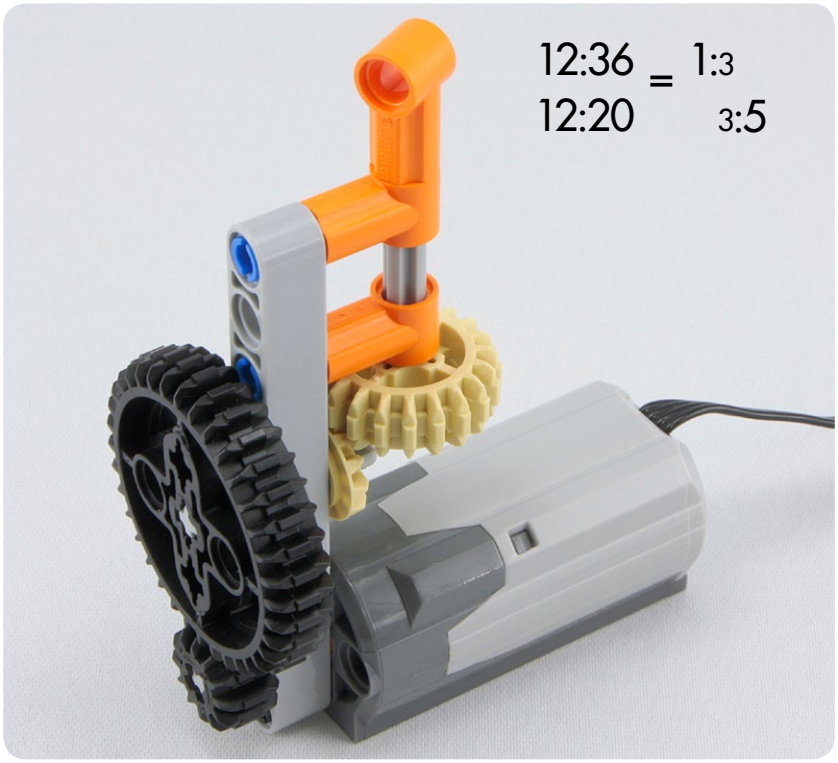

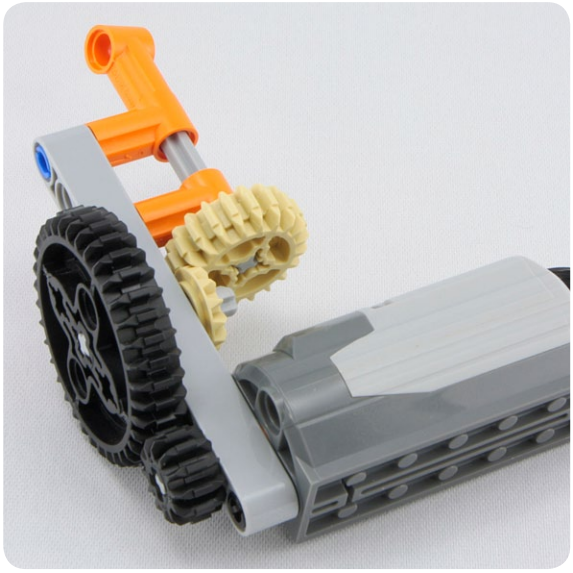

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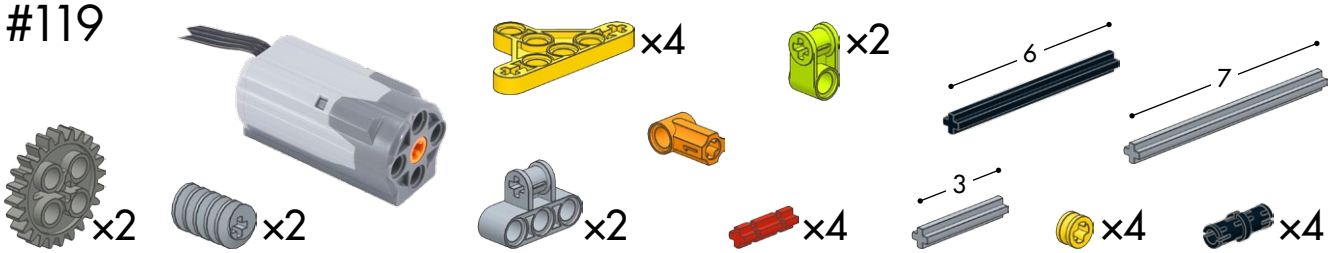

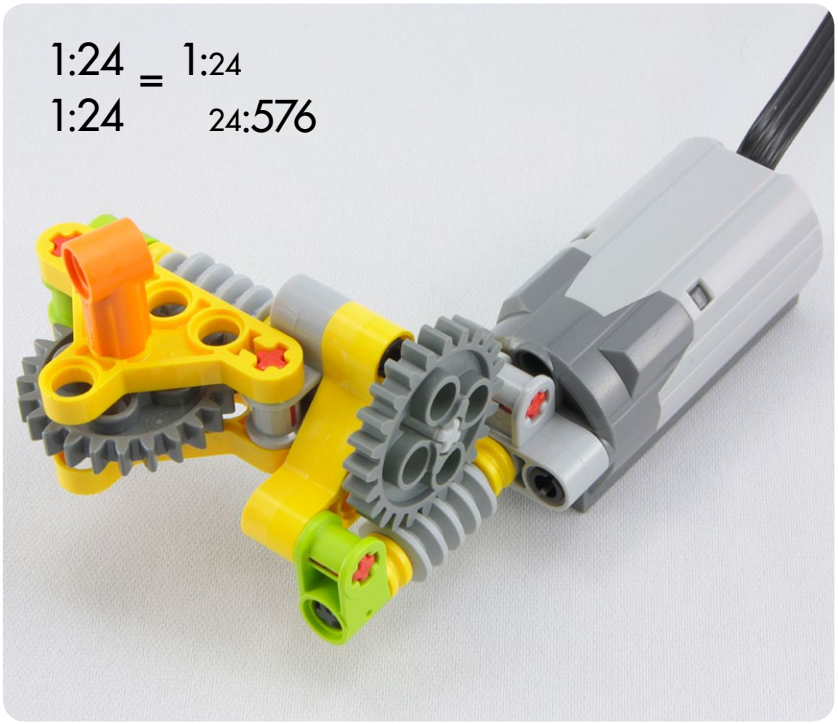

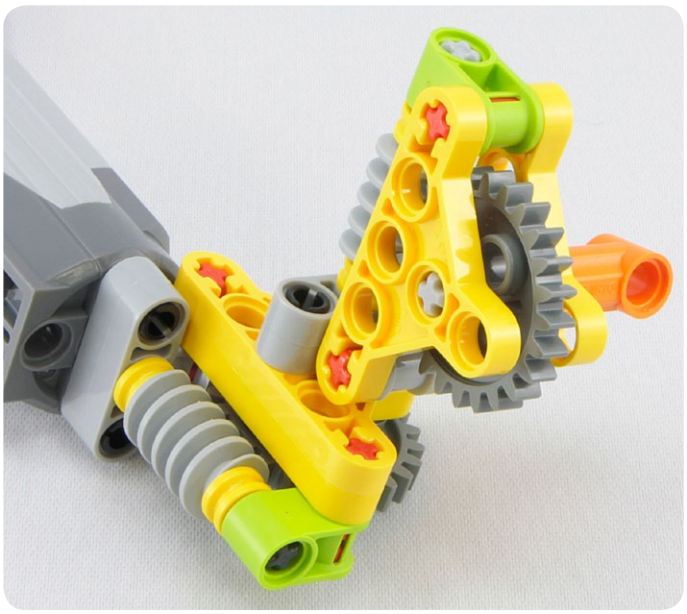

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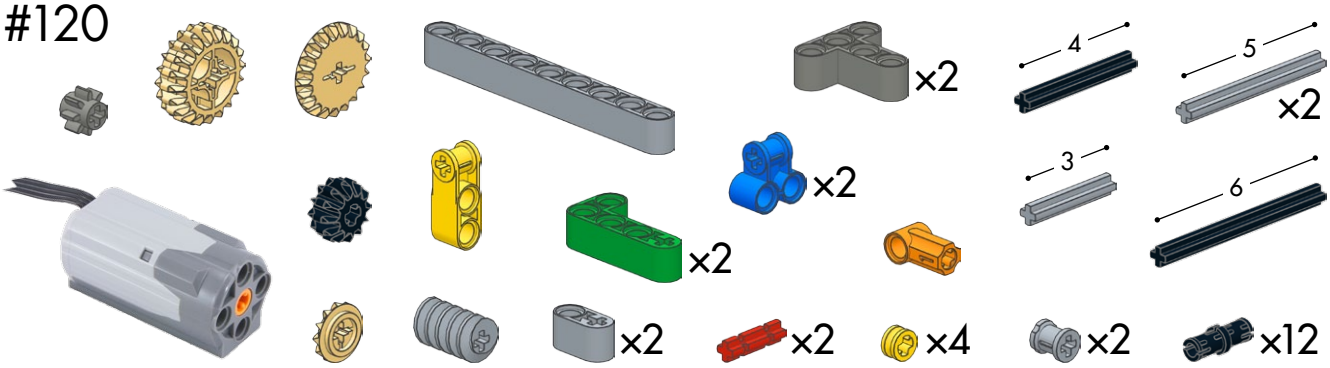

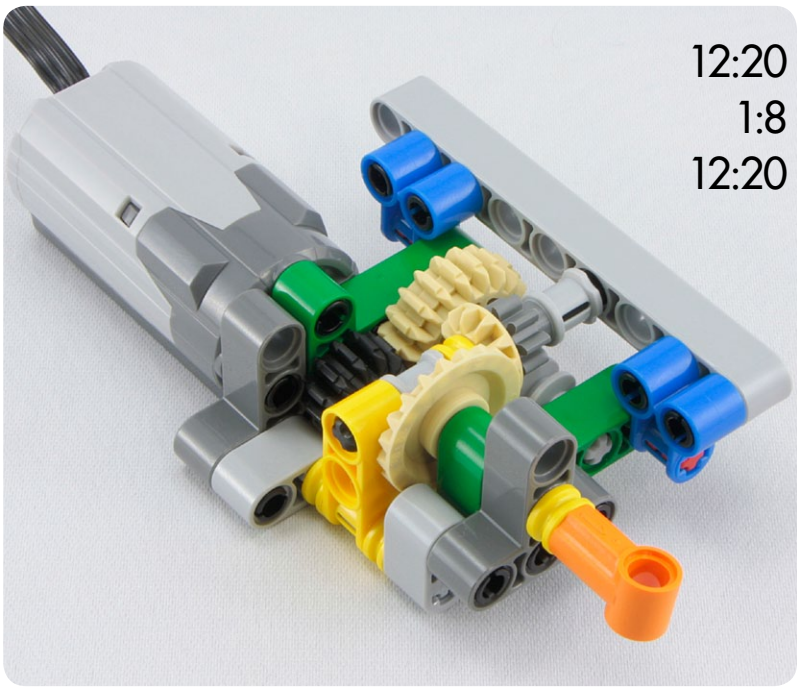

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12:20

9:15
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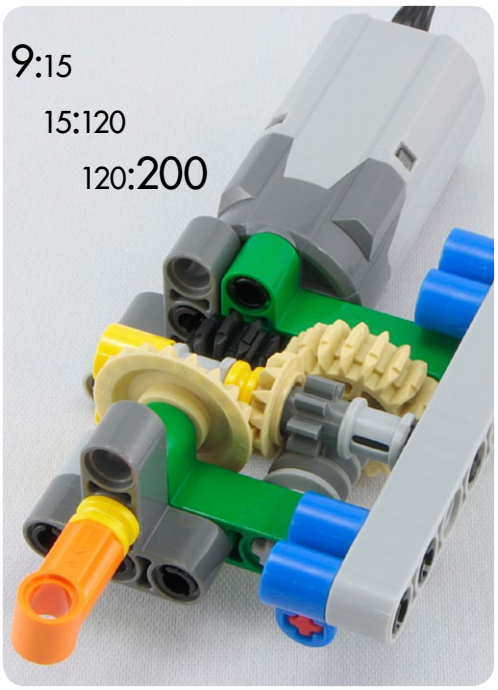
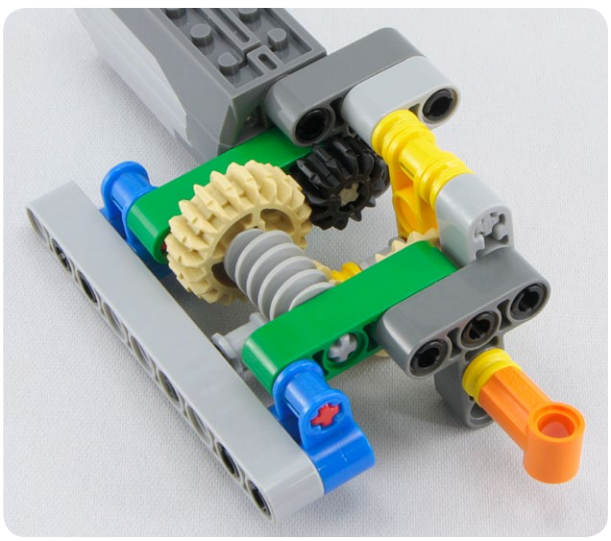
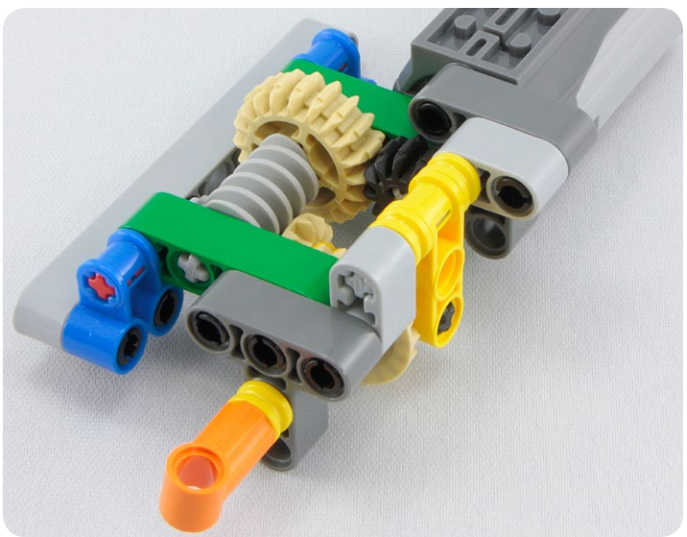
120:200

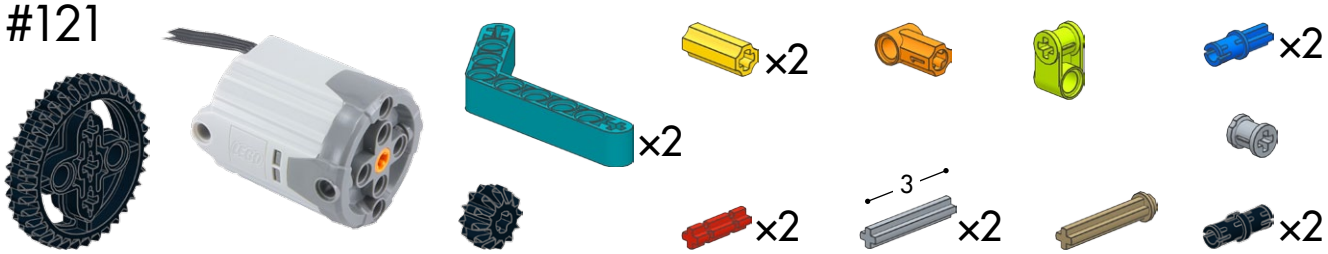


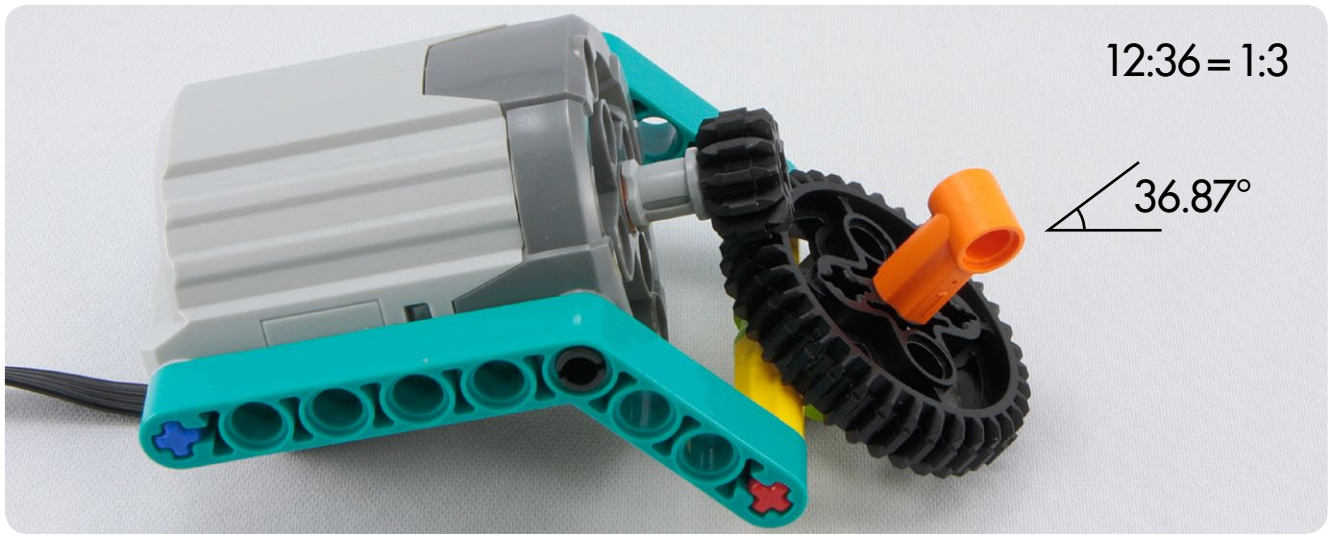


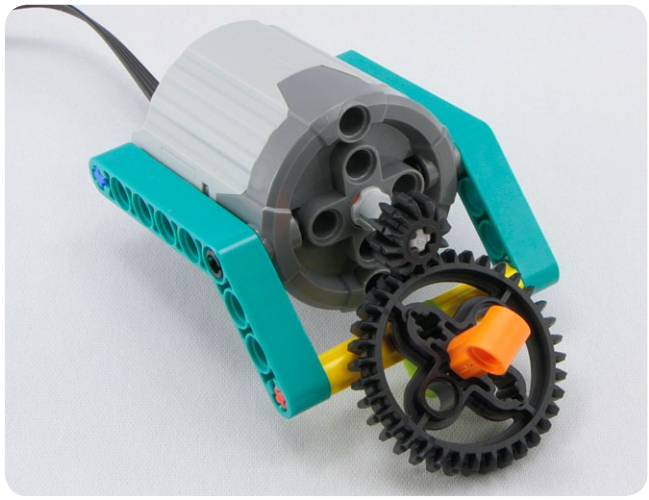


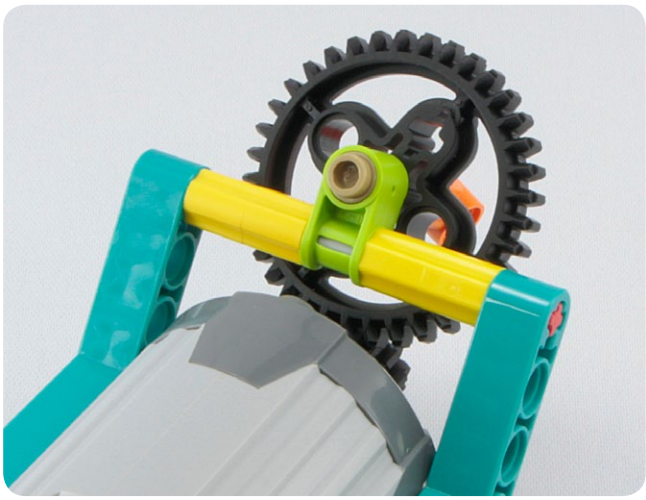
Tilting the angle of the axle

#121









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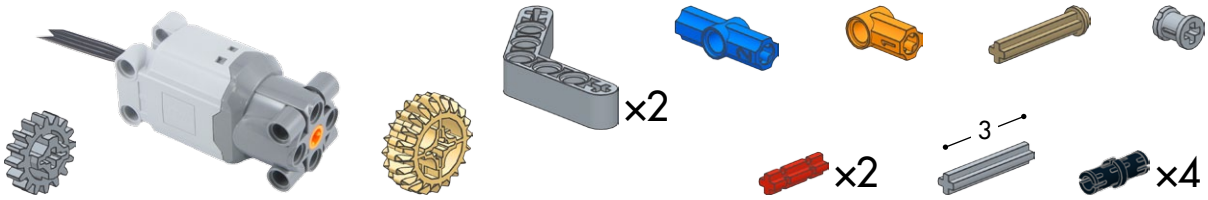

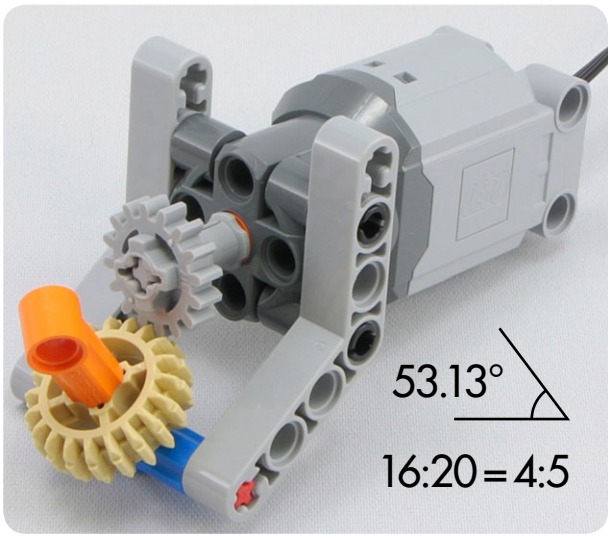

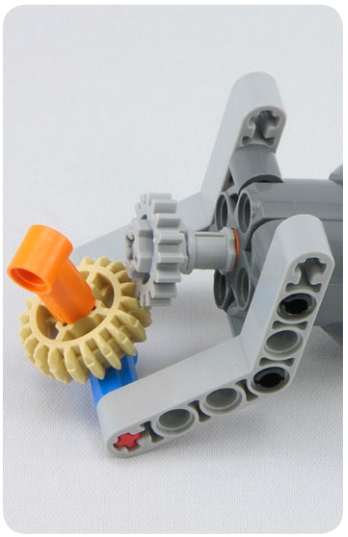

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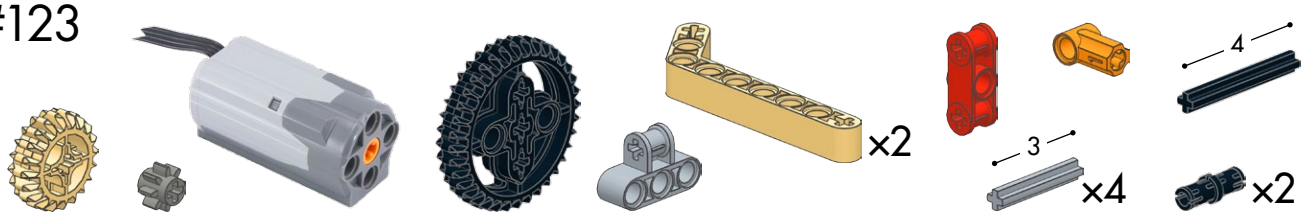

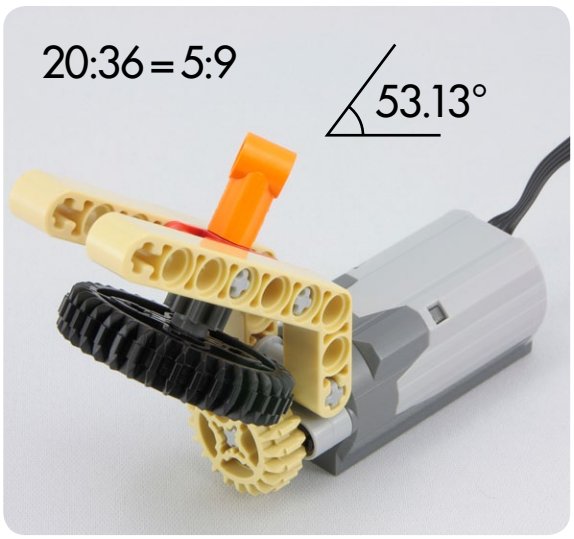

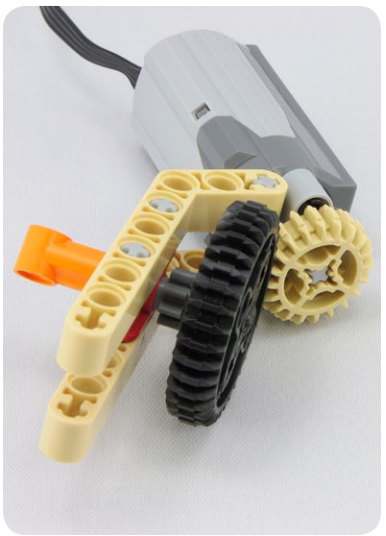

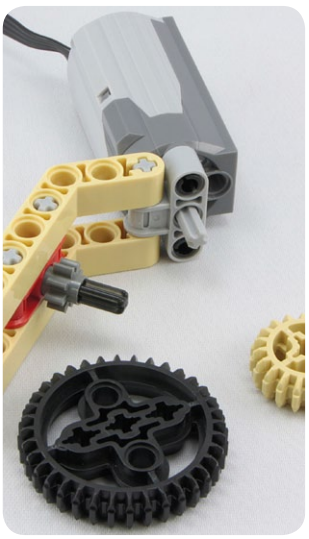

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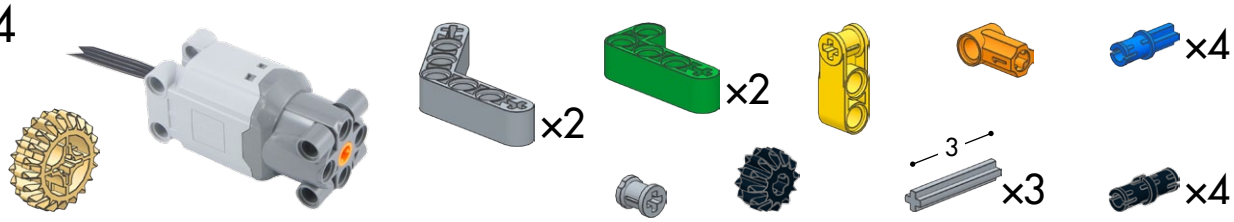

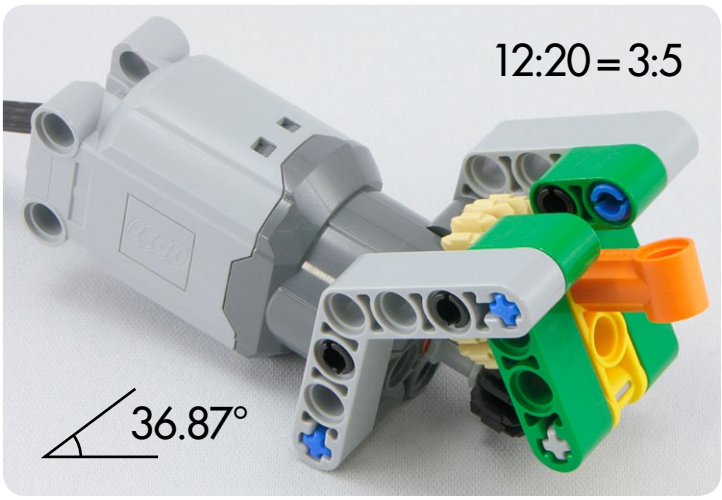

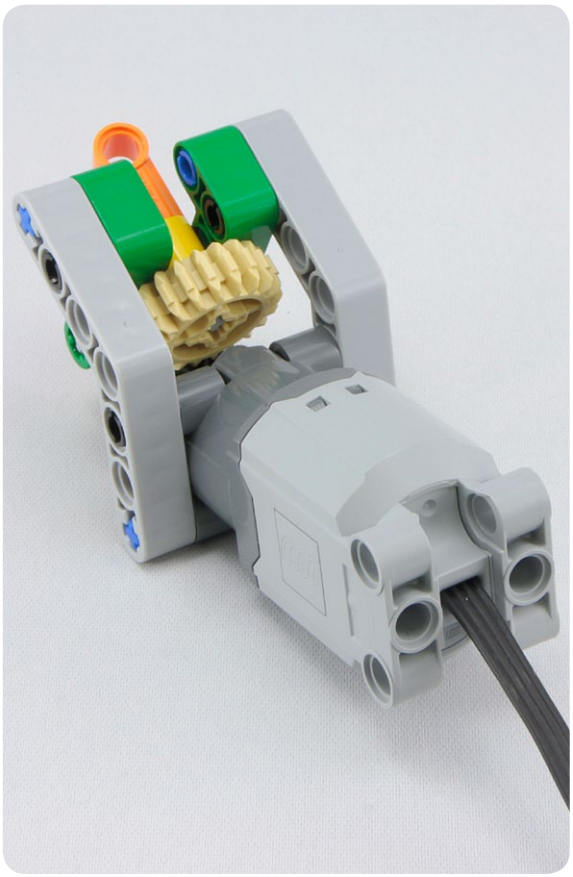

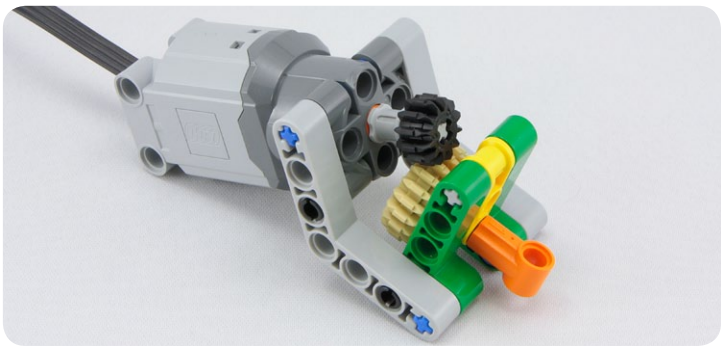

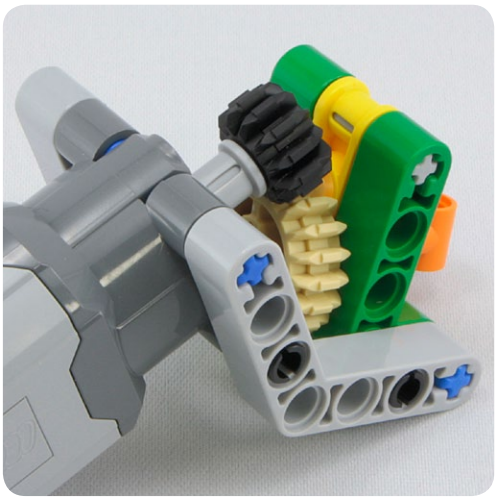

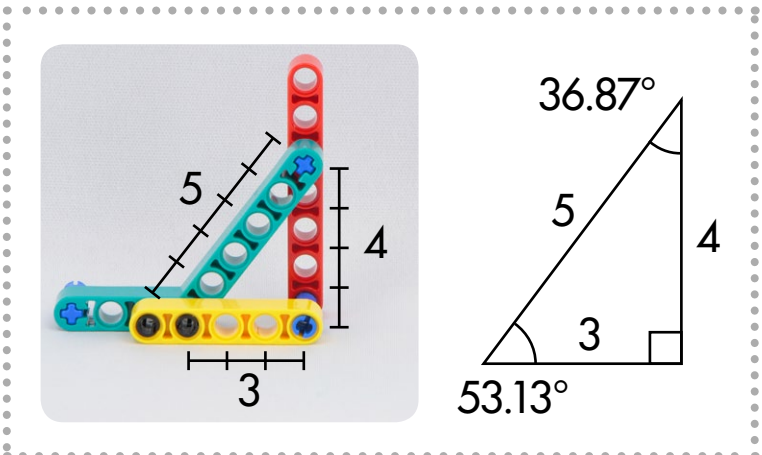

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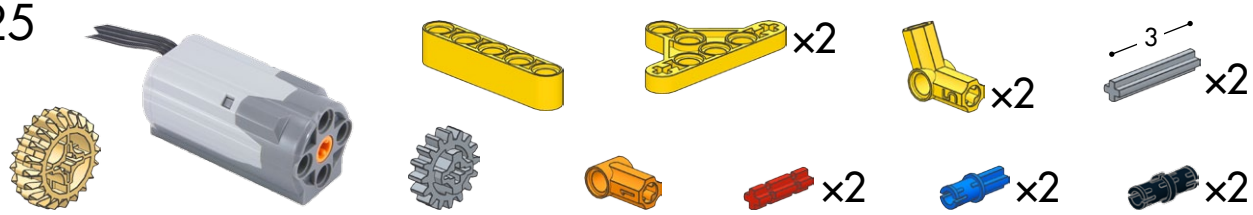

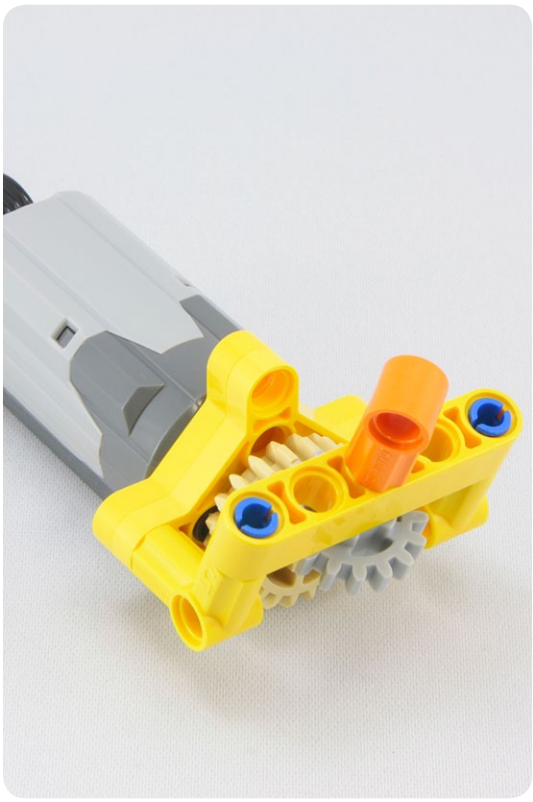

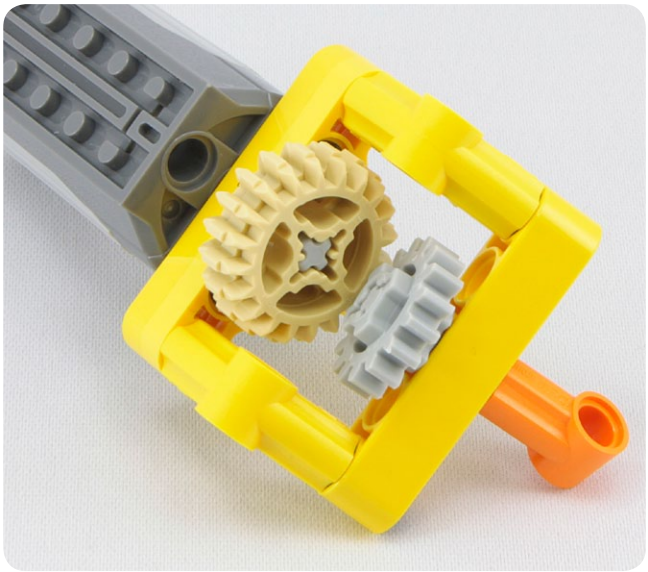

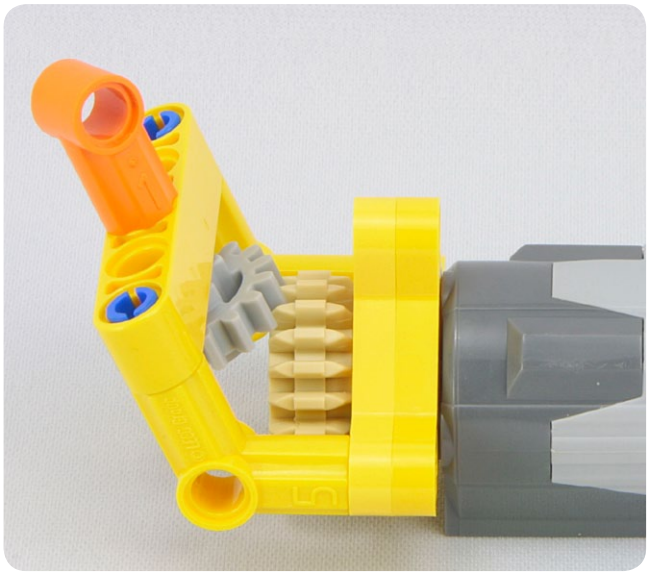

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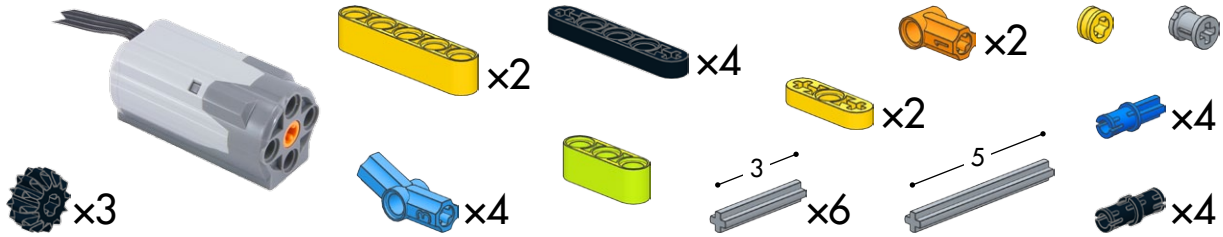
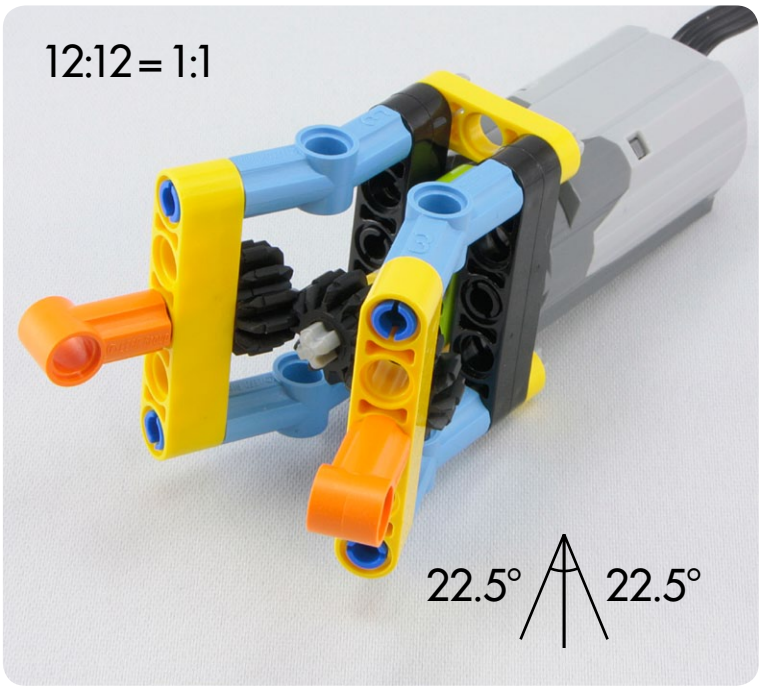
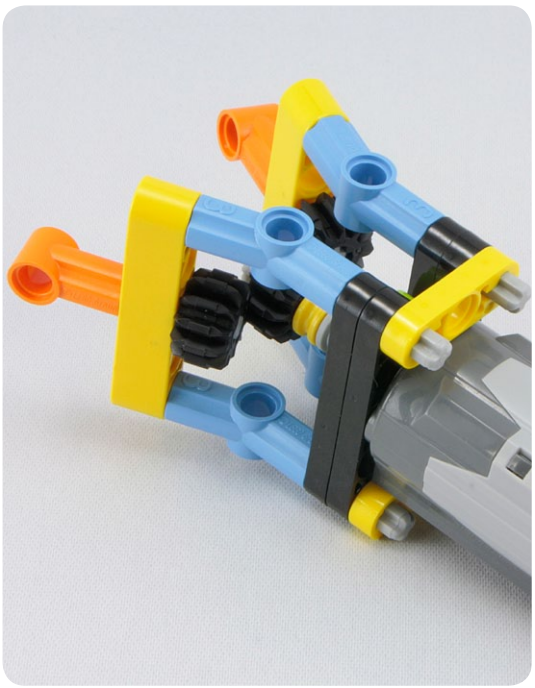
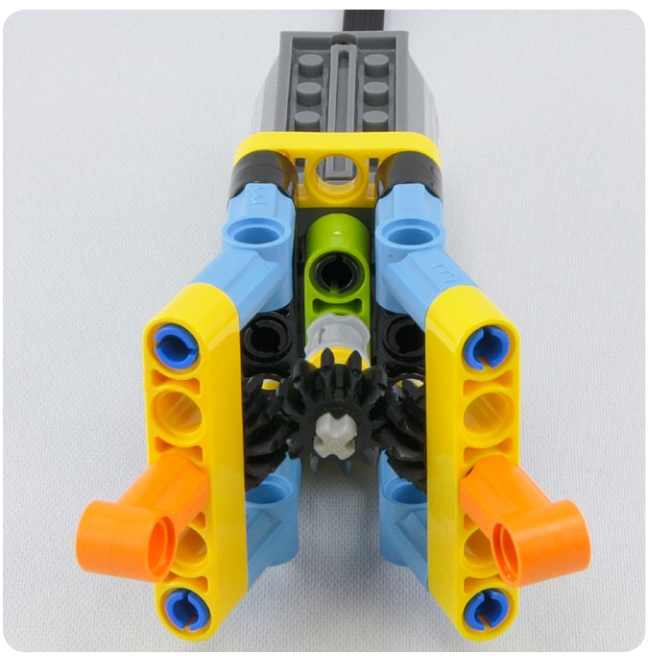


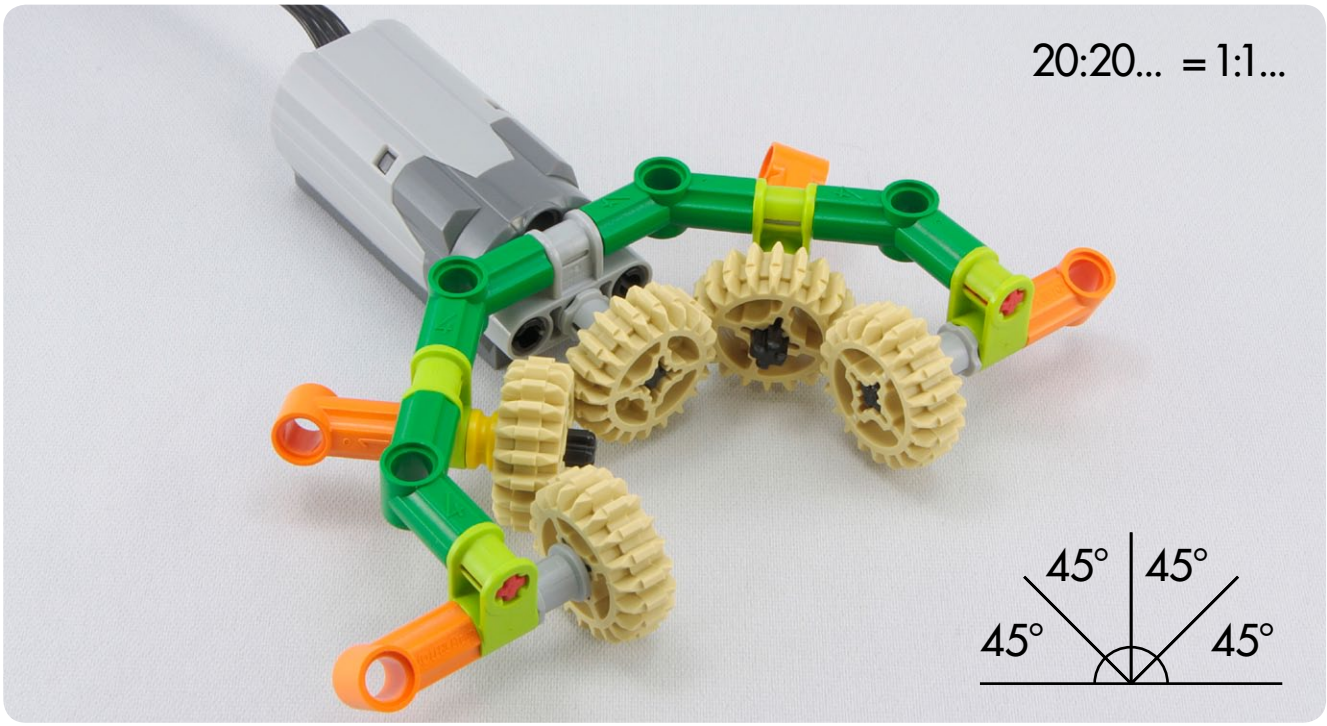


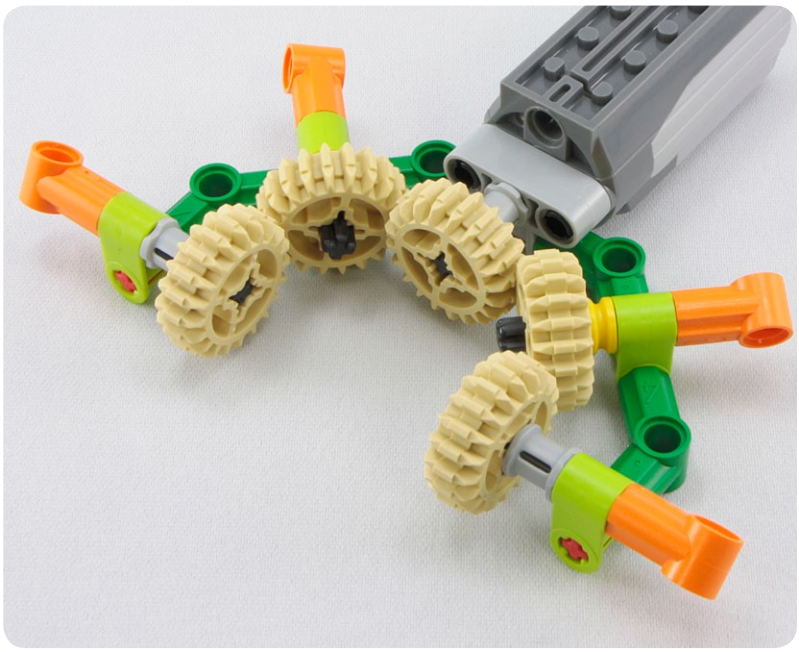


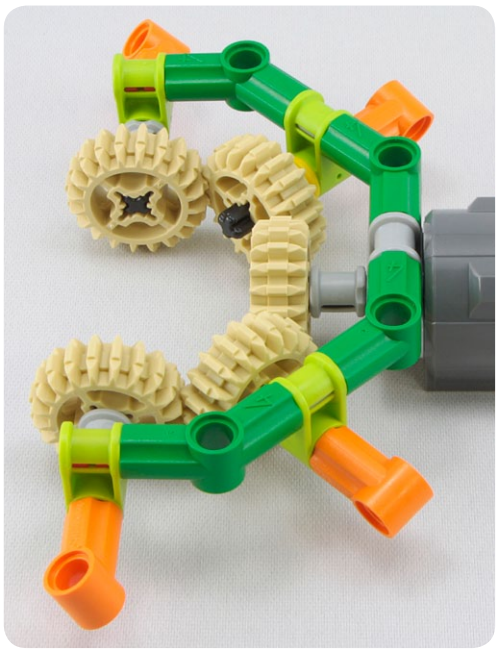


#127

×5 ×4 ×4 ×4 ×3 ×2 3 ×3 4 ×5 ×2 ×2

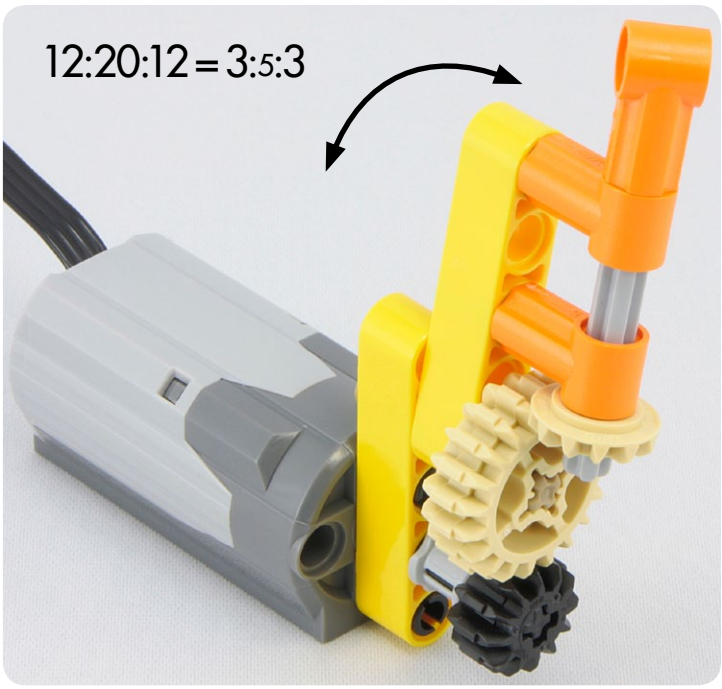


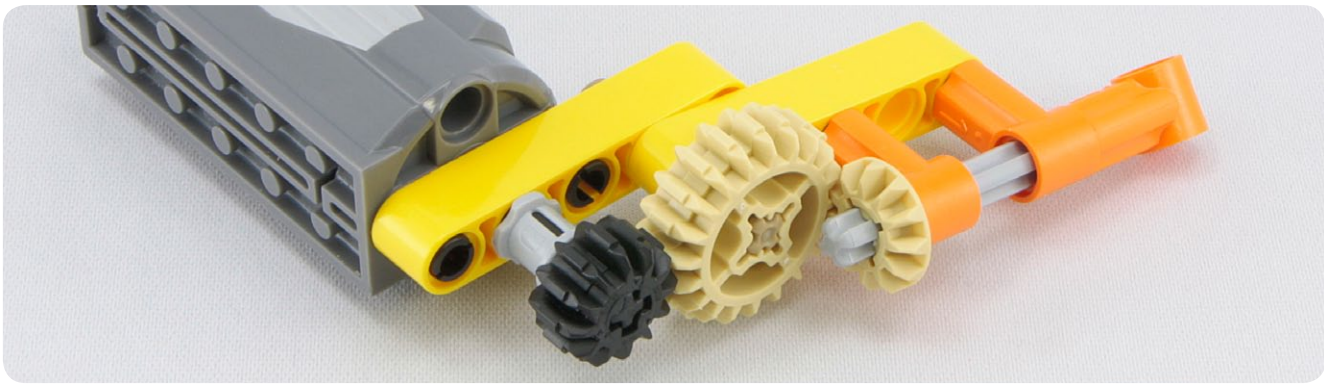




Changing the angle of the axle freely

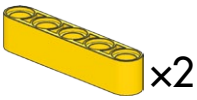
#128

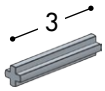


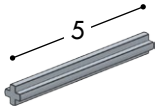


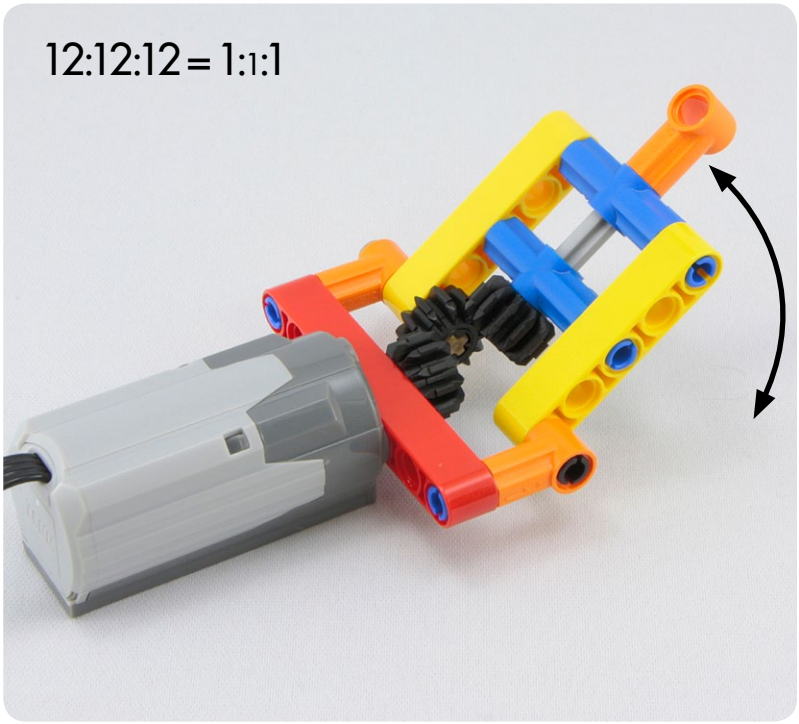
#129

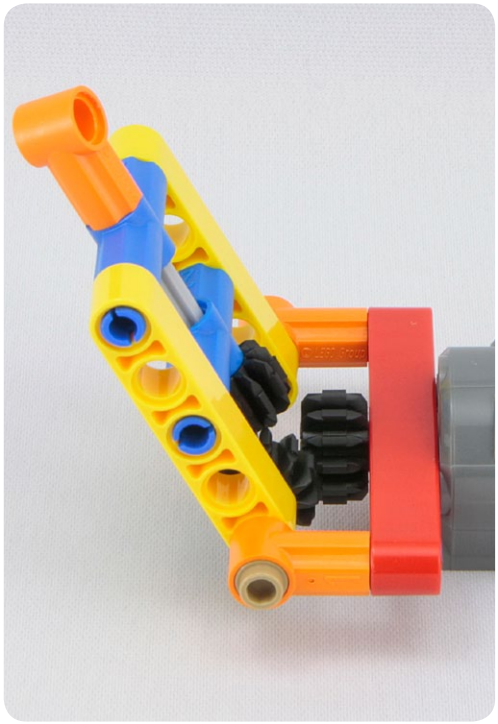


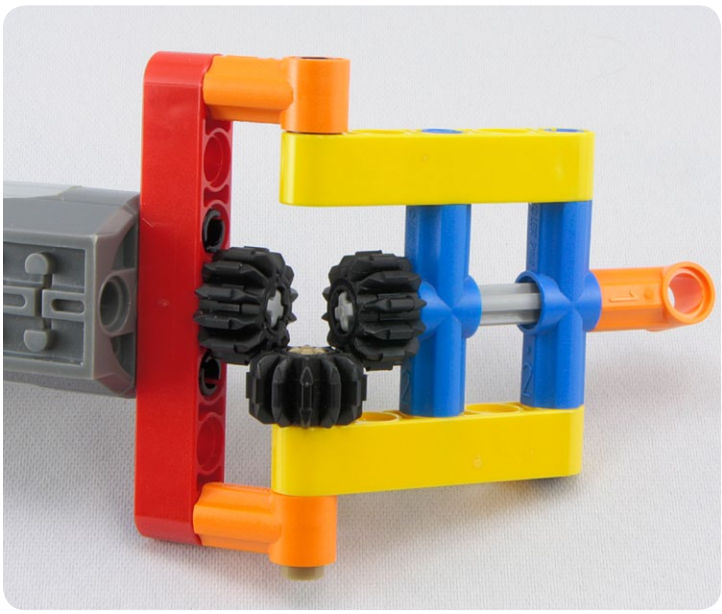










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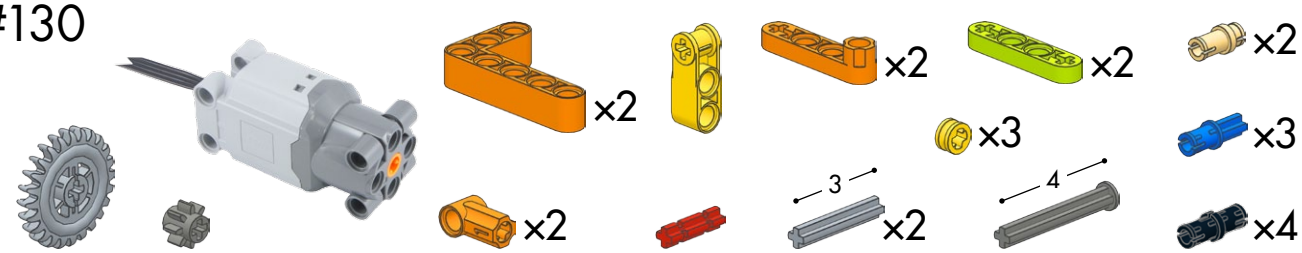
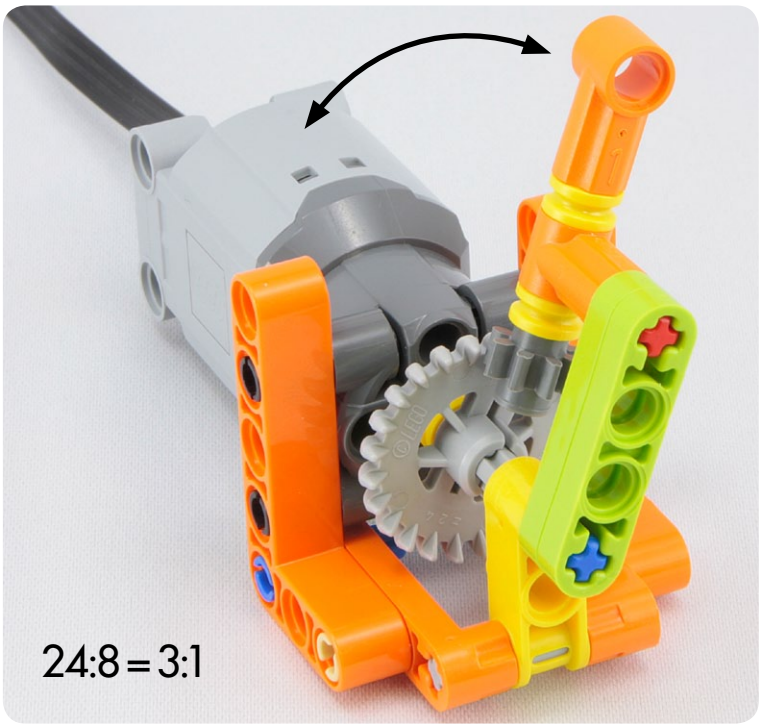
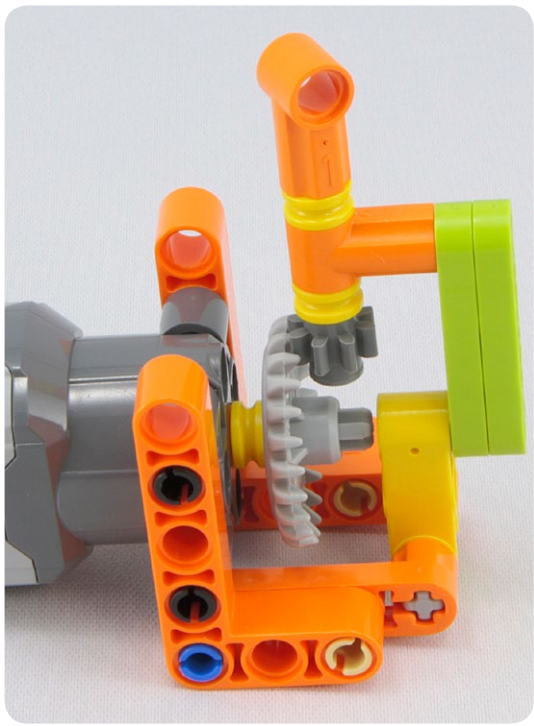
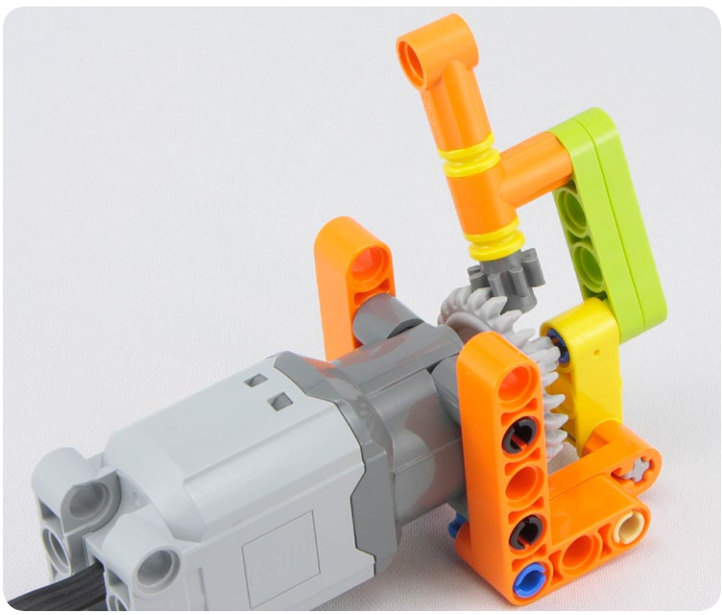
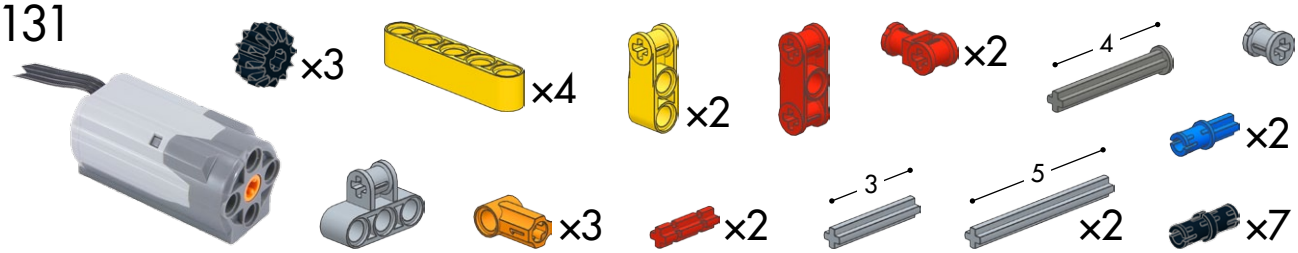


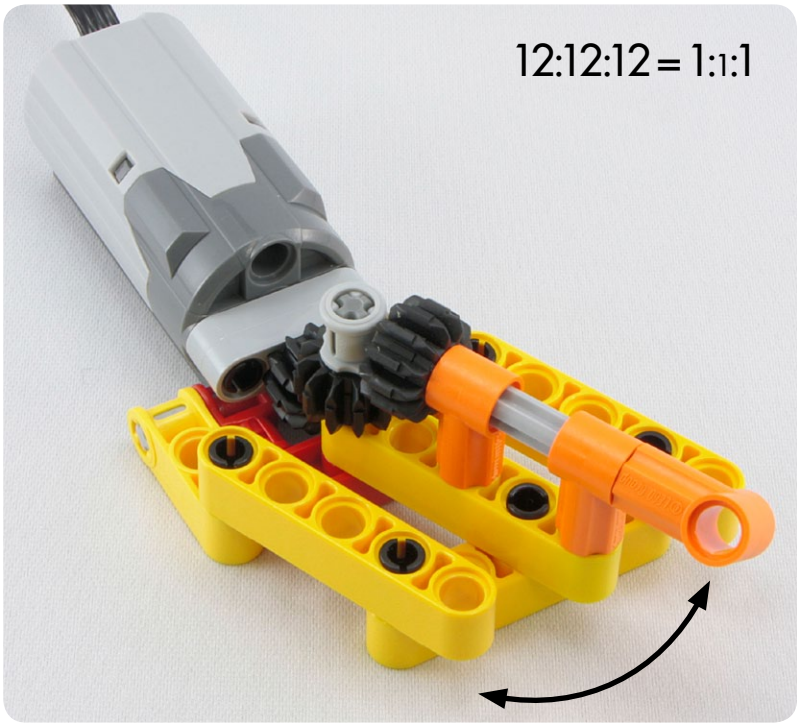


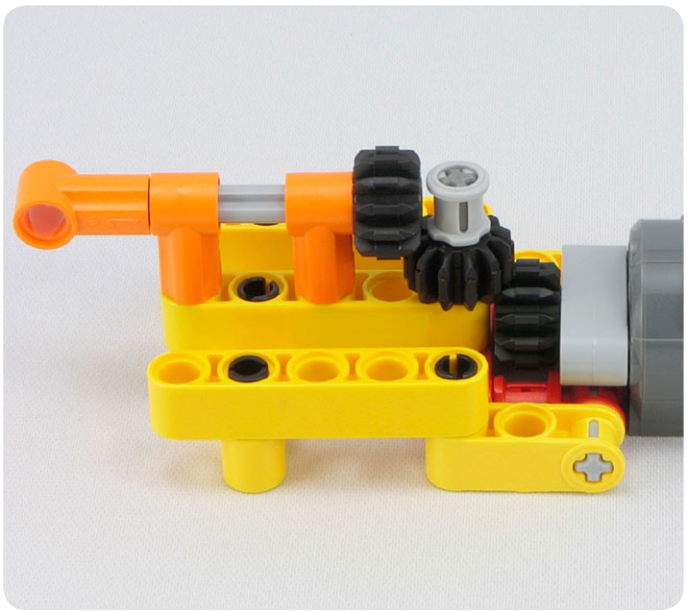




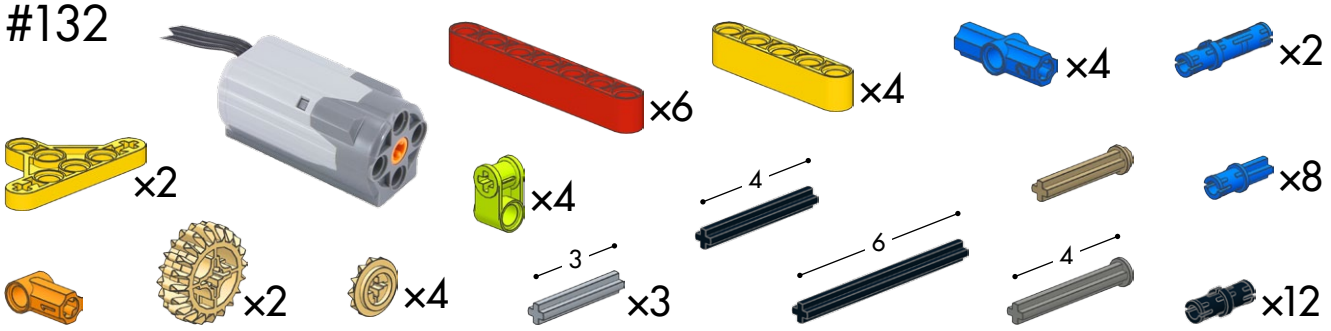
#131

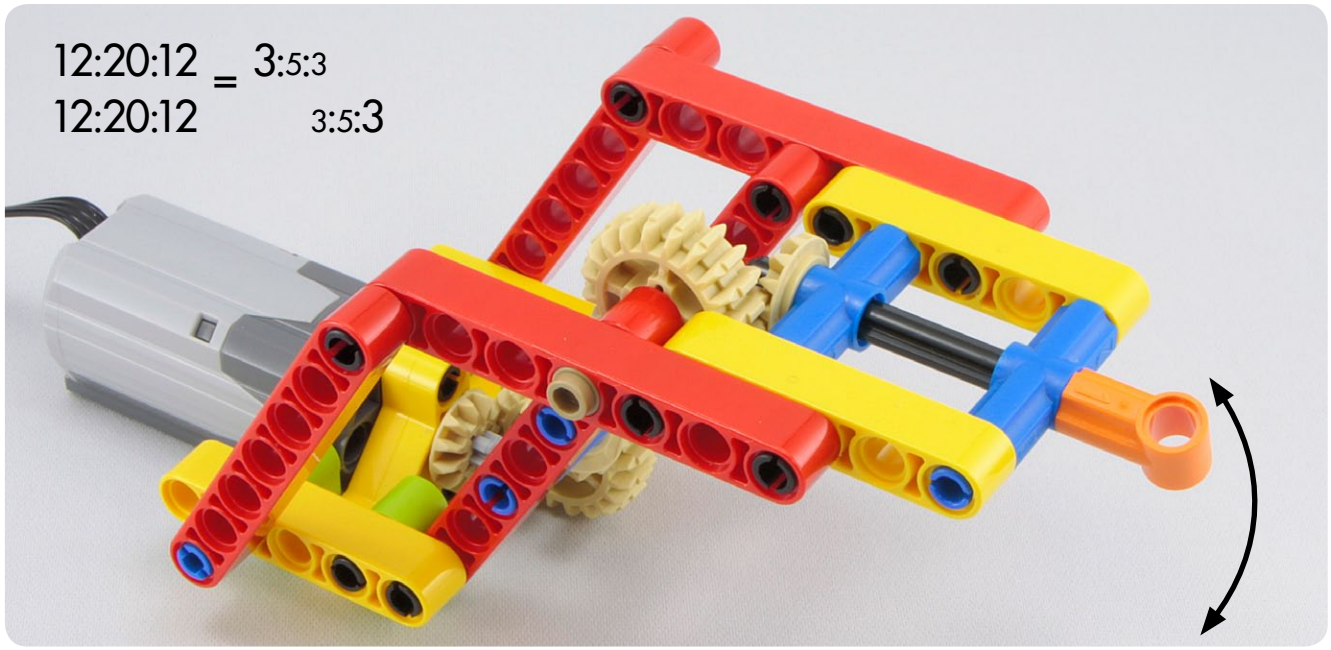


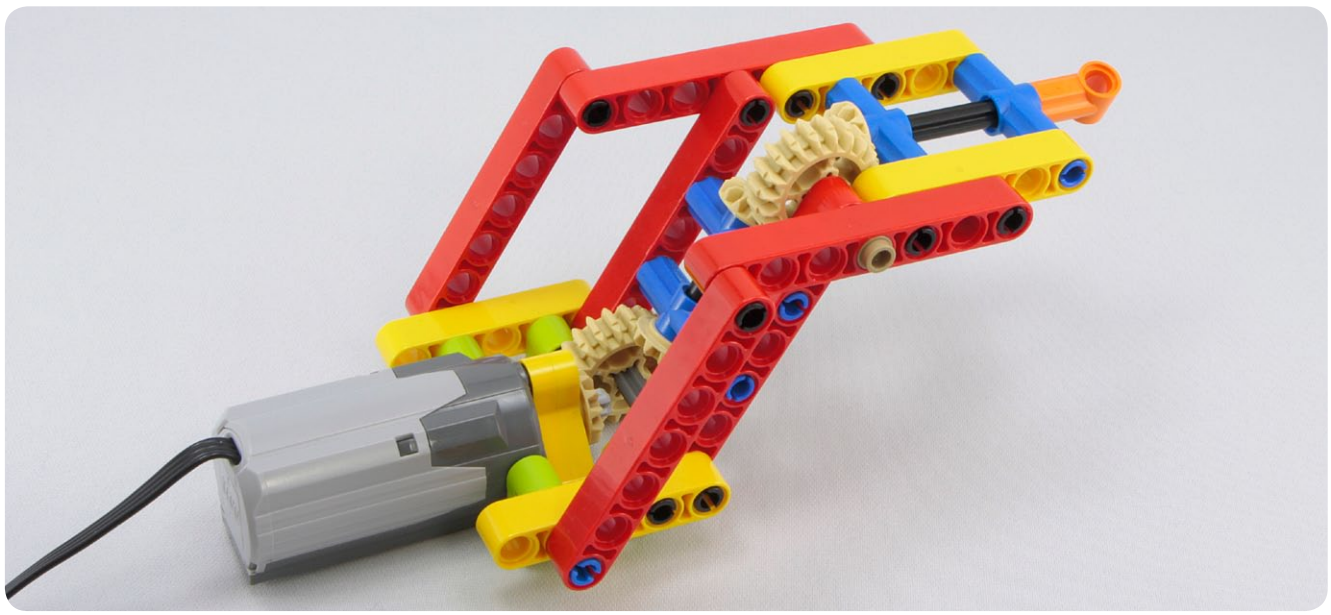


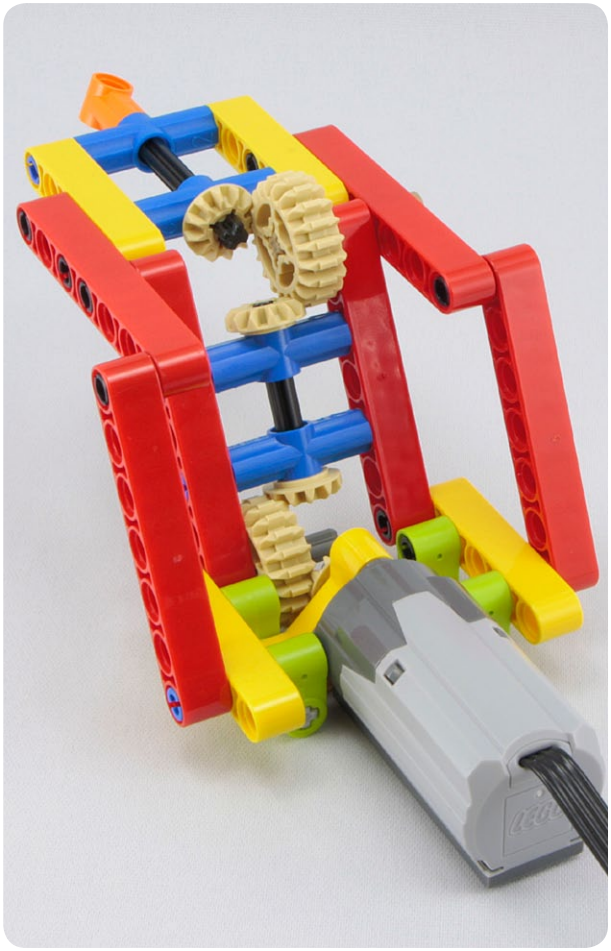


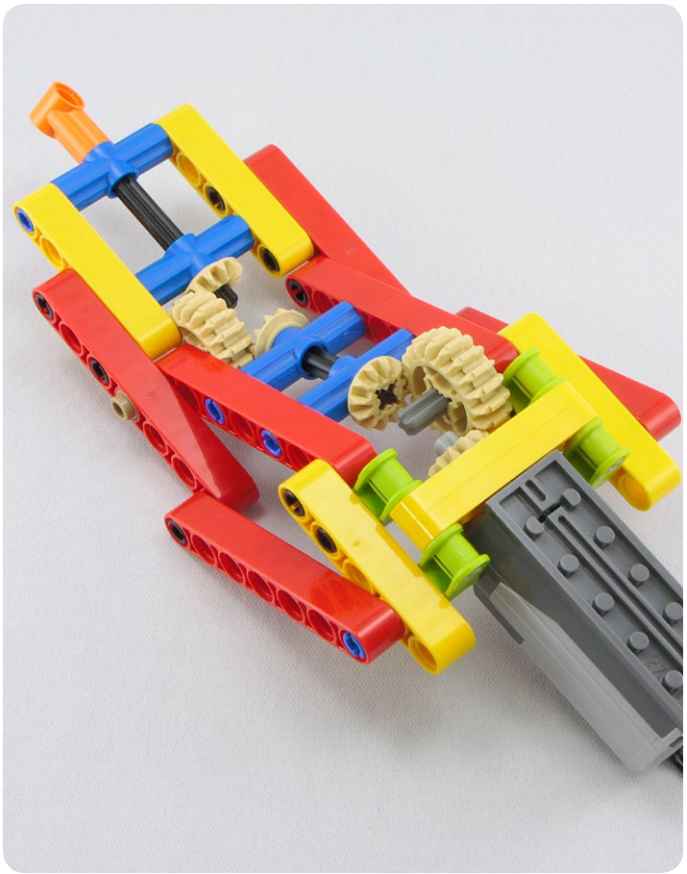
#132





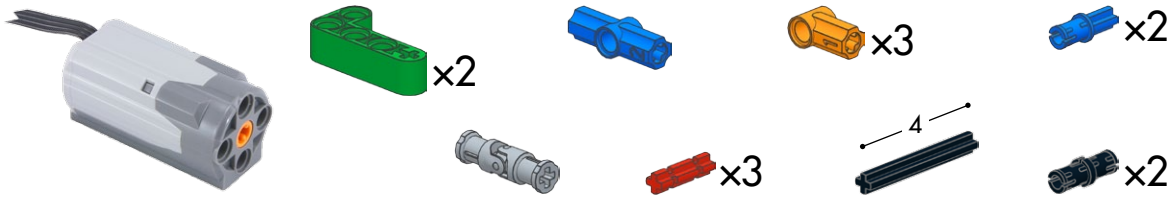


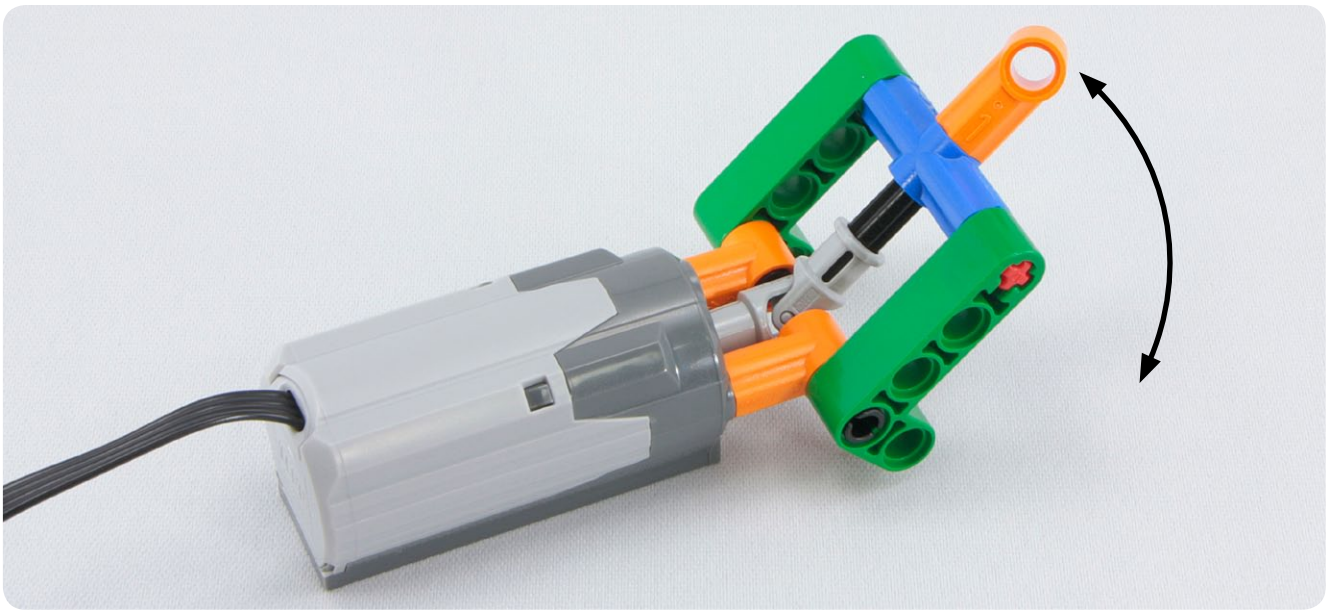


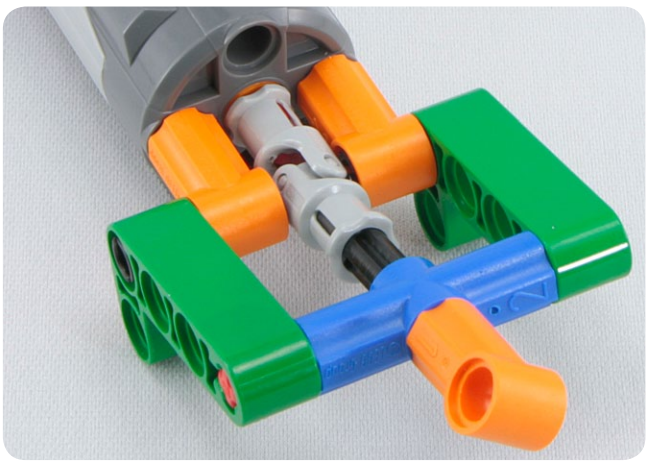


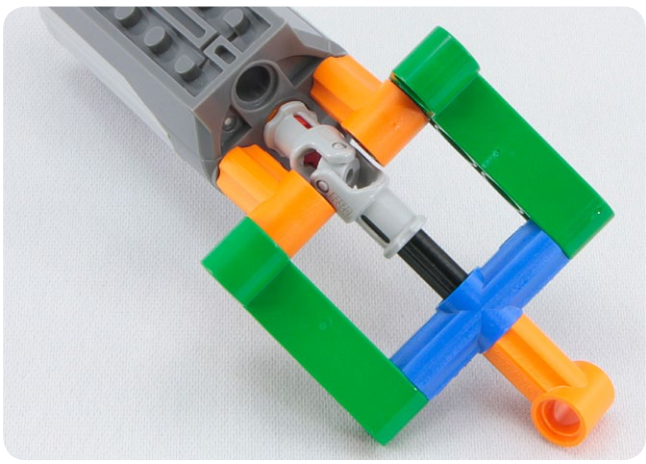
Universal joints

#133









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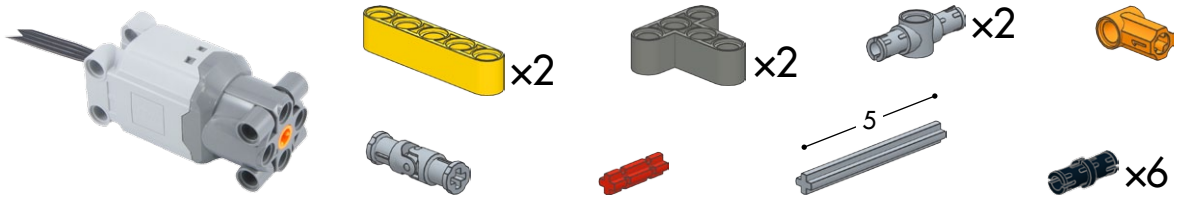

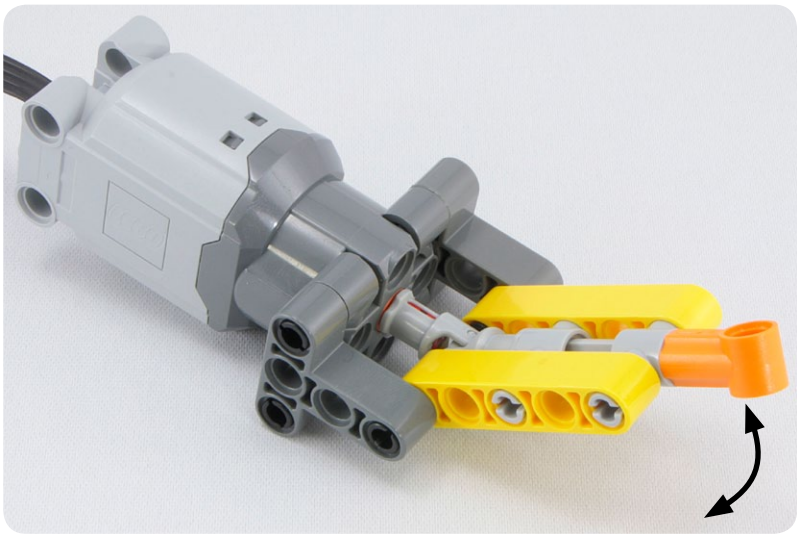

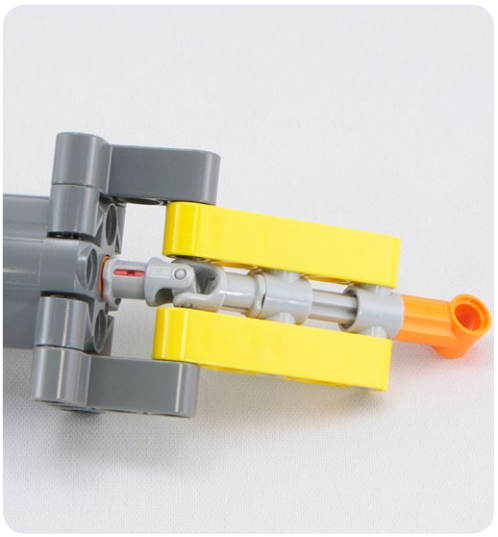

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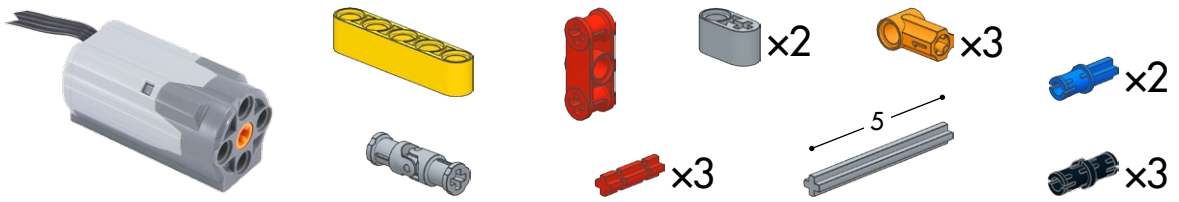

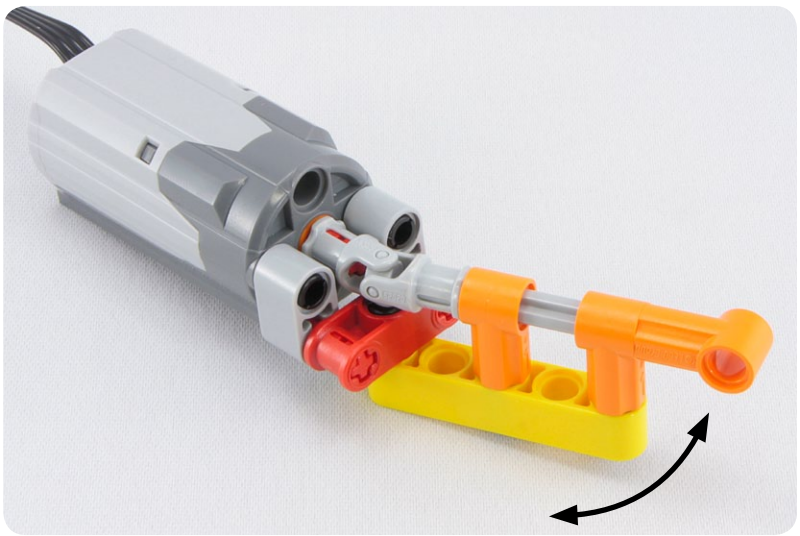

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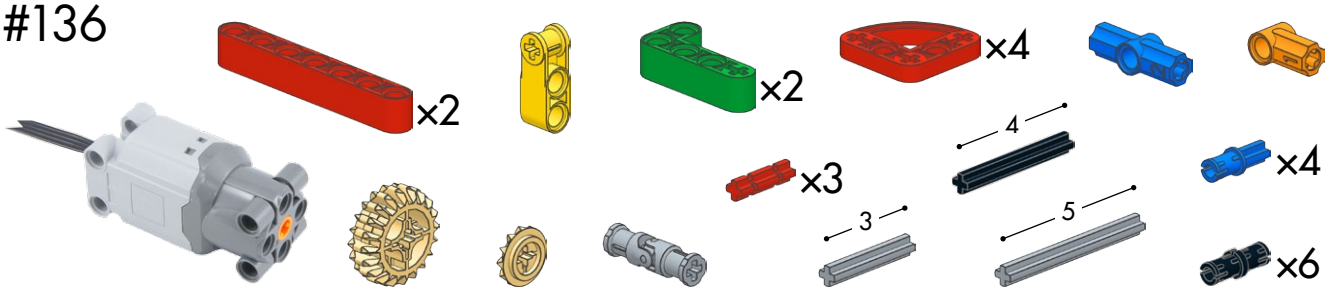

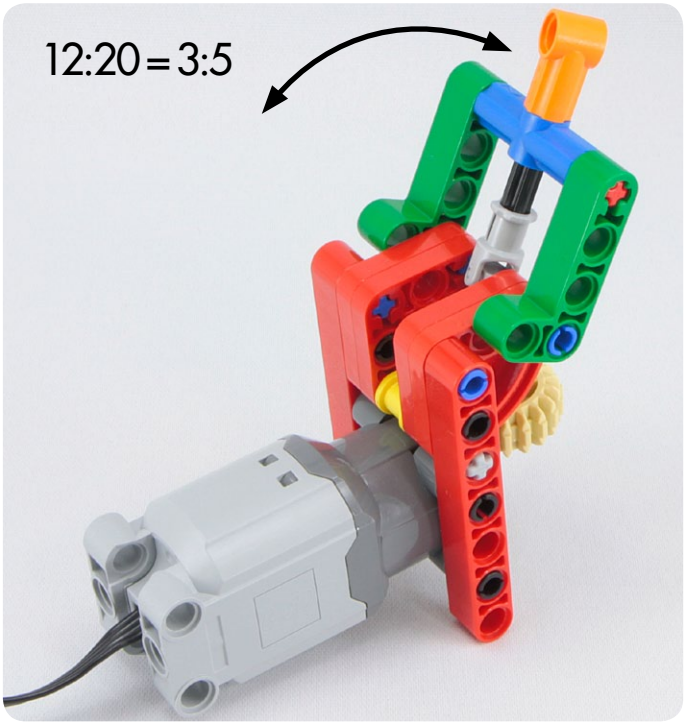

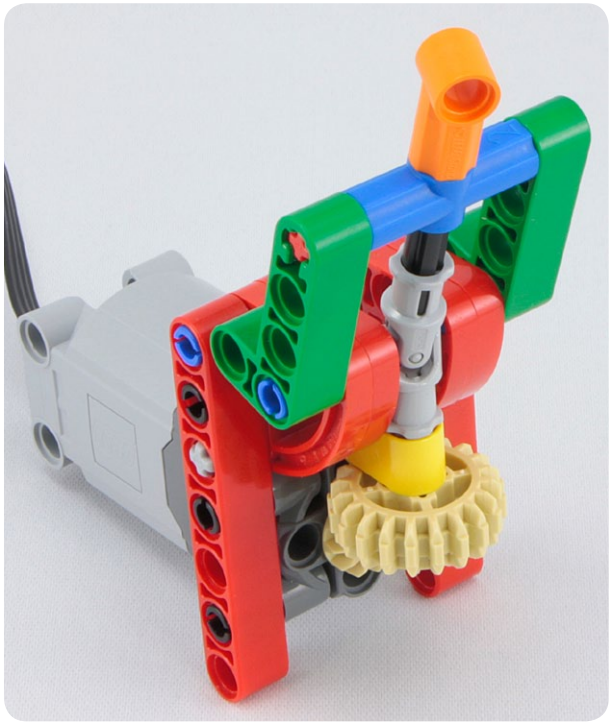

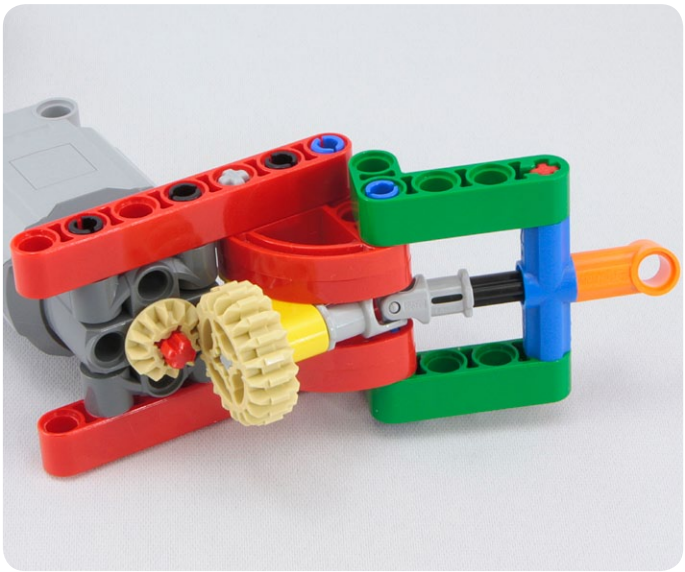

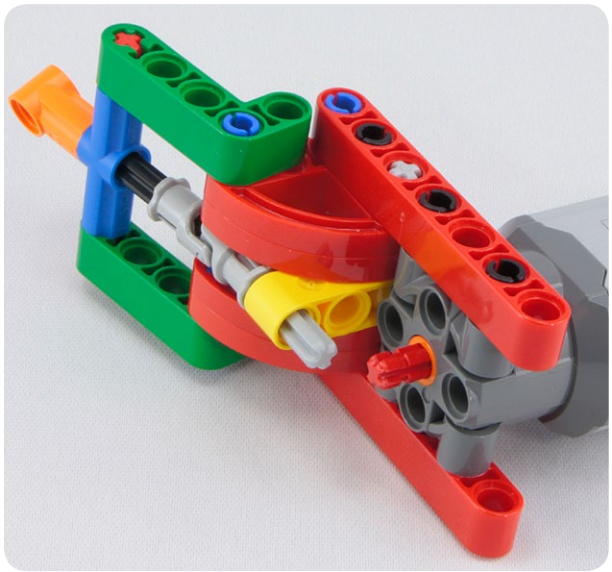

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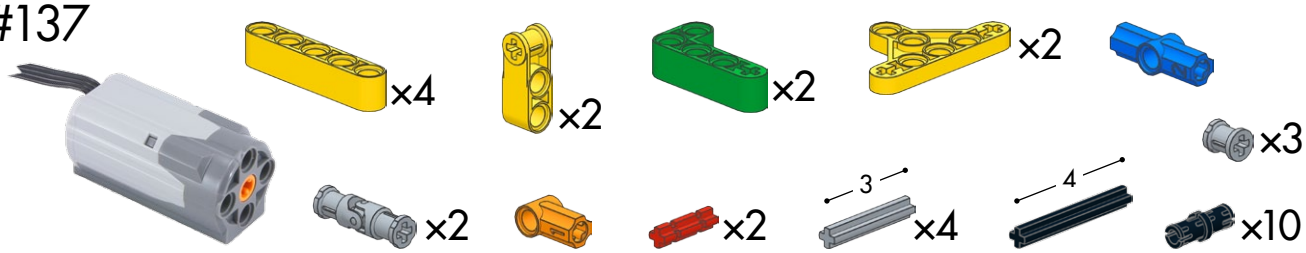

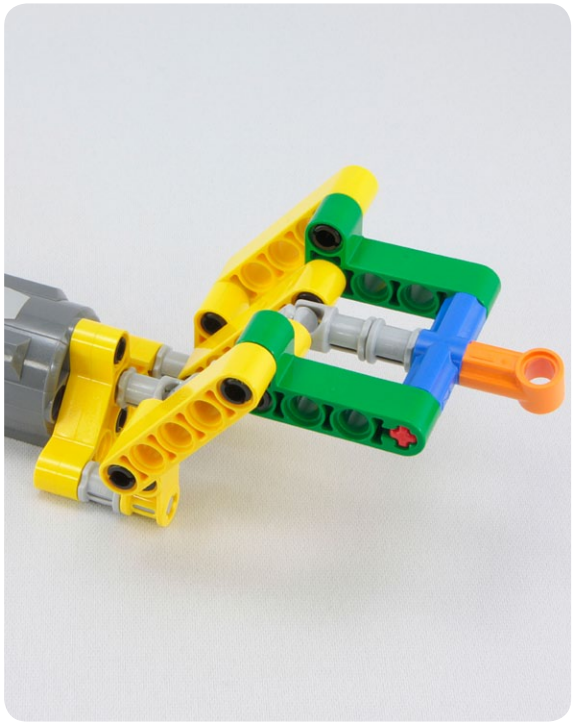

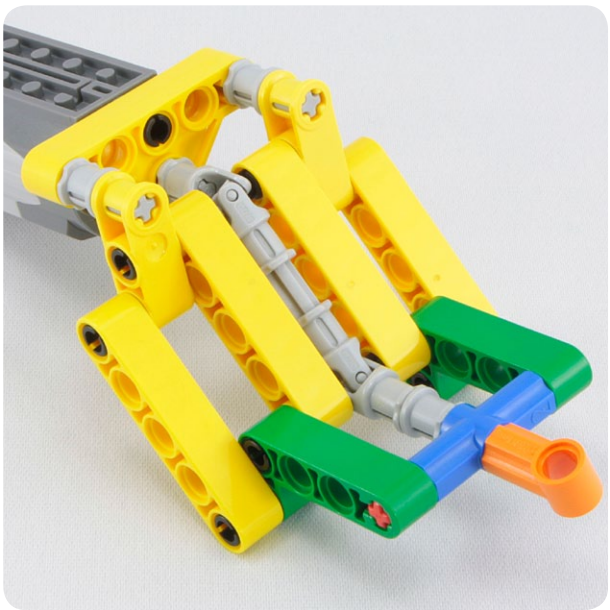

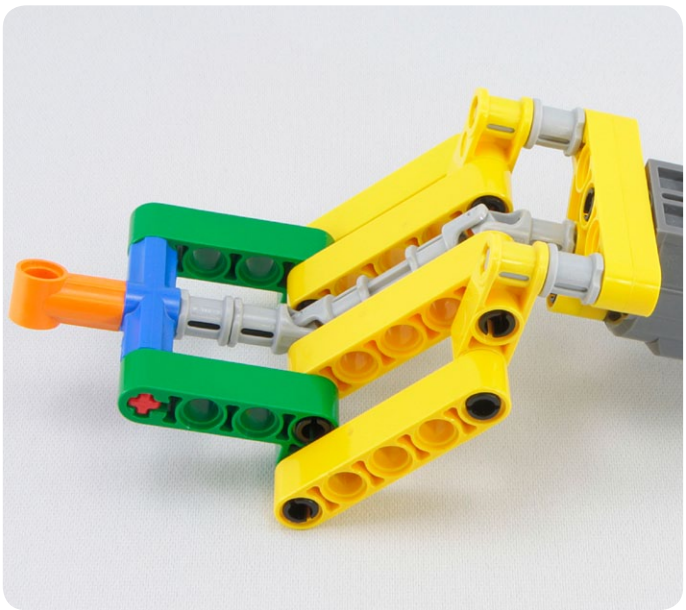

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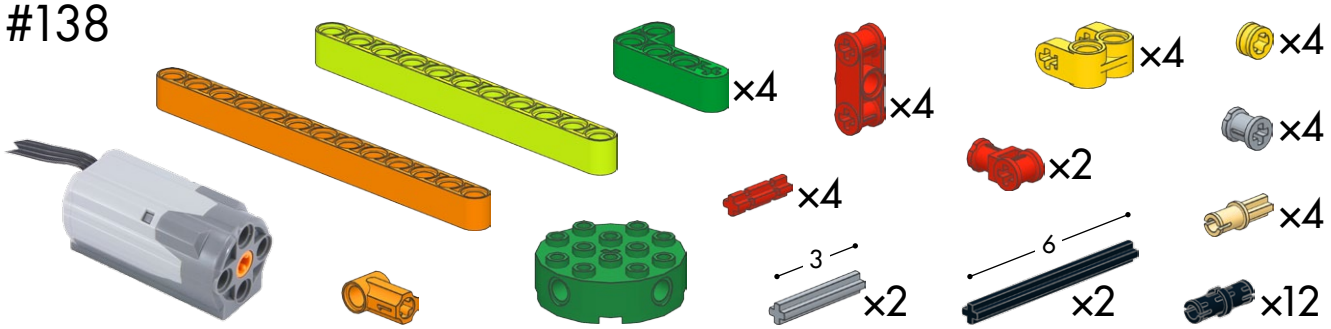

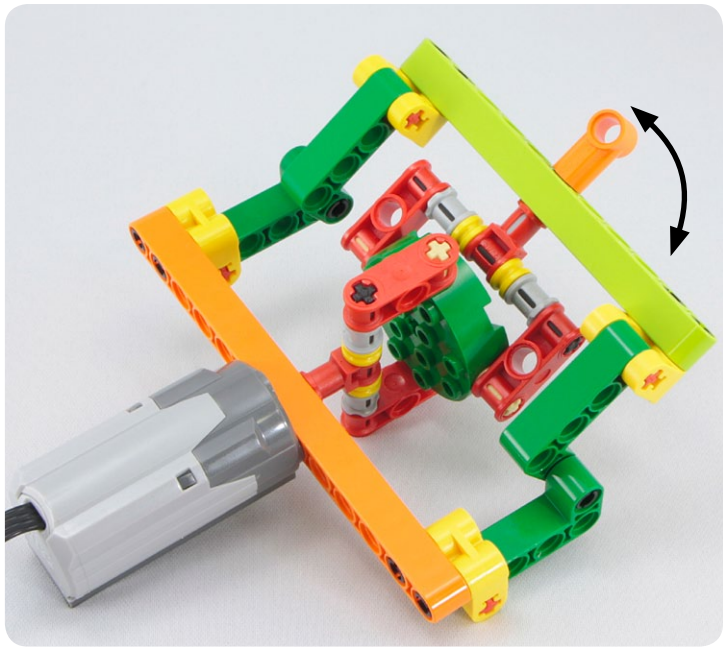

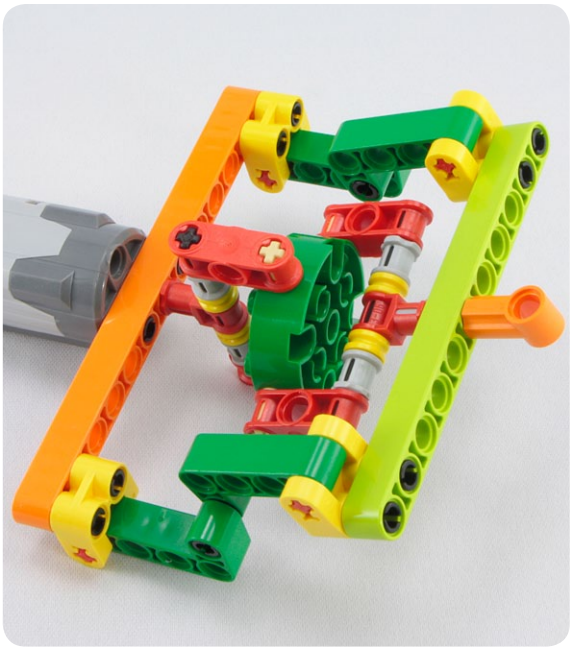

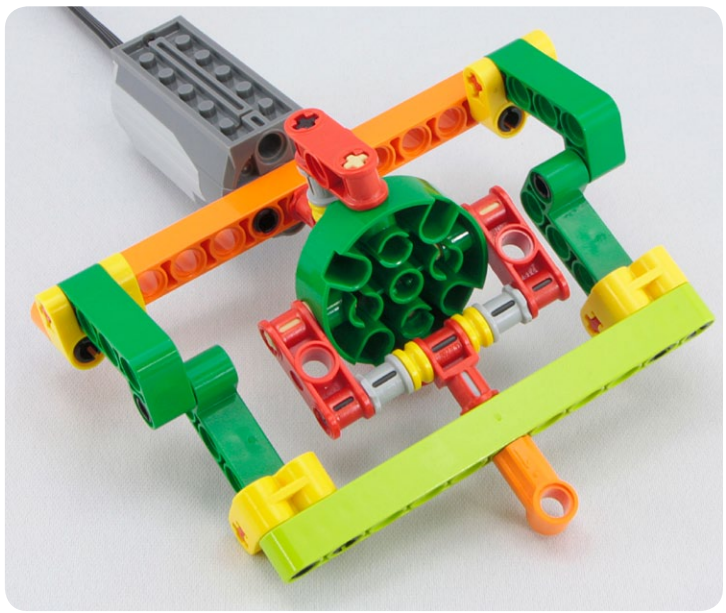

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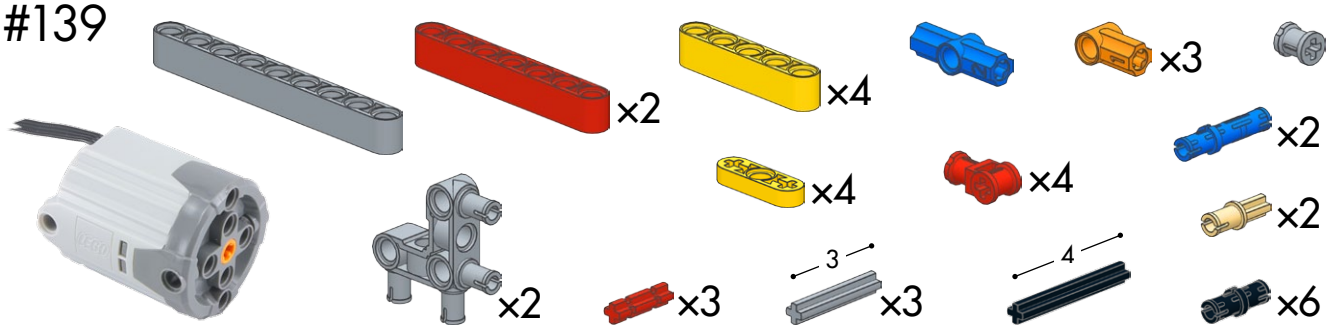

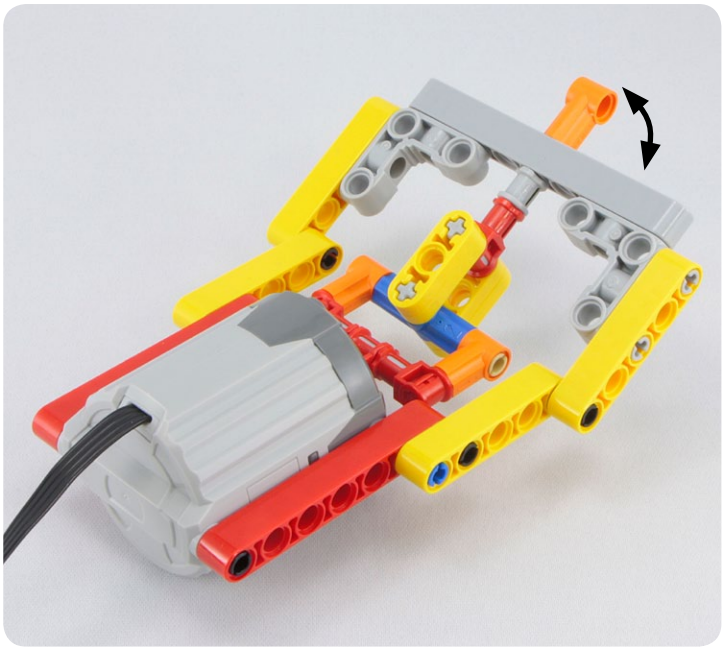

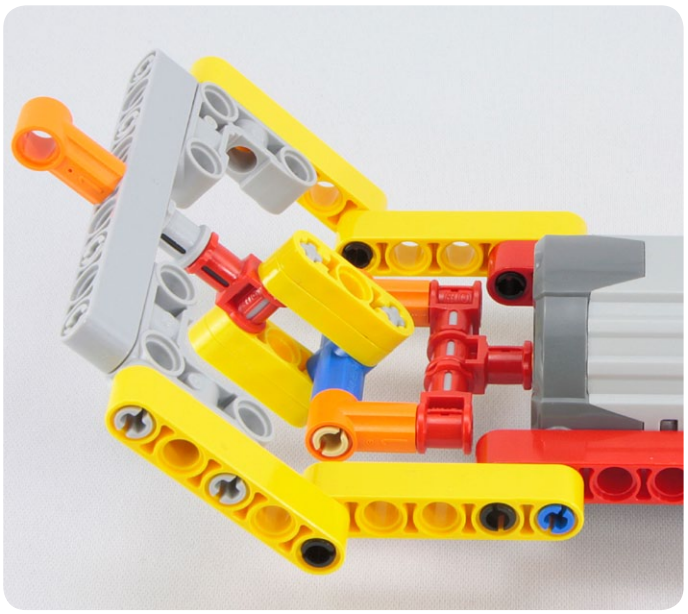

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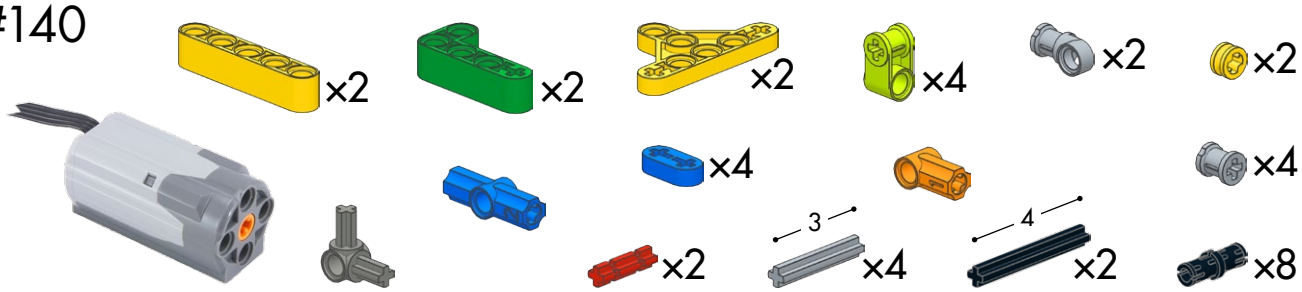

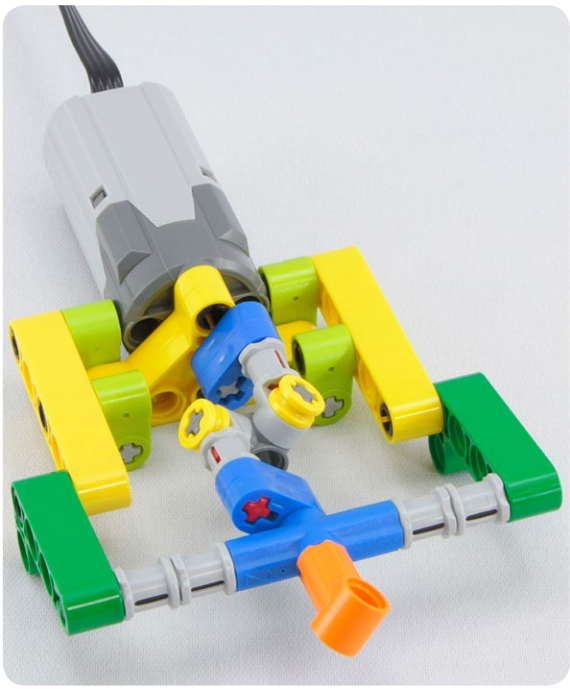

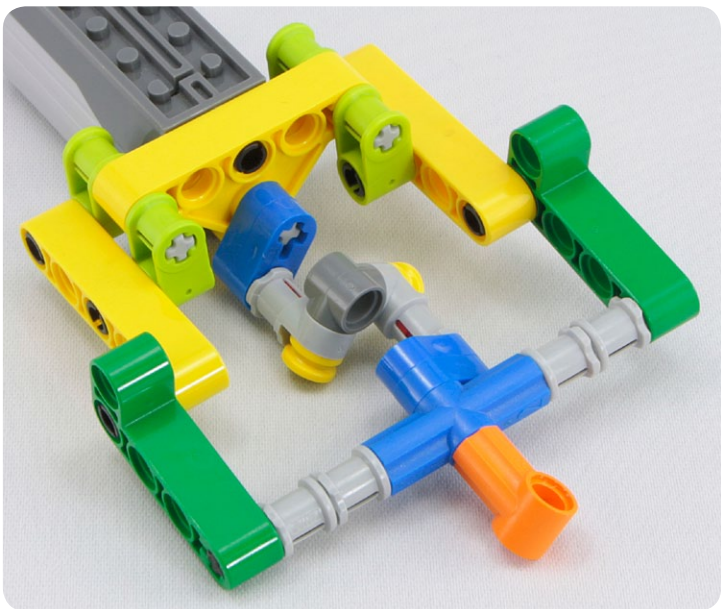

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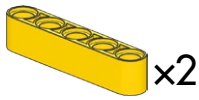

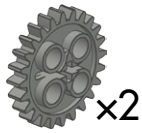

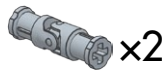

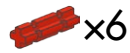

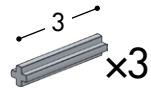

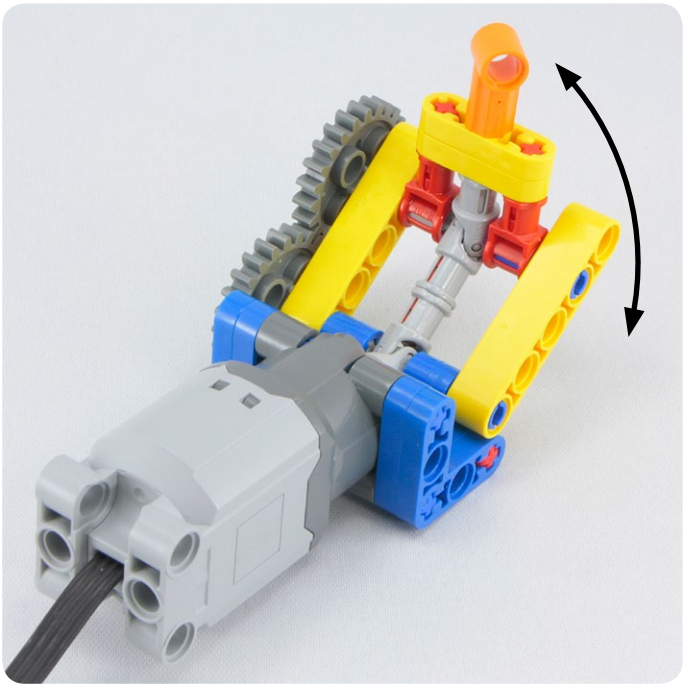

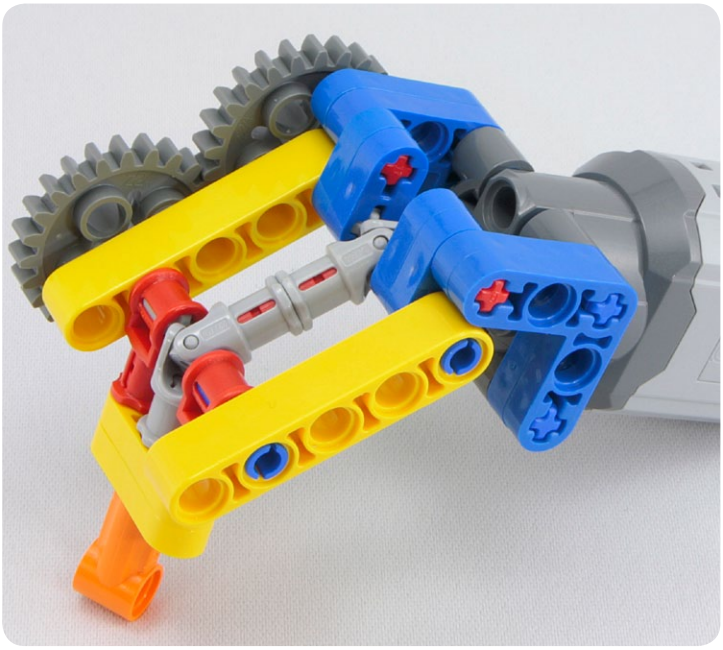

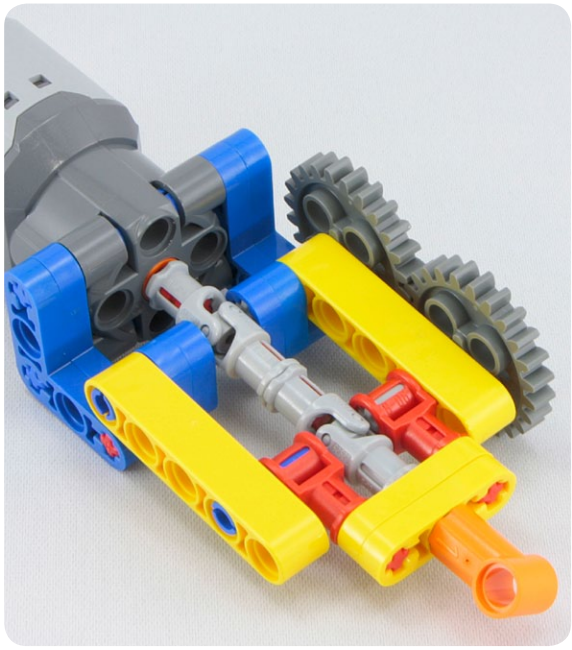

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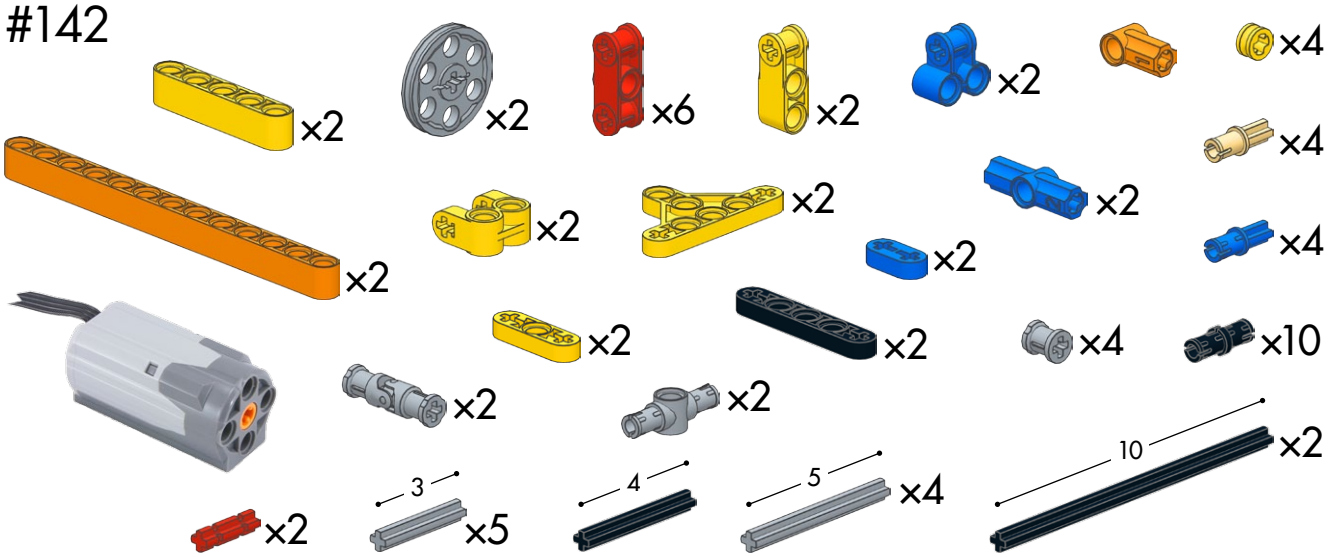
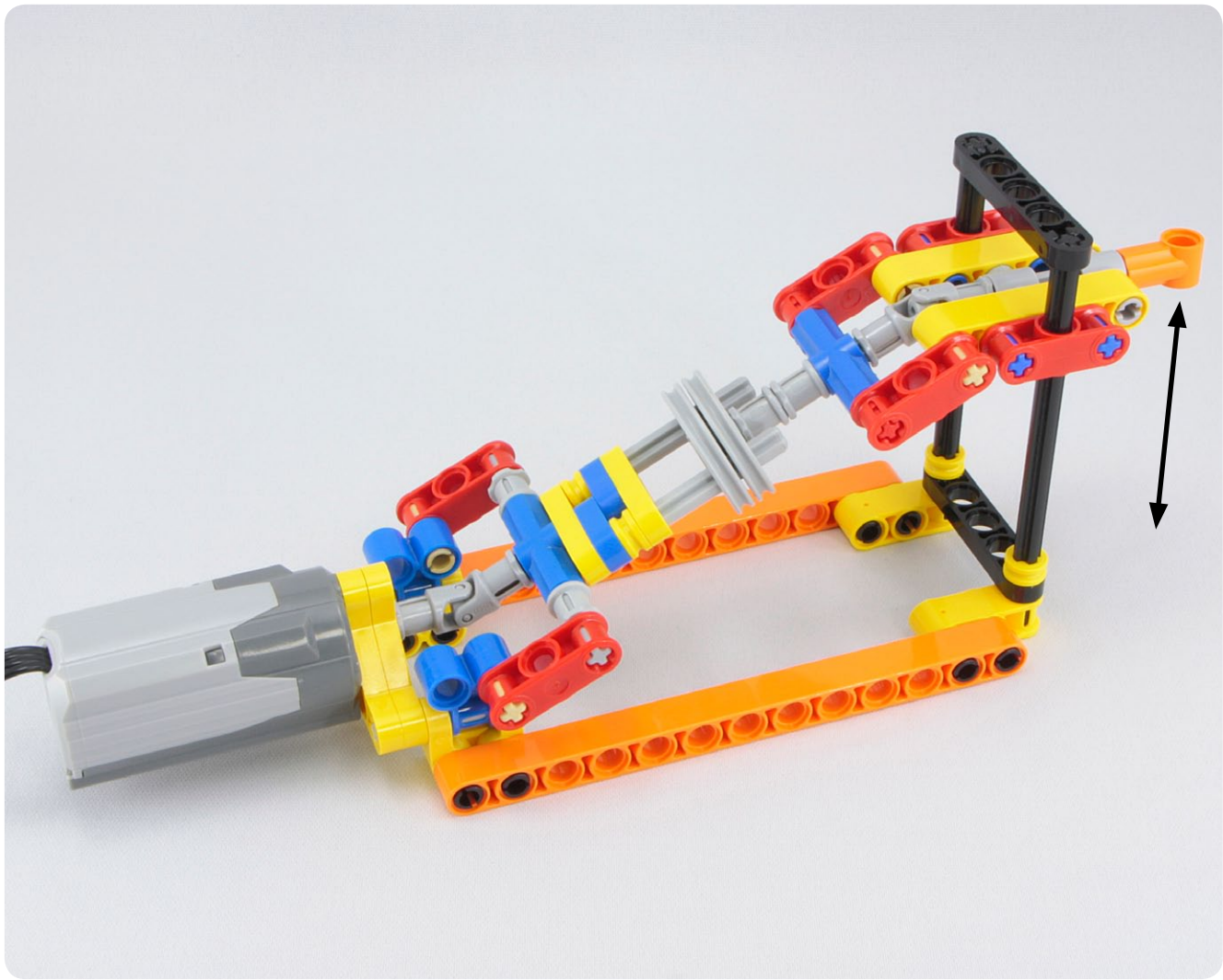
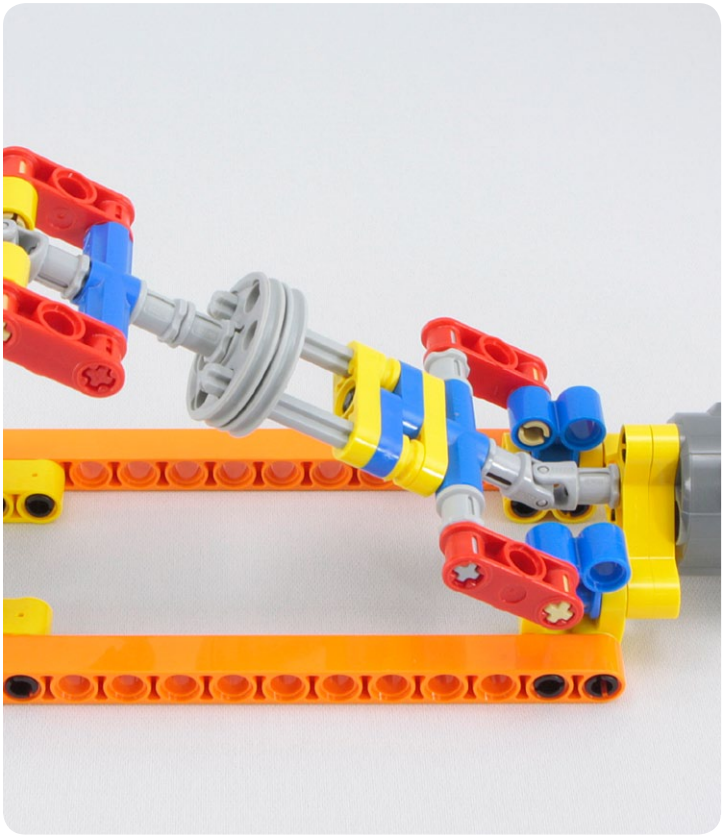
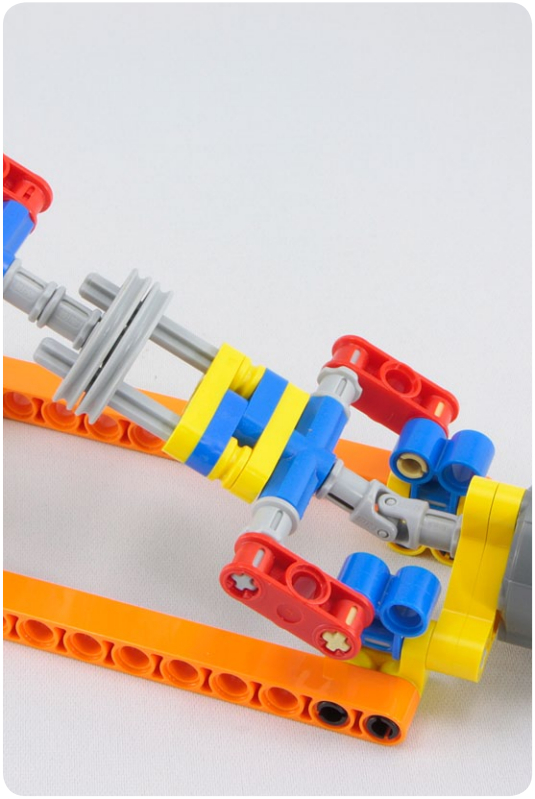


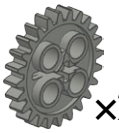
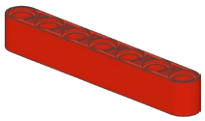
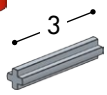






Transmitting rotation with chains and treads

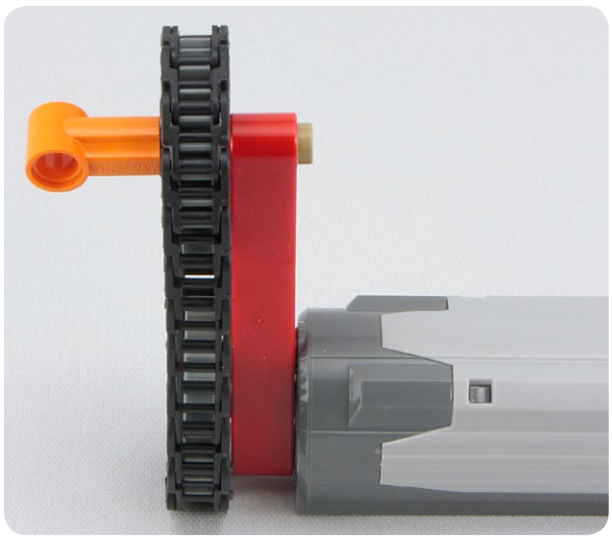
#143



×2


3


×2

×24


24:24 = 1:1



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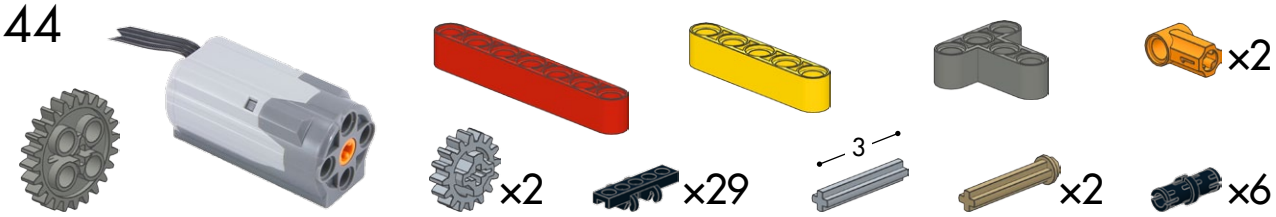

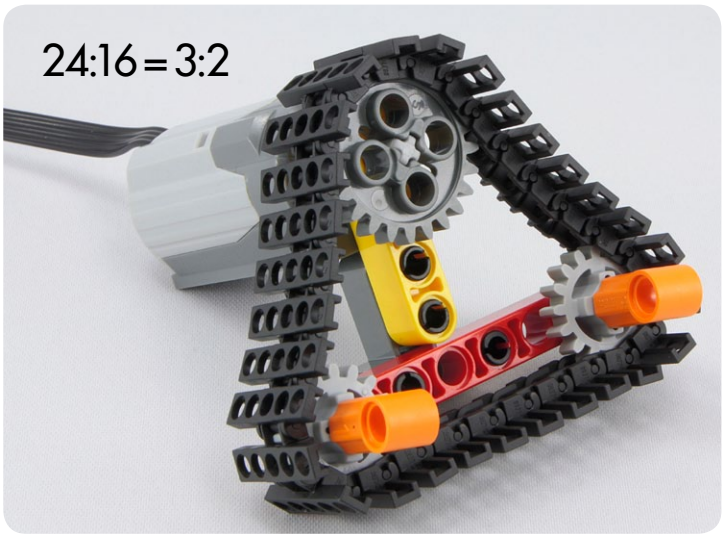

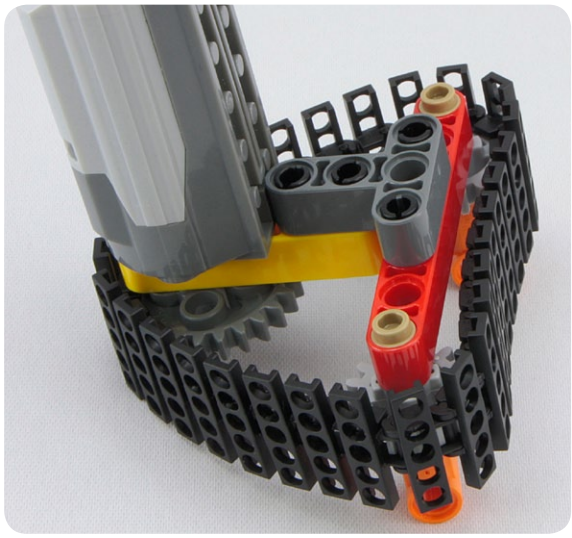

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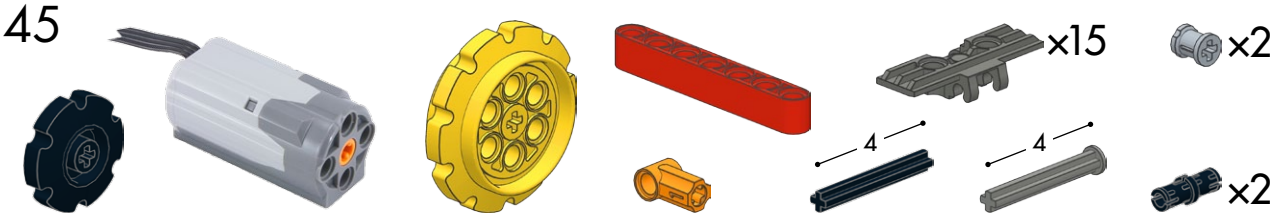

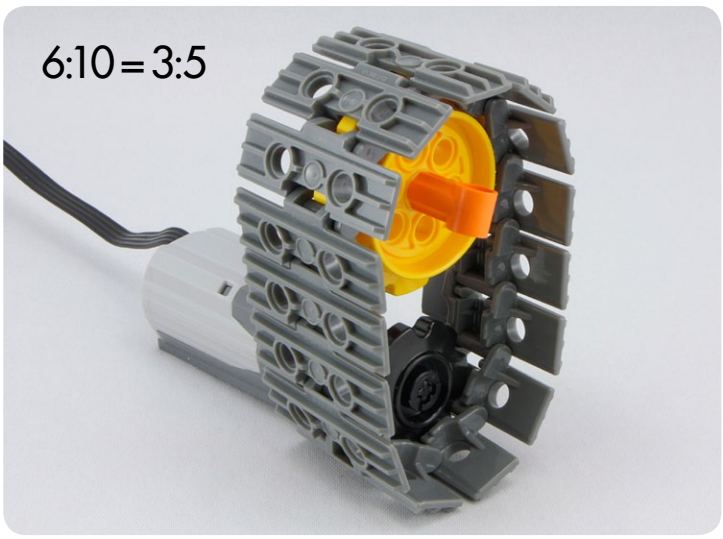

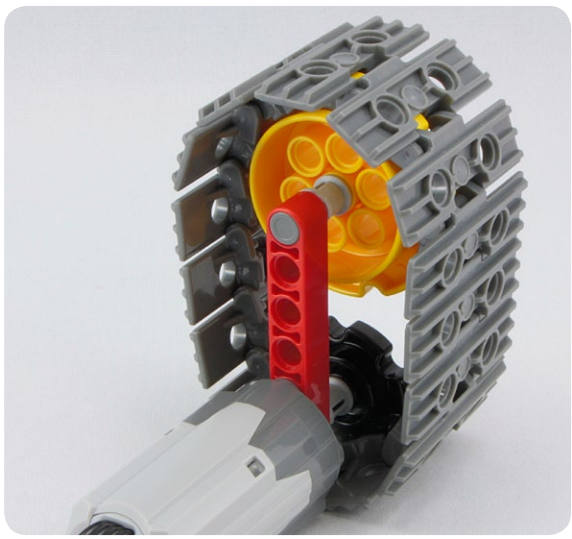

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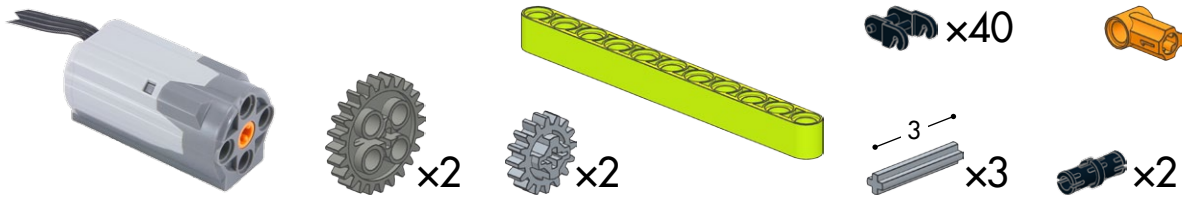

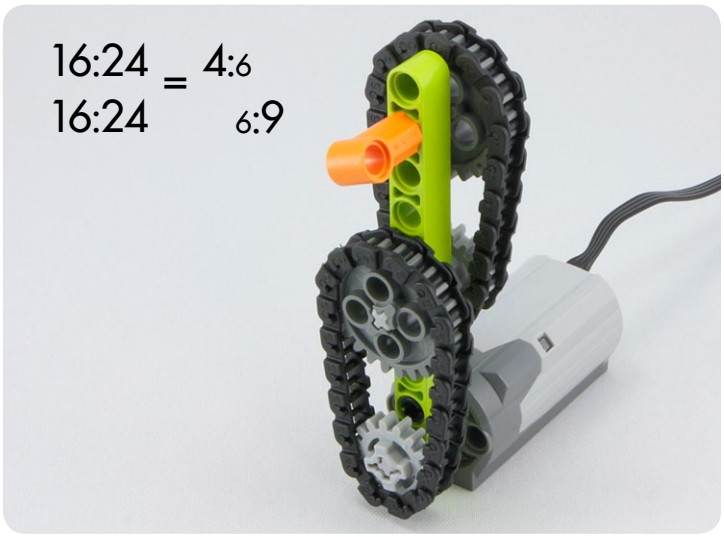

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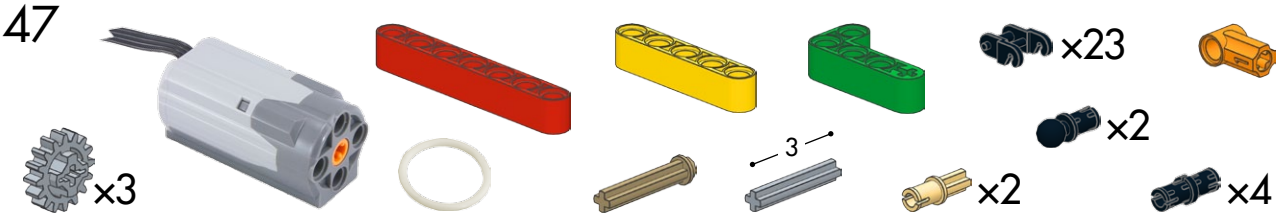

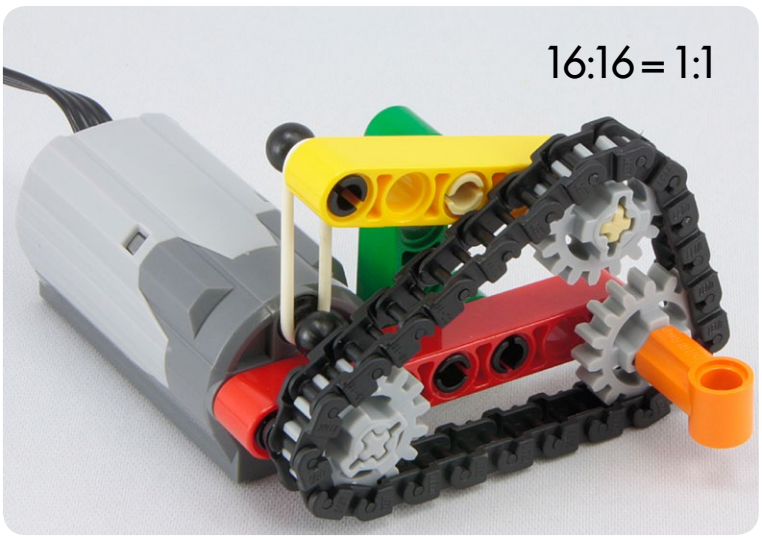

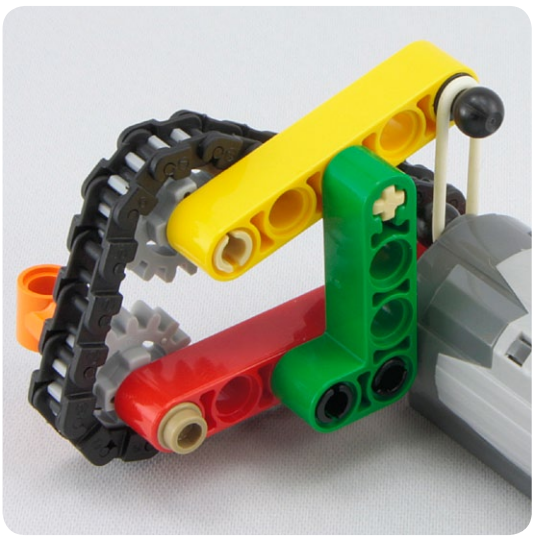

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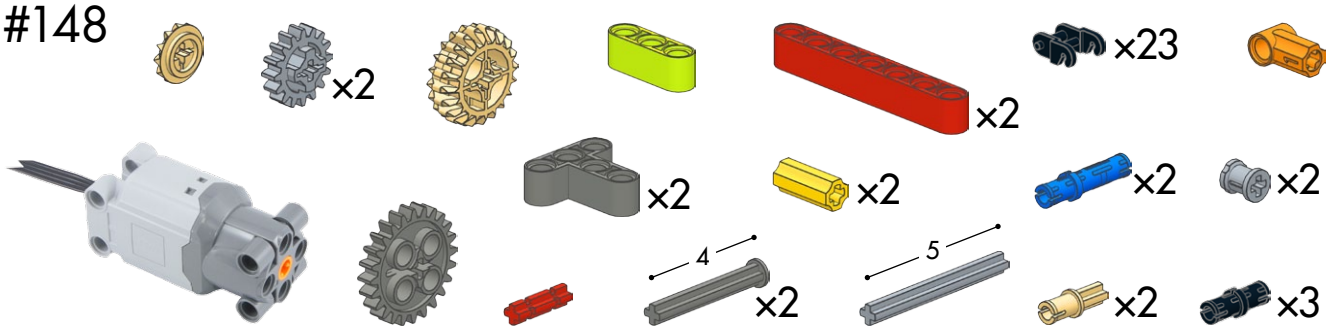
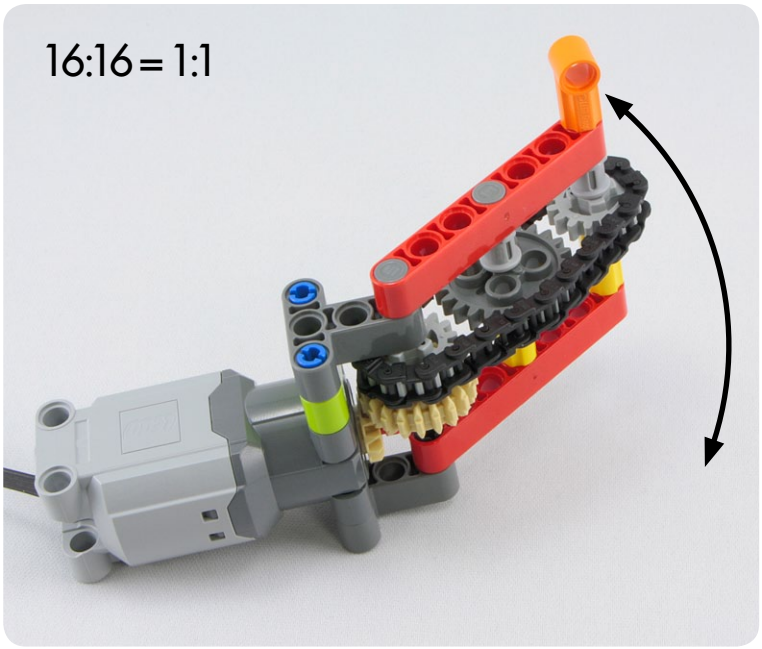
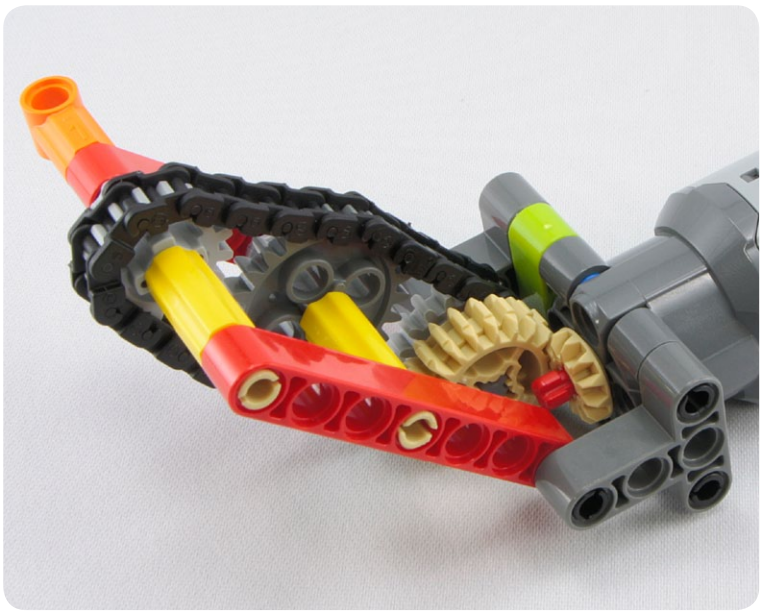
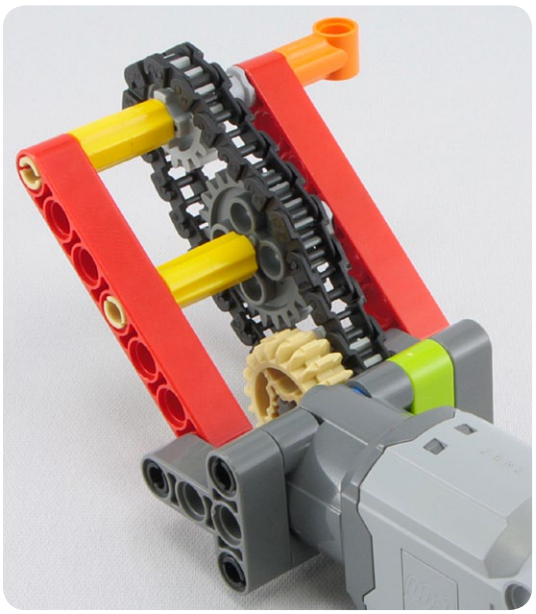


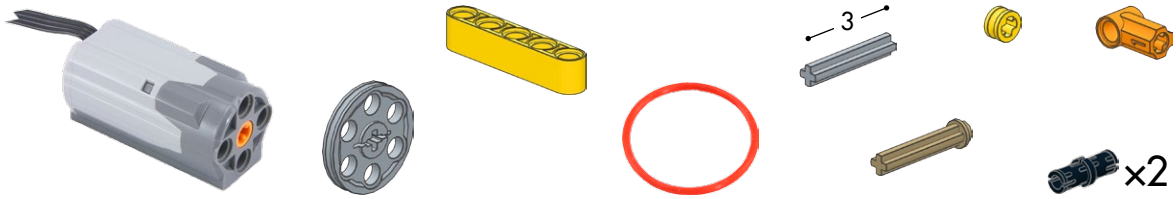


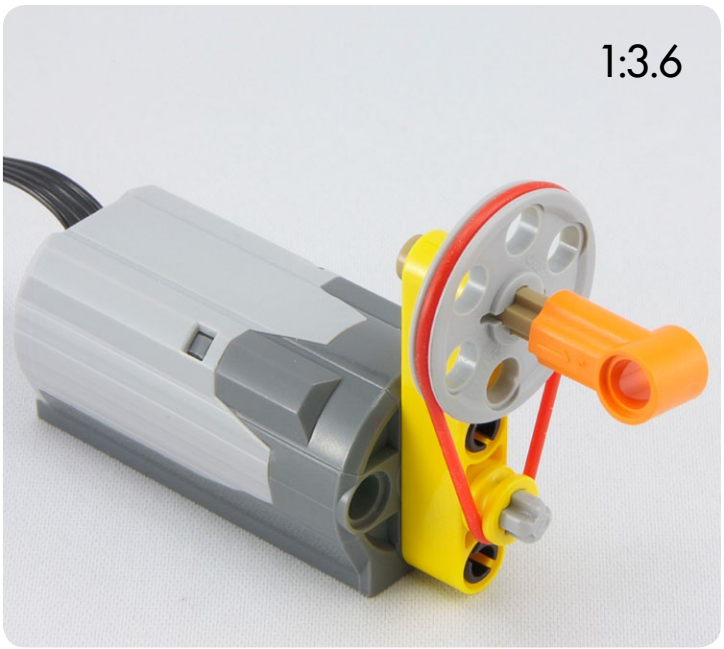


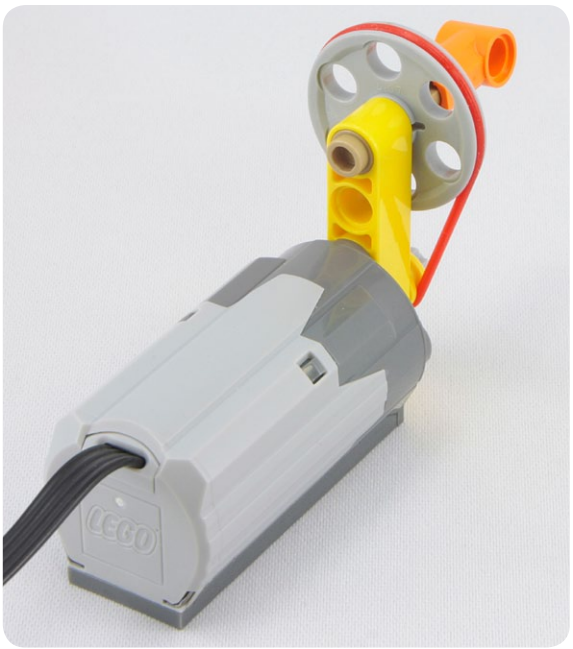


Transmitting rotation with rubber bands

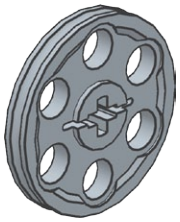
#149





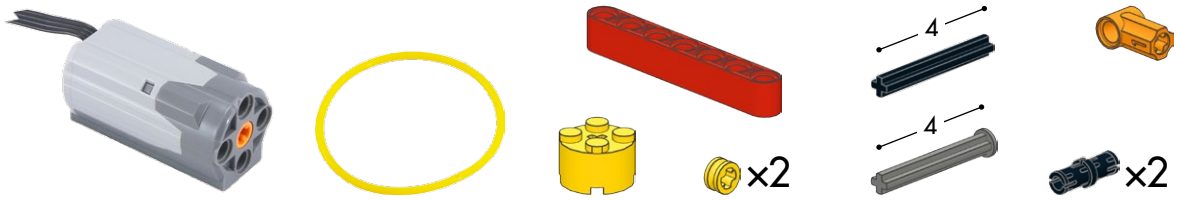


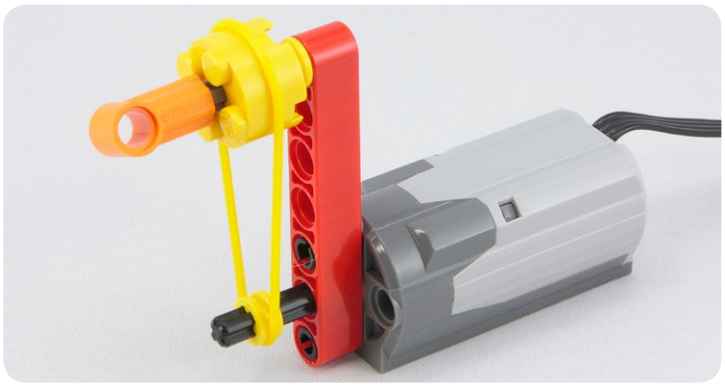

6.2 mm

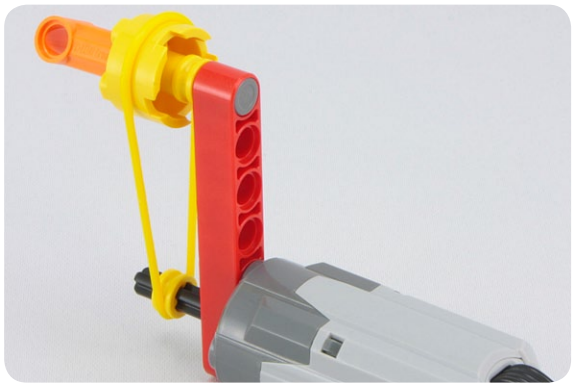

22.3 mm

6.2:22.3 ≈ 1:3.6

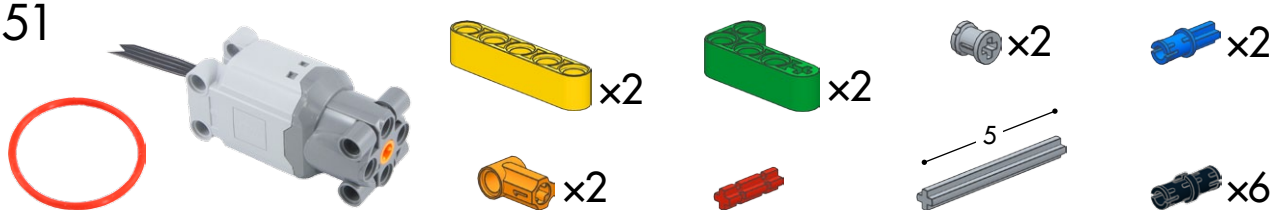
#150

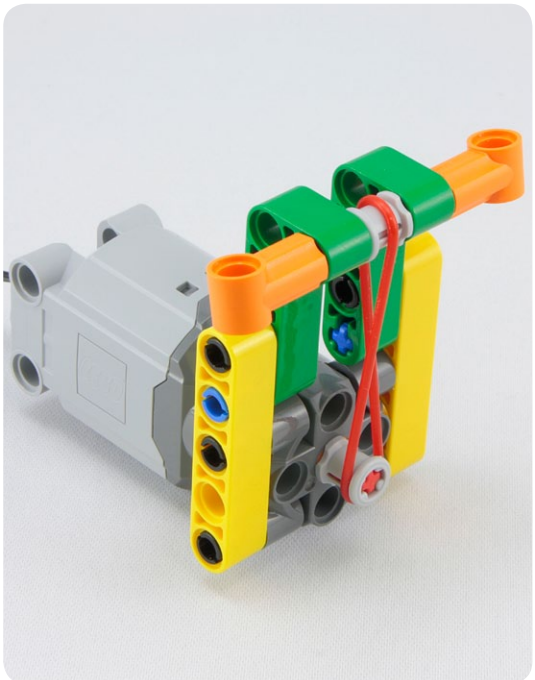


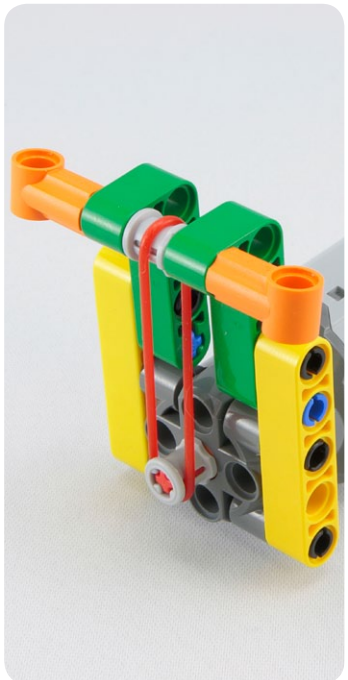




#151







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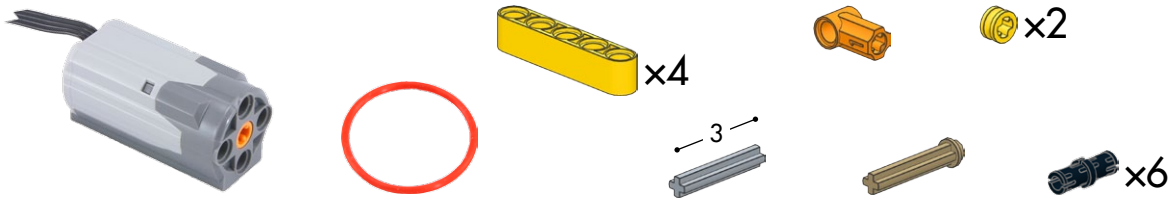
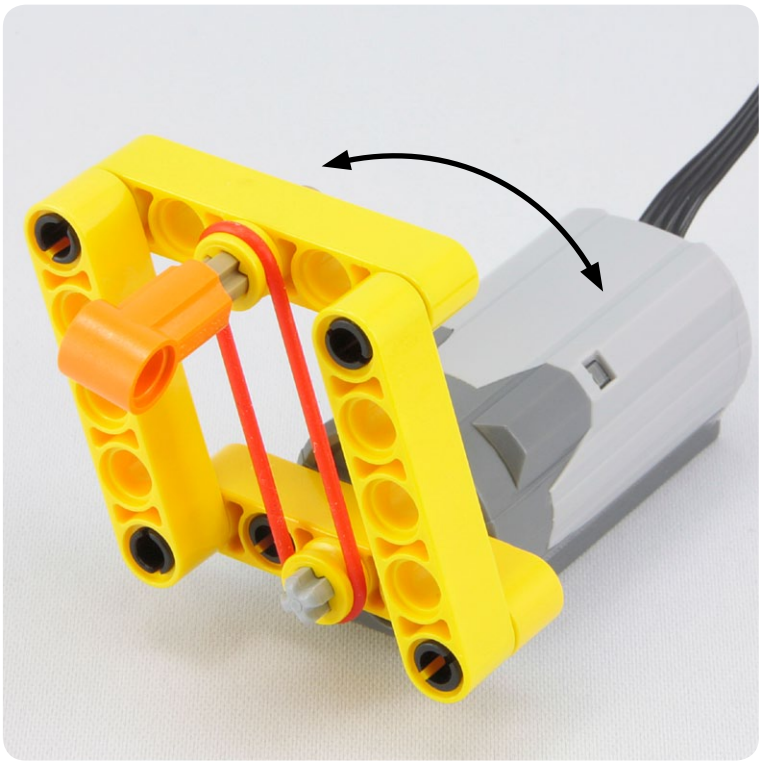
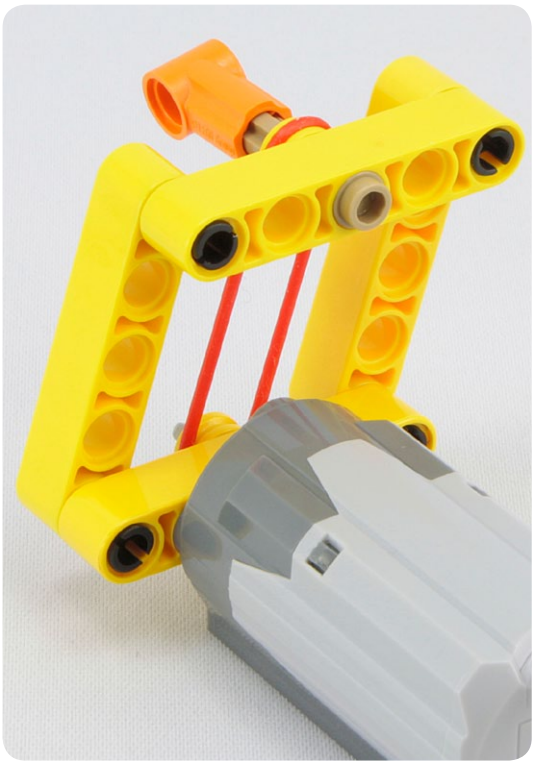
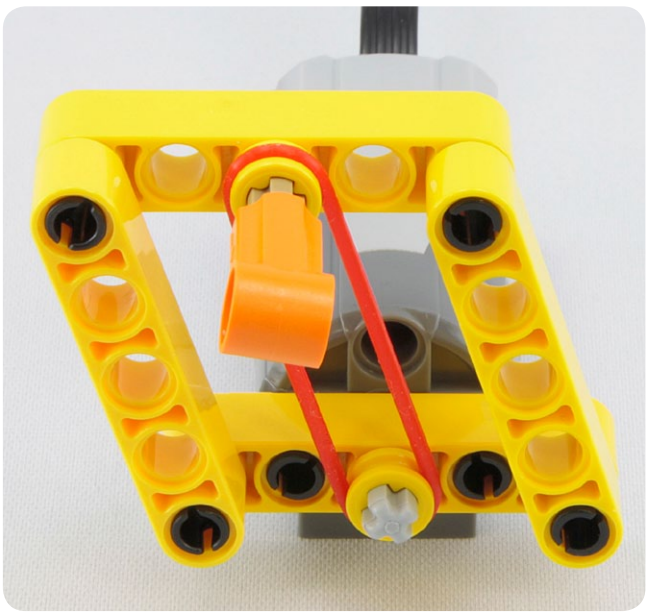
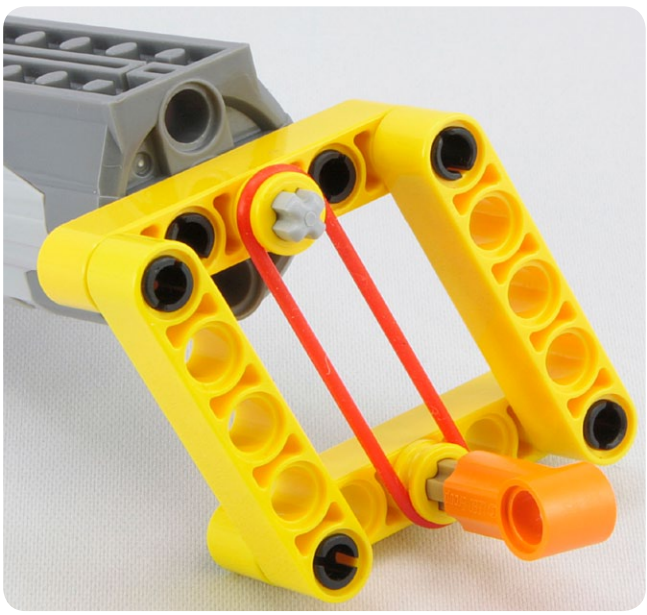


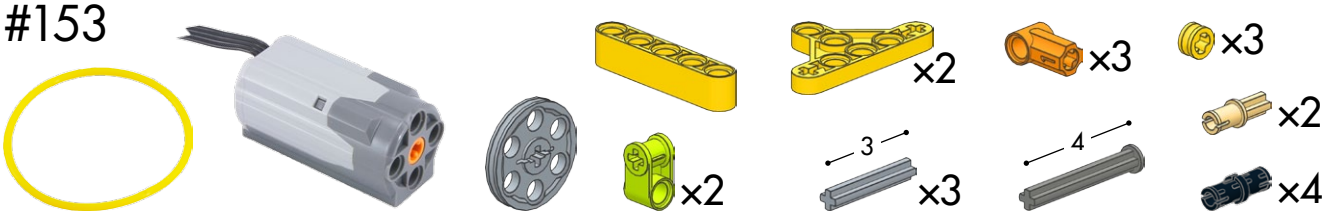


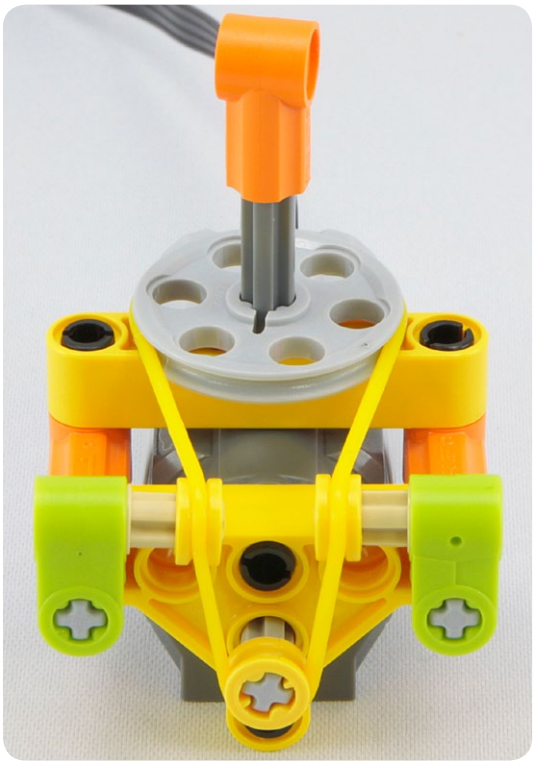


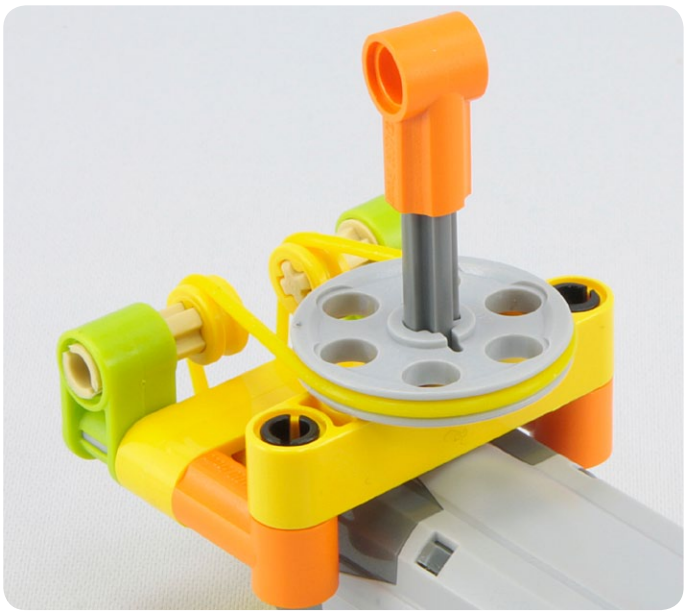




#153

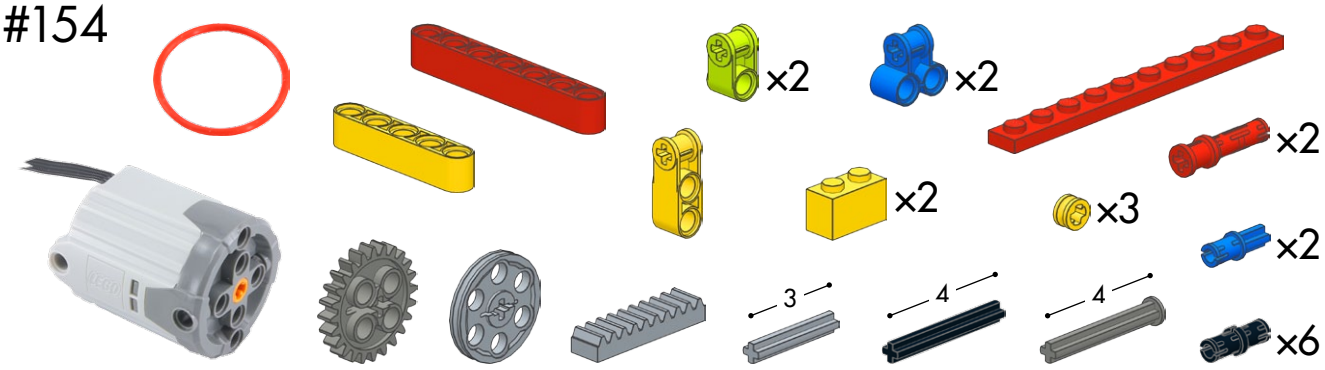


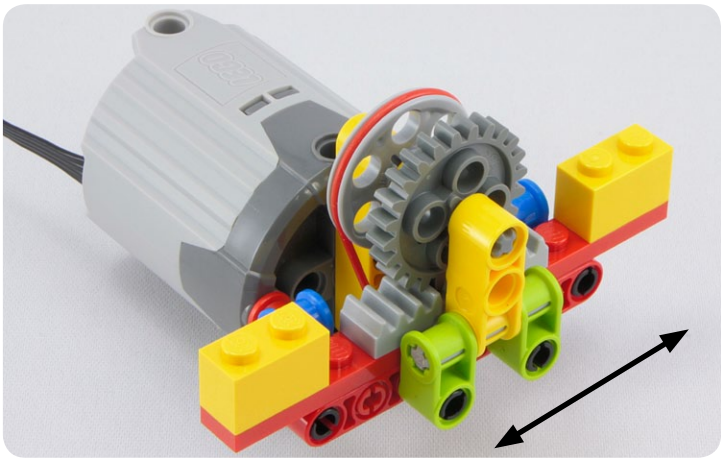


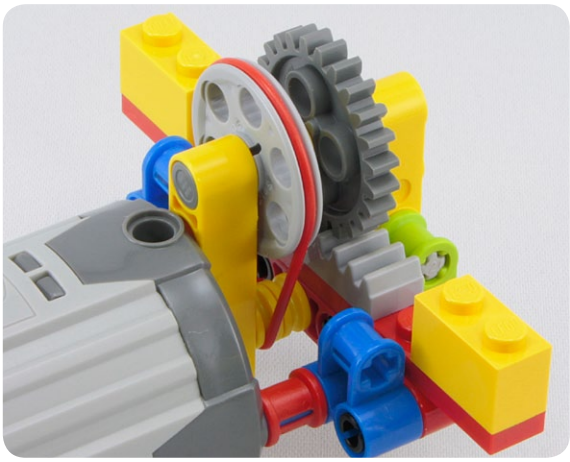


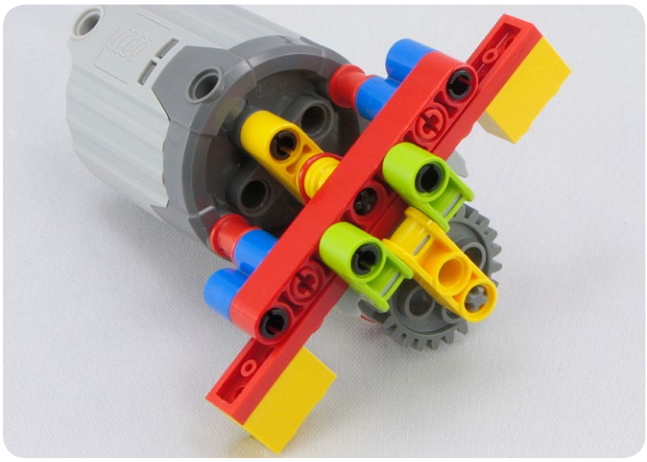
Rack-and-pinion gears

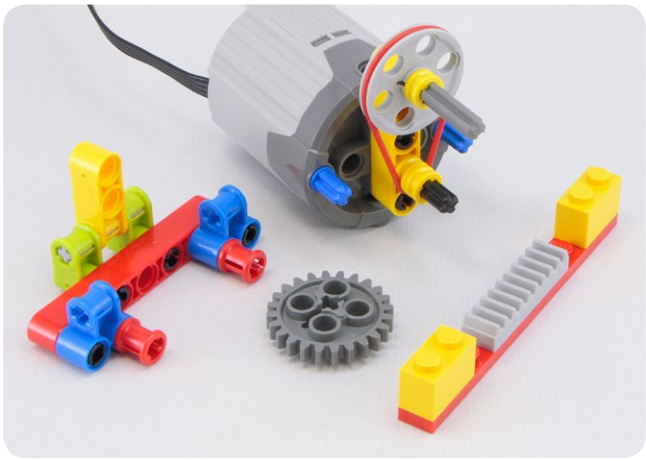
#154



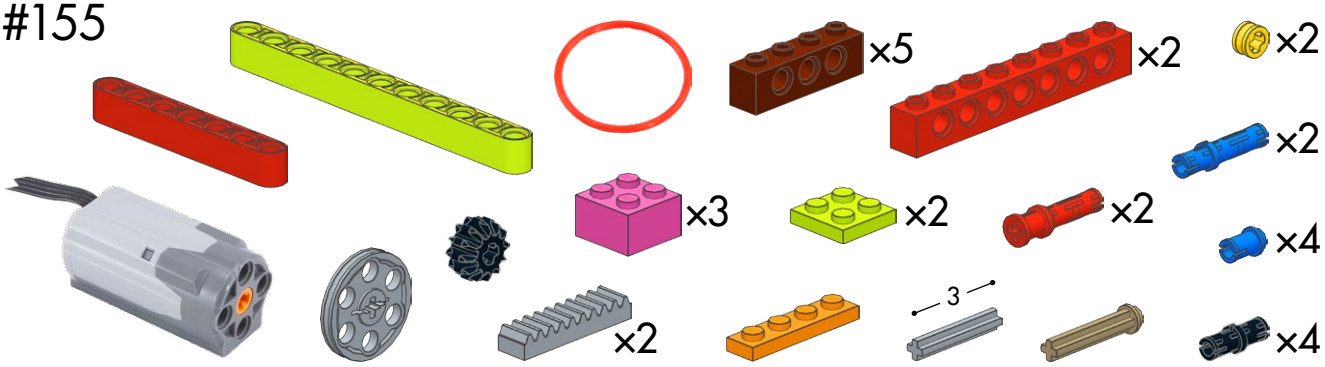


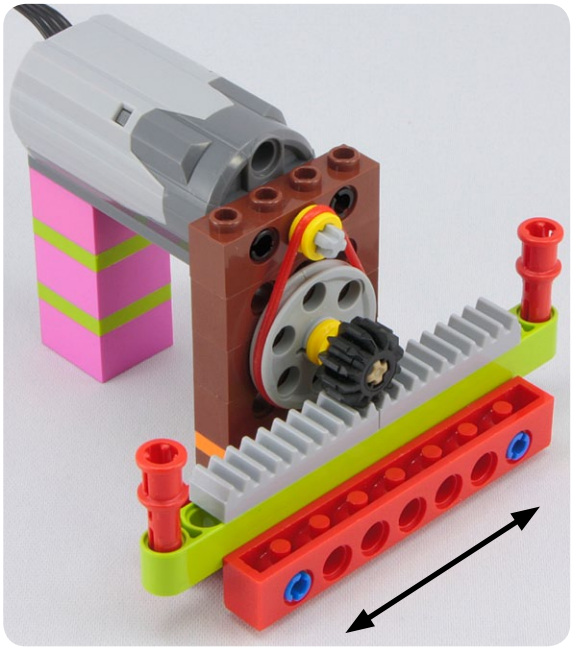


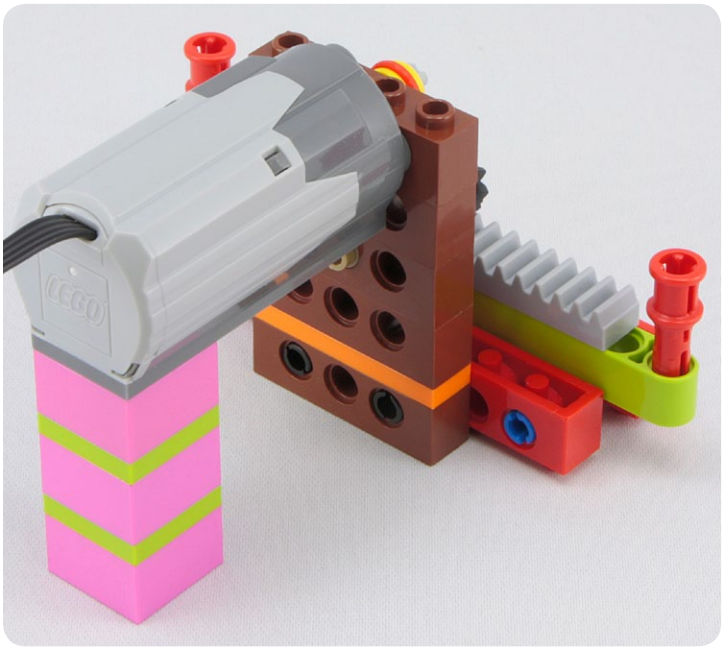


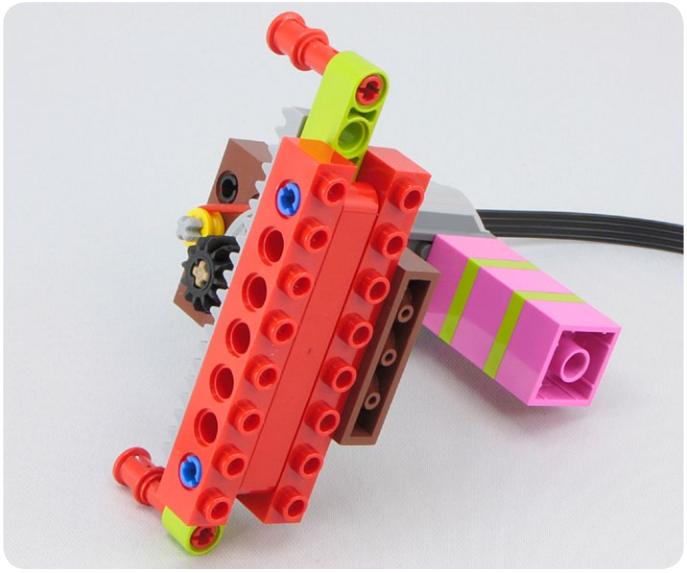


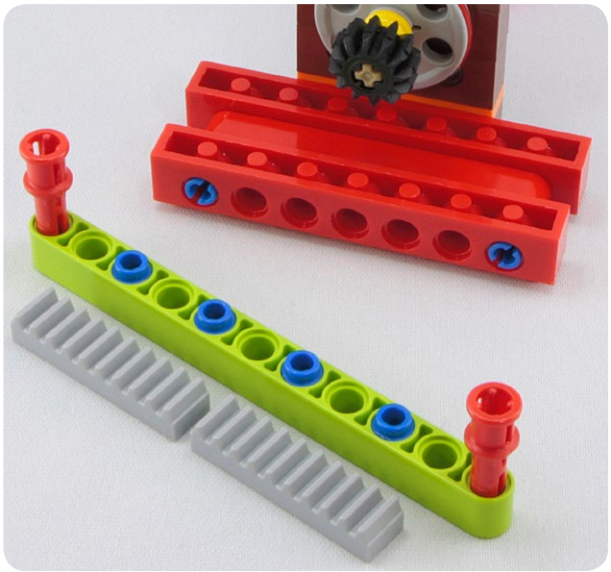
#155











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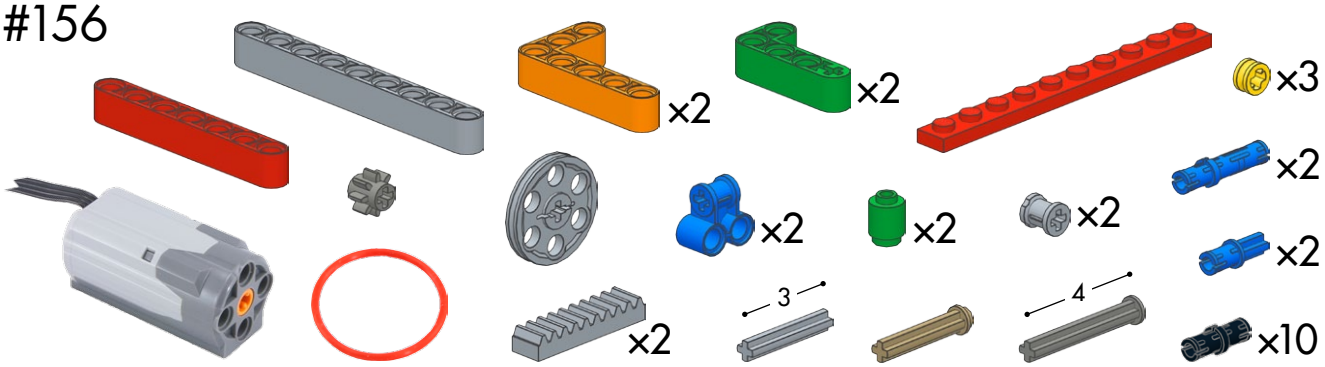

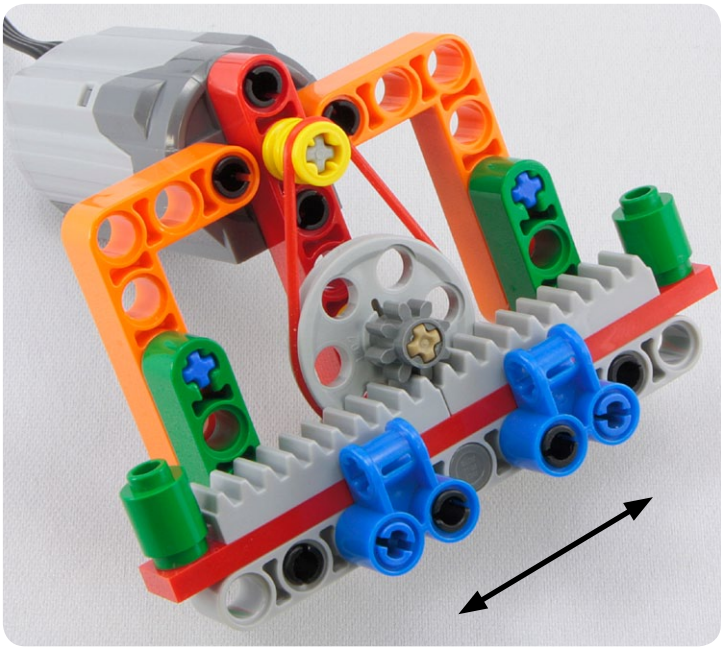

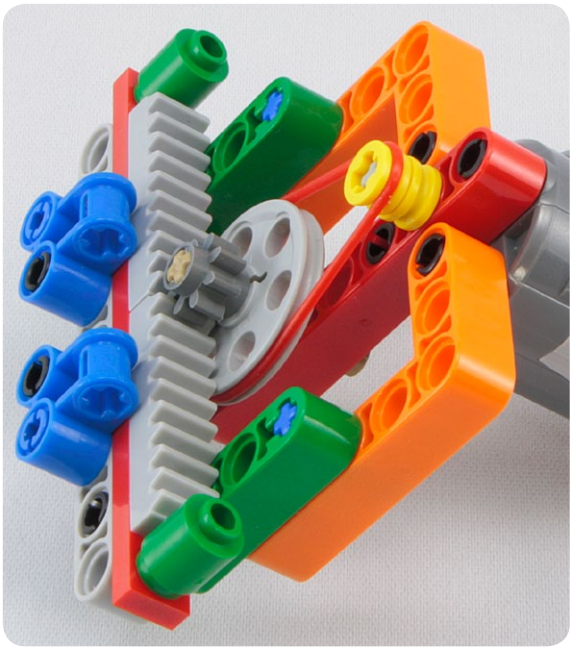

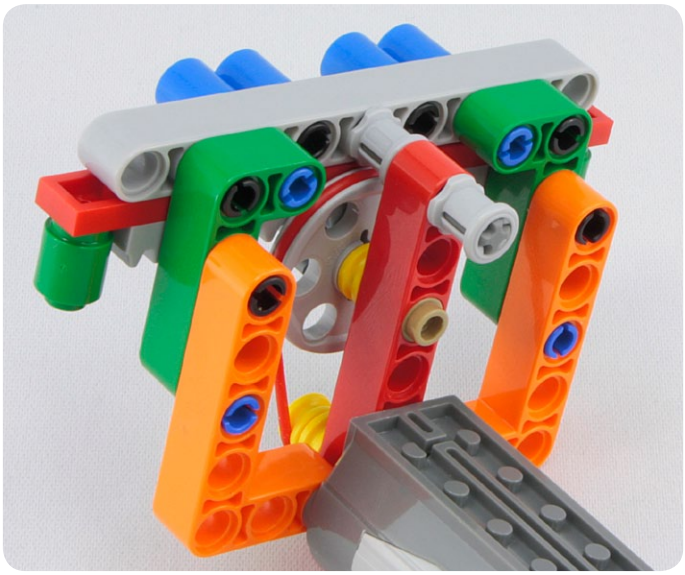

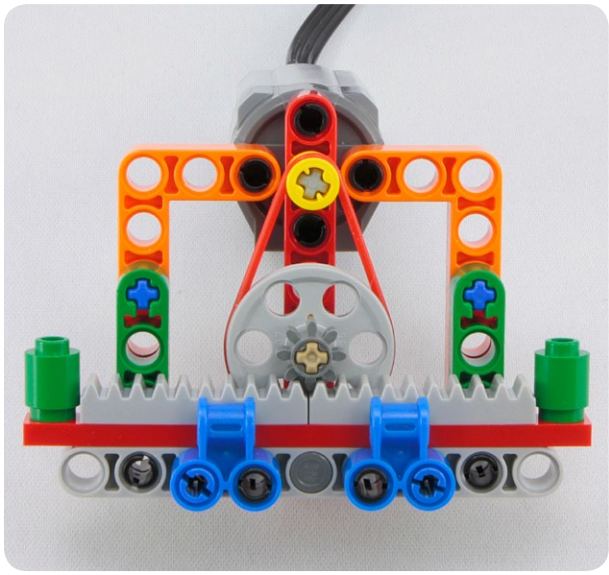

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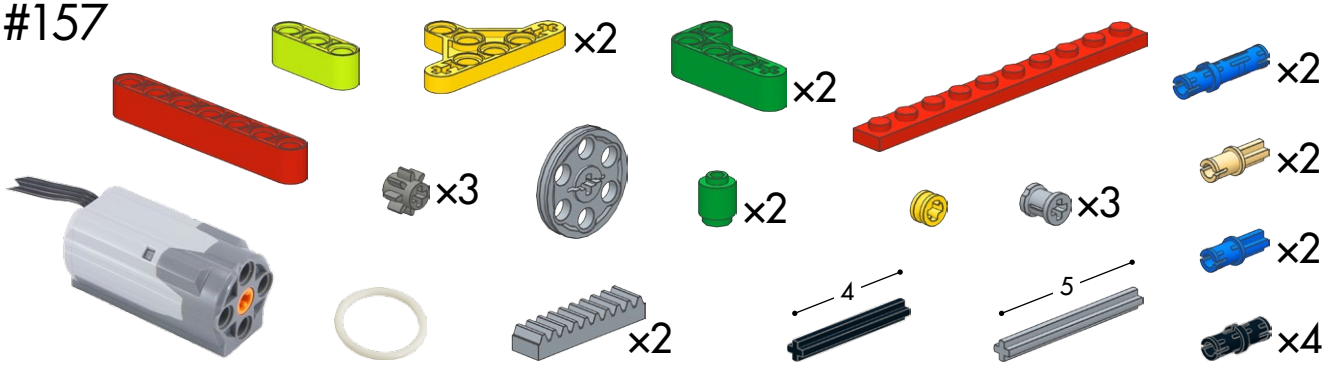

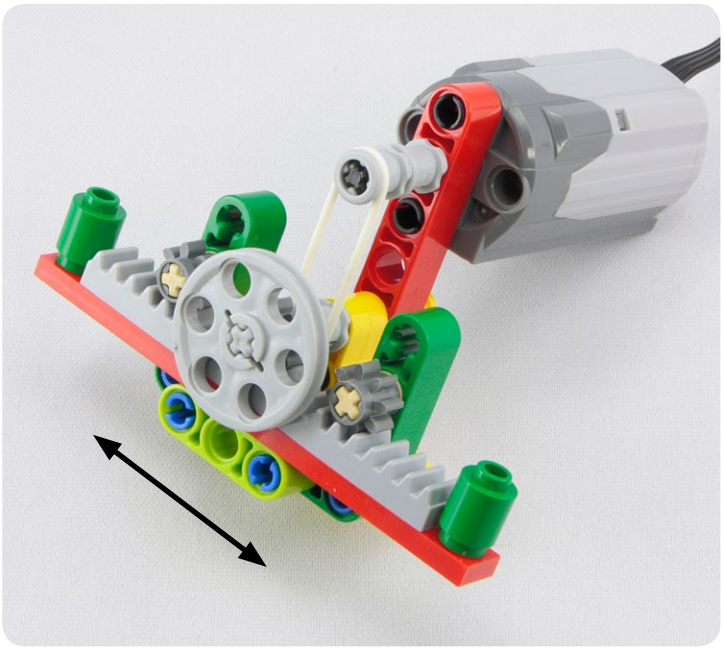

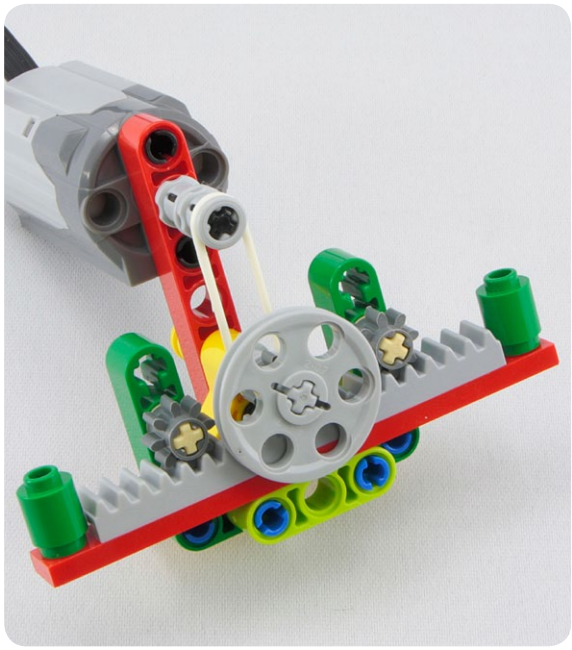

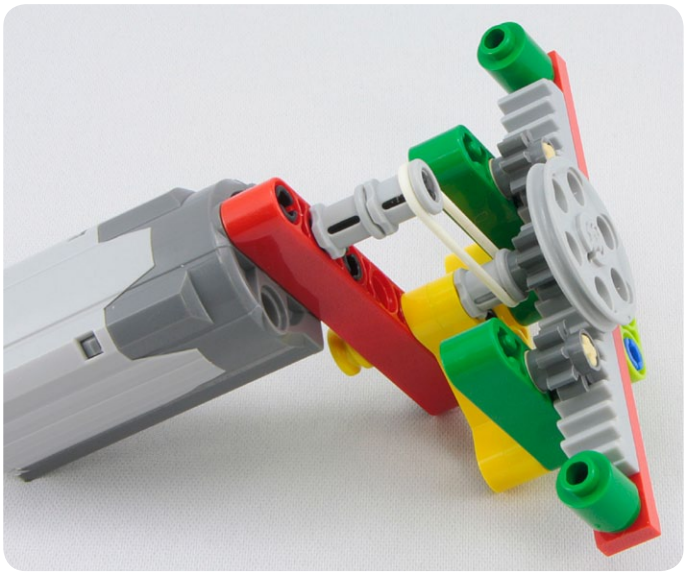

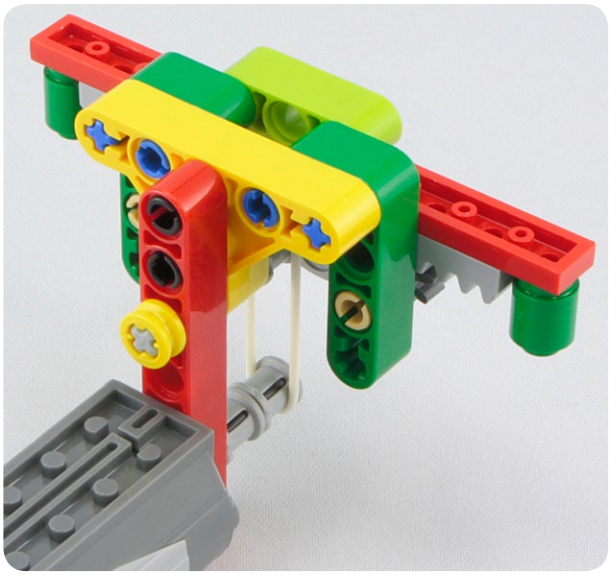

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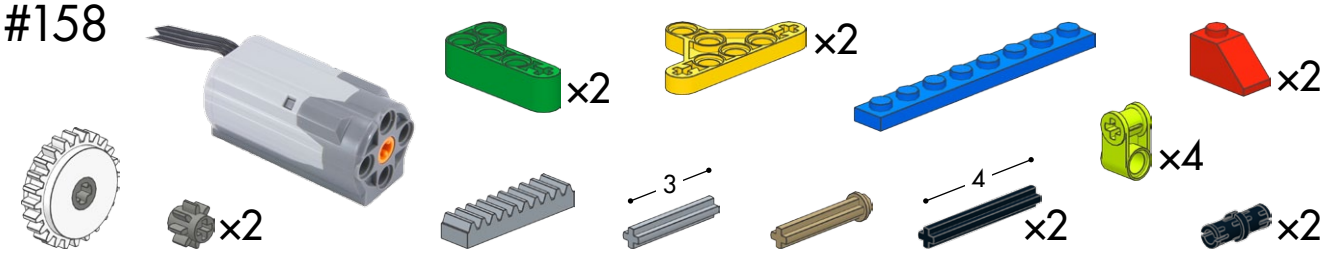

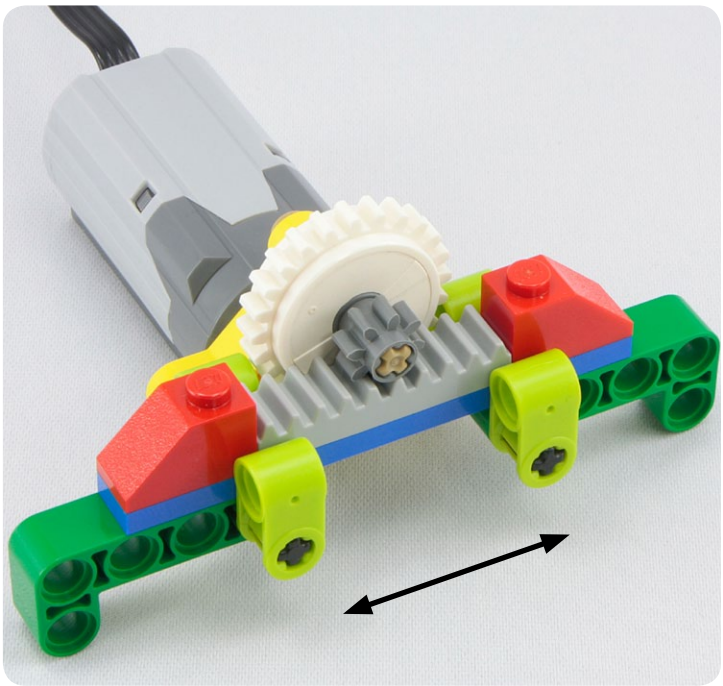

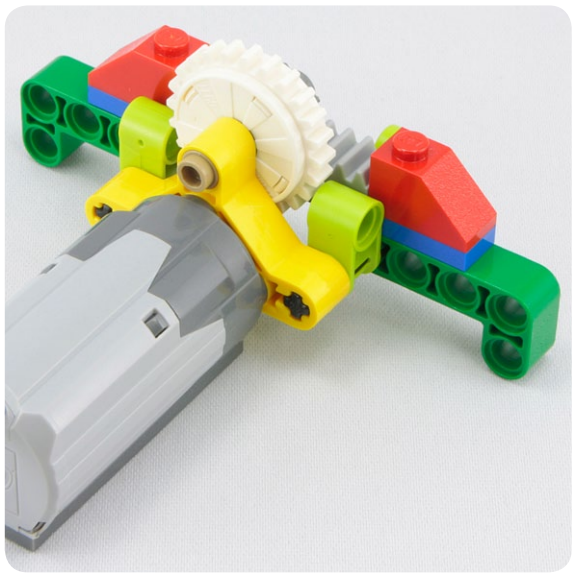

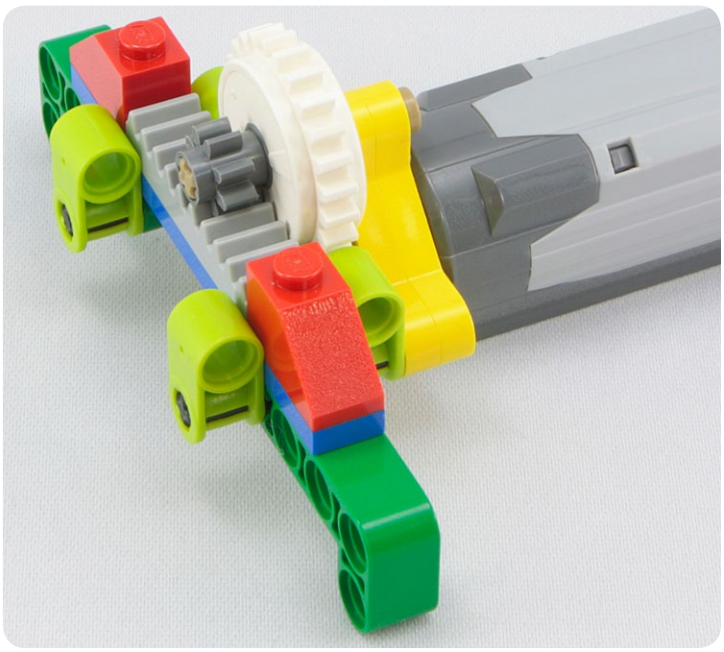

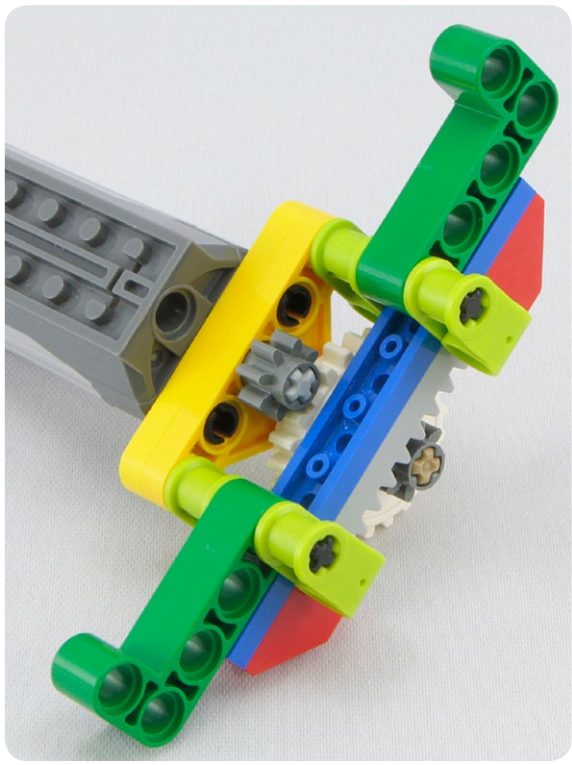

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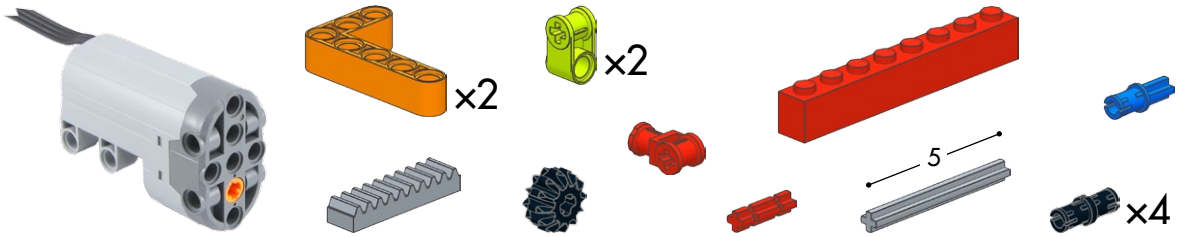

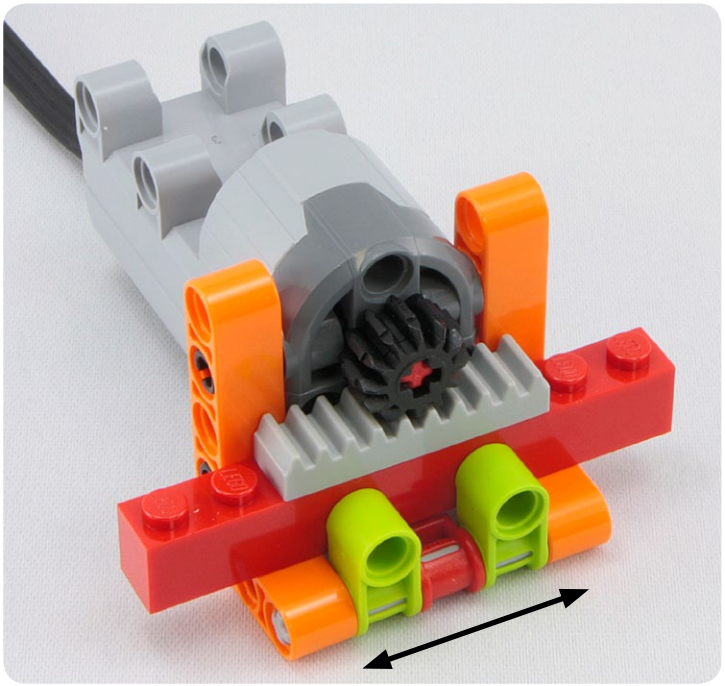

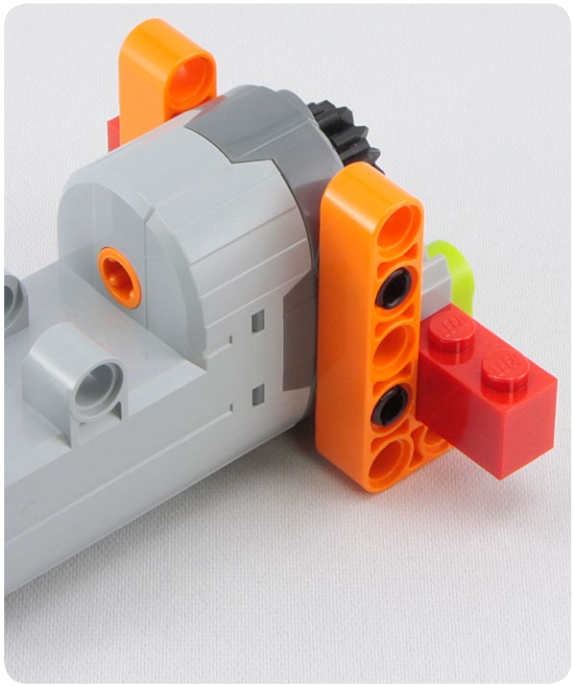

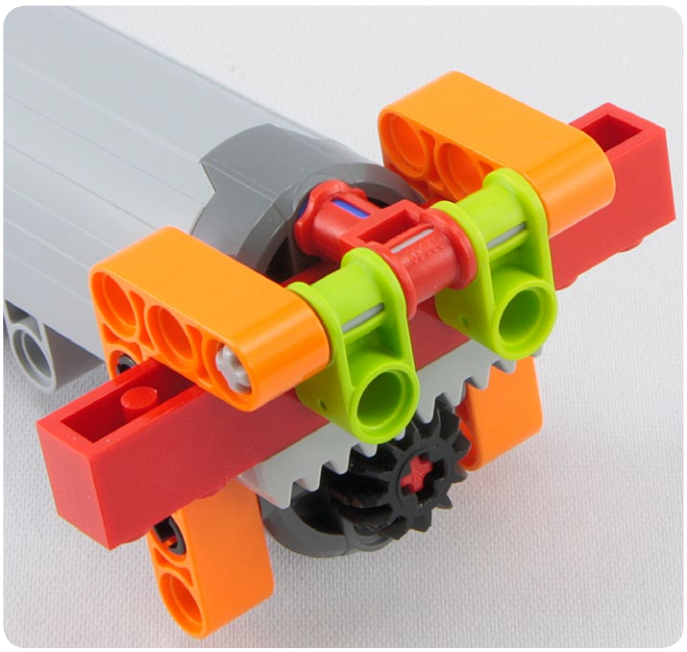

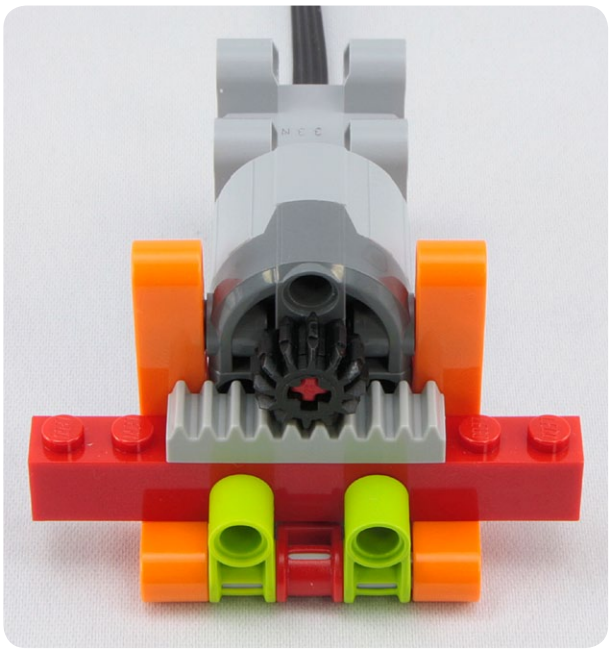

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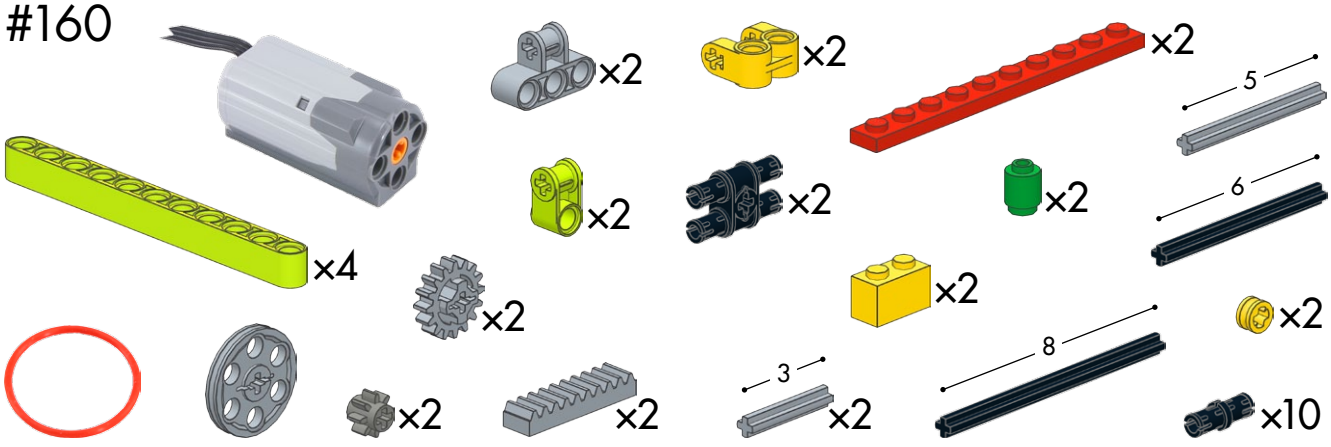

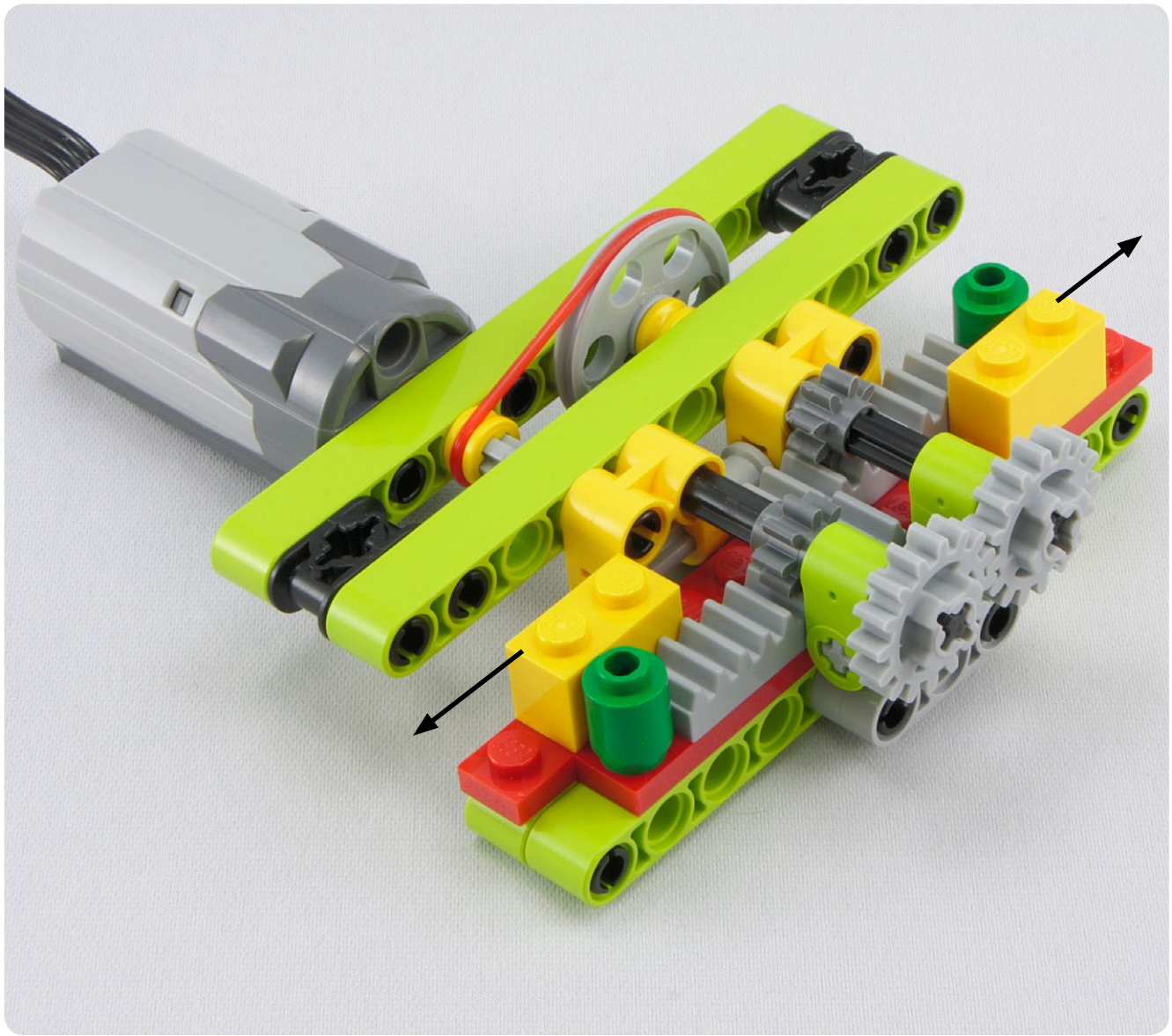

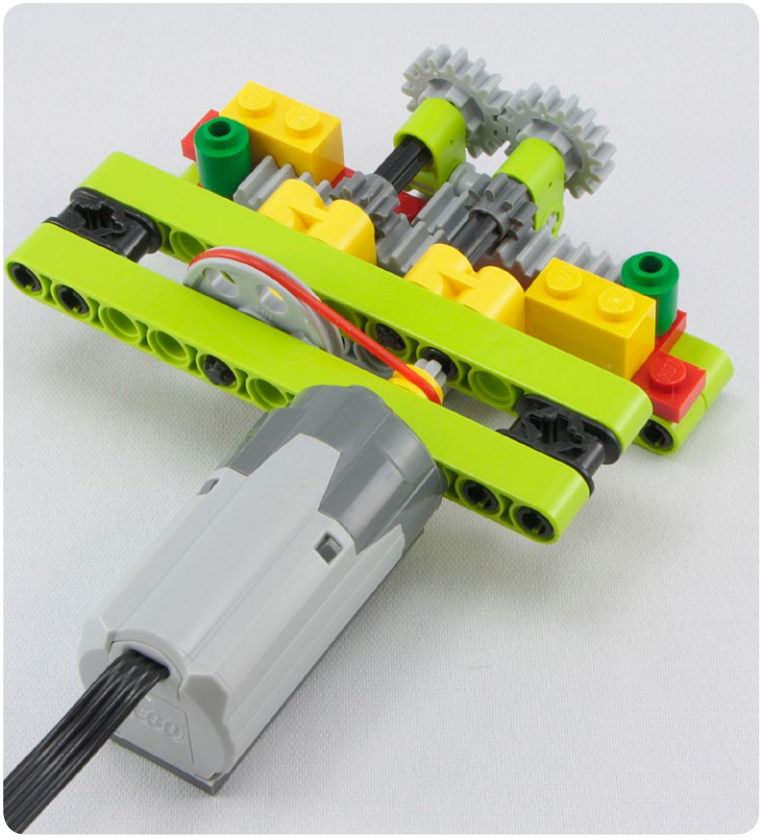

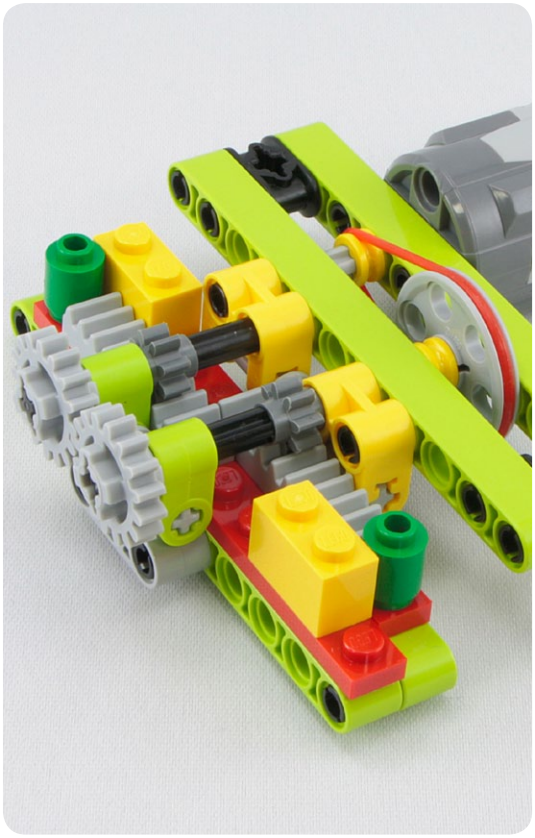

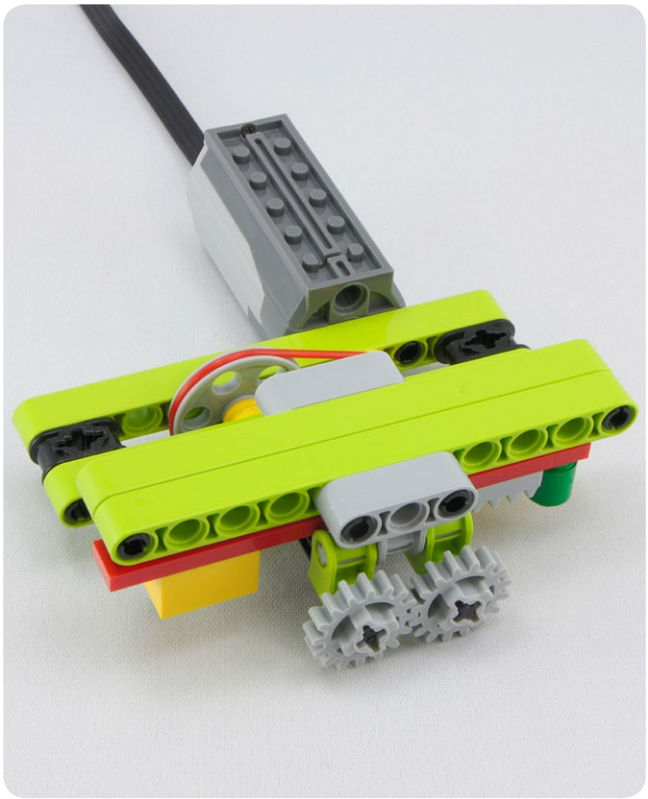

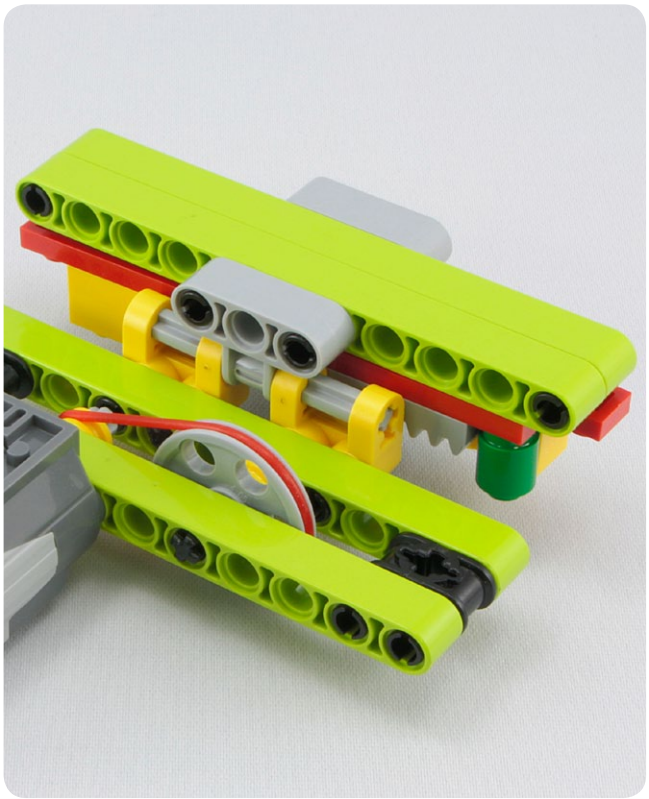

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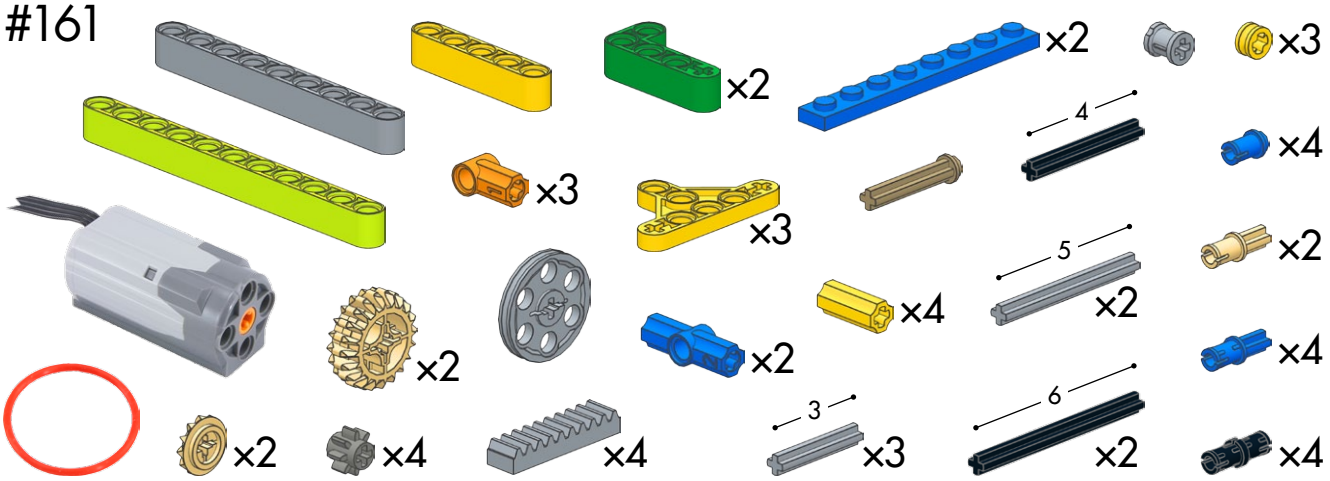
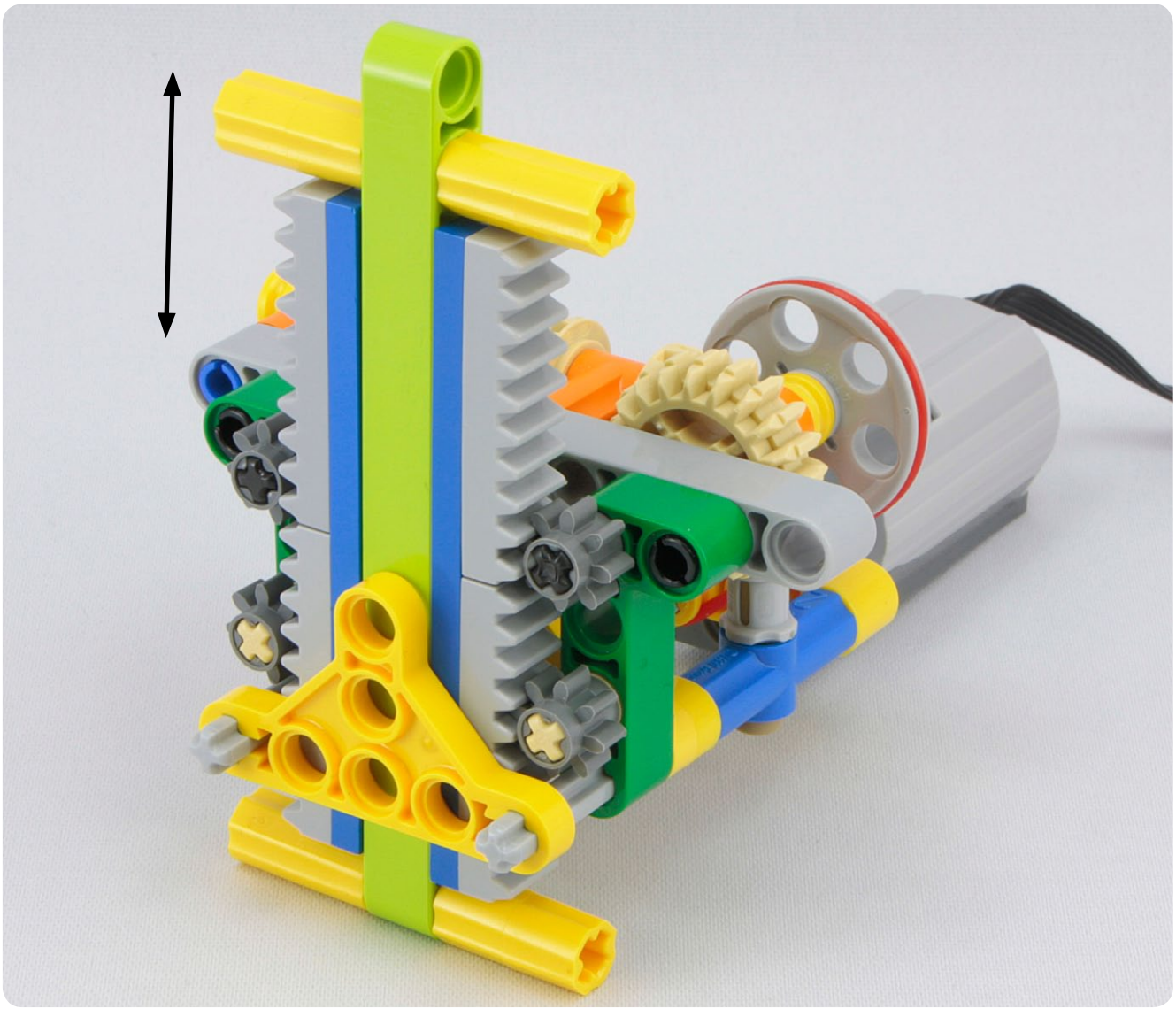
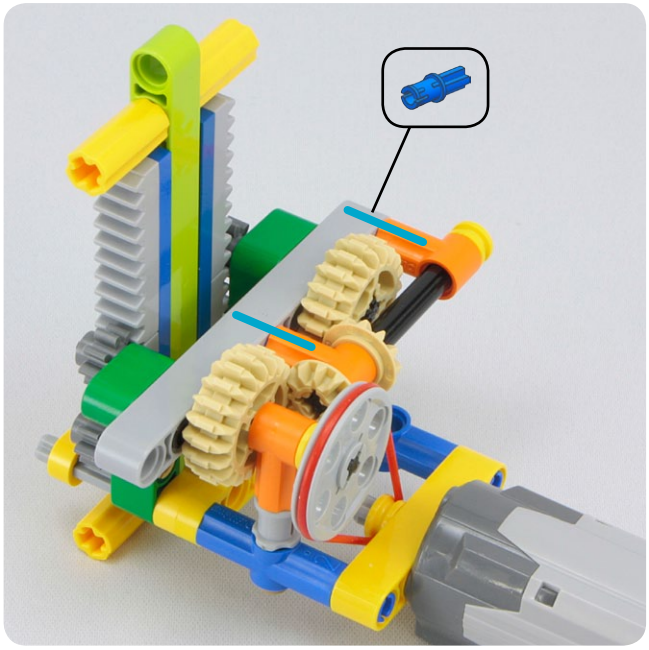
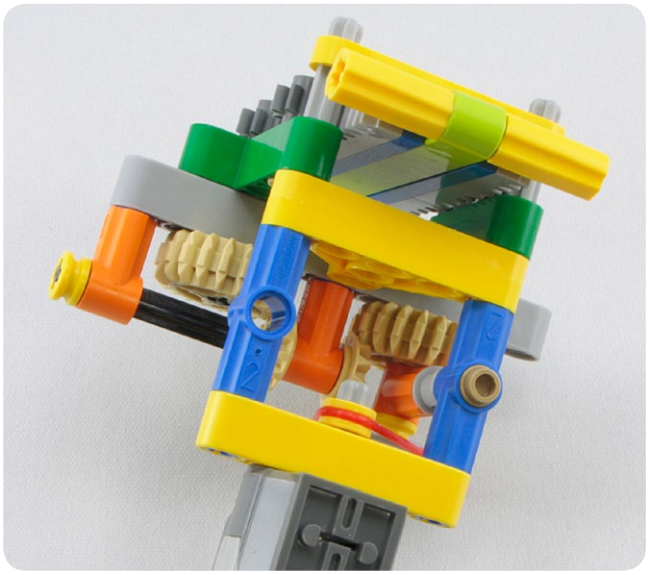
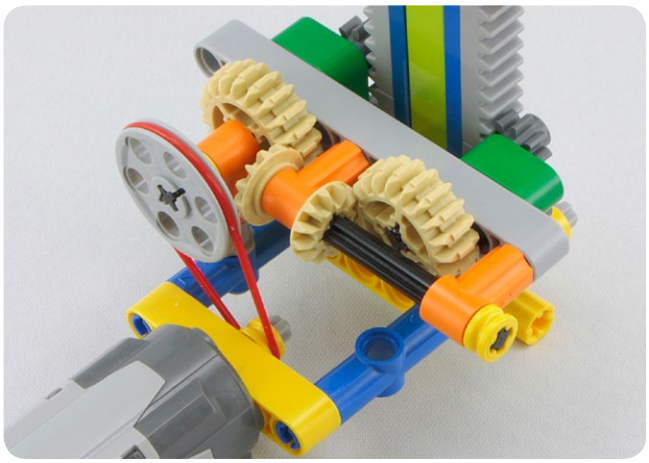
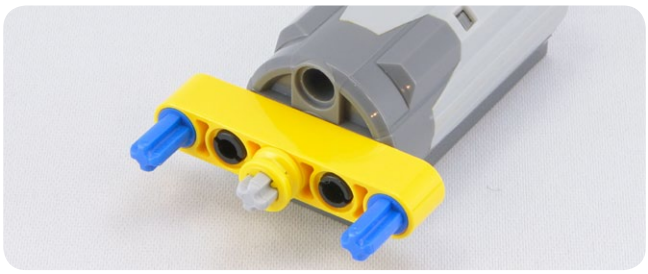


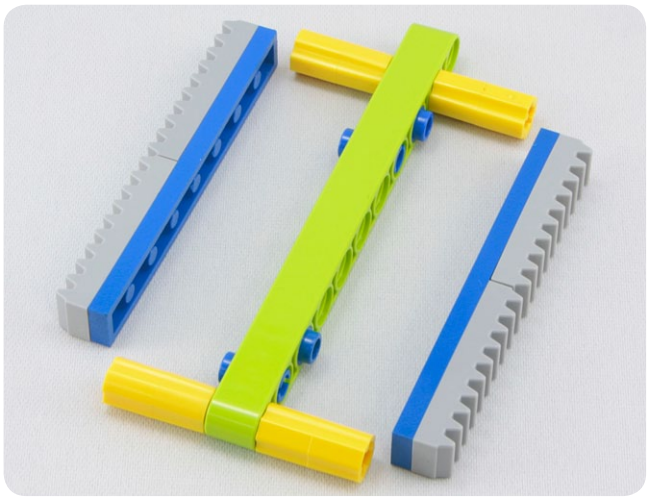






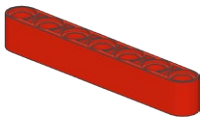


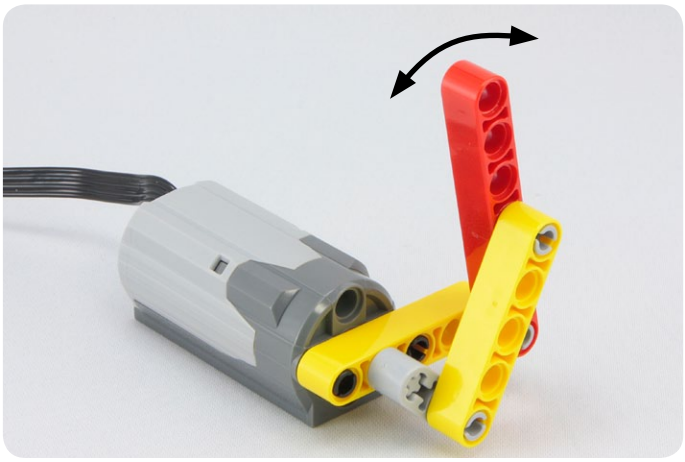


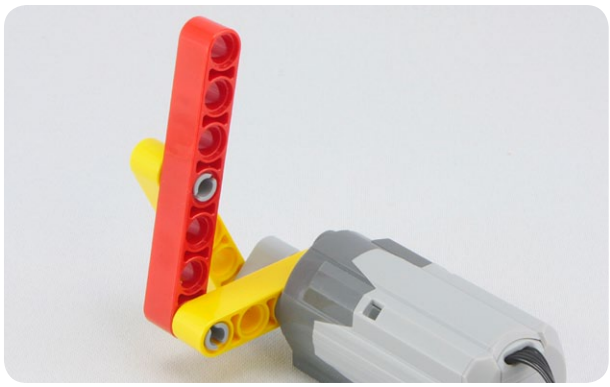


Swinging mechanisms

#162







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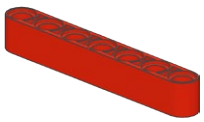

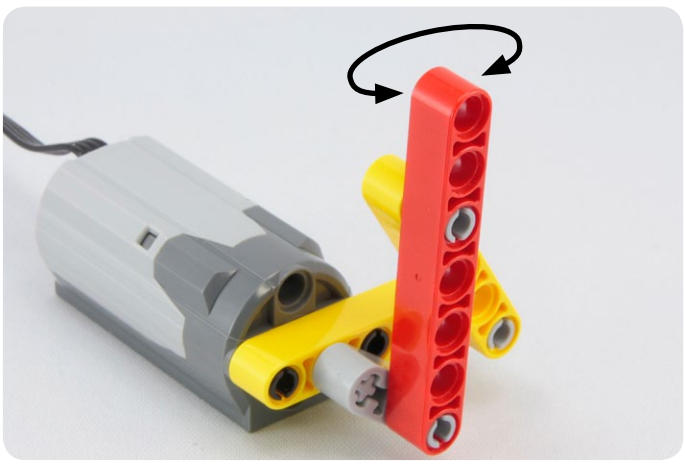

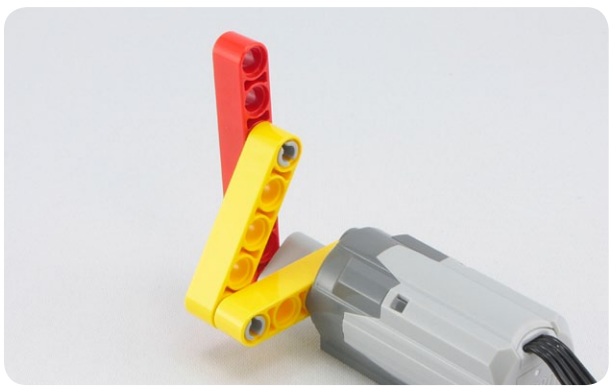

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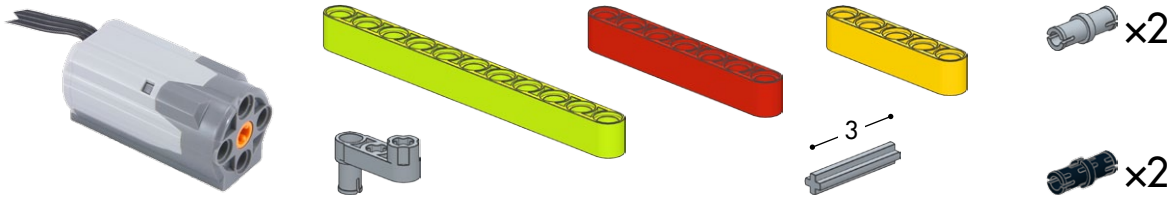

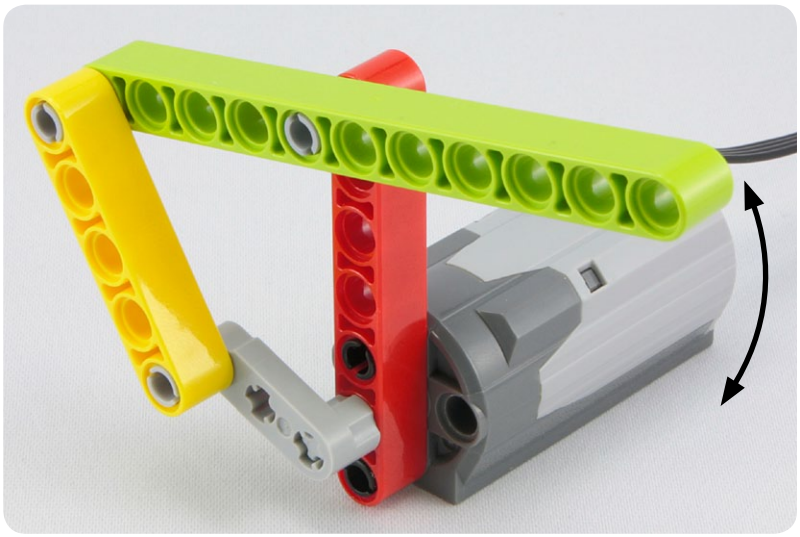

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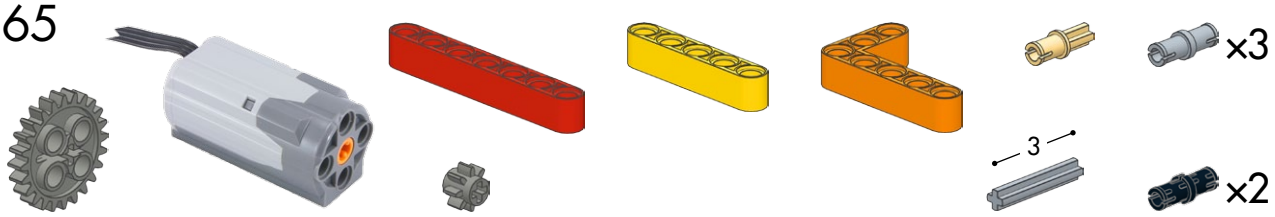

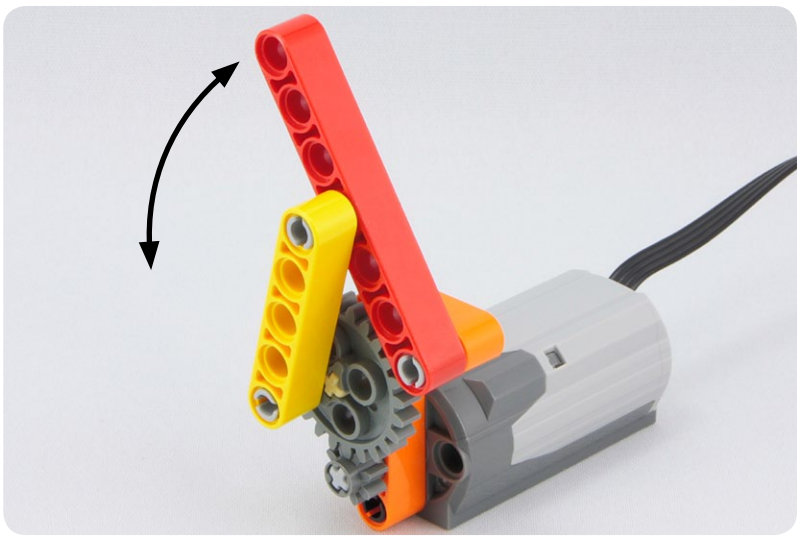

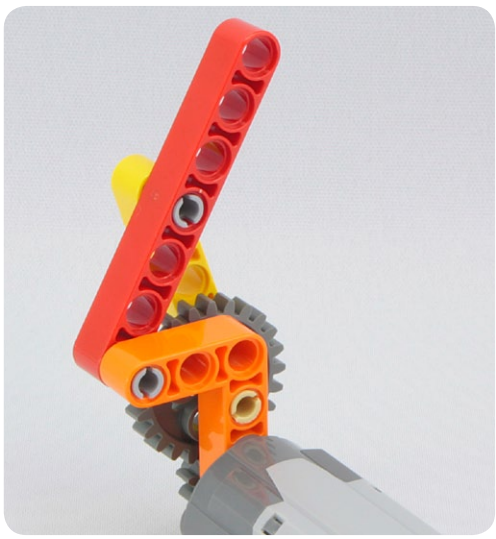

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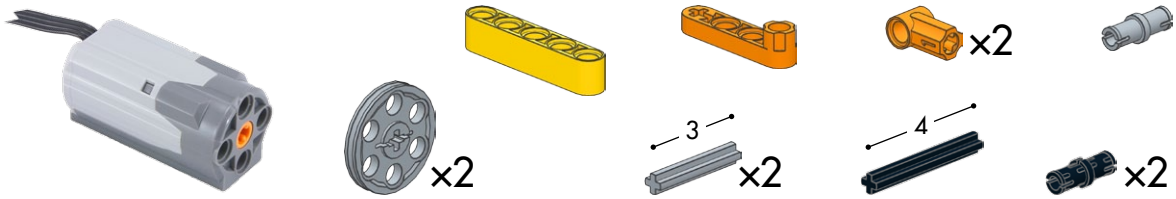

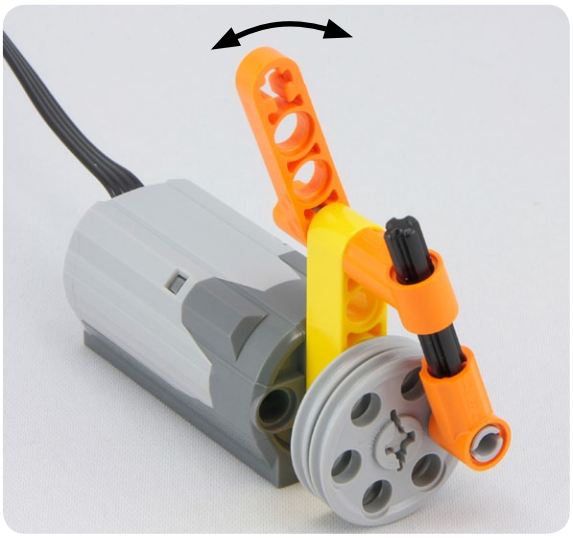

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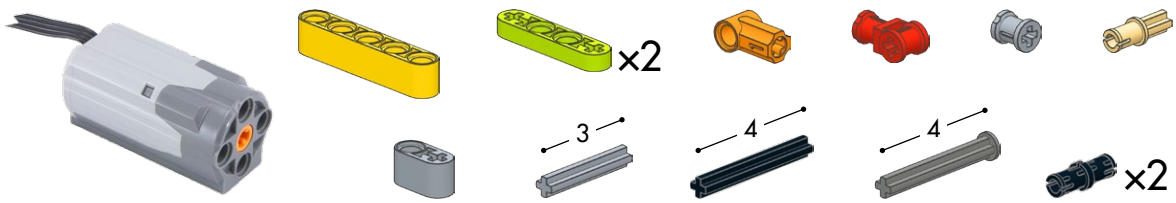

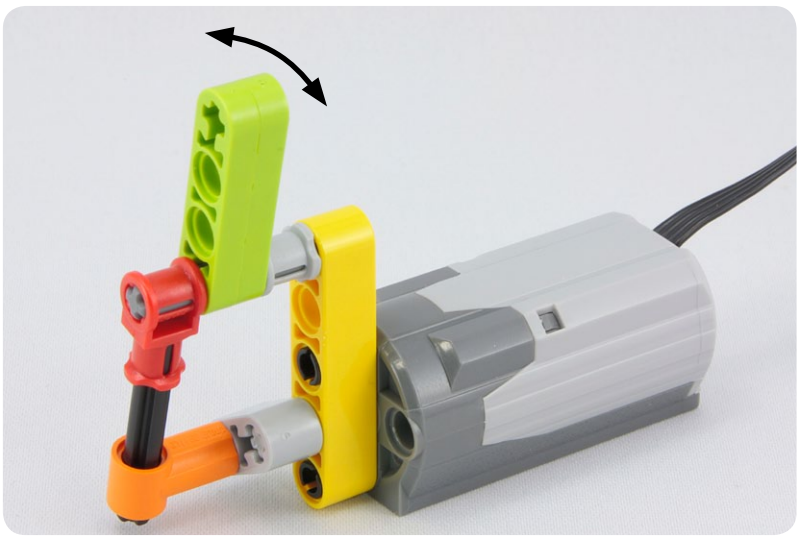

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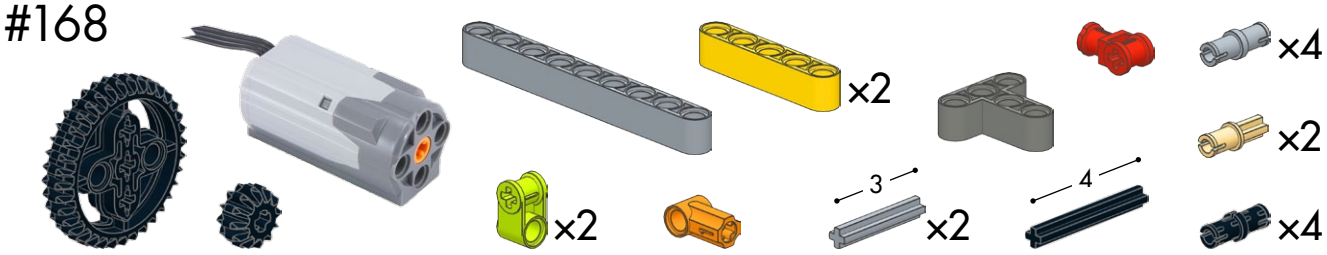

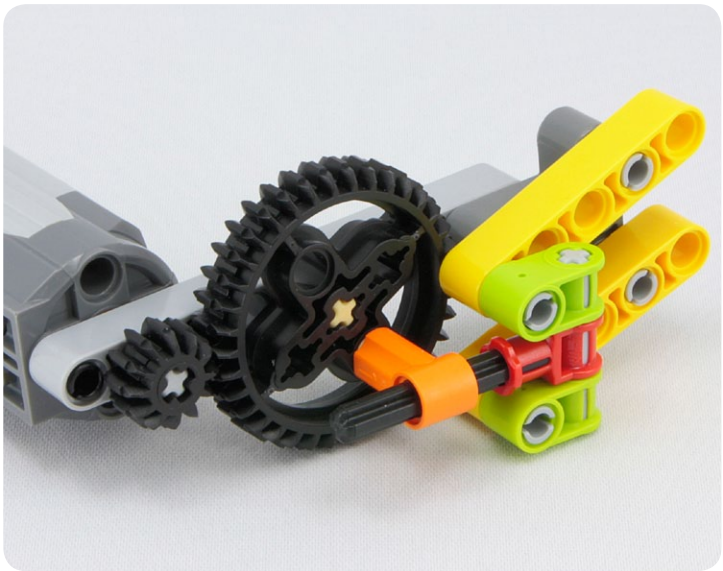

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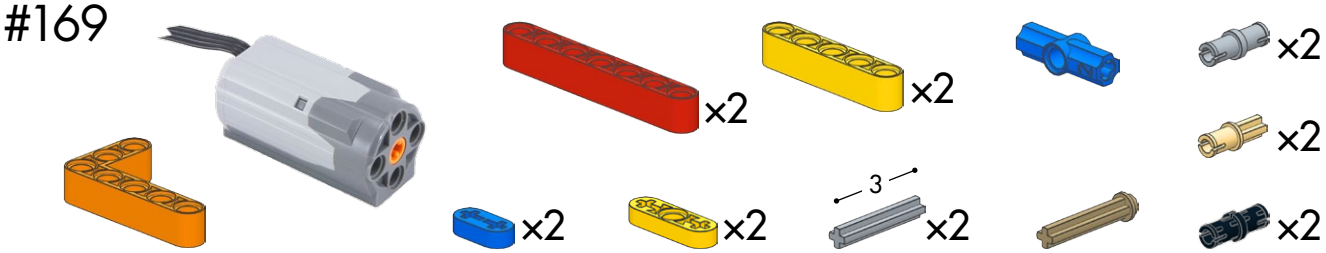

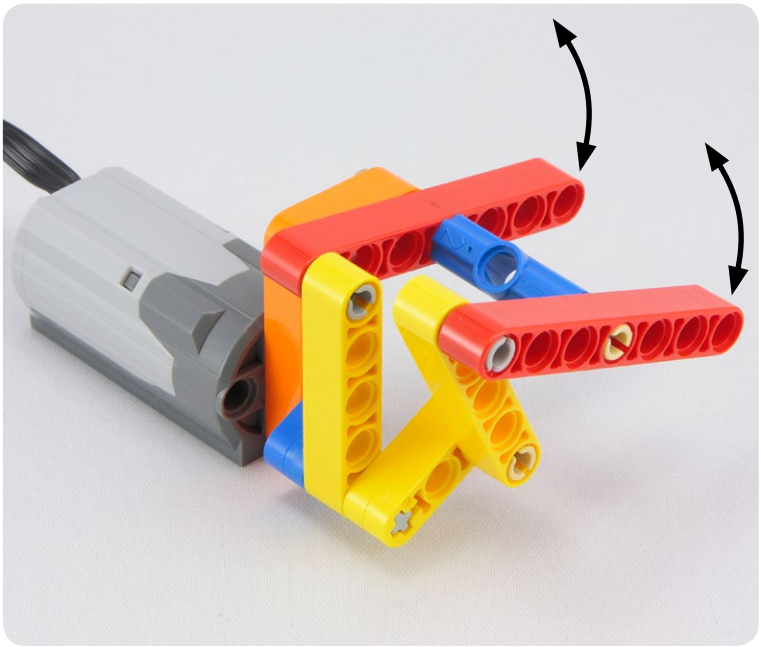

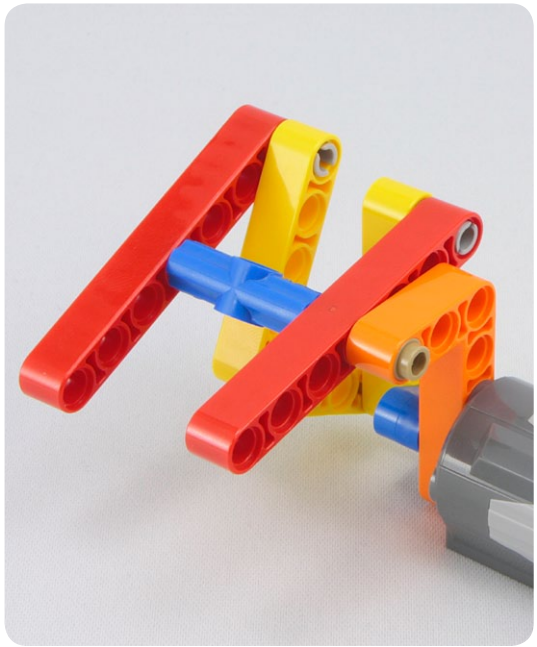

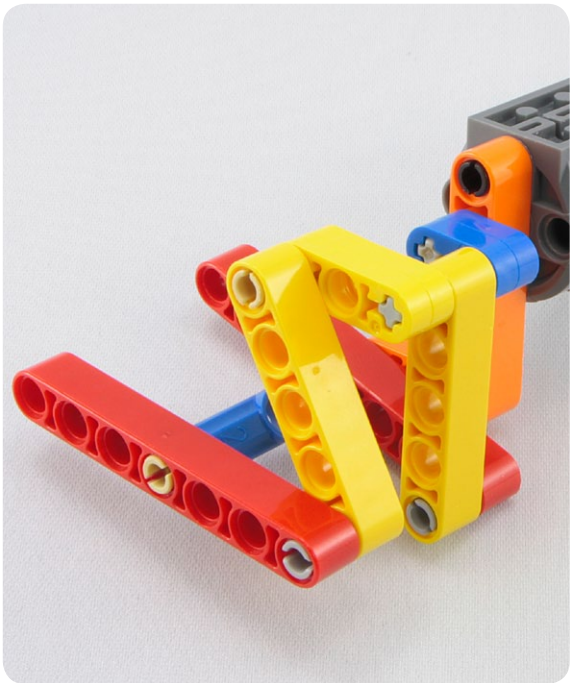

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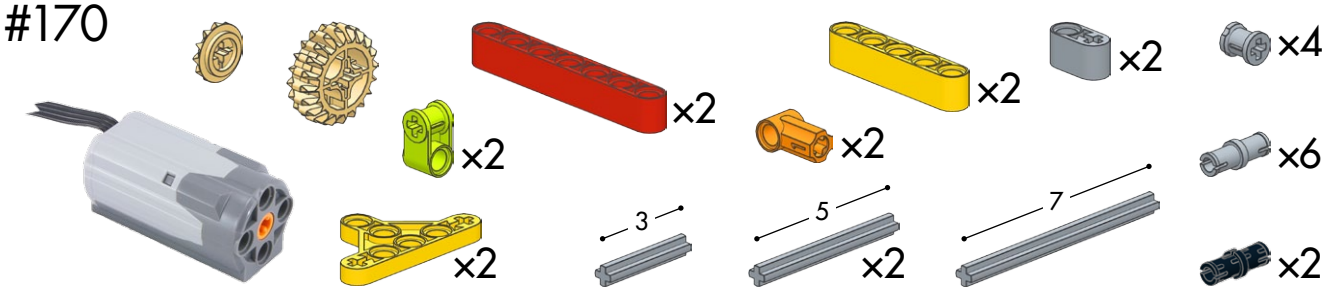

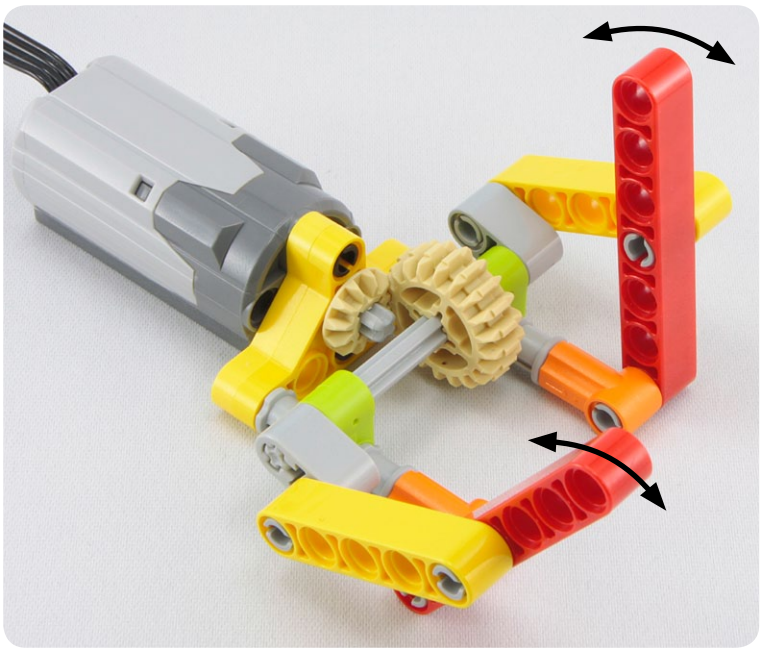

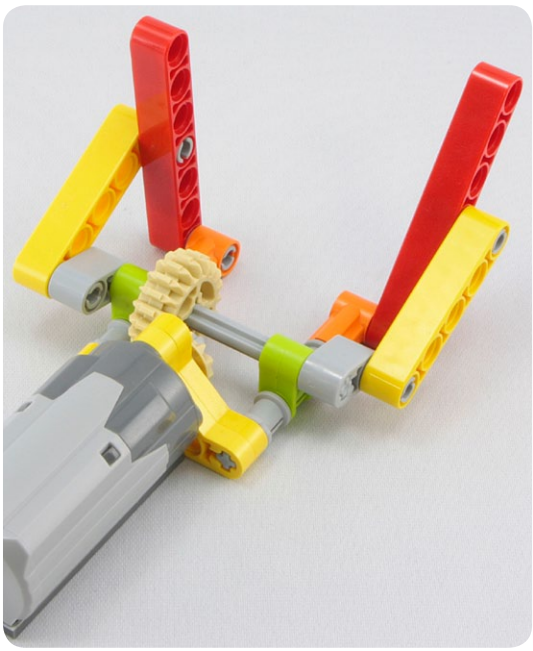

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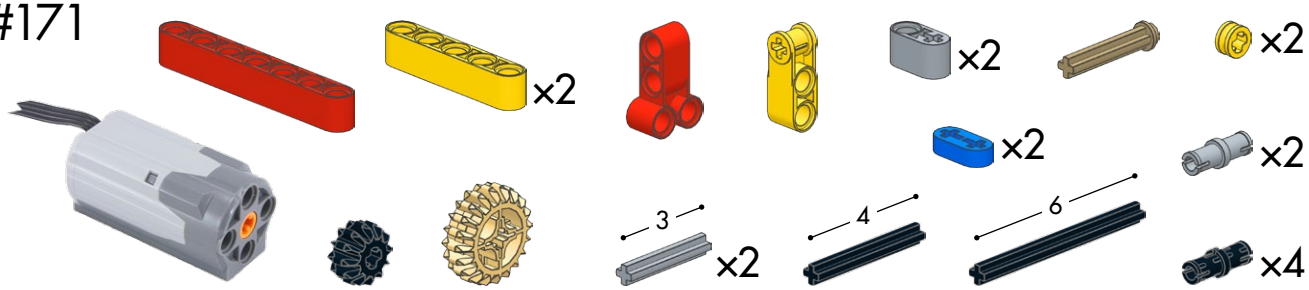

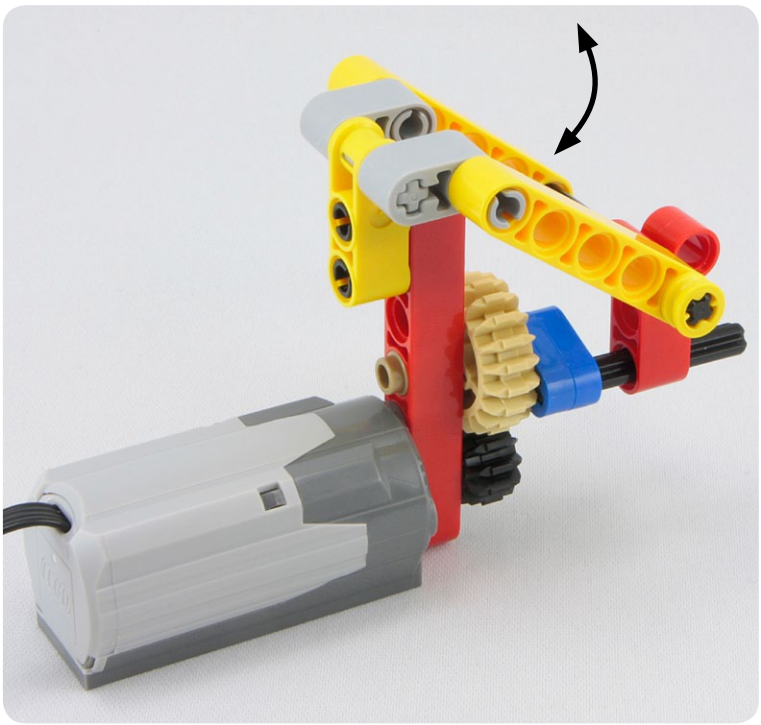

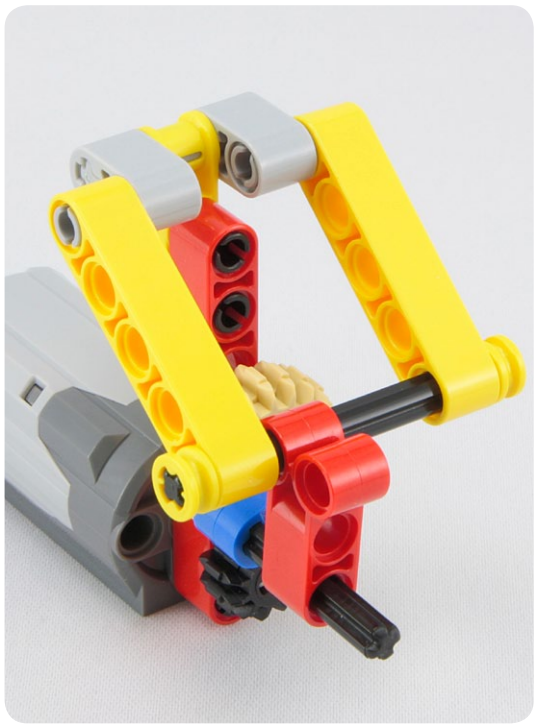

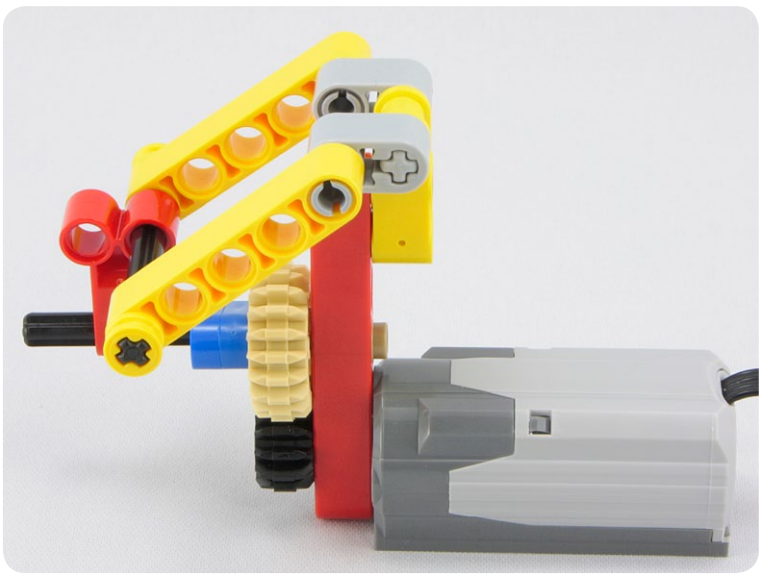

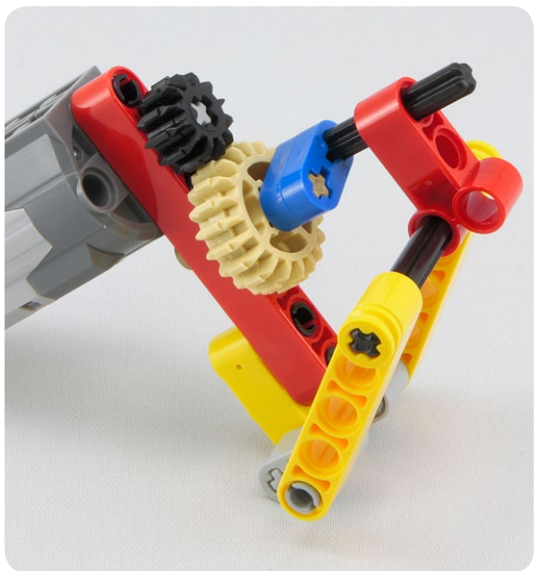

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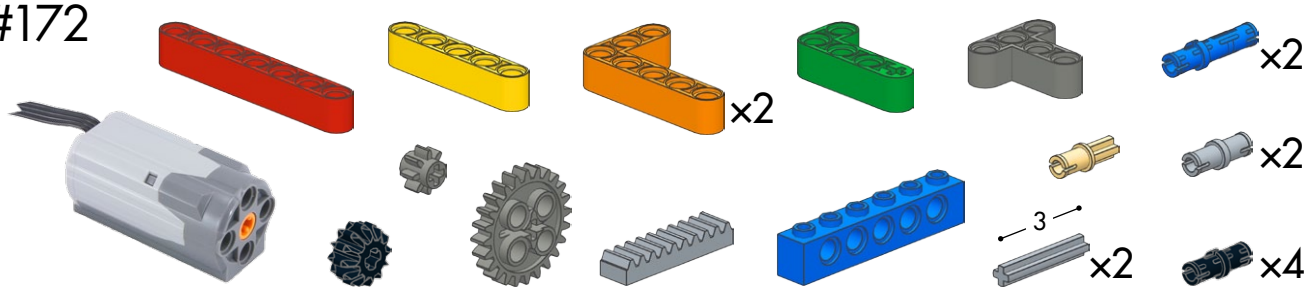

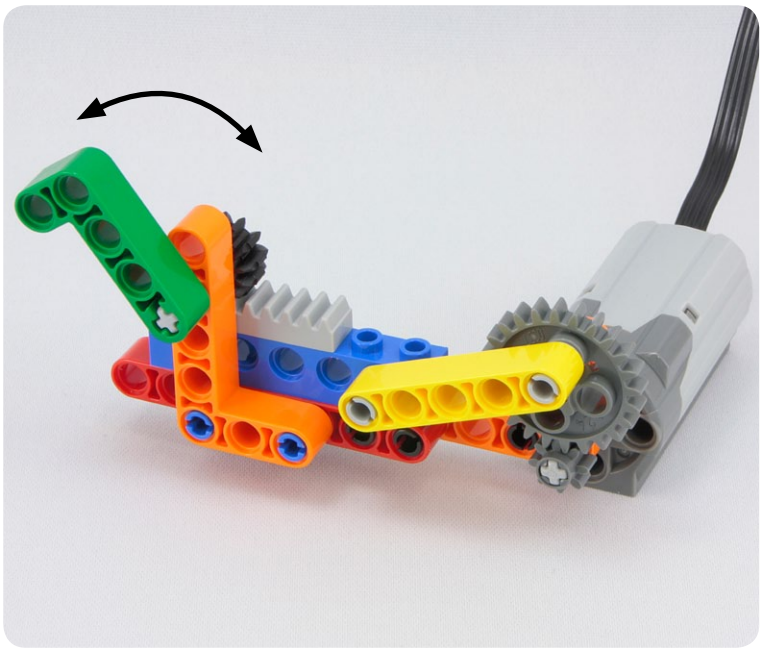

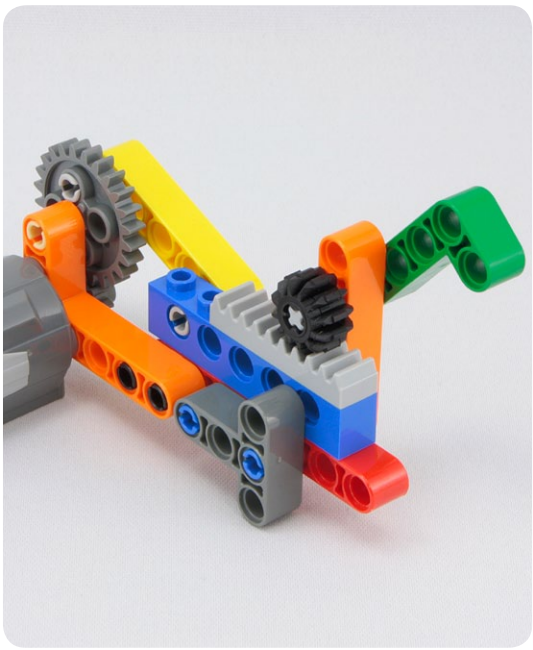

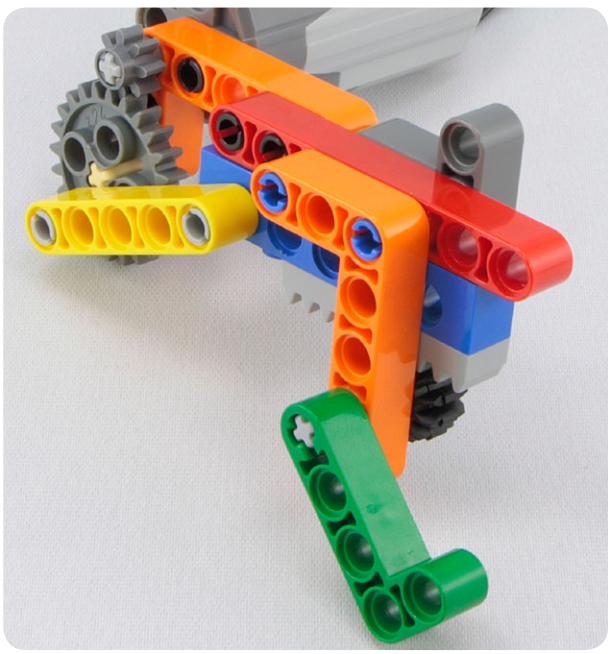

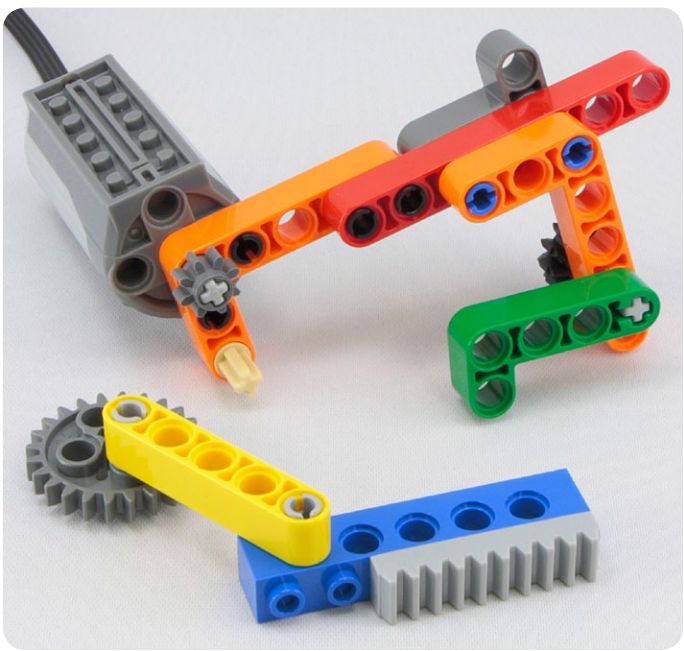

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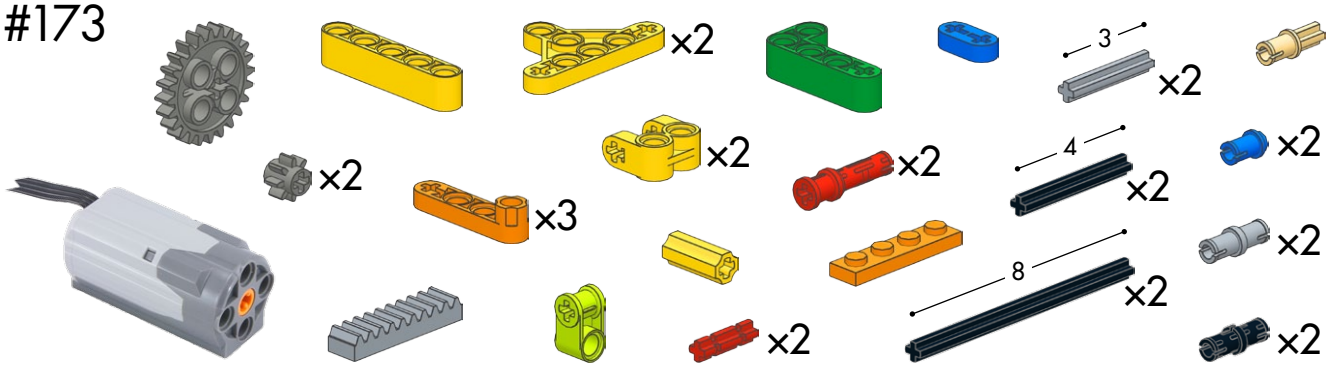
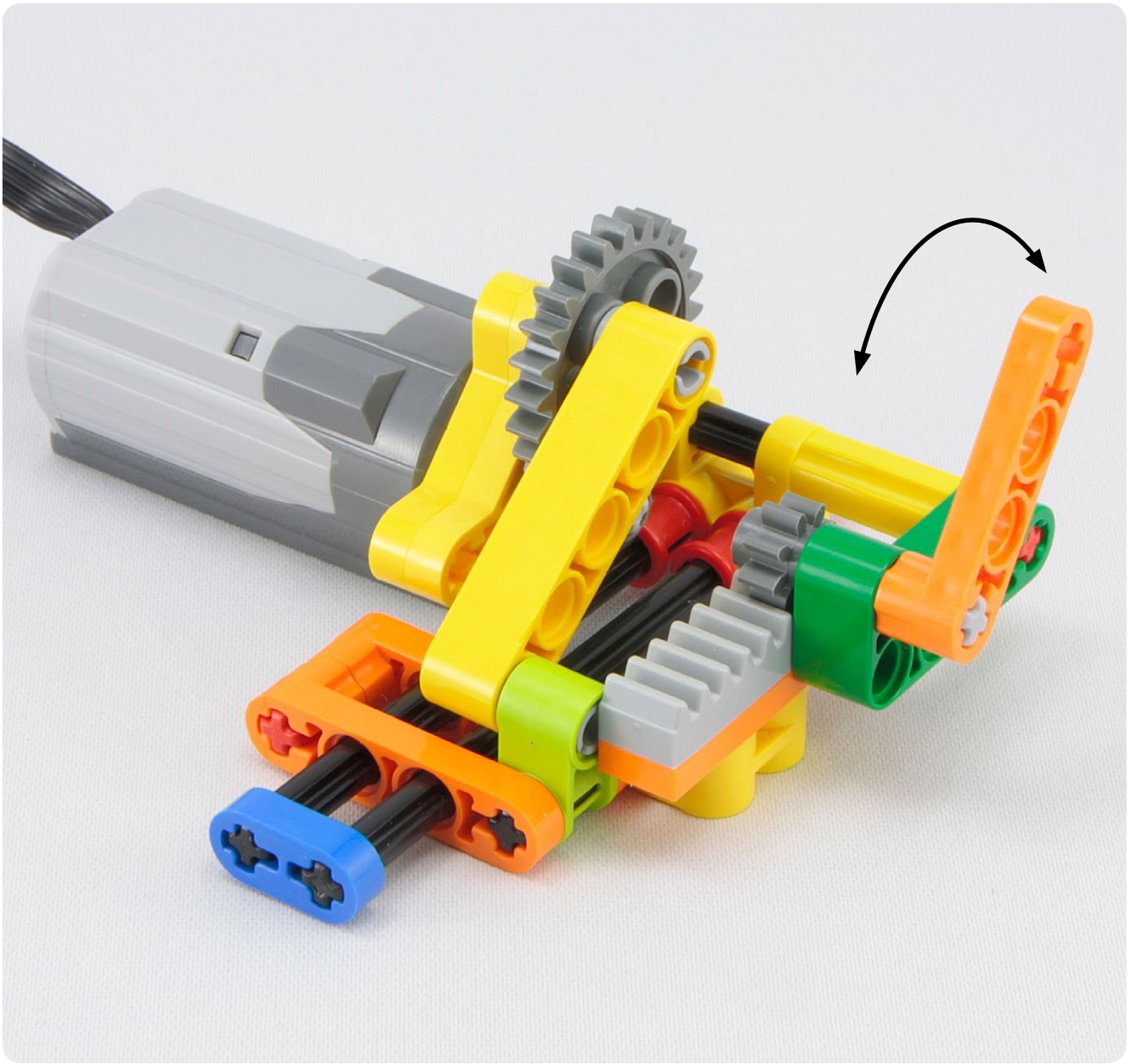
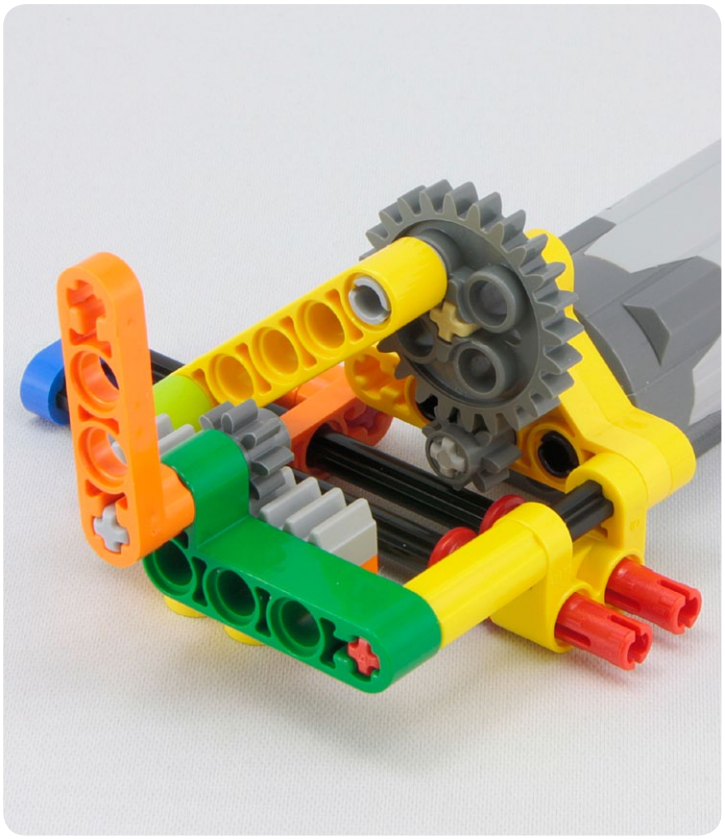
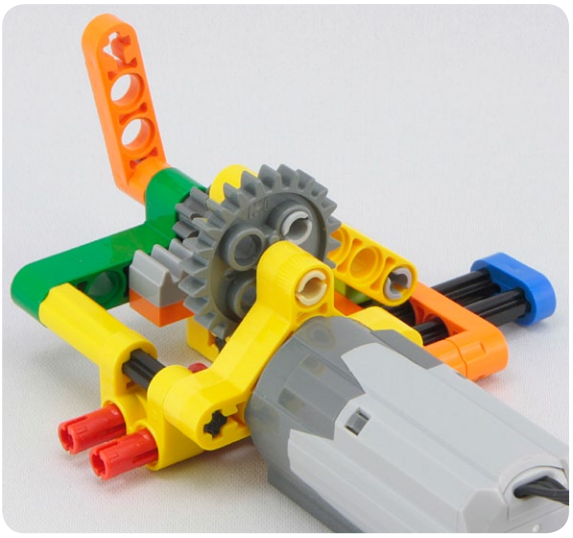
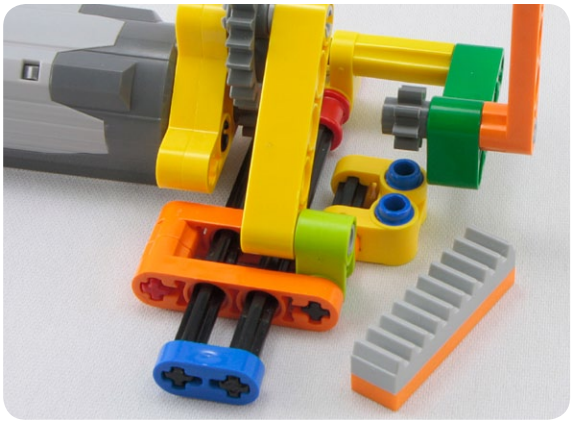
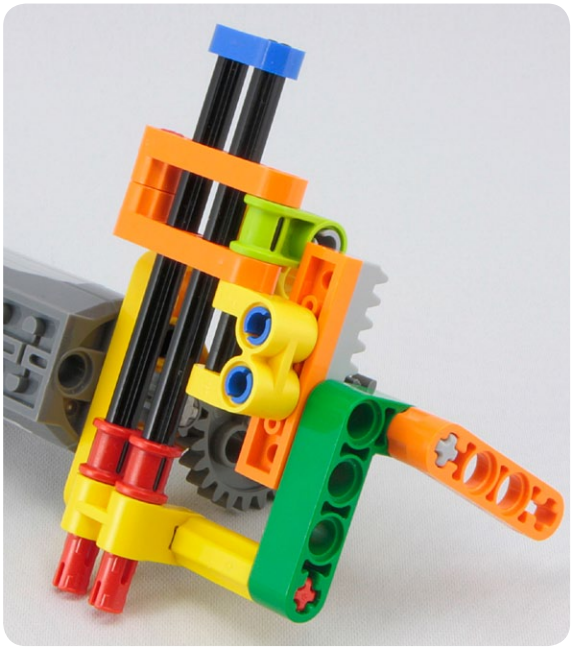






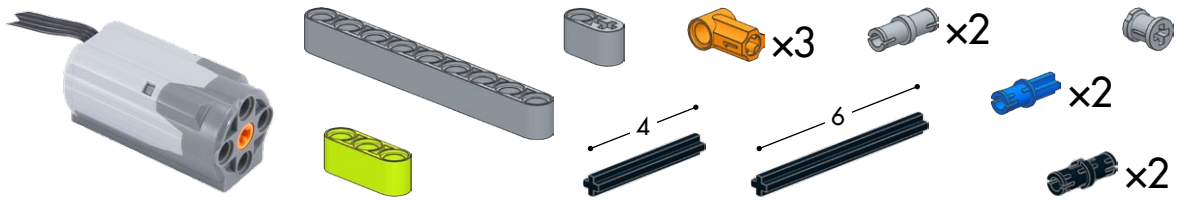


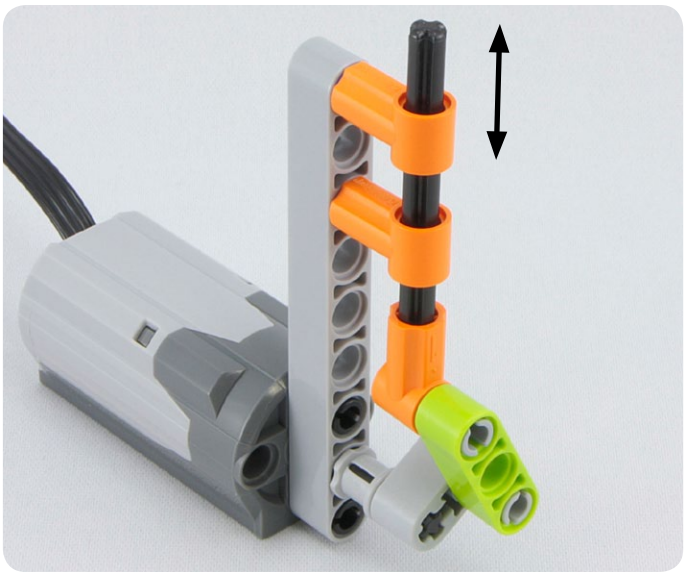


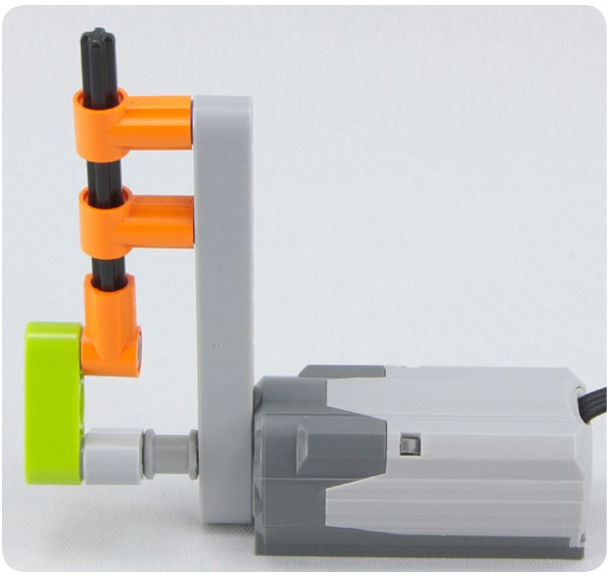


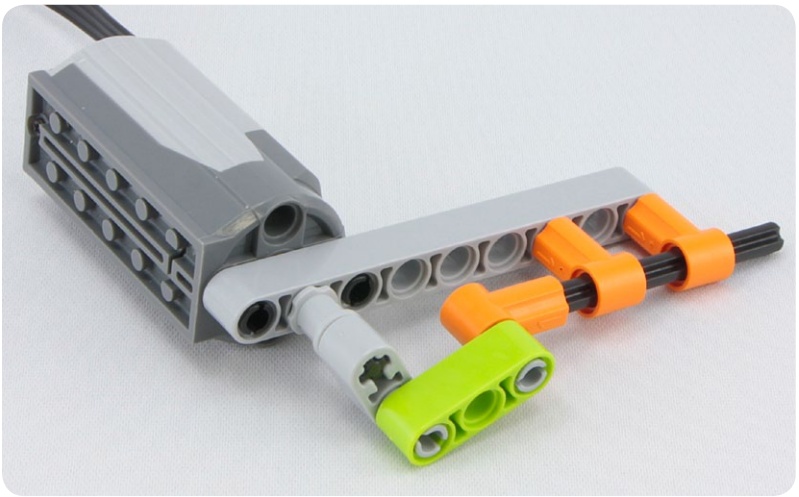
Reciprocating mechanisms

#174









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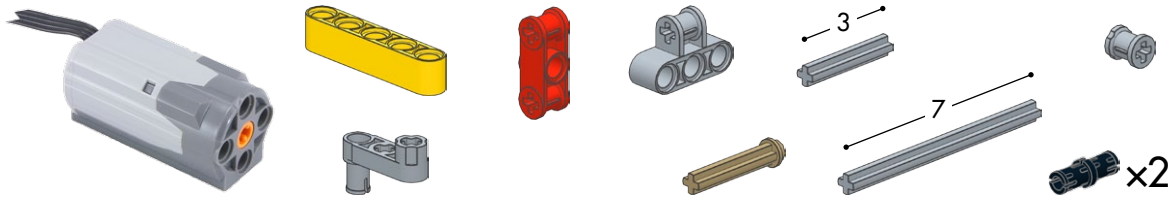

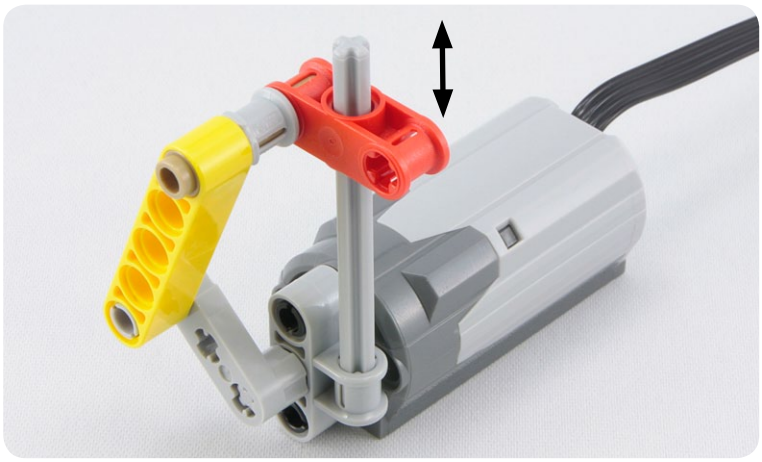

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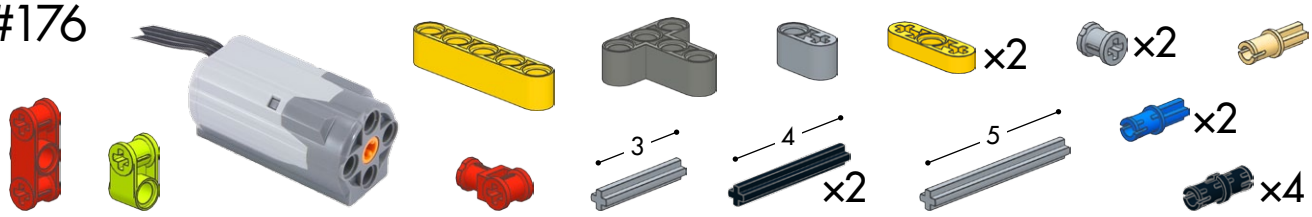

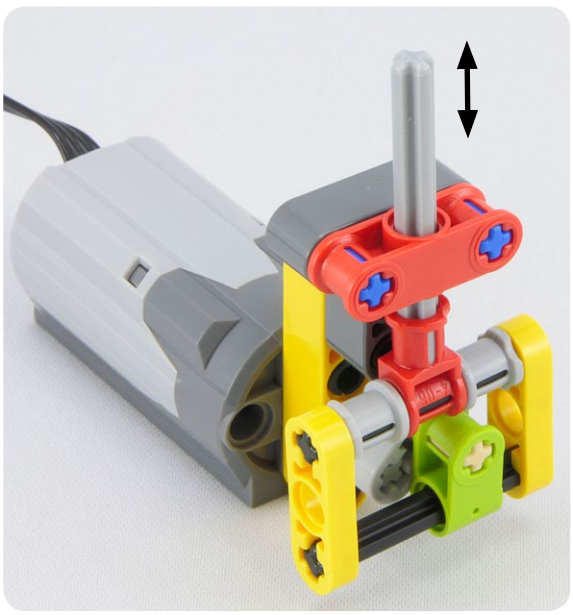

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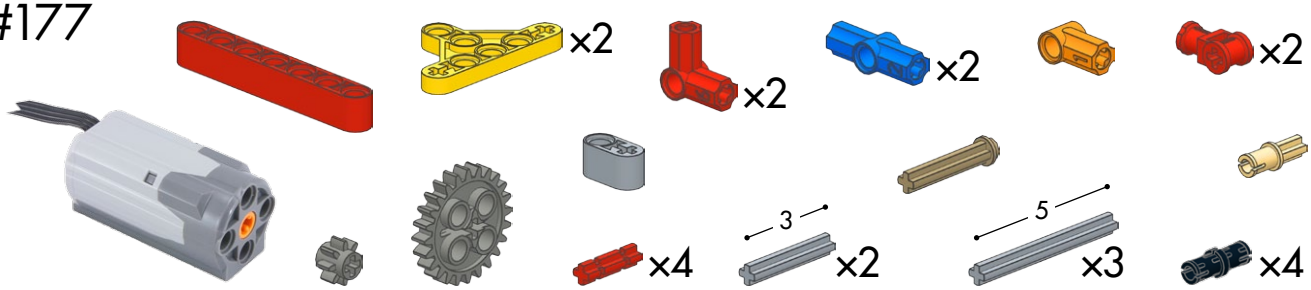

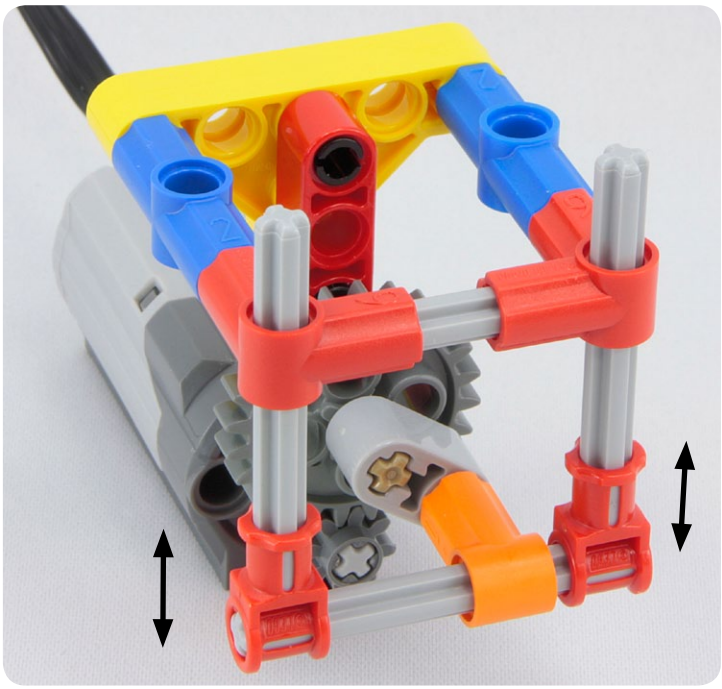

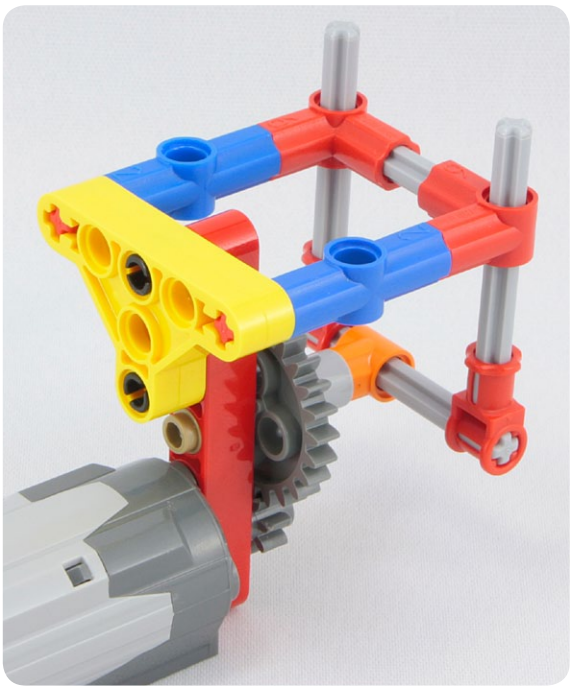

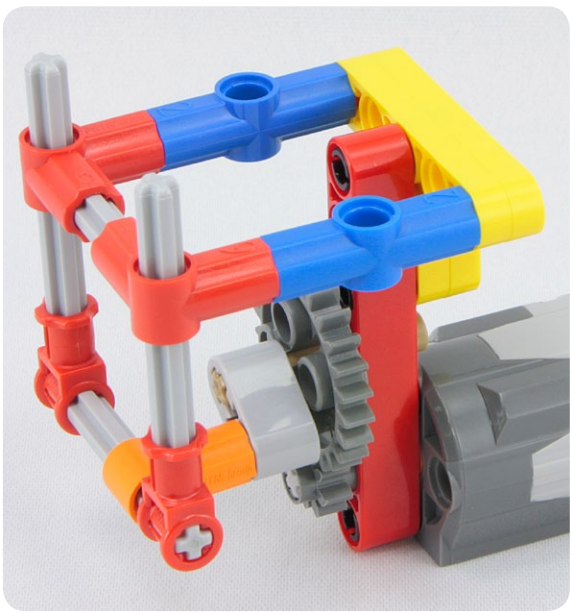

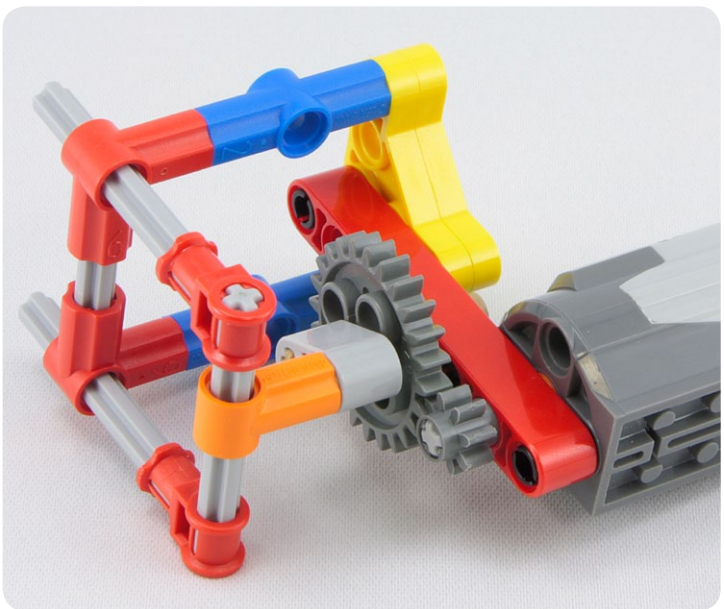

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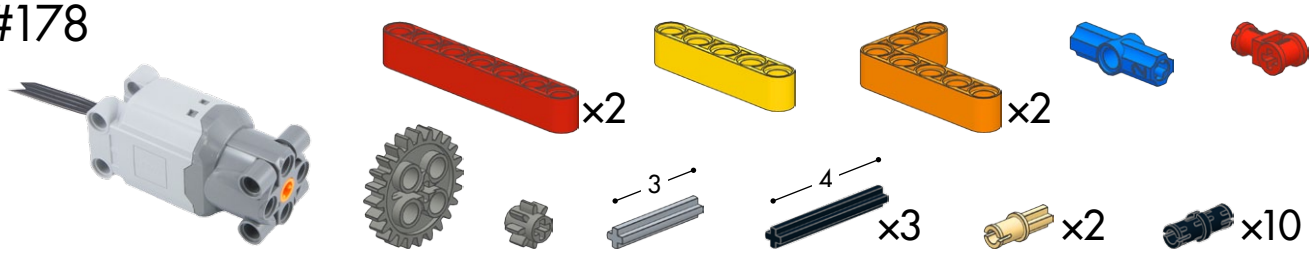

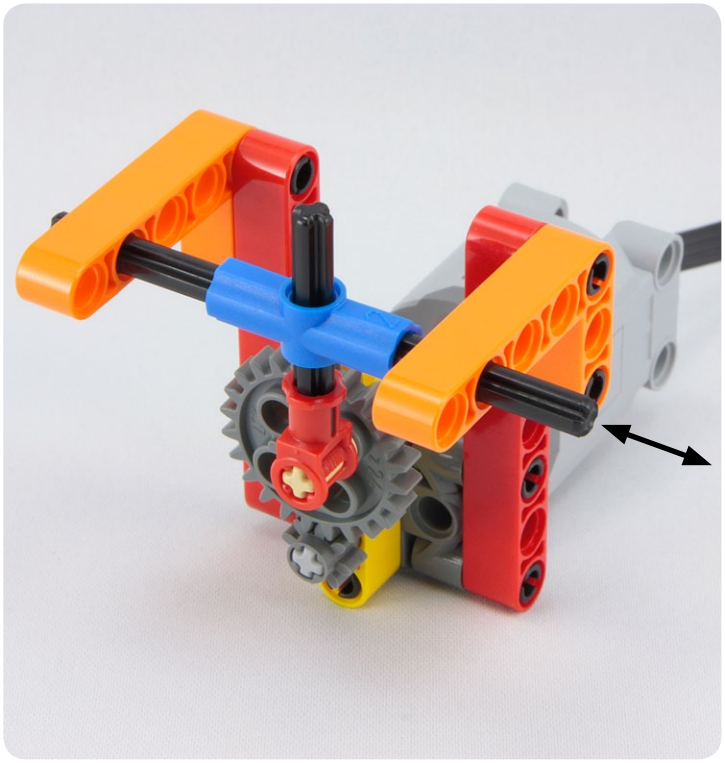

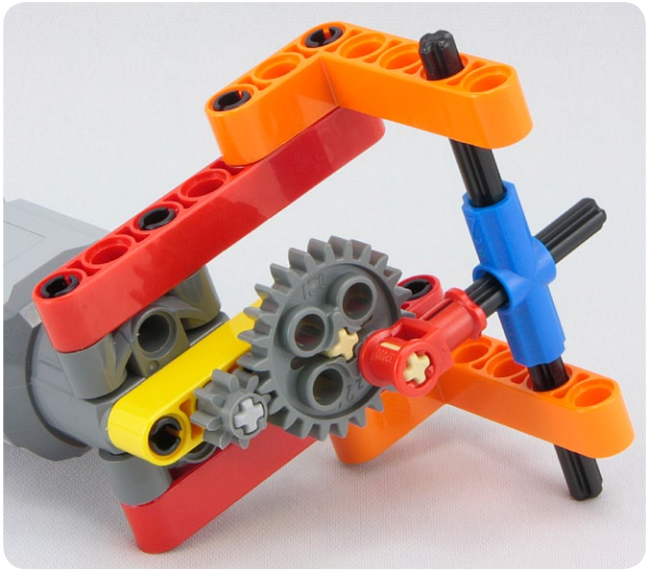

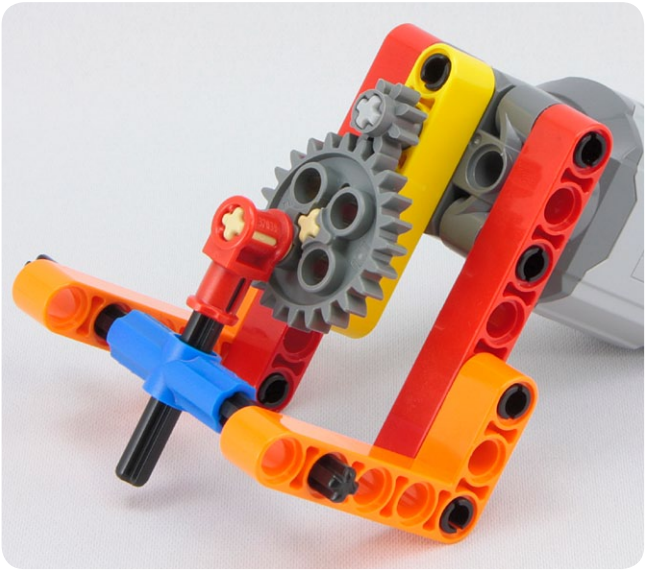

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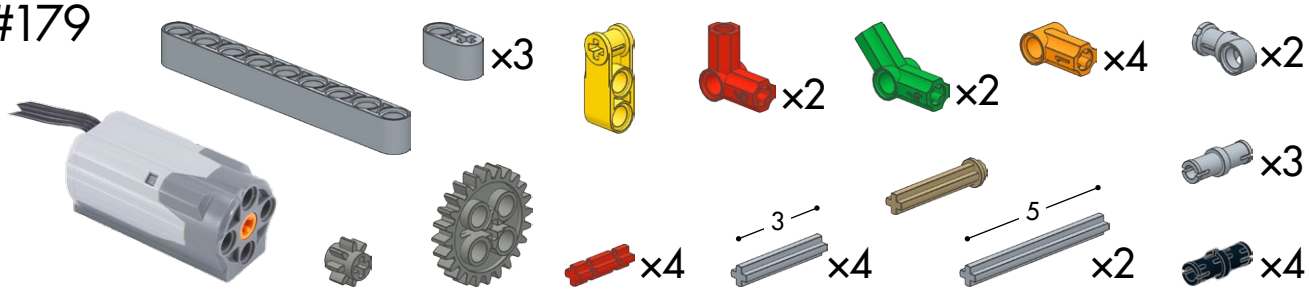

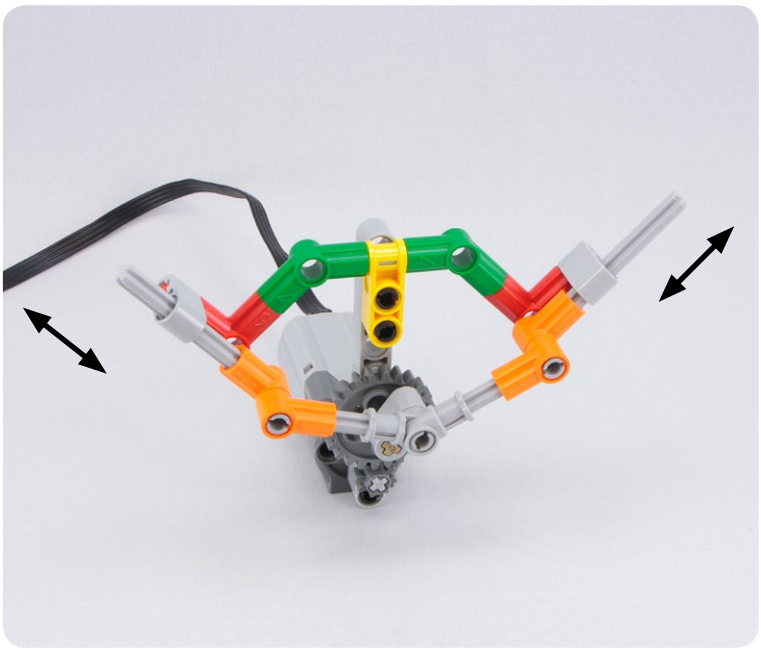

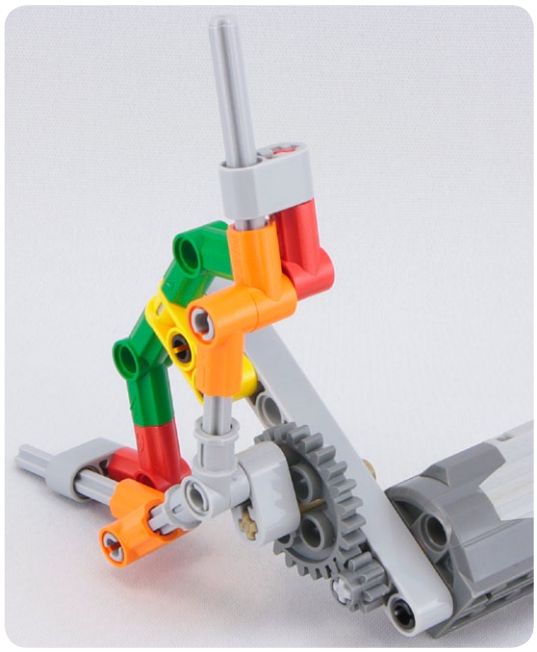

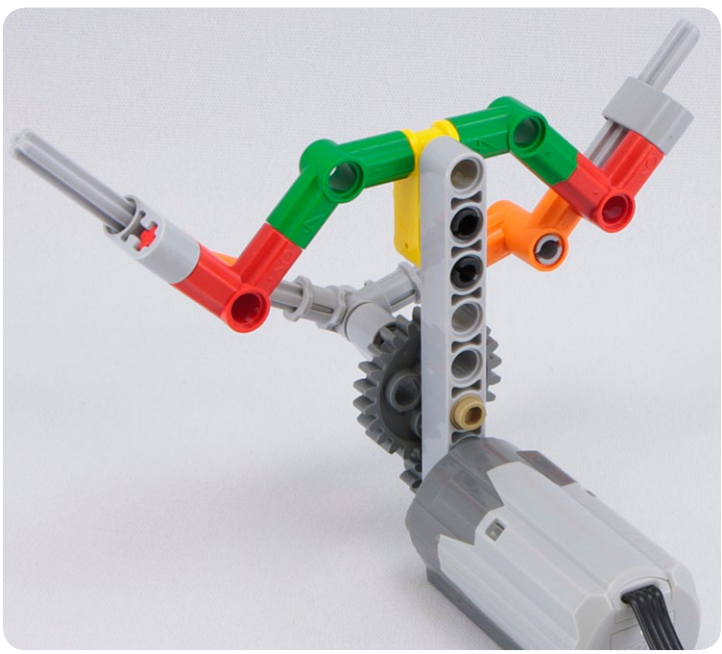

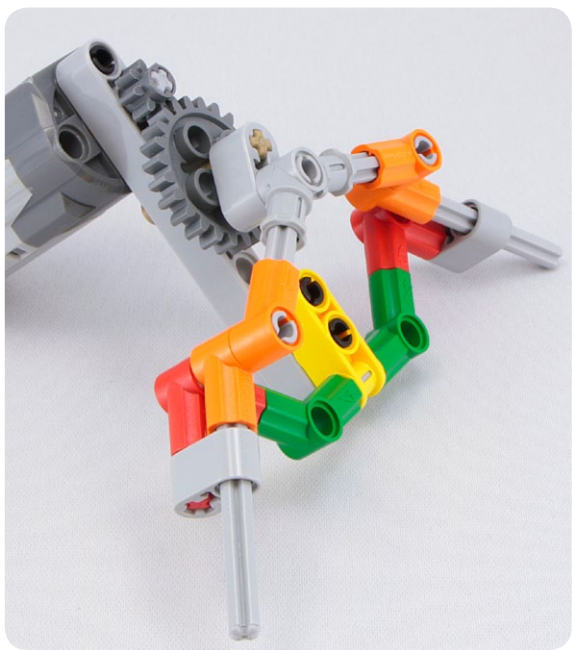

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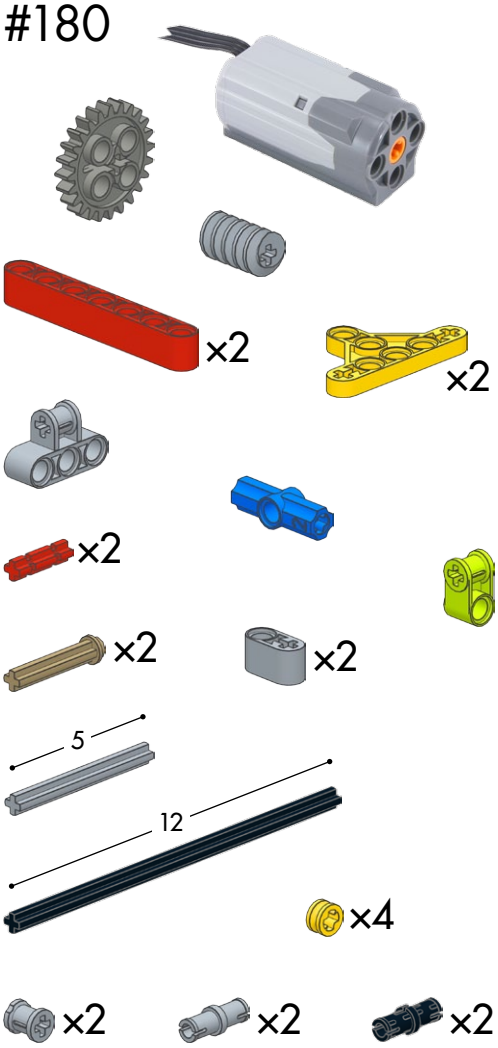

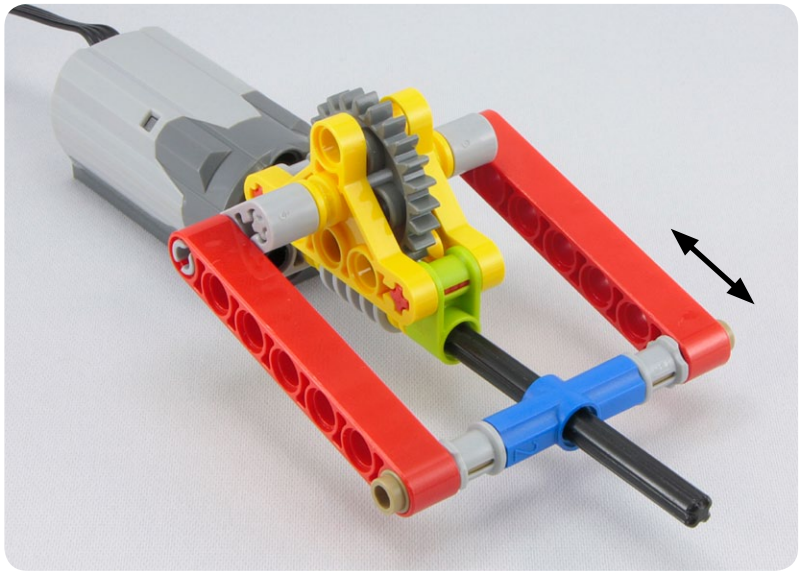

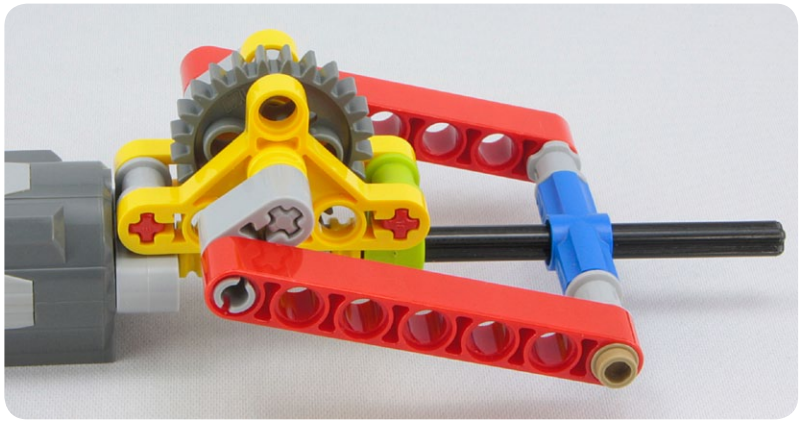

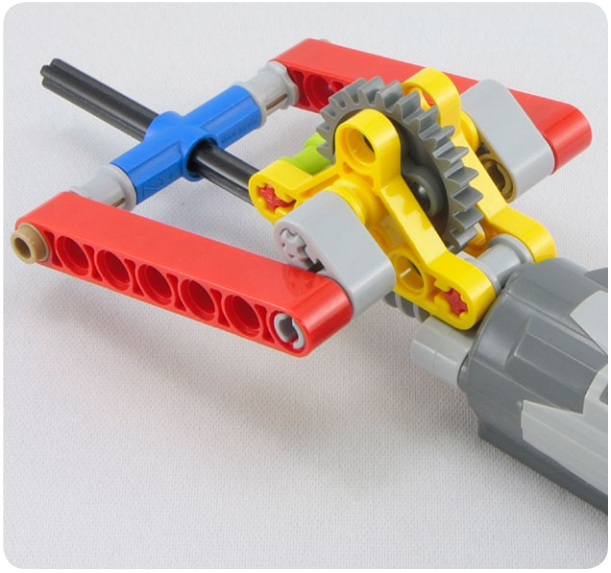

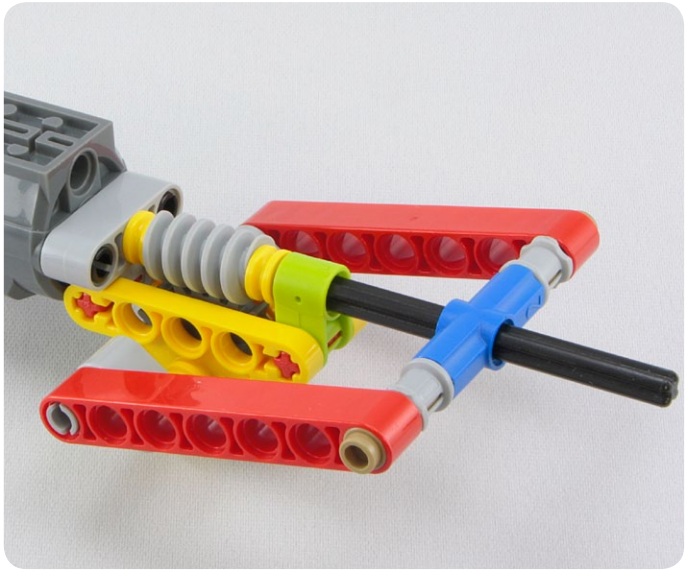

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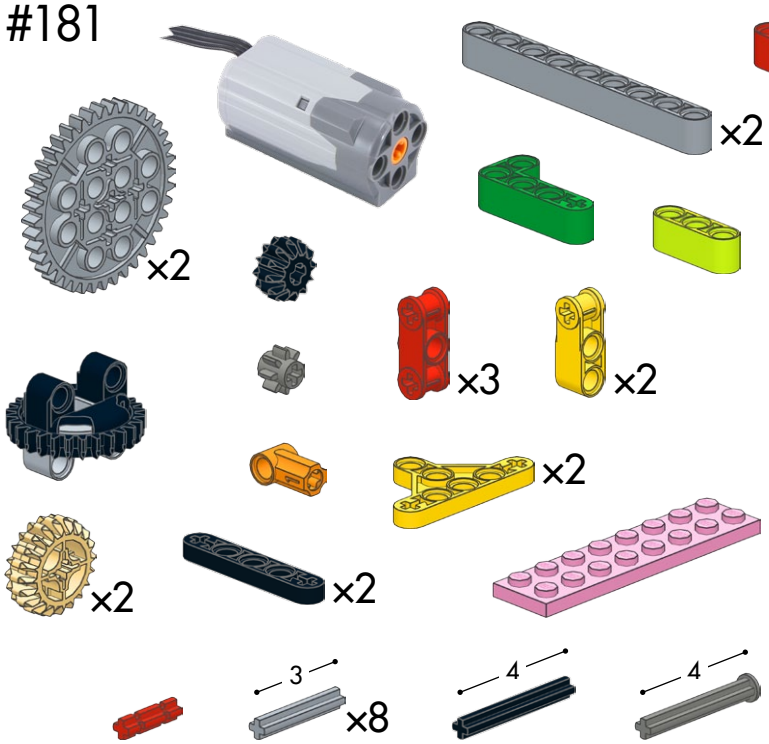

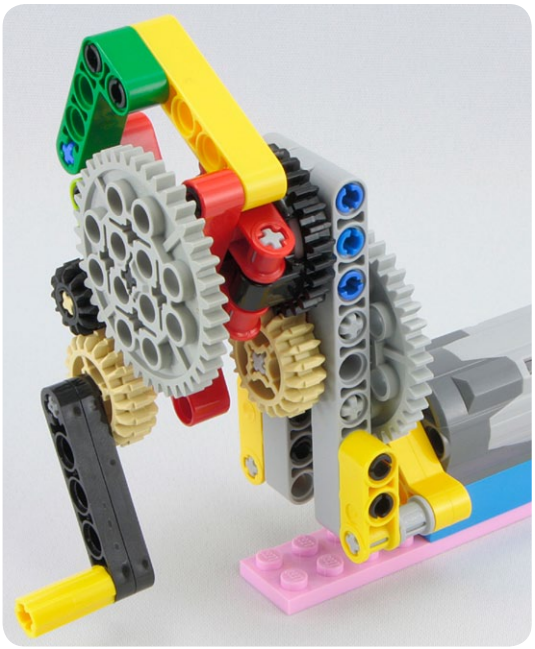

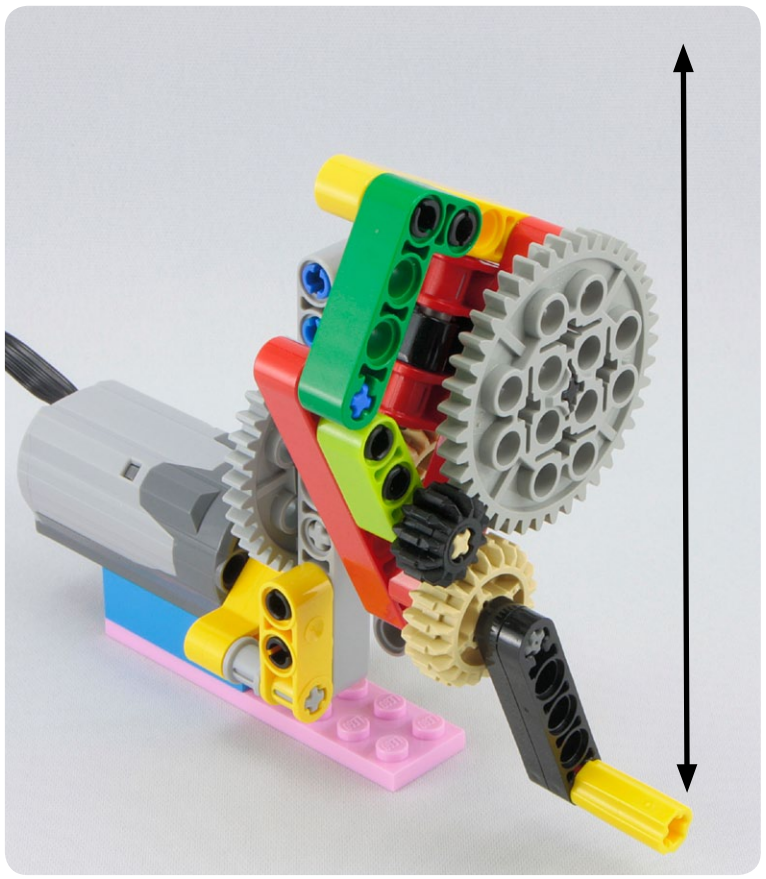

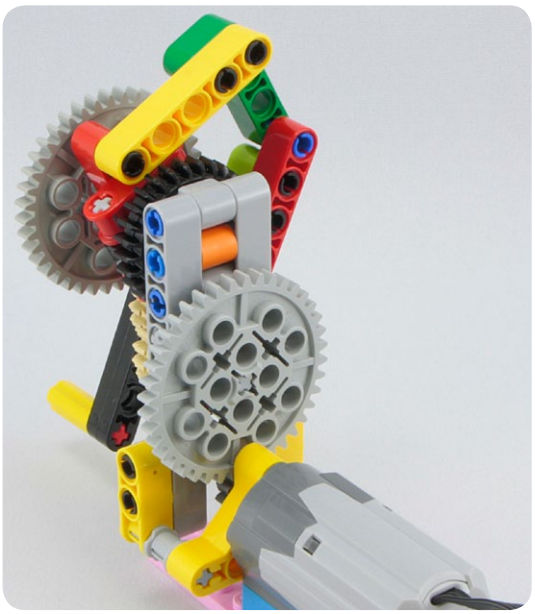

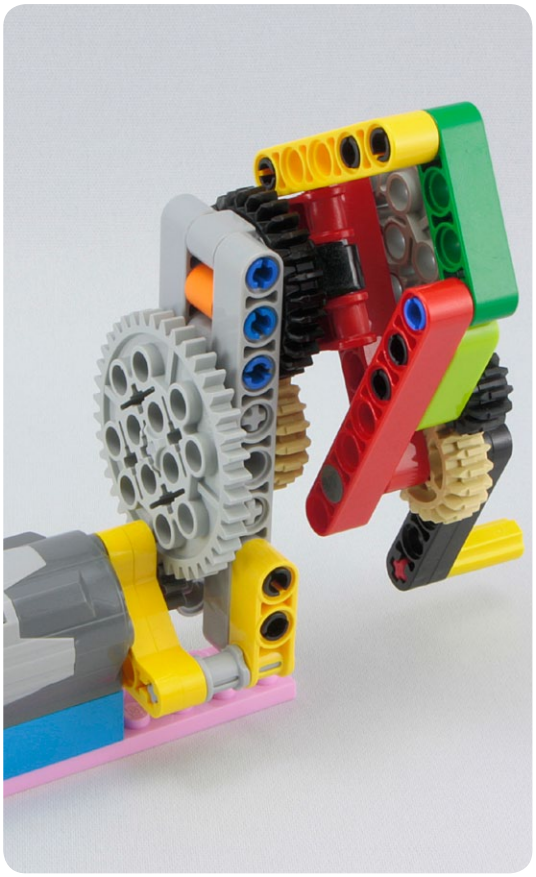

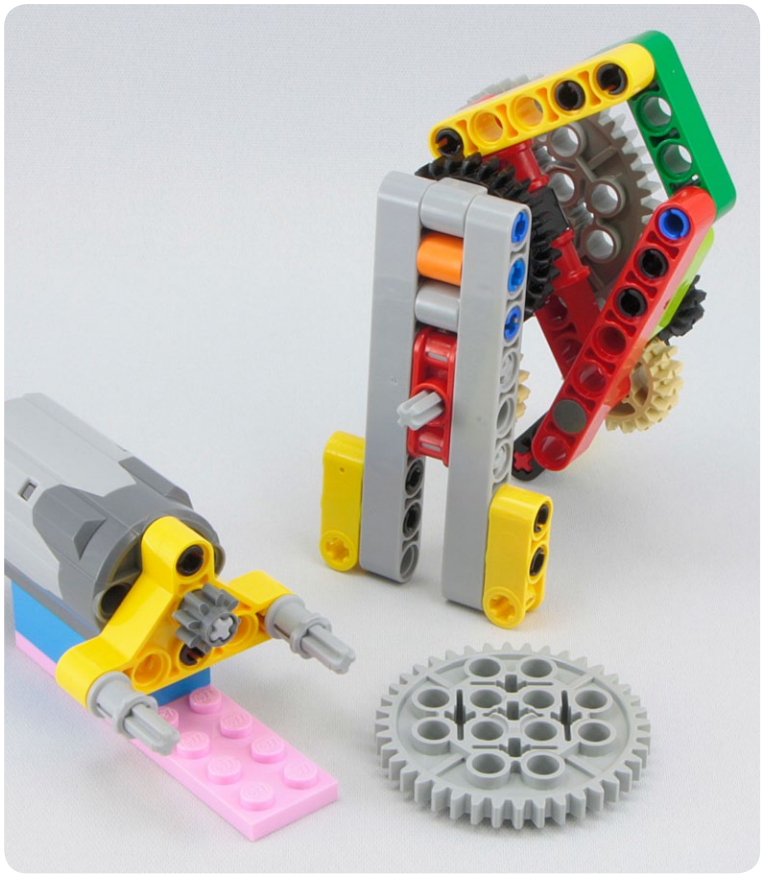

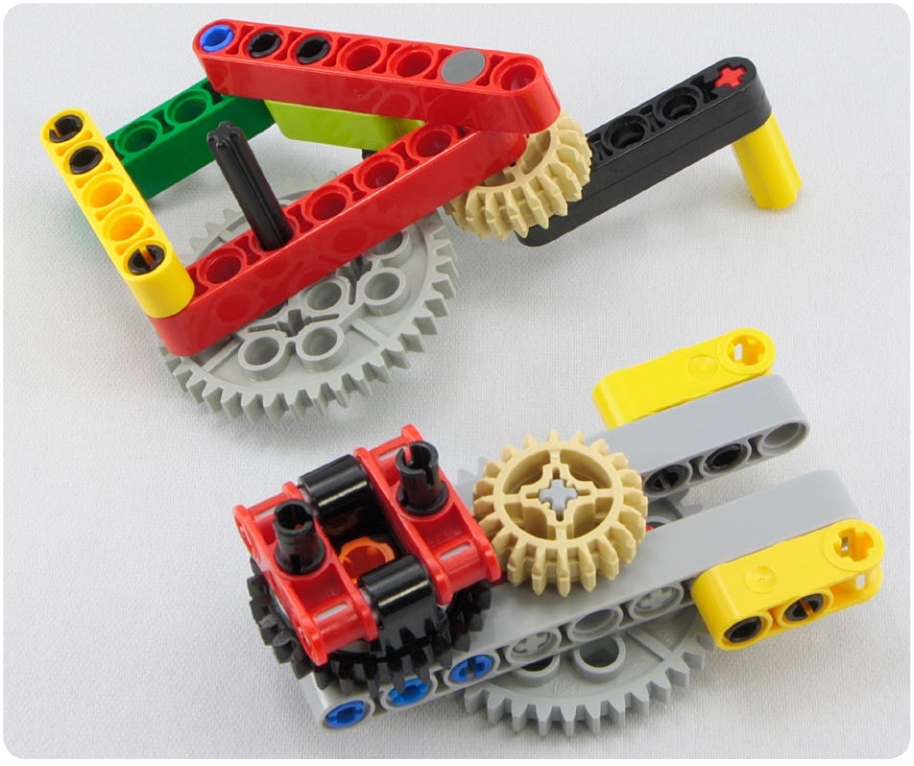

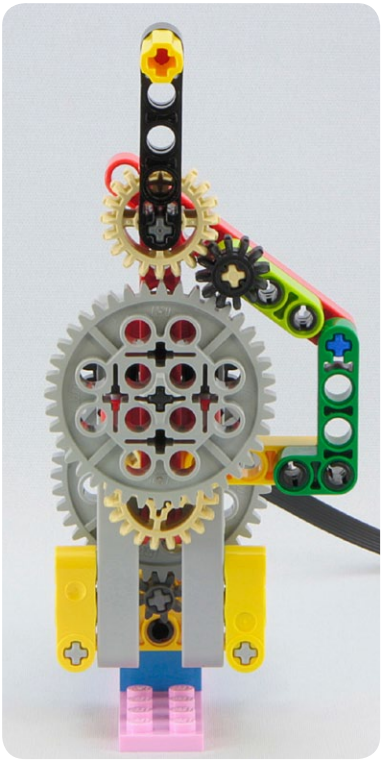

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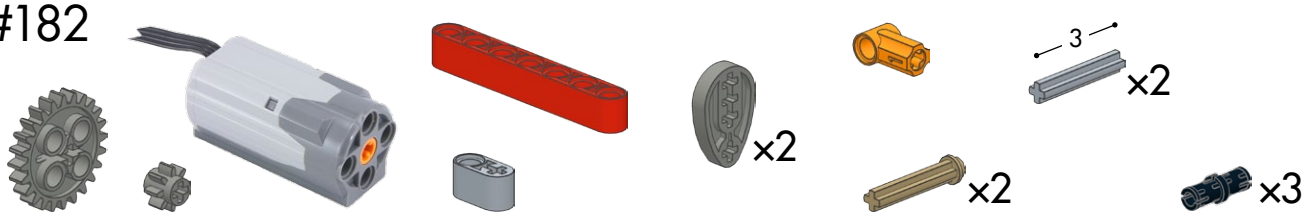

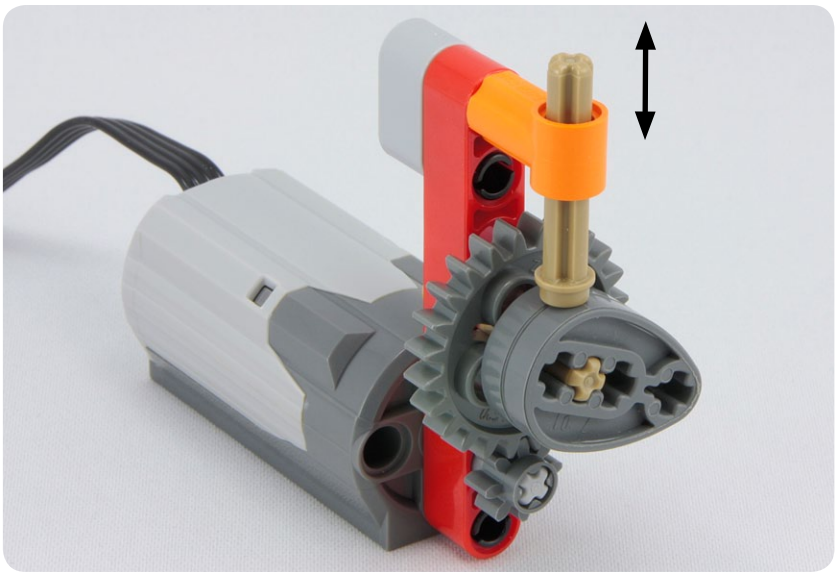

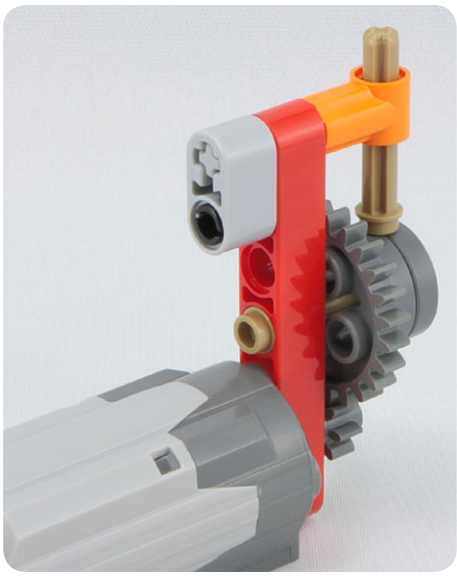

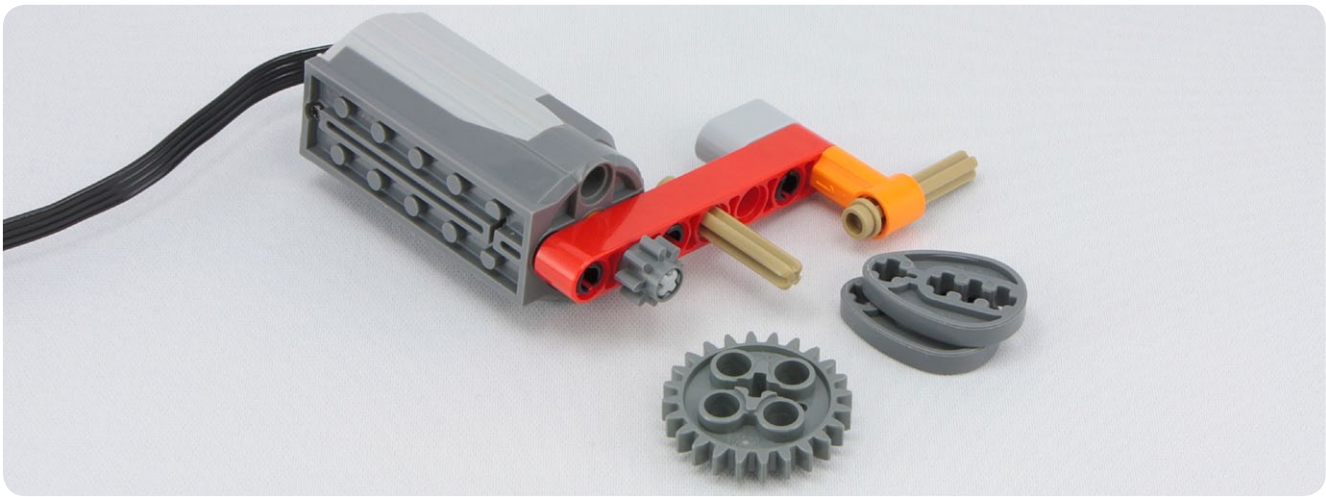

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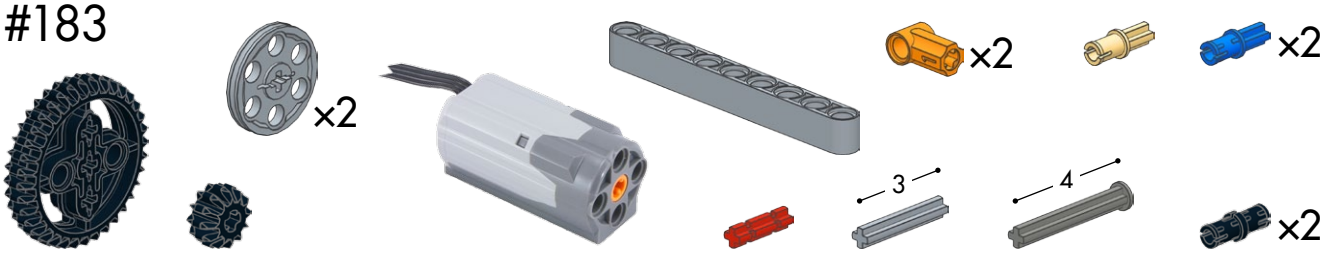

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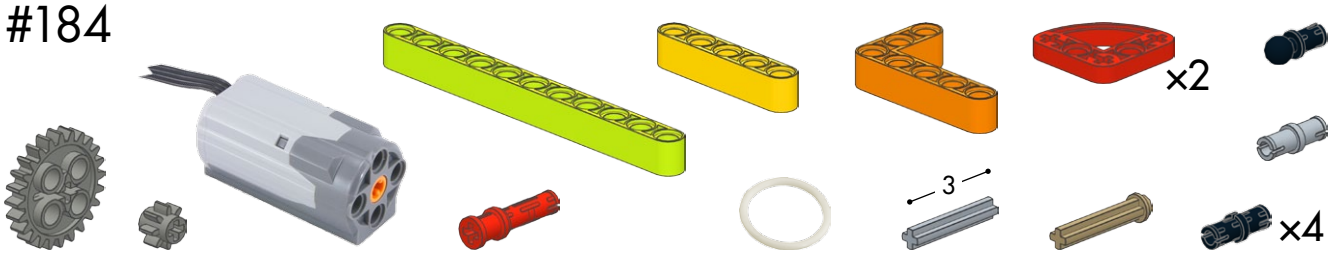

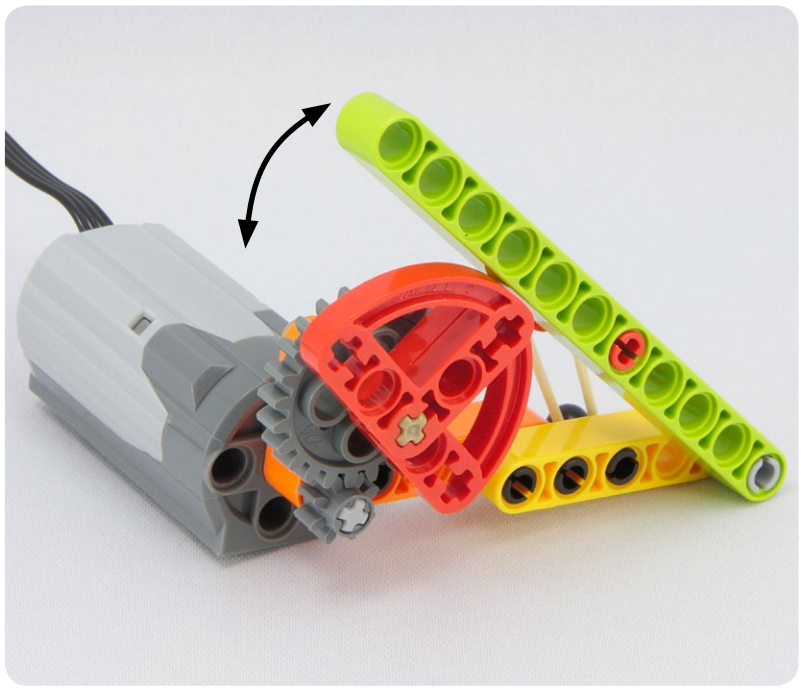

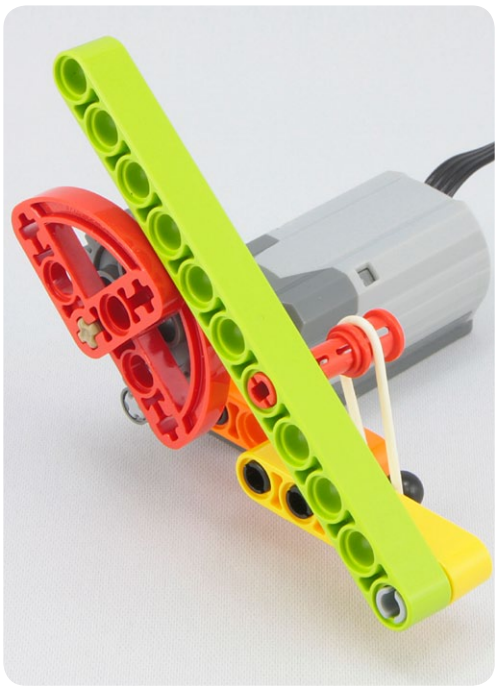

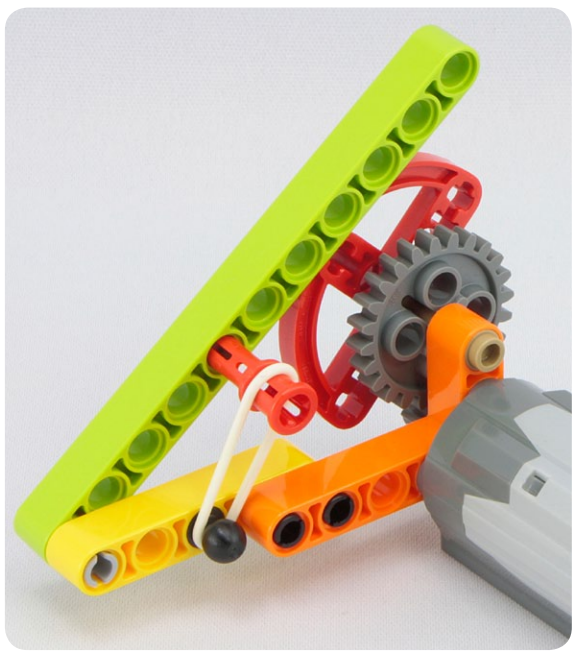

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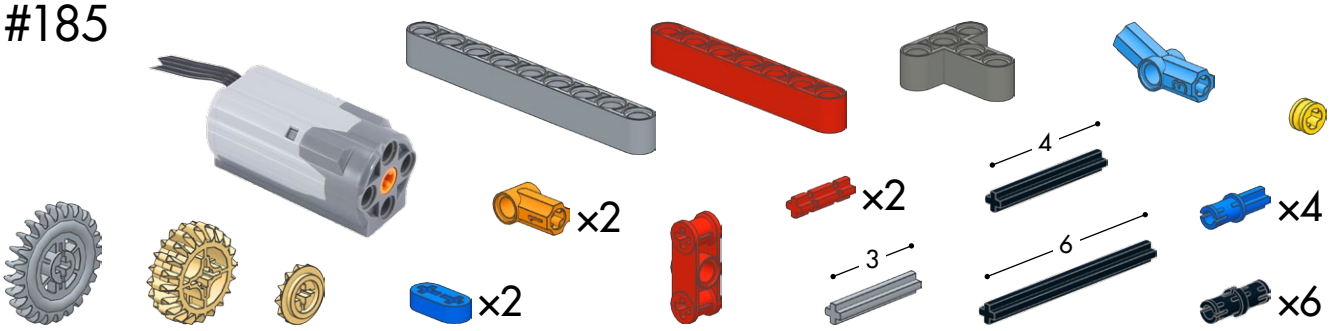

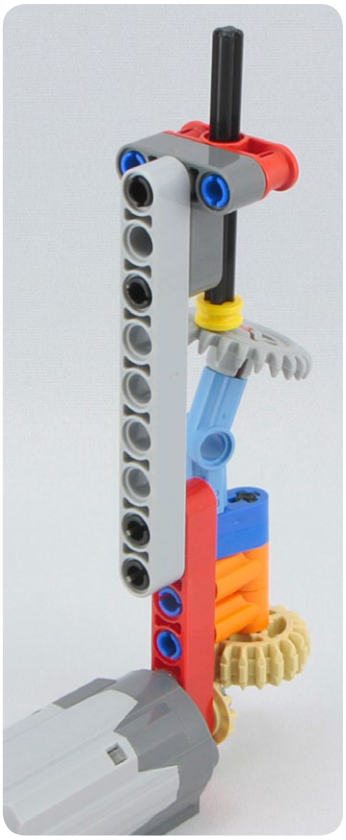

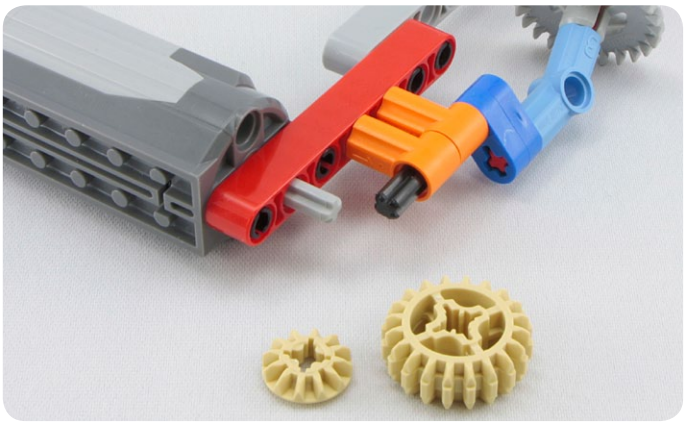

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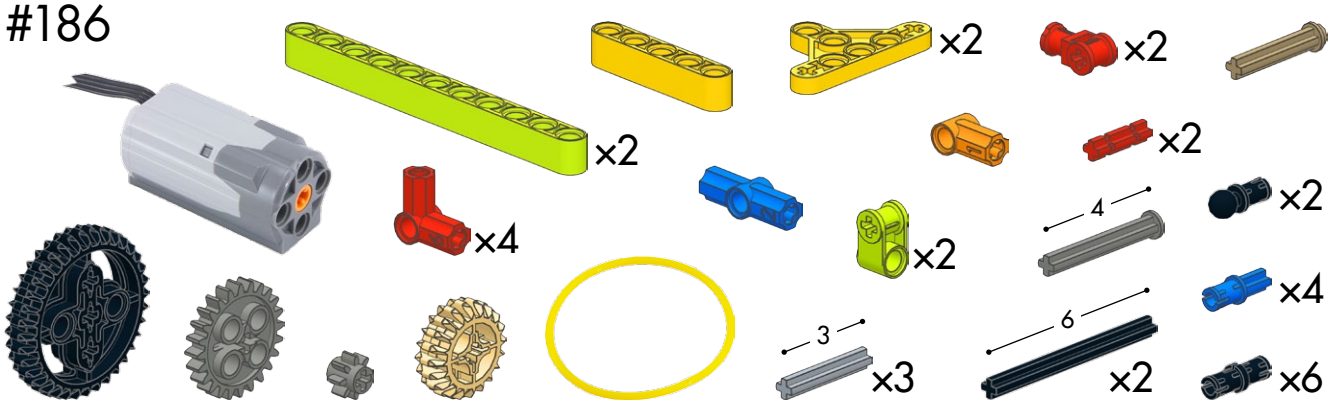

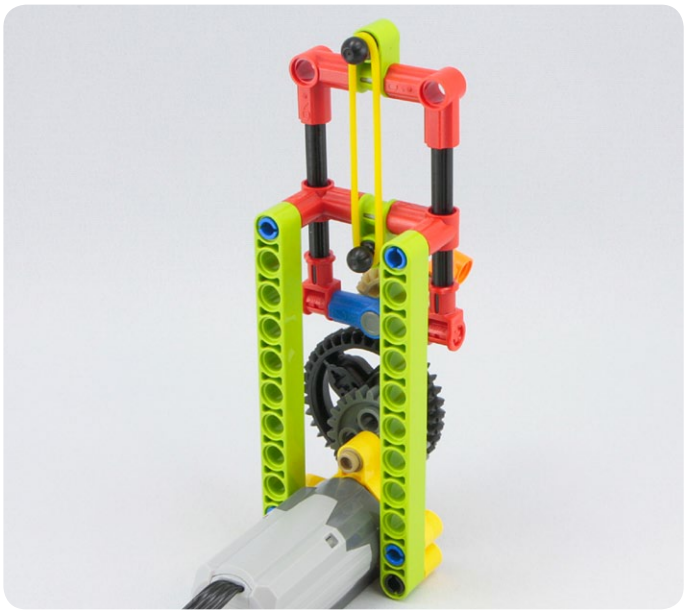

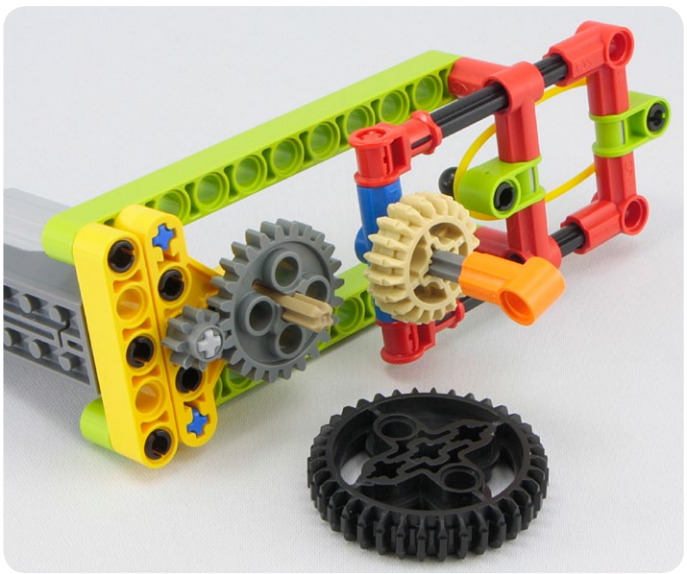

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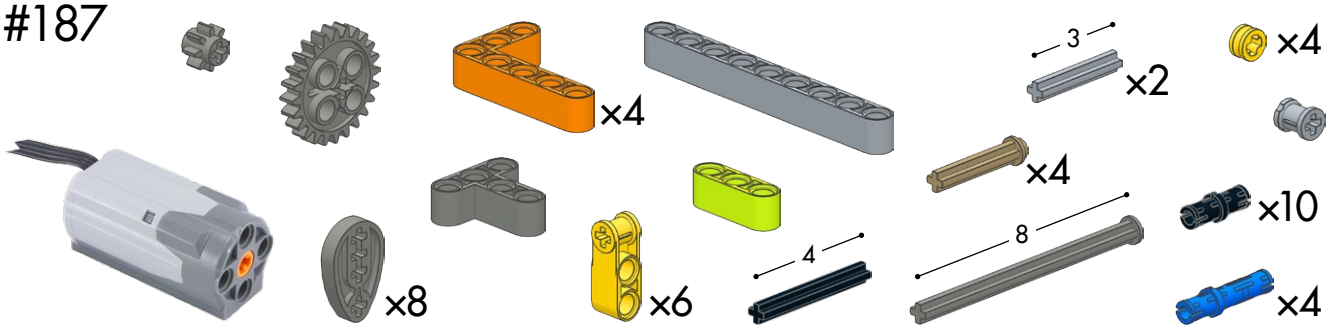

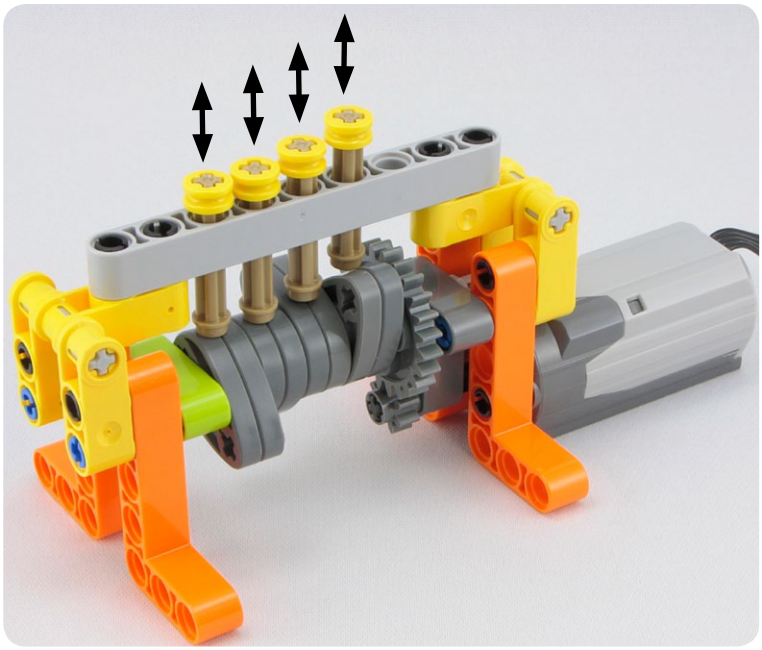

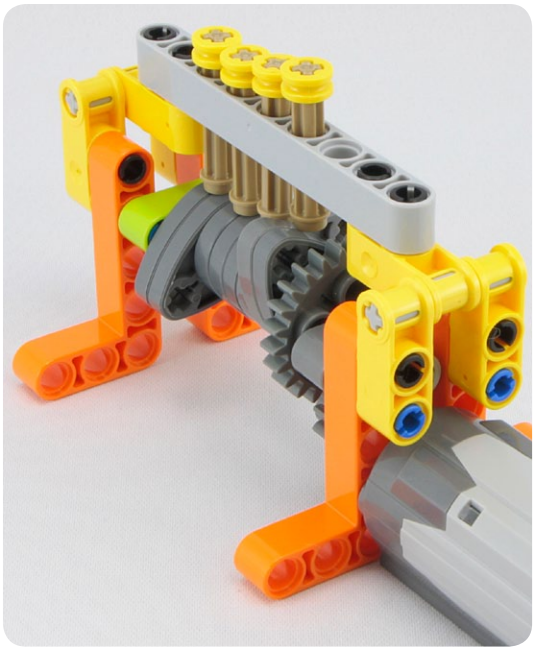

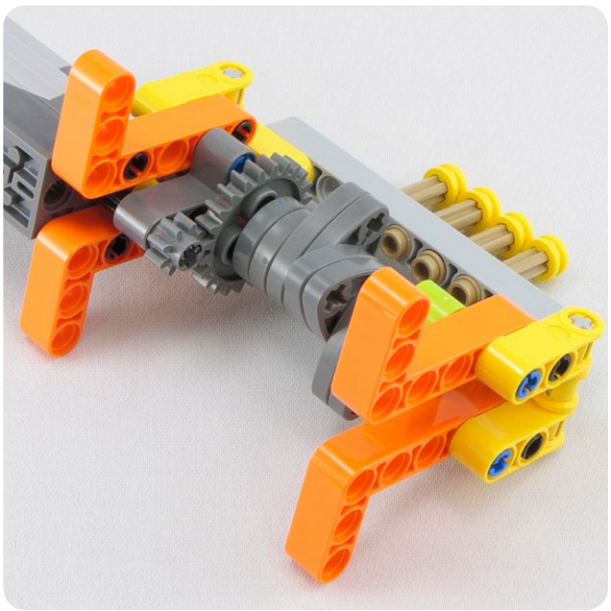

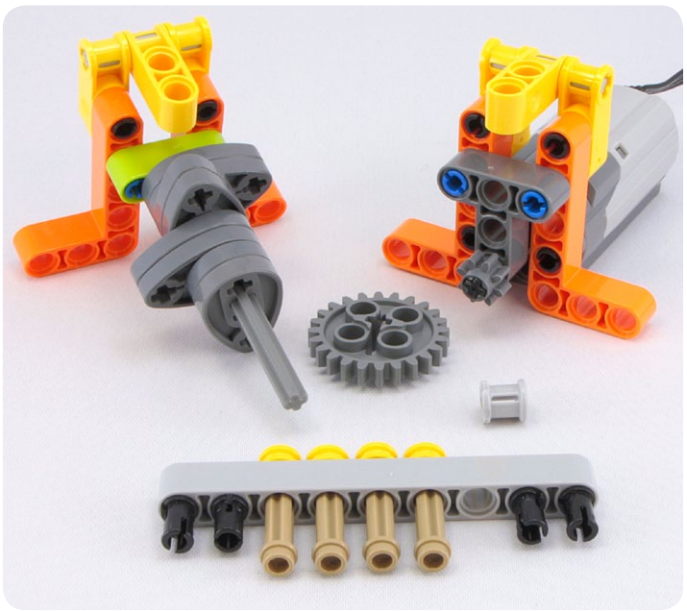

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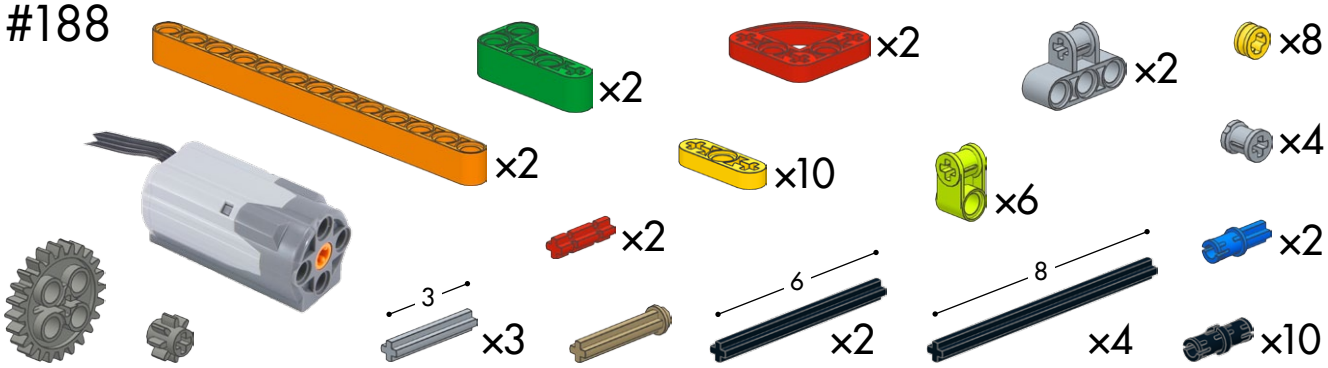

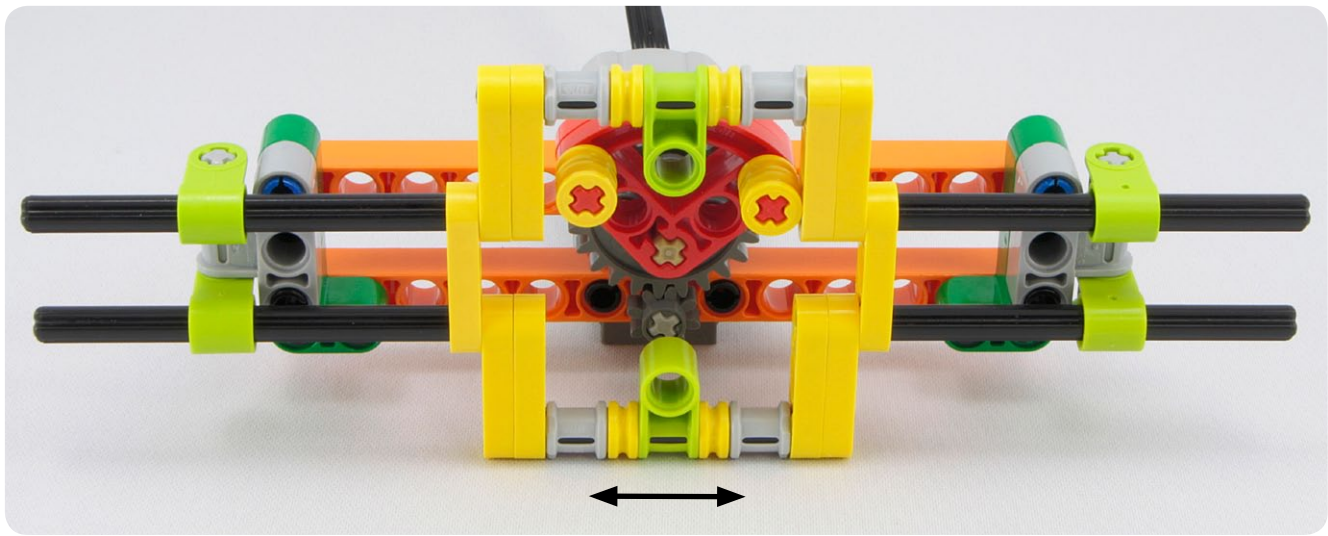

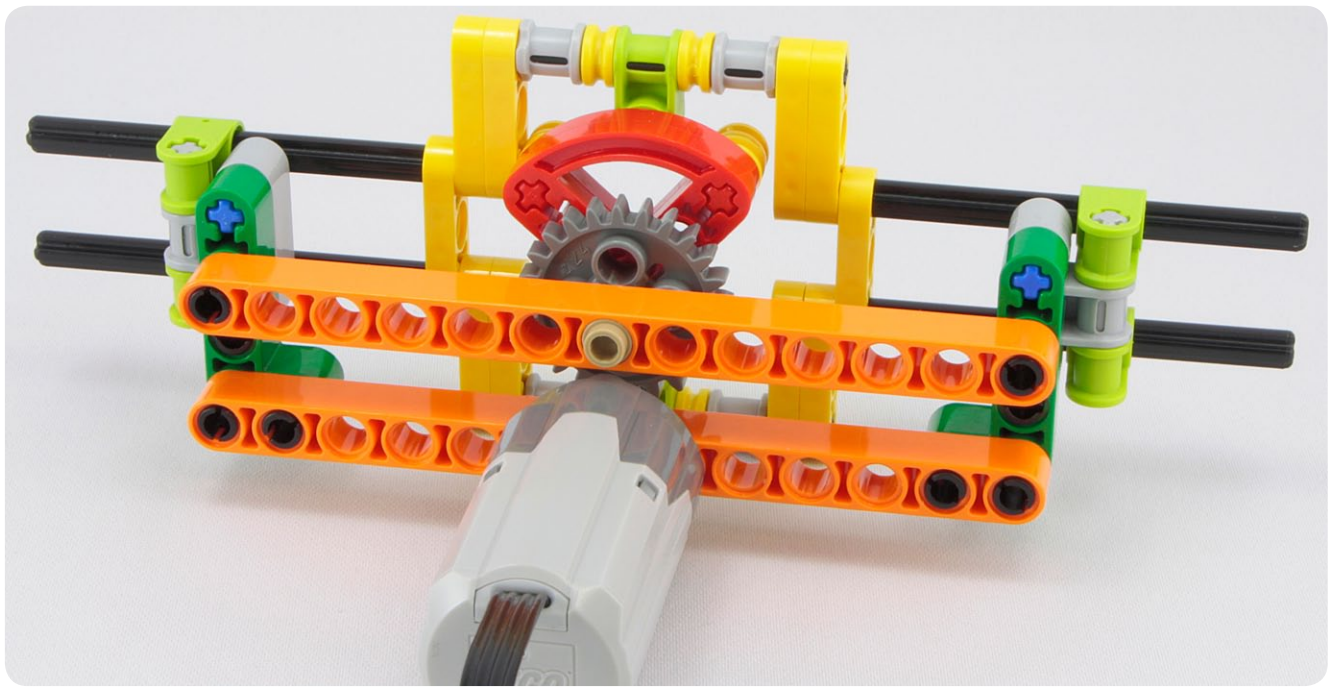

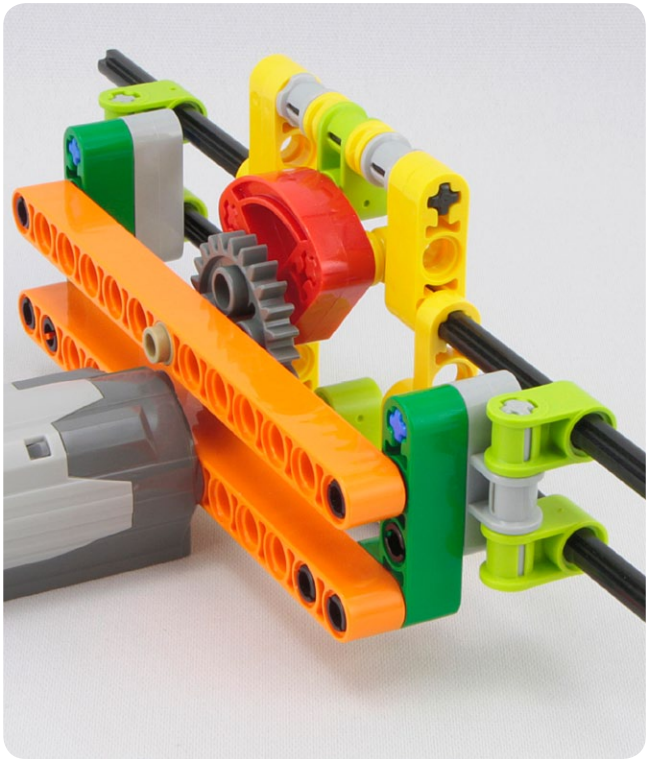

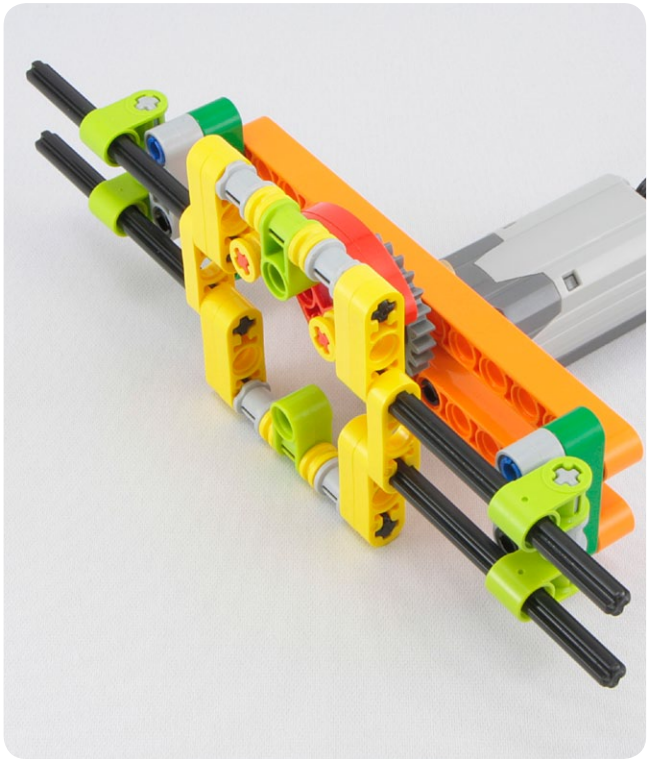

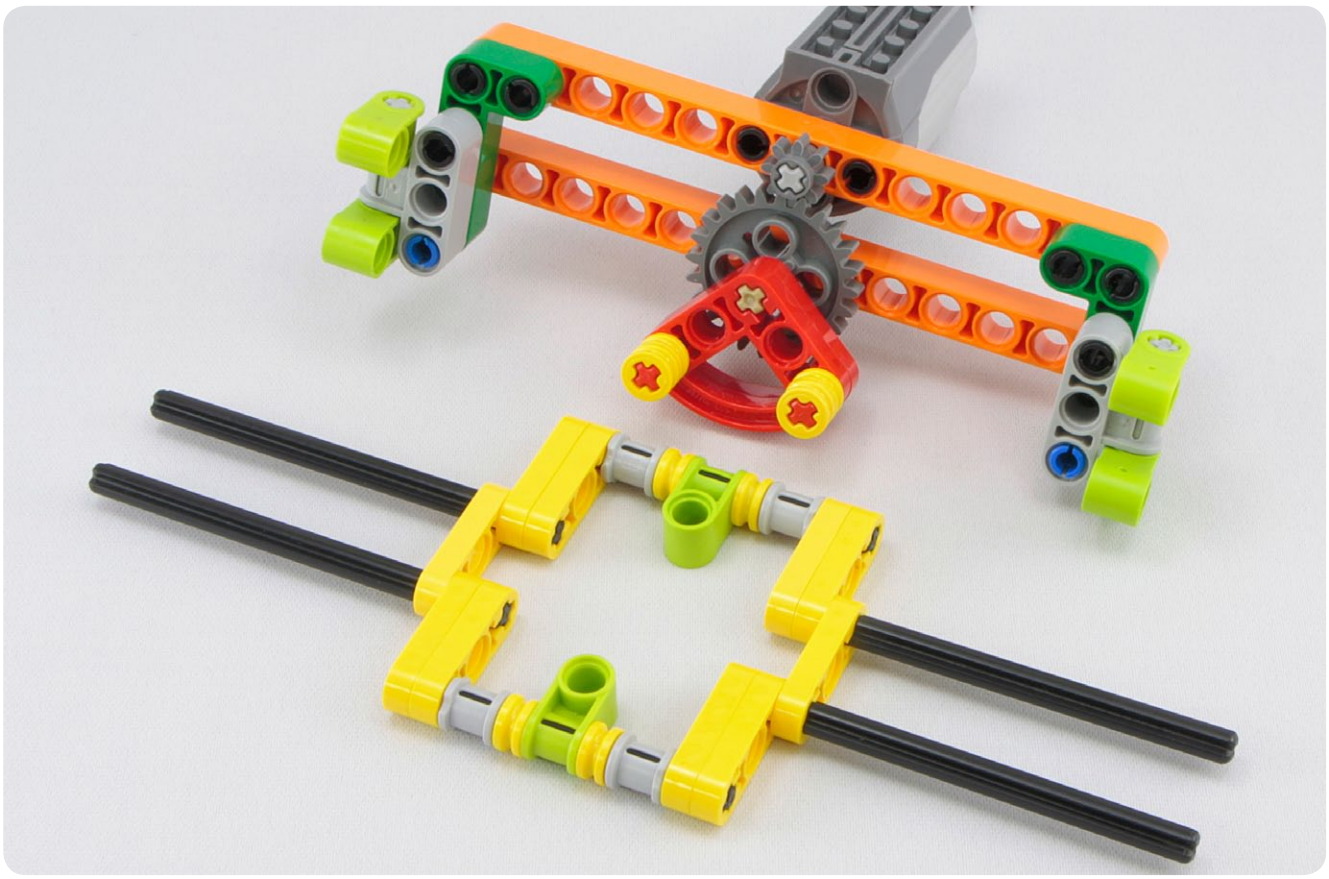

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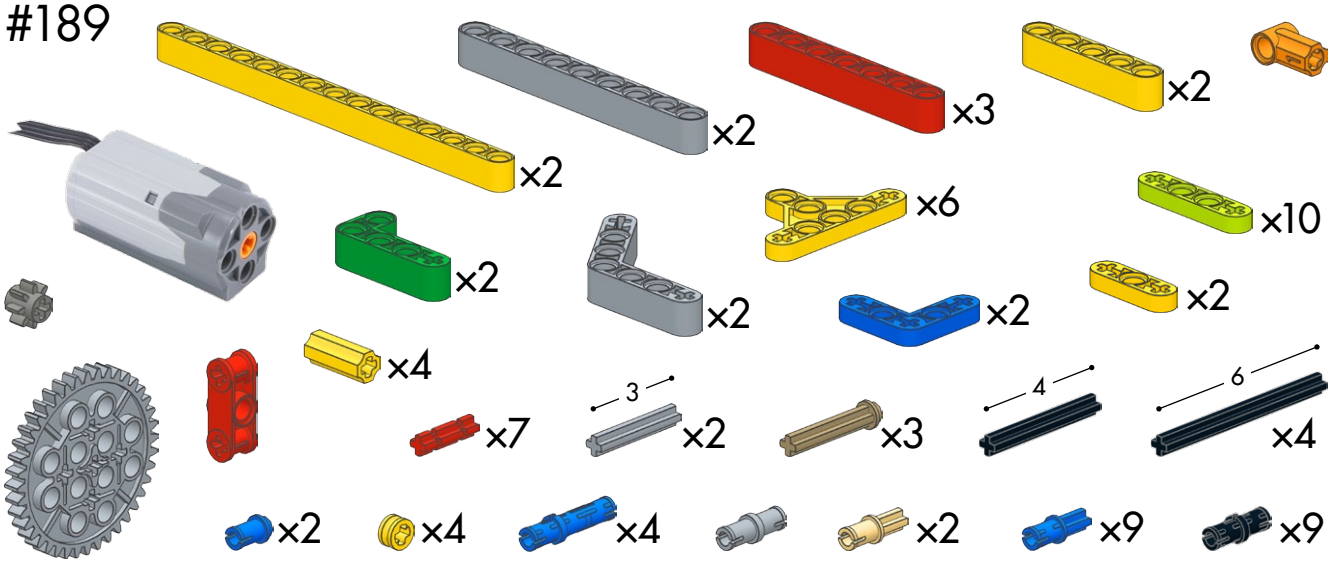

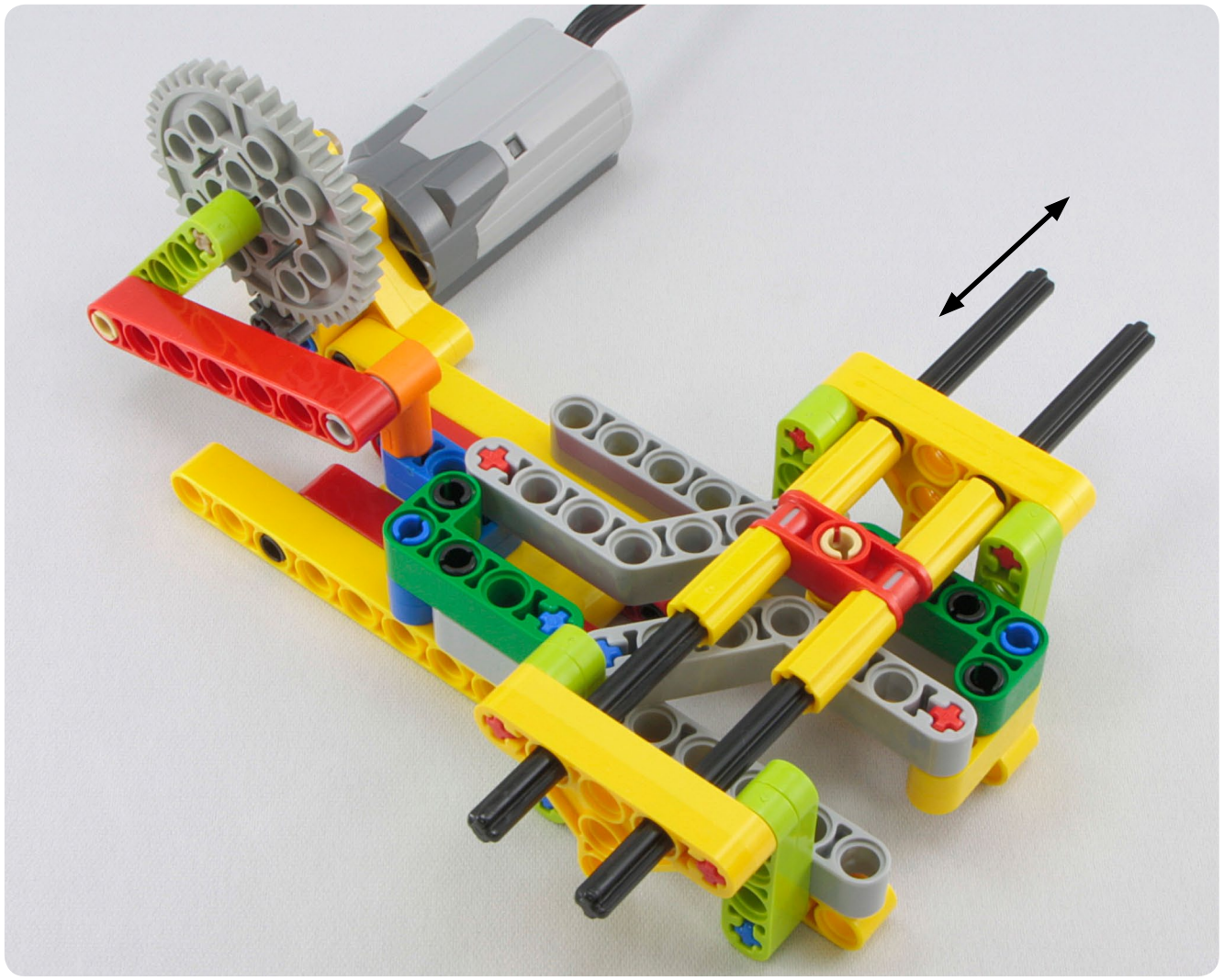

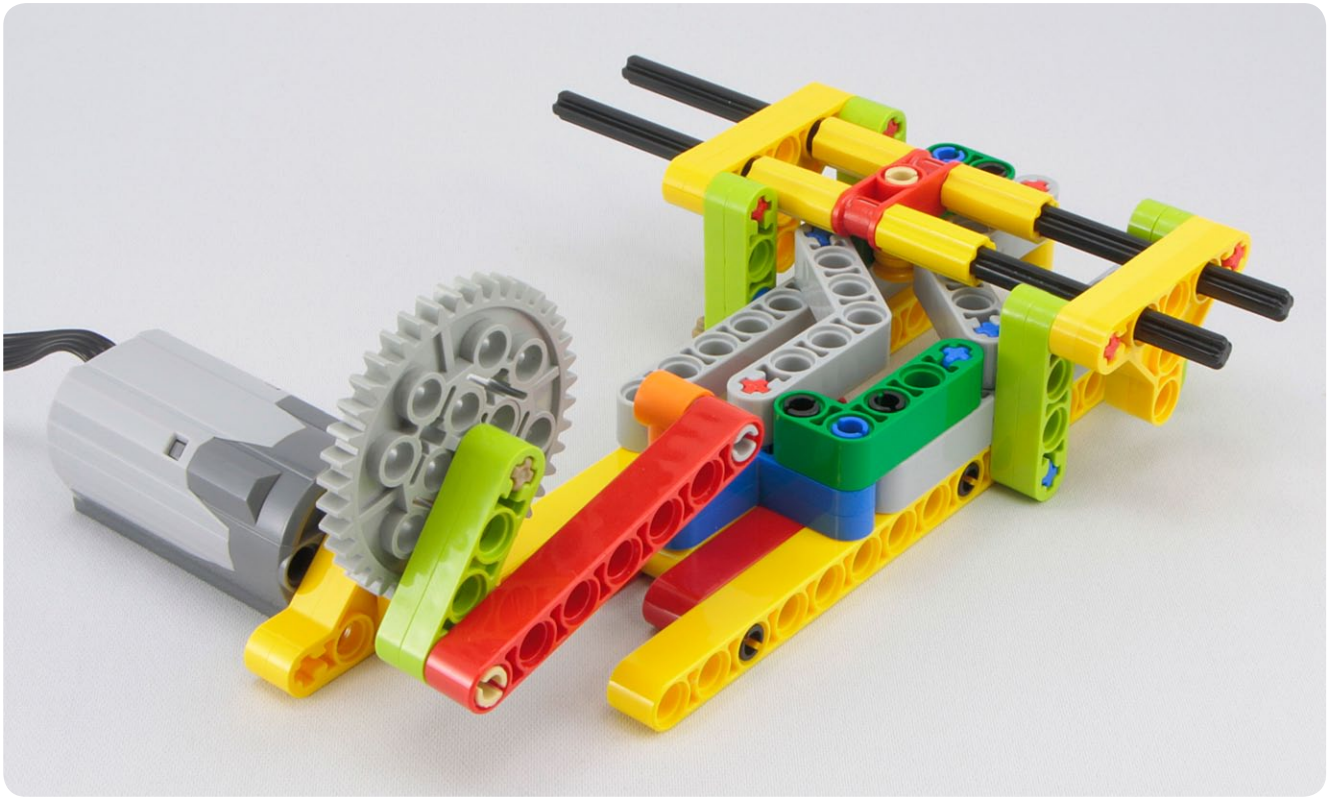

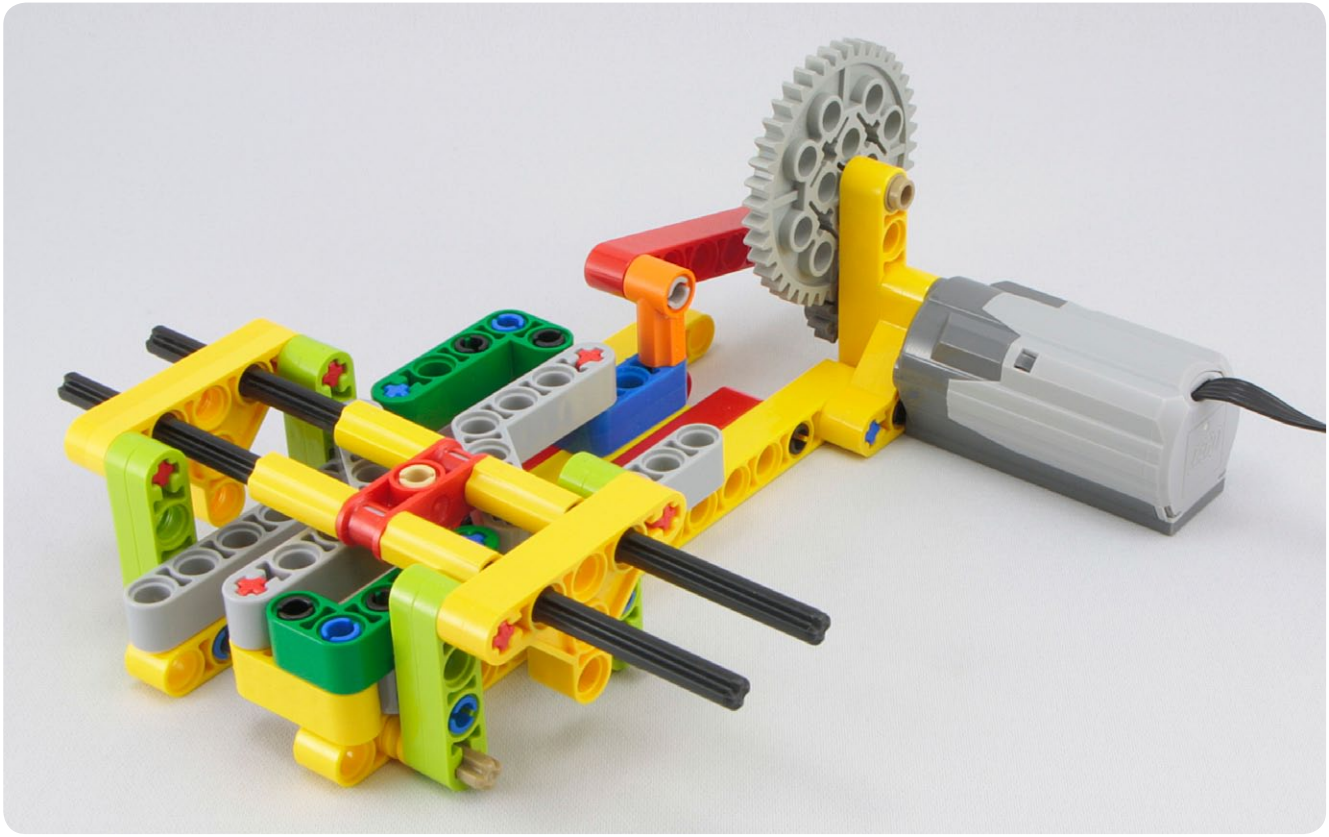

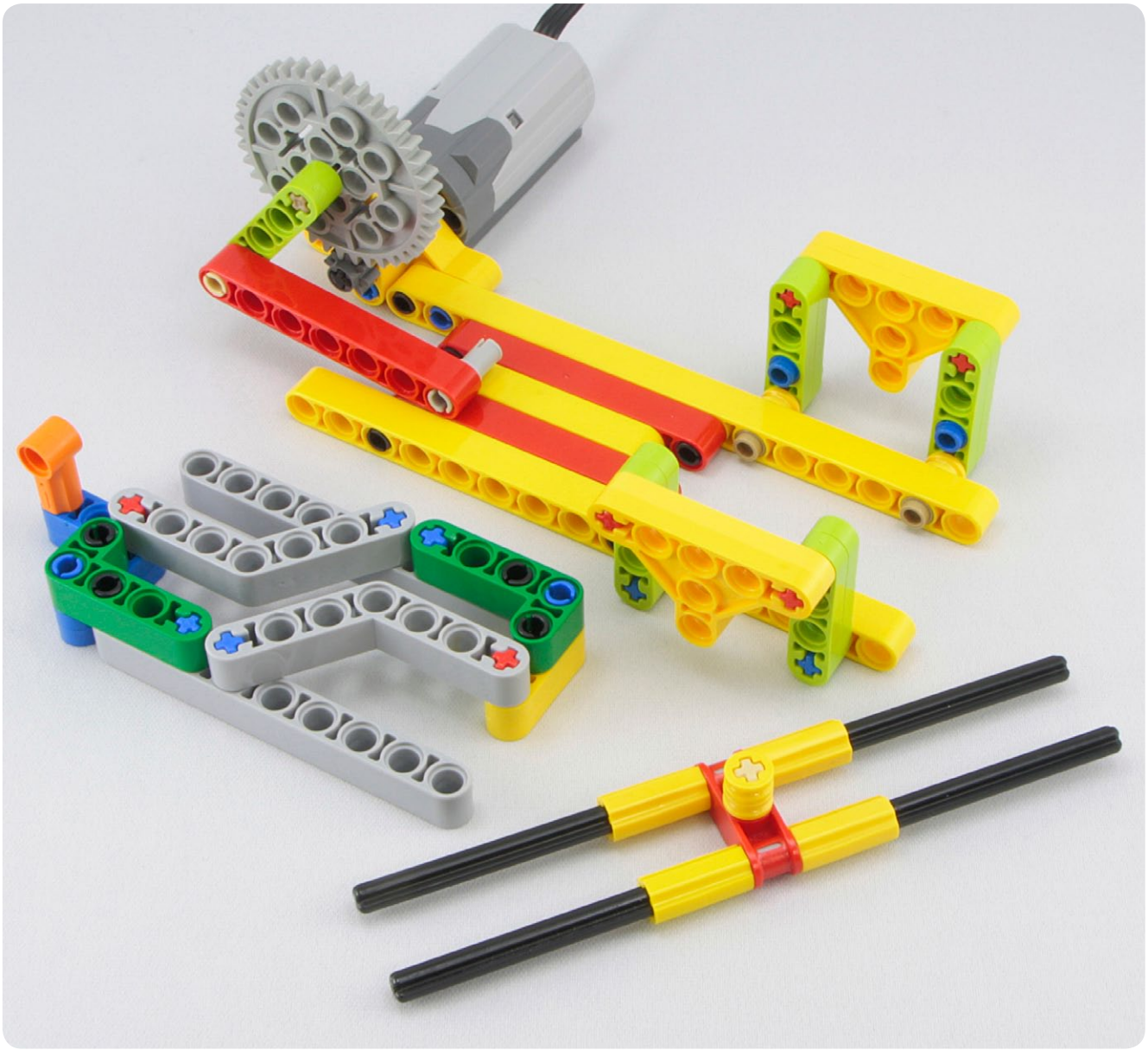

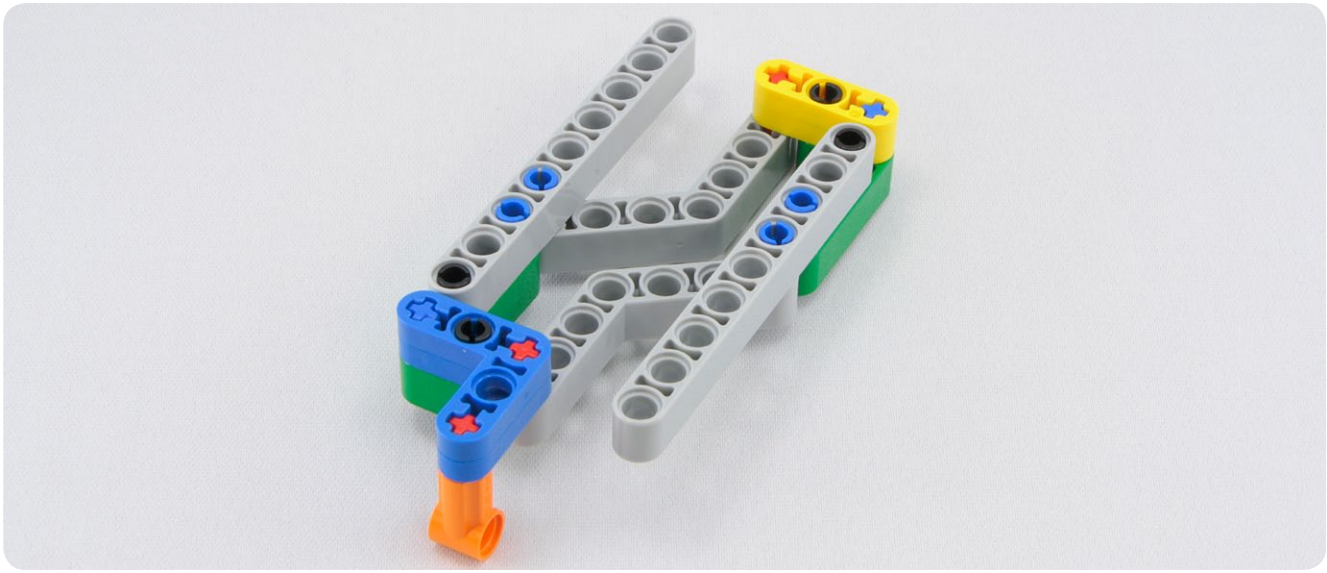

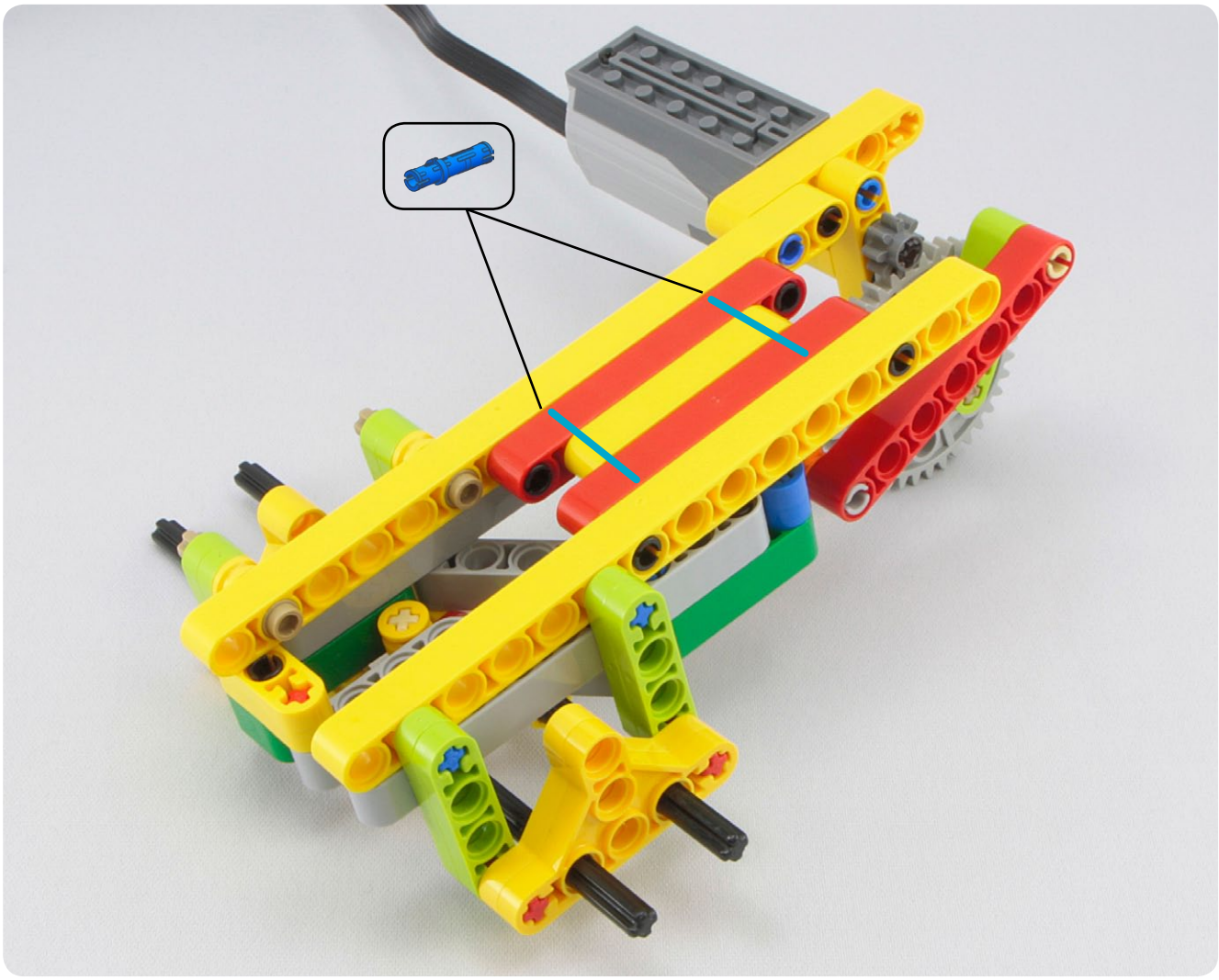

1:? Gear systems with whole number ratios

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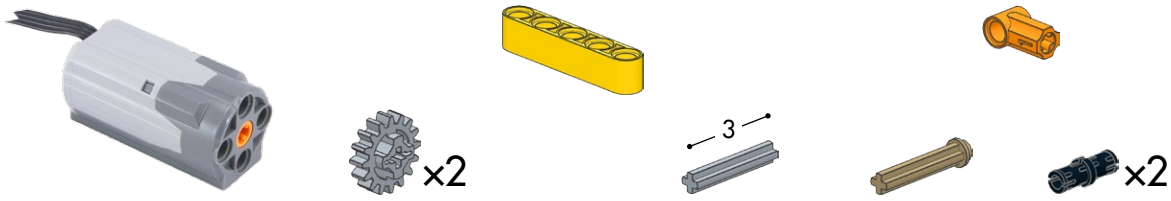

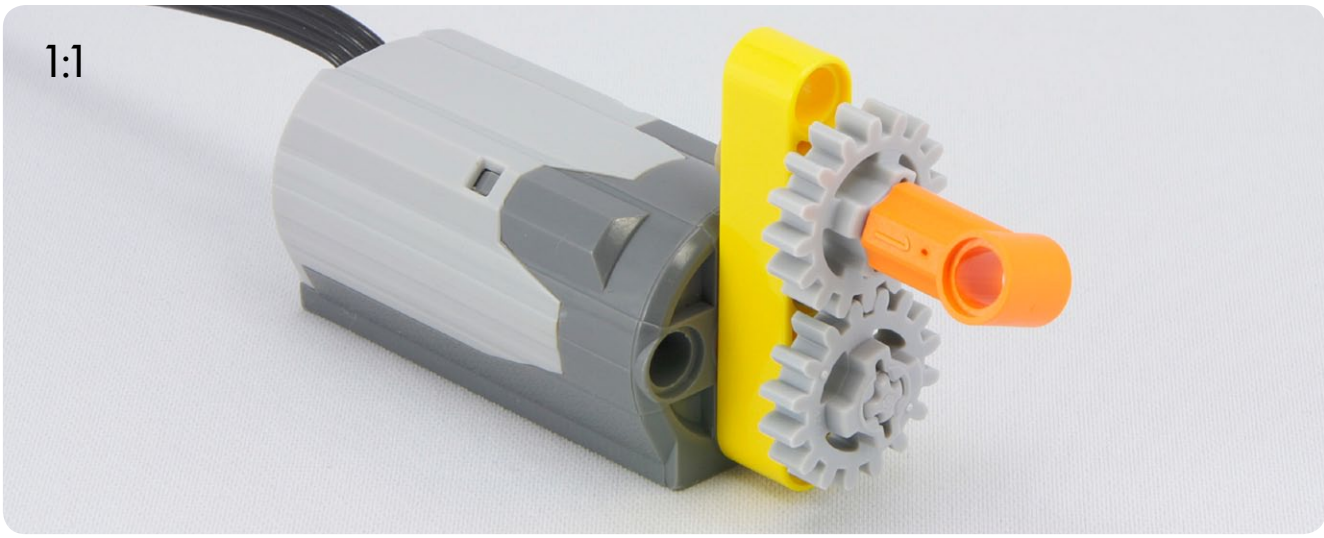

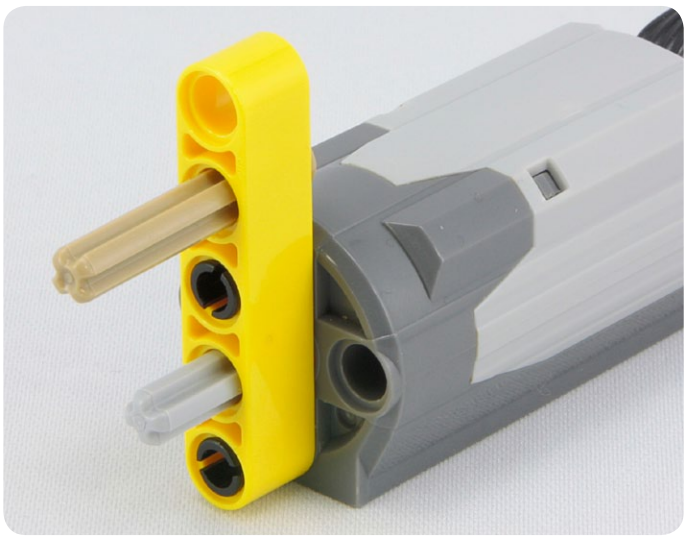

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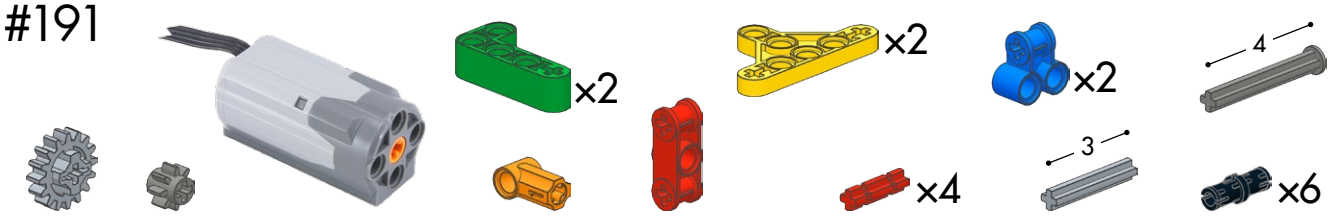

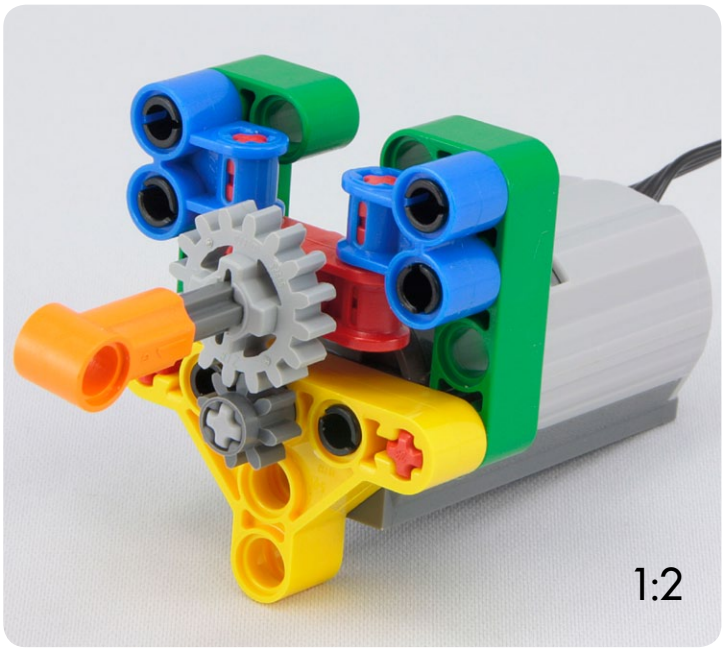

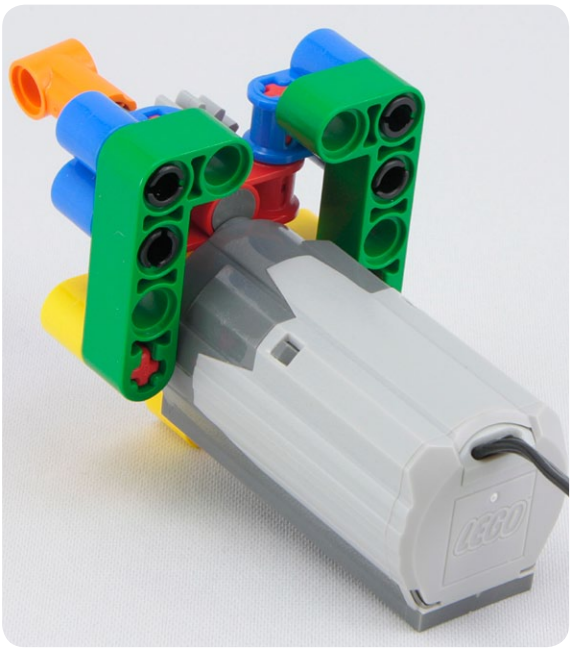

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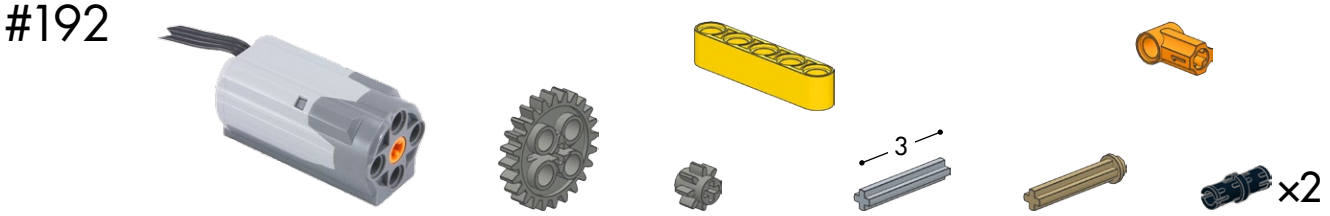

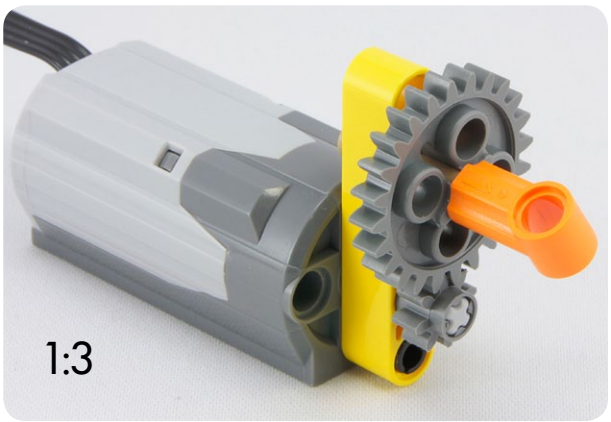

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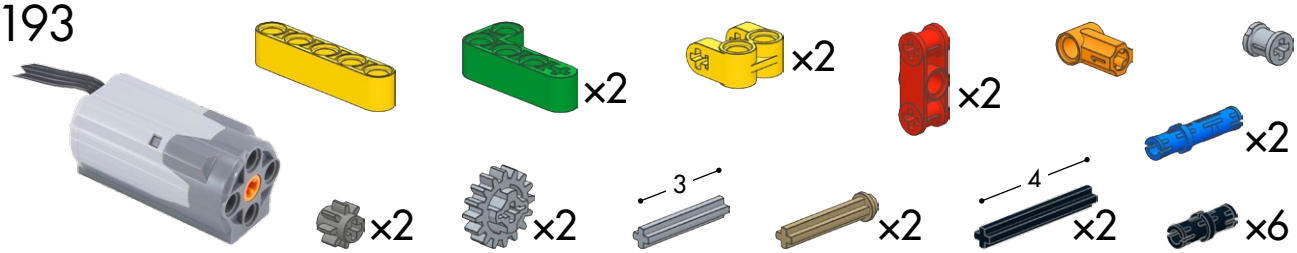

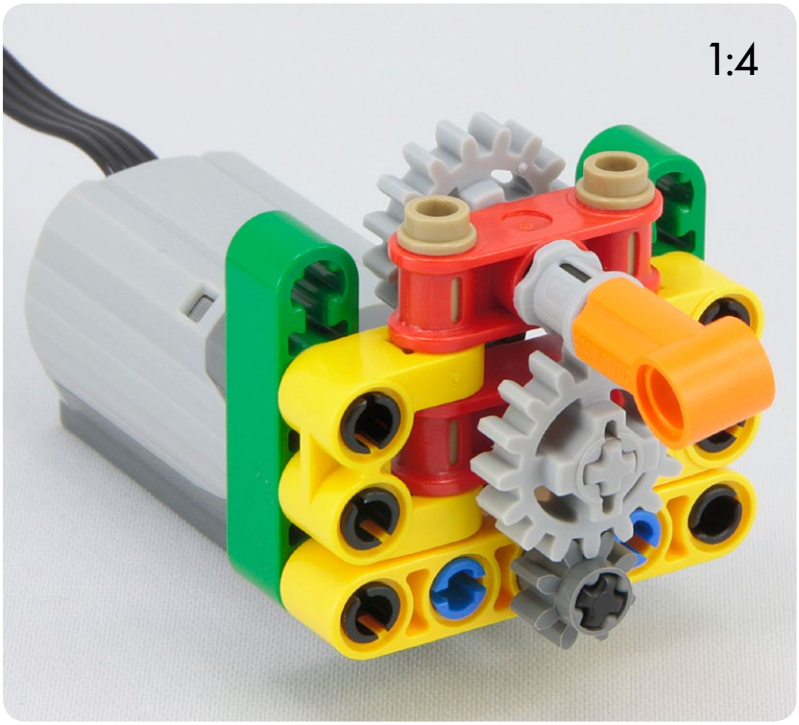

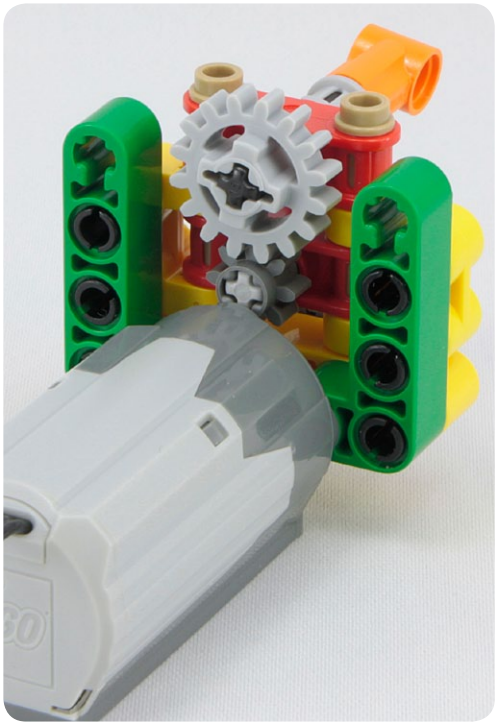

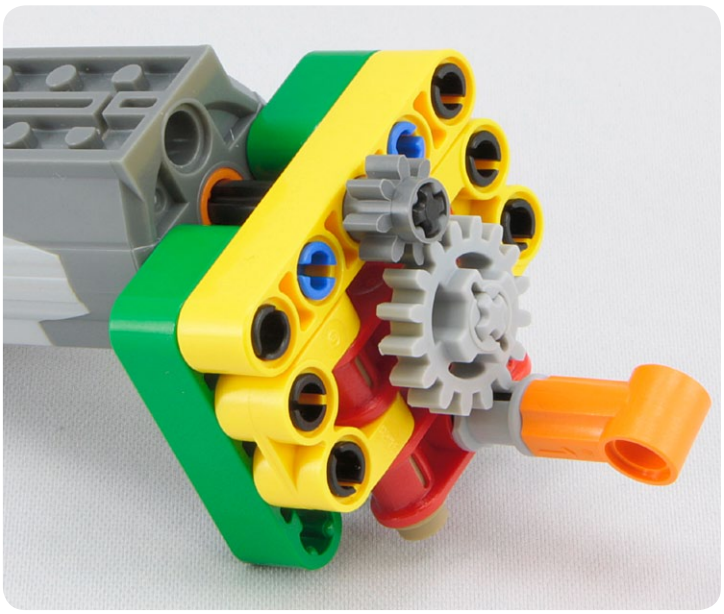

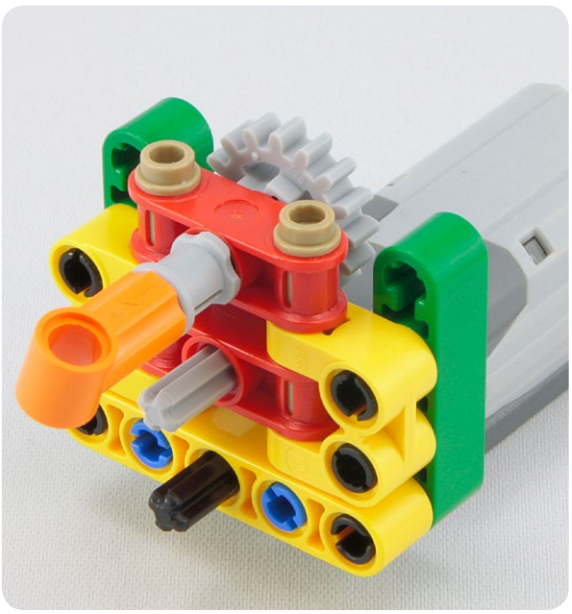

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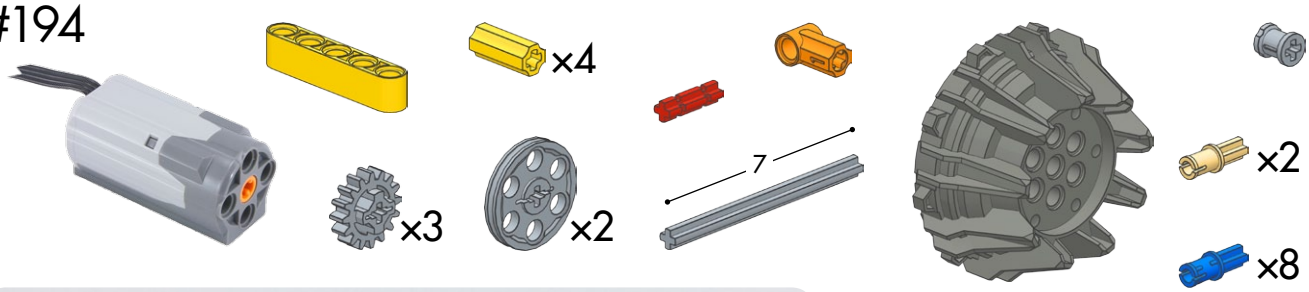

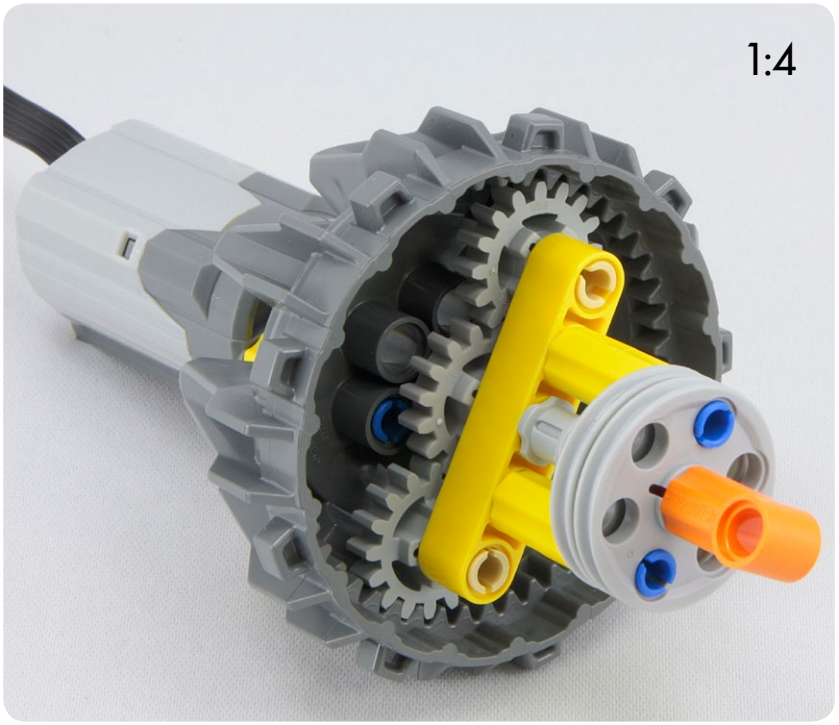

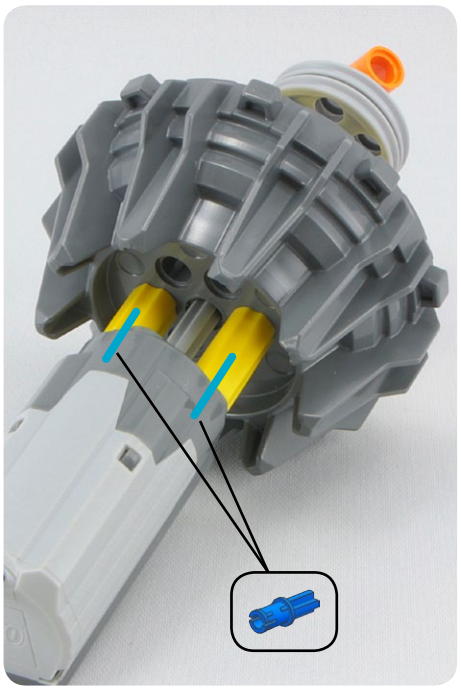

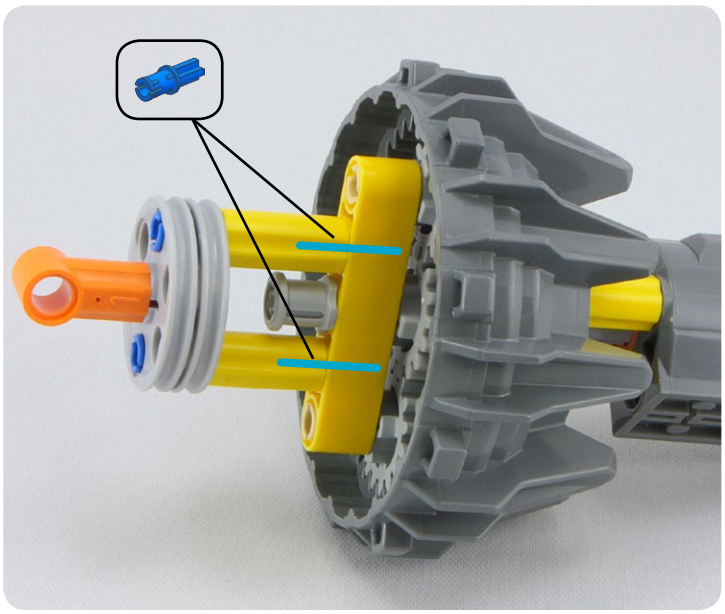

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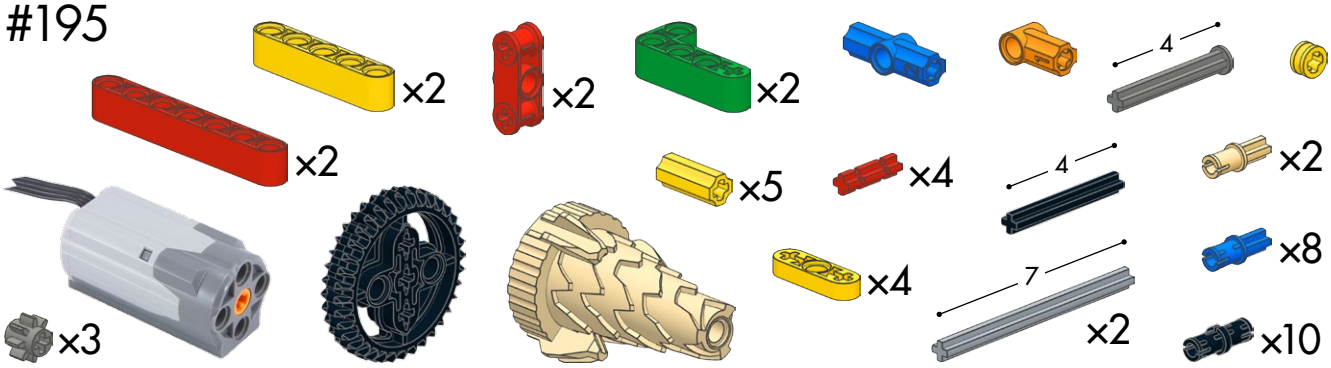

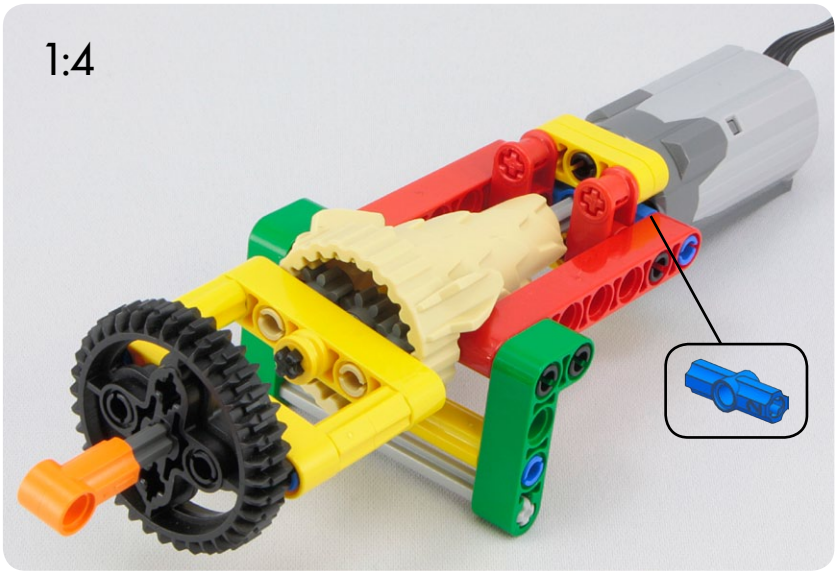

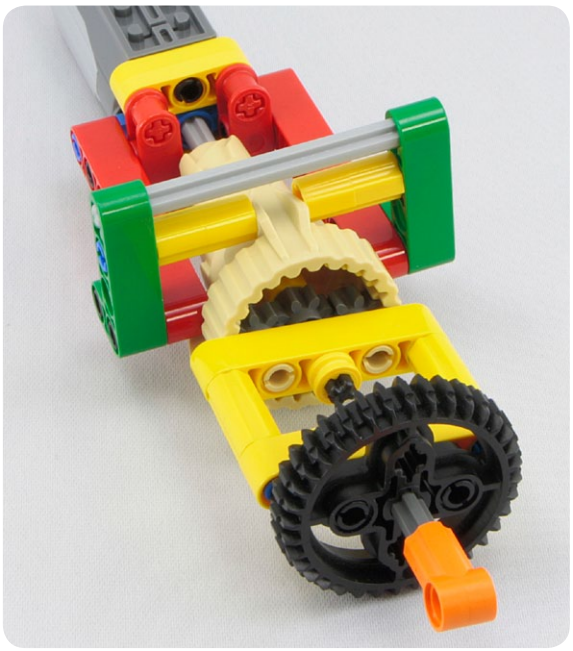

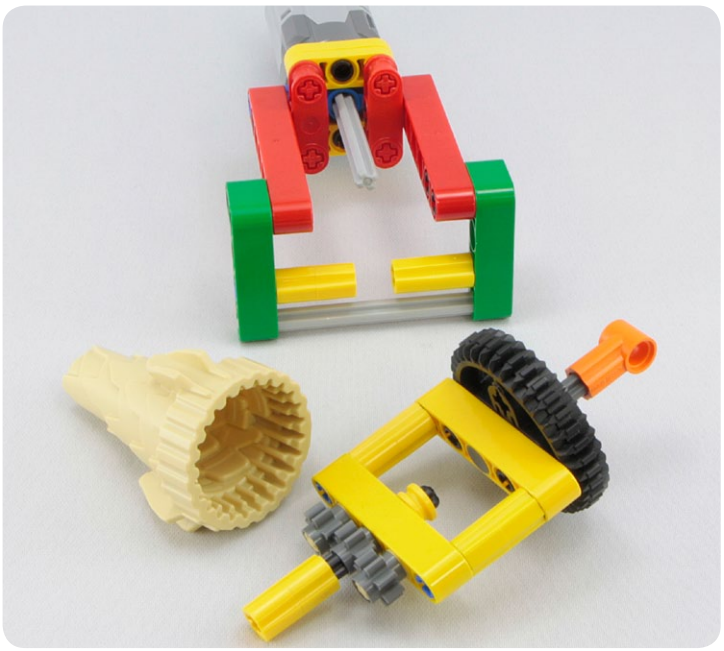

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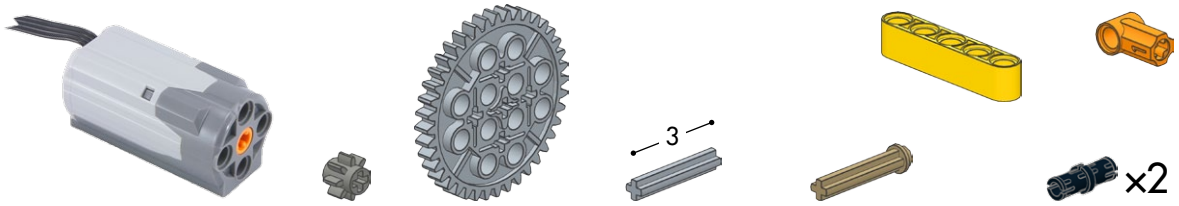

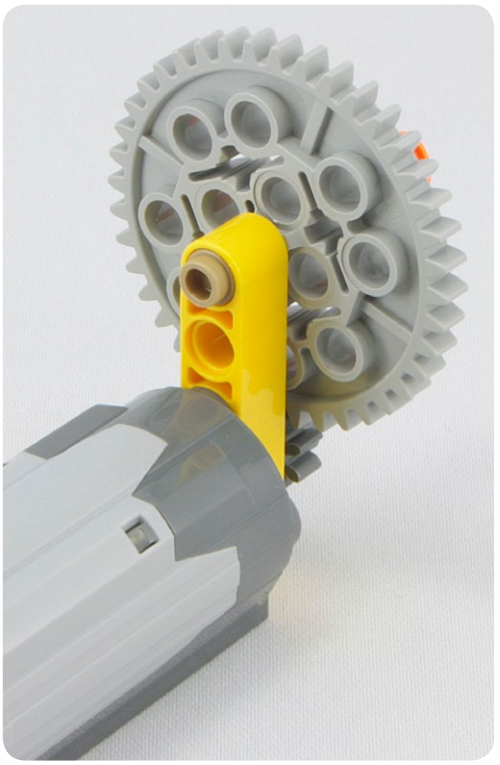

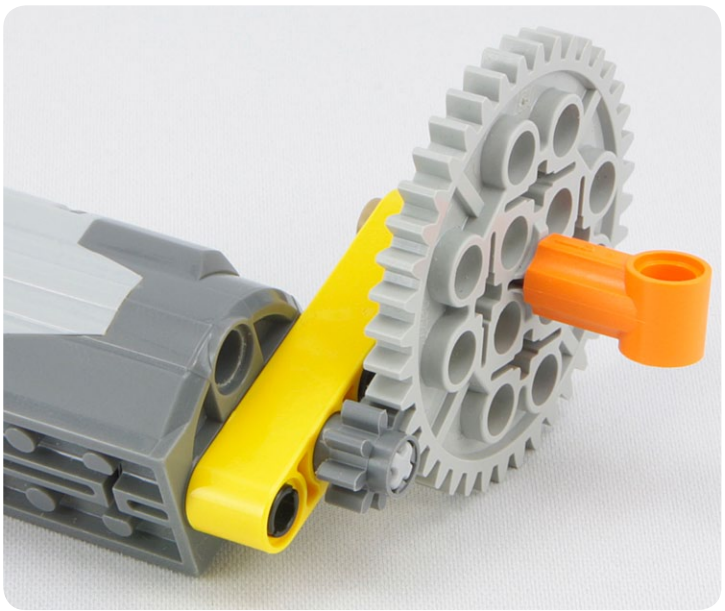

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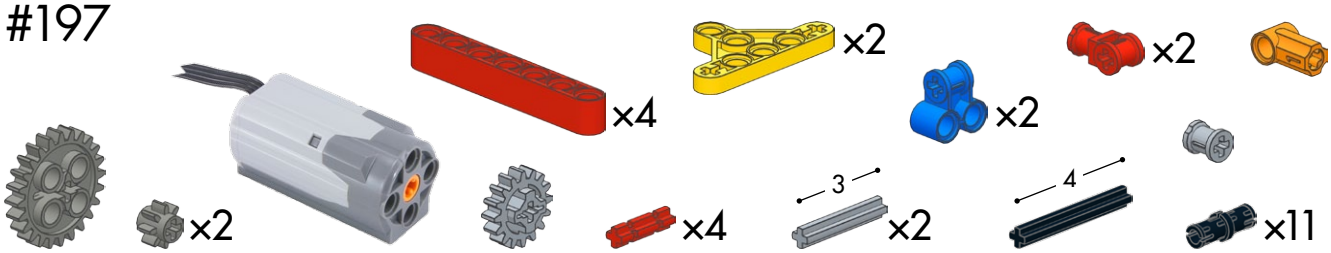

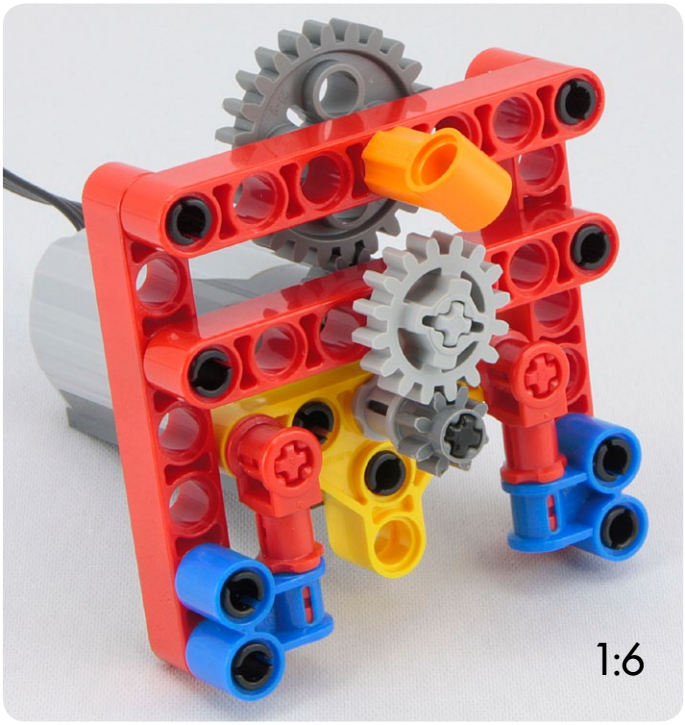

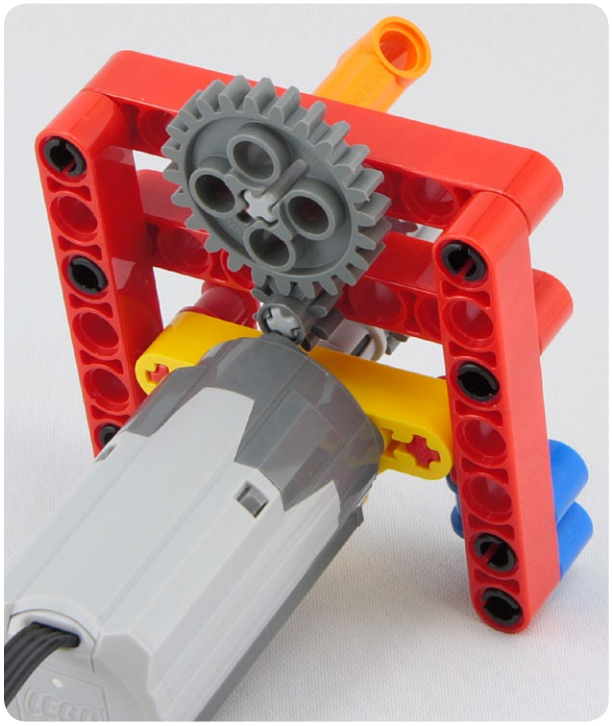

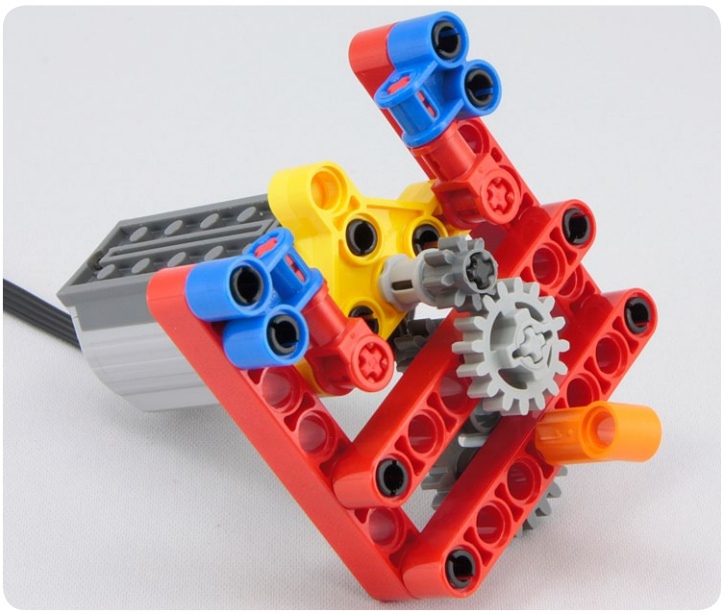

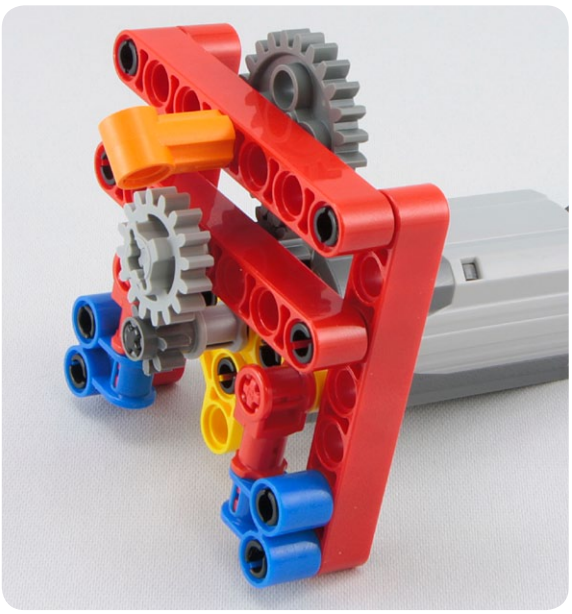

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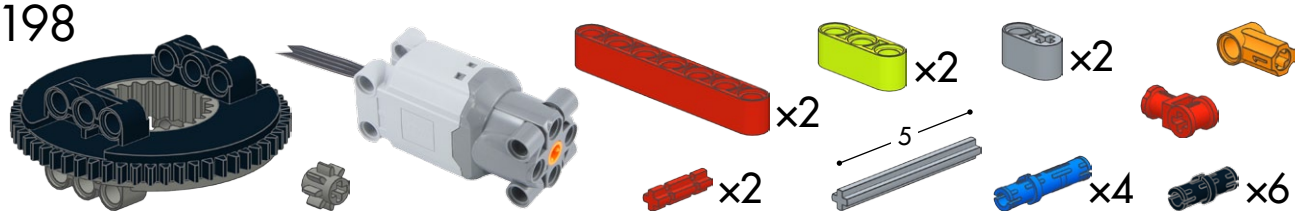

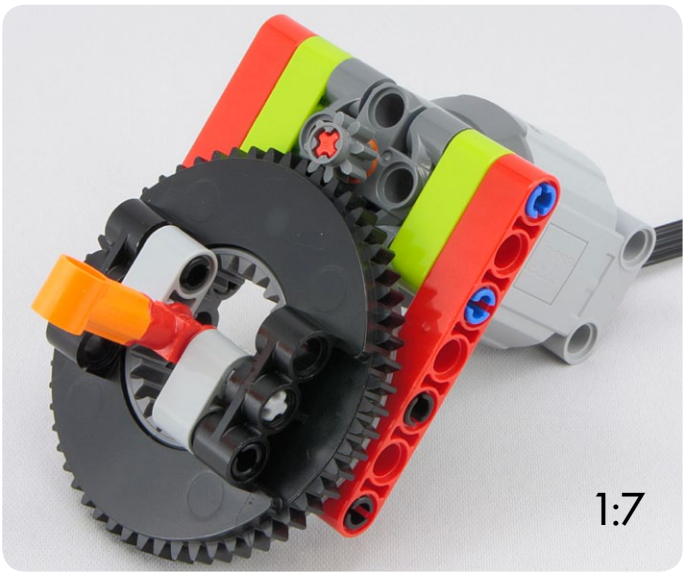

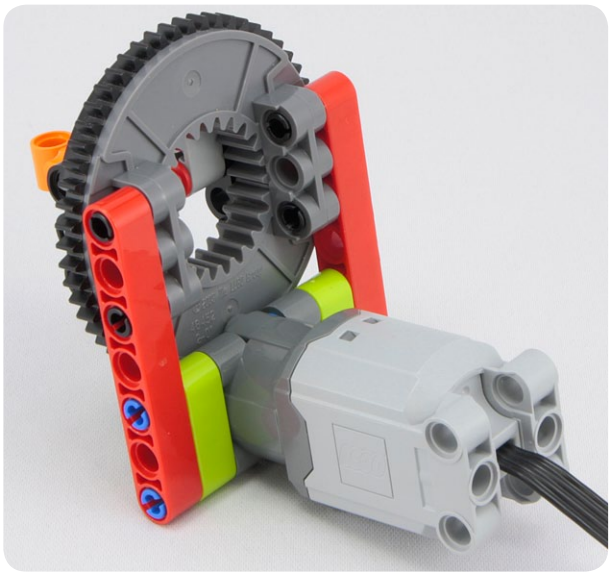

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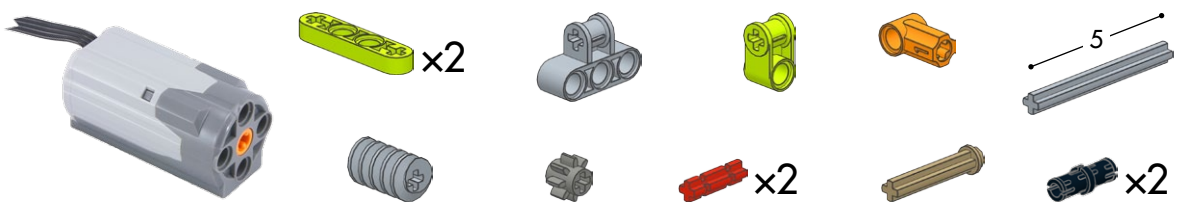

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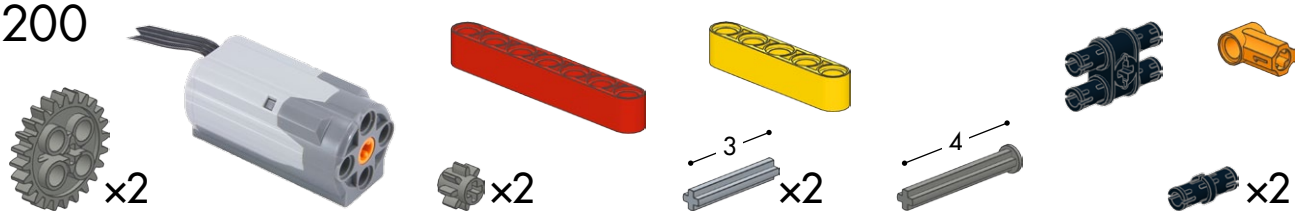

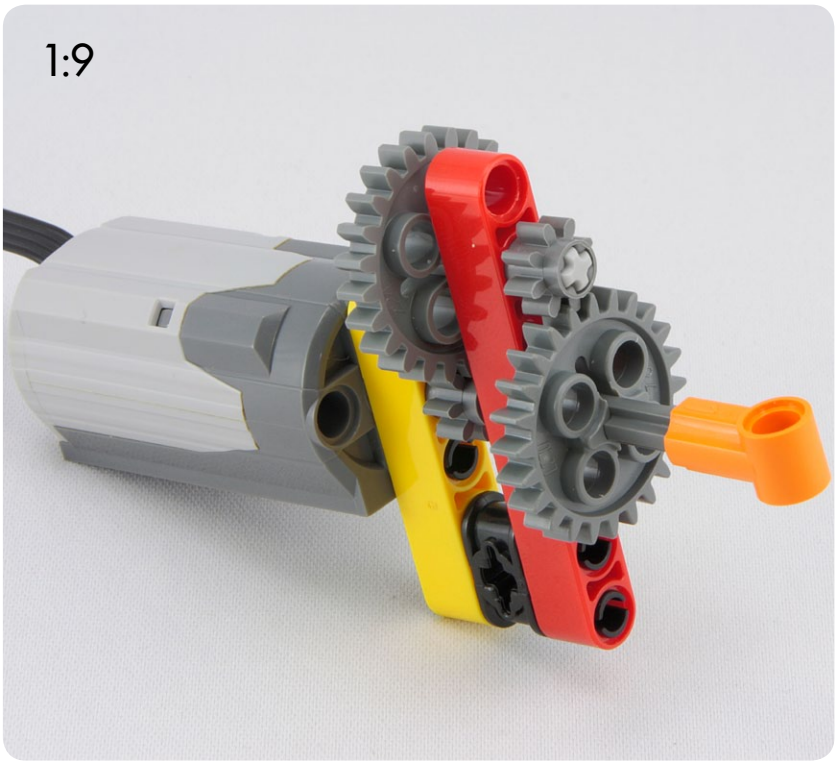

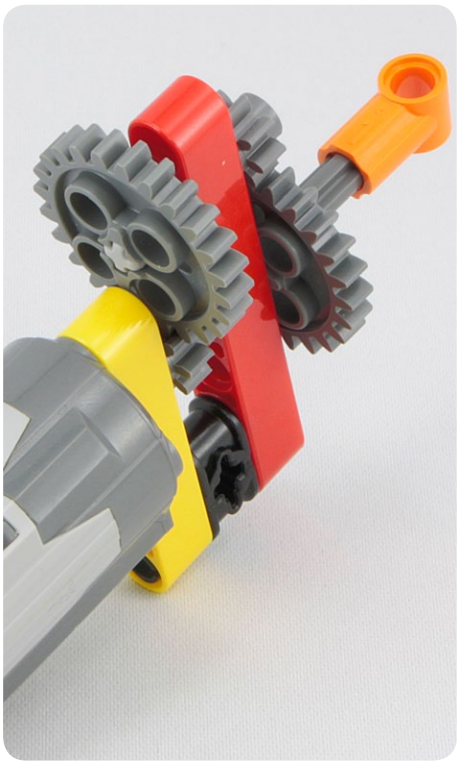

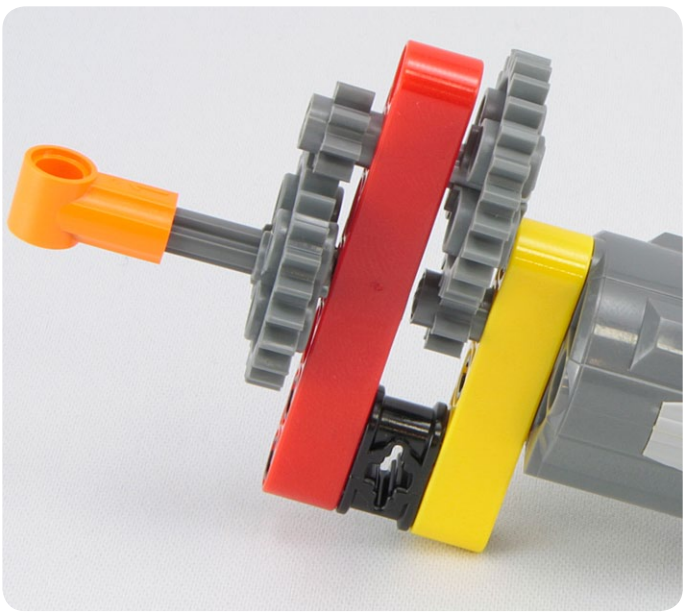

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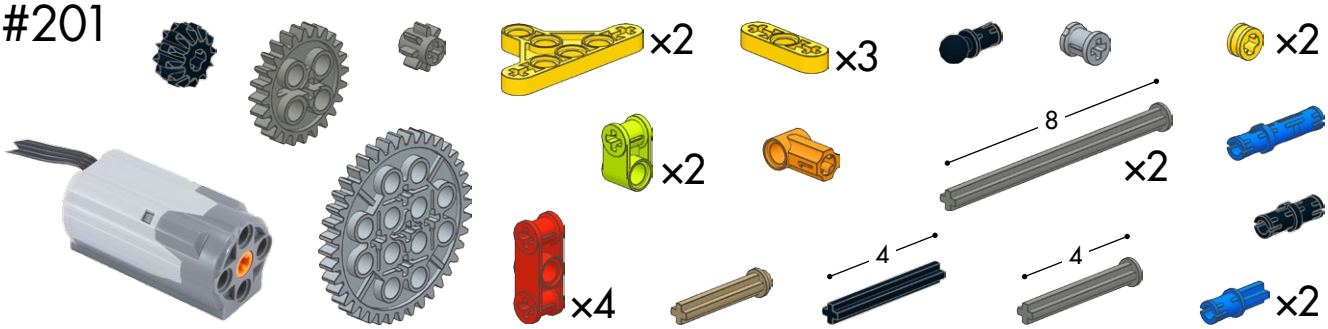

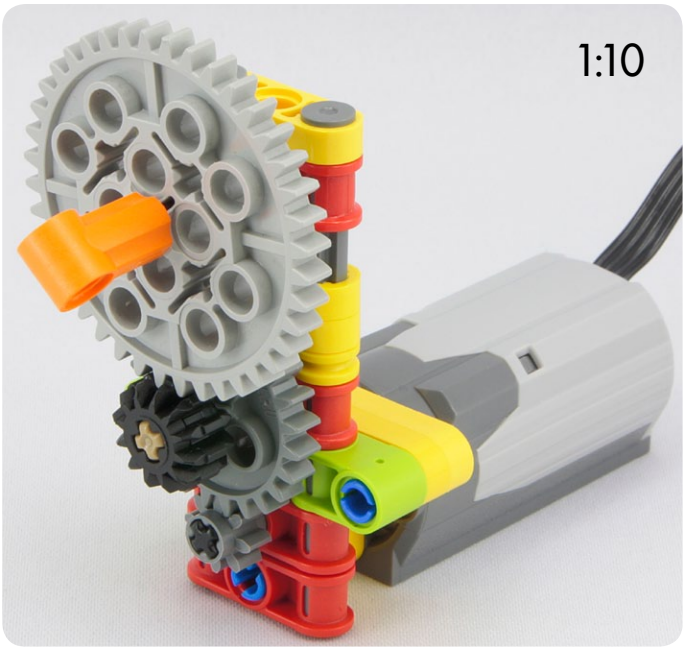

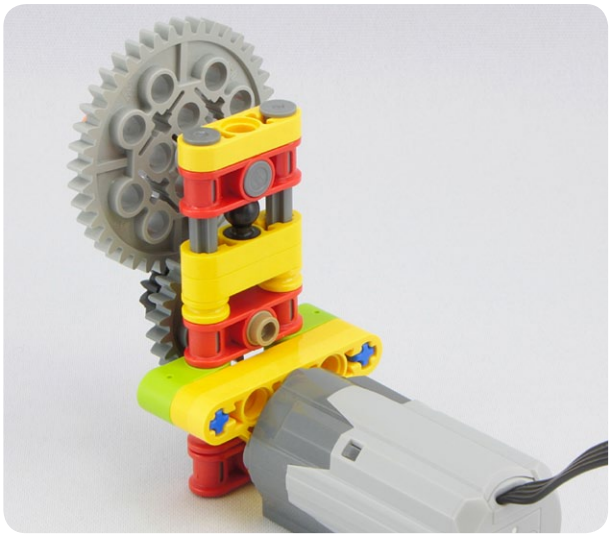

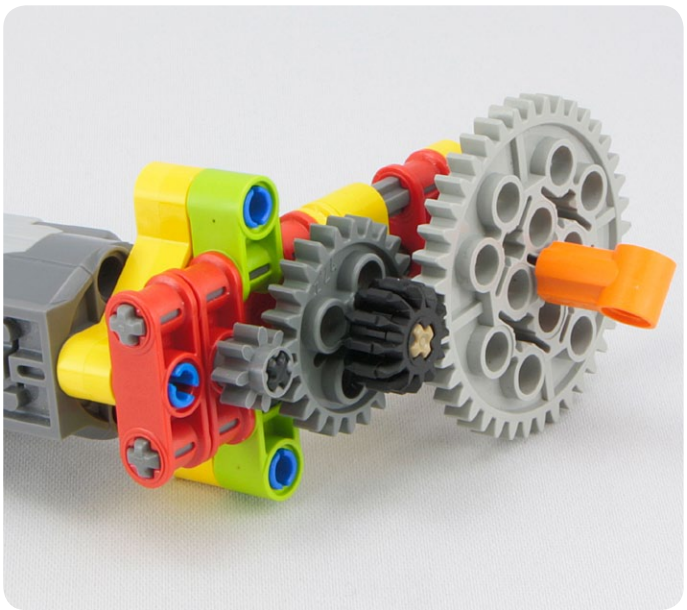

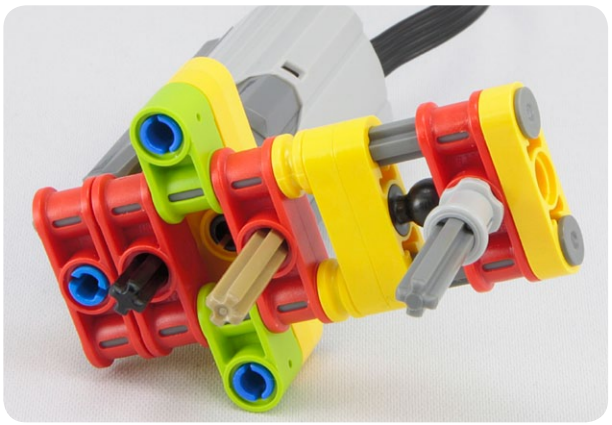

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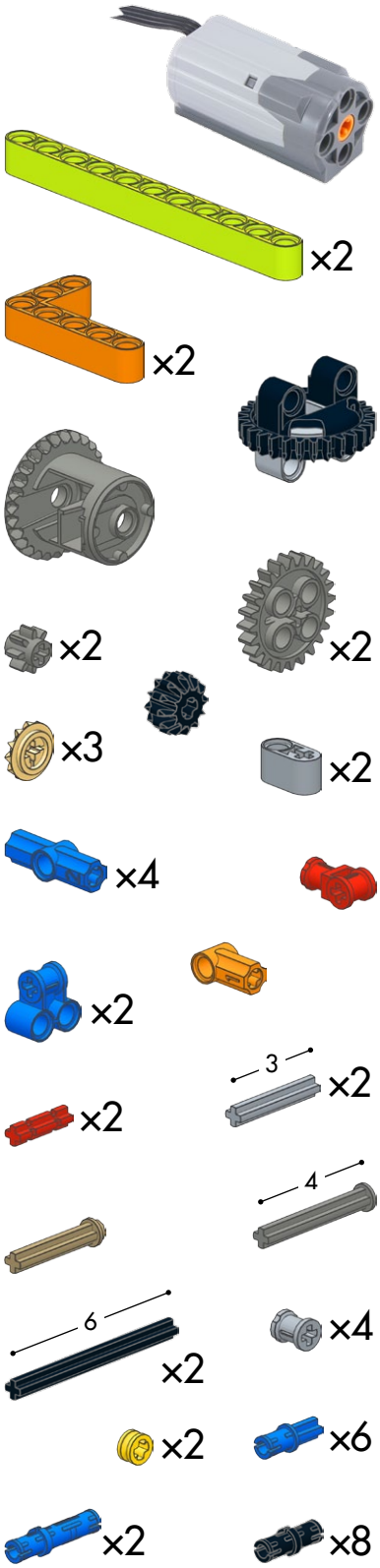

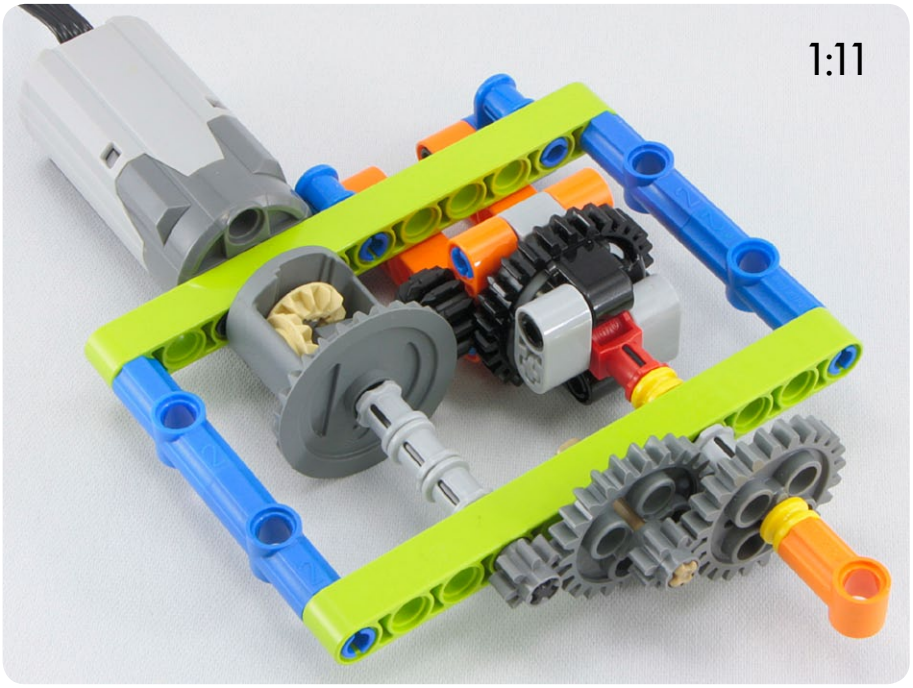

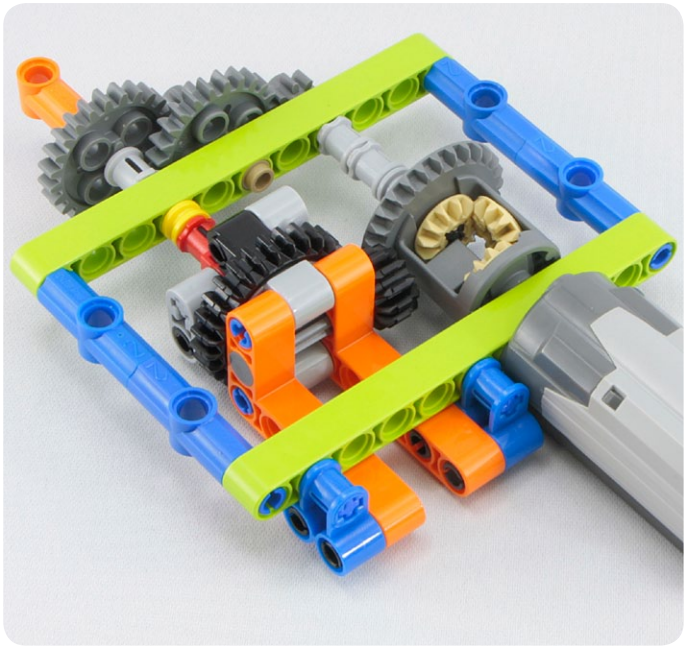

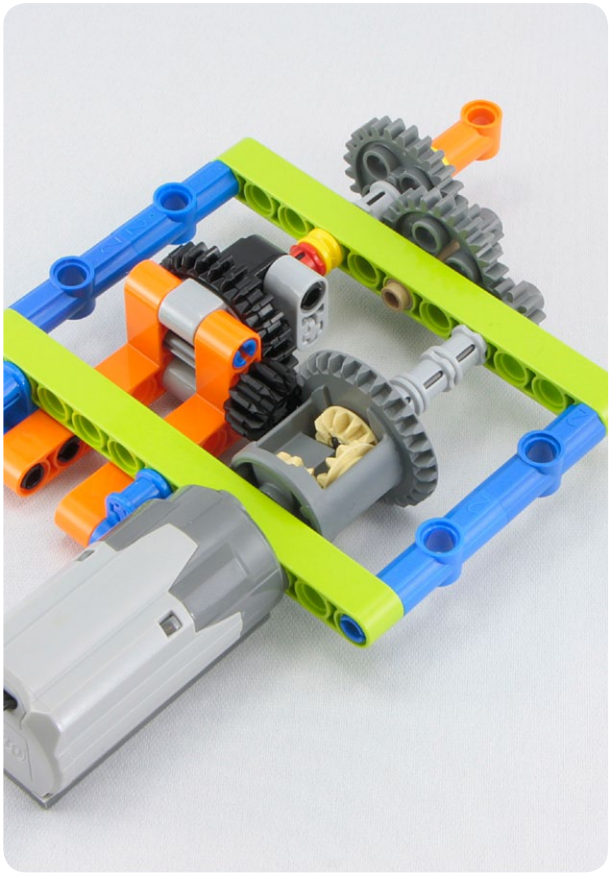

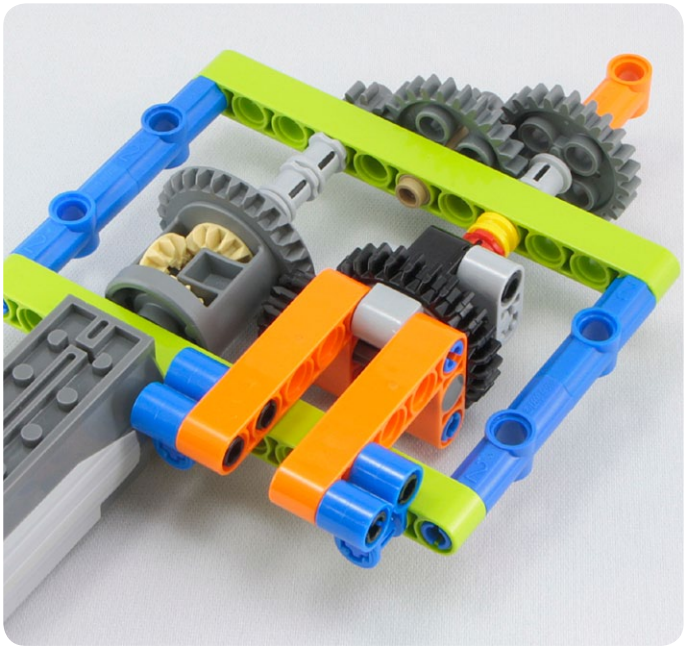

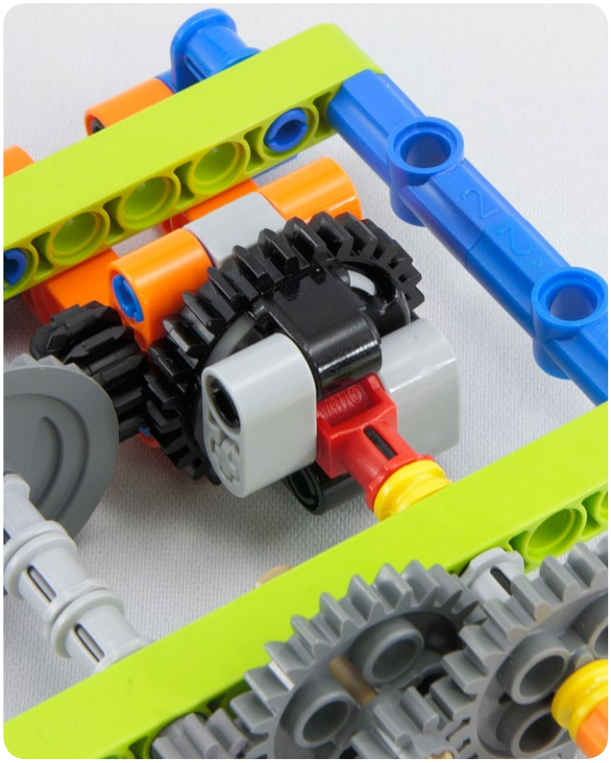

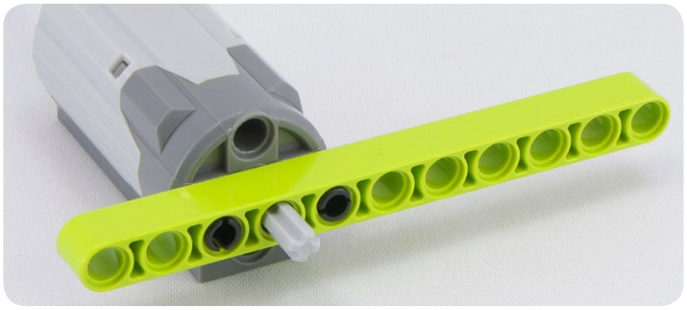

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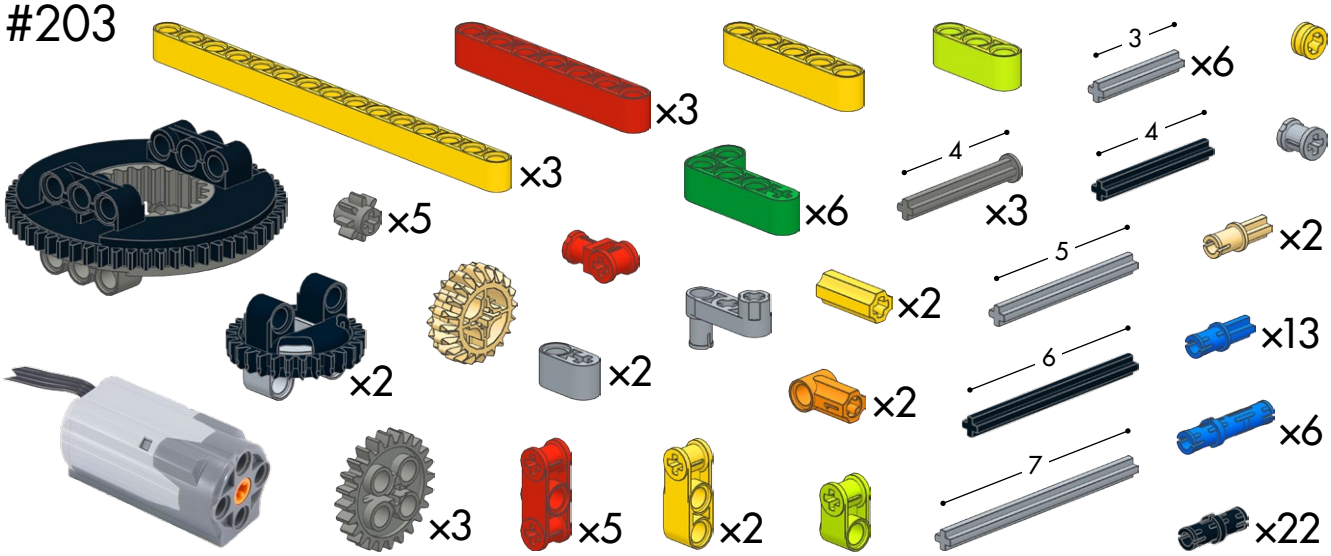

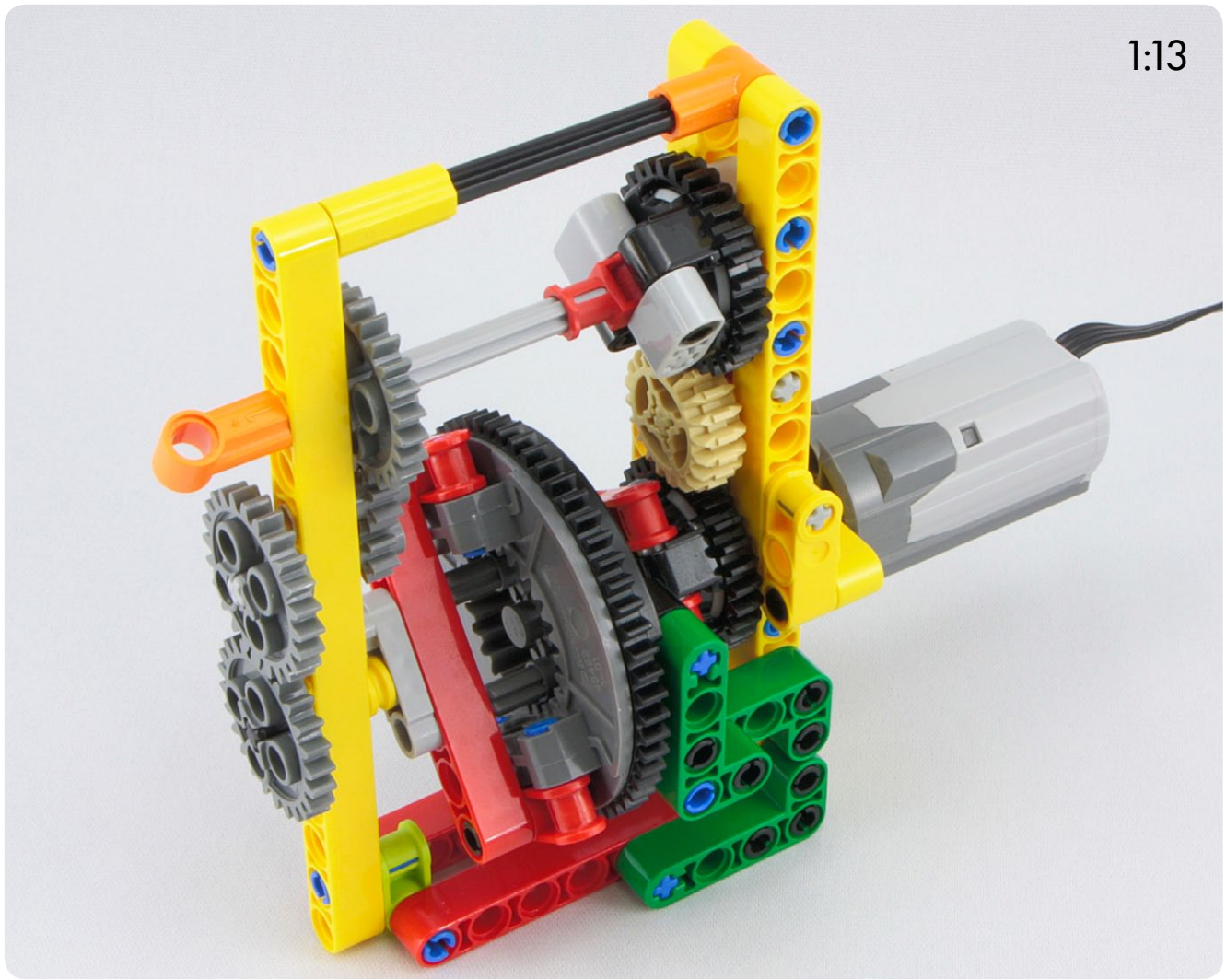

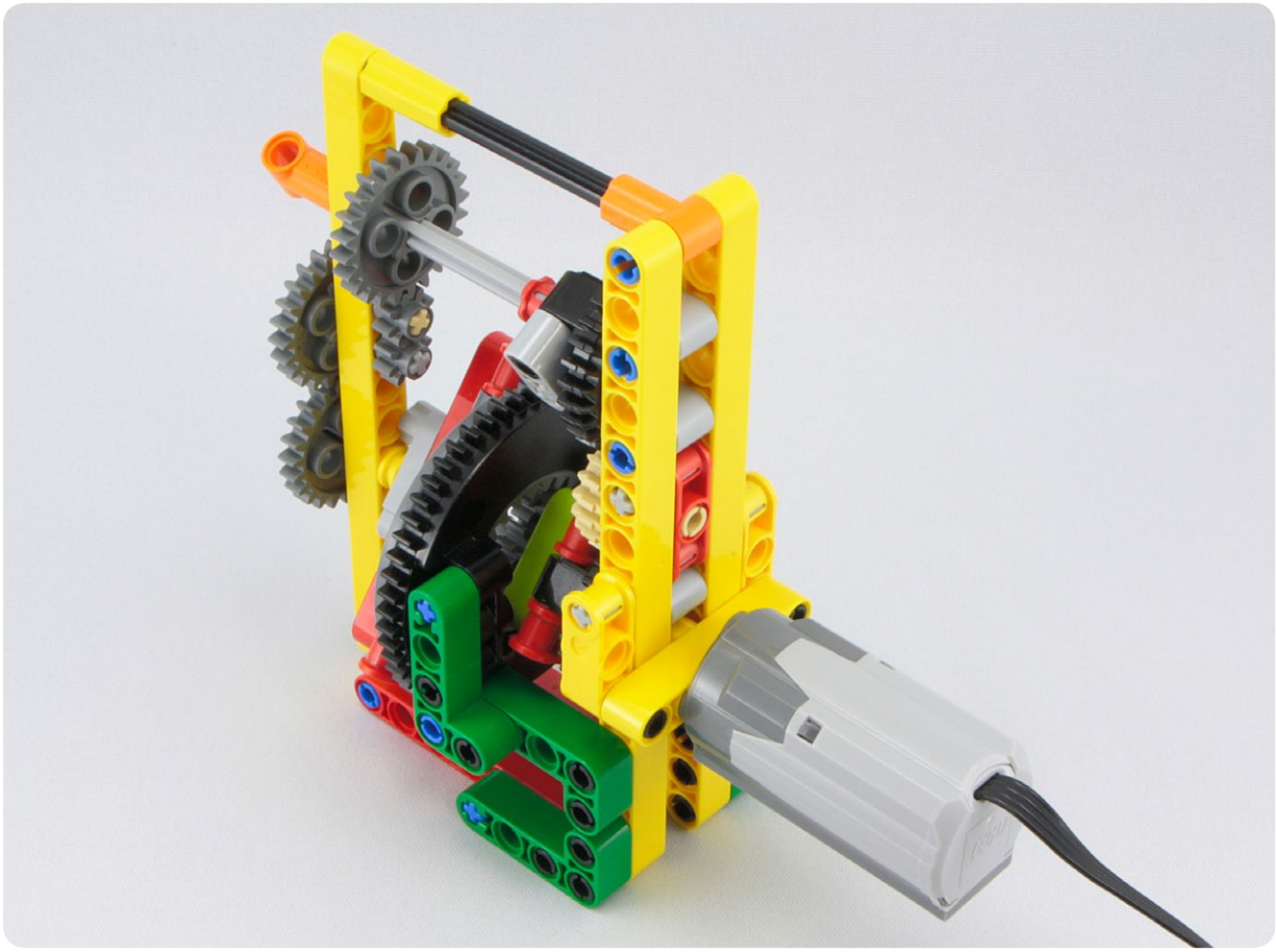

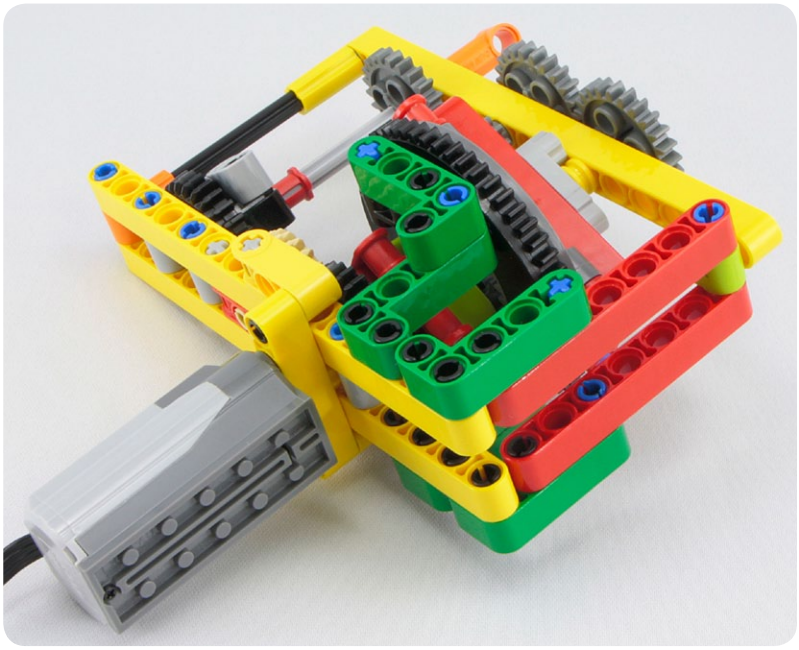

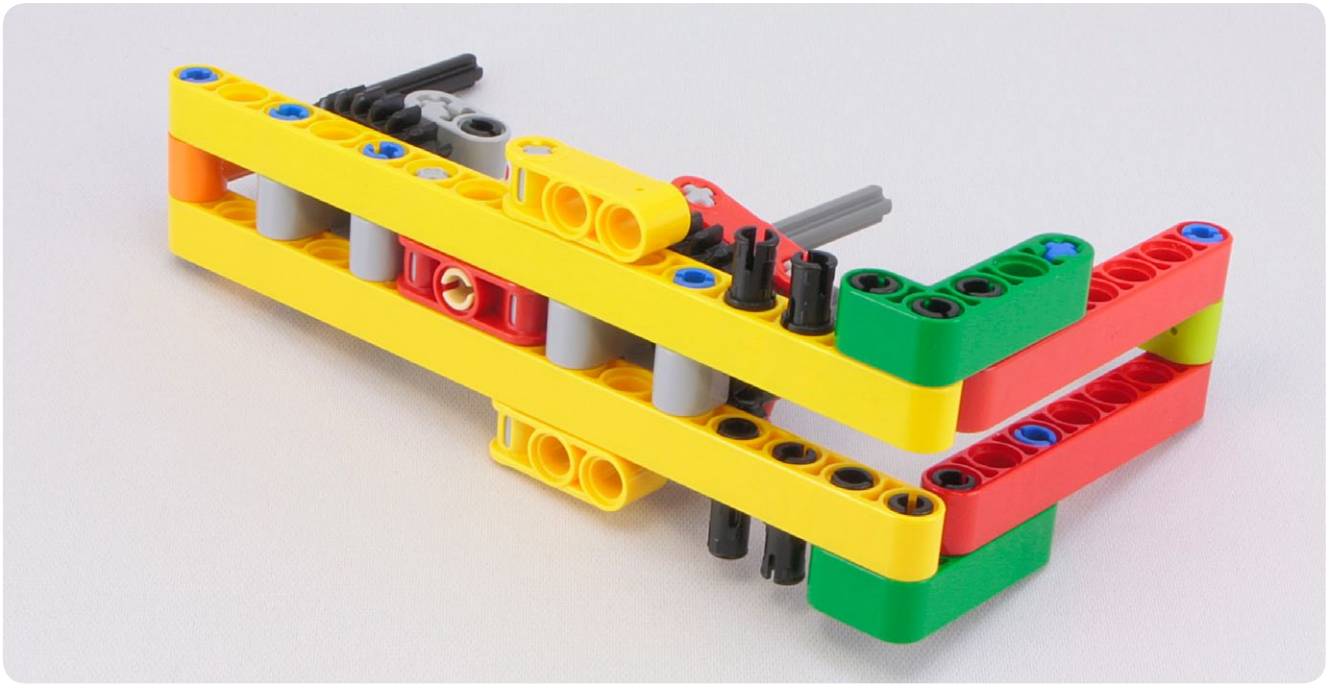

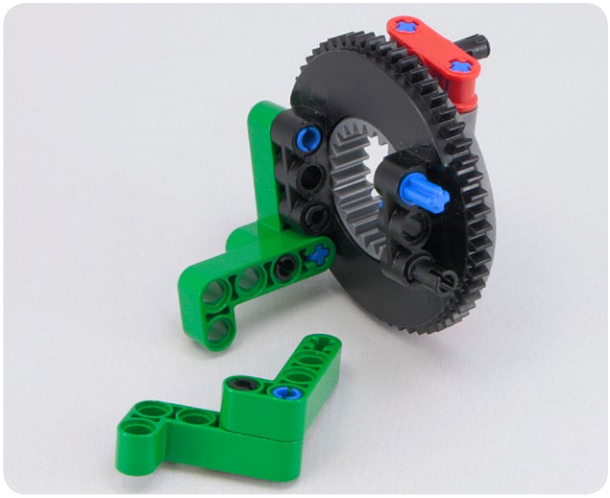

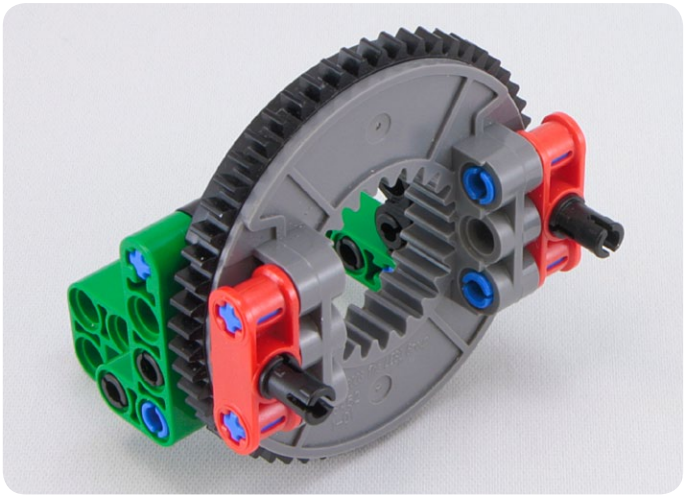

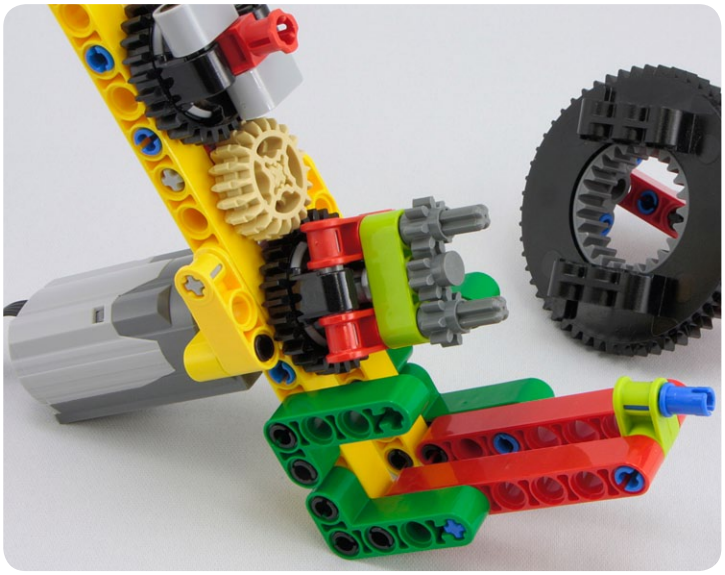

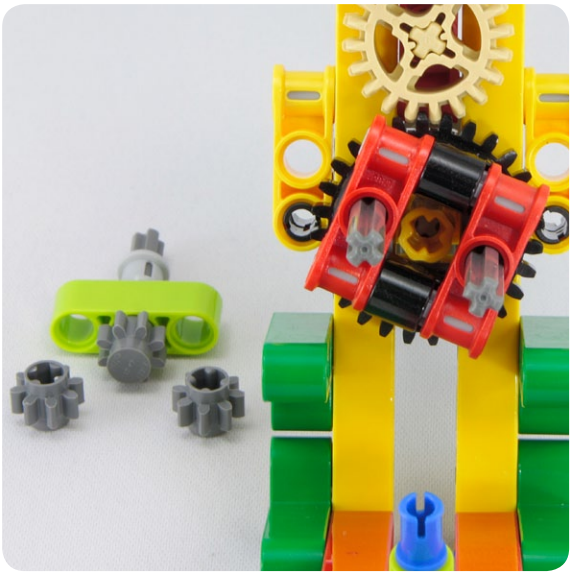

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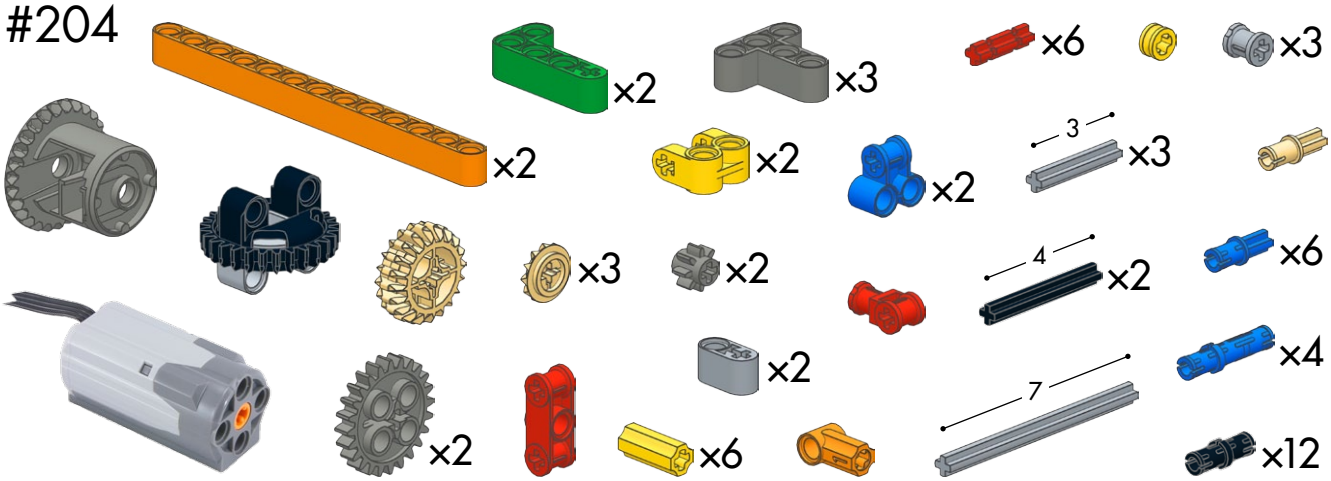
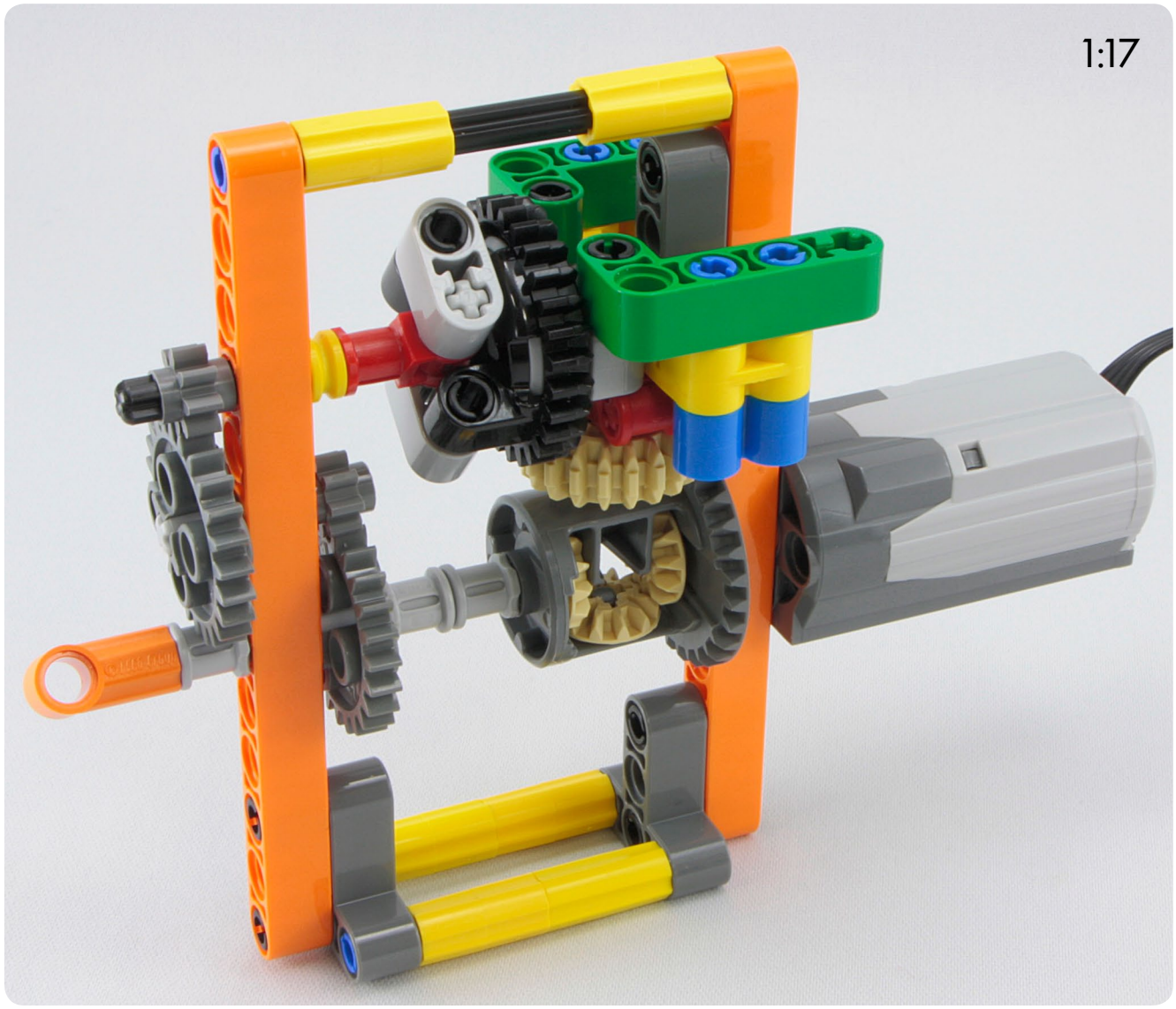
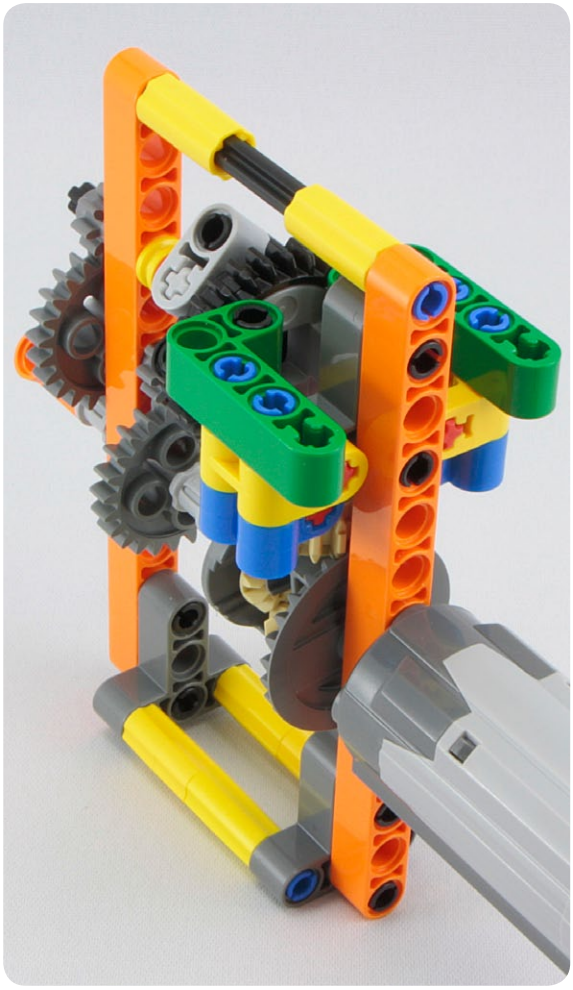
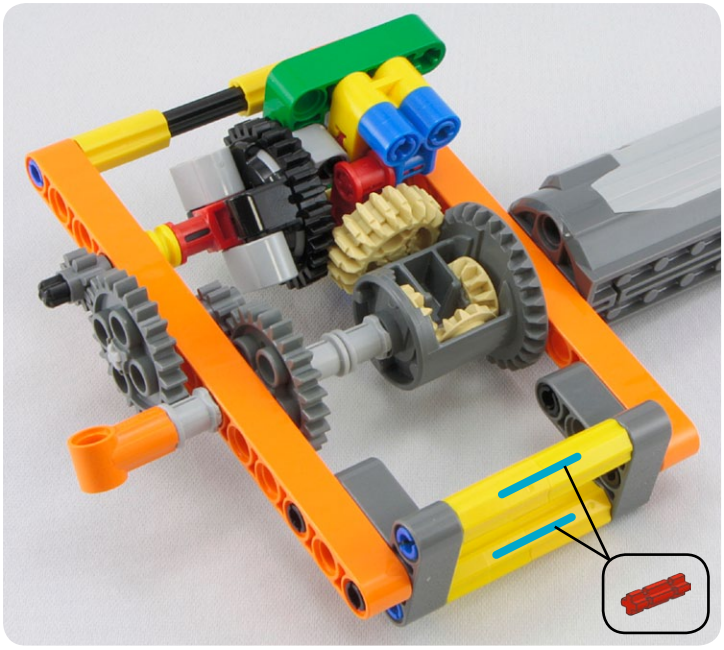
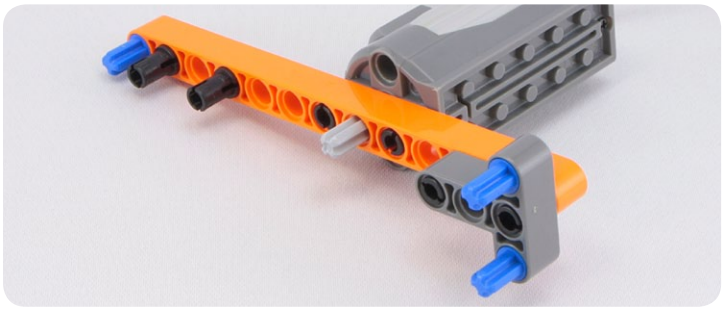
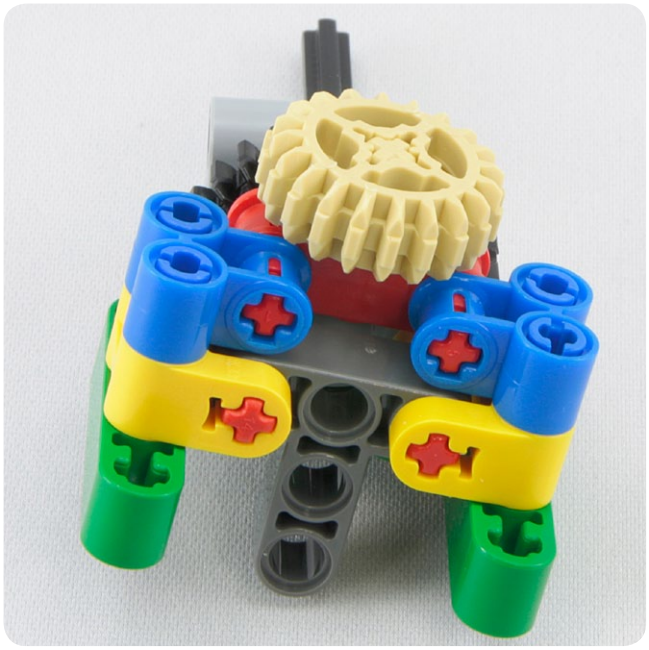






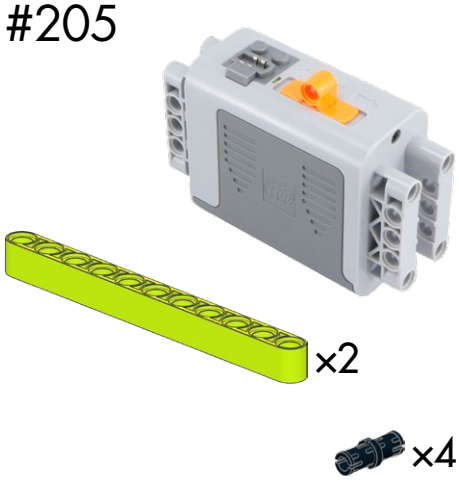


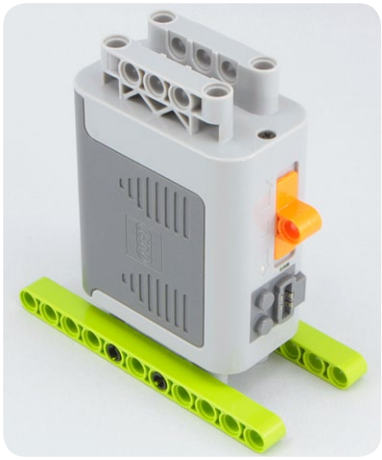




Attaching a battery box

#205





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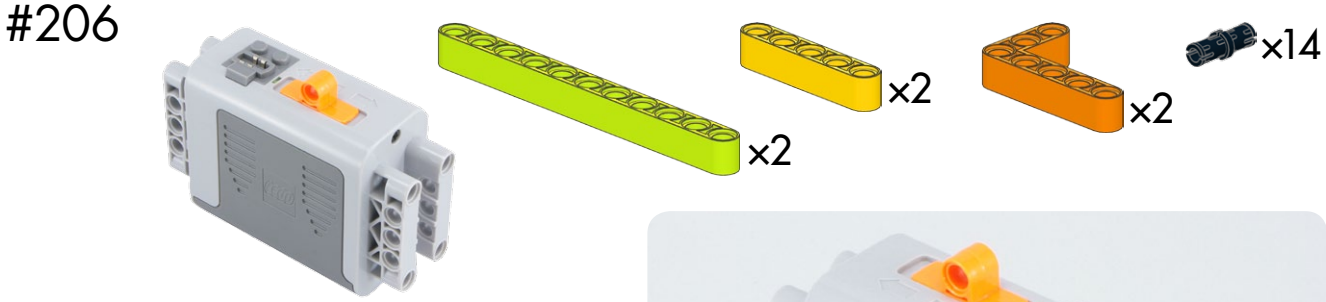

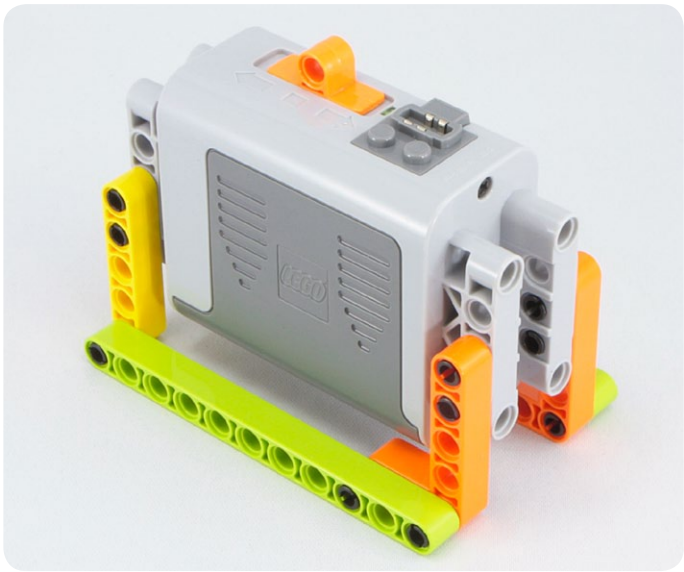

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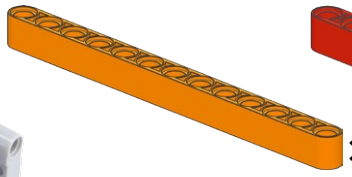

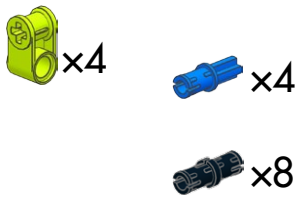

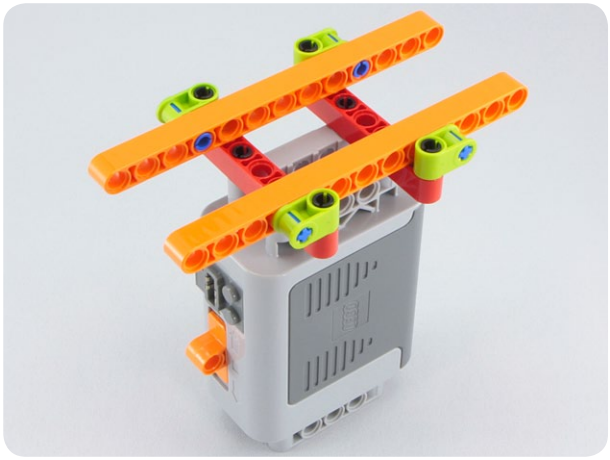

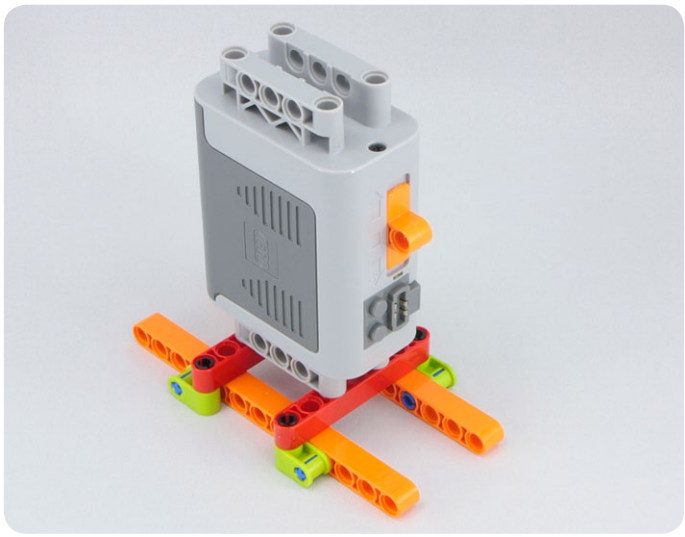

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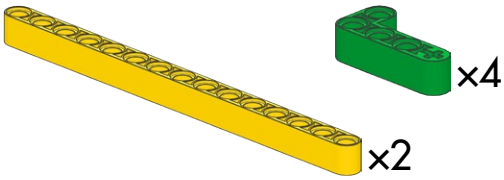

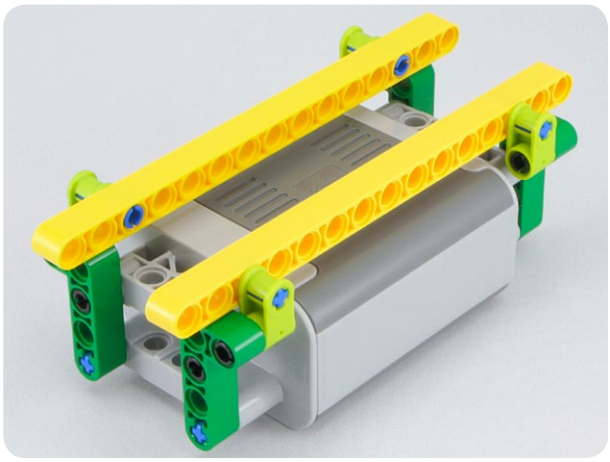

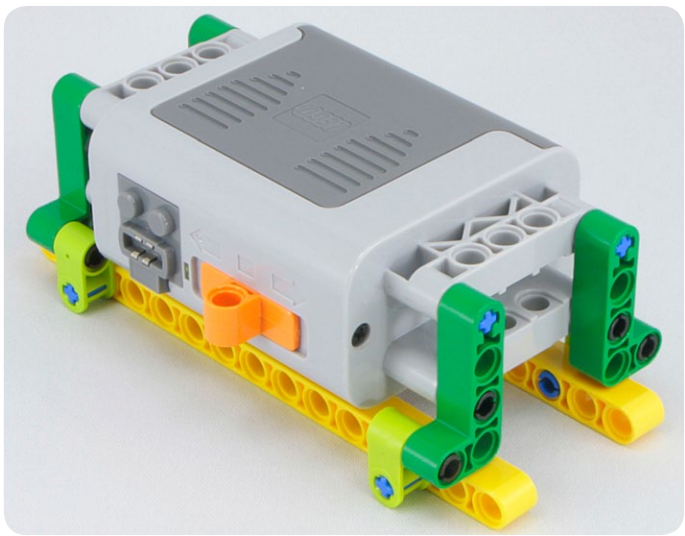

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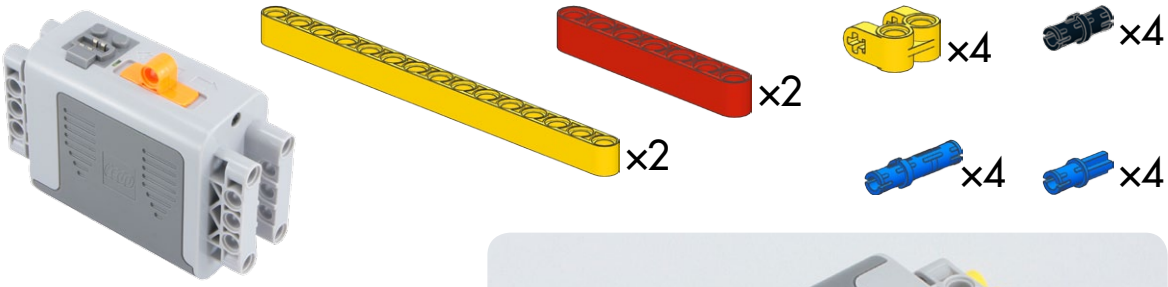

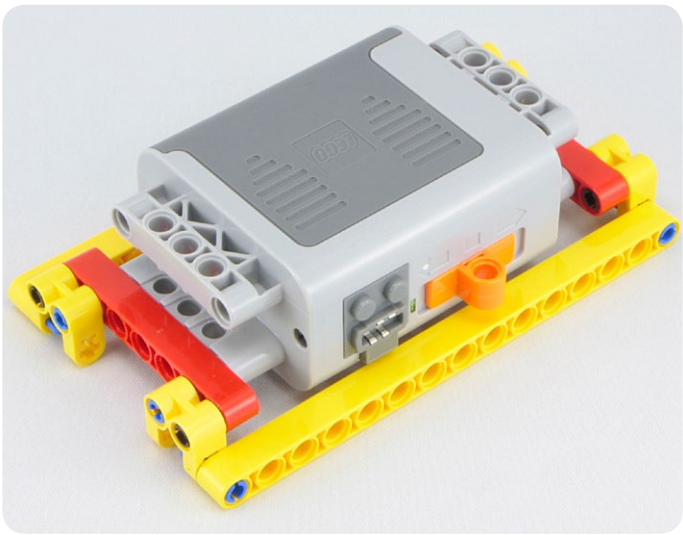

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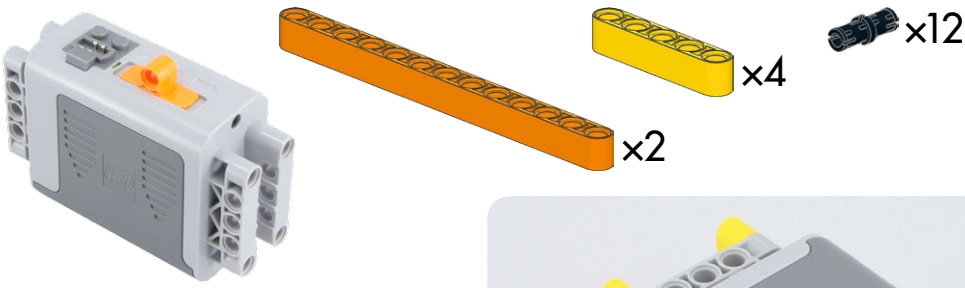

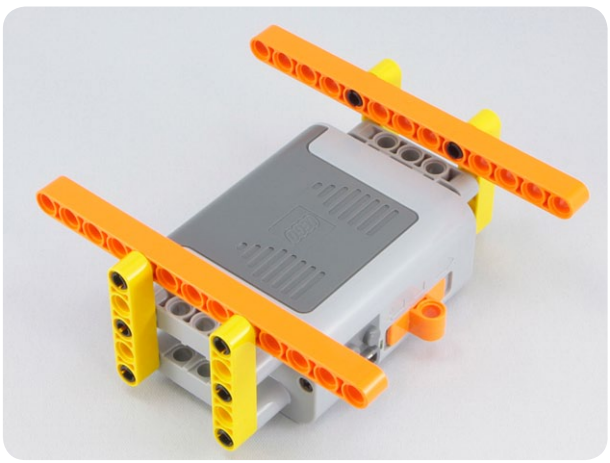

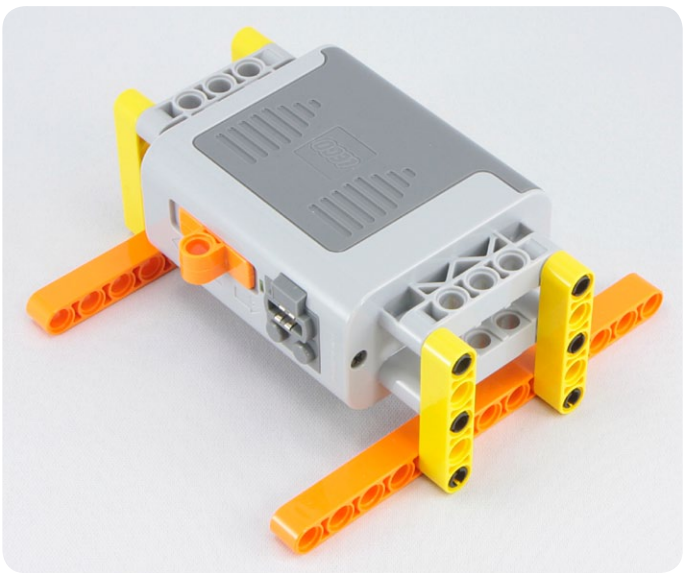

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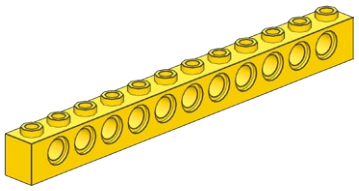

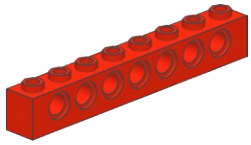

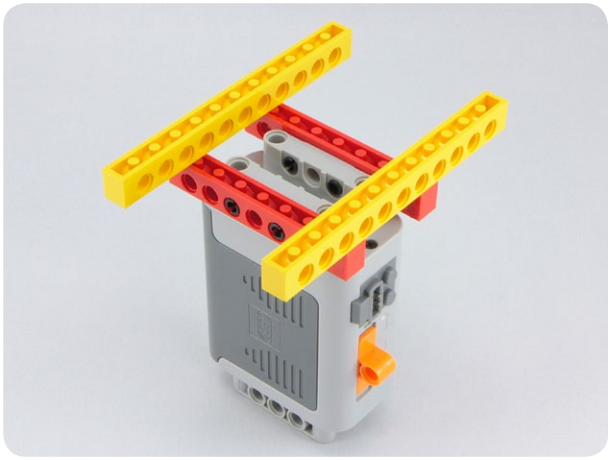

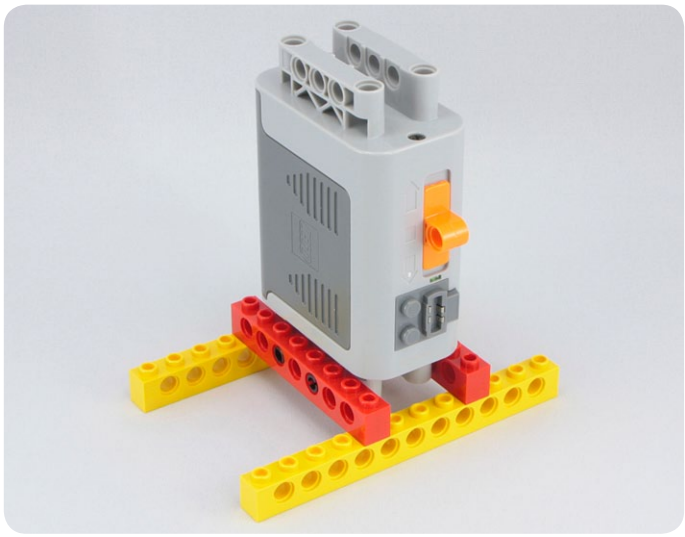

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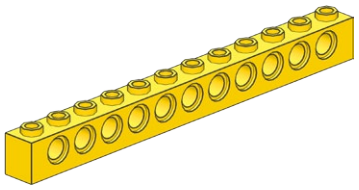

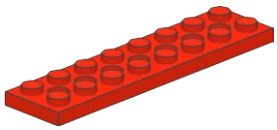

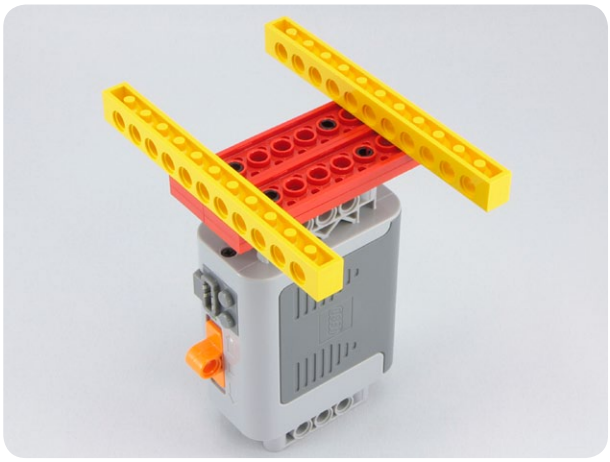

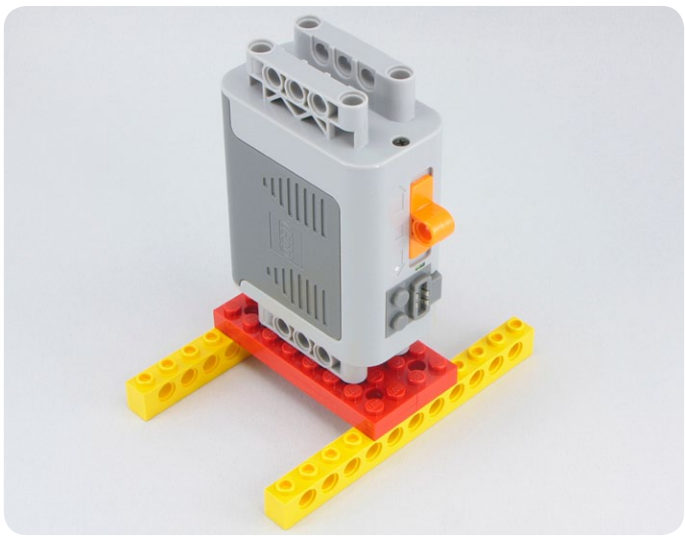

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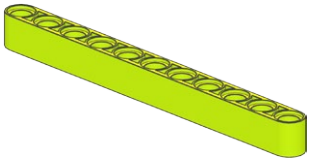

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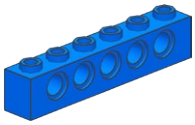

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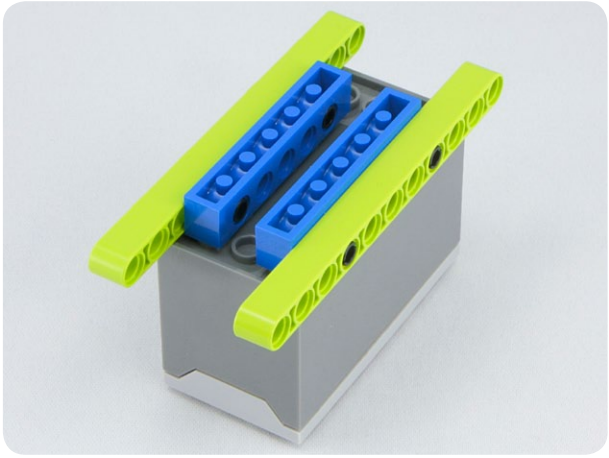

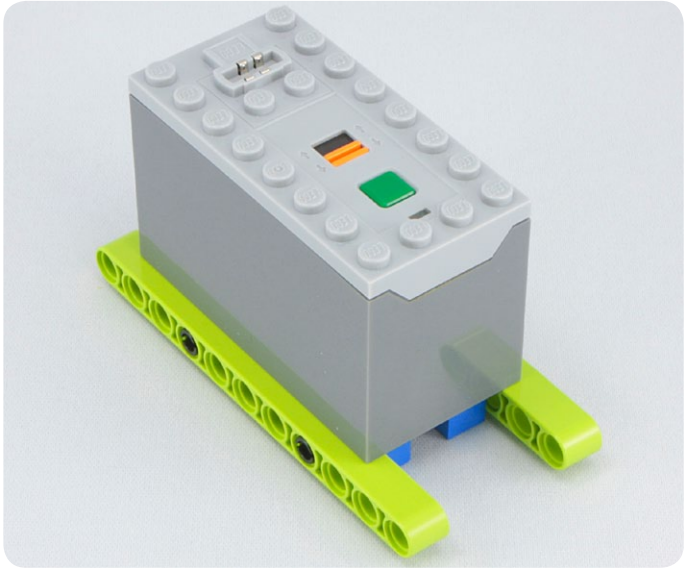

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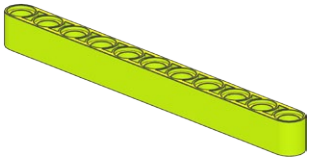

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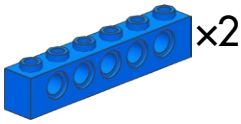

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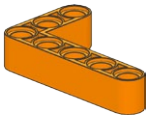

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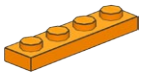

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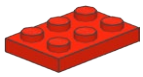

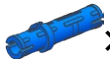

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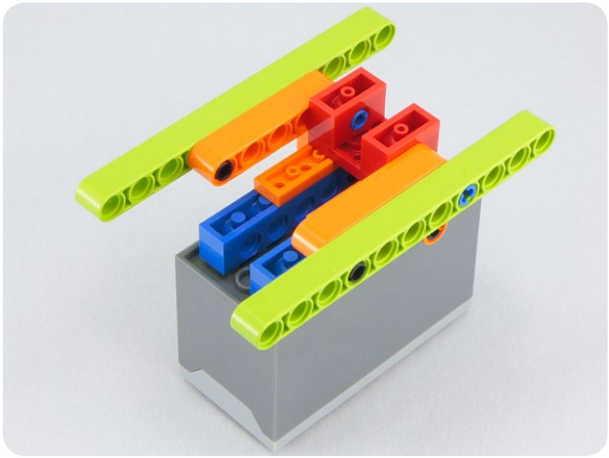

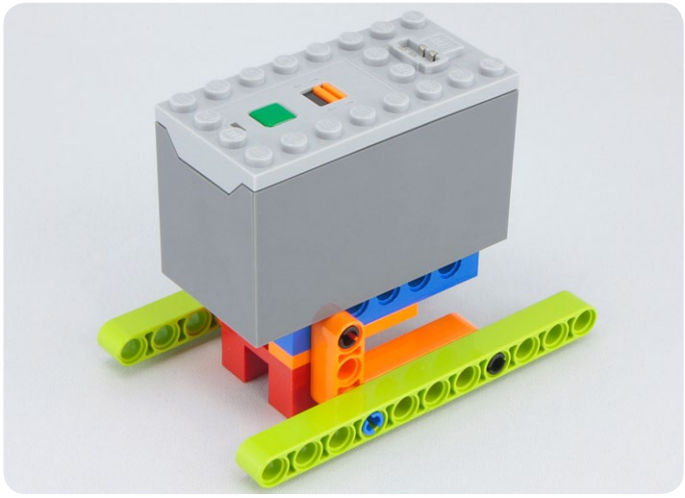

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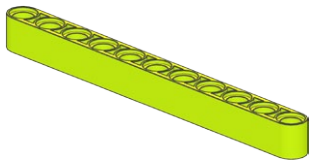
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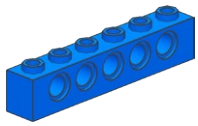
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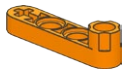
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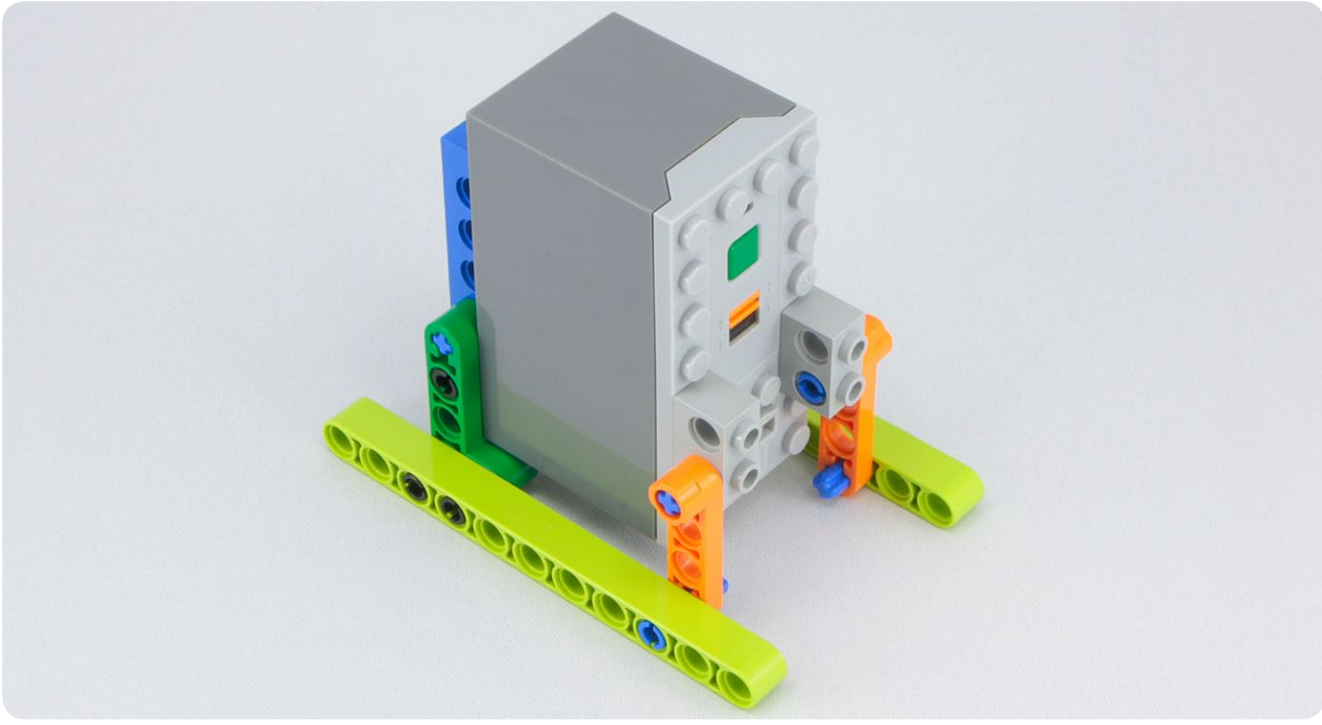
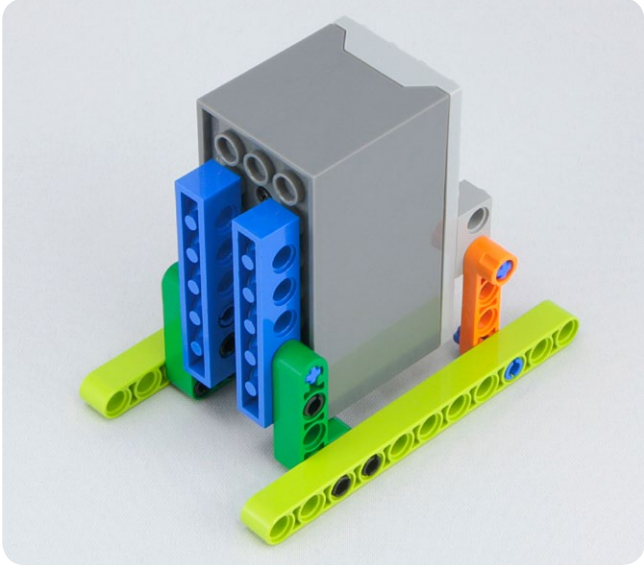
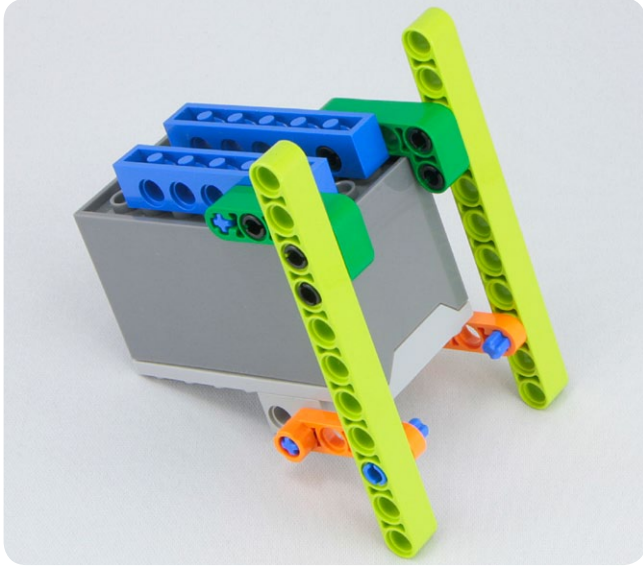
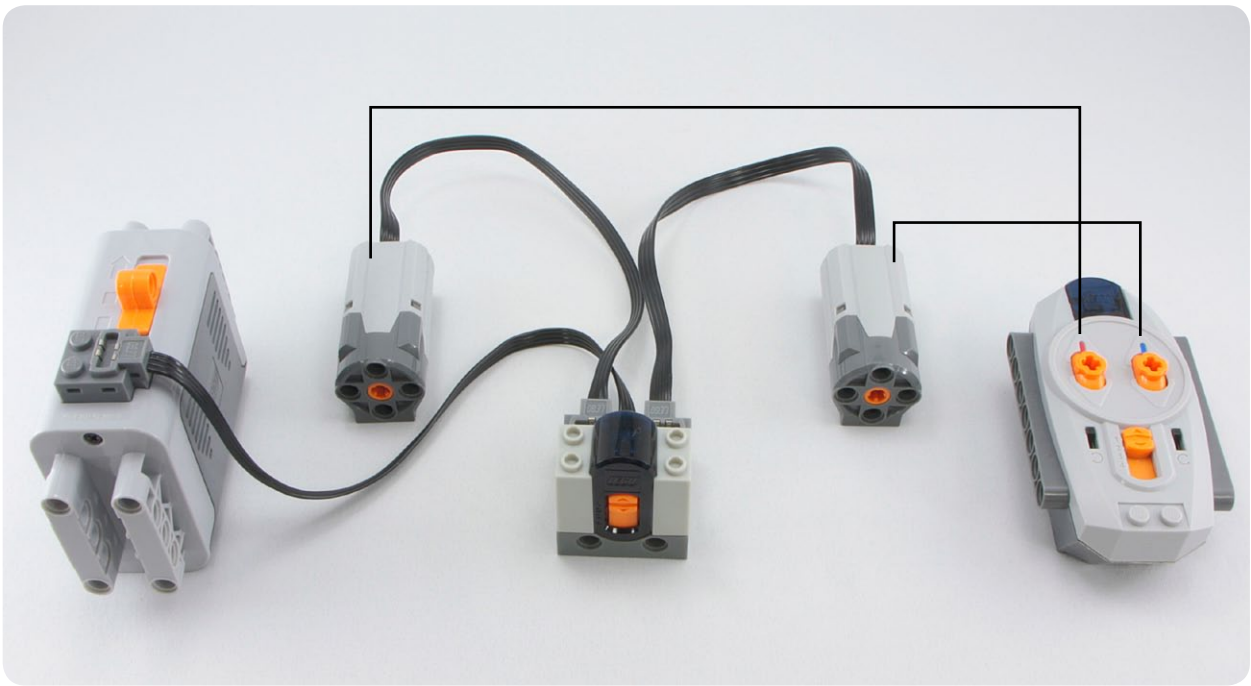






Attaching an infrared receiver



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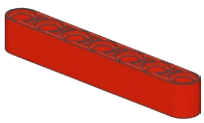

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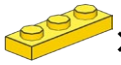

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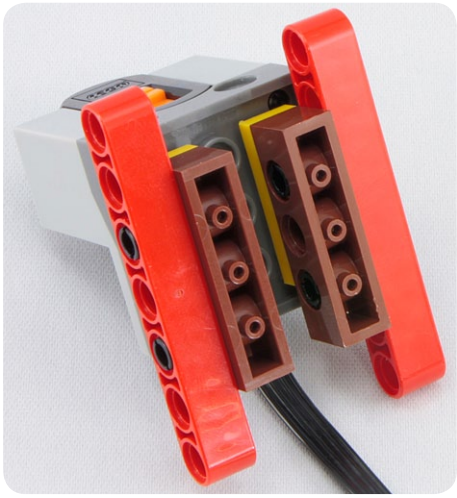

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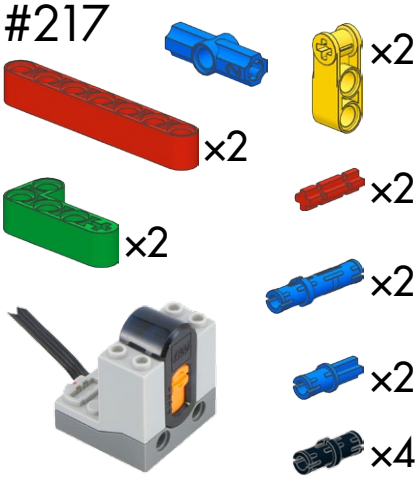

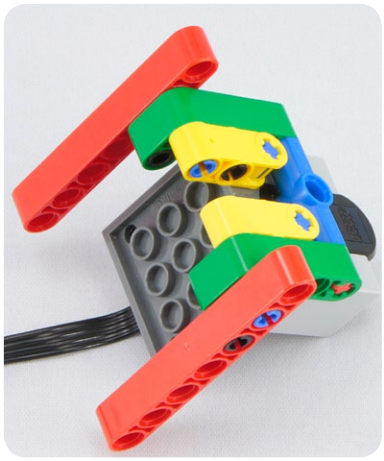

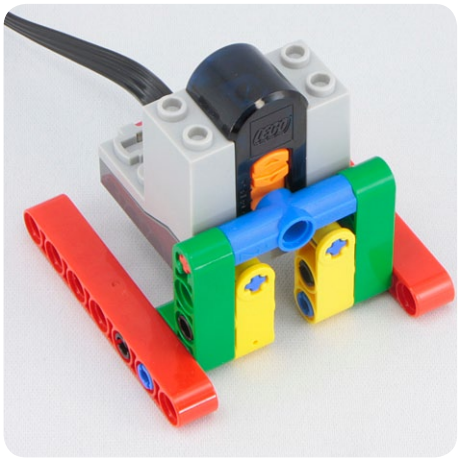

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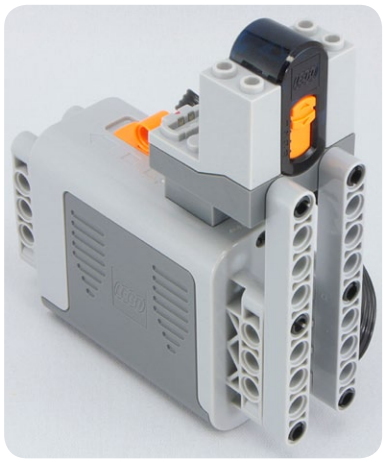

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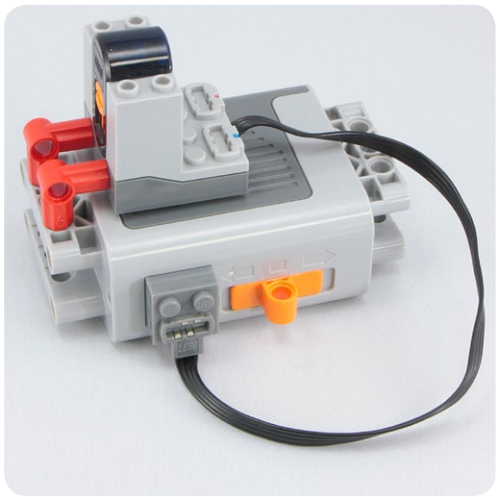
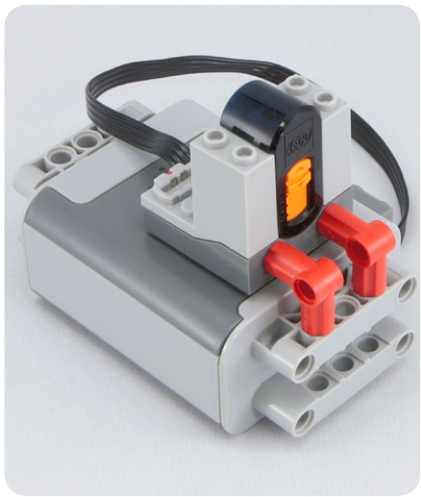
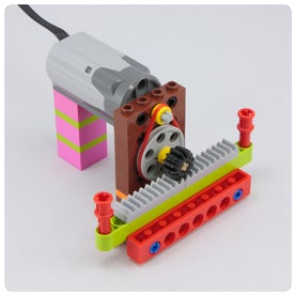
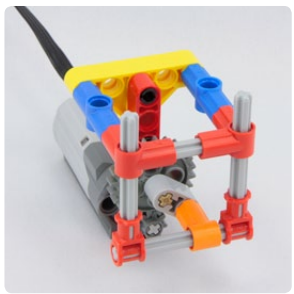
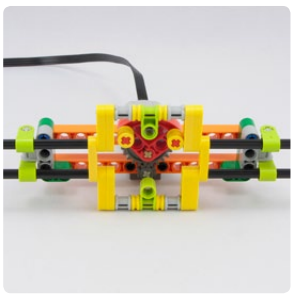








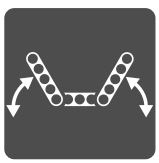



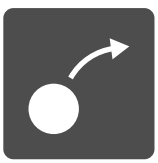


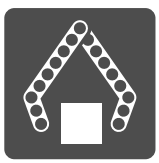


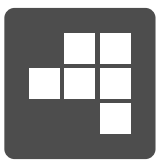
PART 2

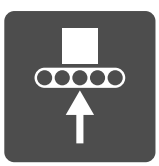
Arms, Wings, and Other Movements

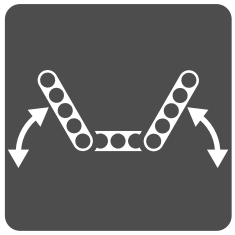






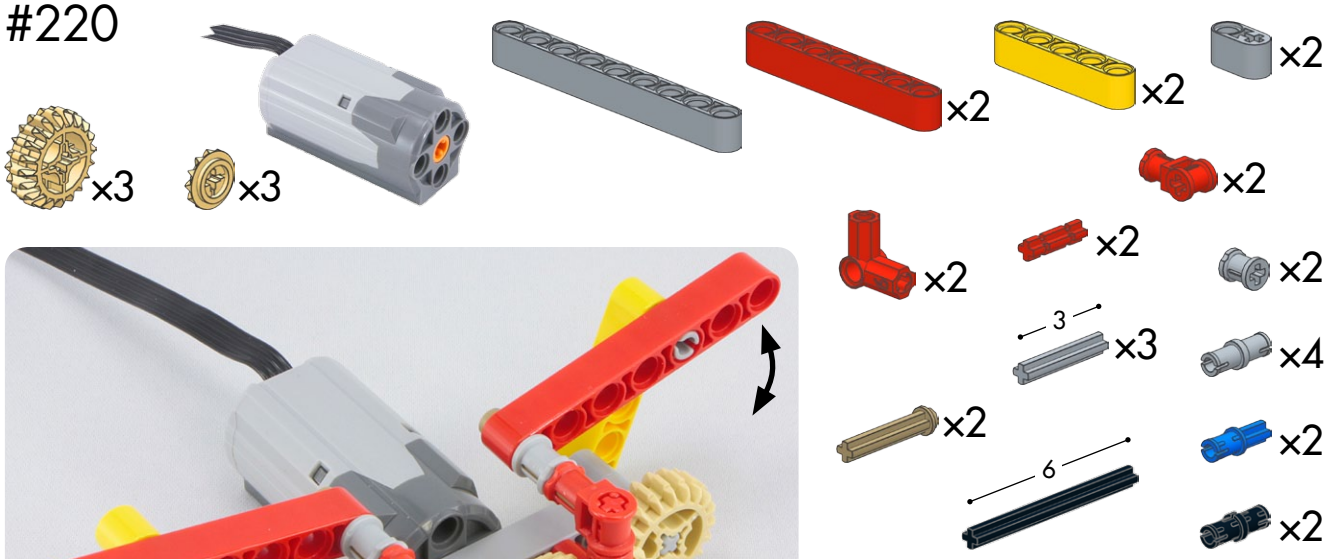


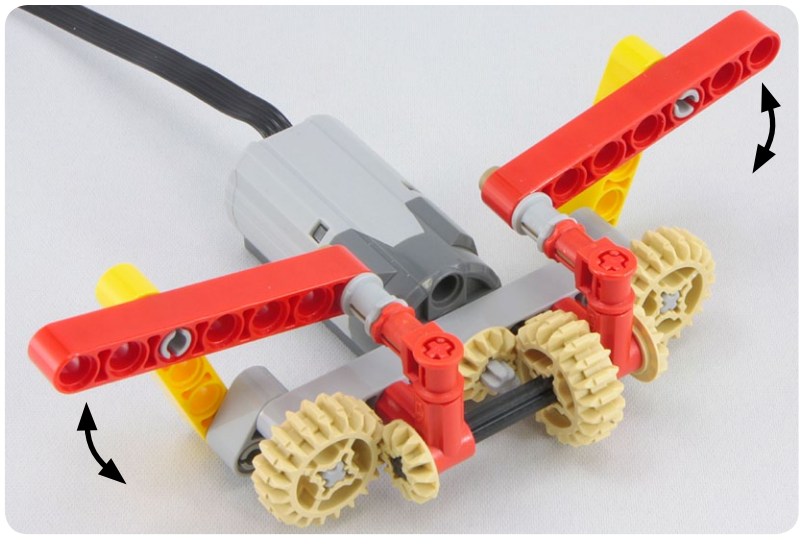


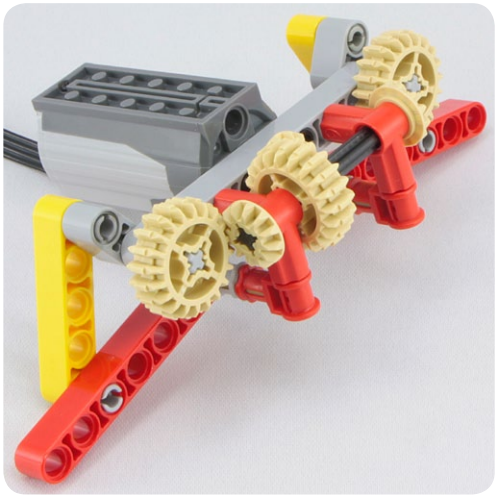


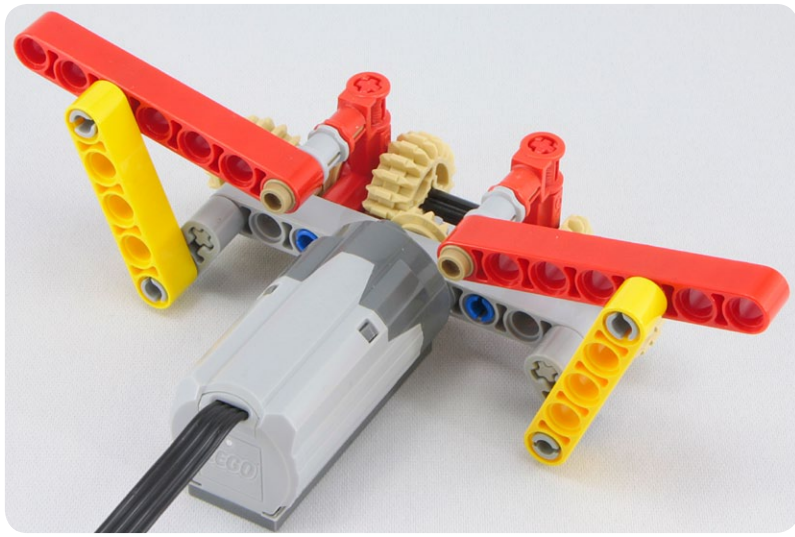
Flapping wings

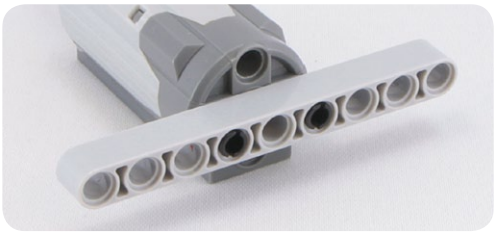
#220











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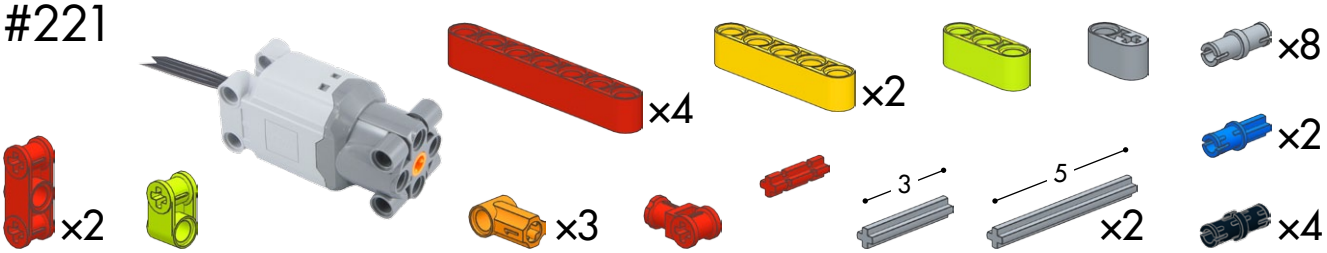

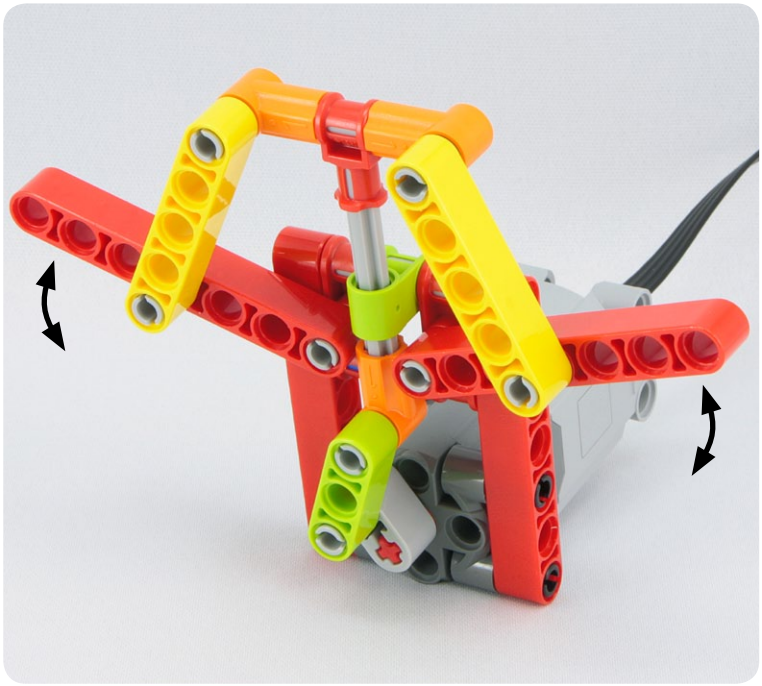

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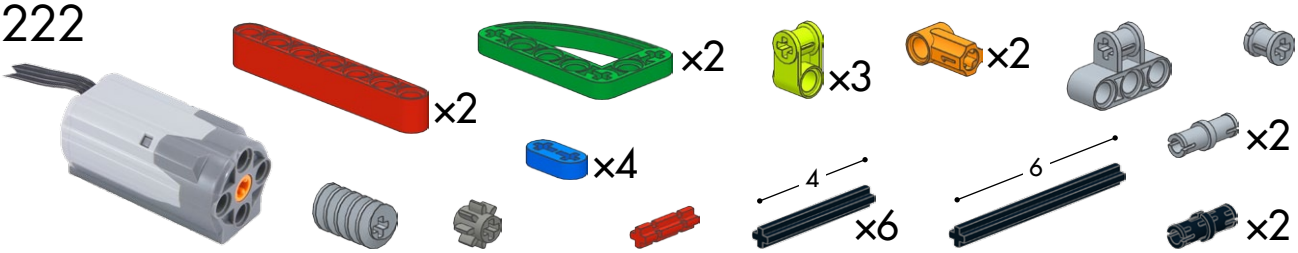

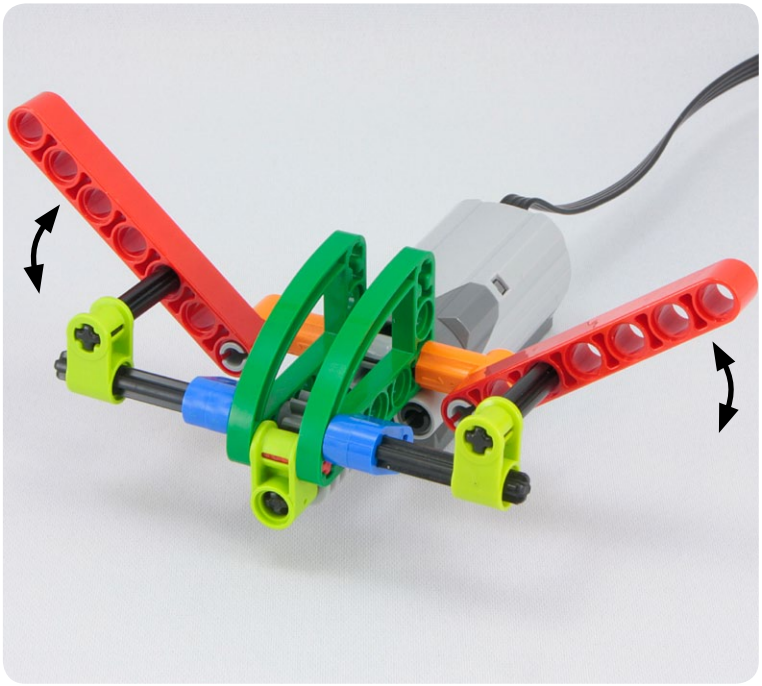

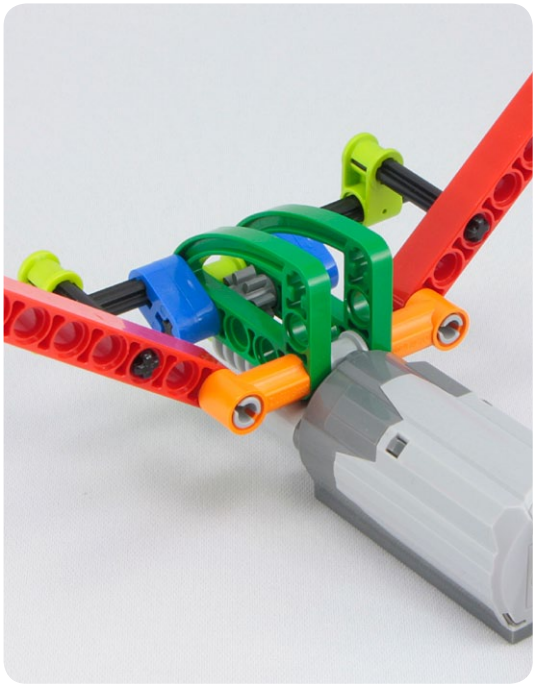

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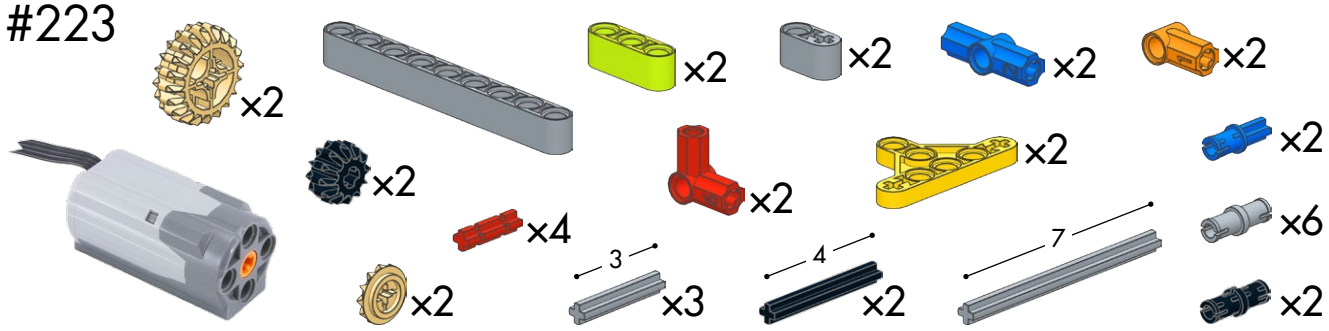

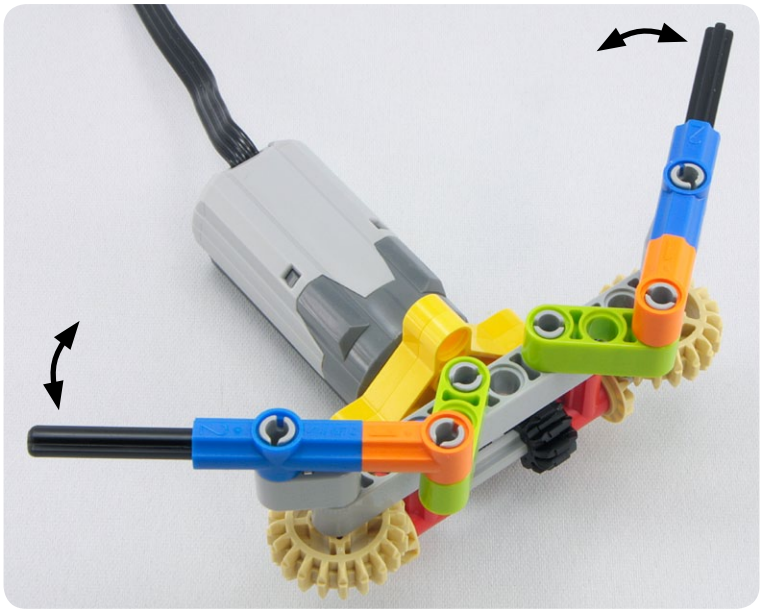

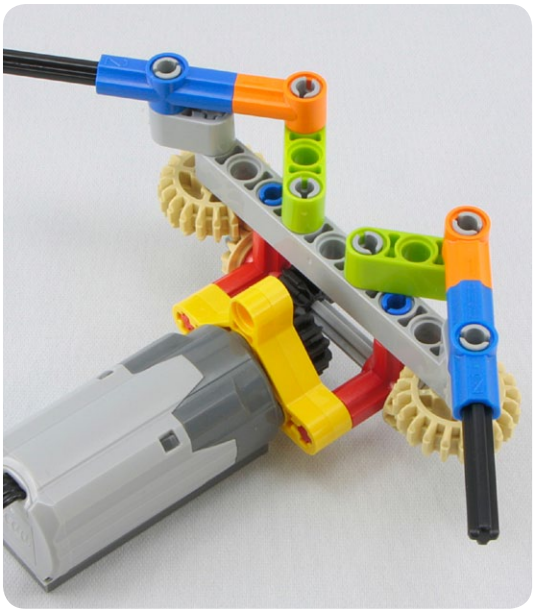

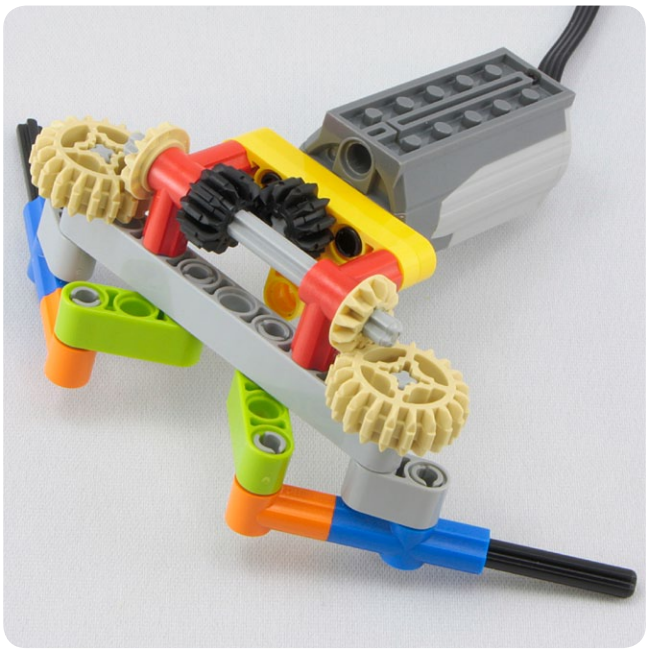

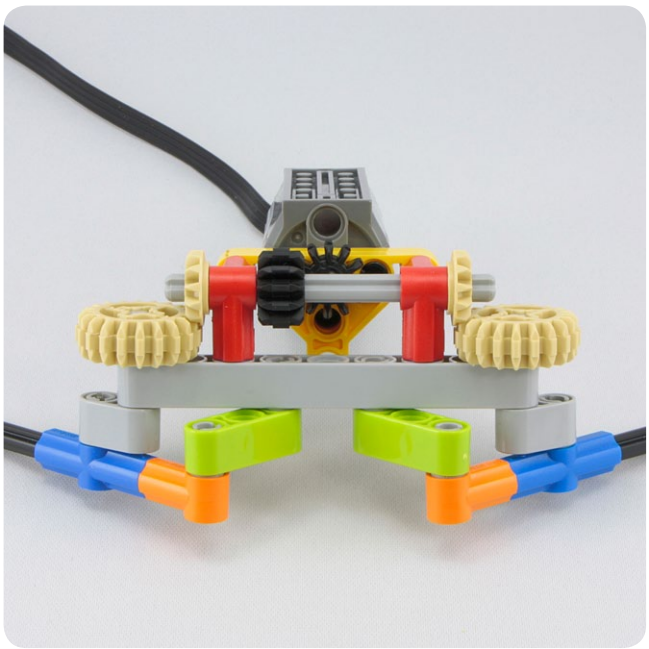

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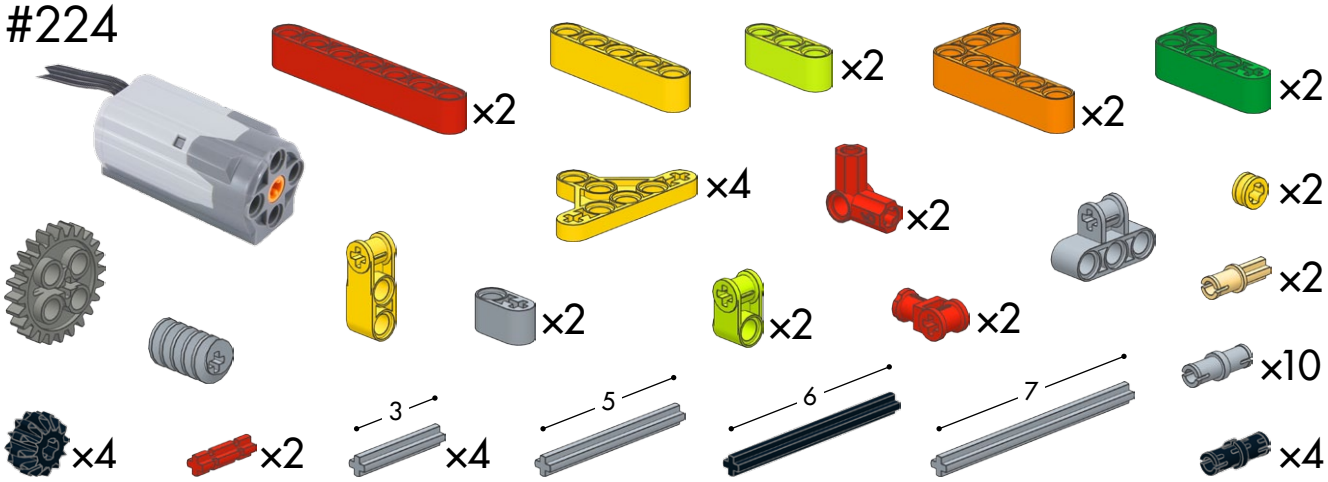
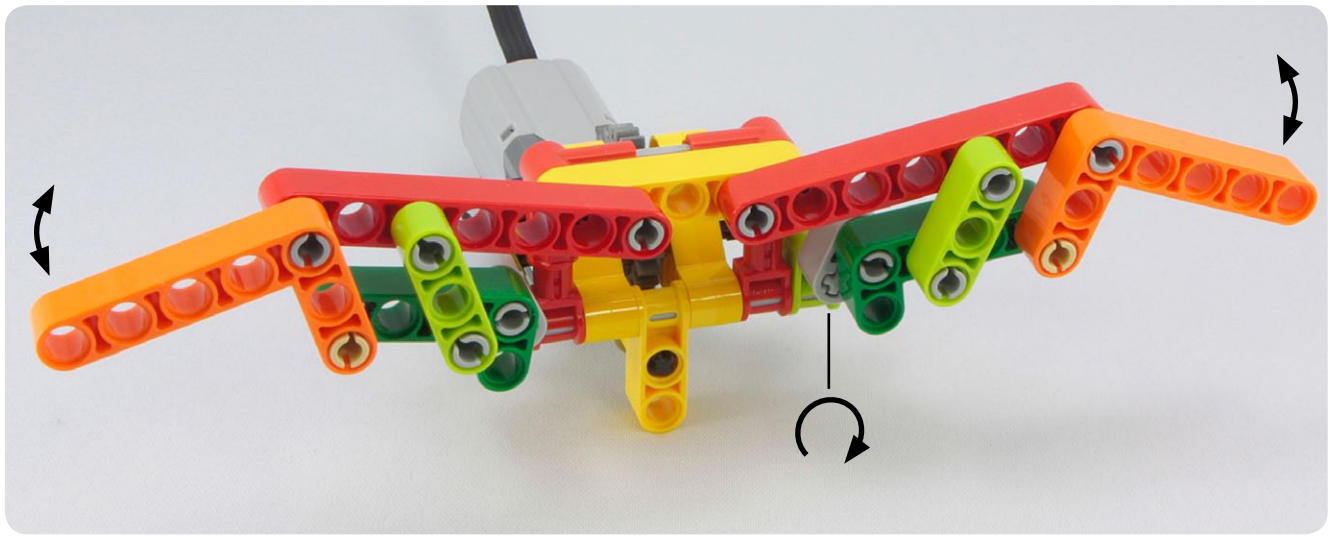
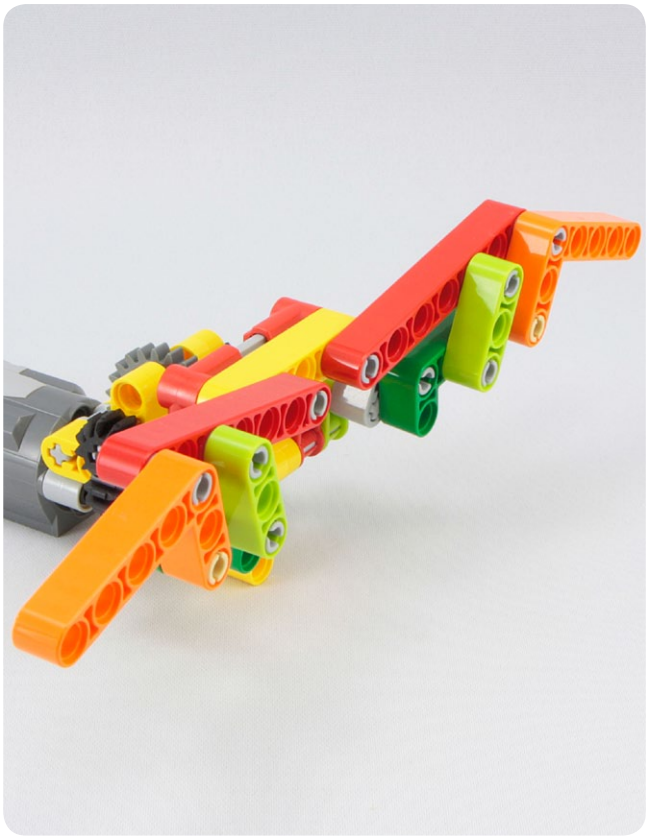
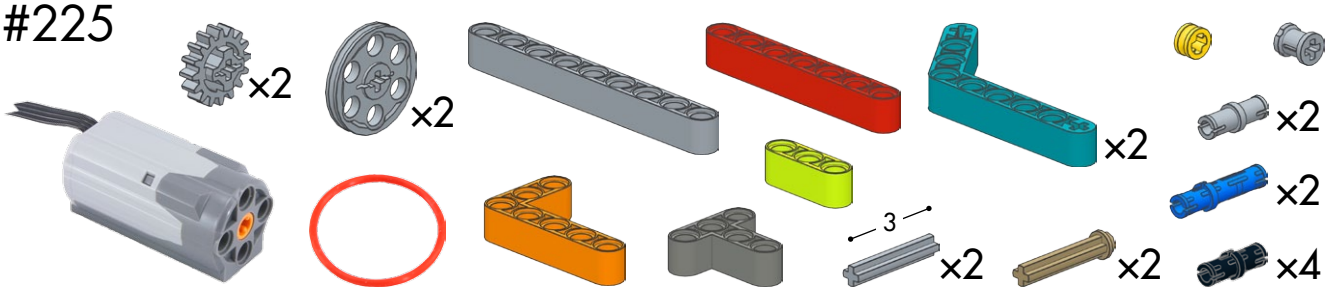


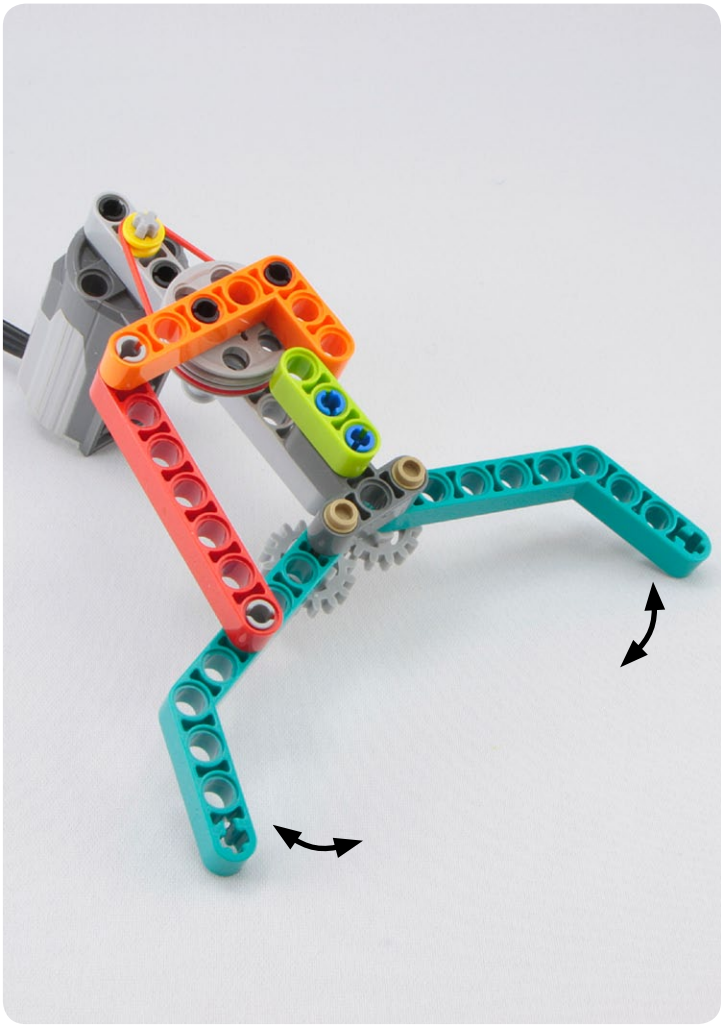


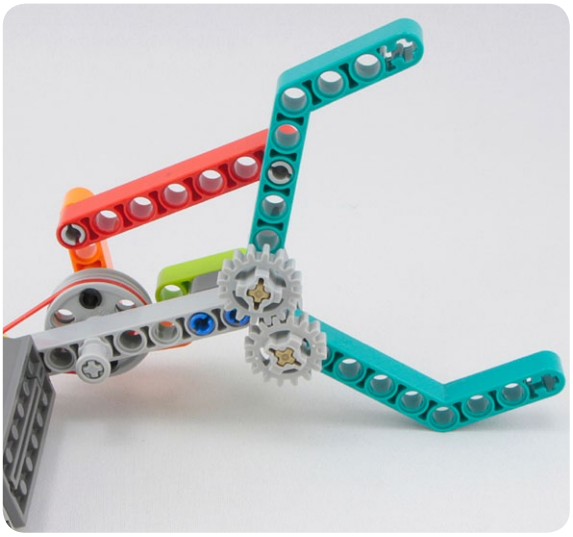


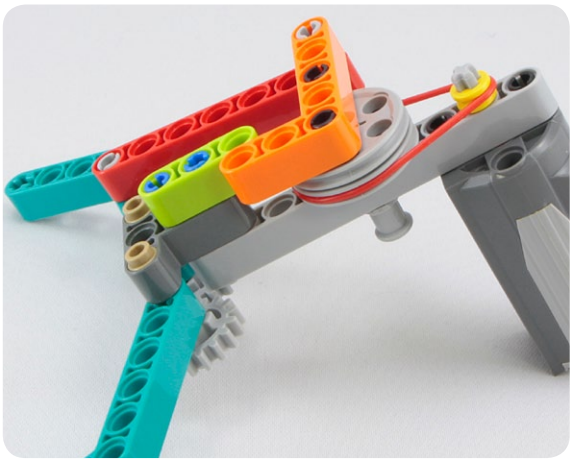
Gripping fingers

#225









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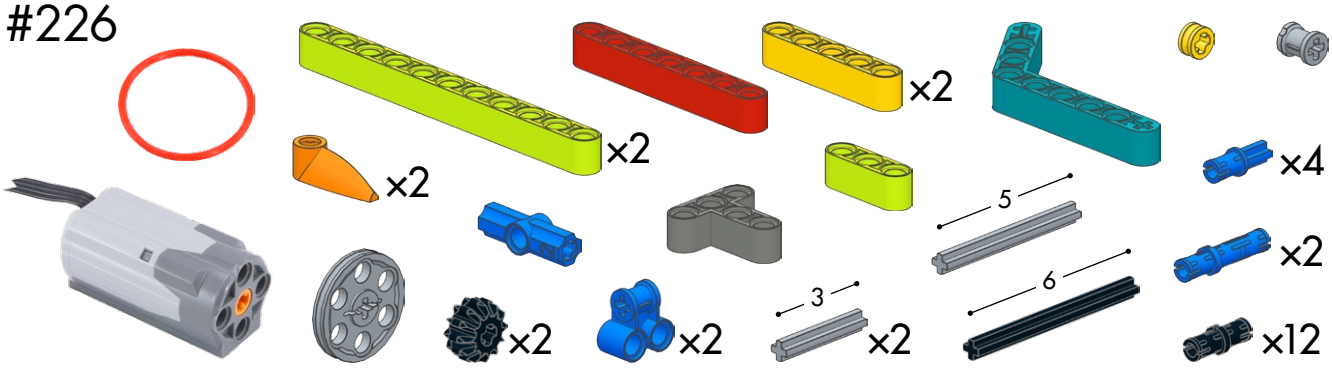

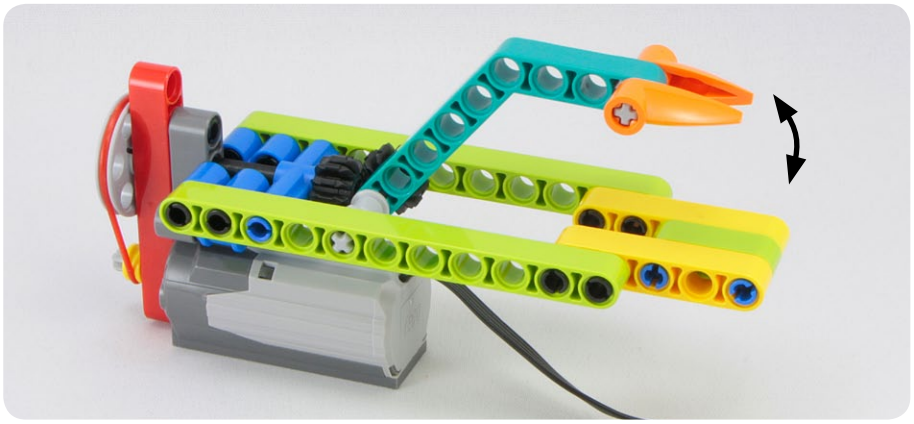

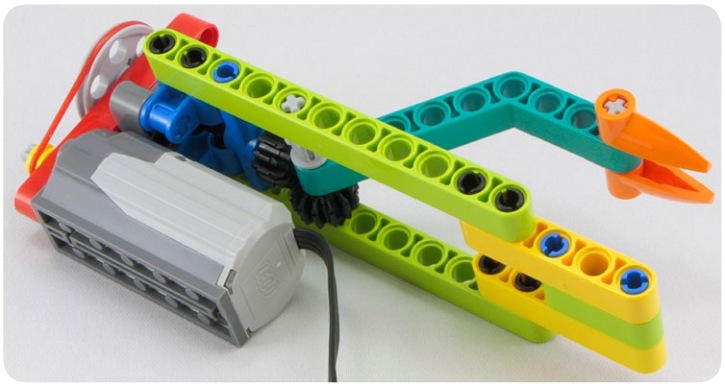

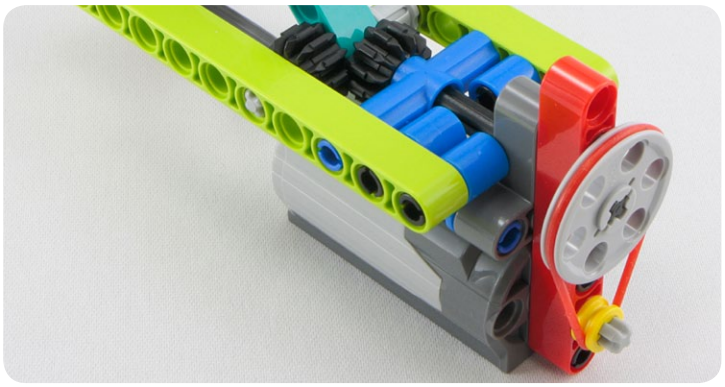

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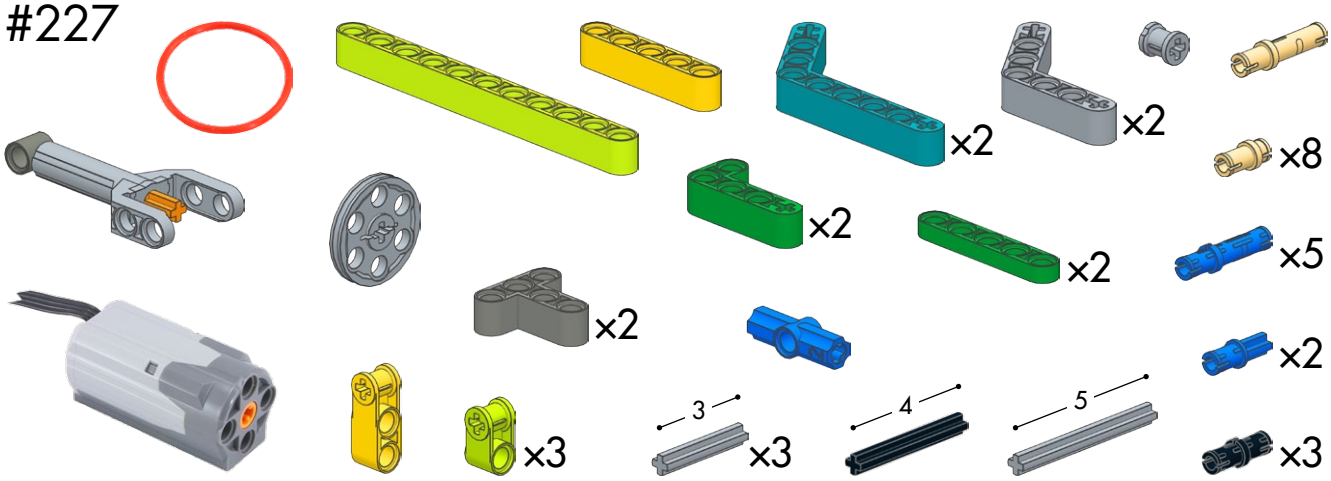

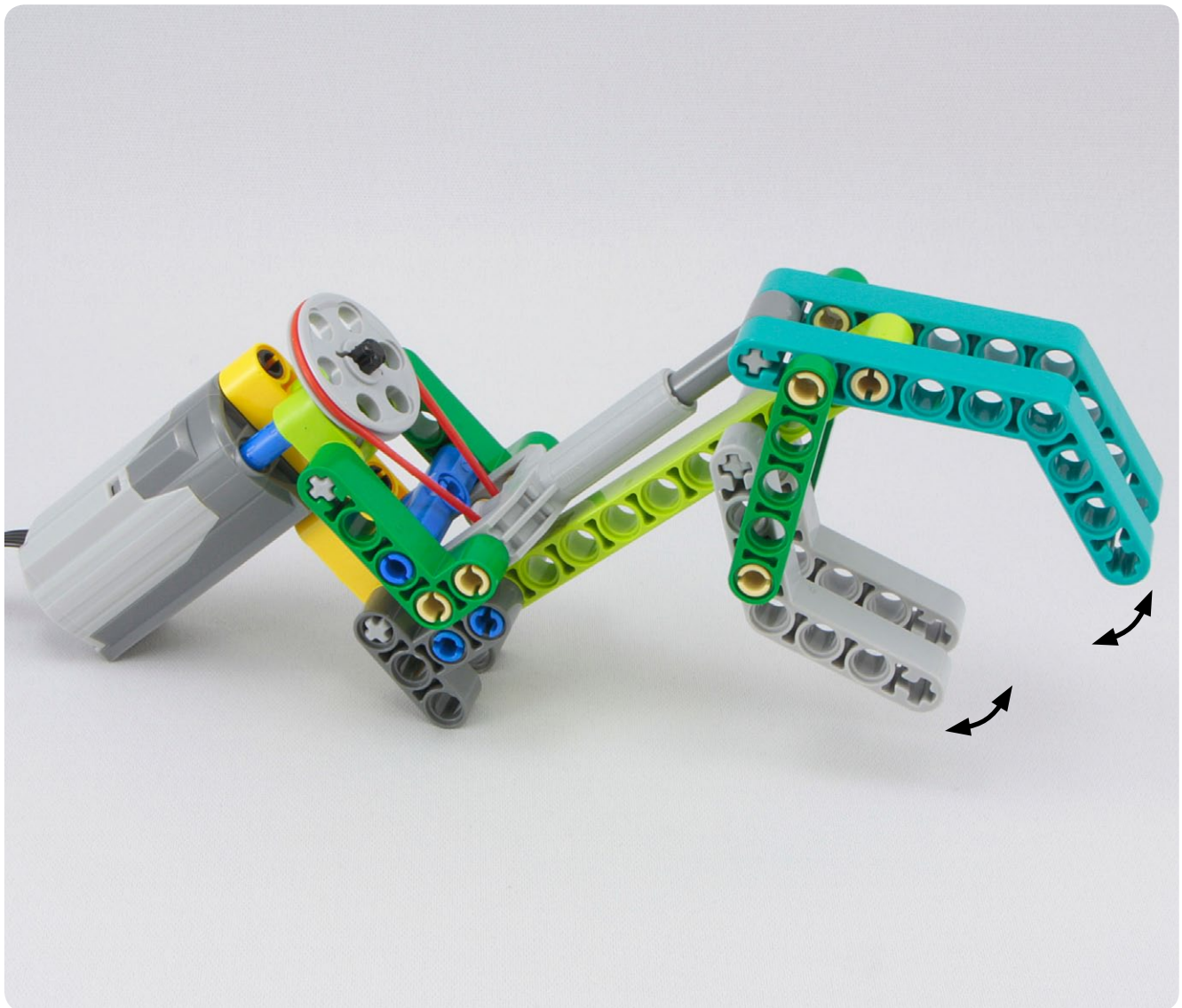

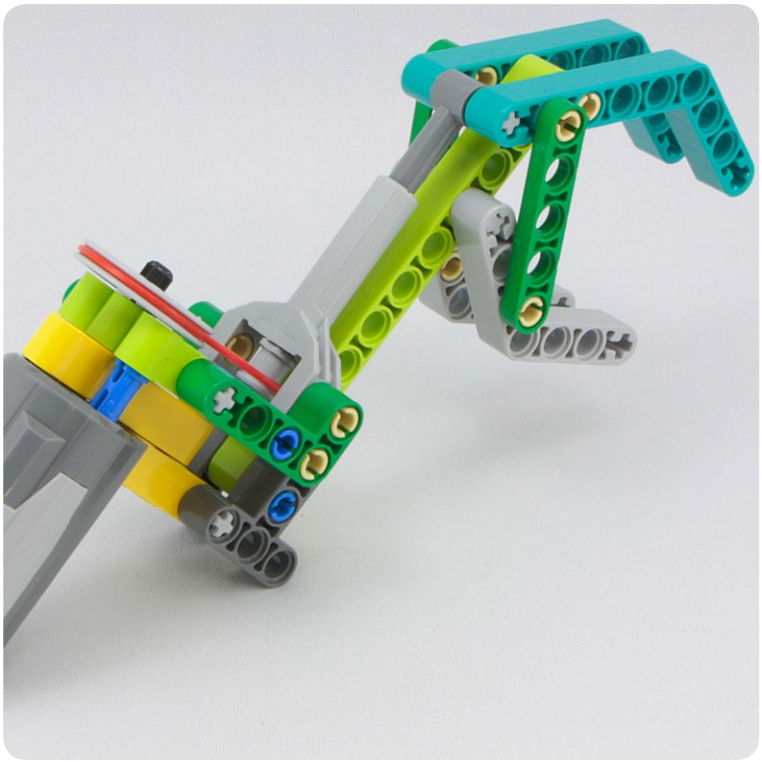

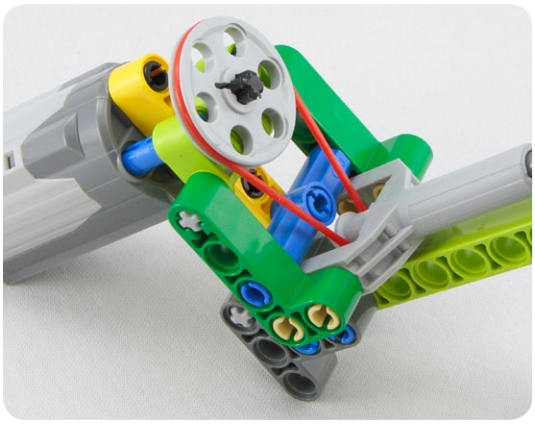

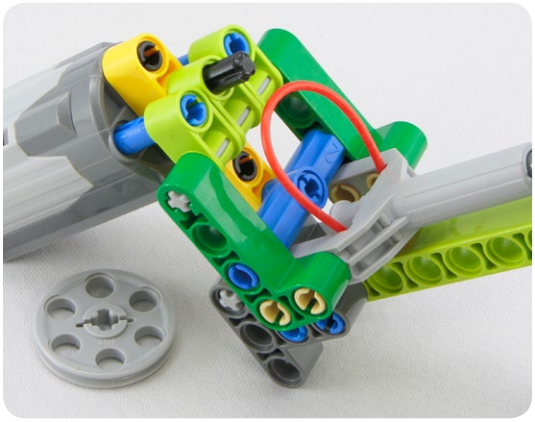

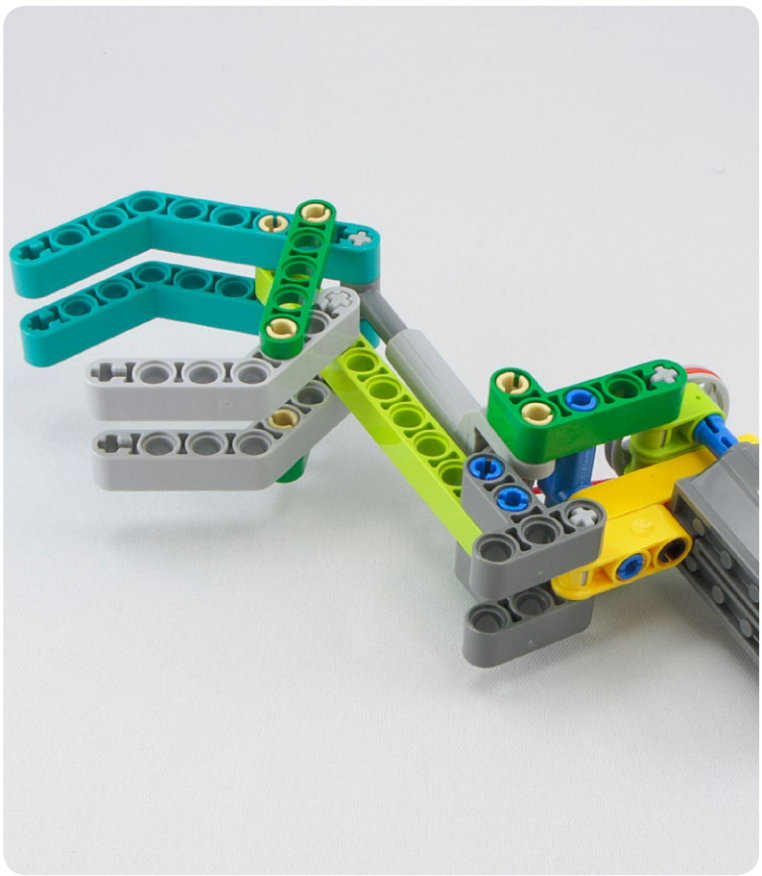

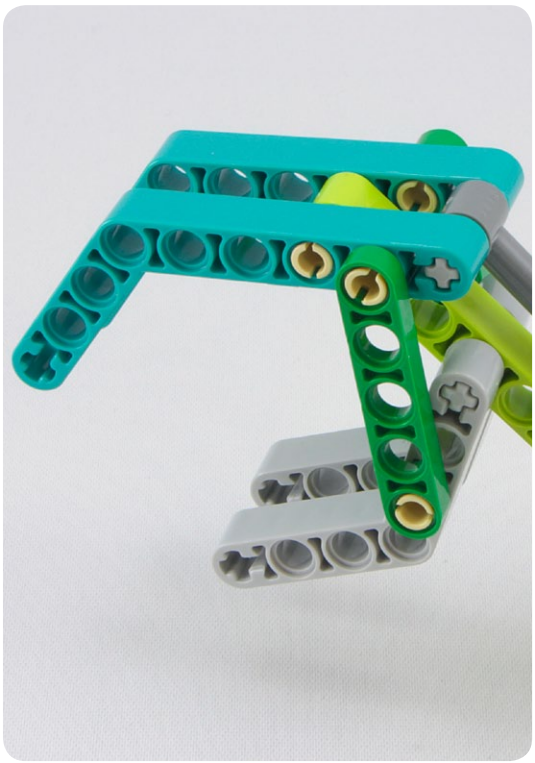

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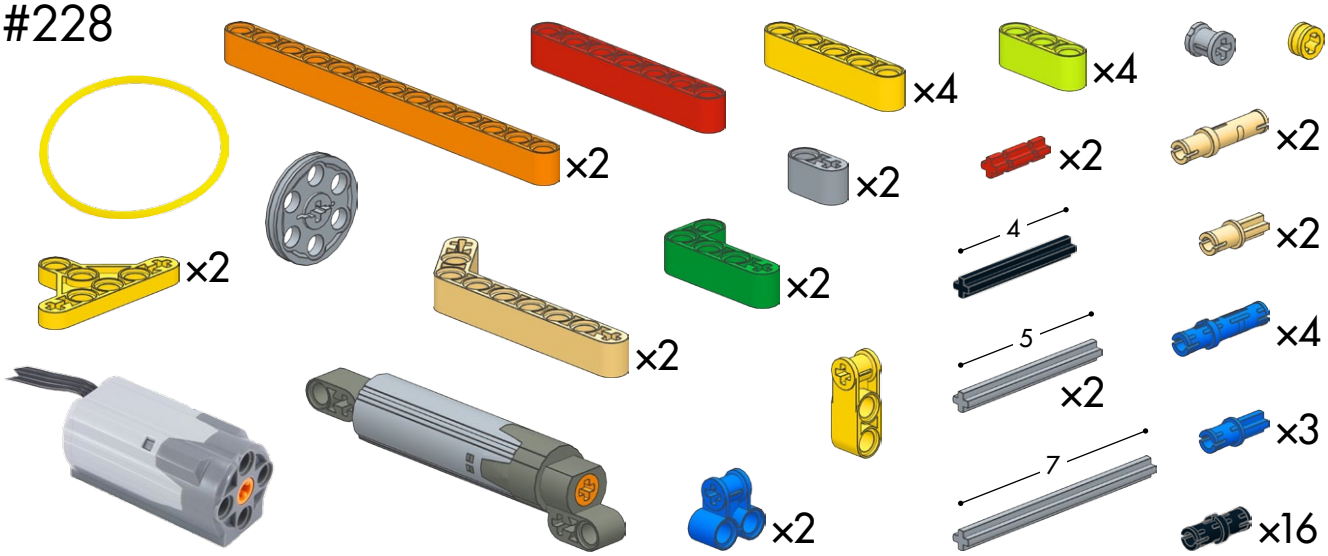

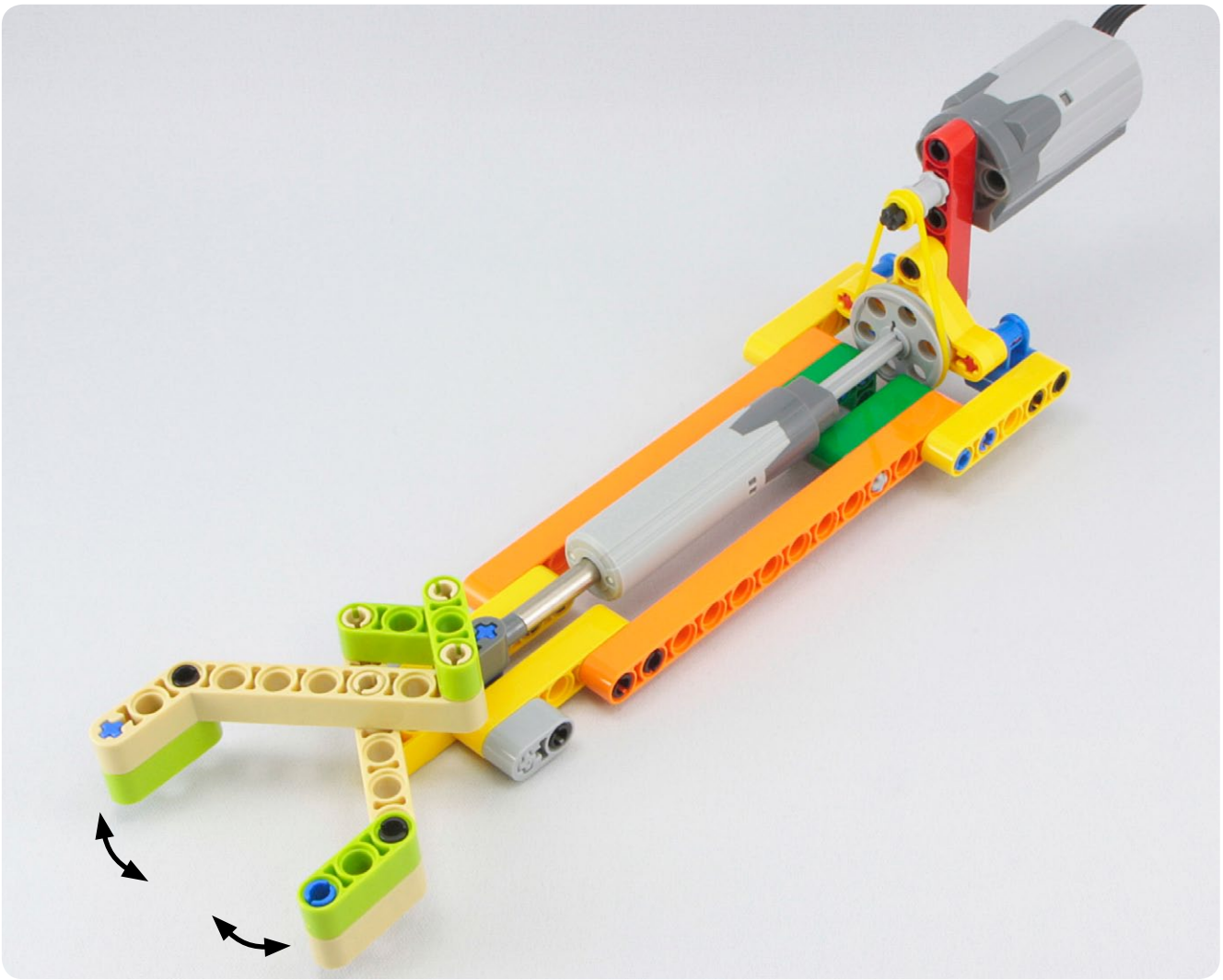

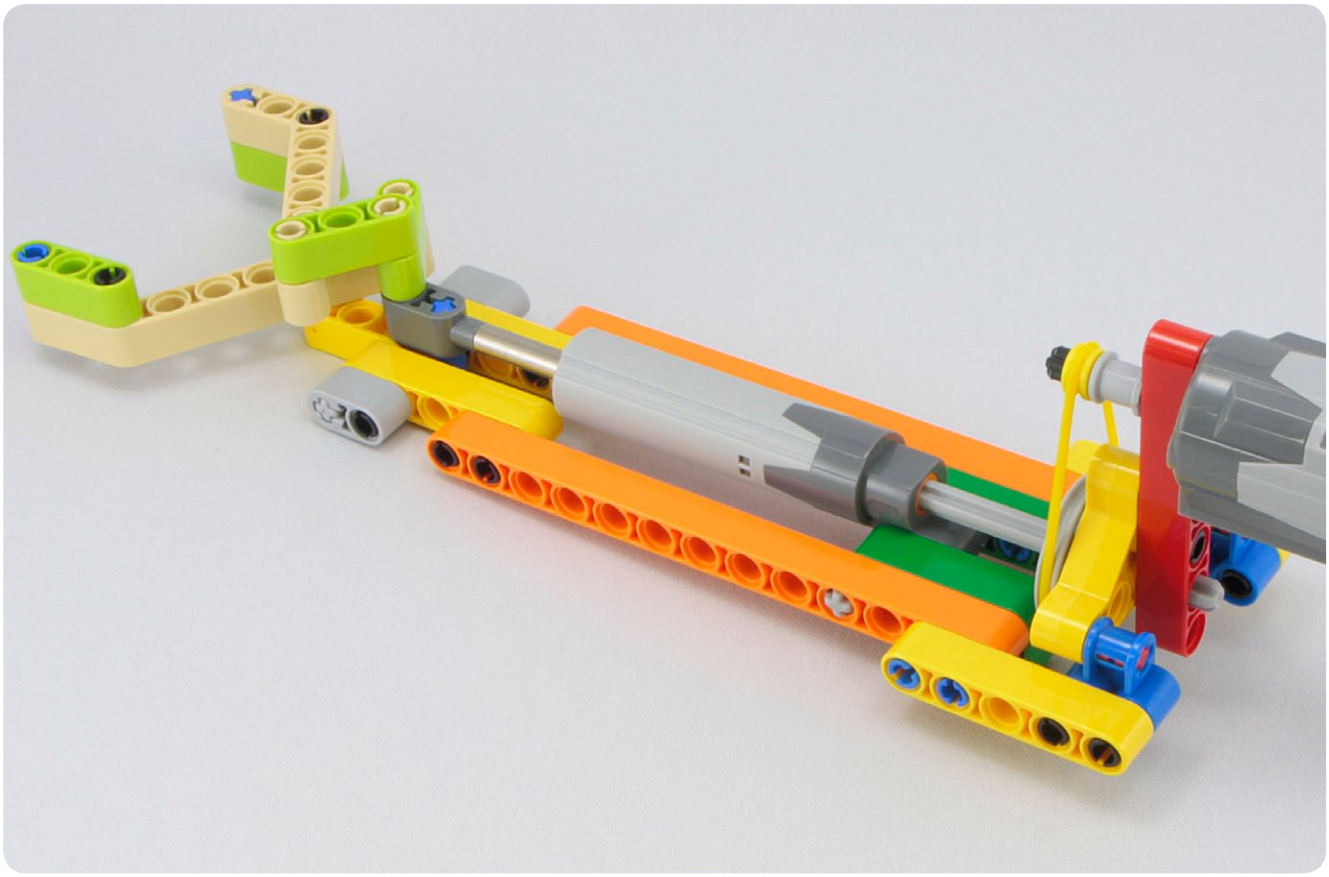

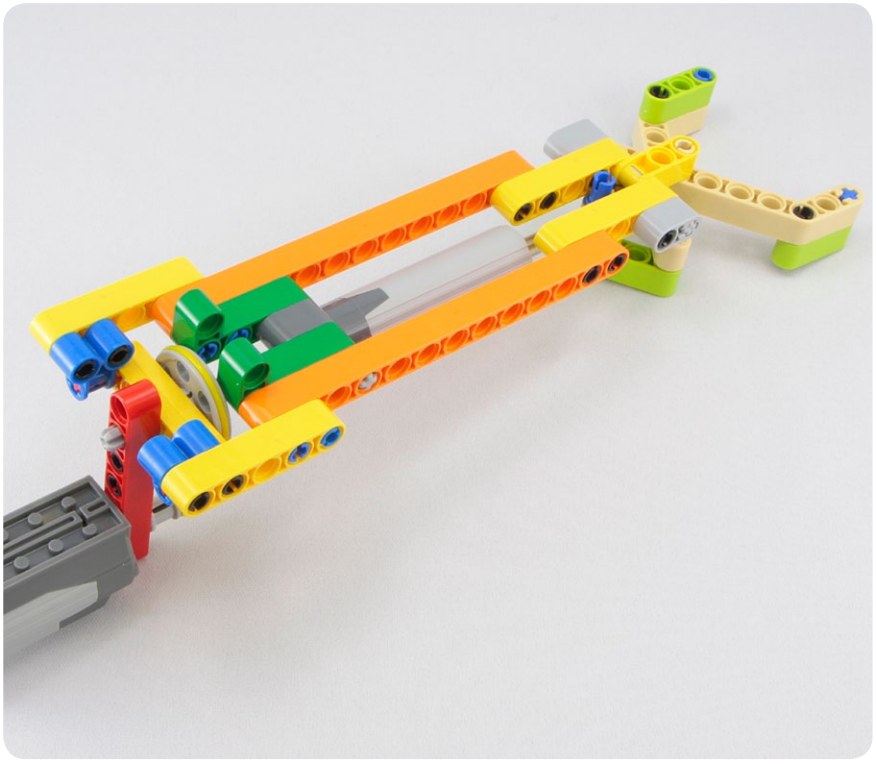

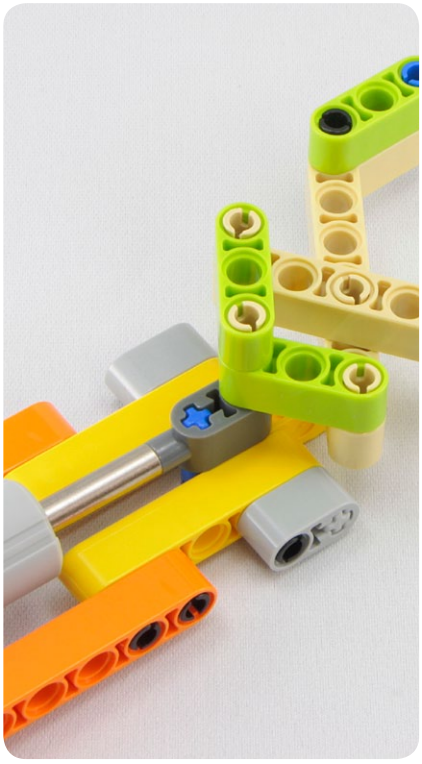

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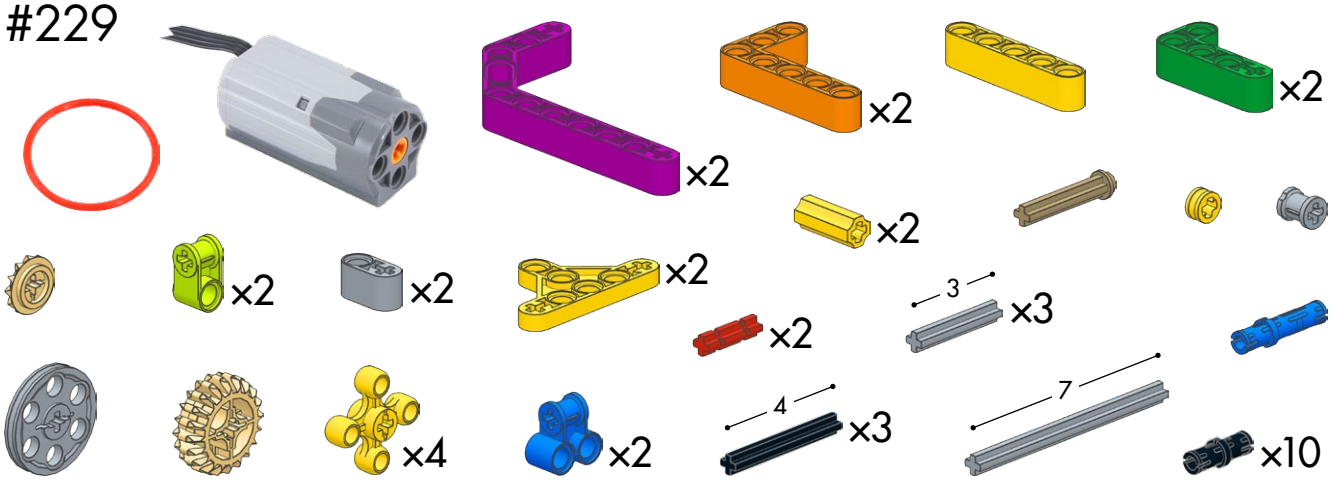

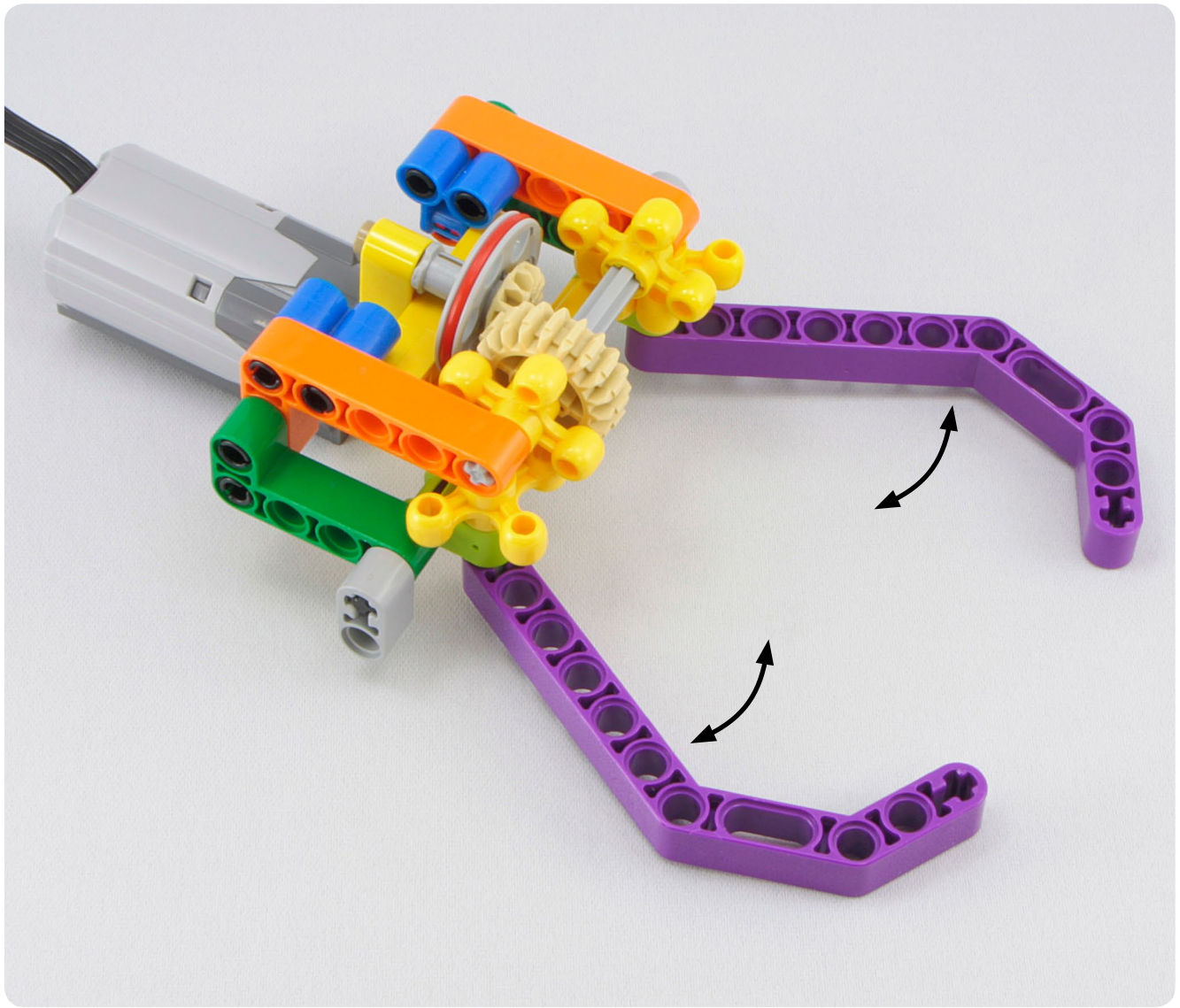

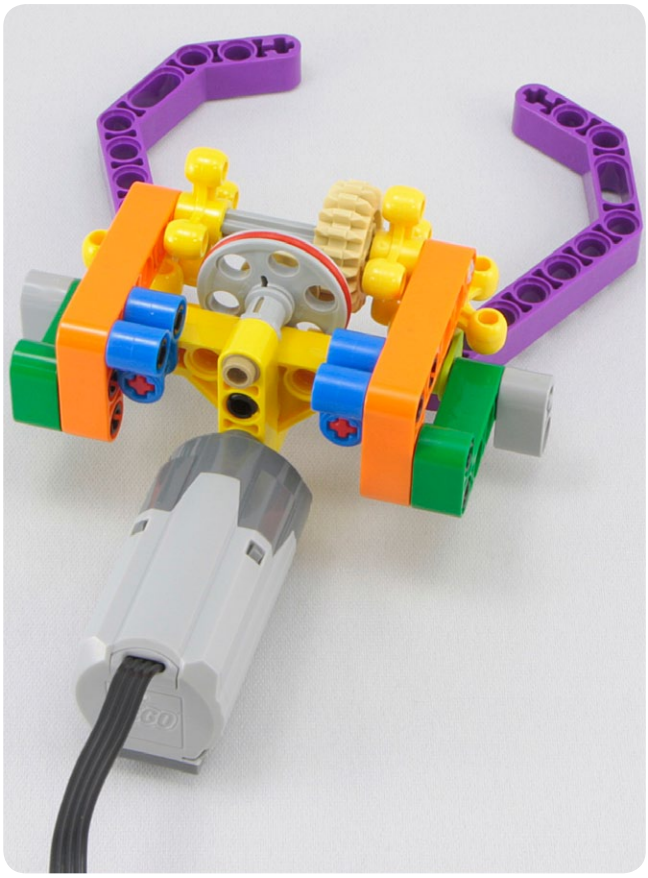

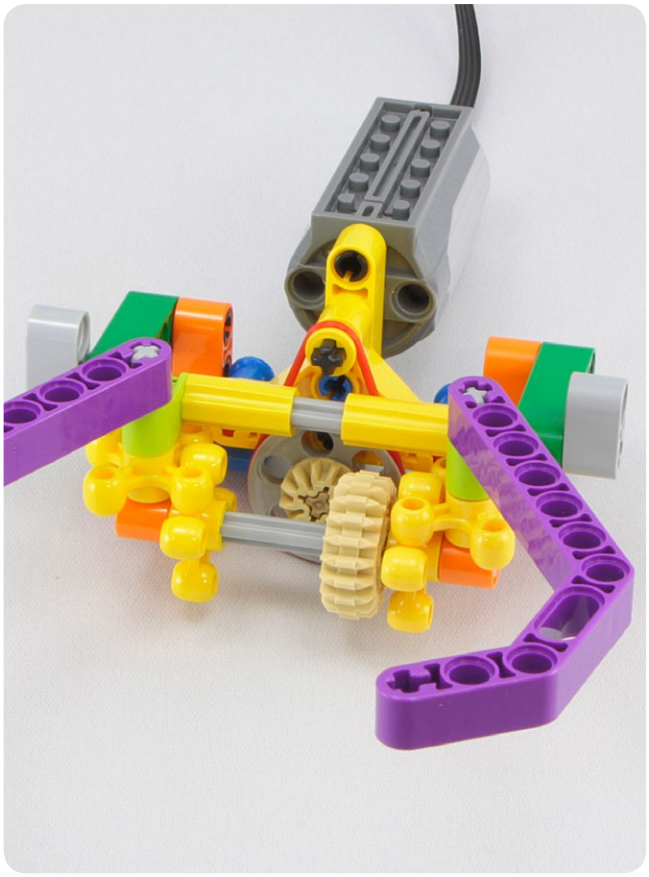

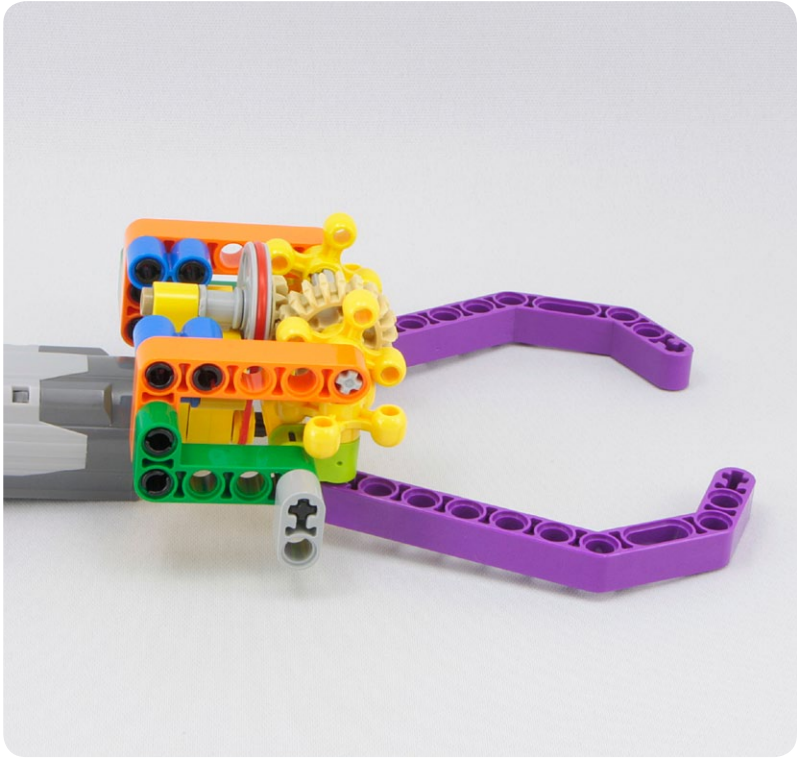

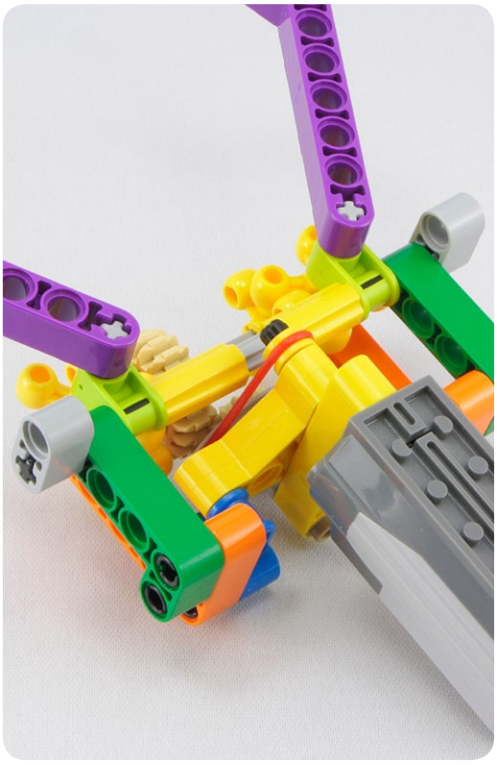

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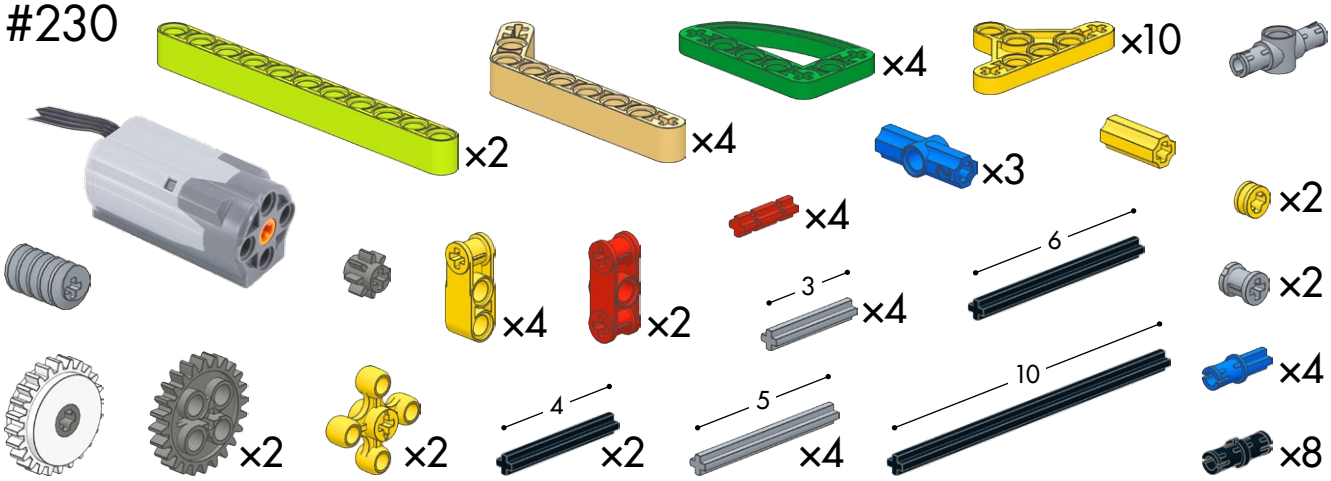

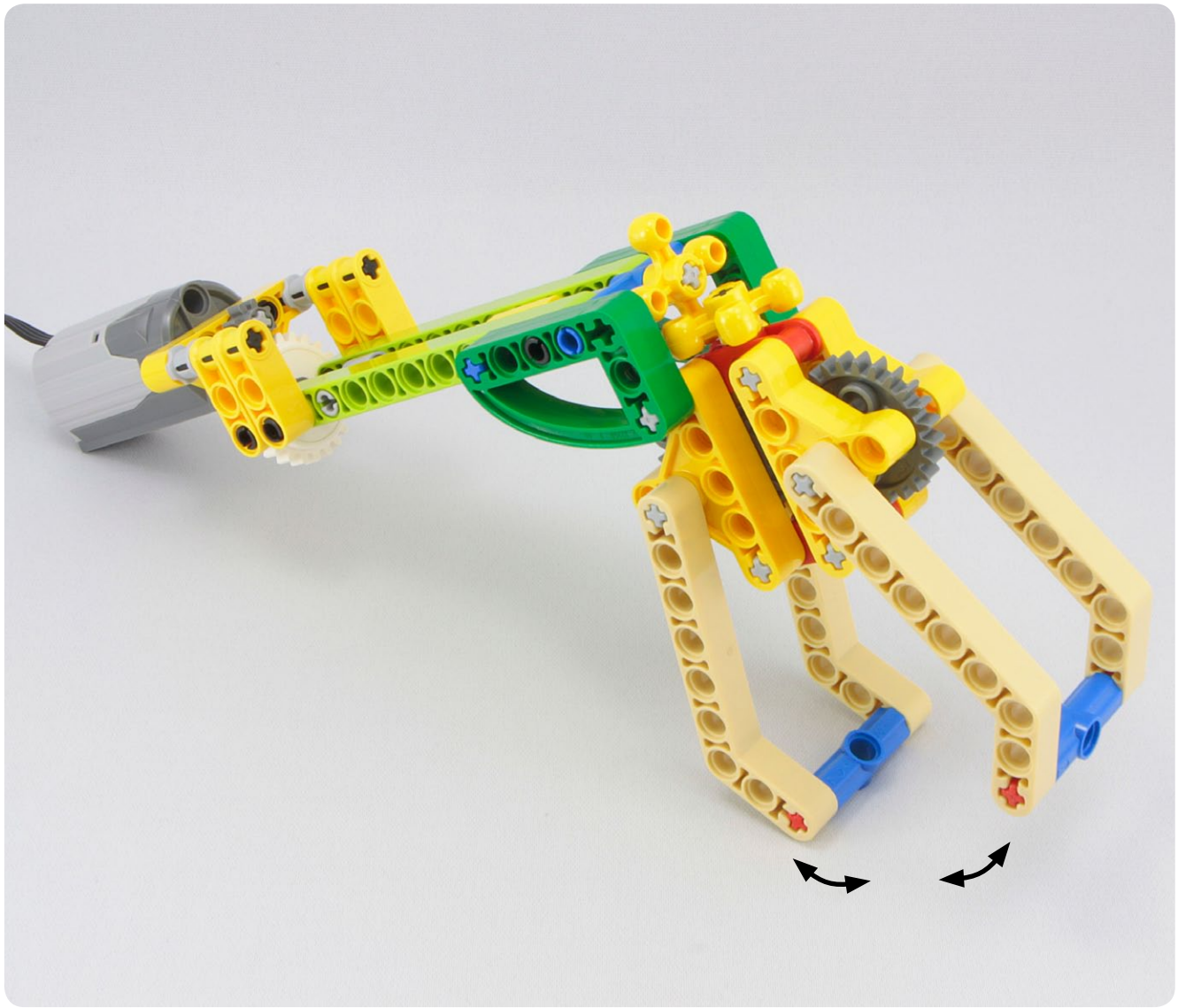

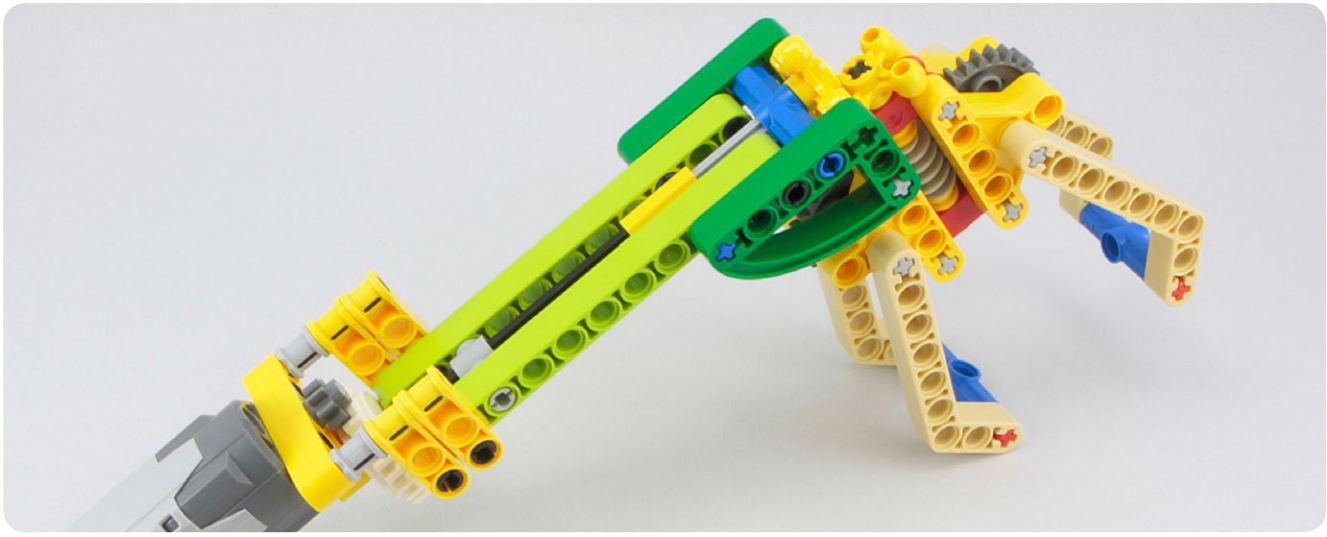

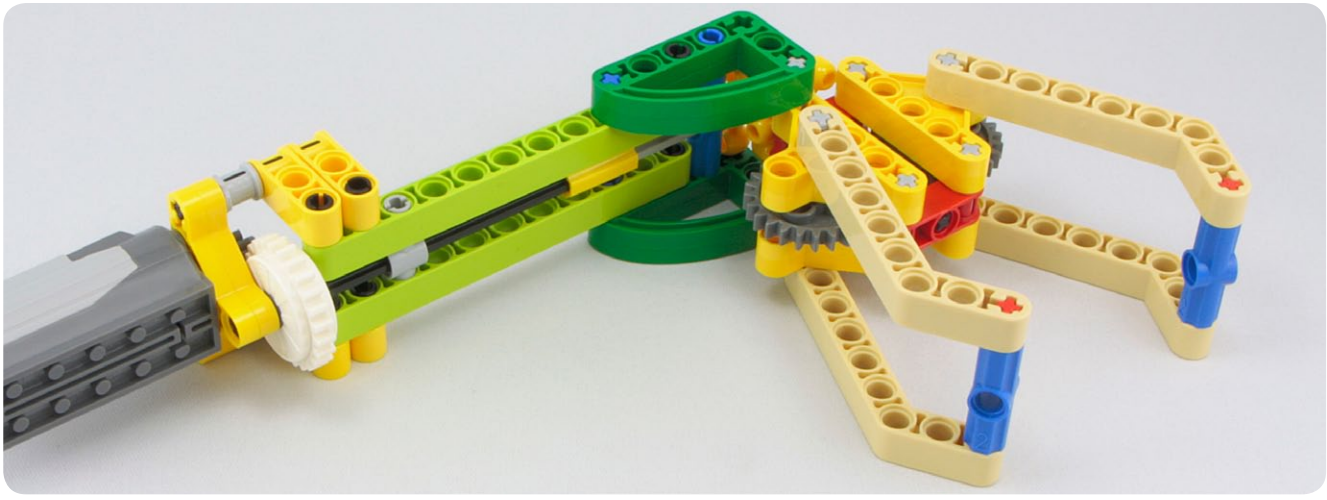

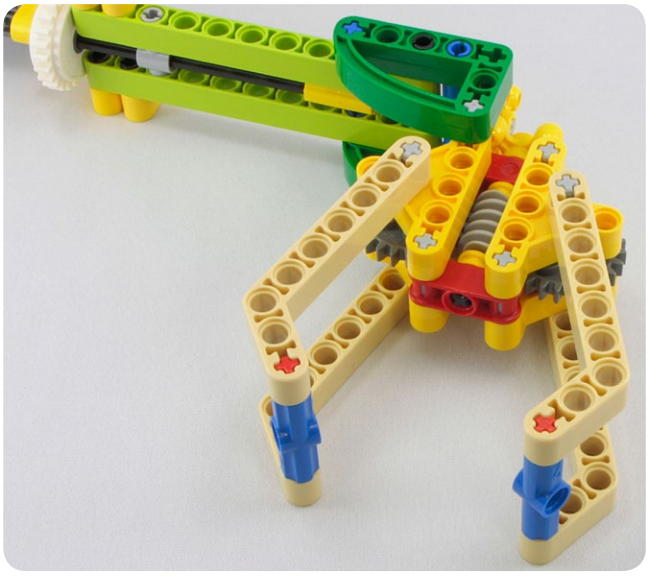

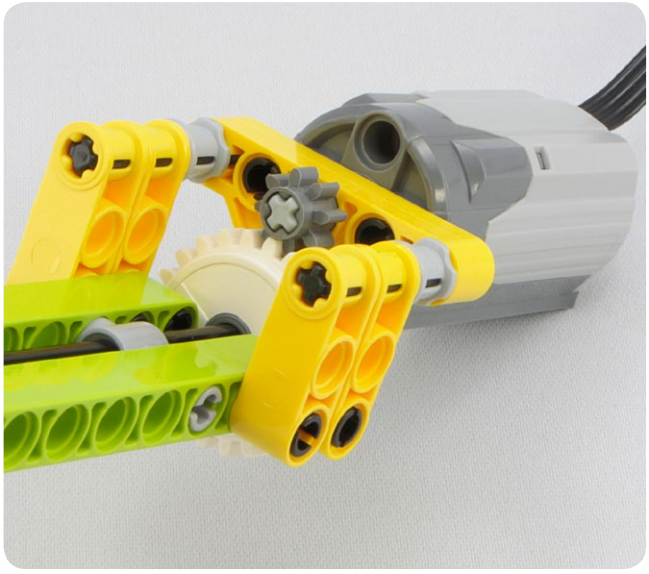

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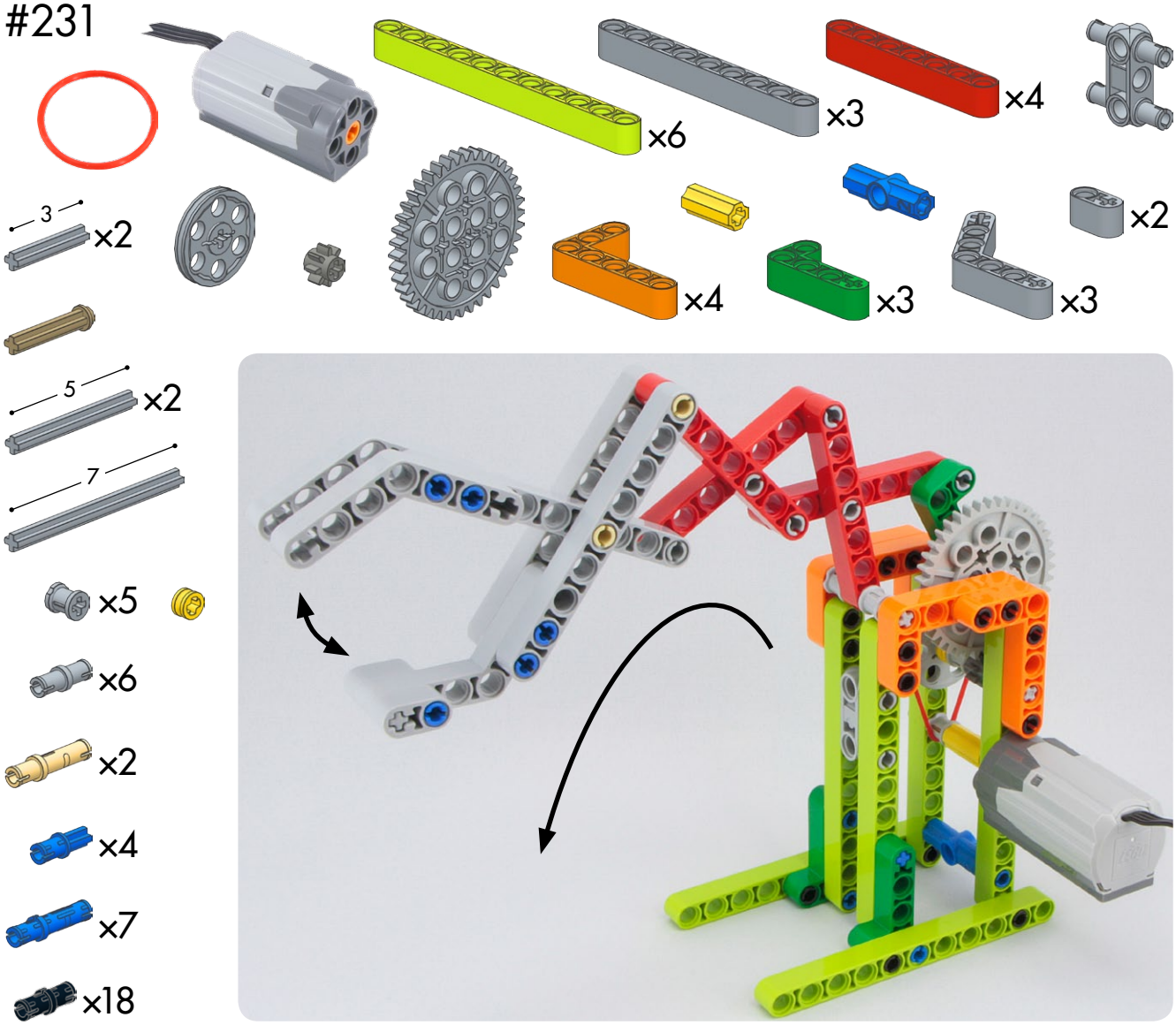

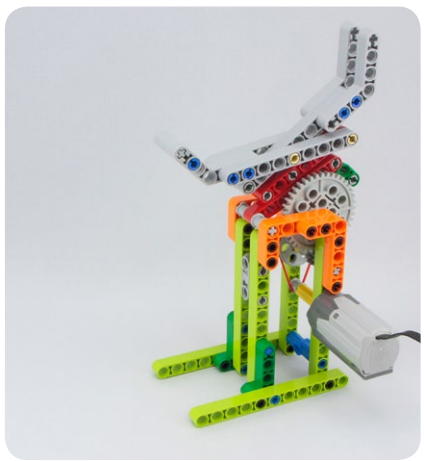

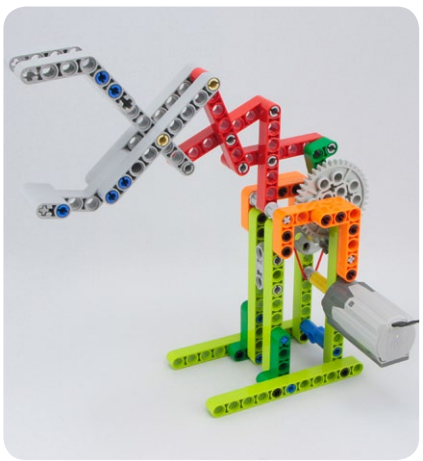

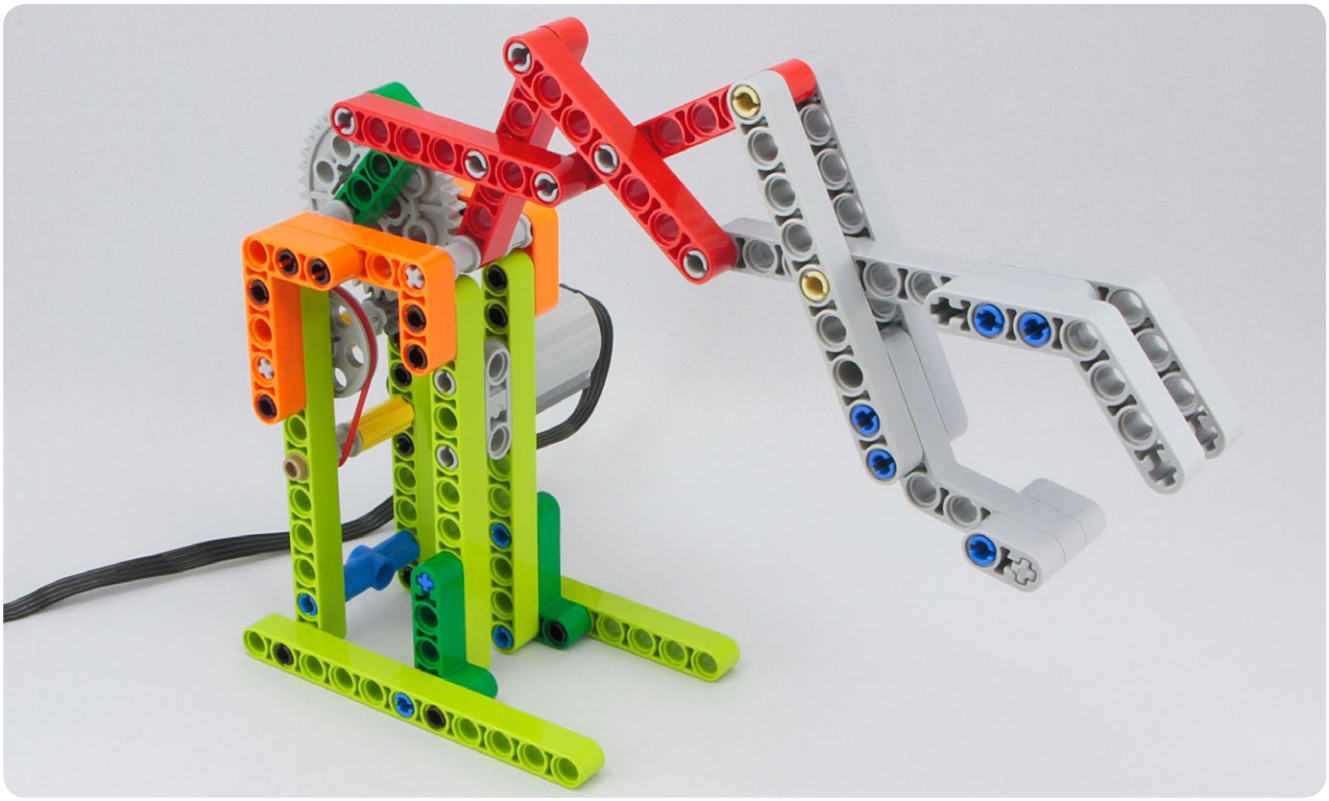

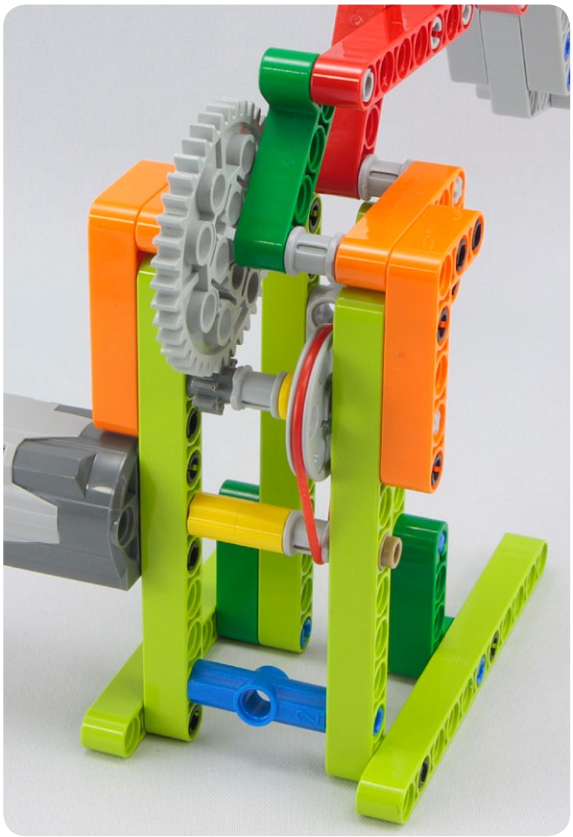

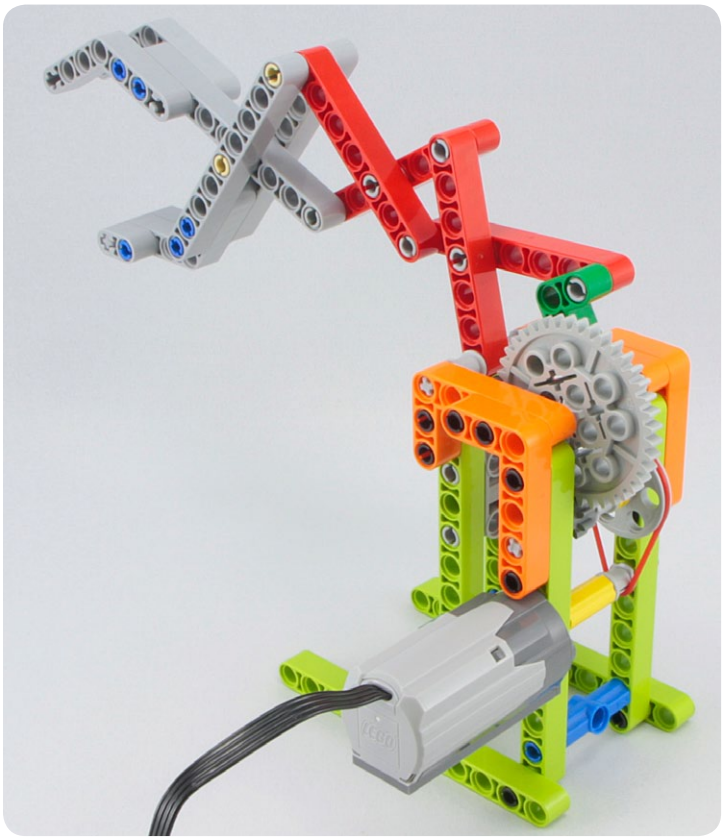

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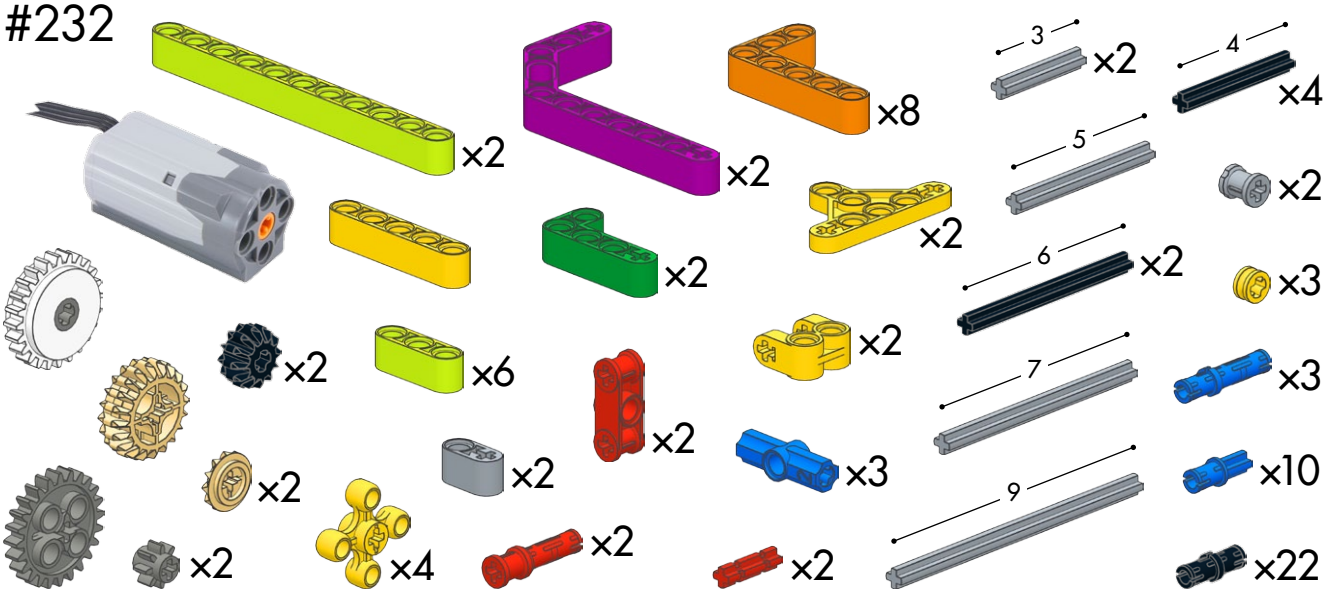
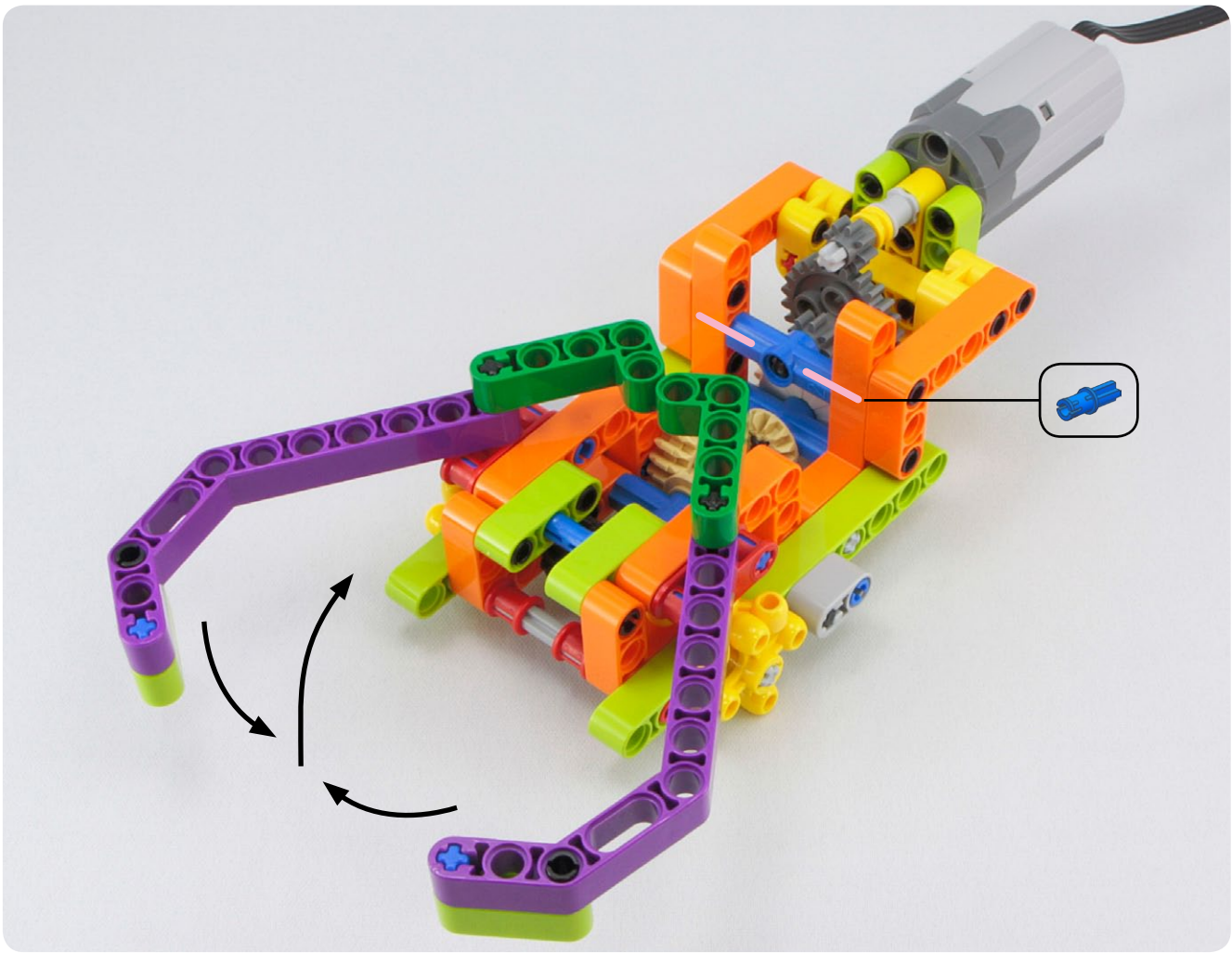
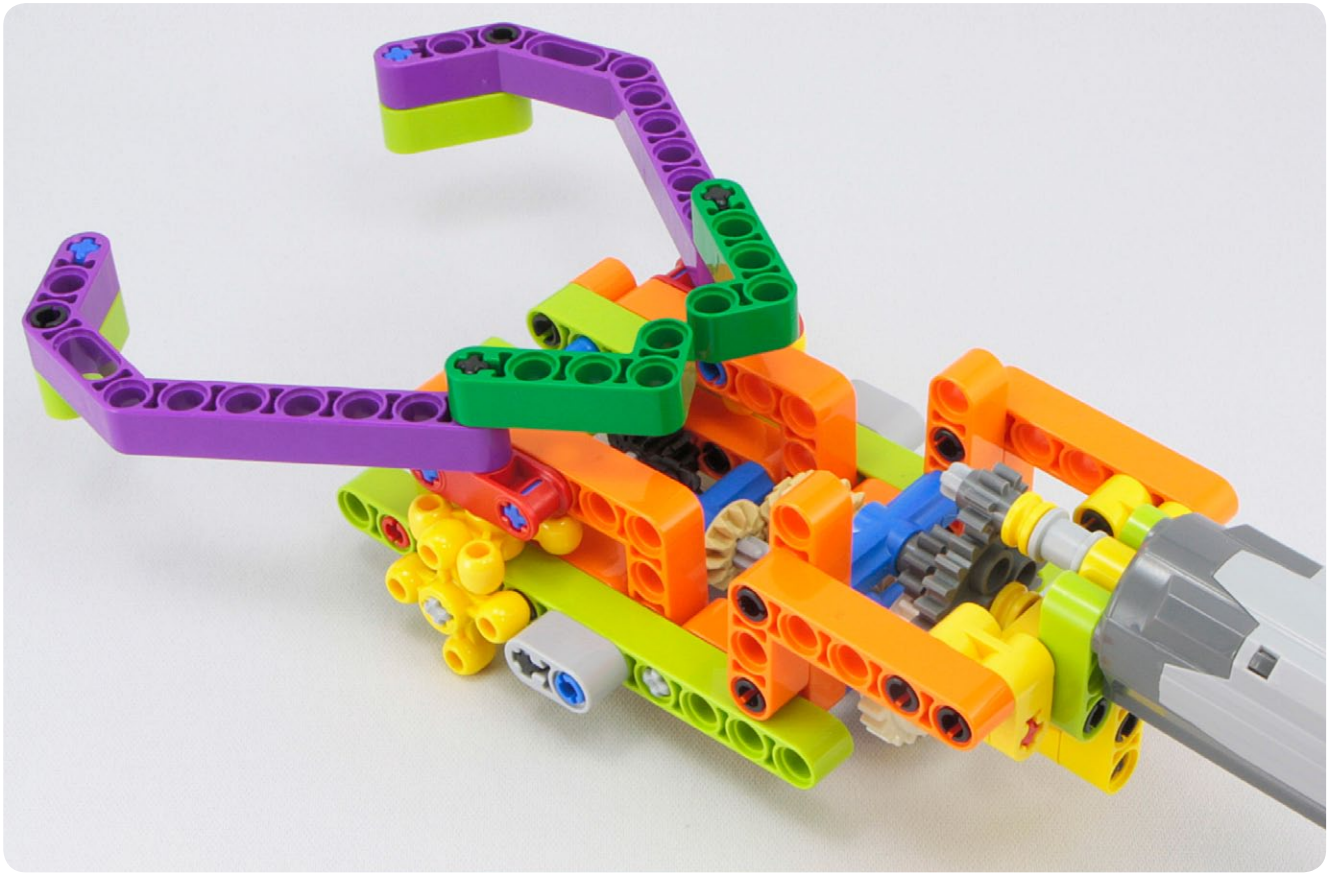
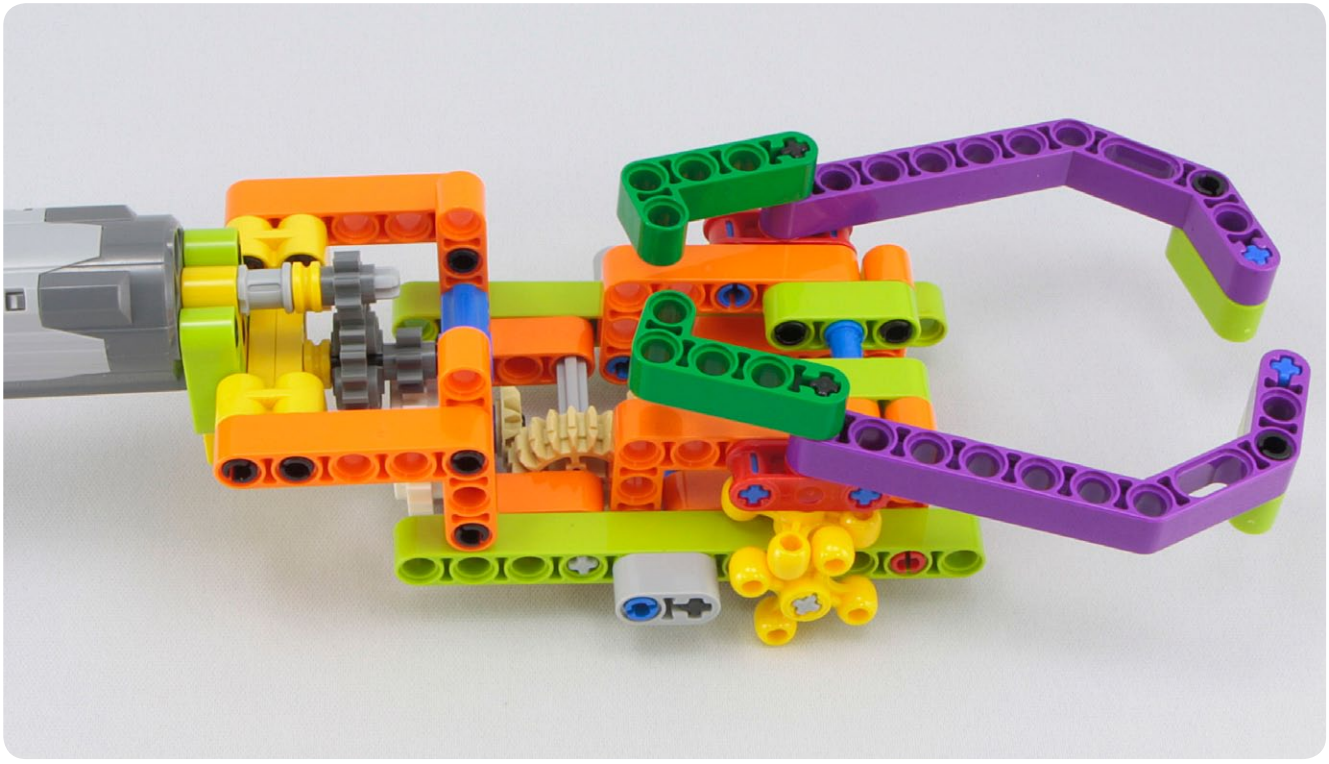
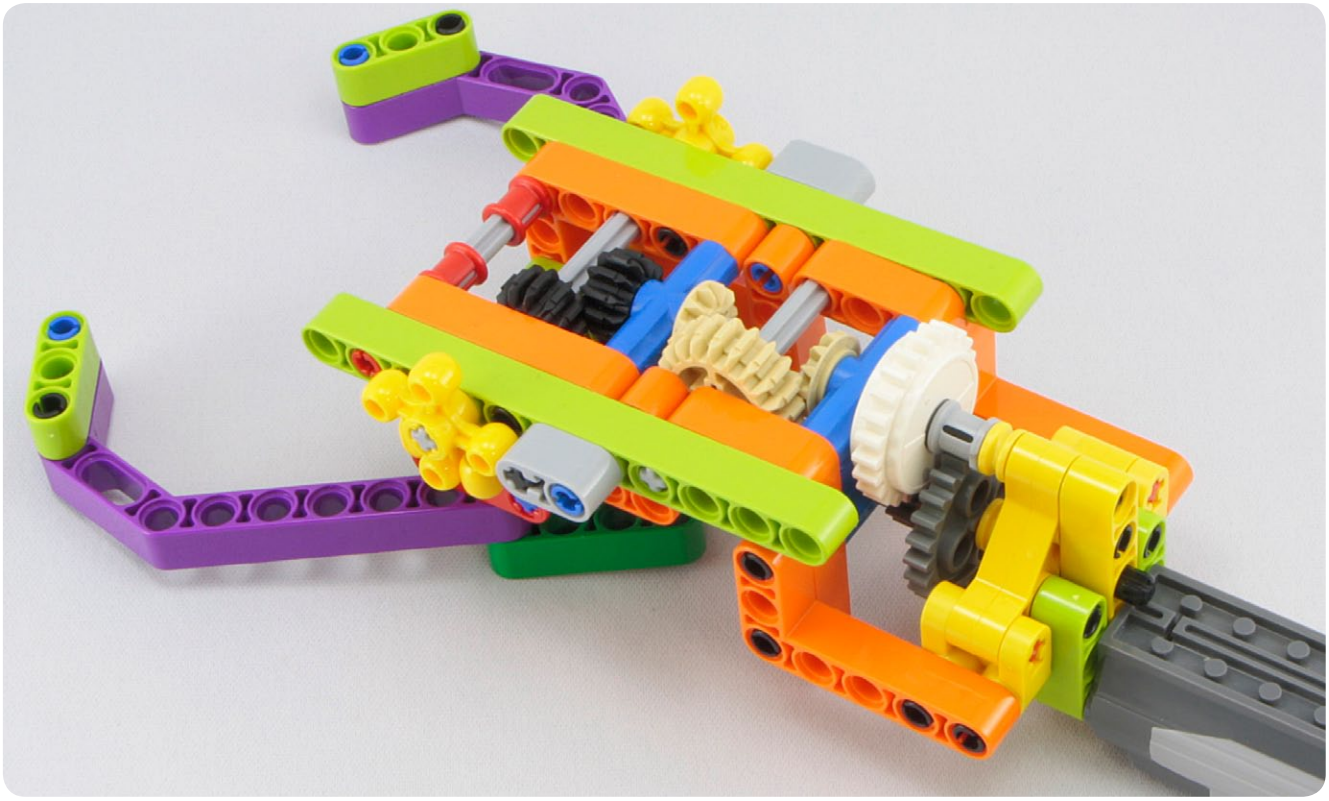
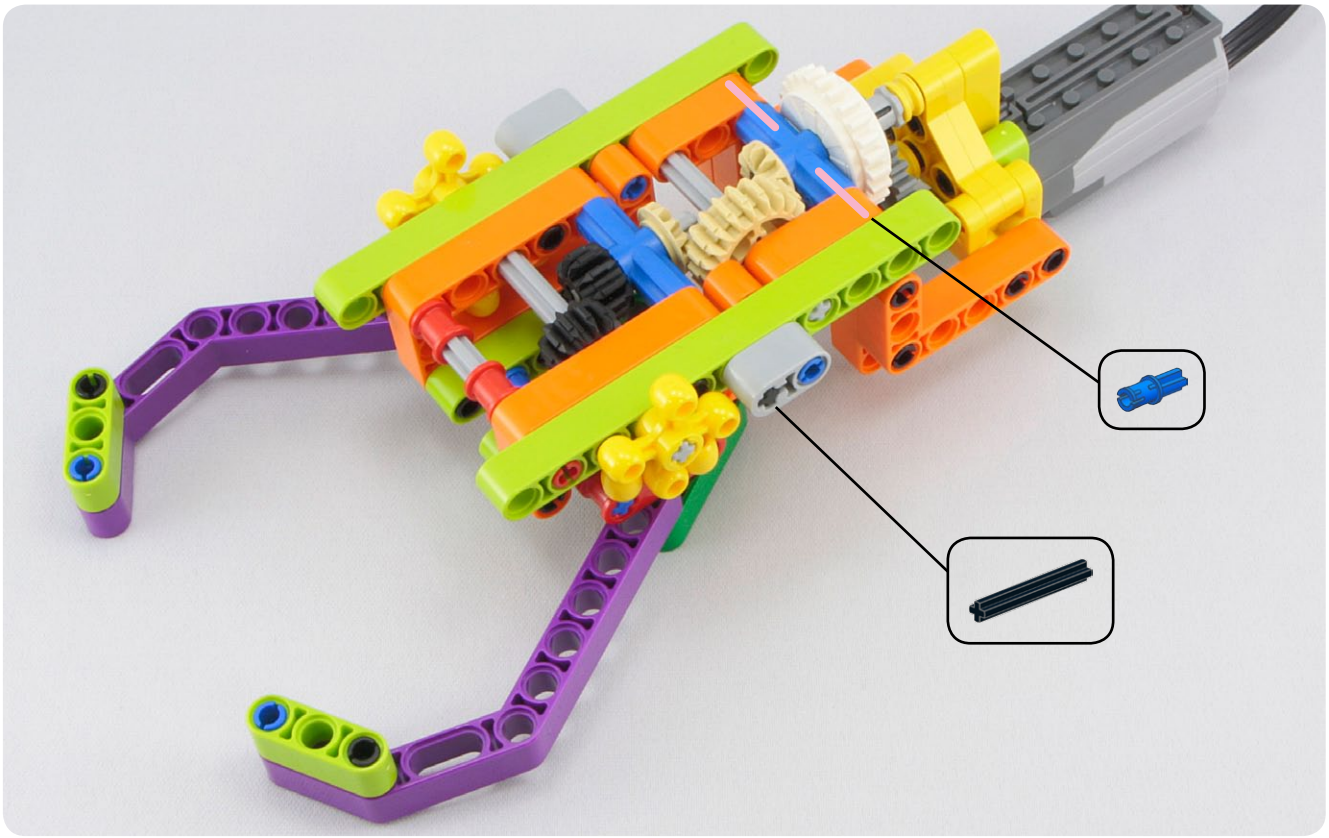


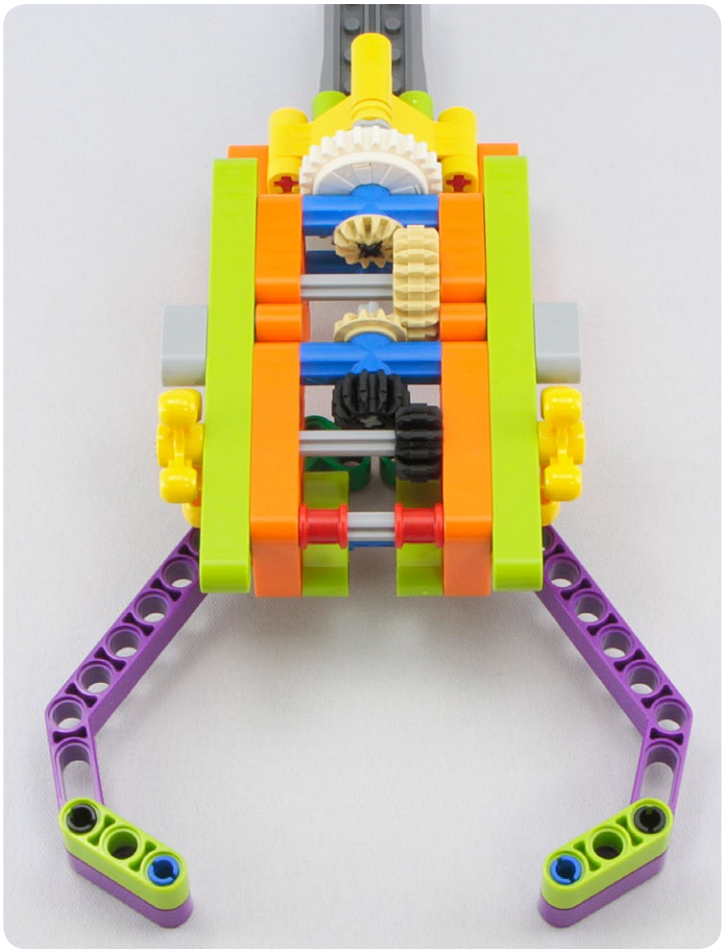


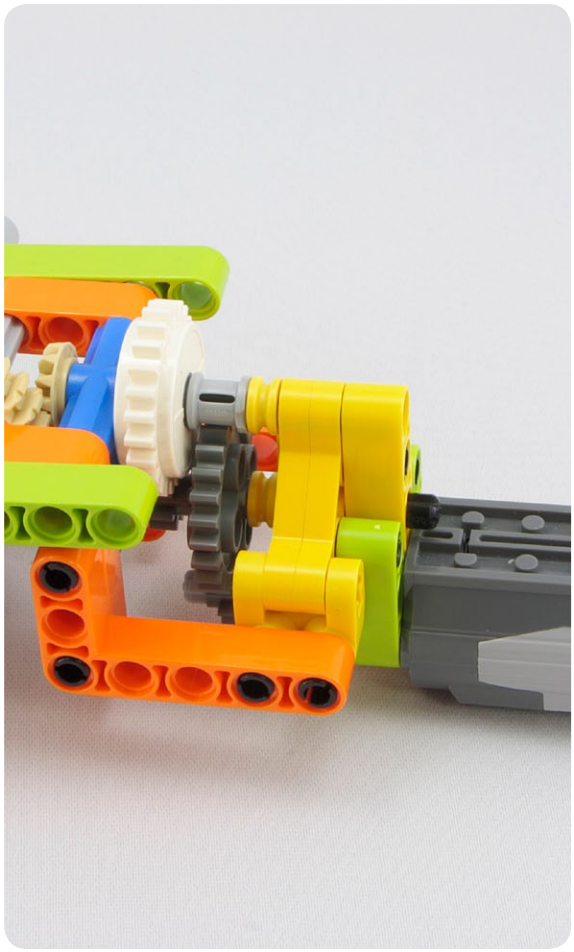


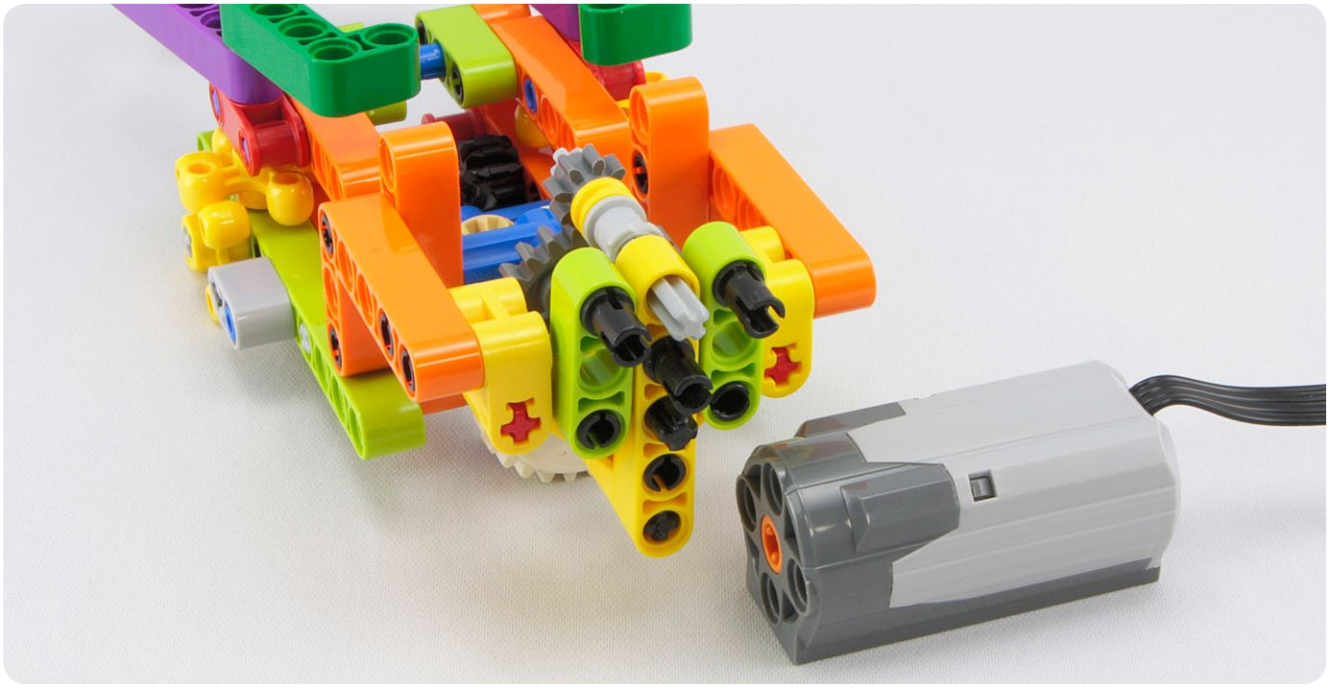






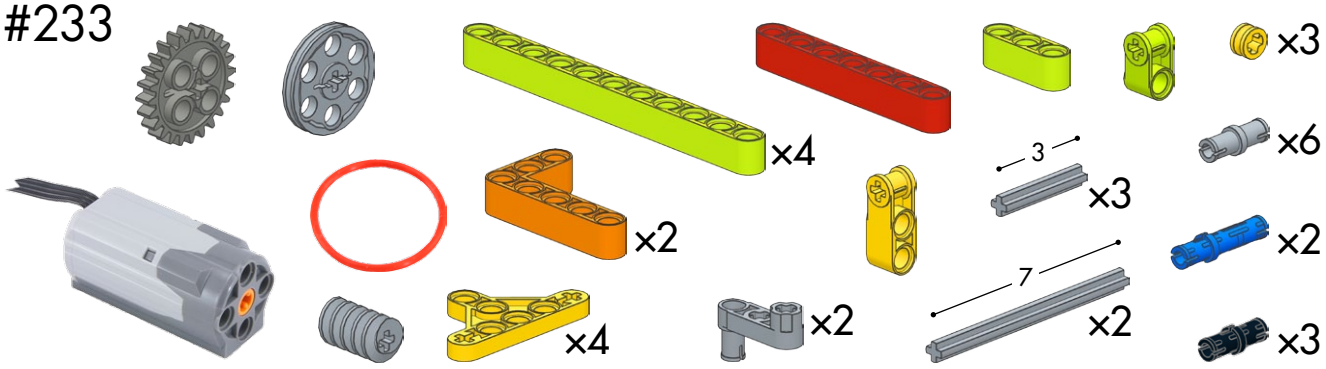


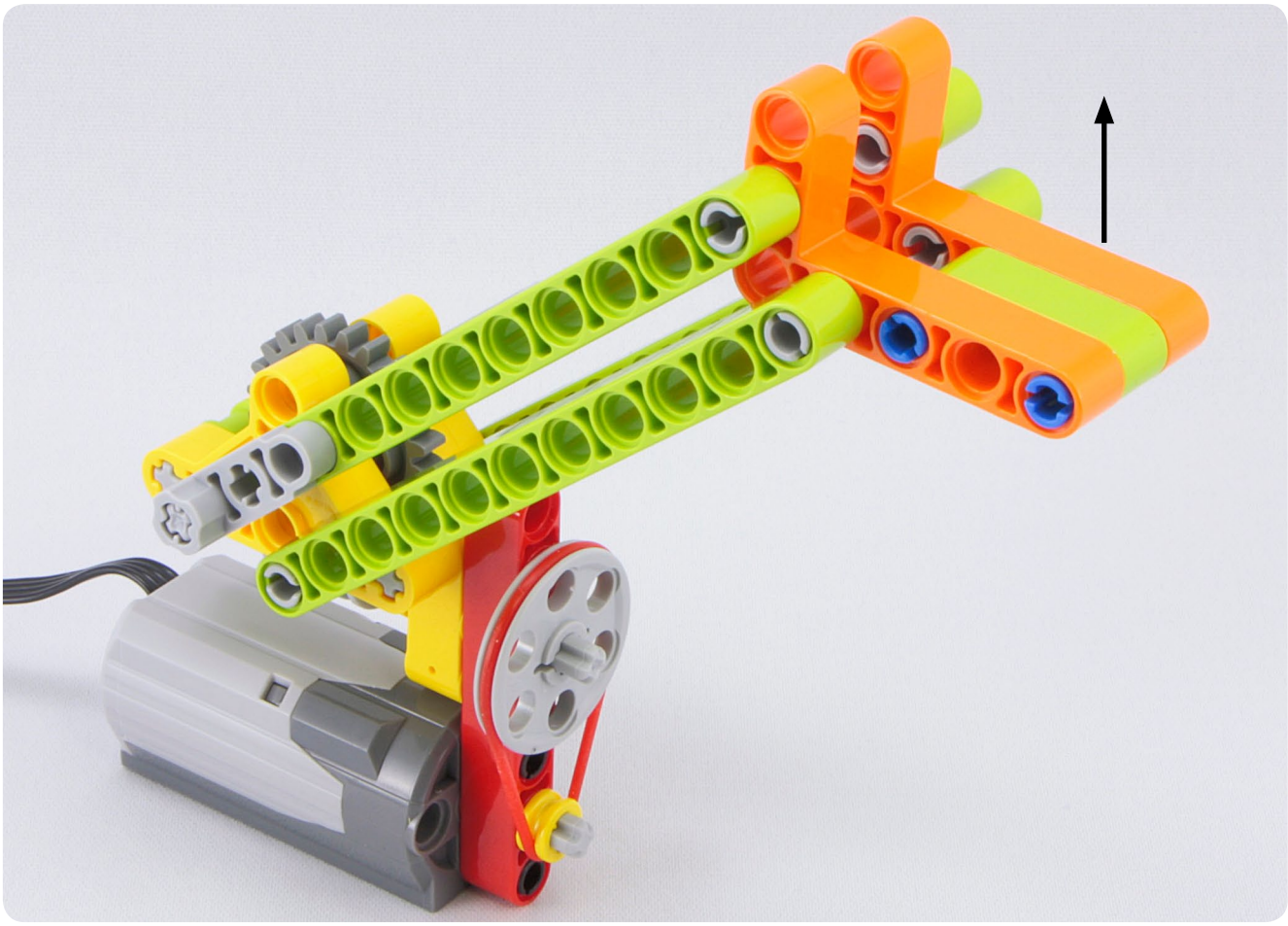




Lifting things

#233





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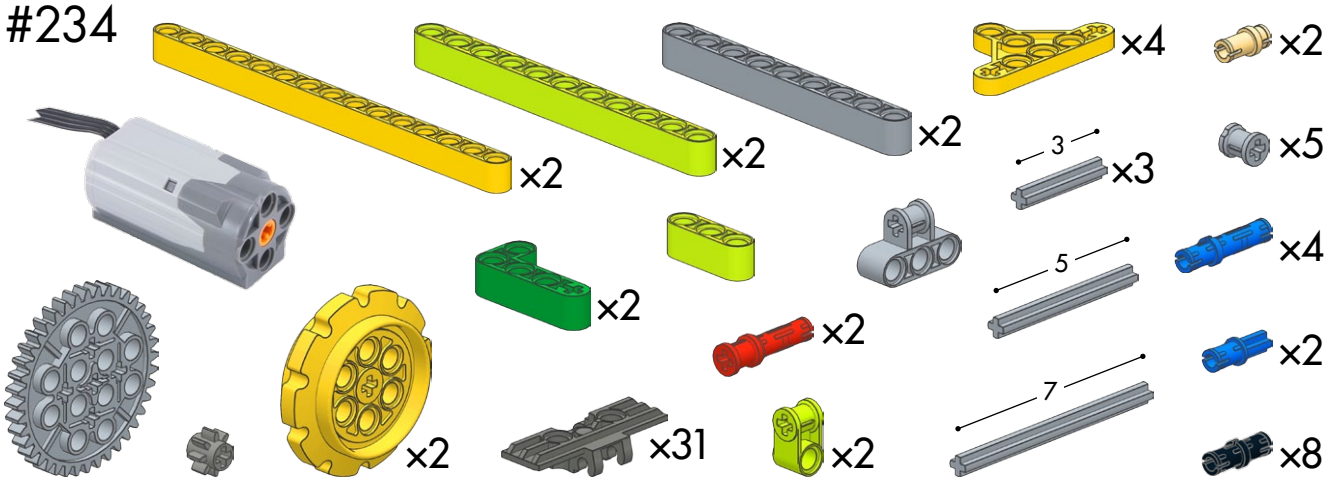

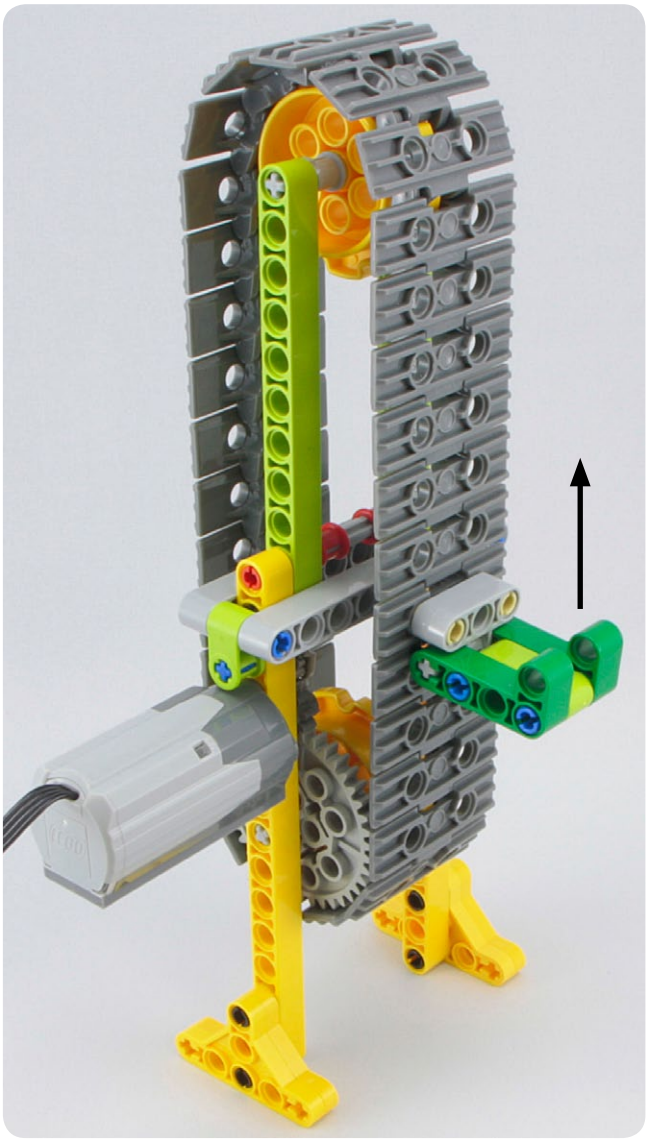

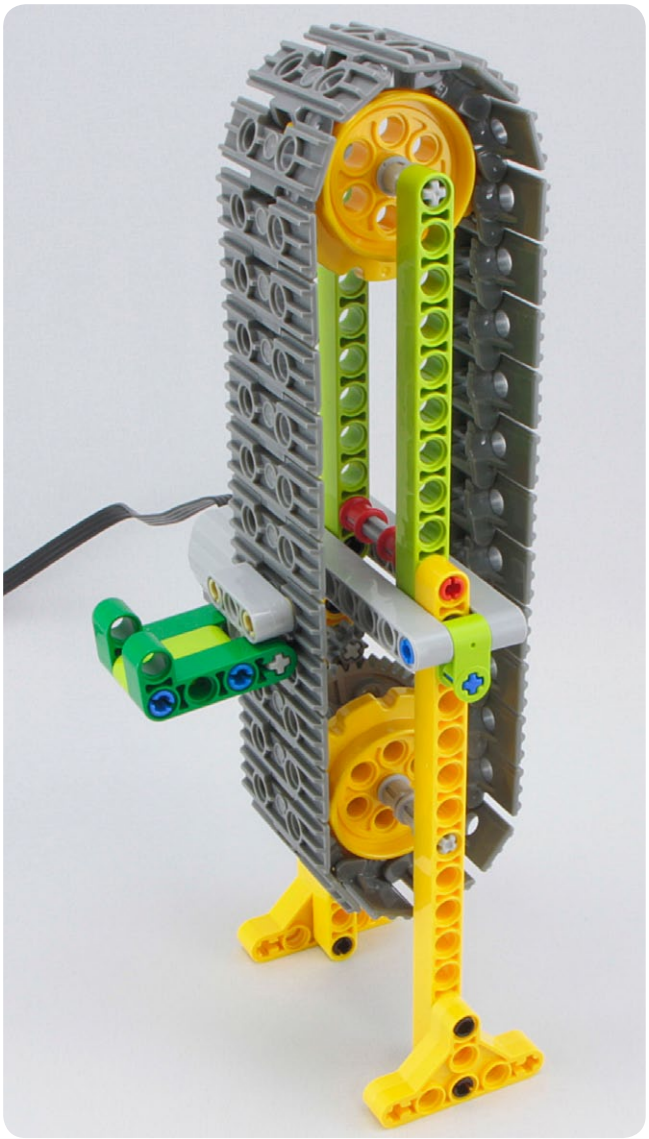

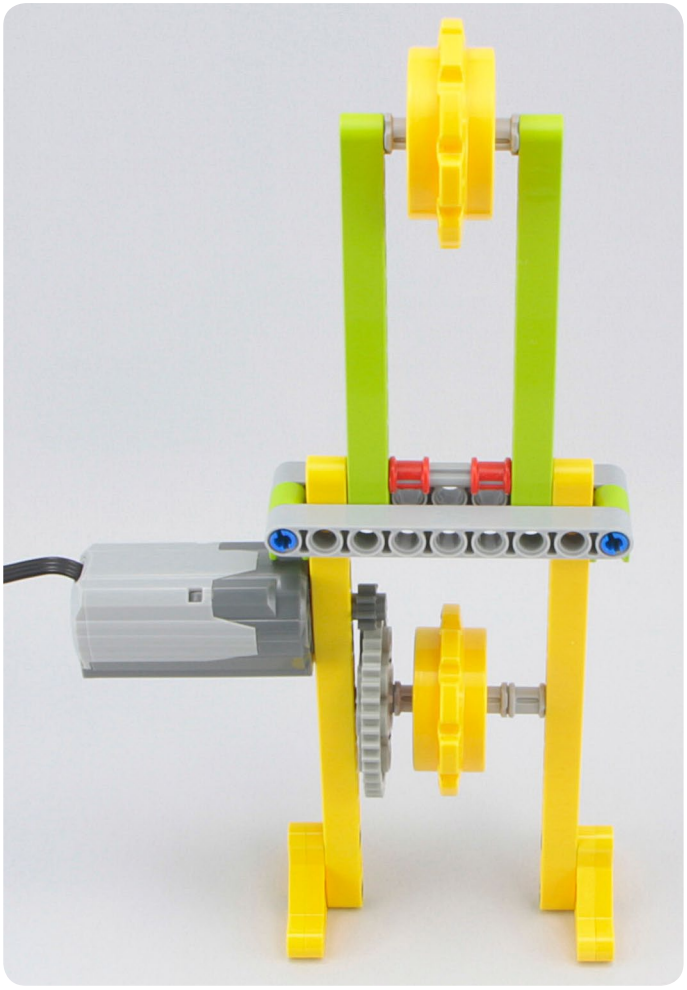

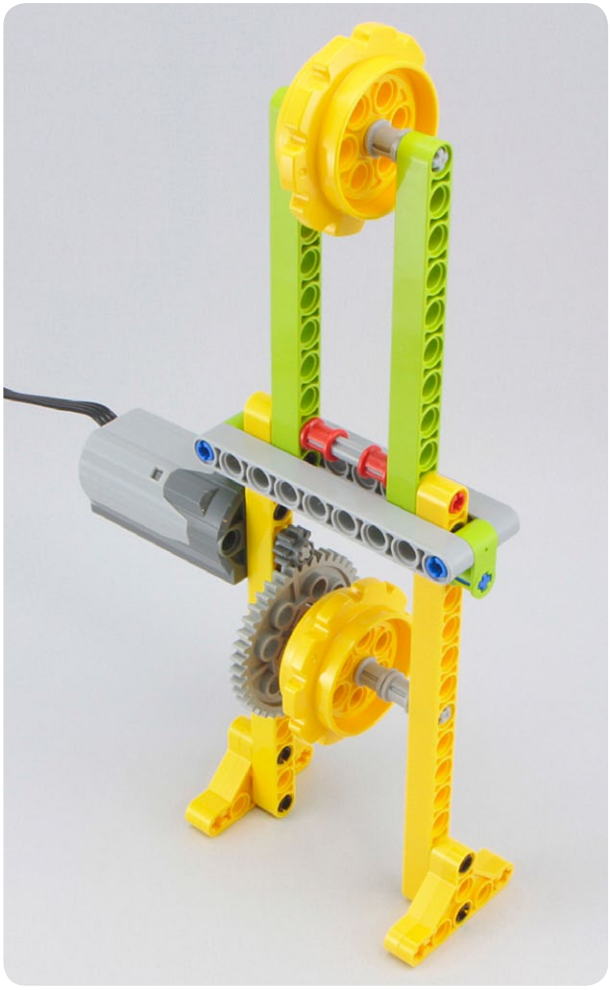

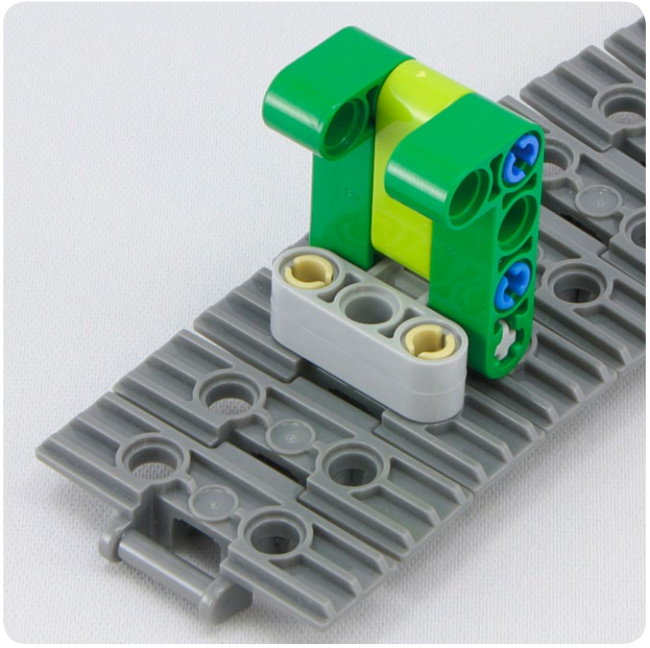

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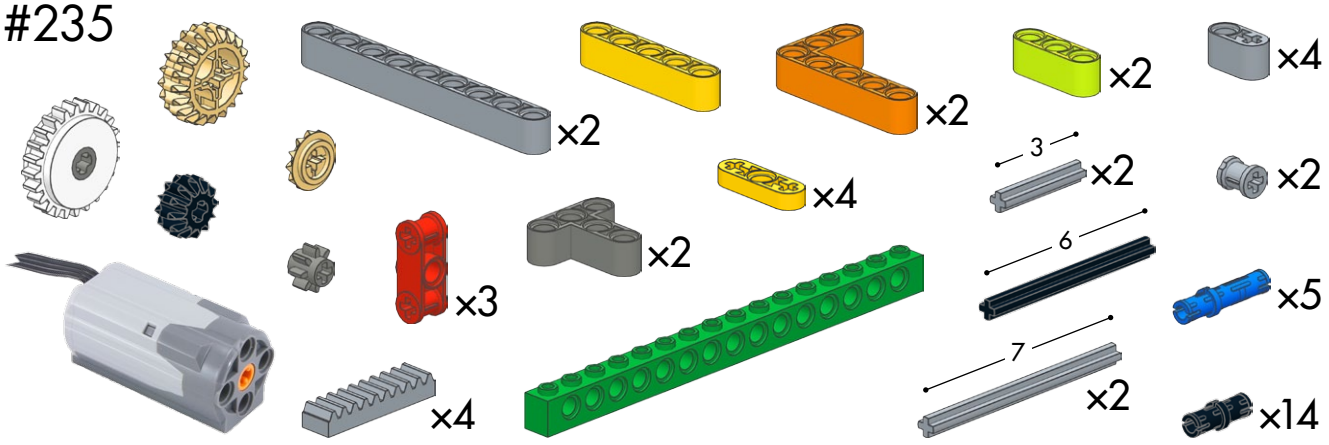

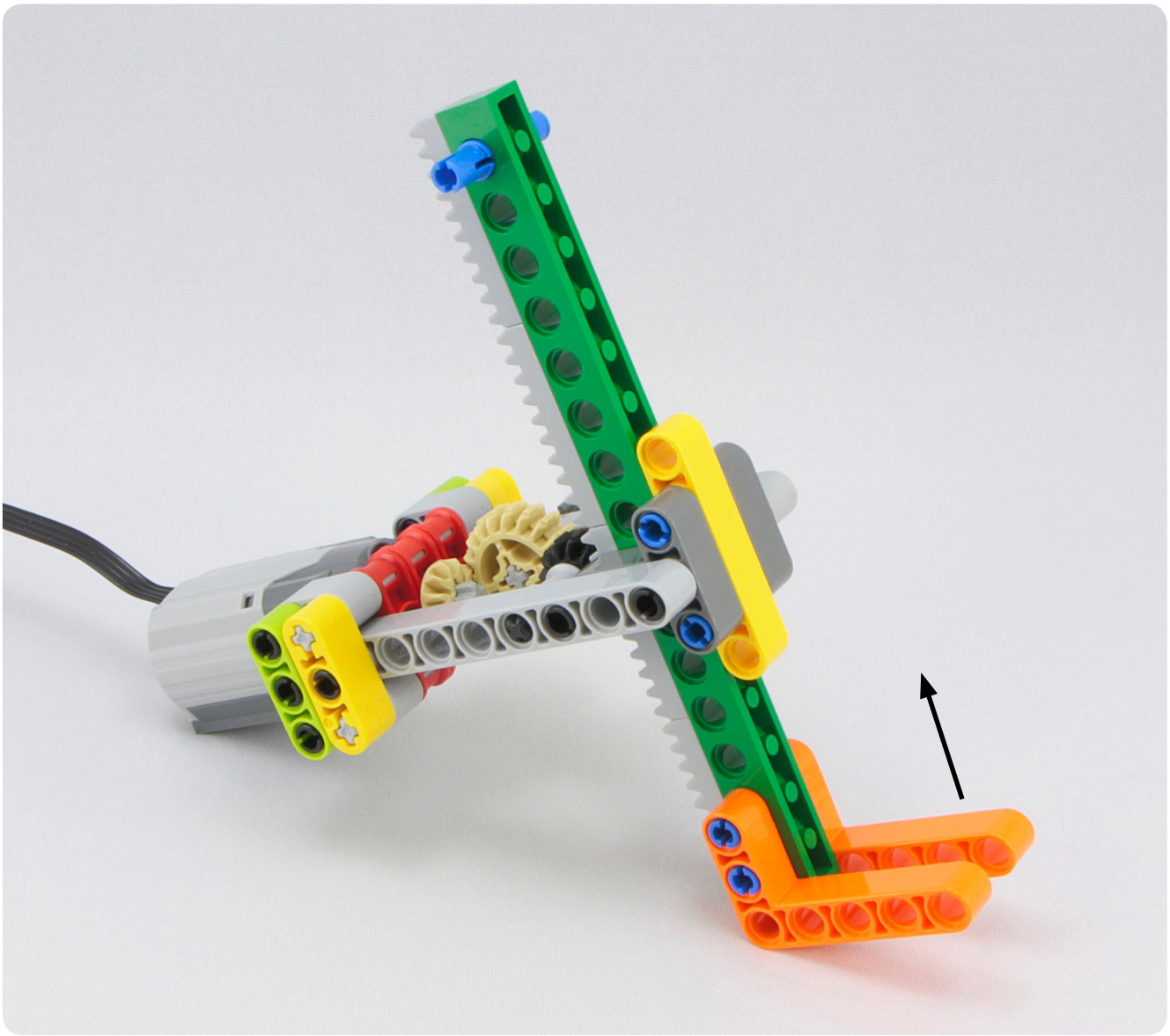

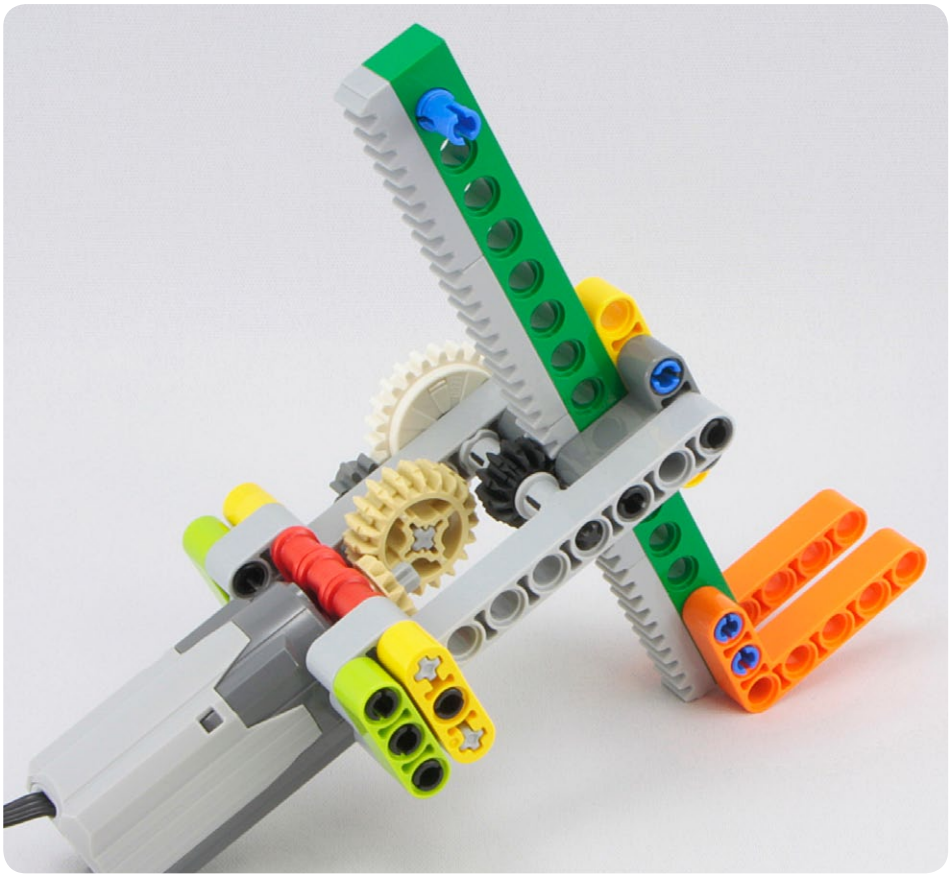

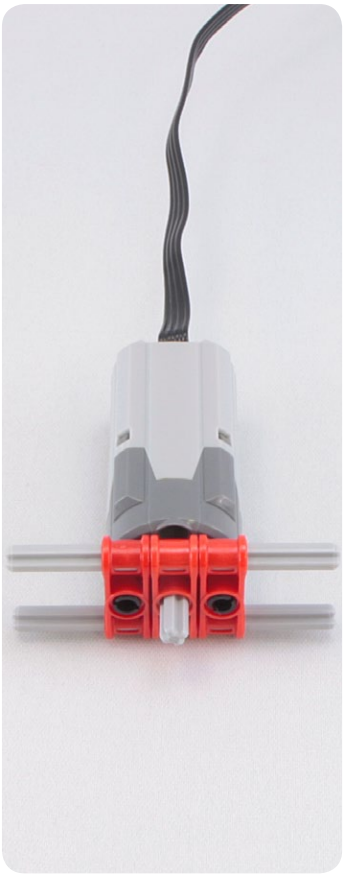

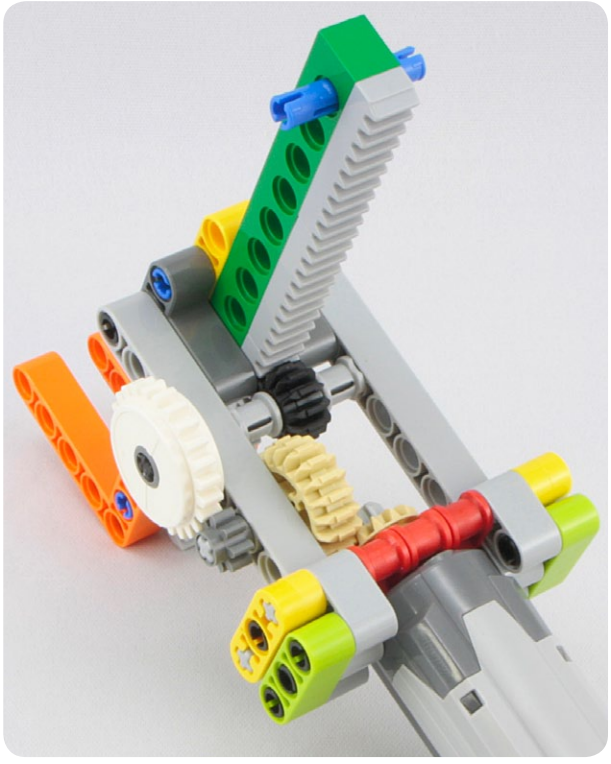

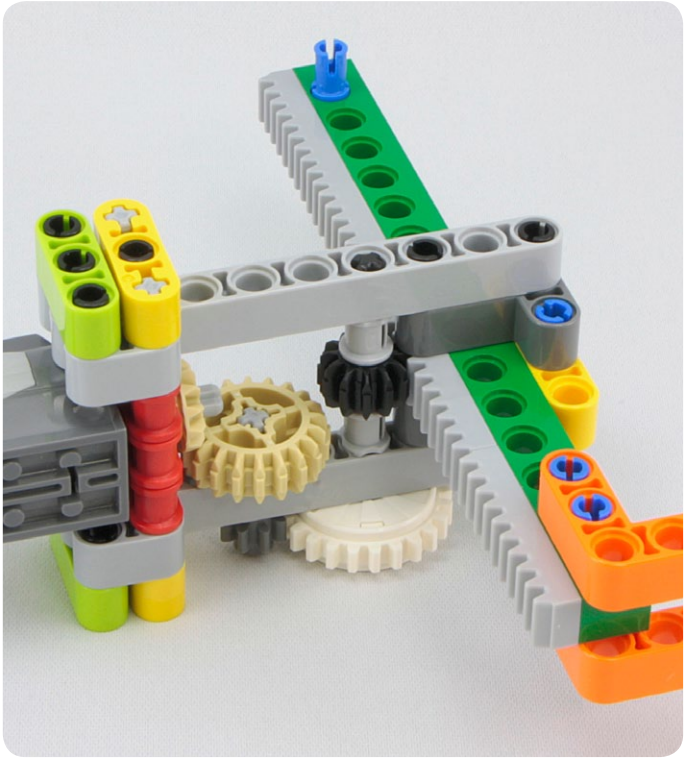

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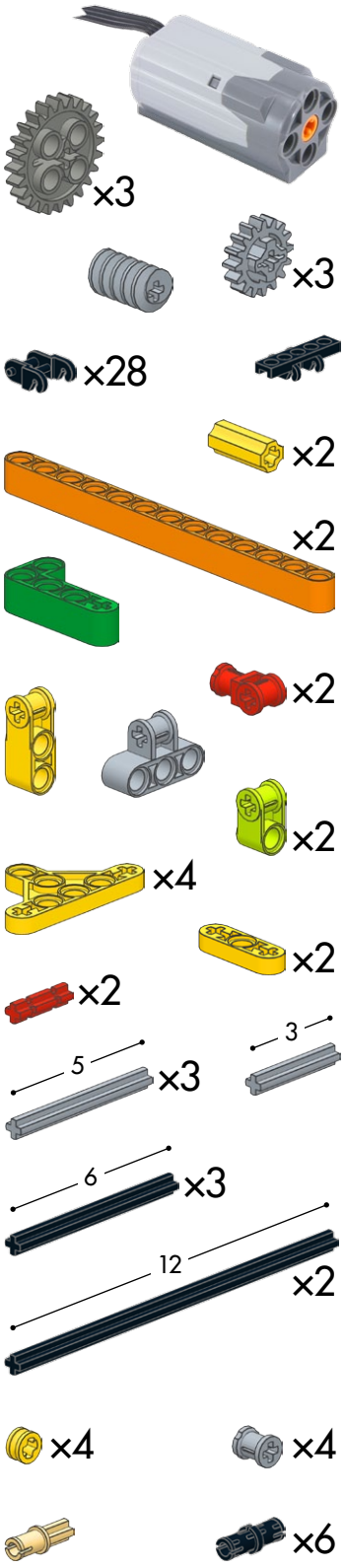

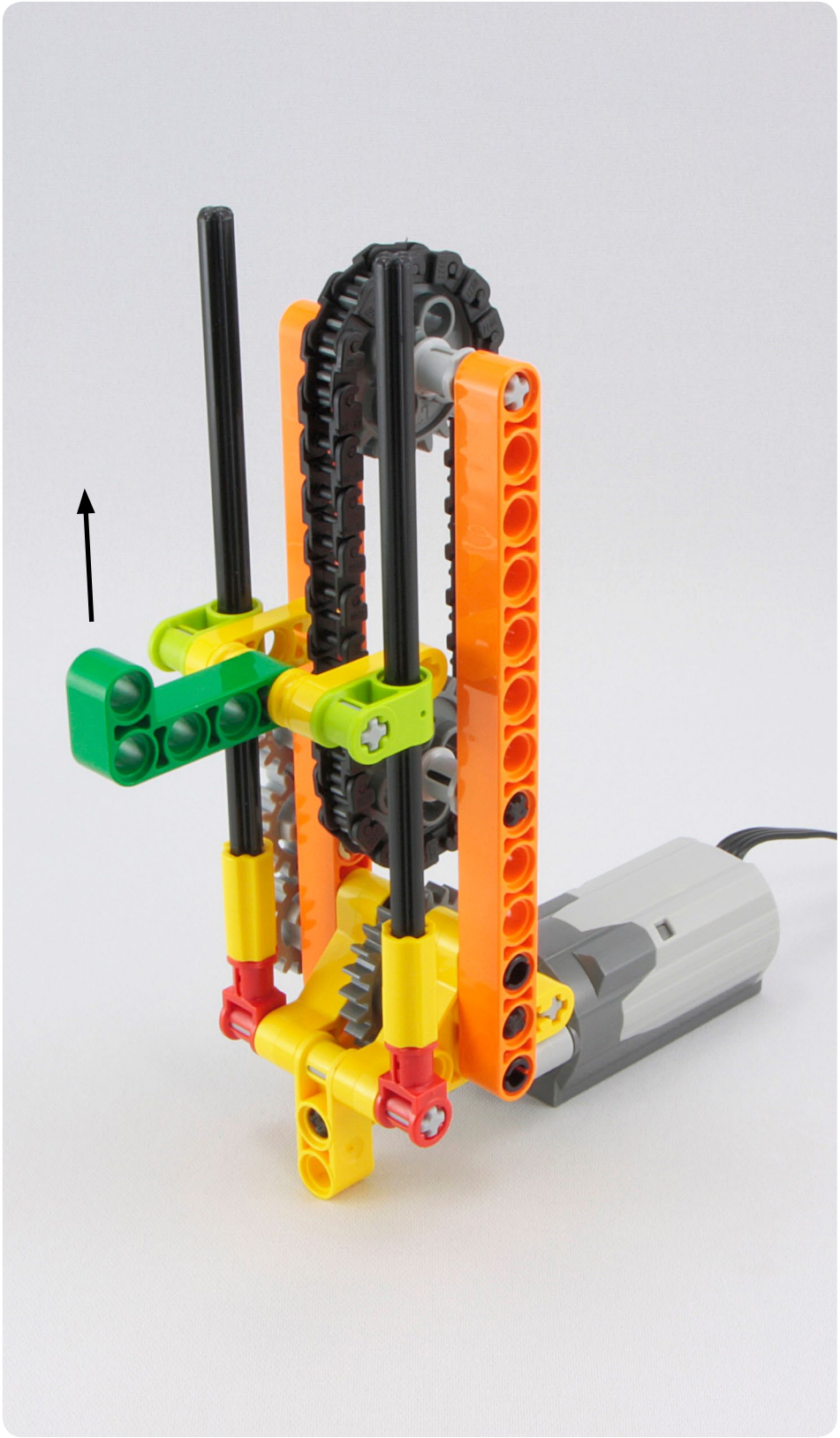

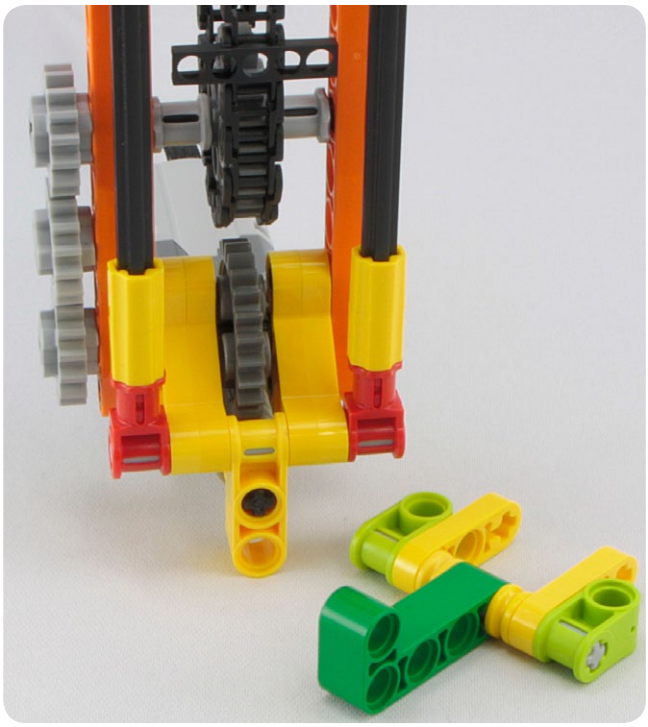

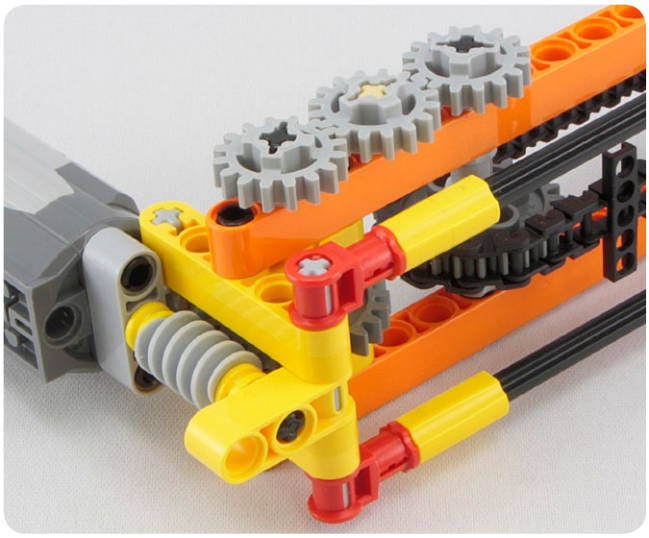

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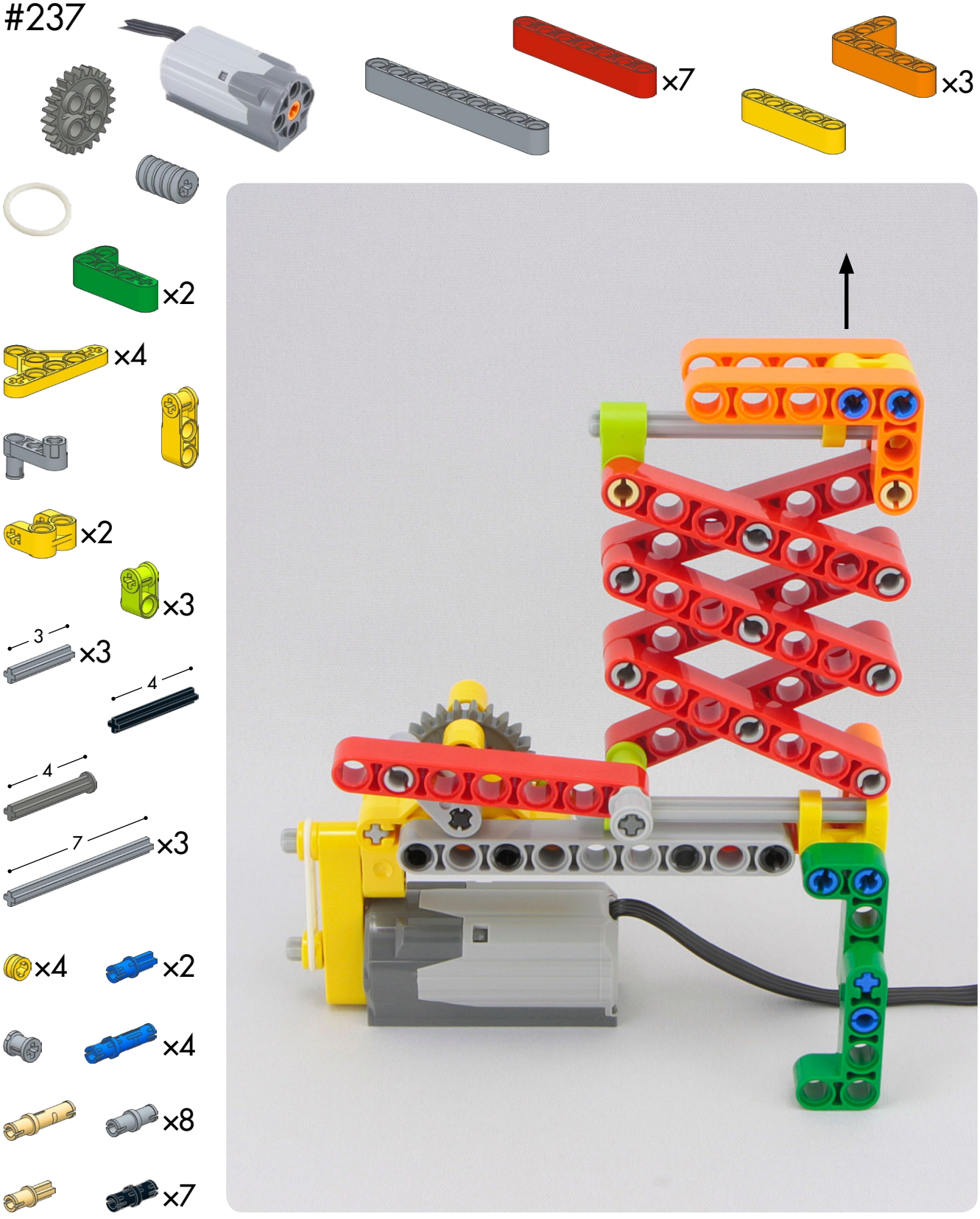
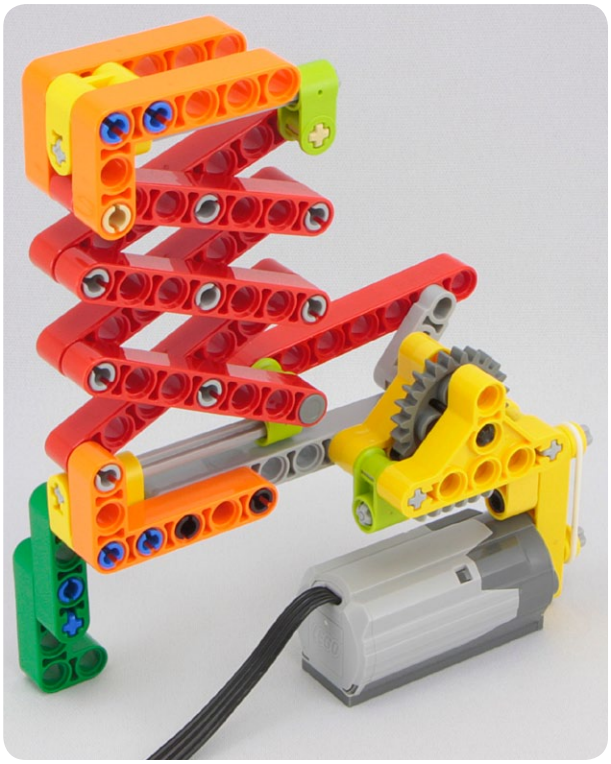
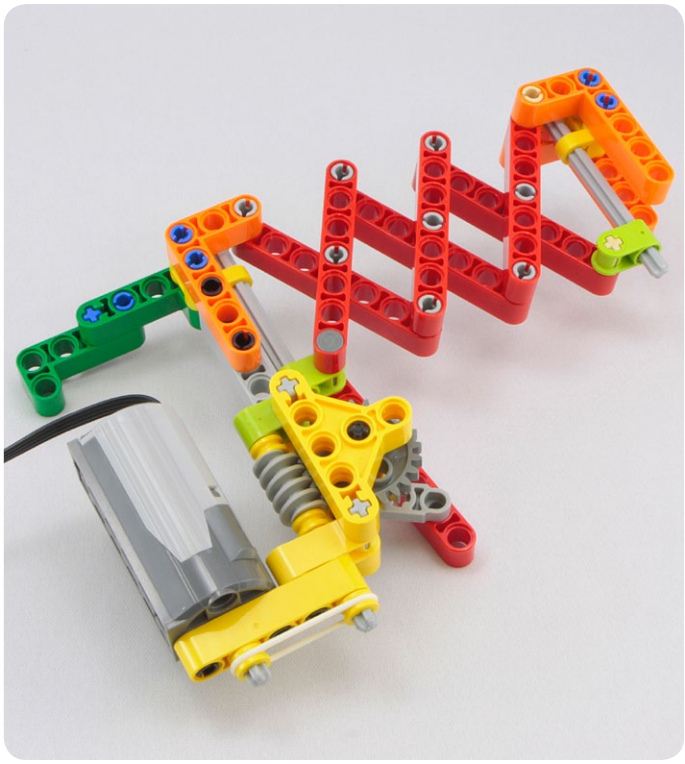
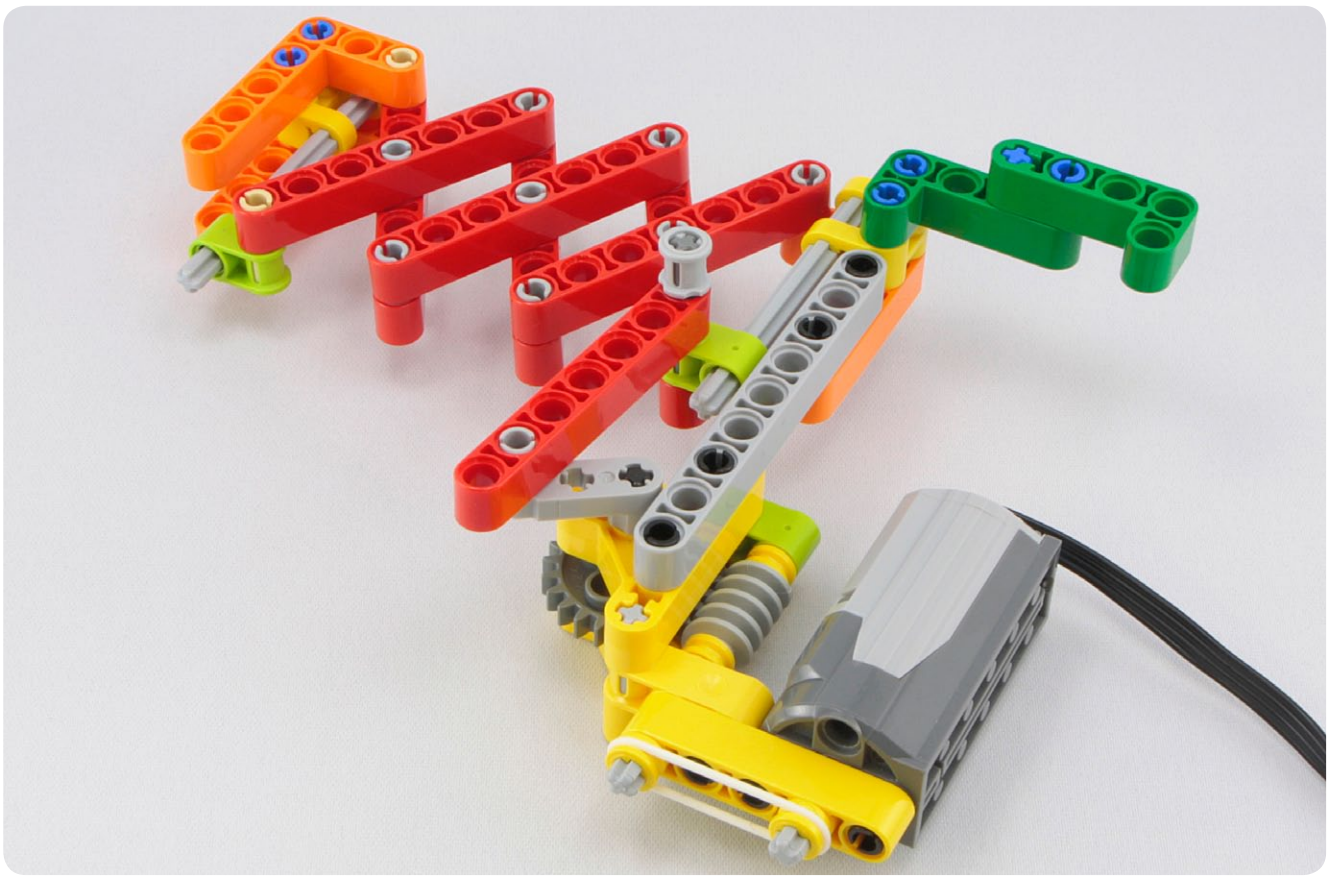


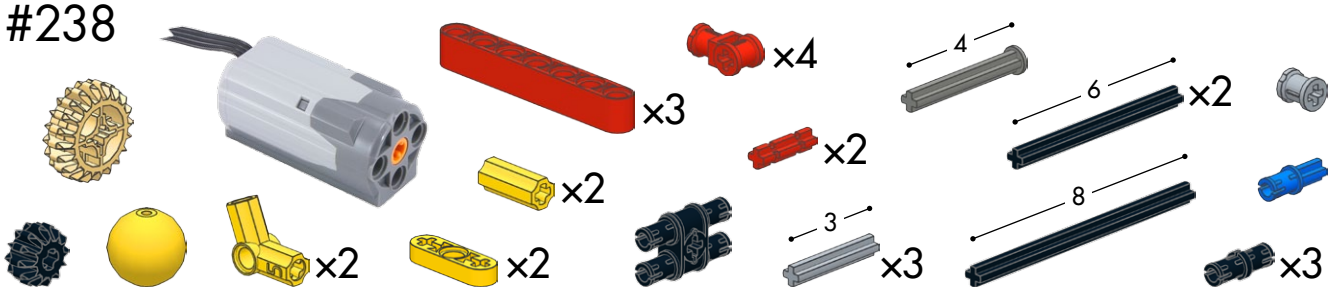


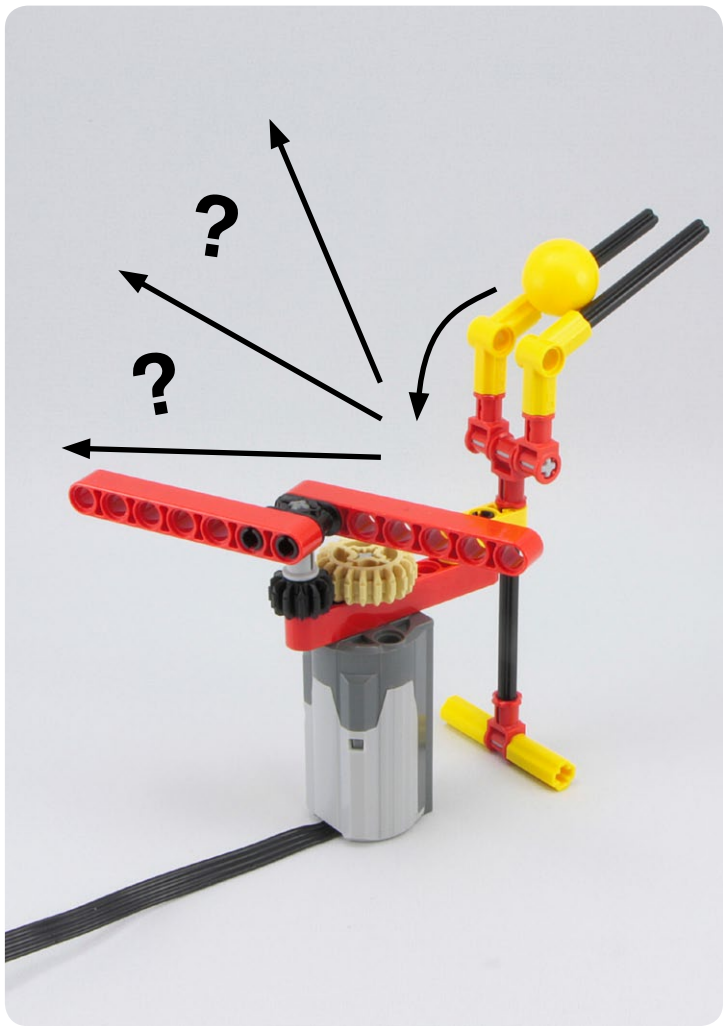




Shooting things

#238





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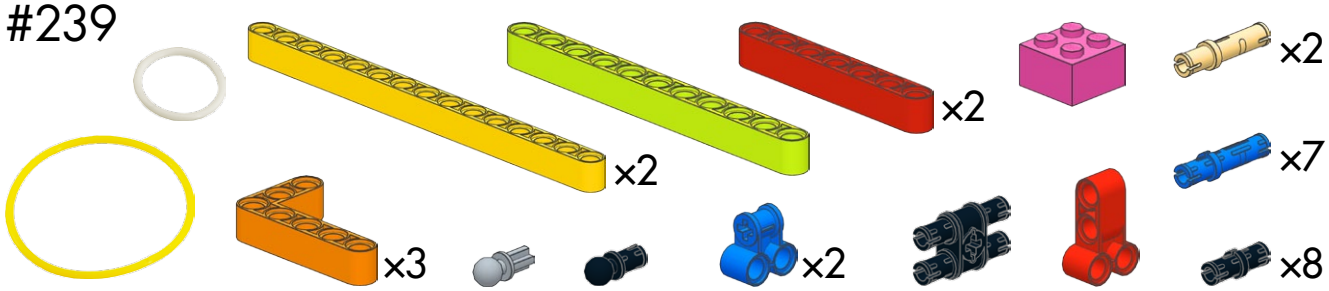

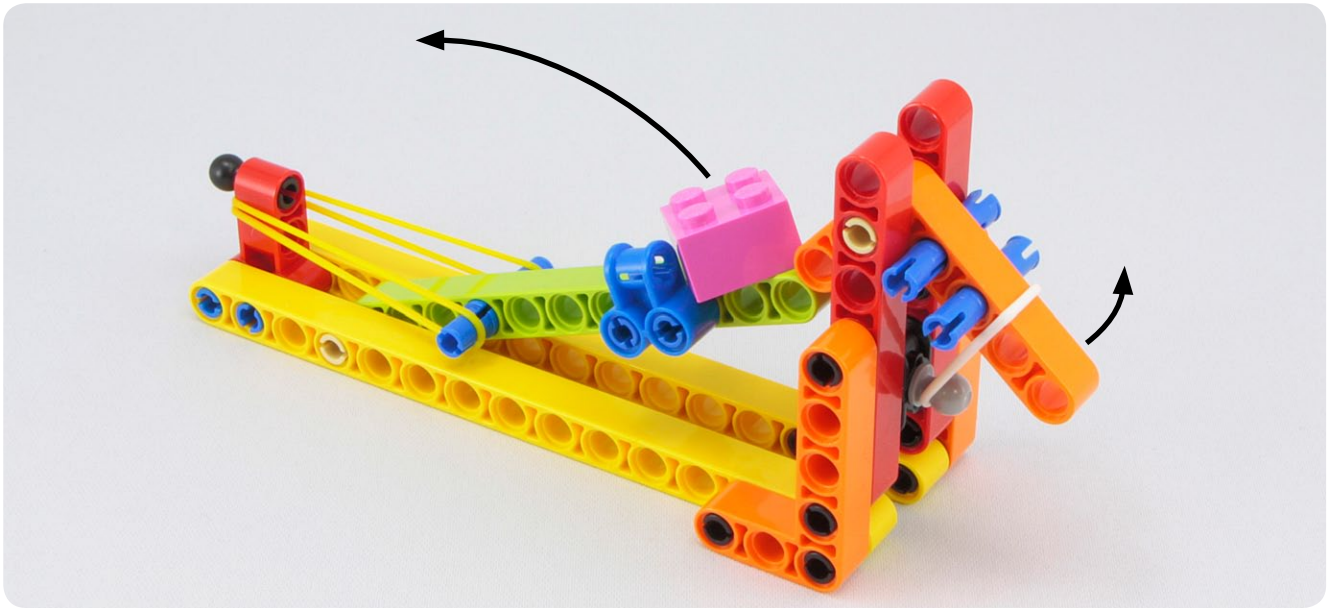

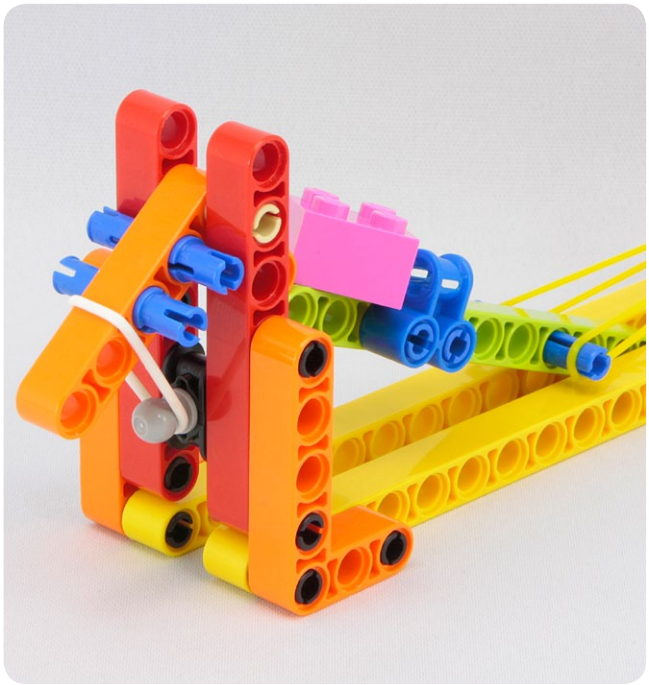

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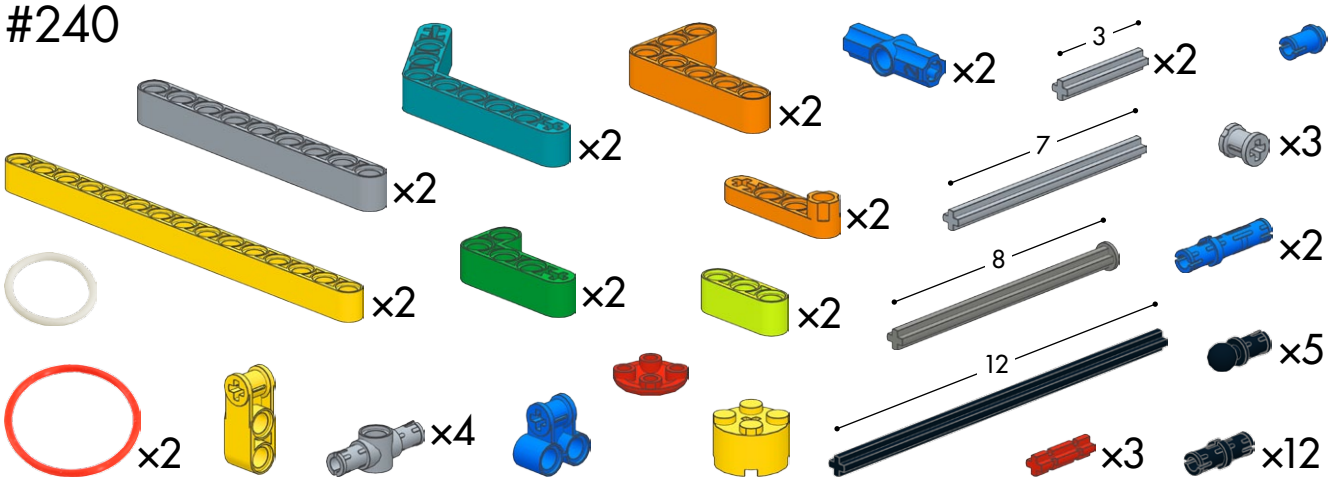

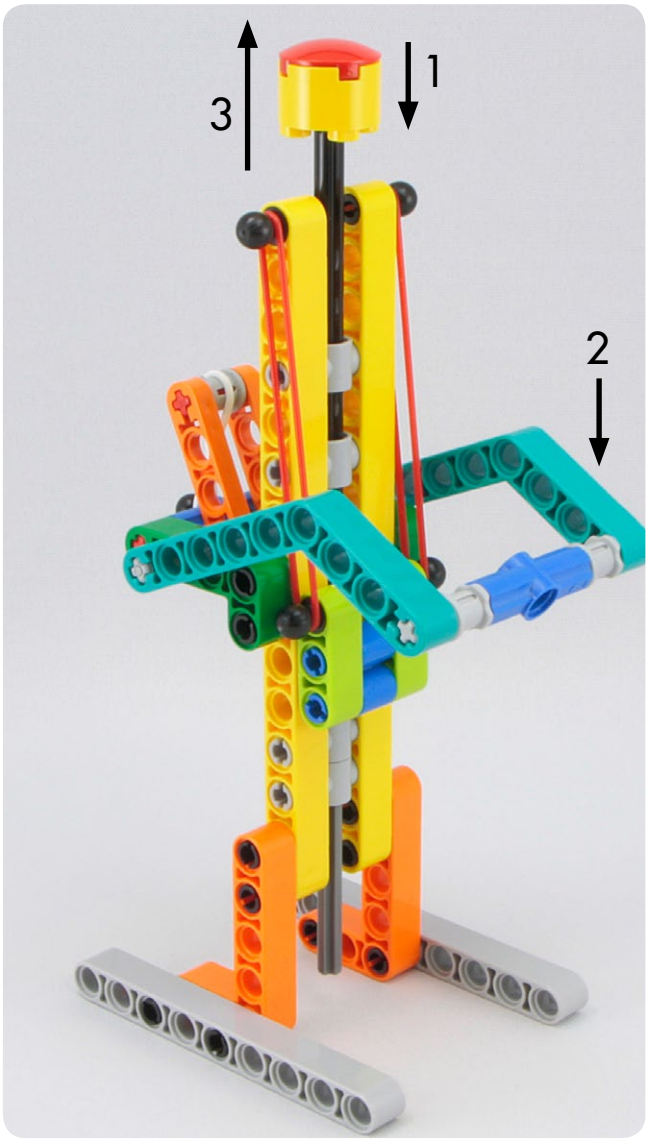

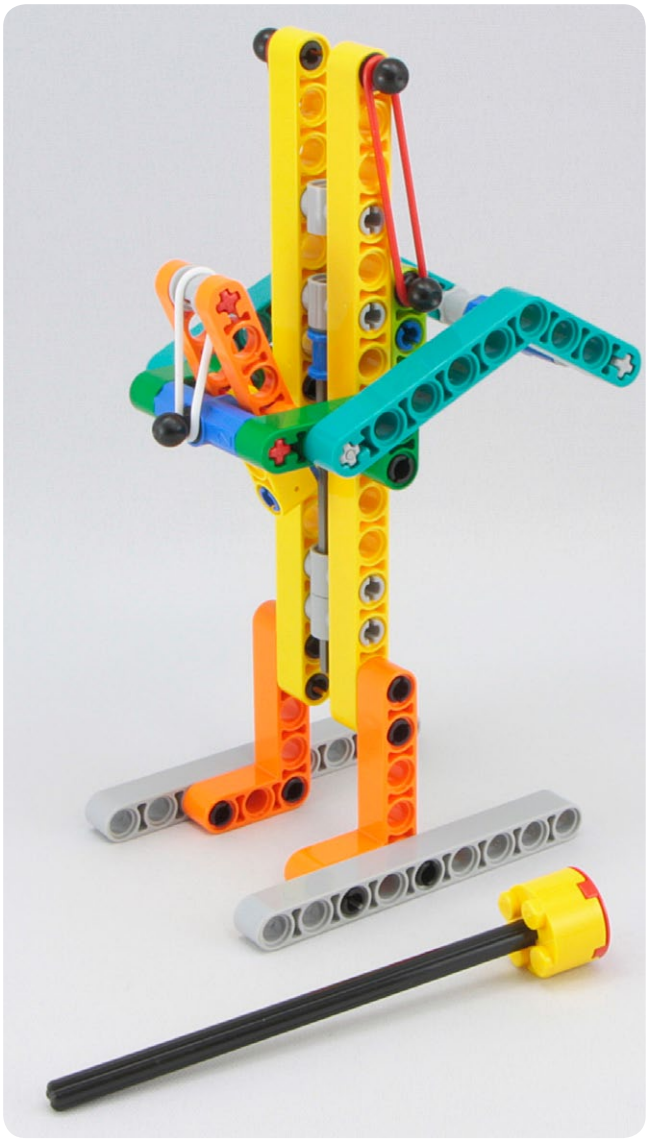

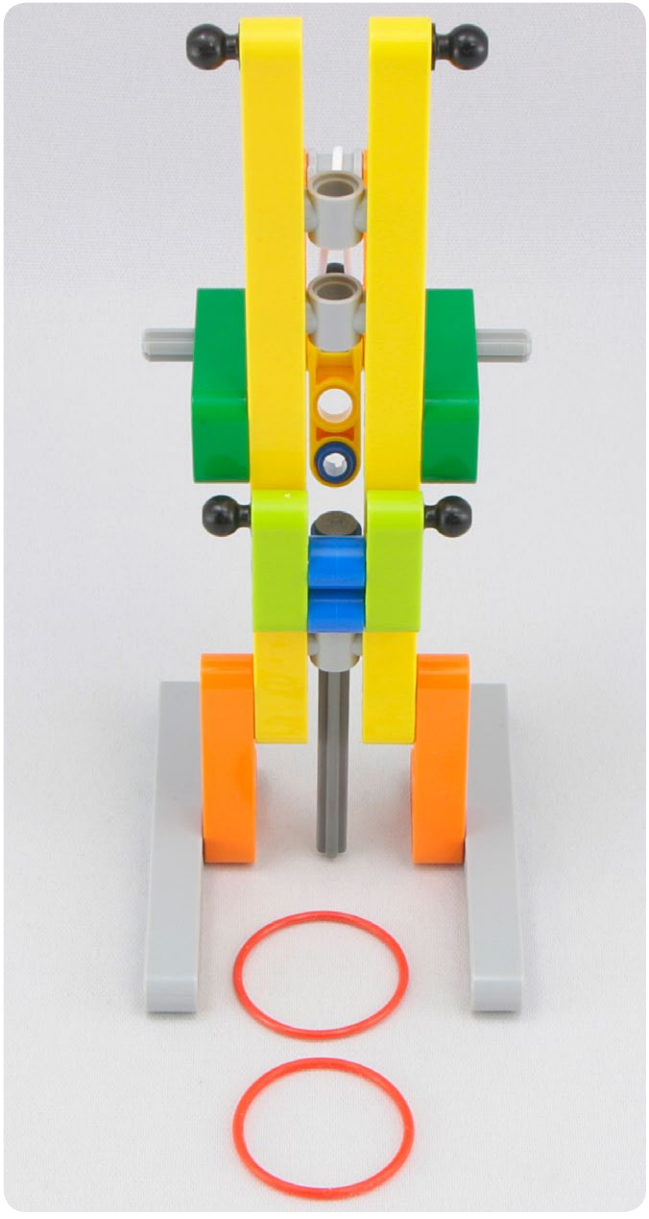

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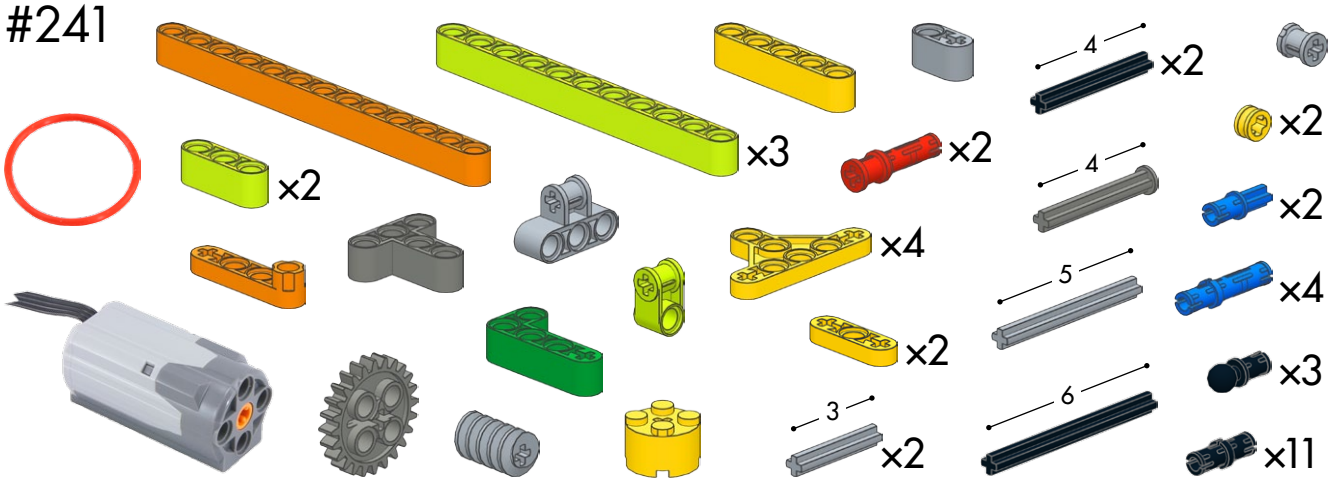

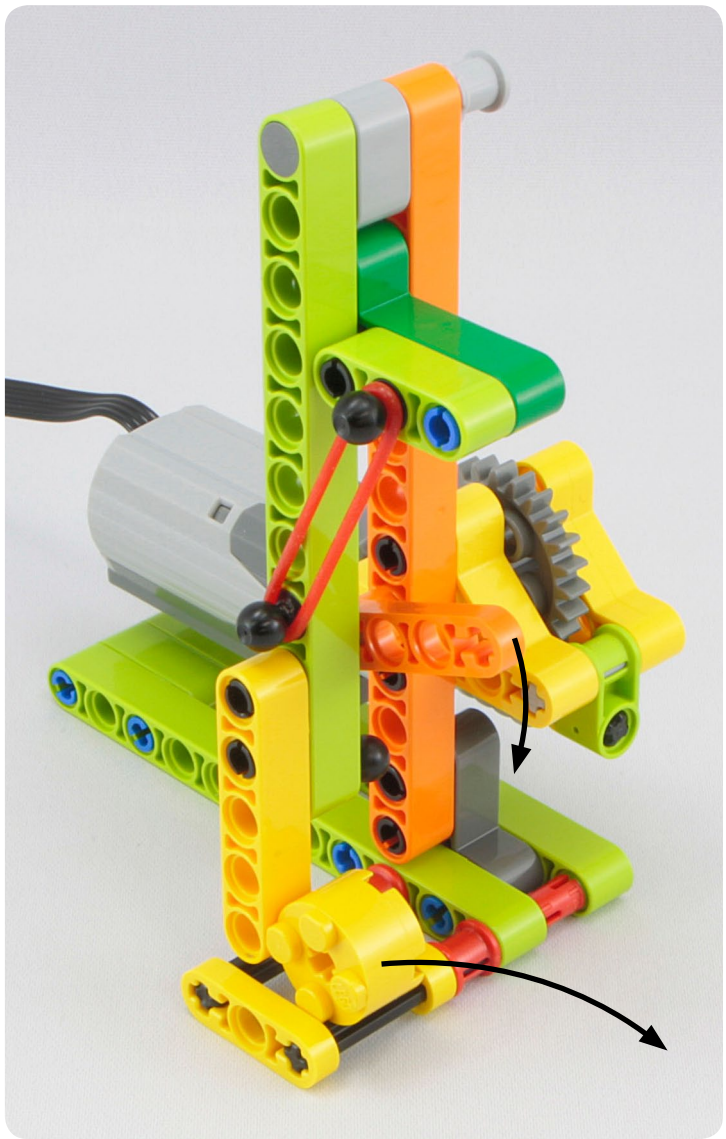

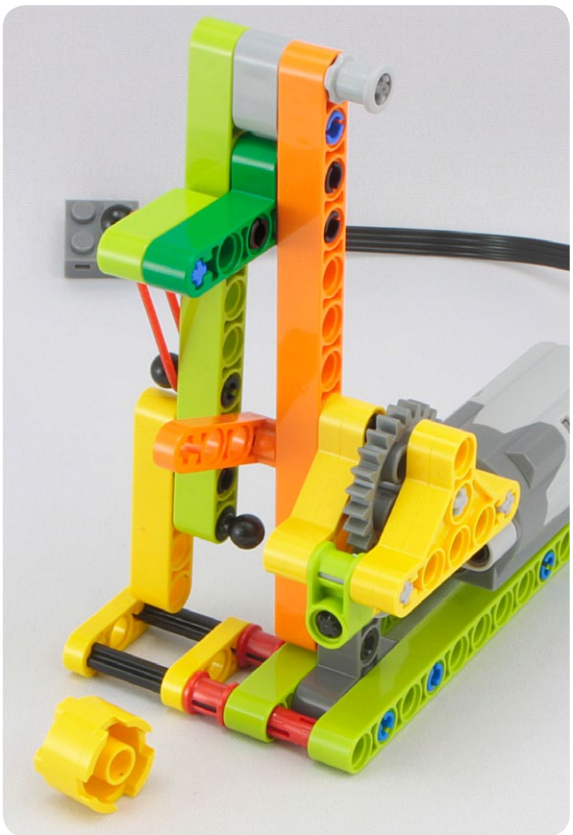

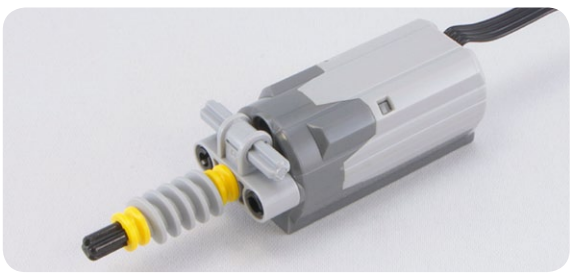

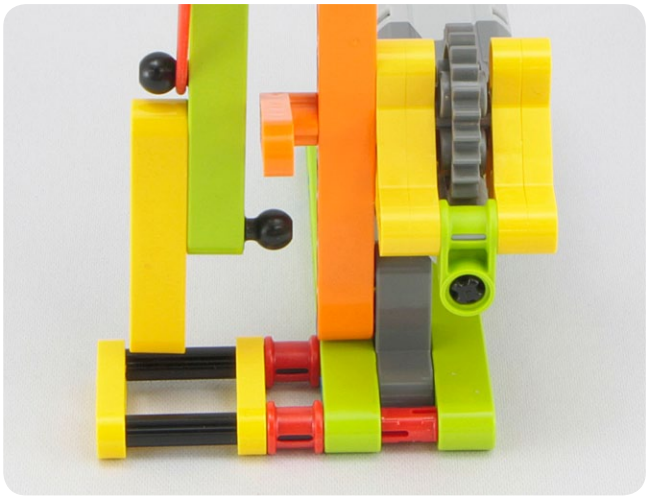

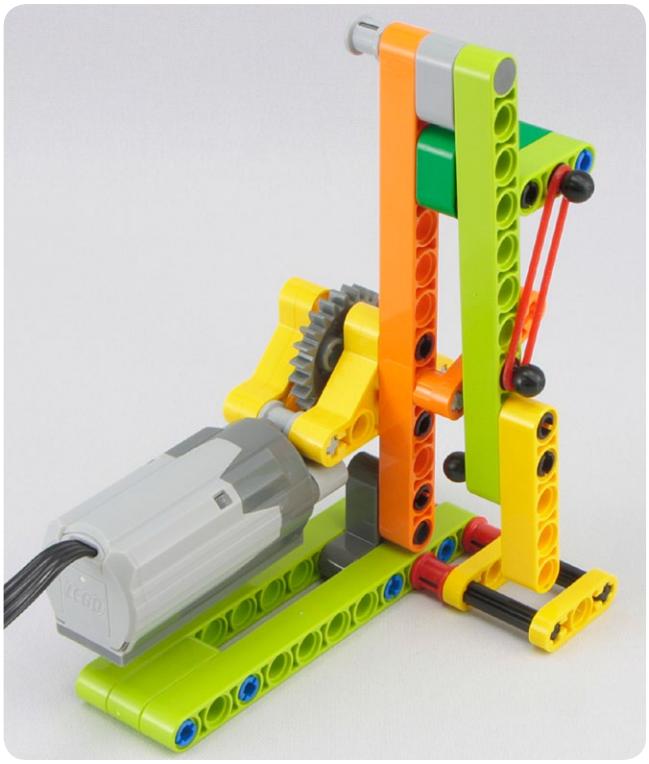

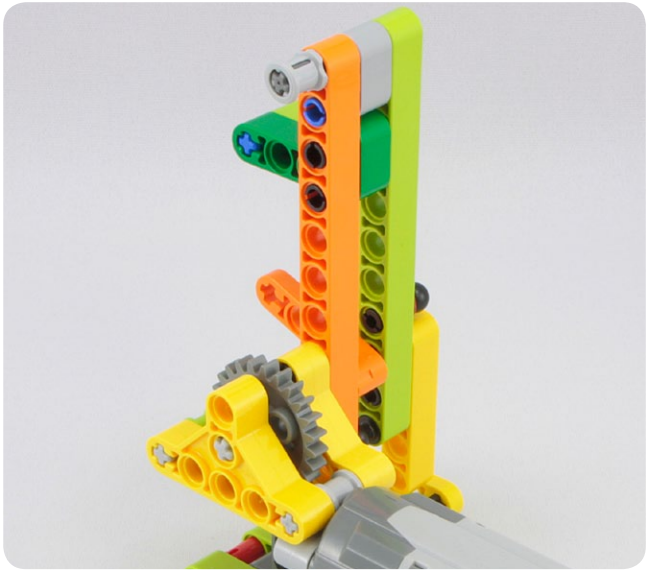

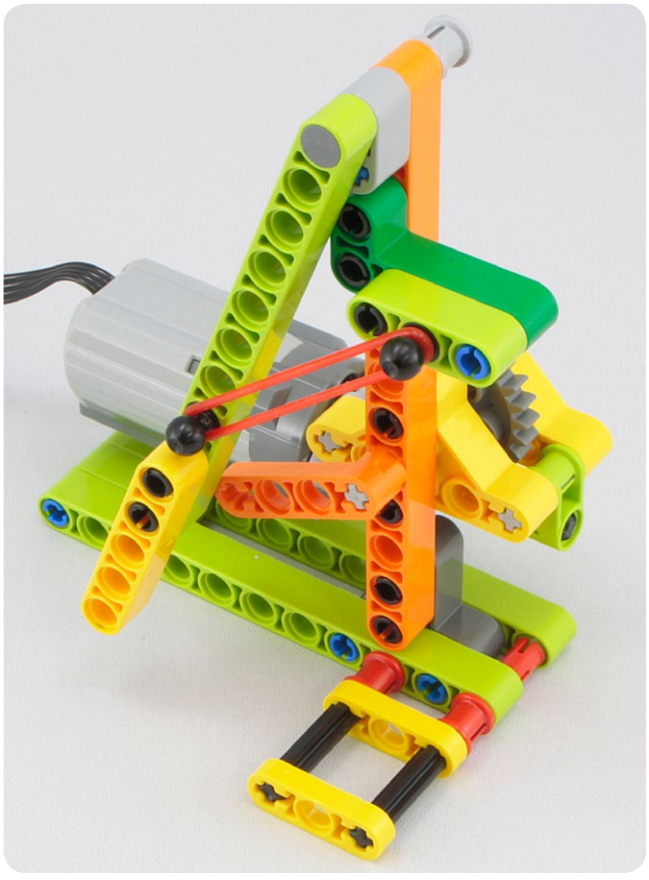

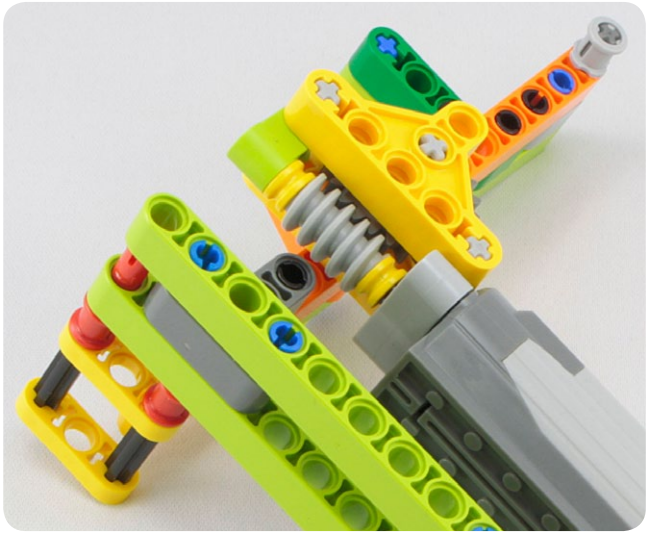

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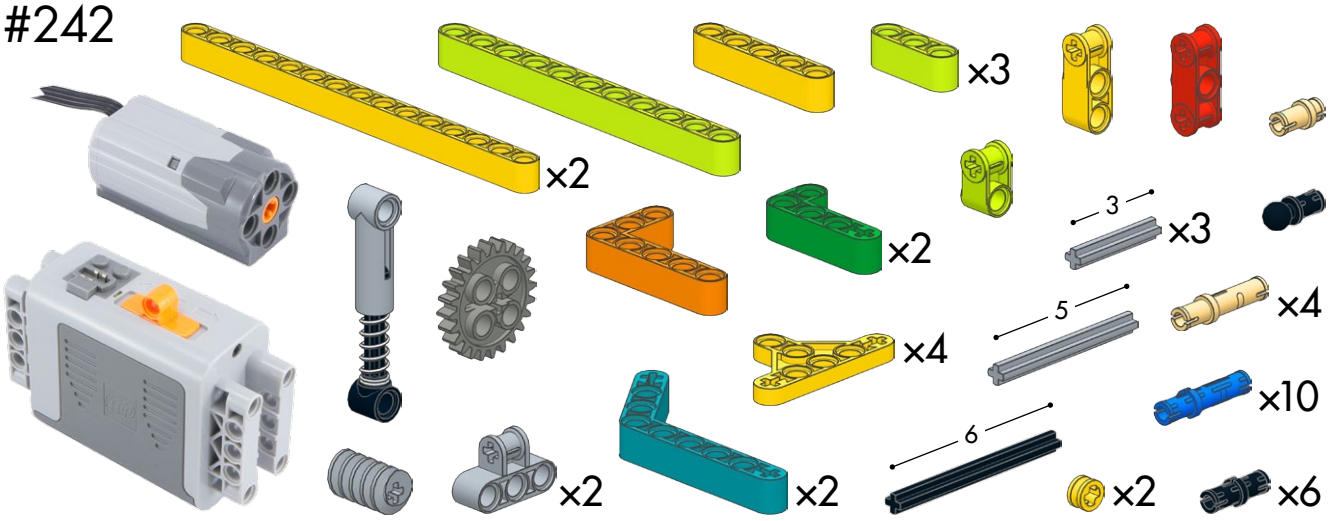

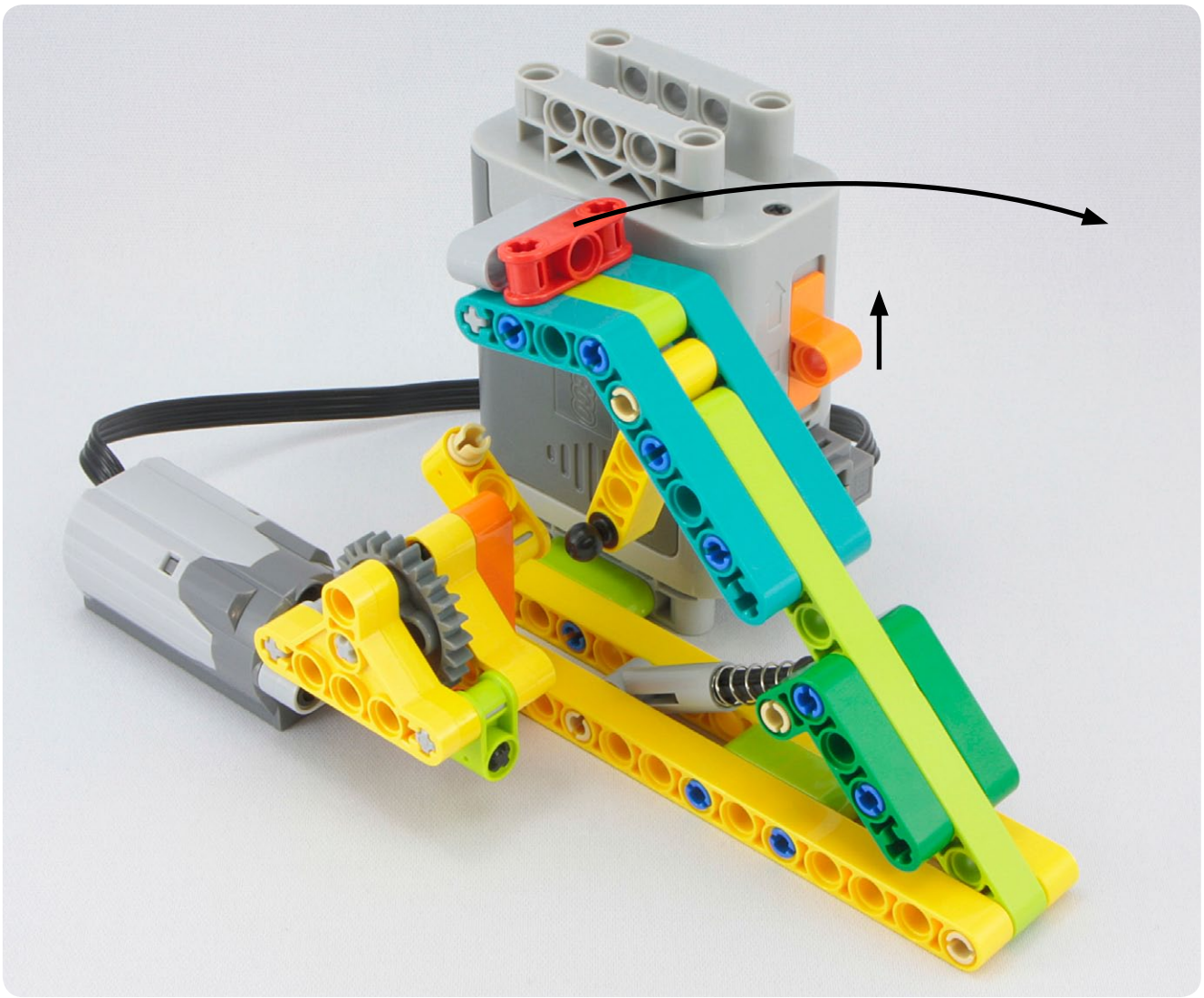

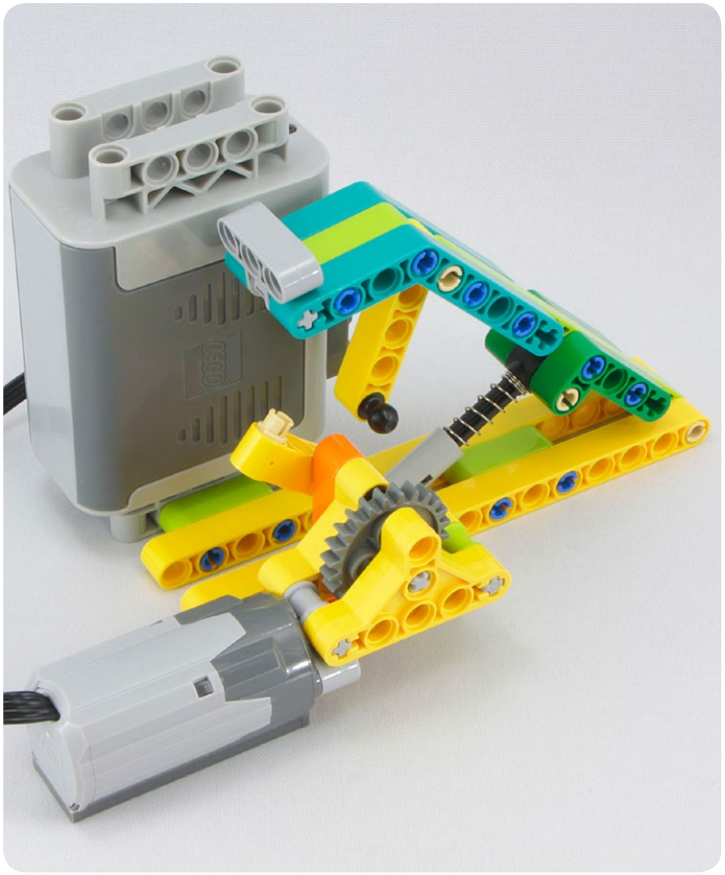

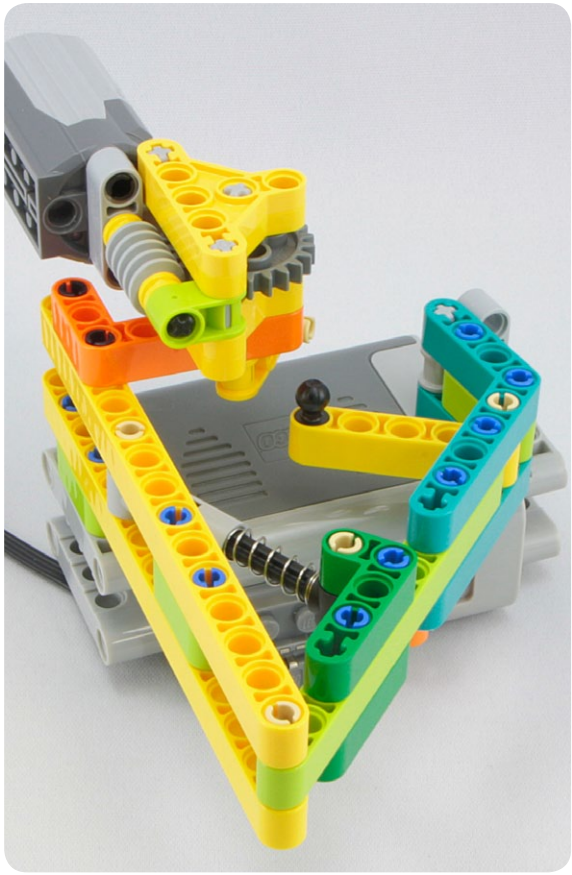

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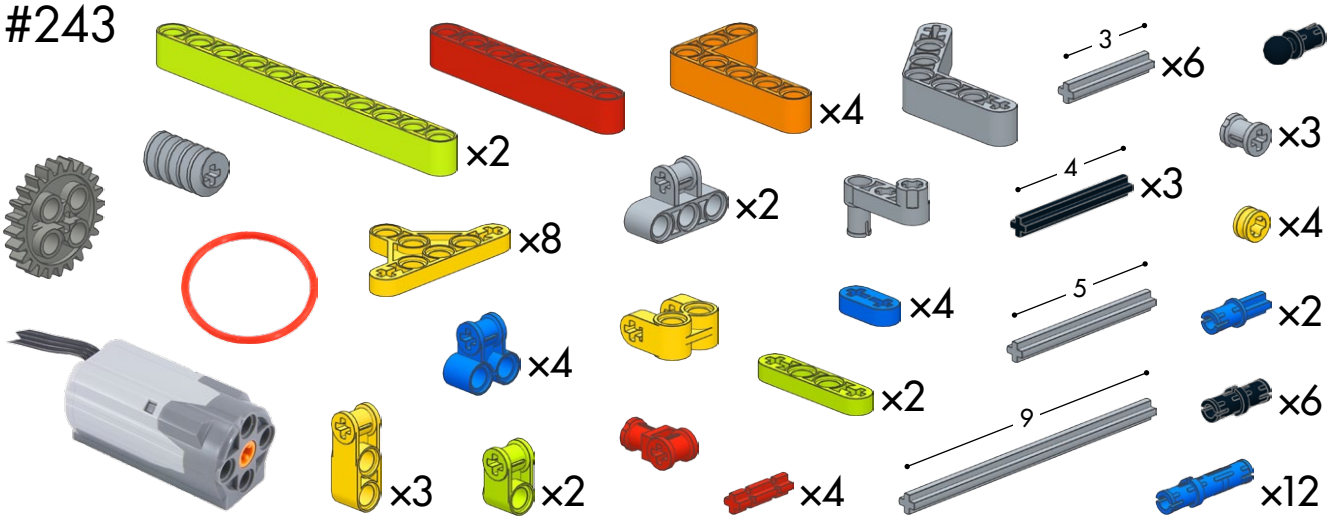
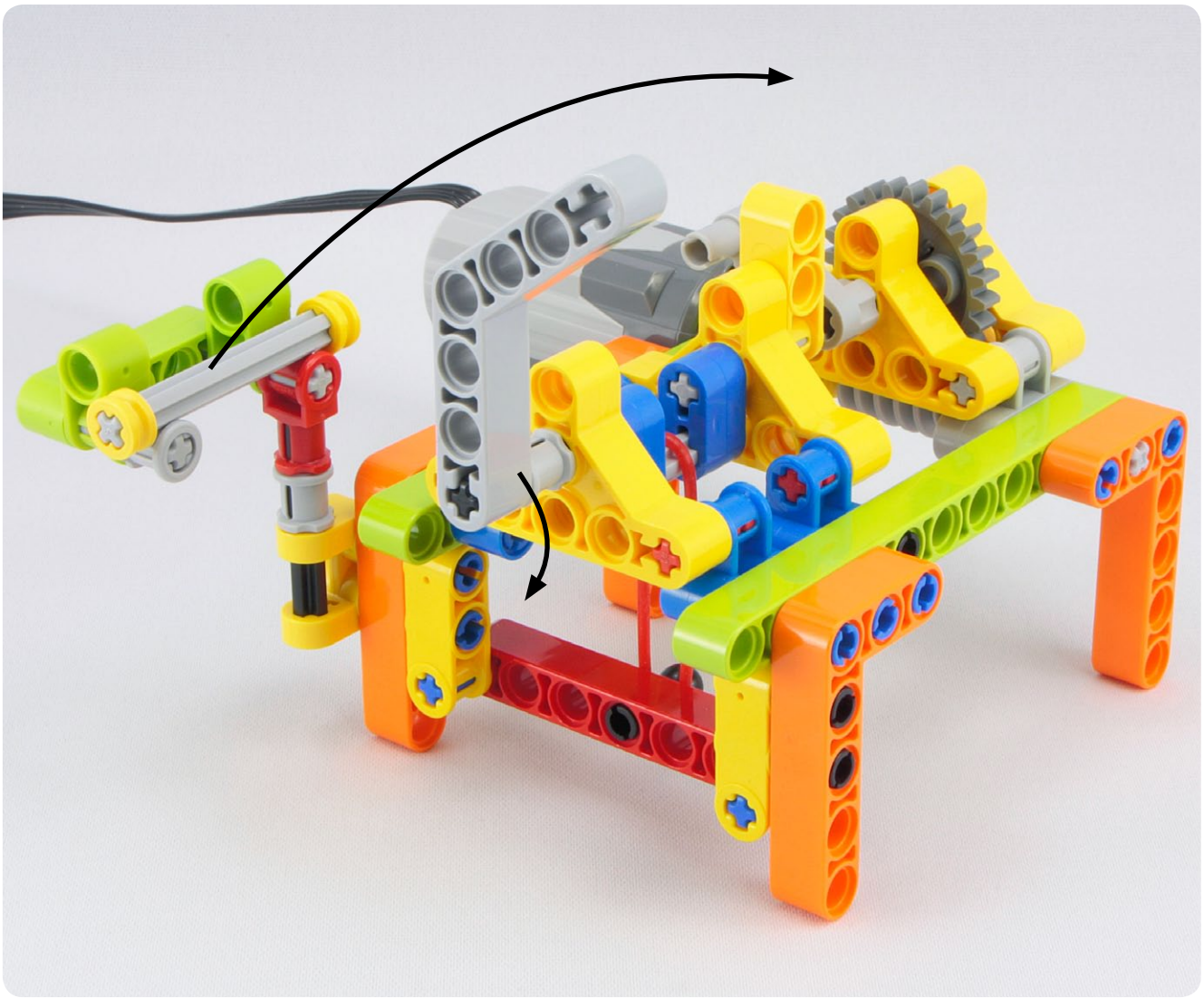
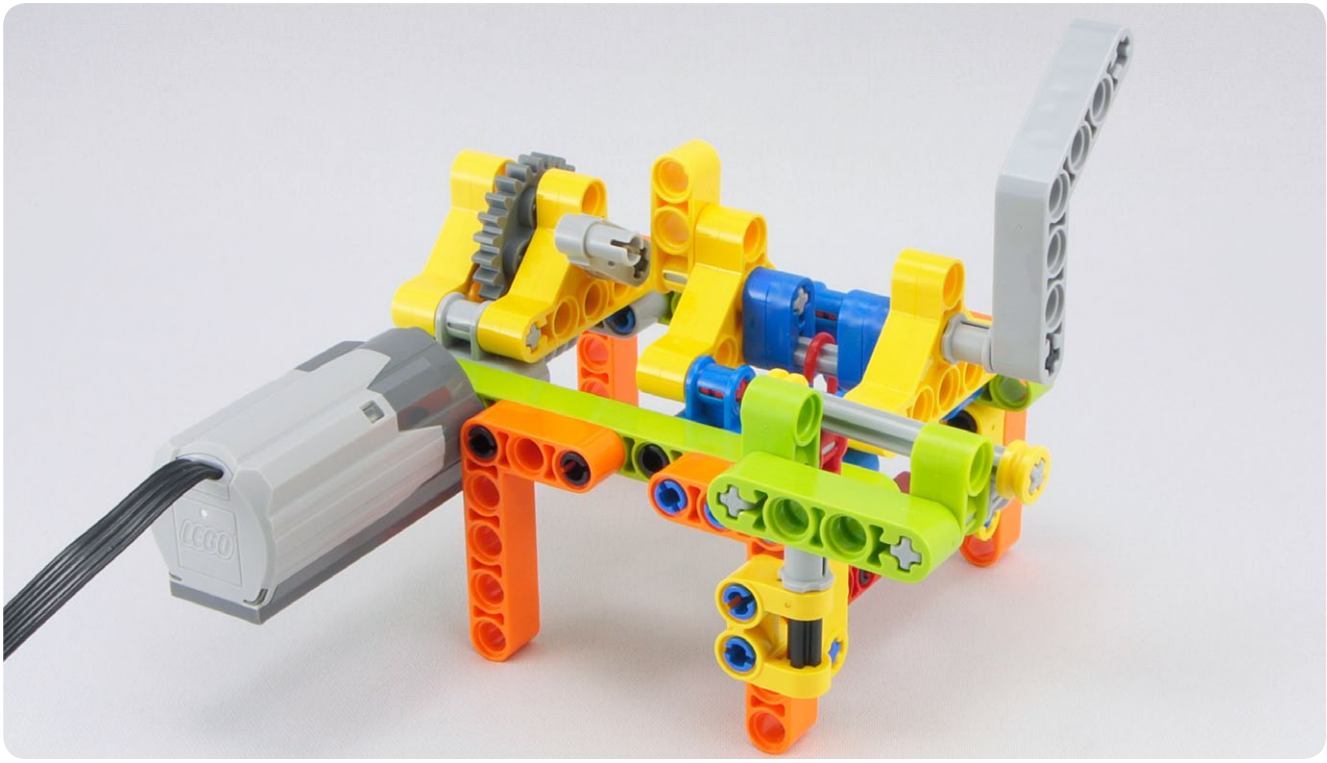
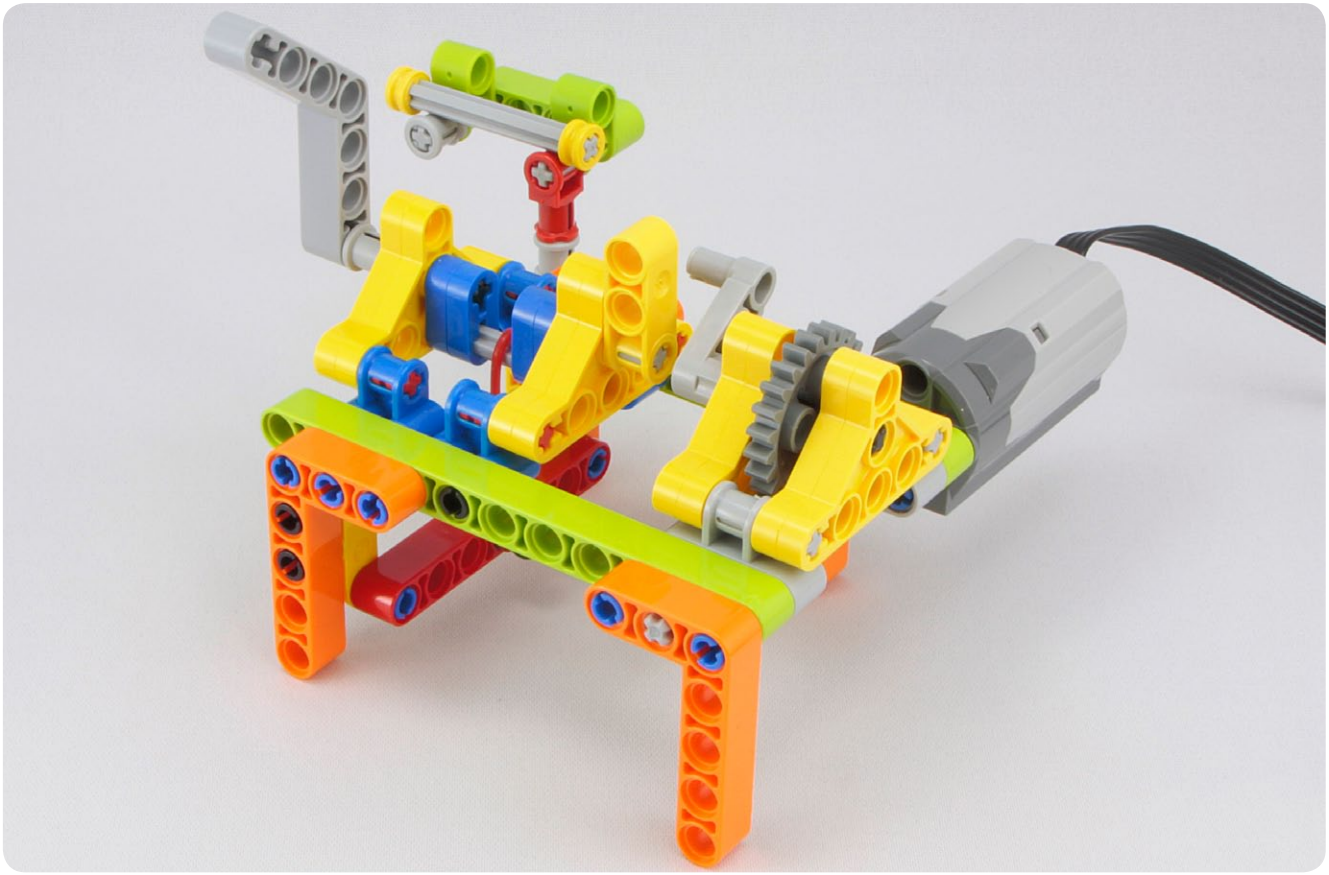
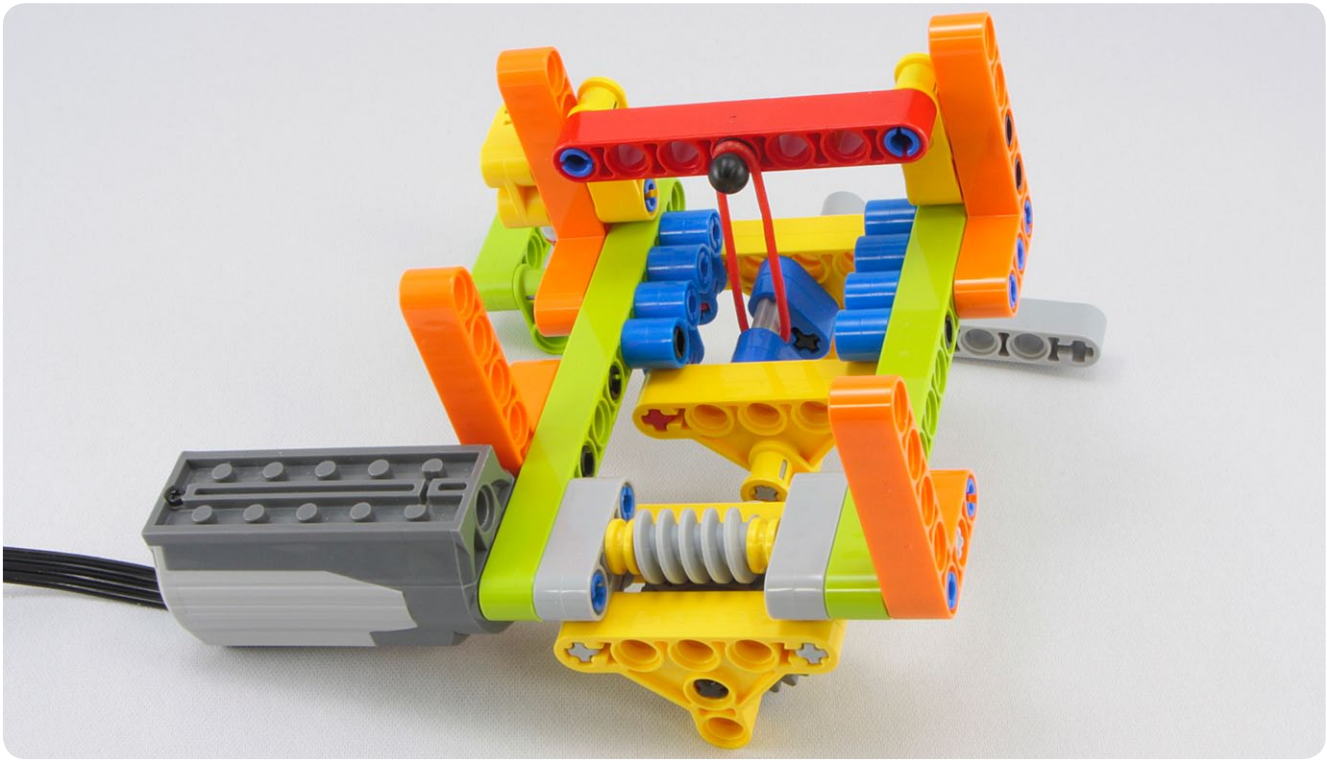
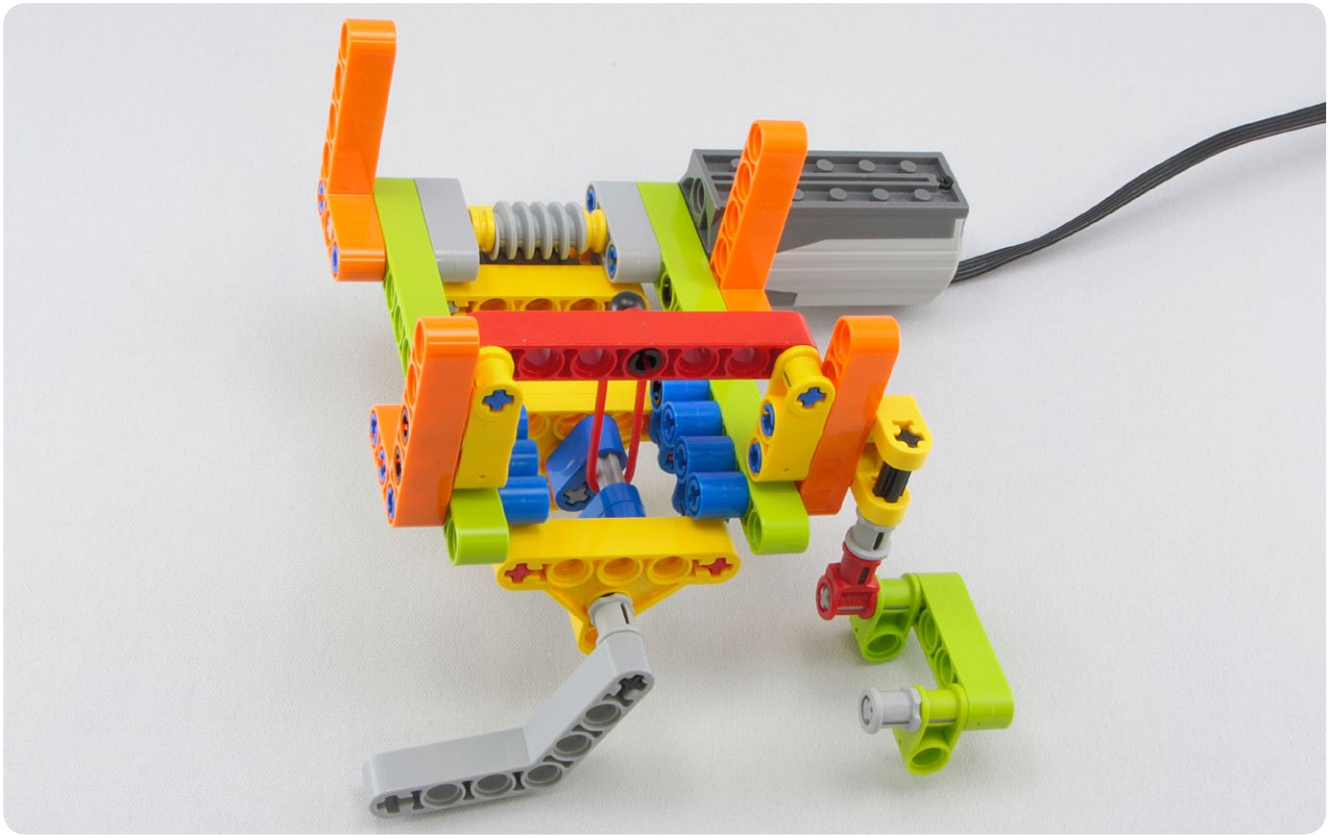


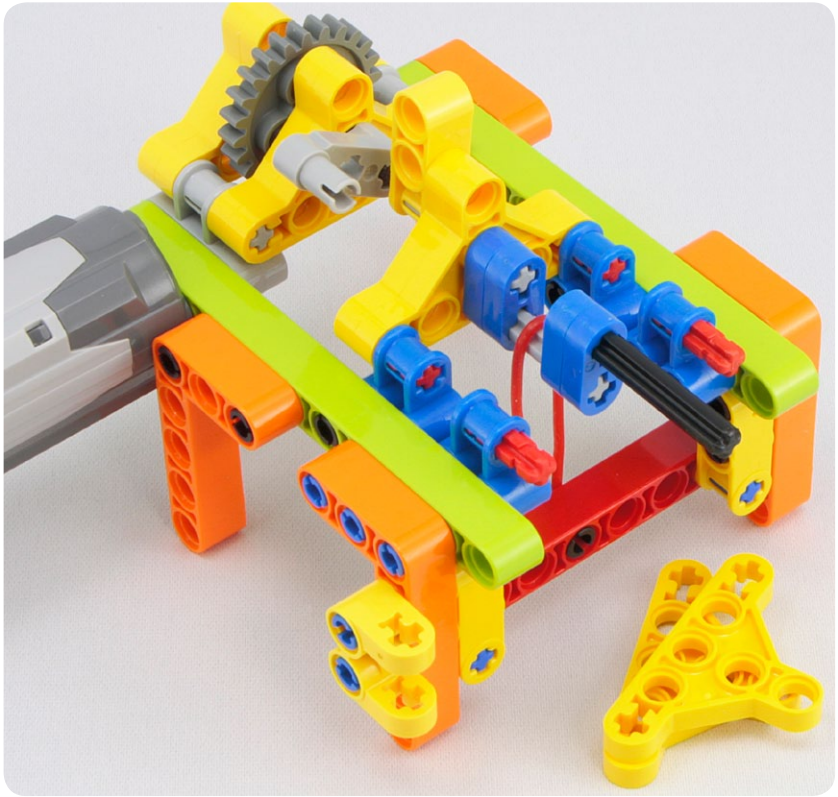


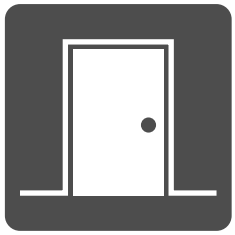






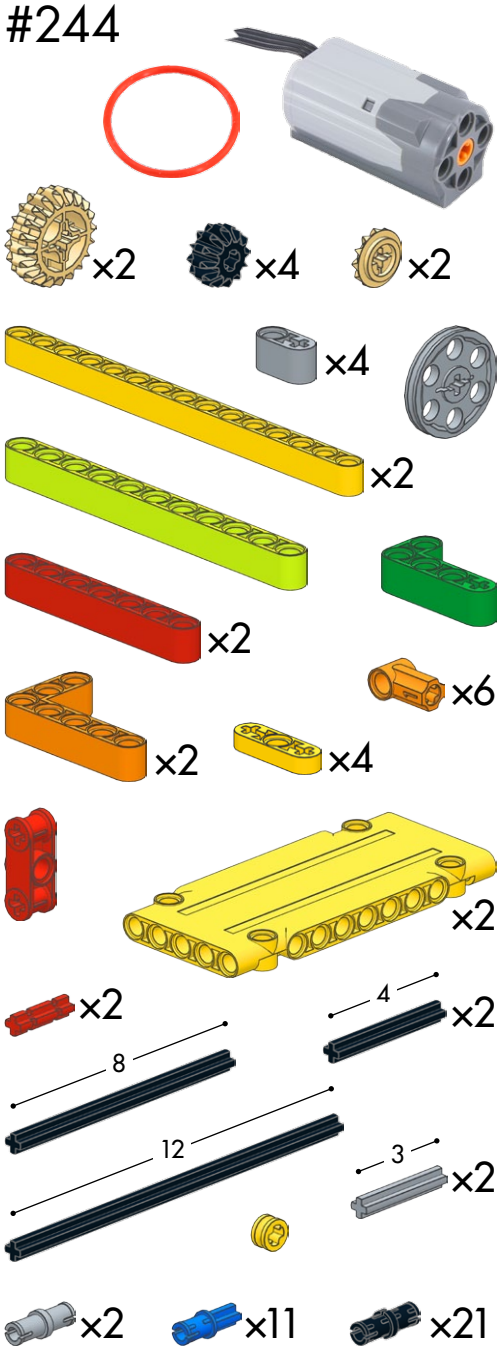


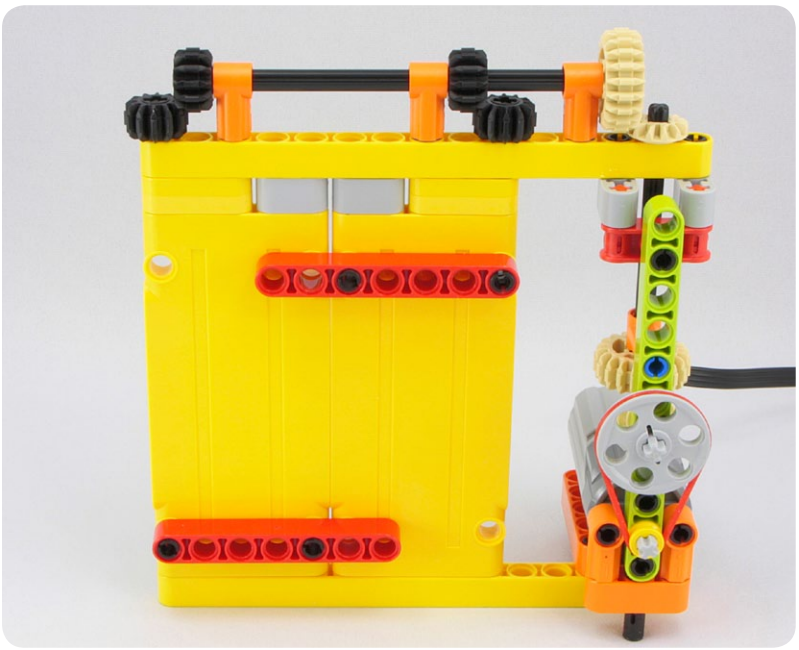


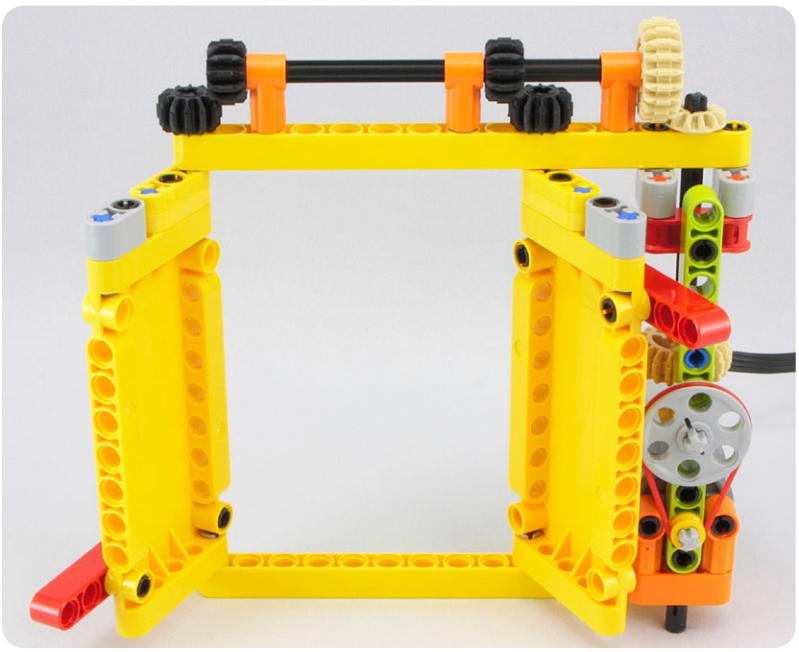


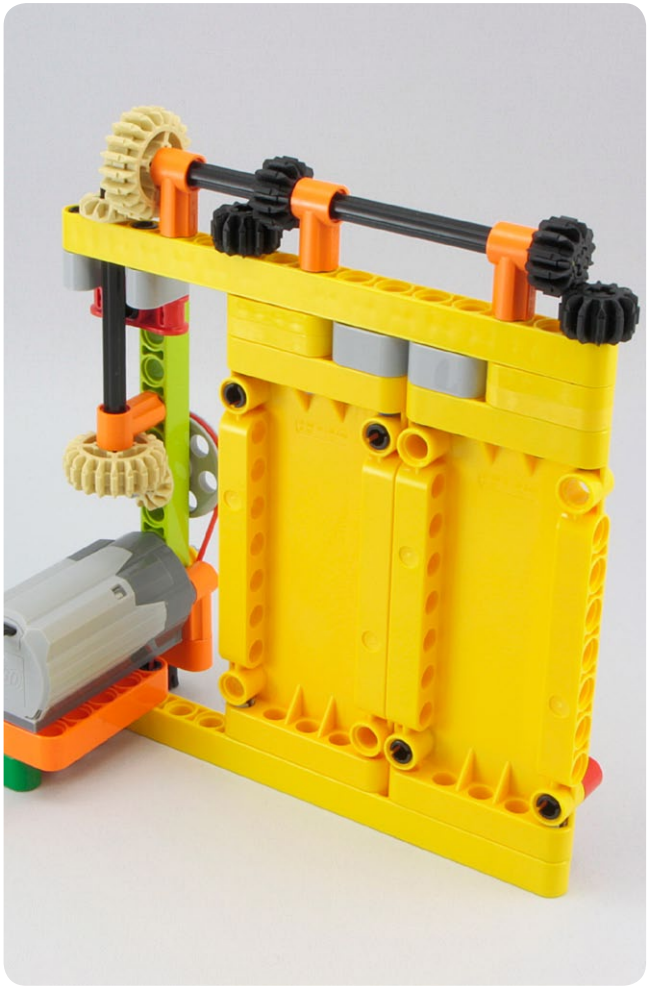
Automatic doors

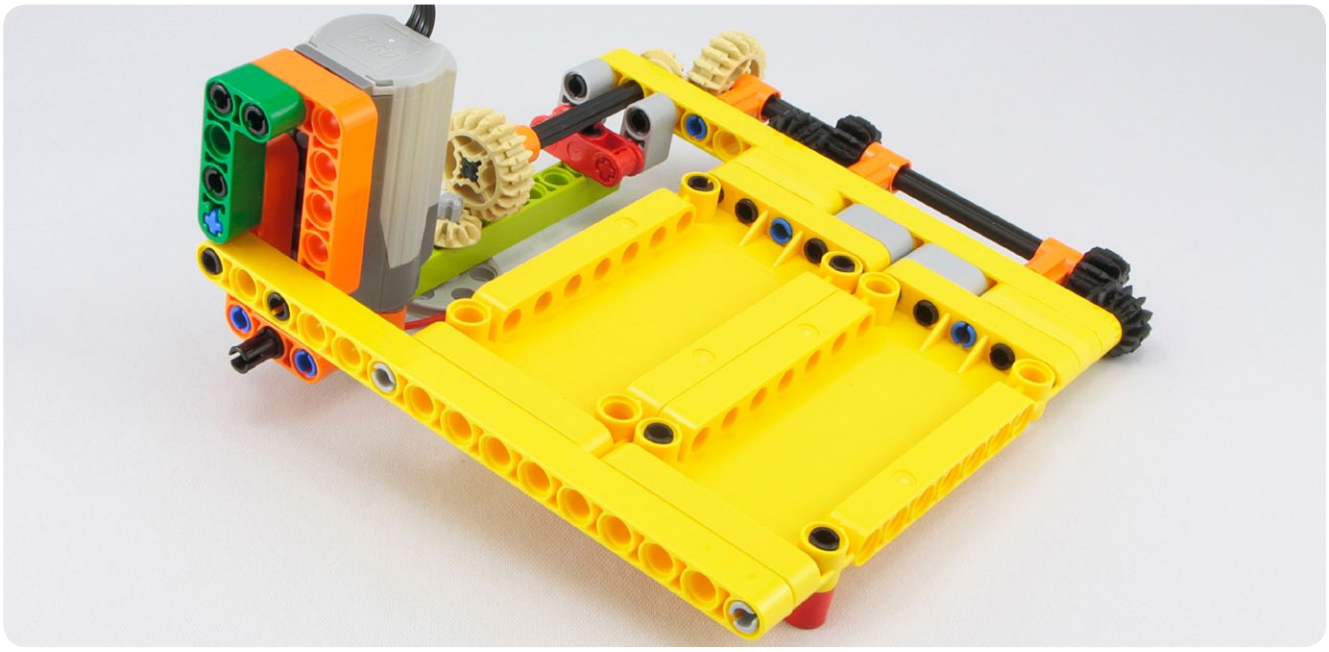
#244



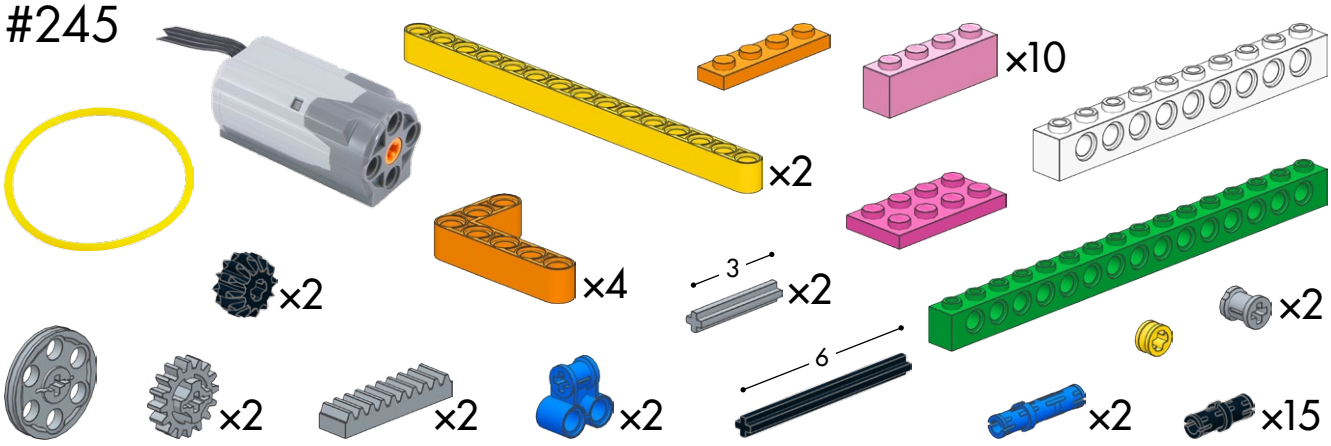


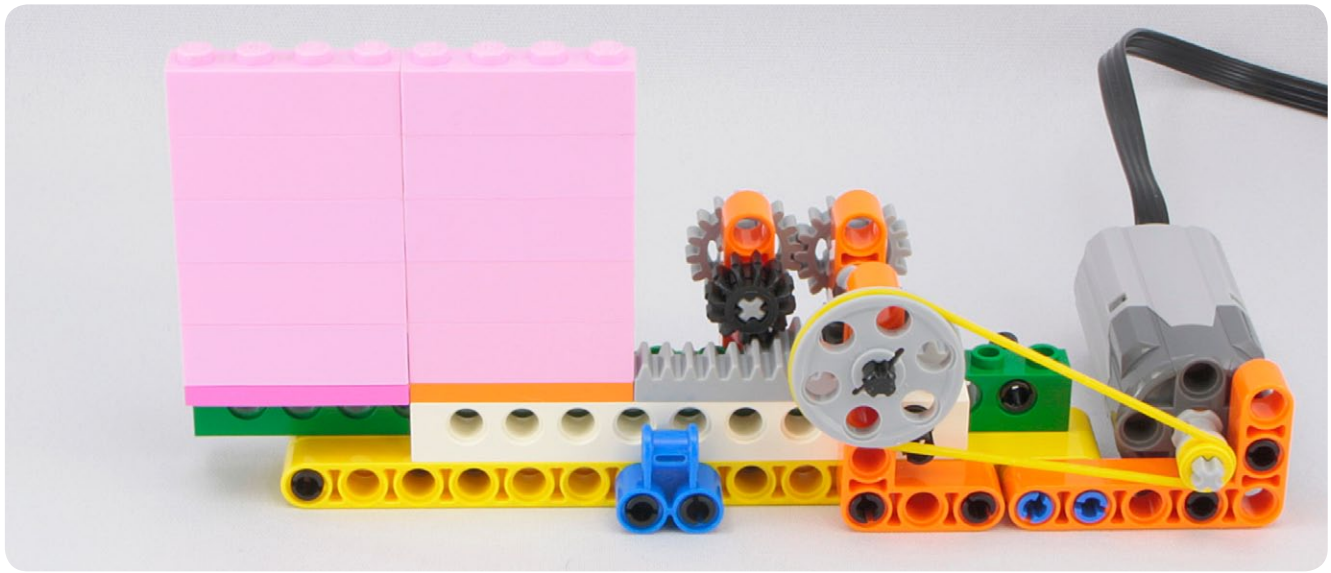


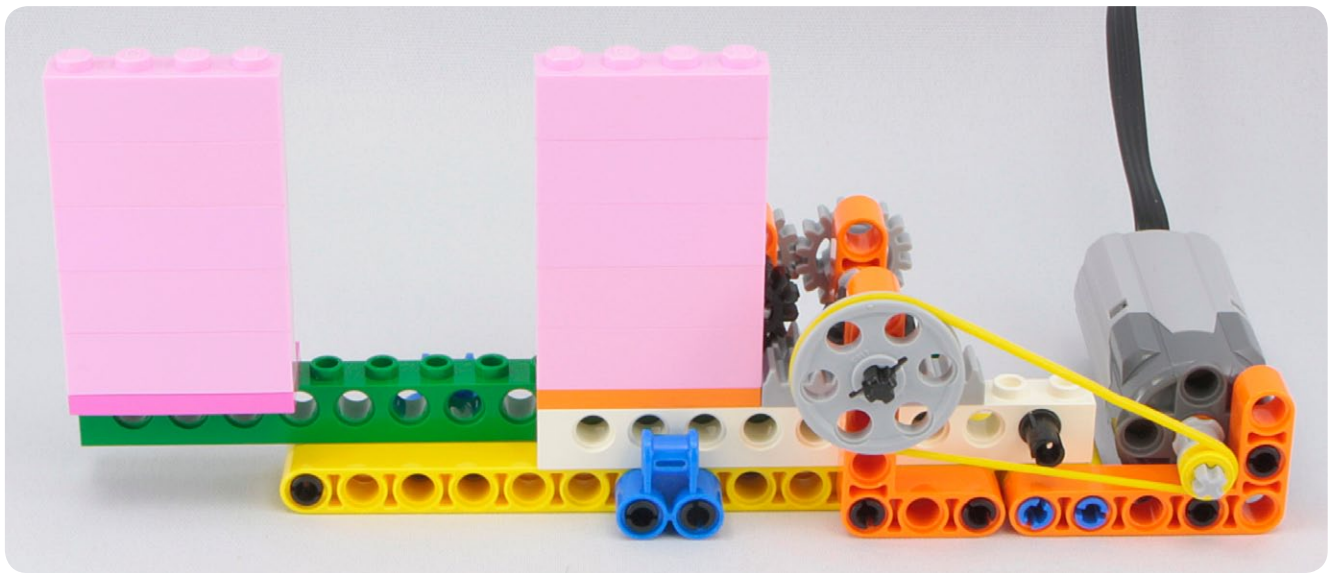


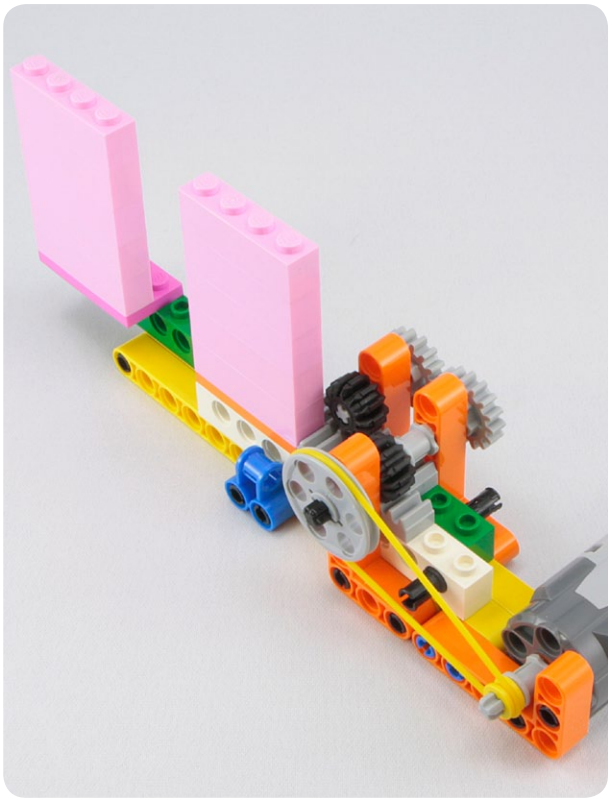


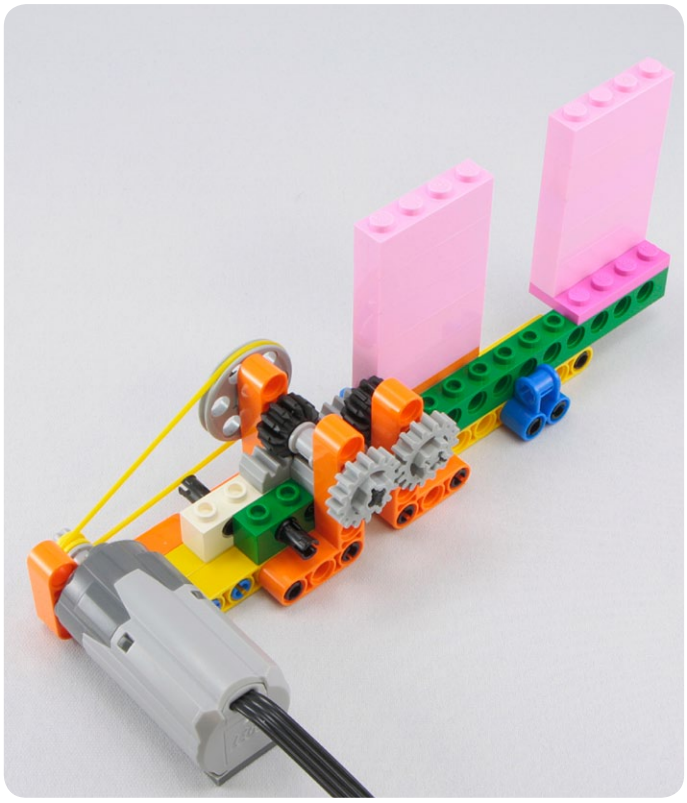
#245

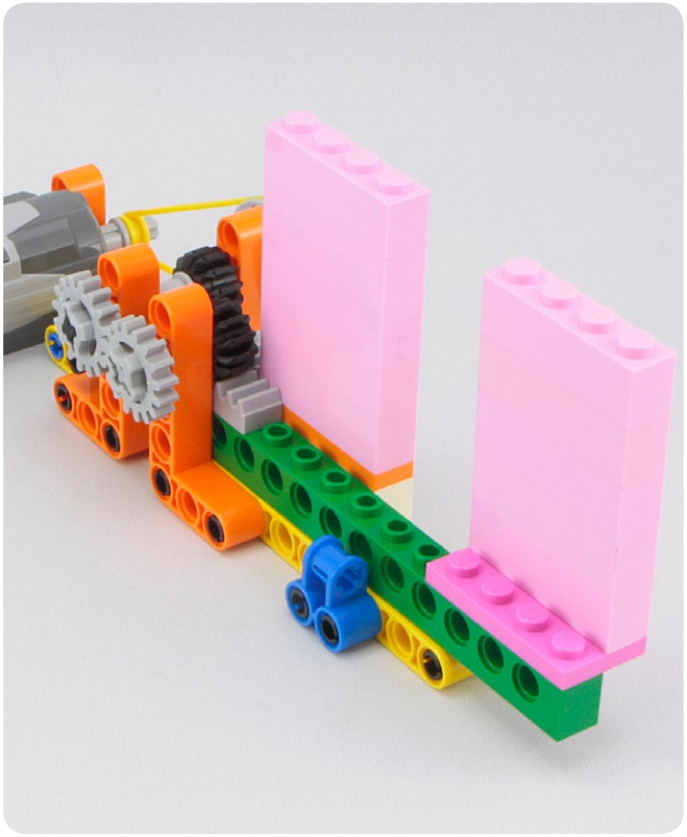


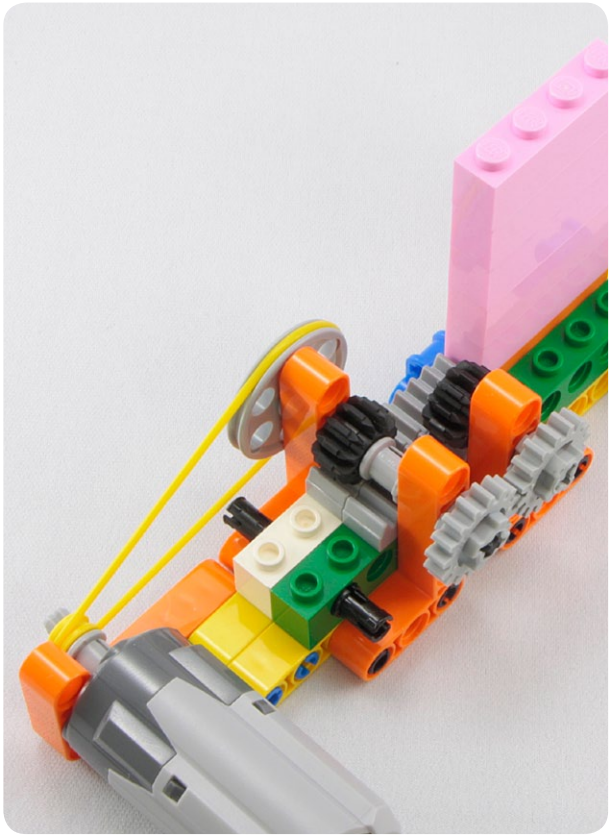












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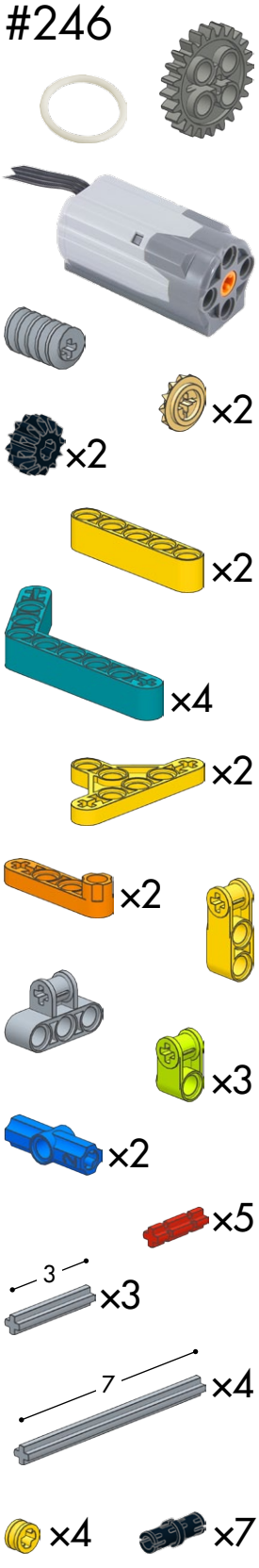

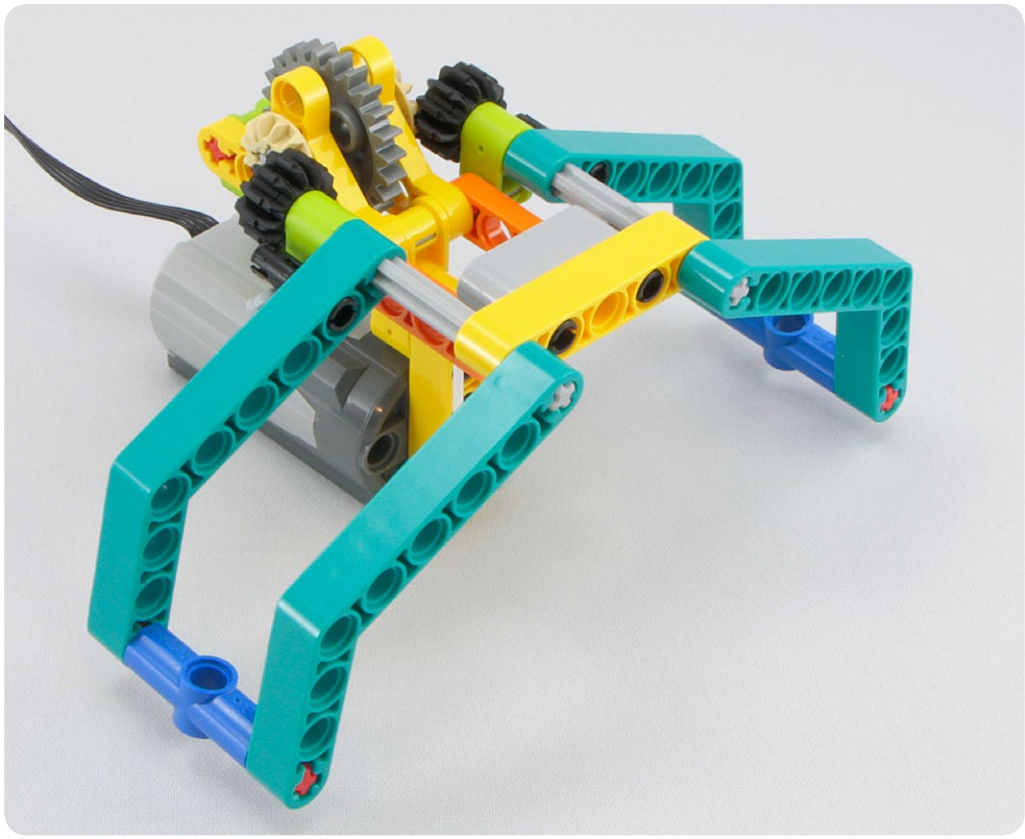

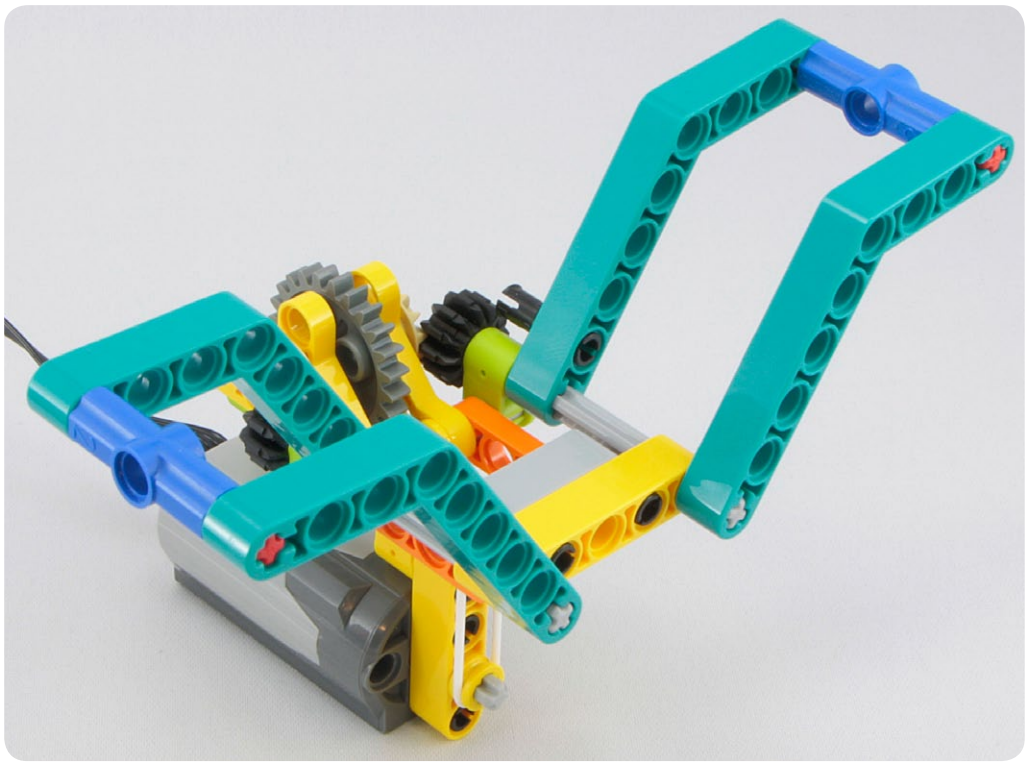

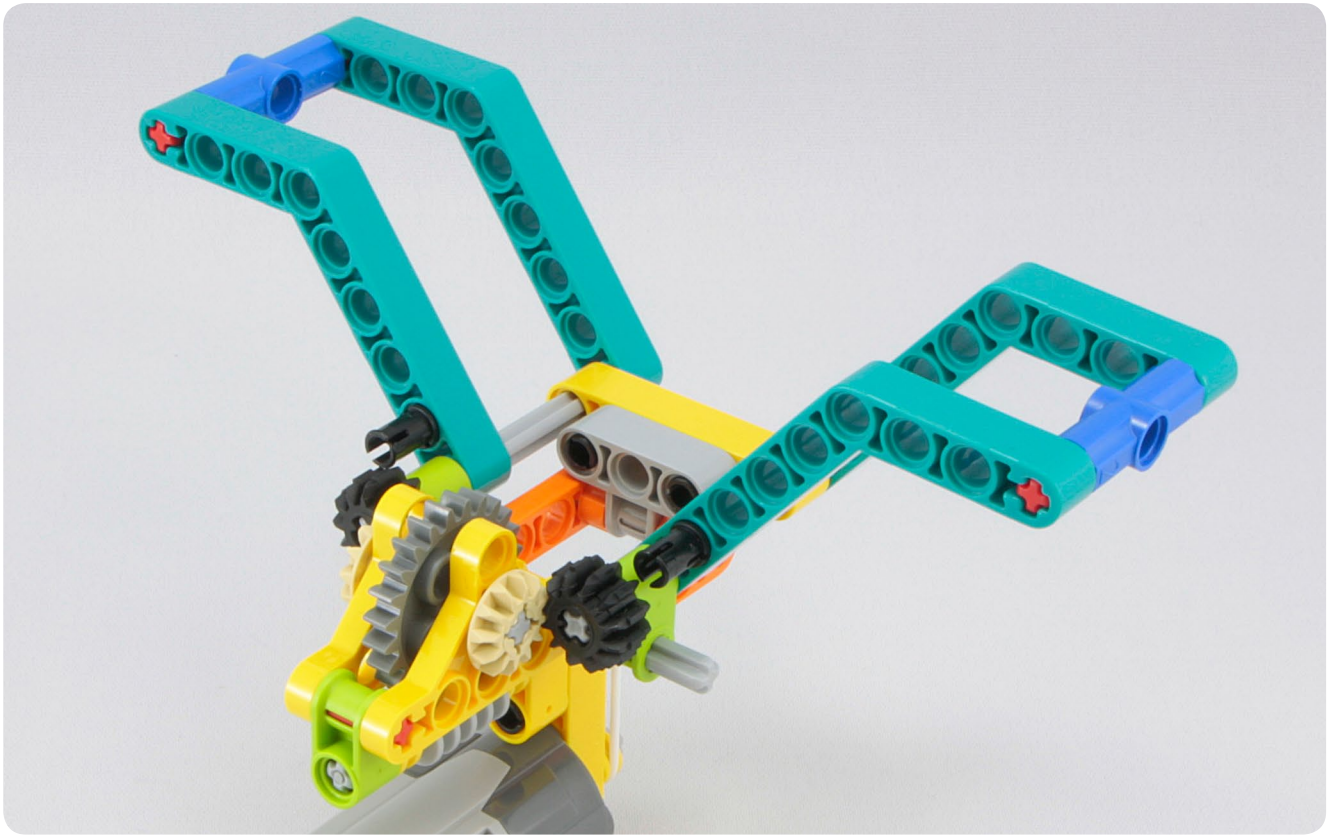

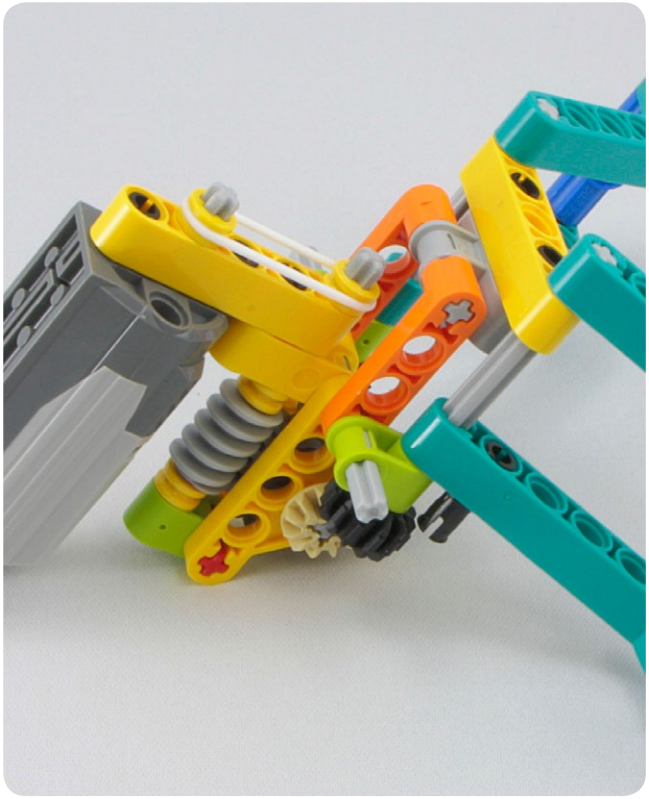

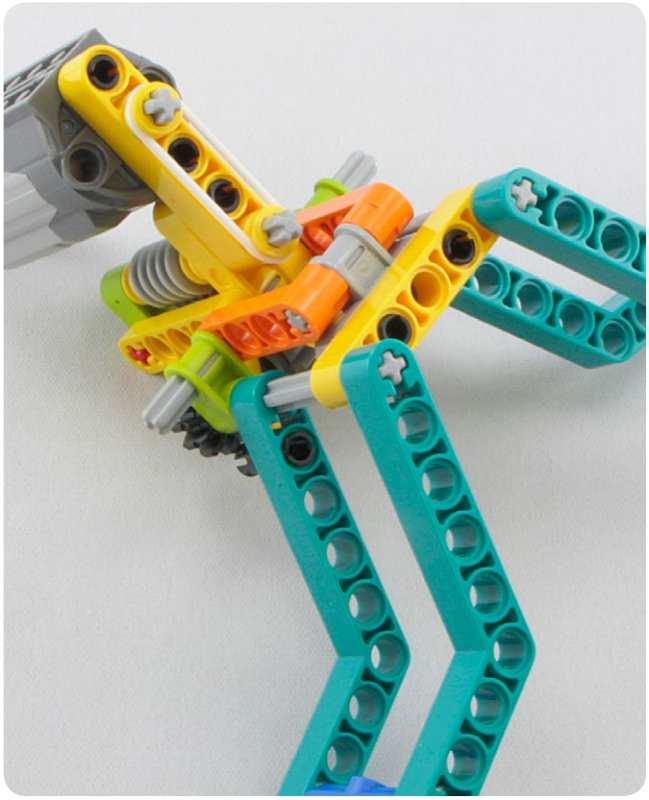

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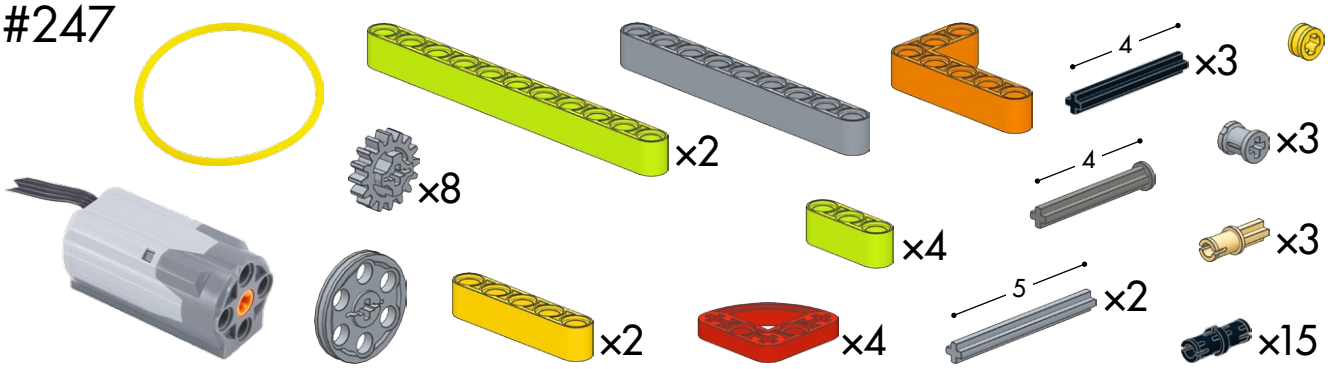

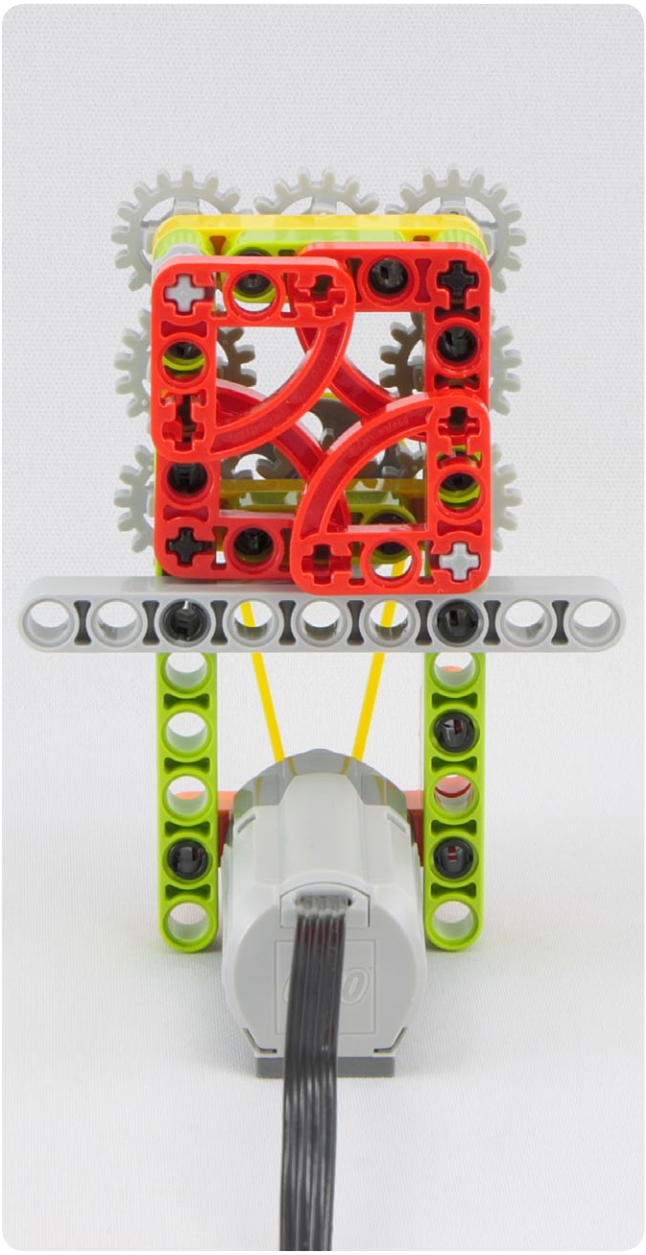

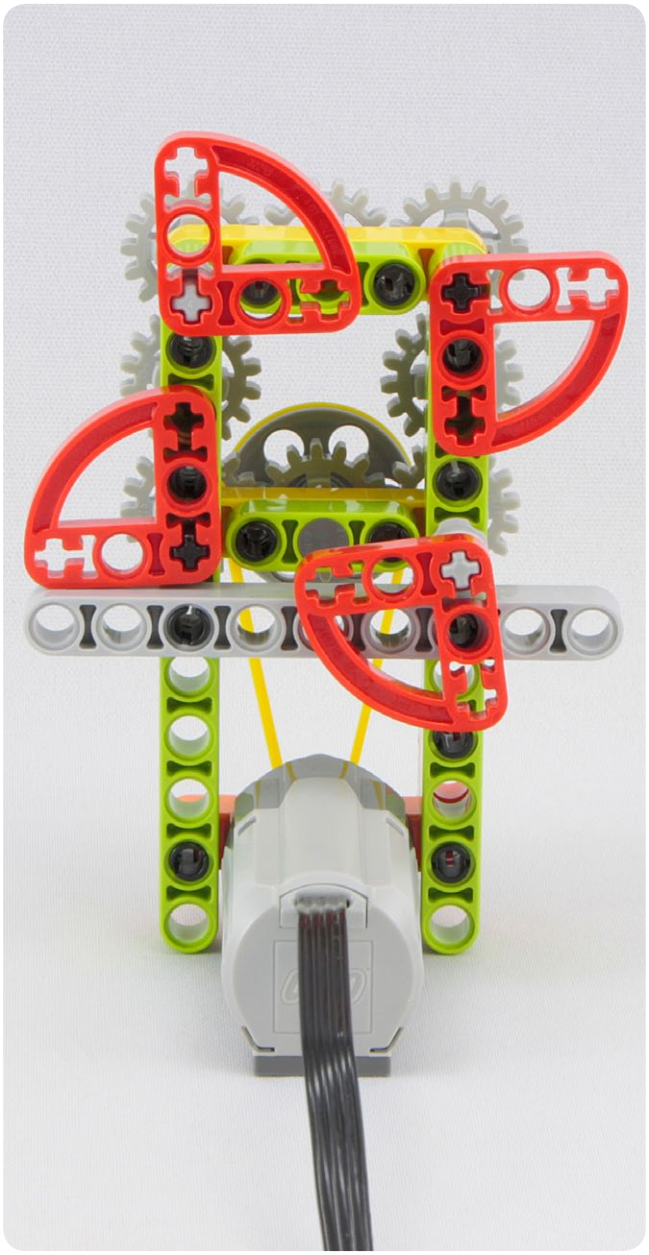

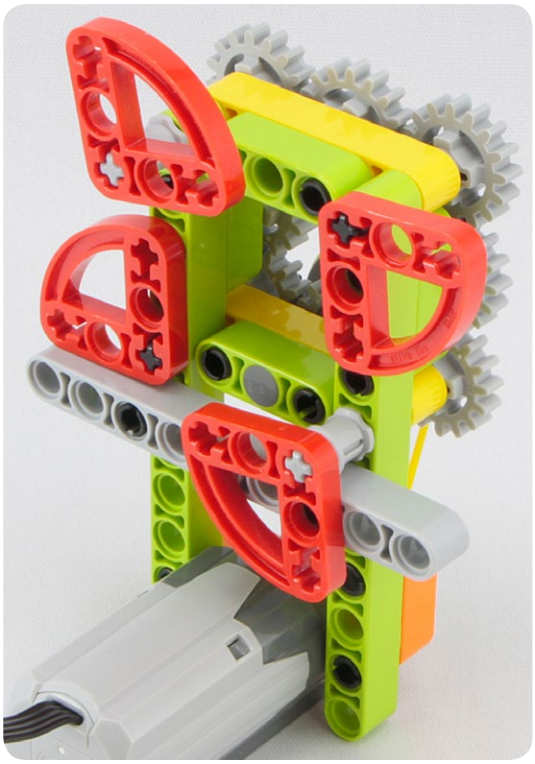

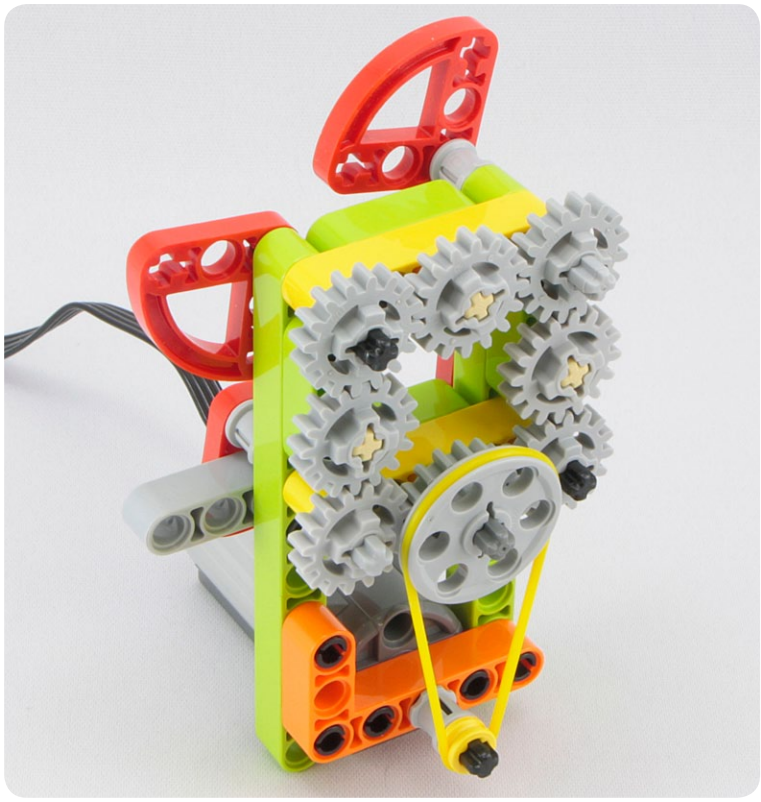

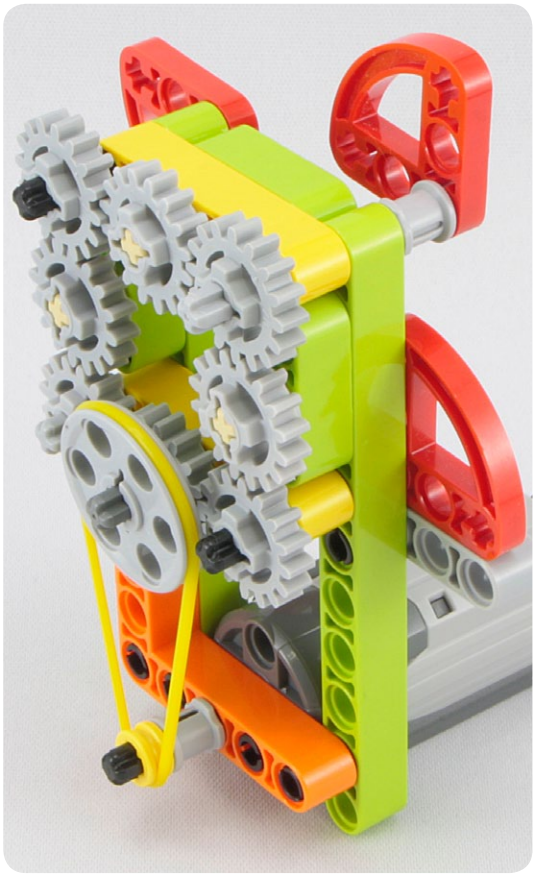

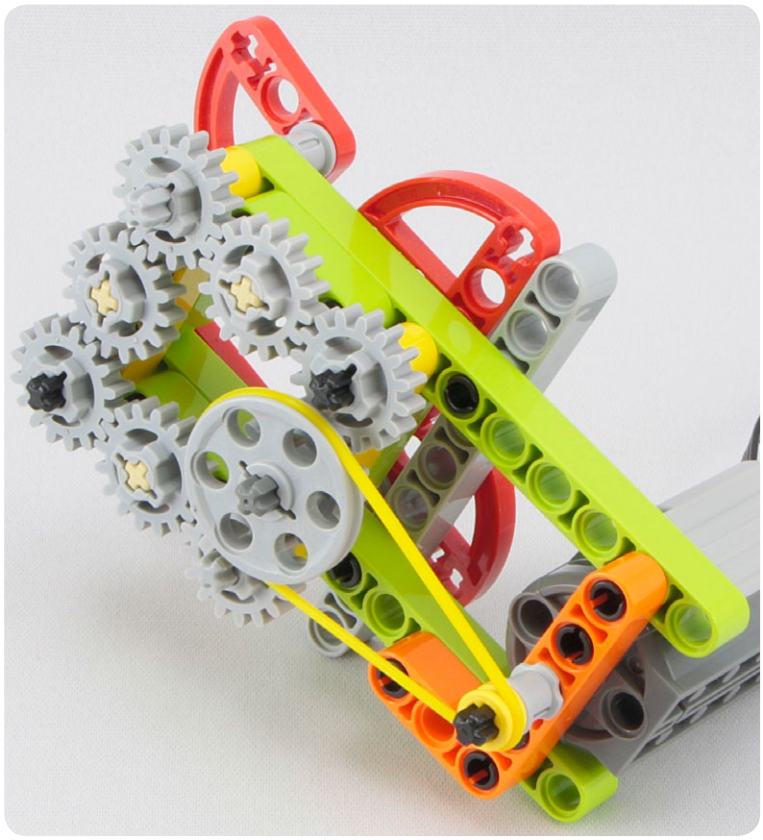

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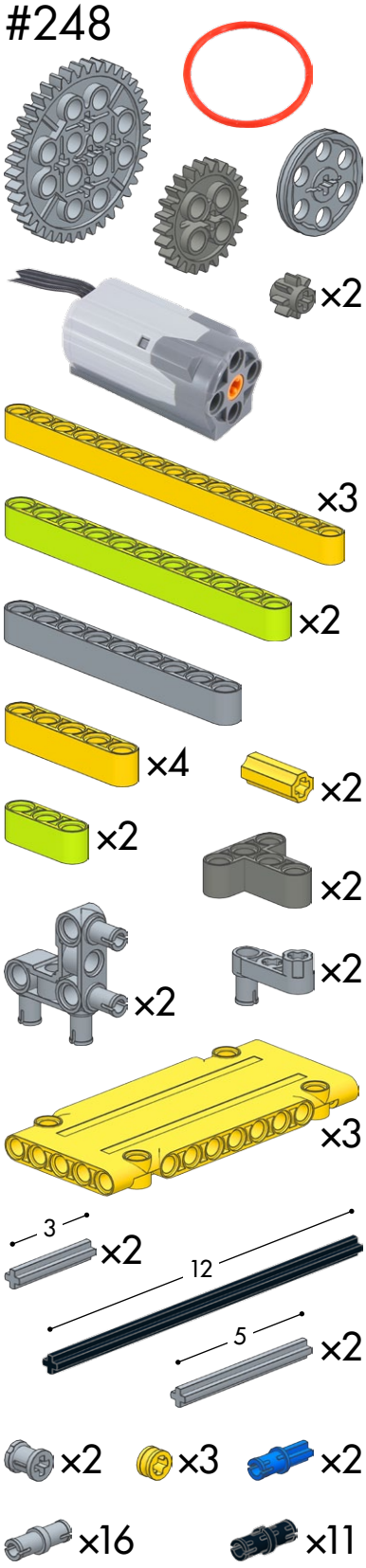

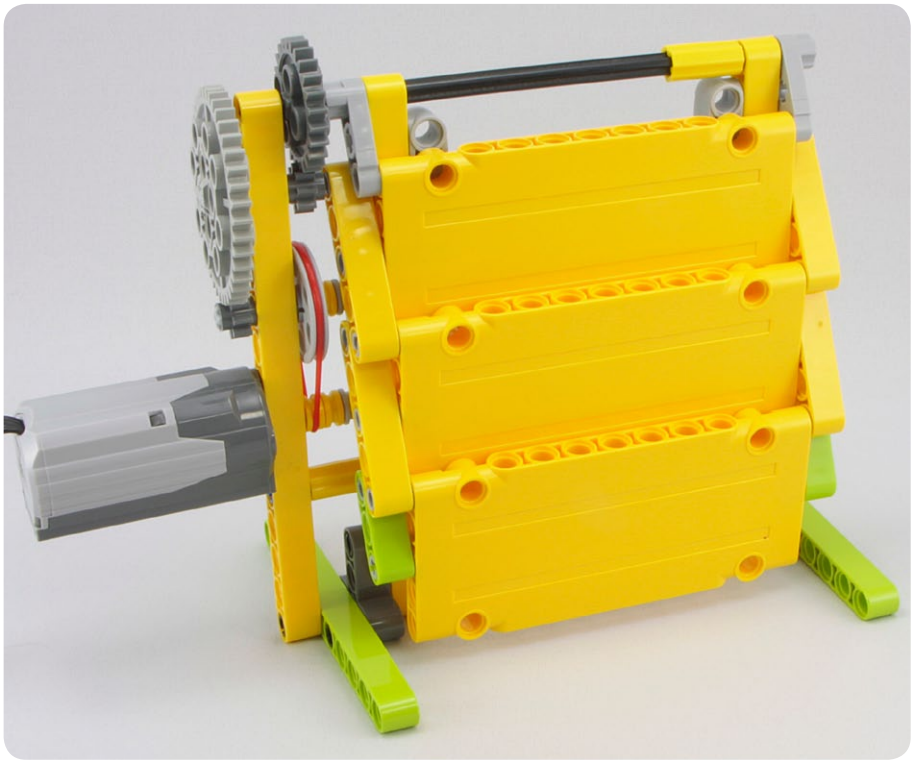

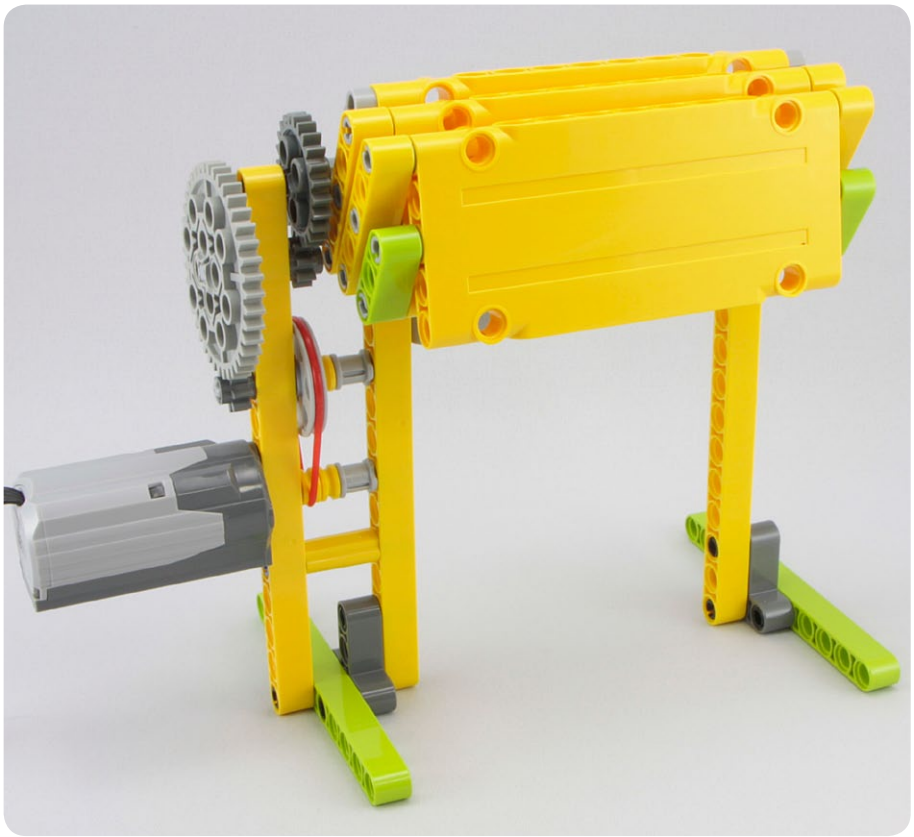

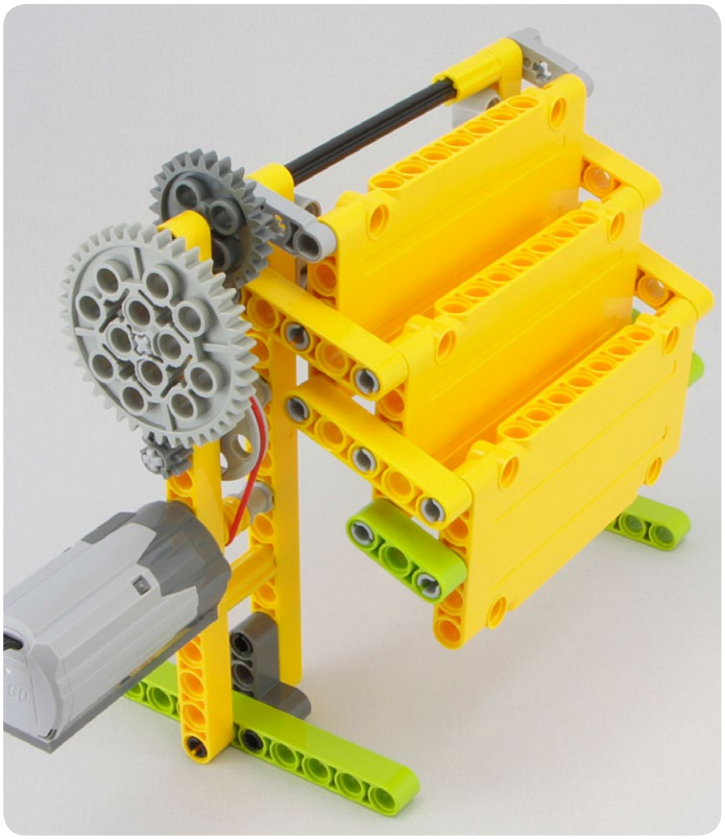

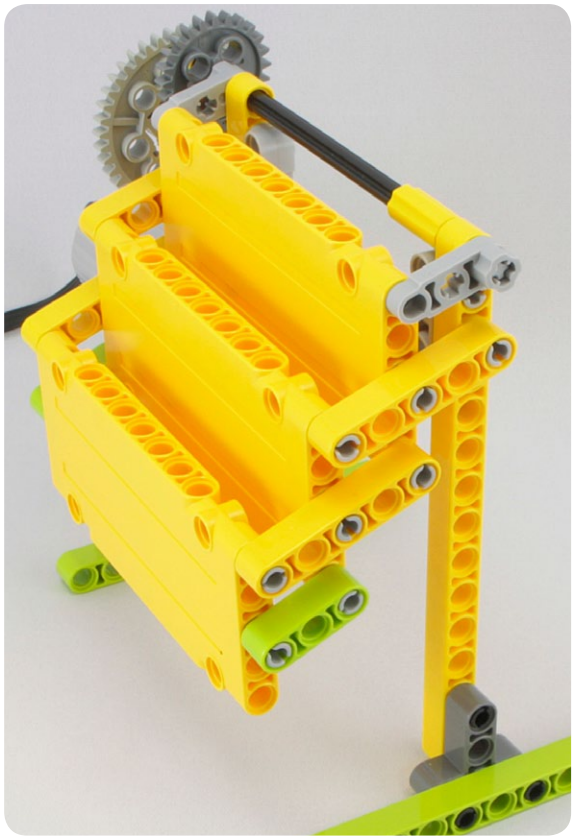

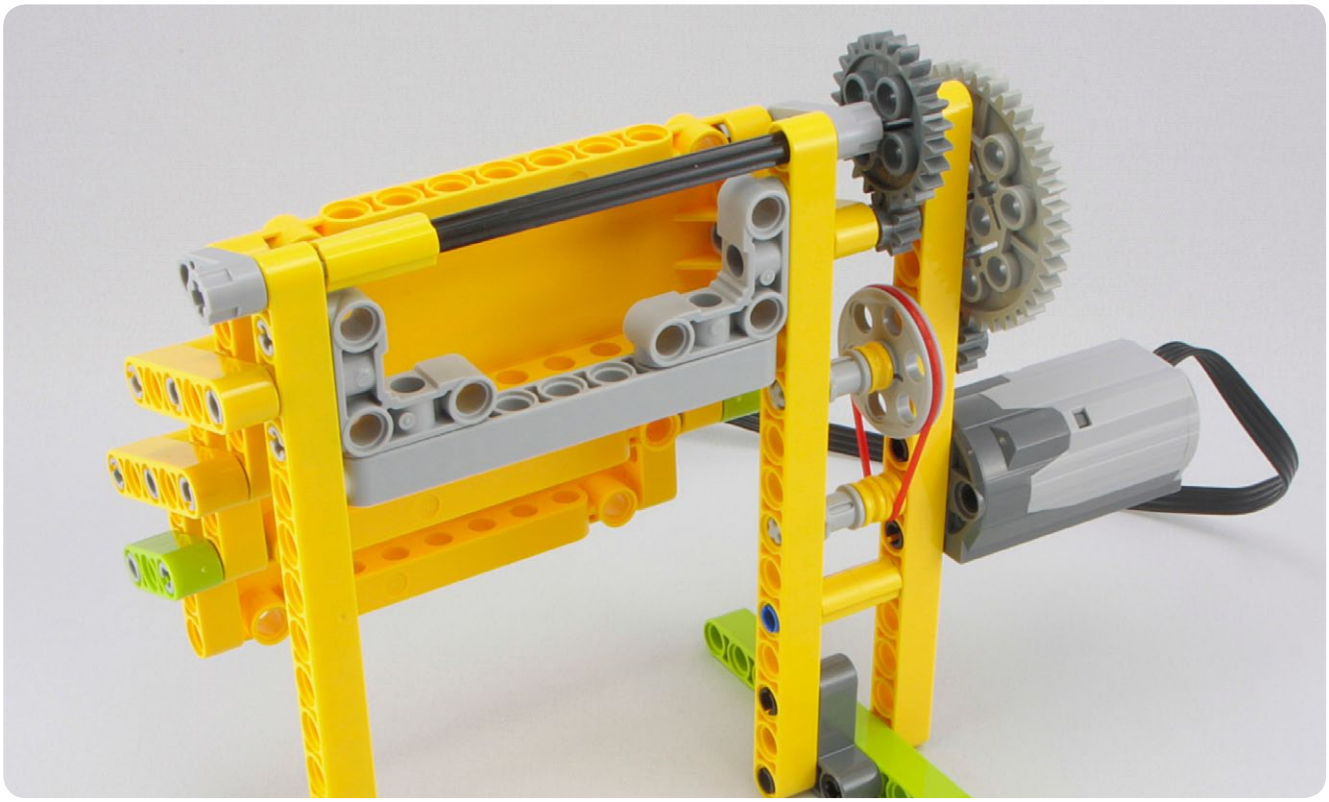

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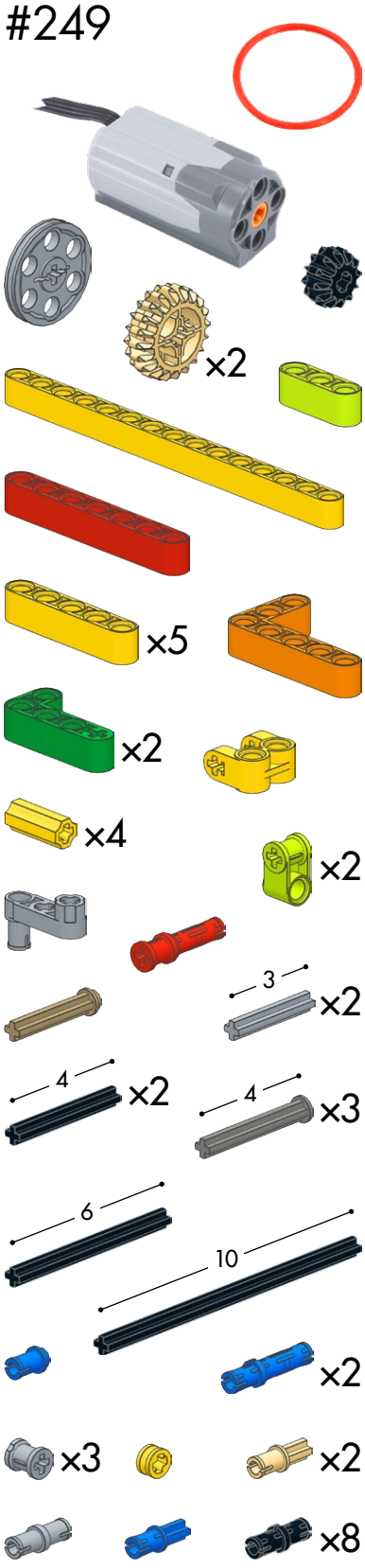
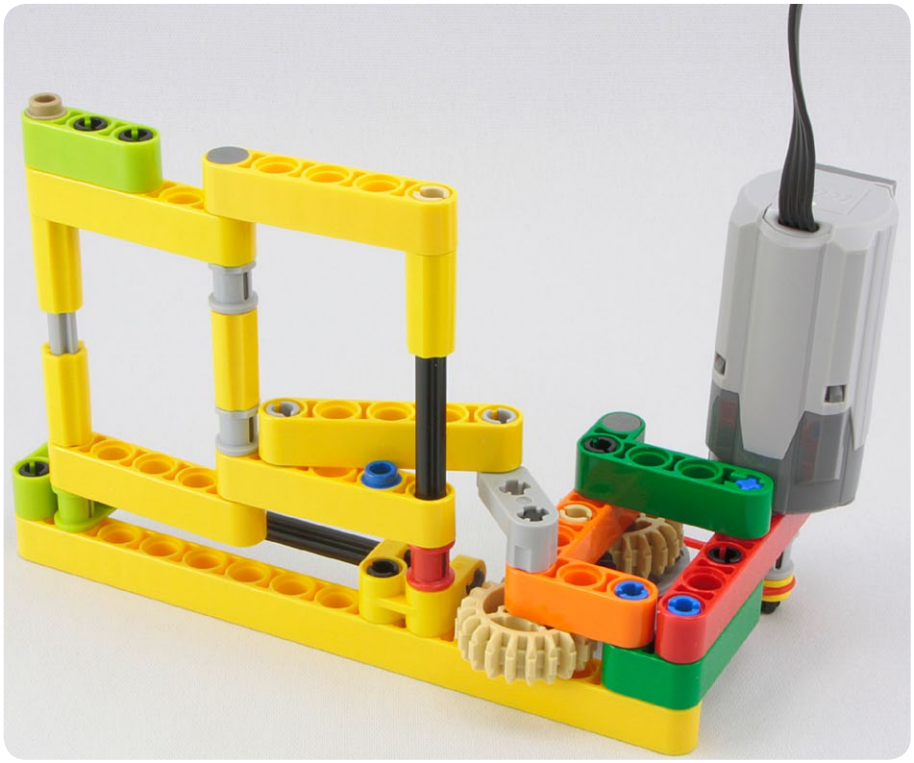
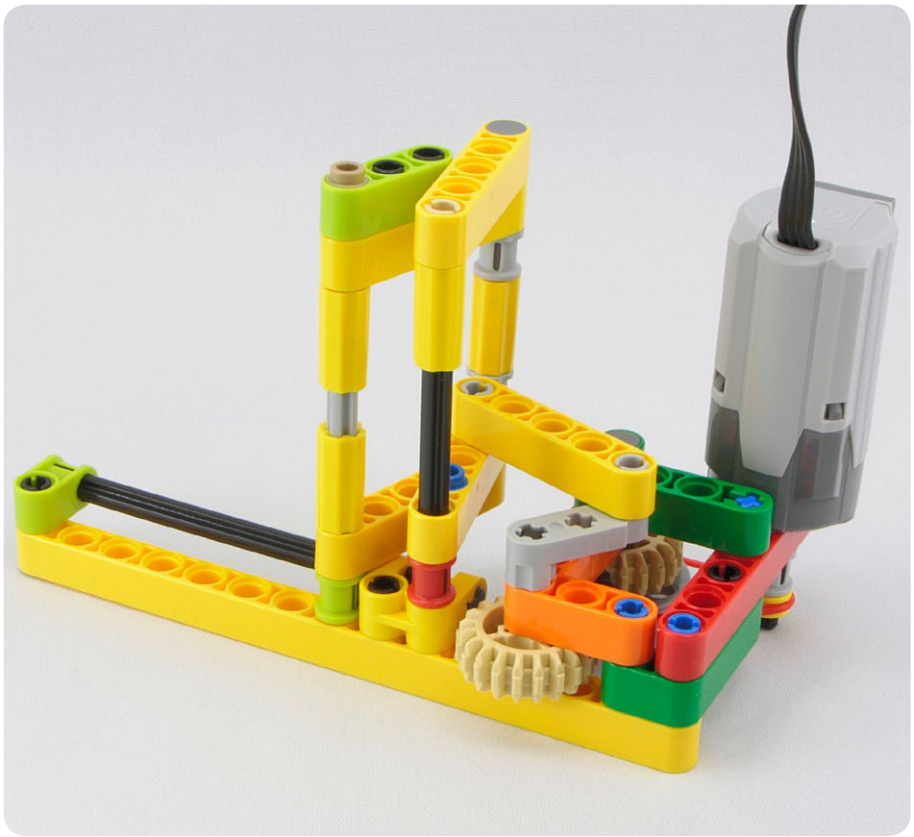
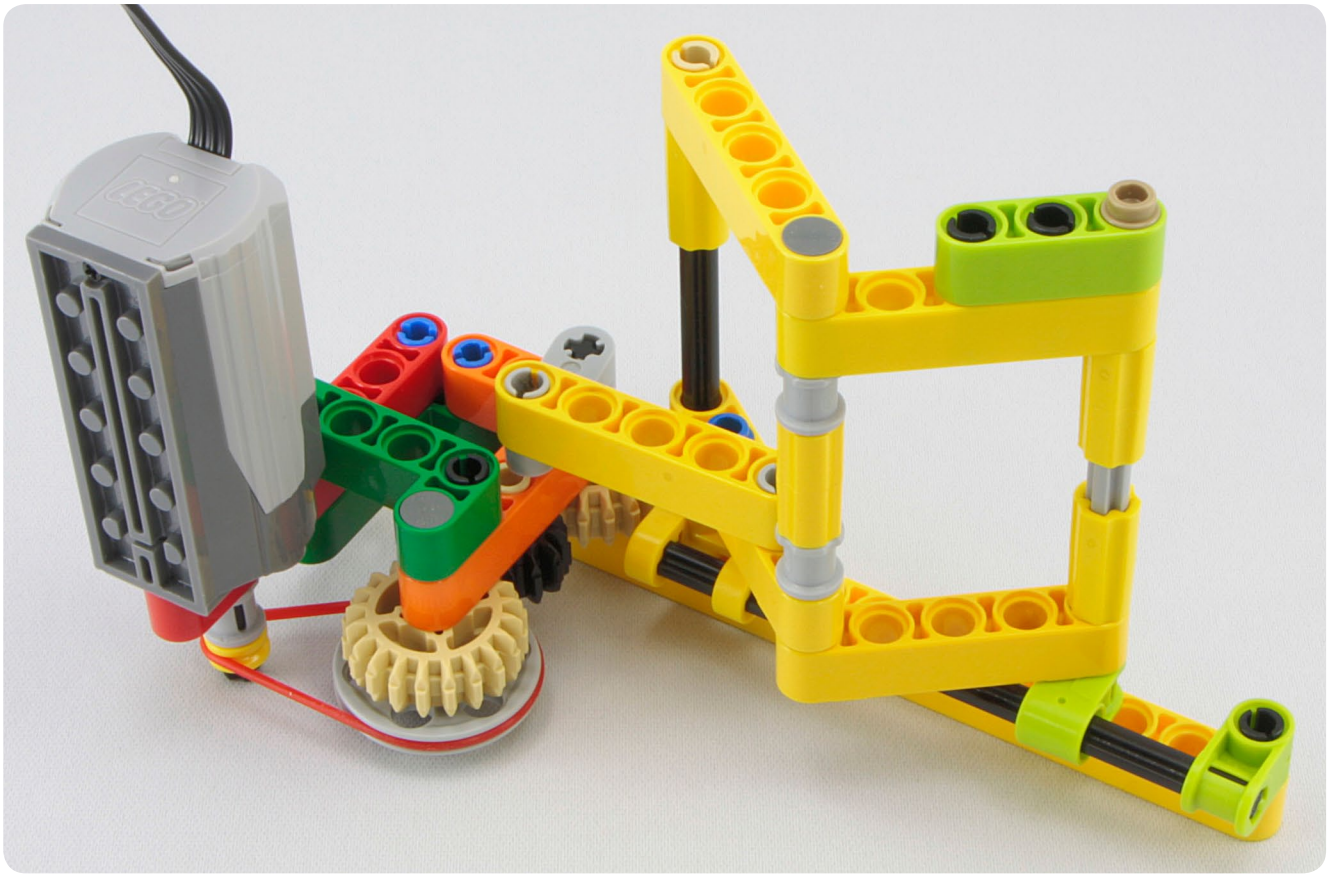
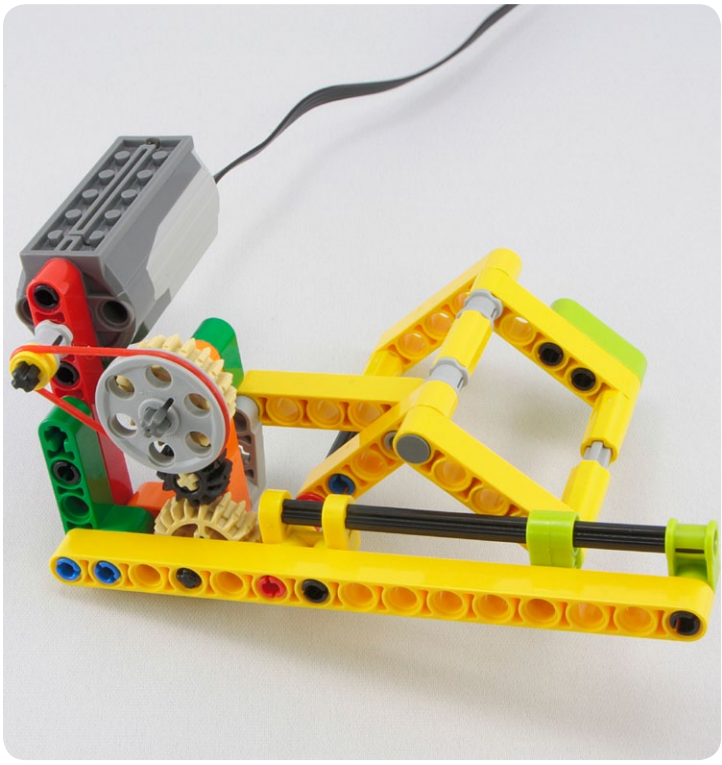




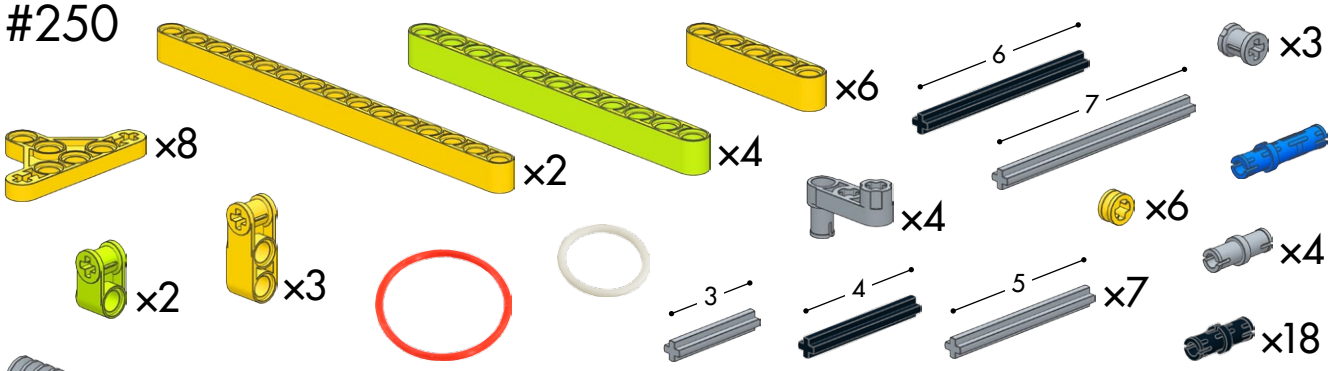


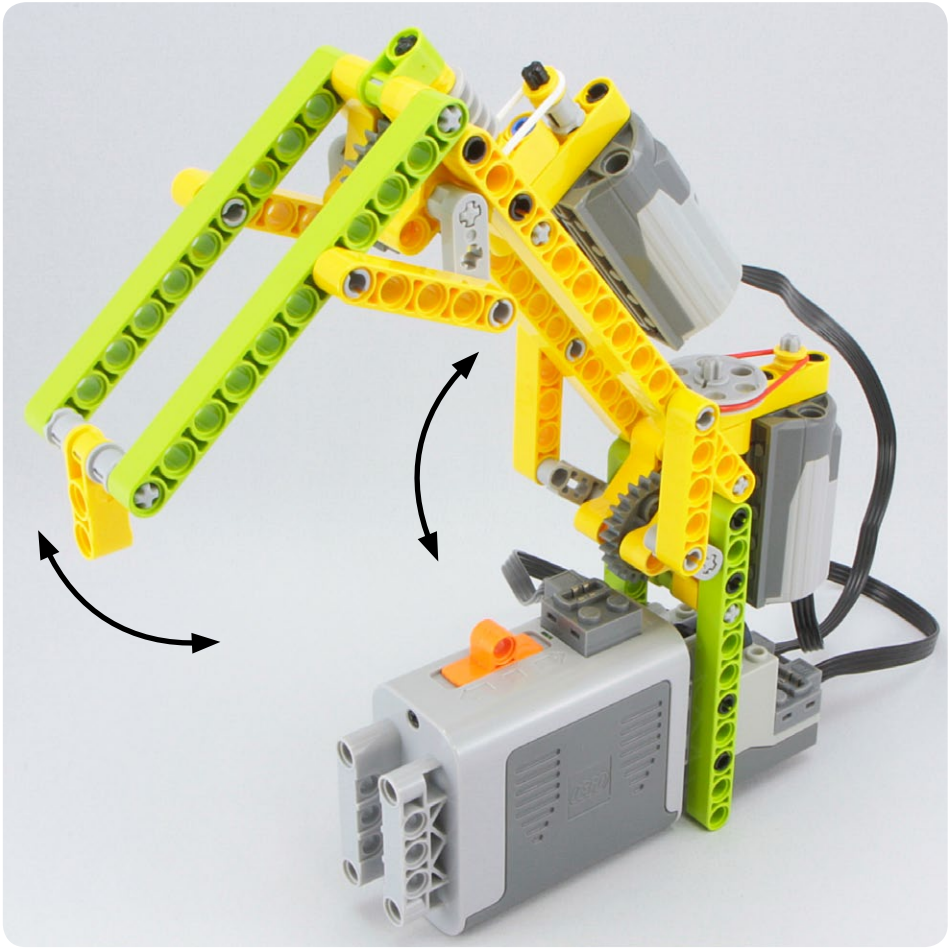


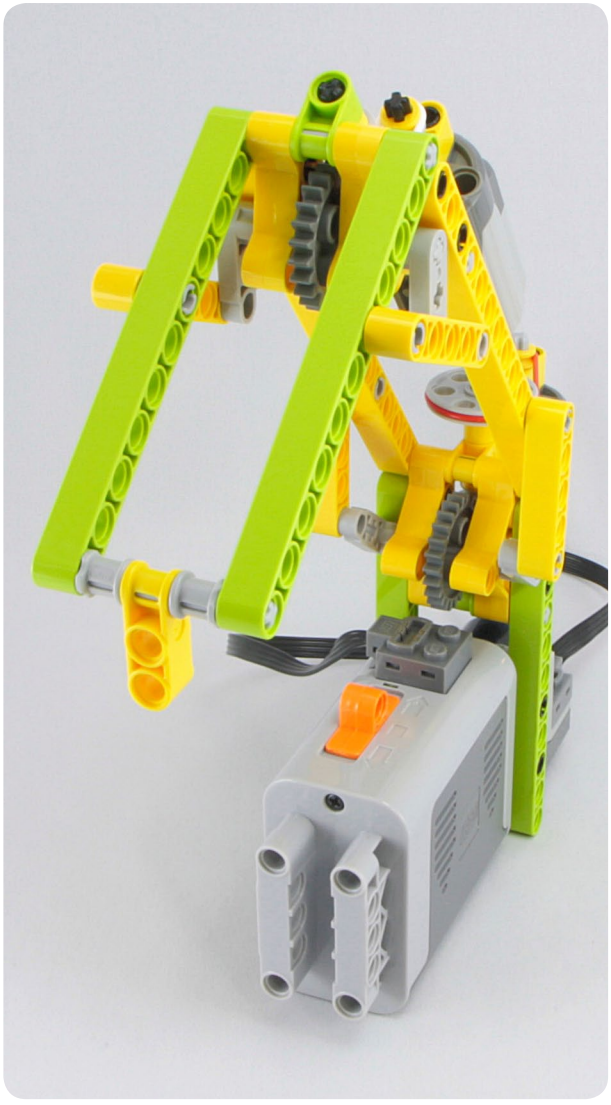


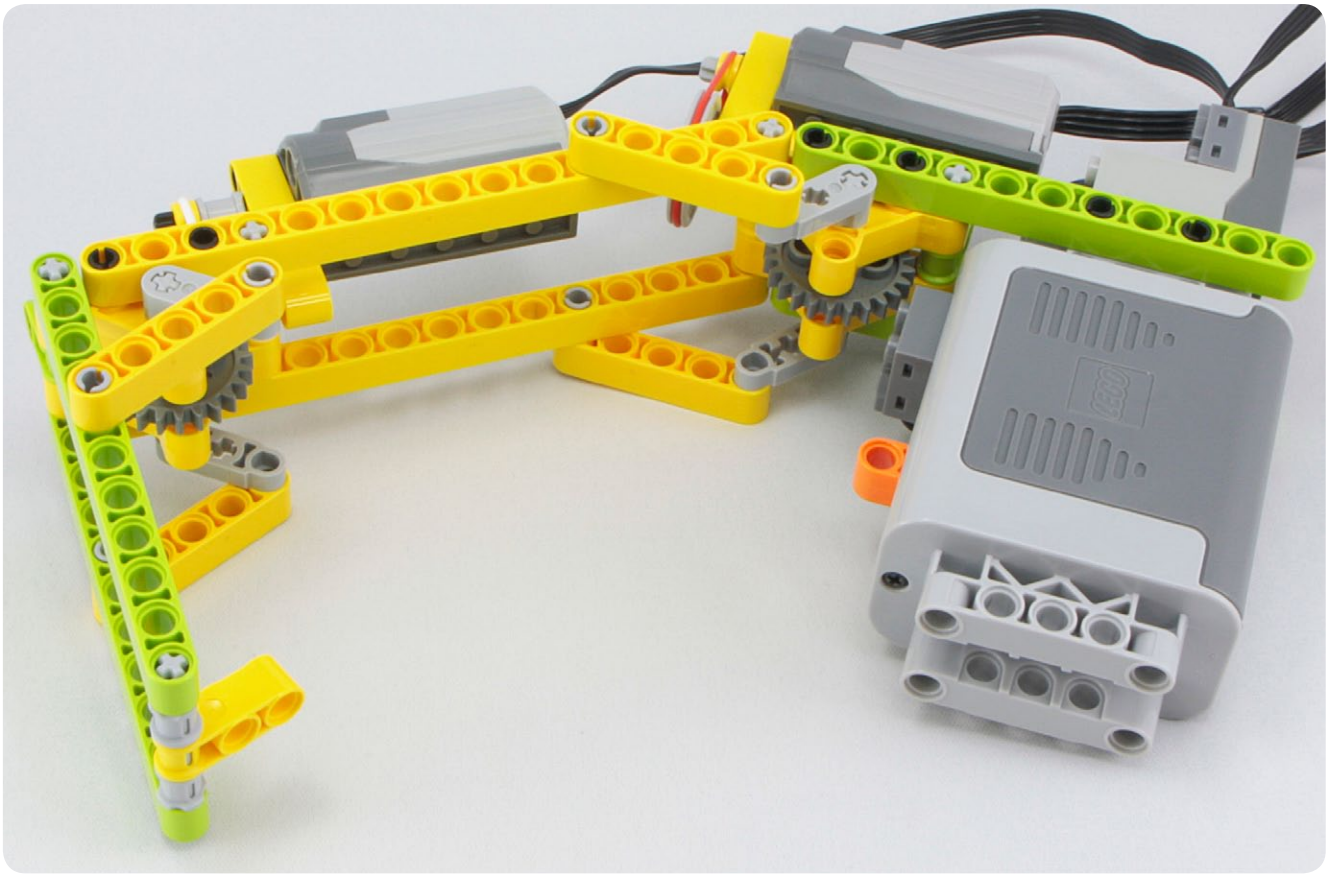
Moving arms

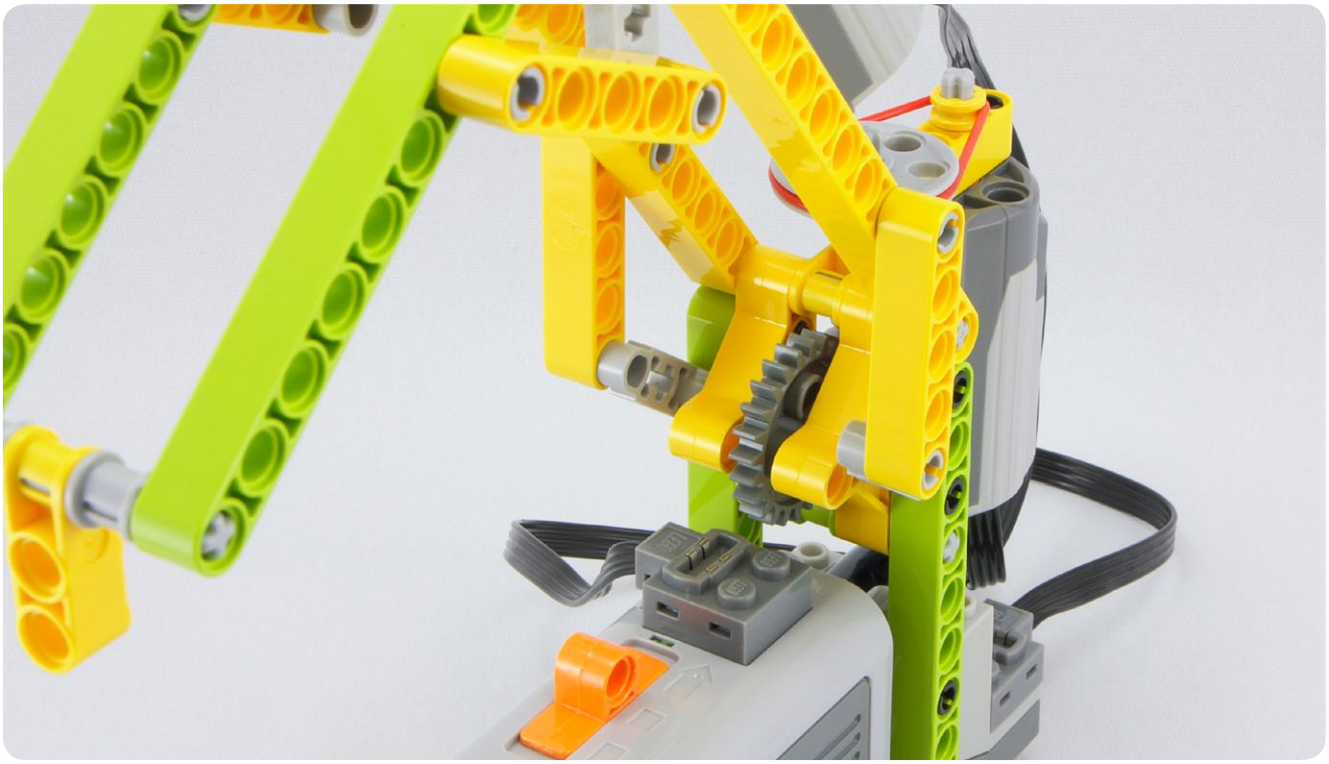
#250

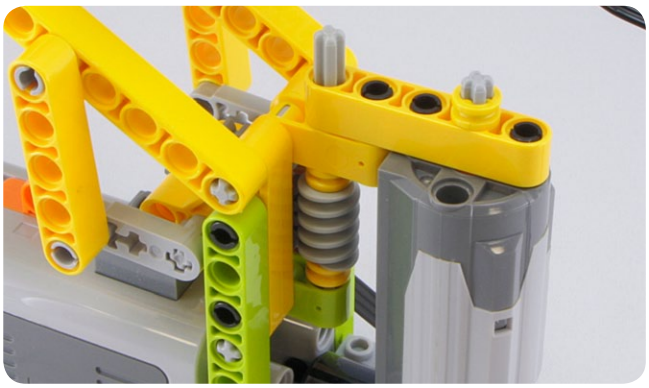


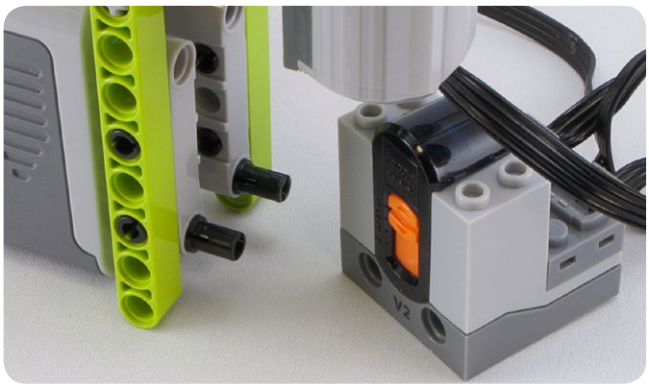












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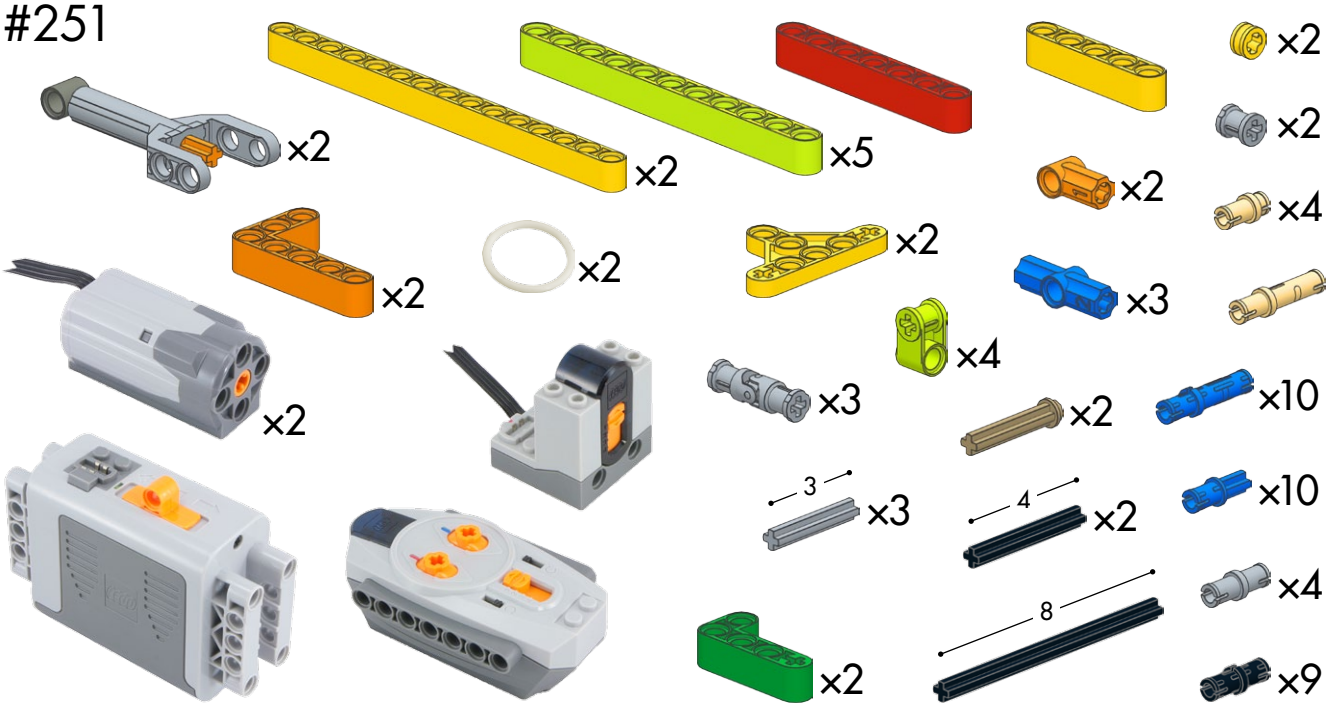

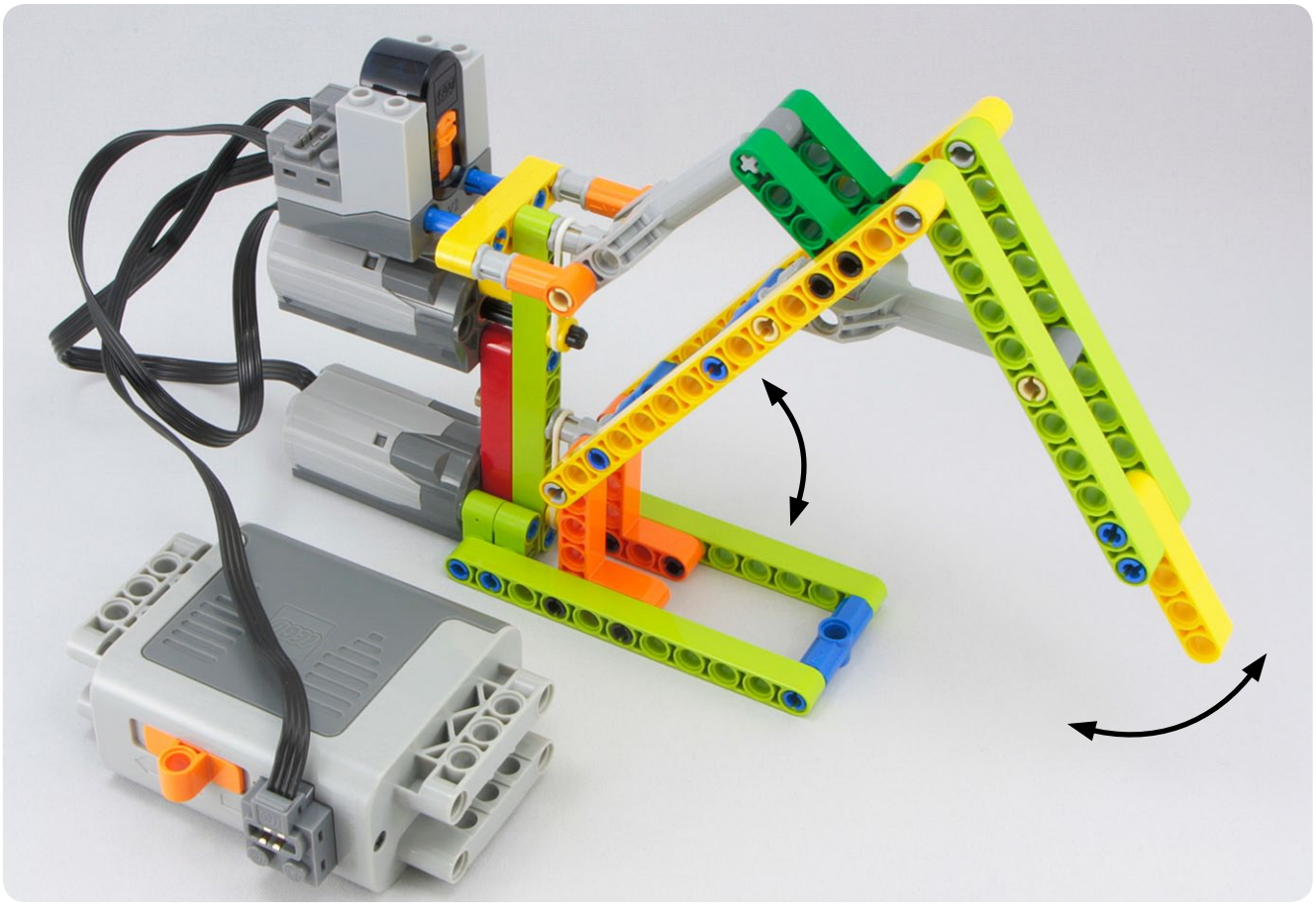

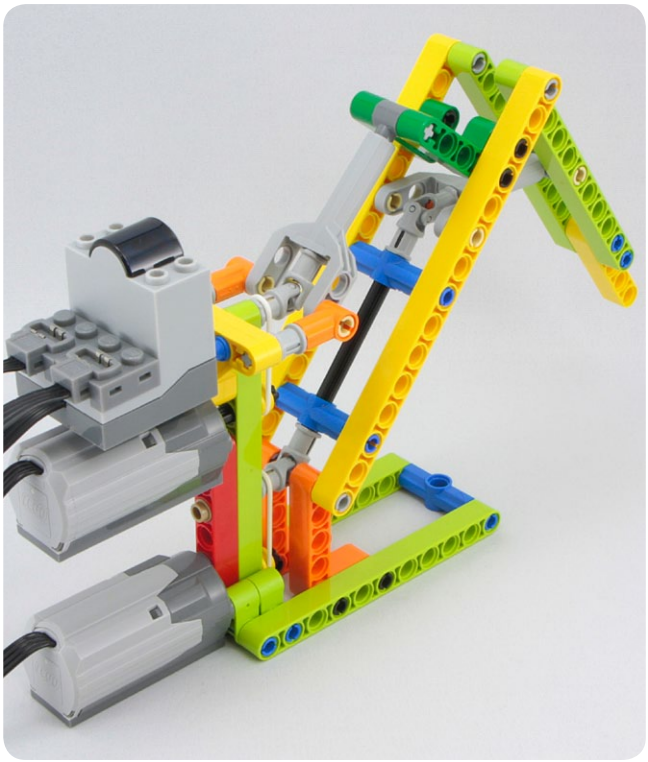

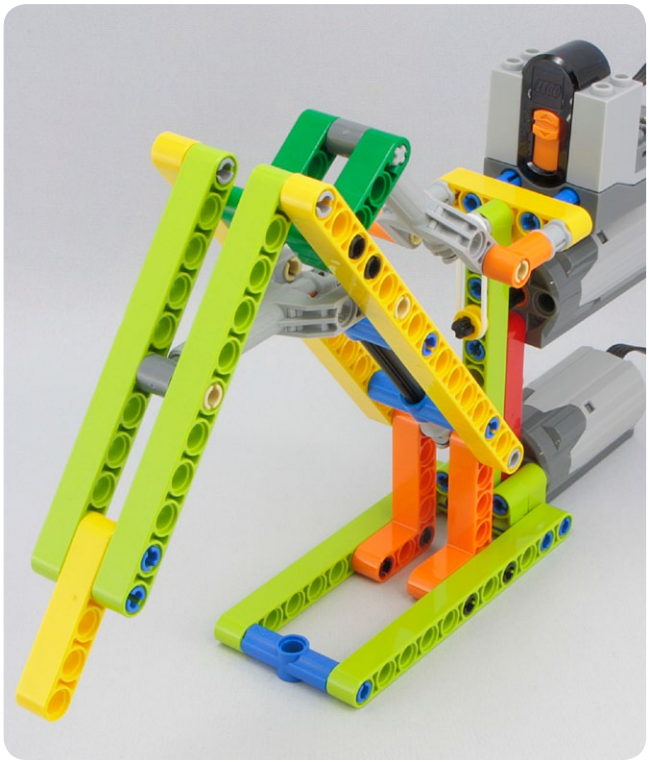

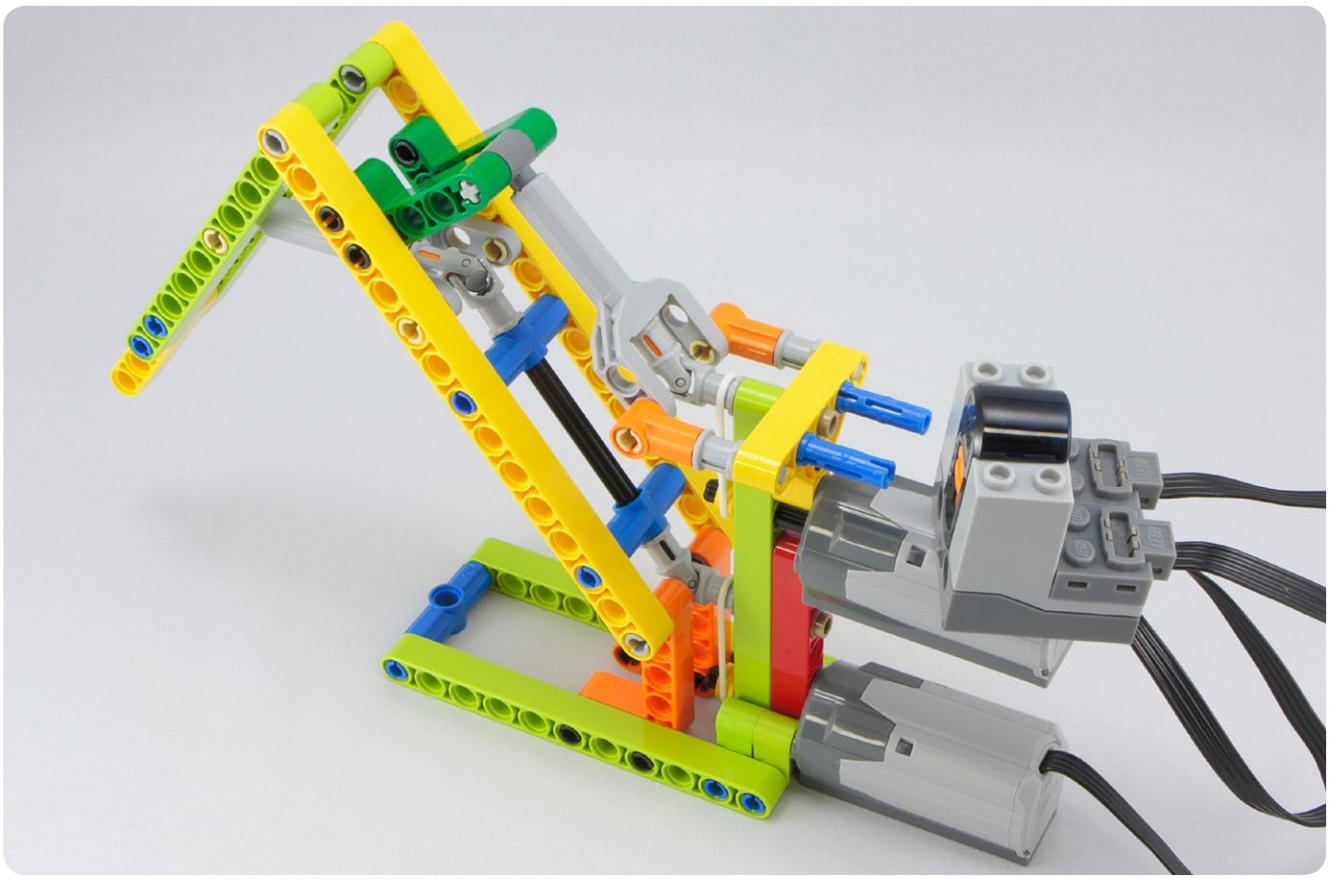

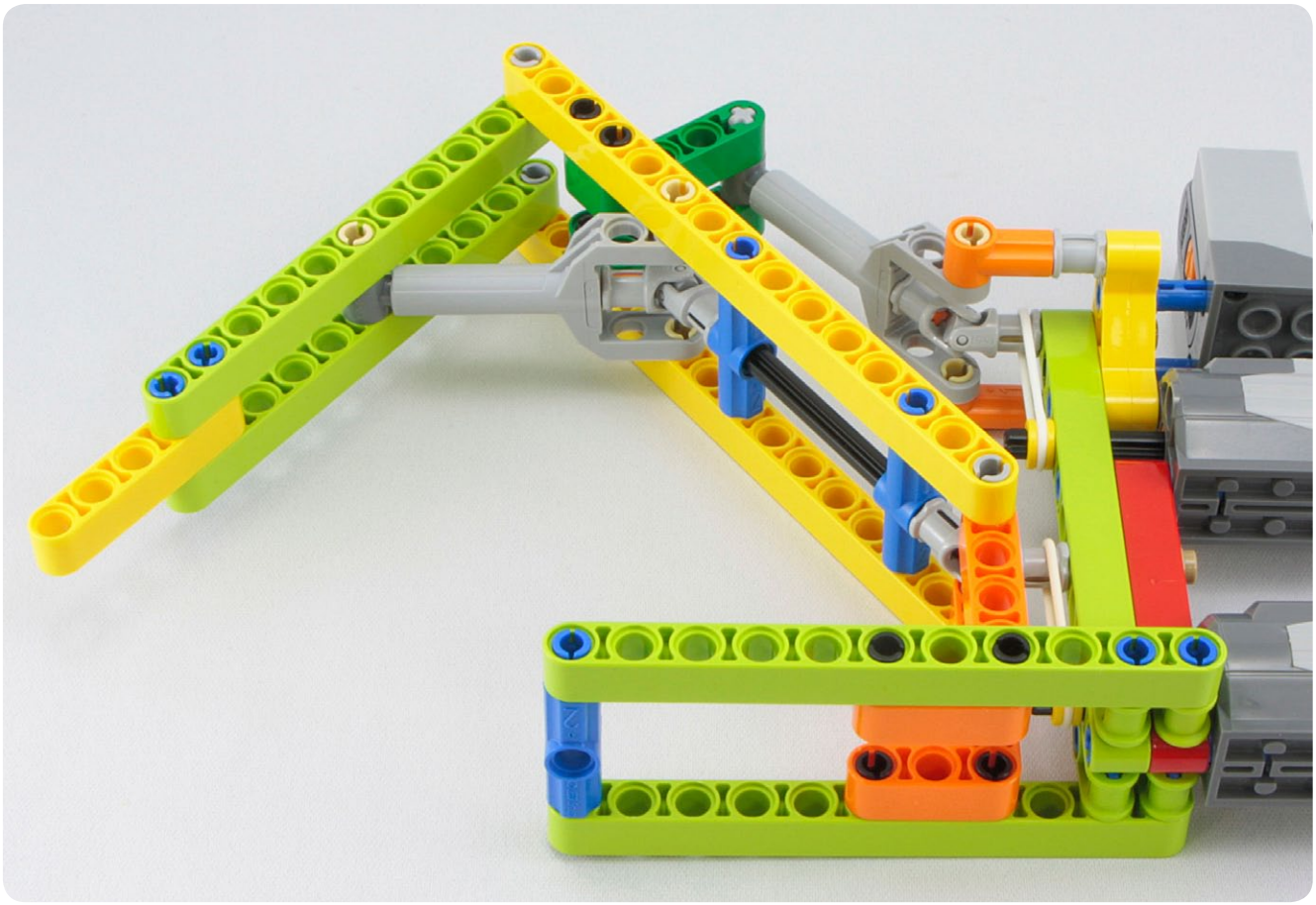

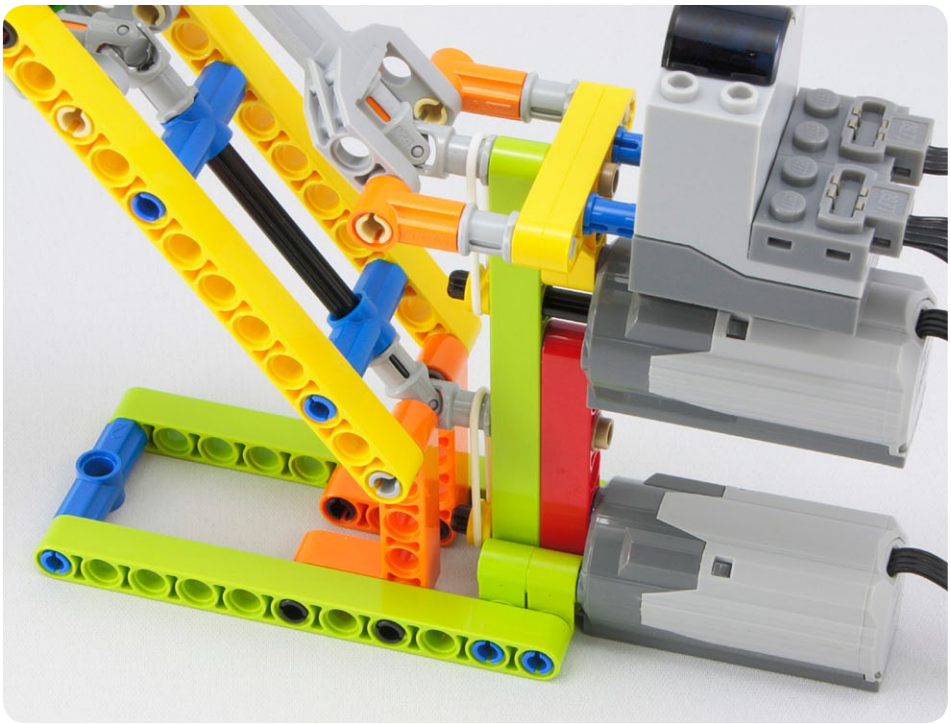

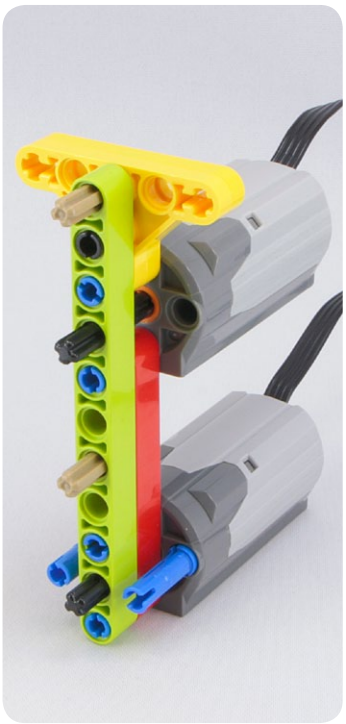

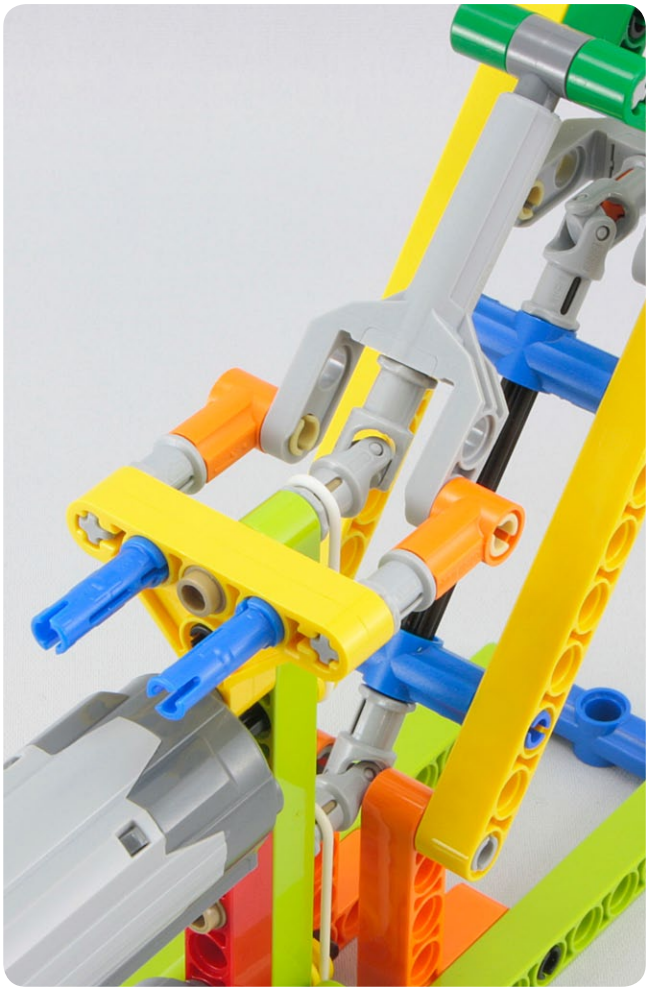

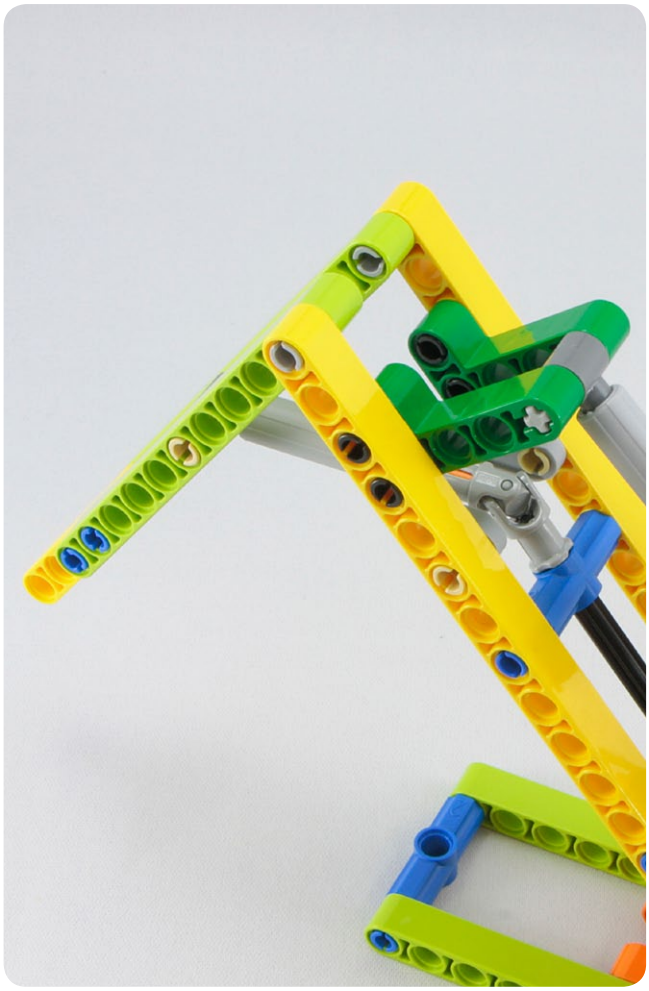

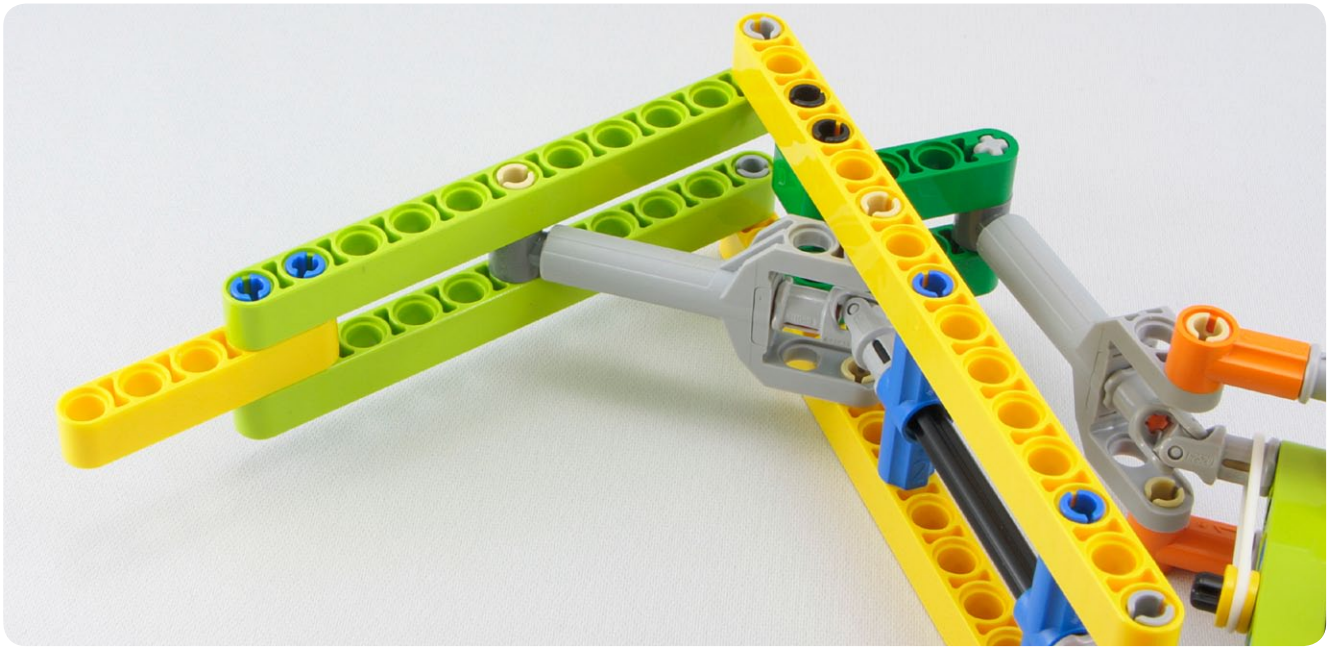

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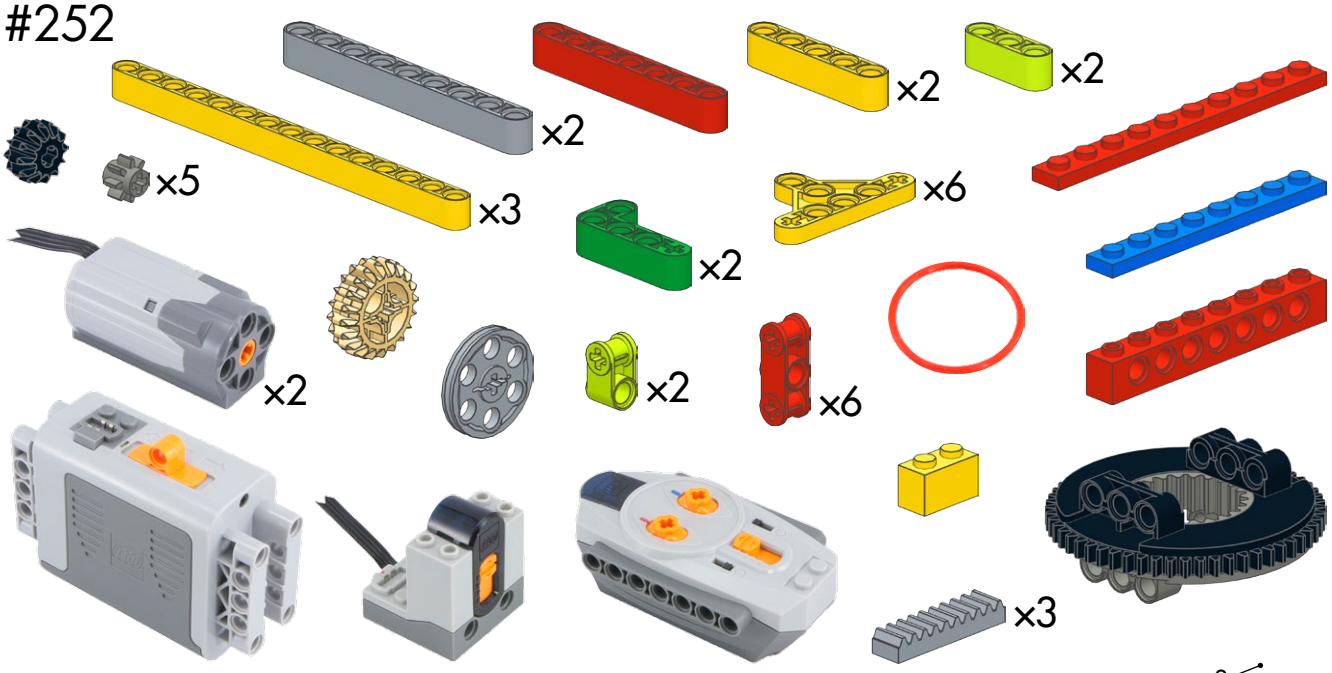
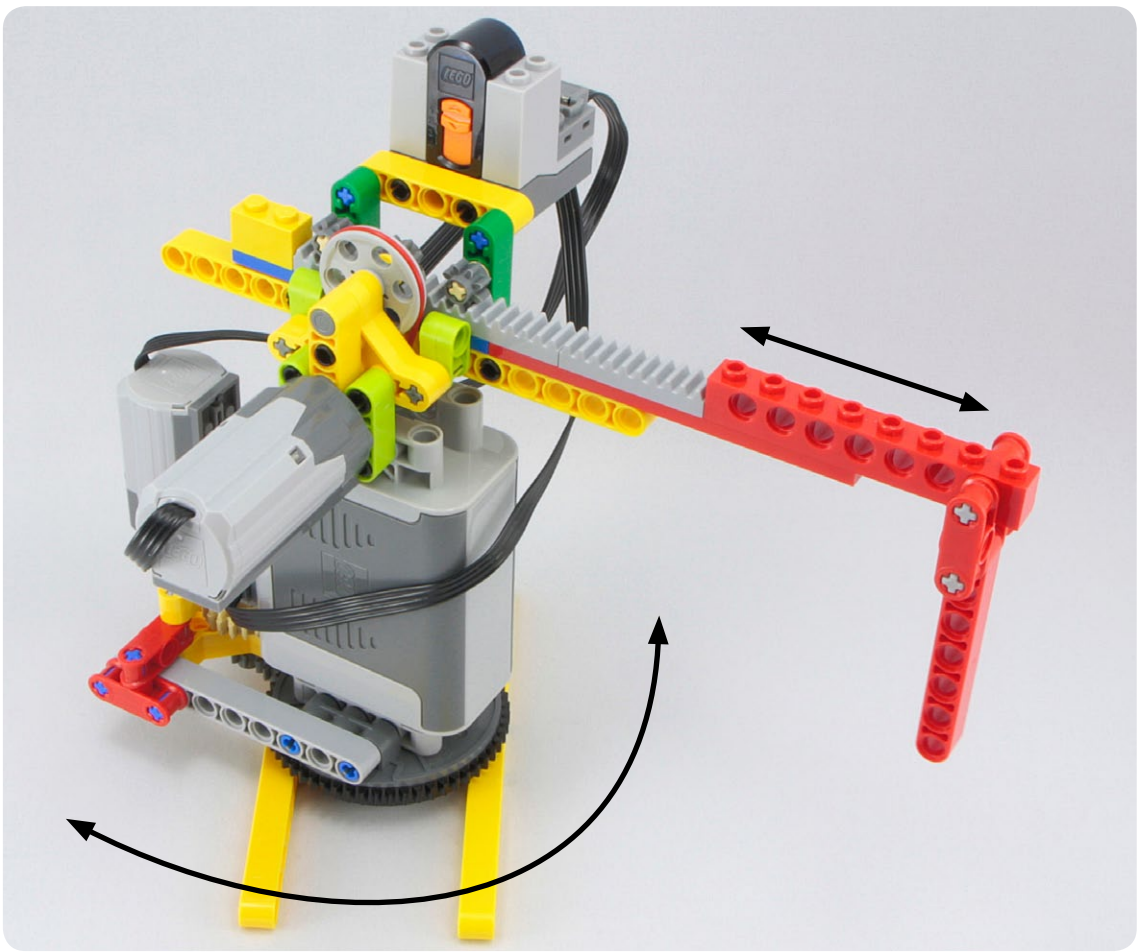
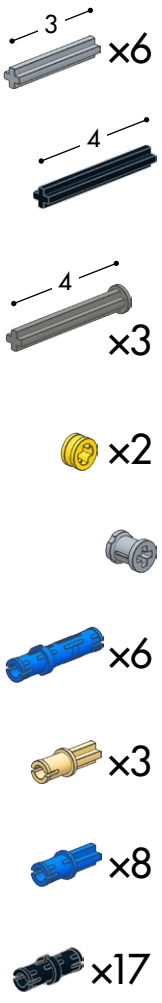
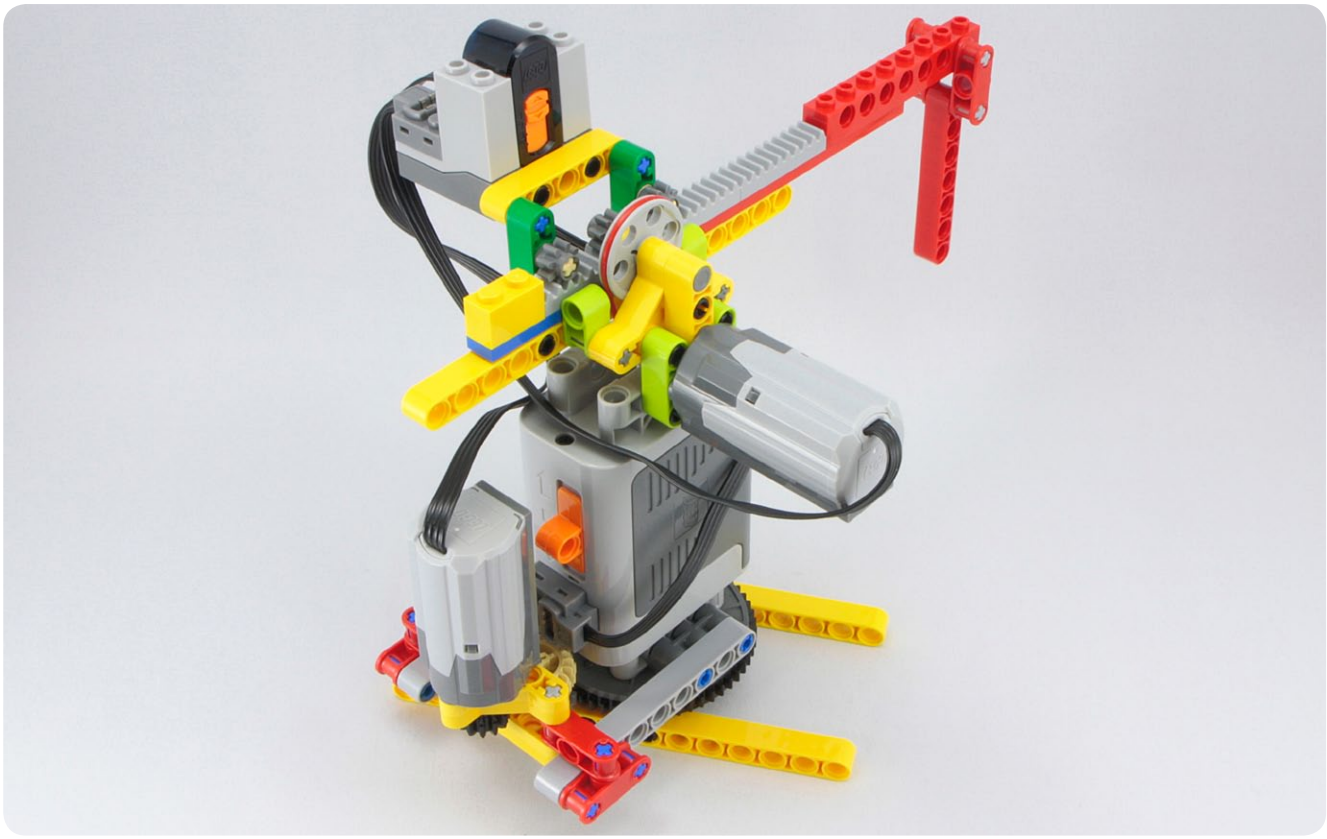
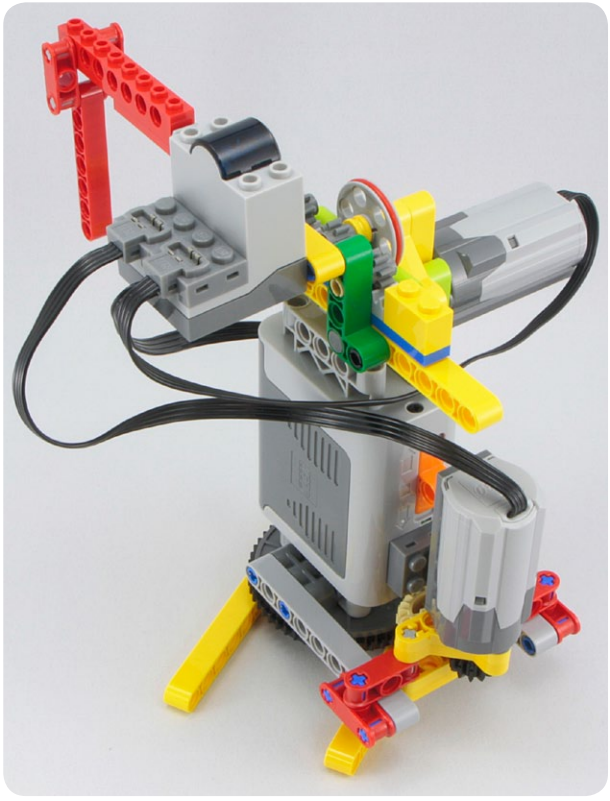
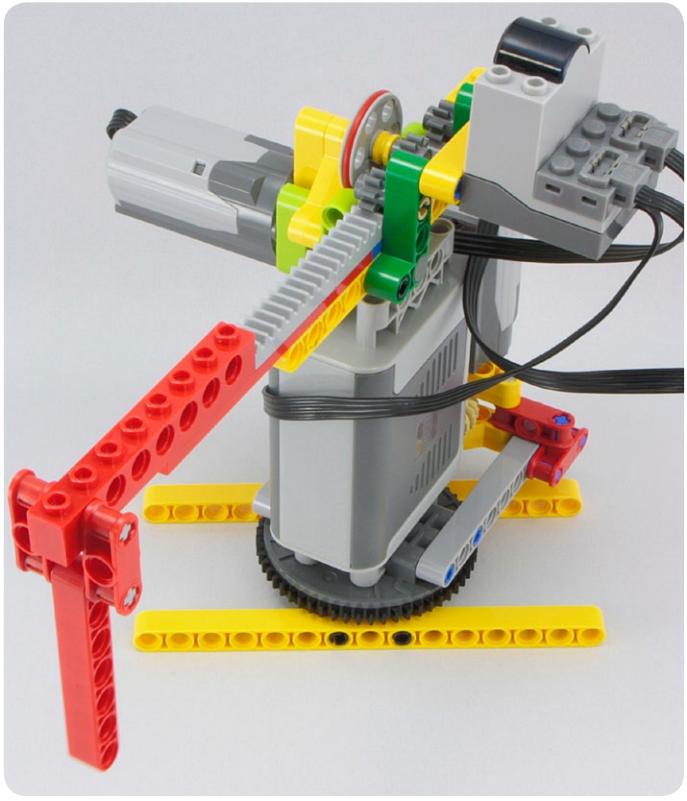


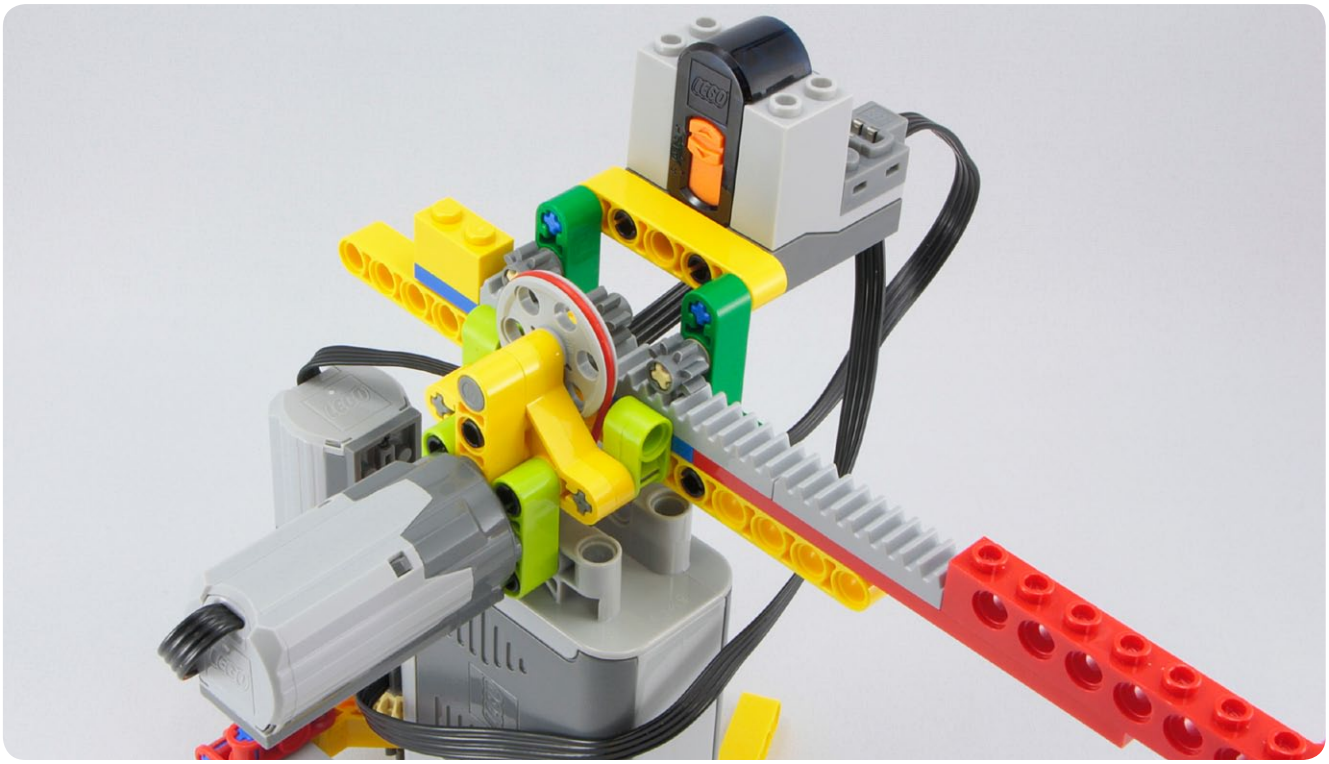


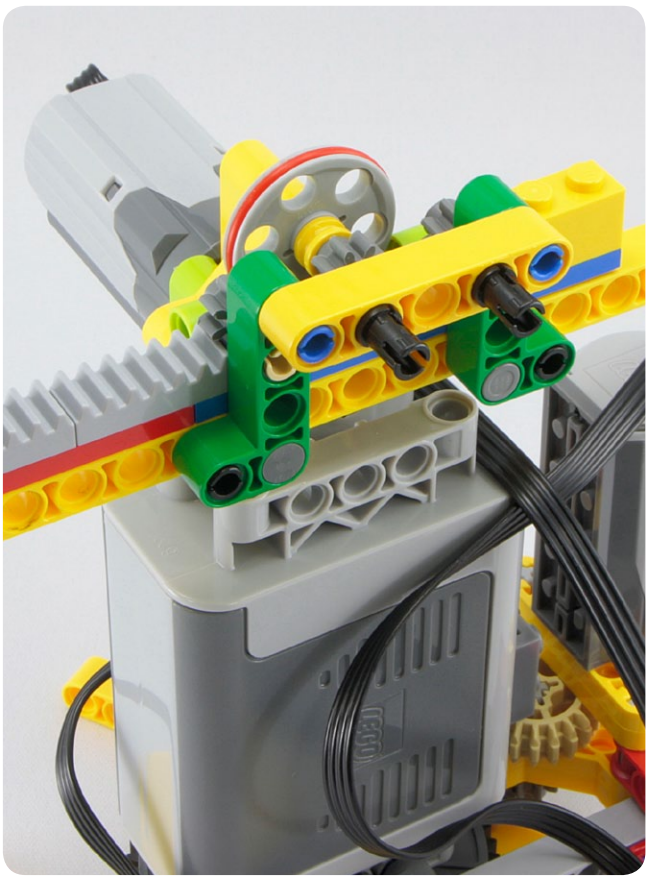


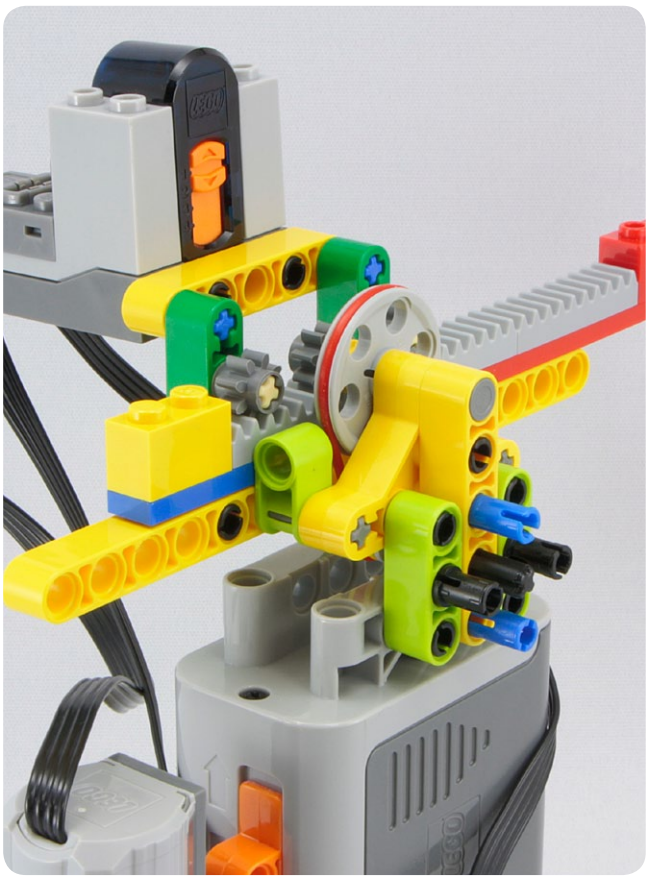


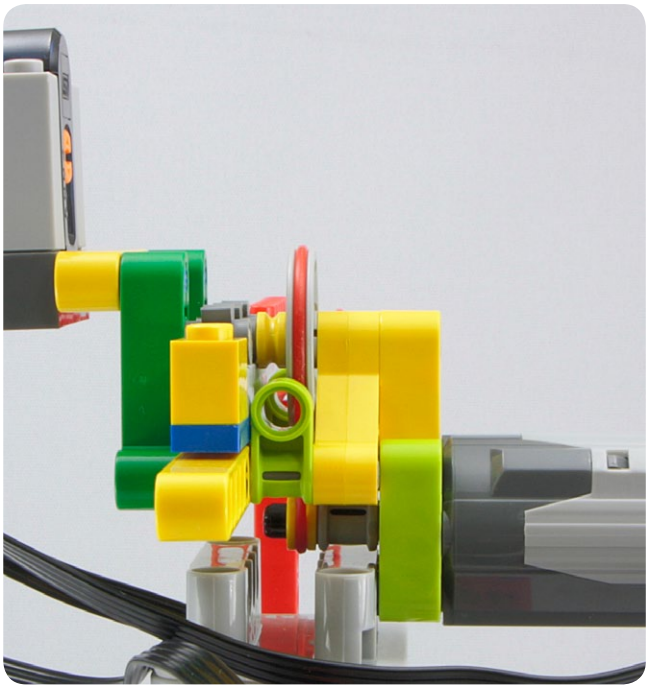


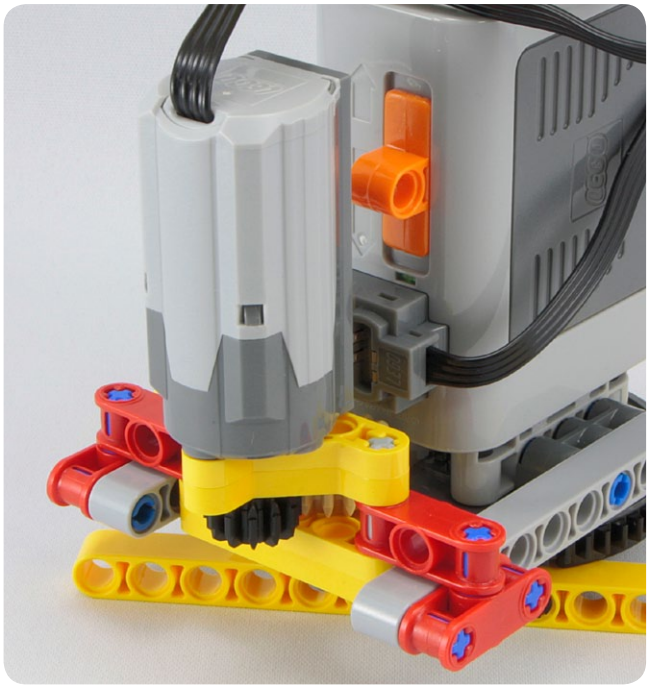


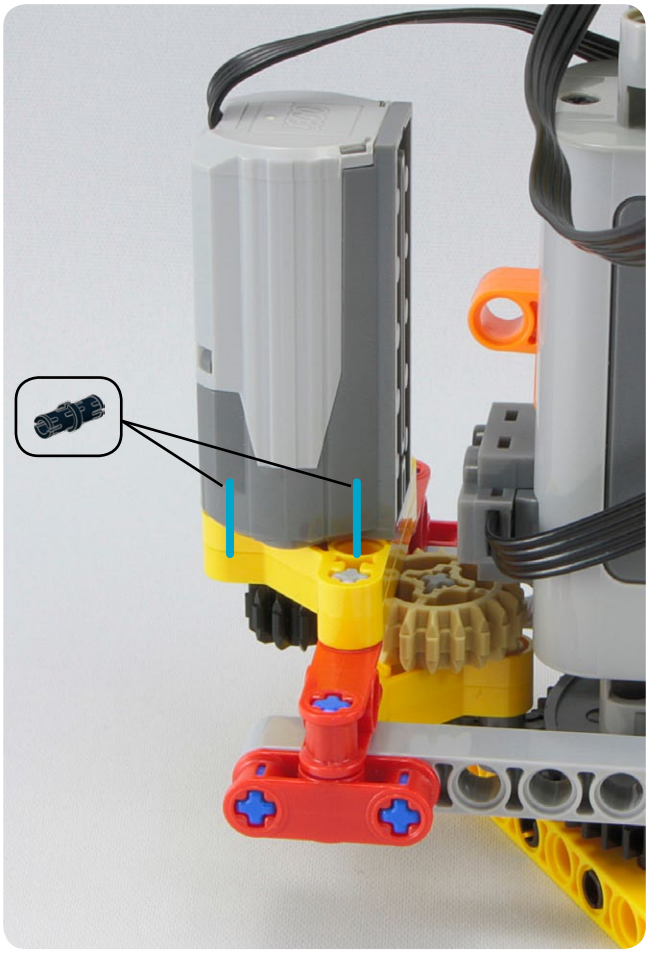


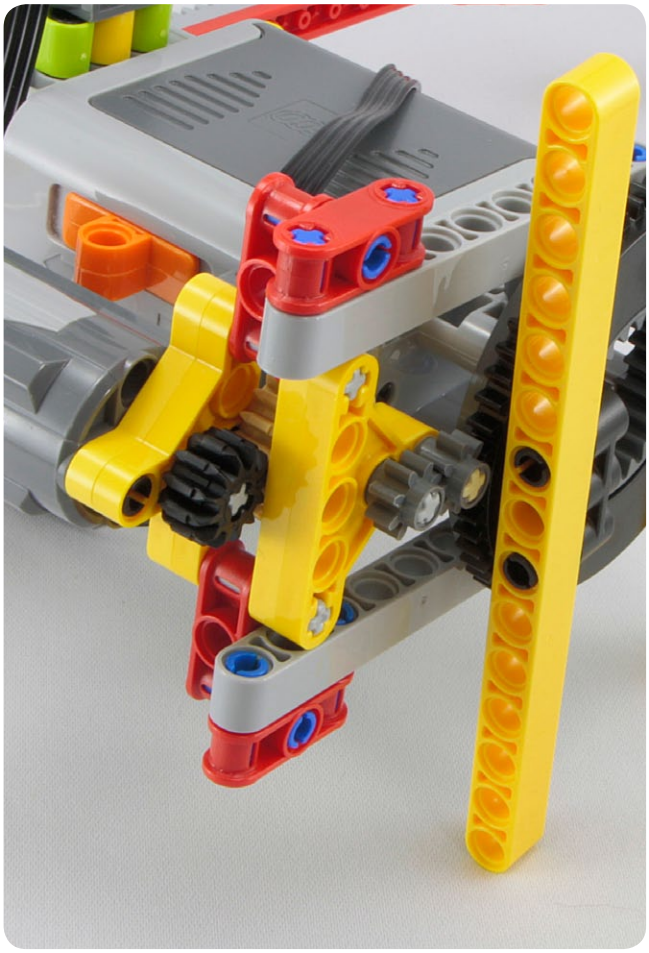


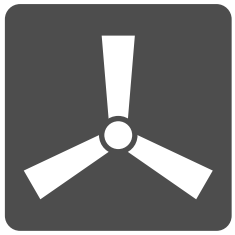










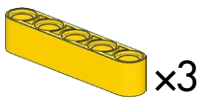


Caution!
These models spin.
Protect your eyes.

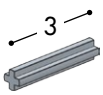
Spinning fans

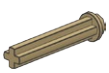
#253

×2



×3





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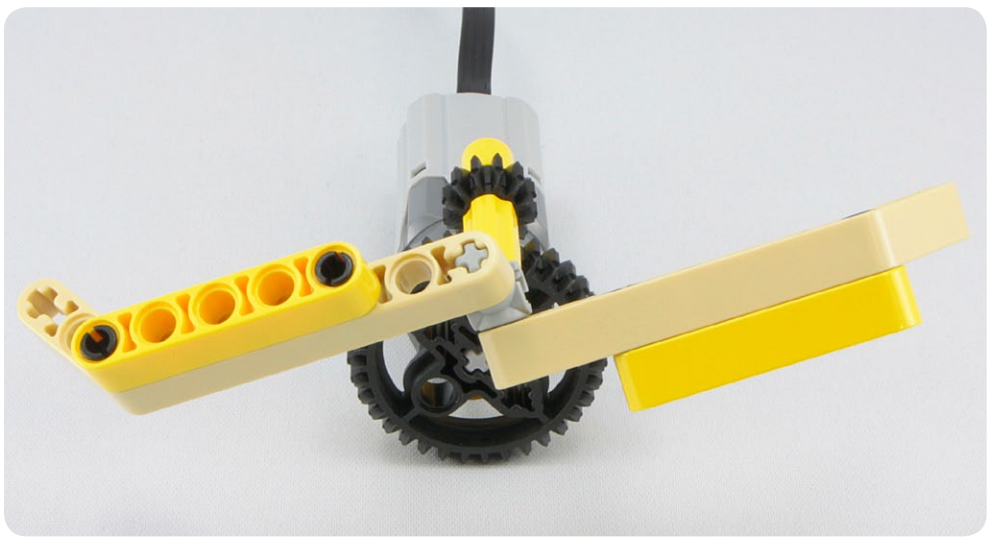

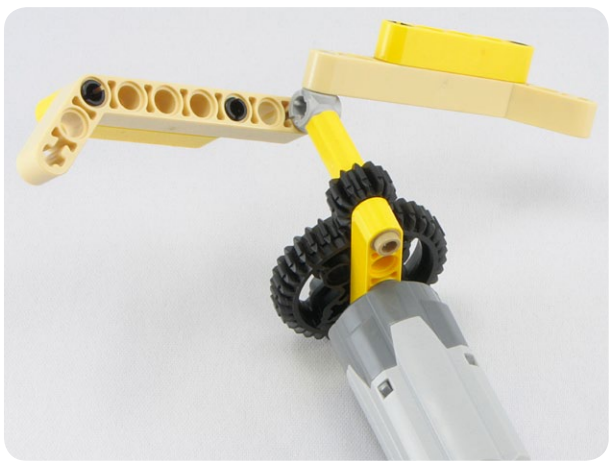

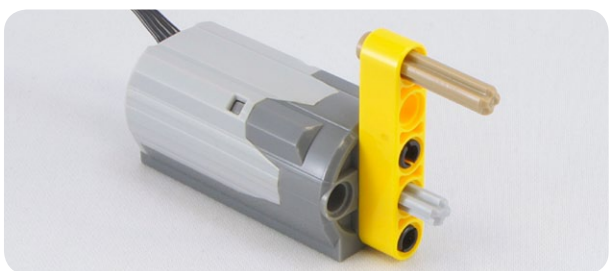

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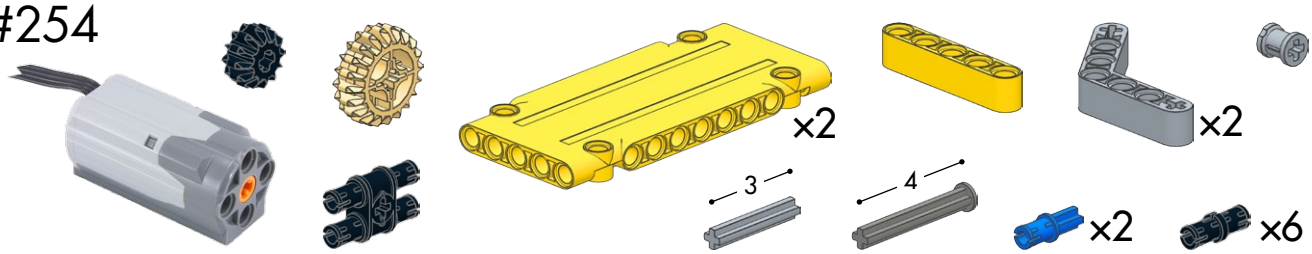

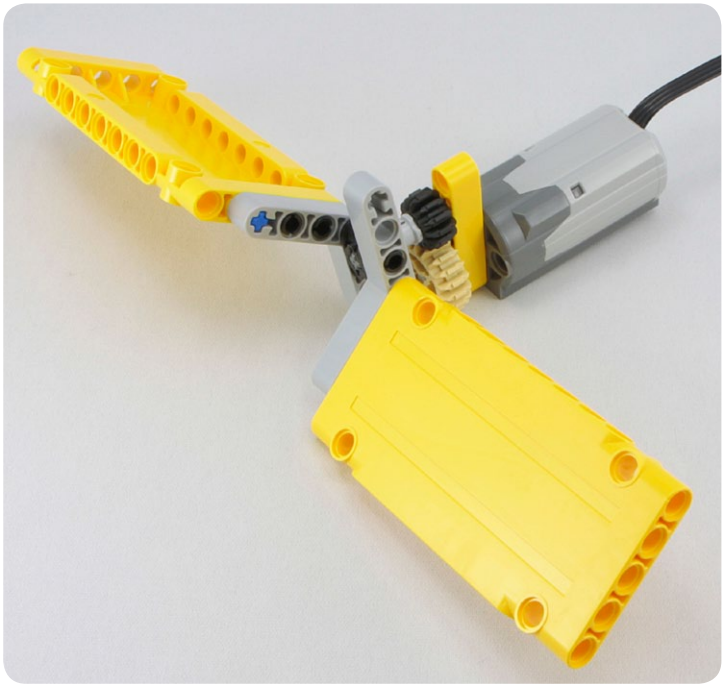

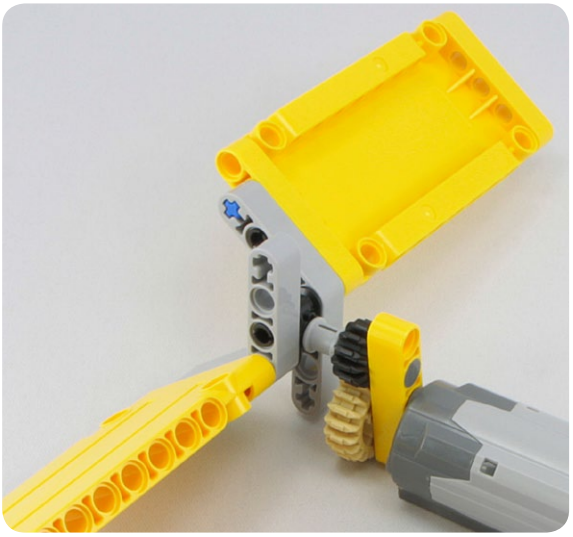

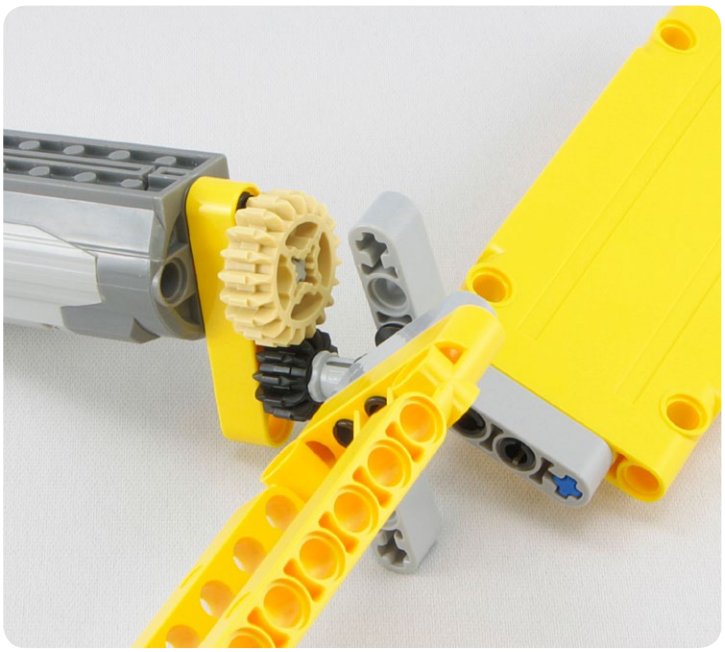

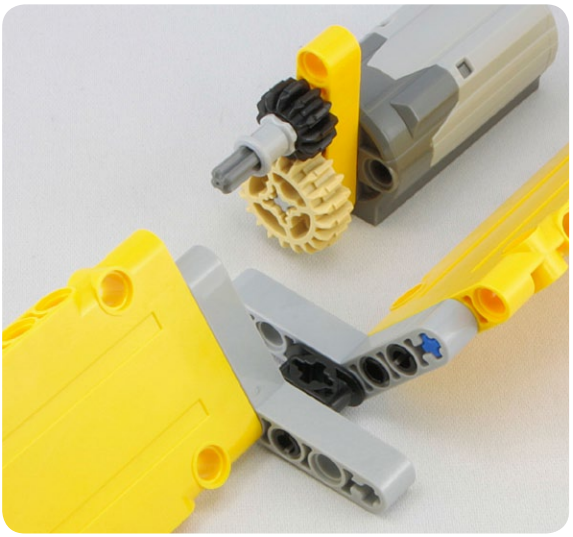

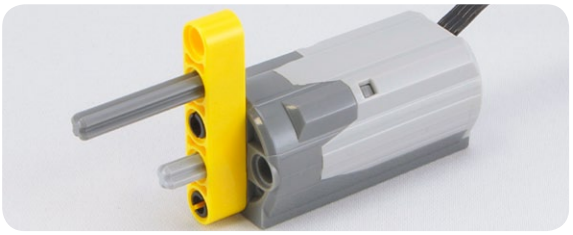

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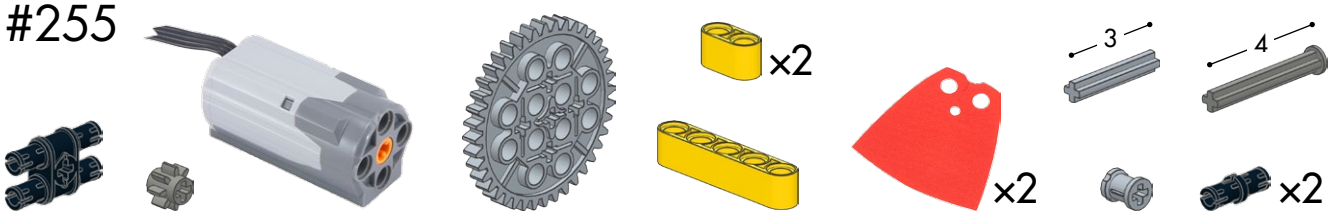

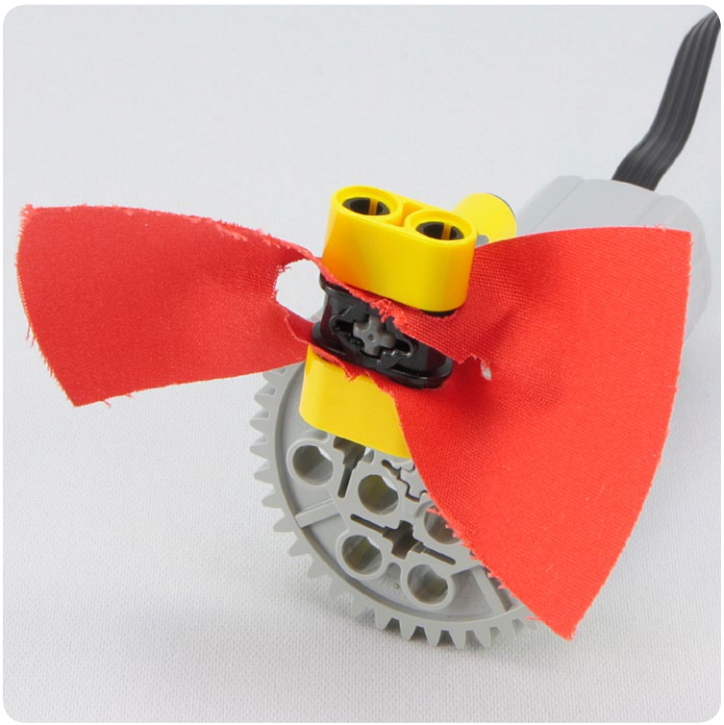

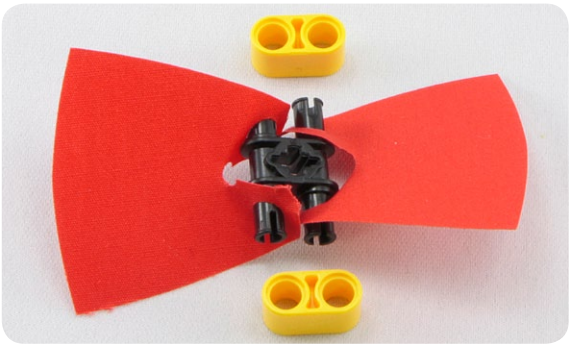

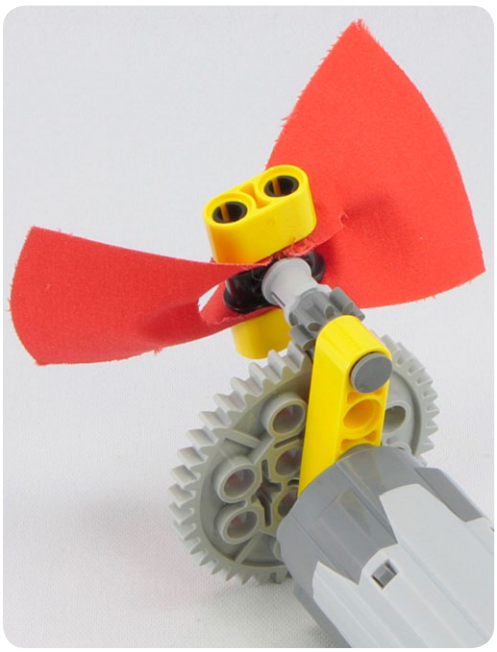

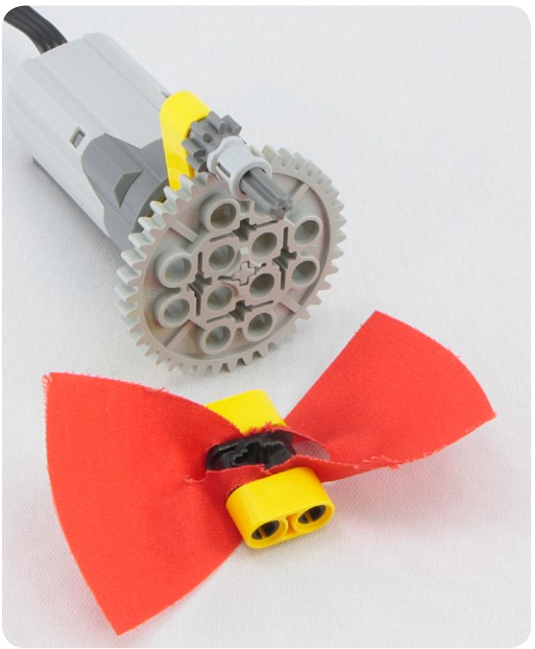

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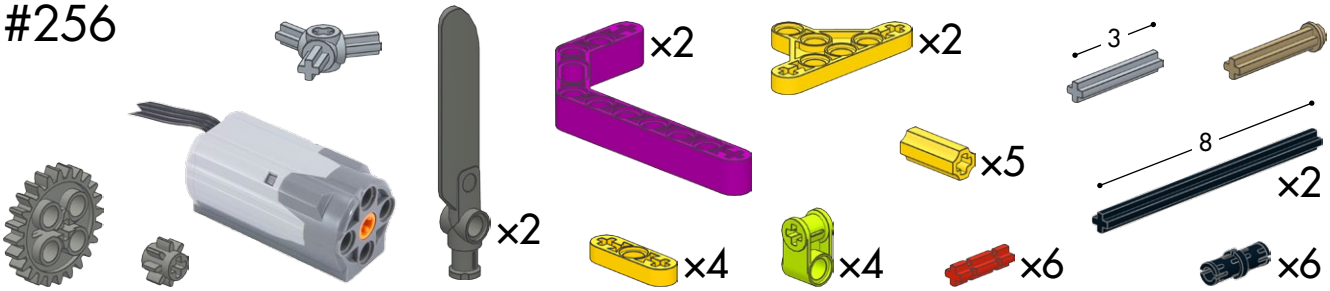

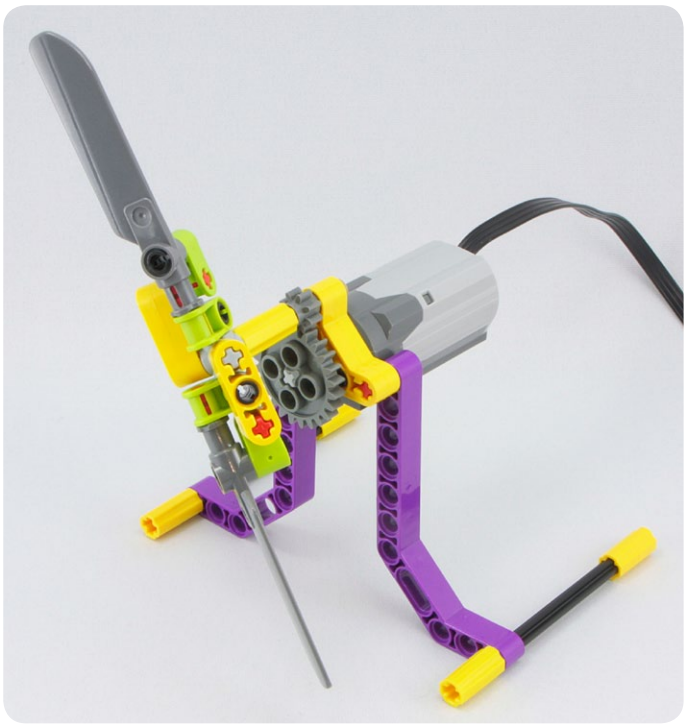

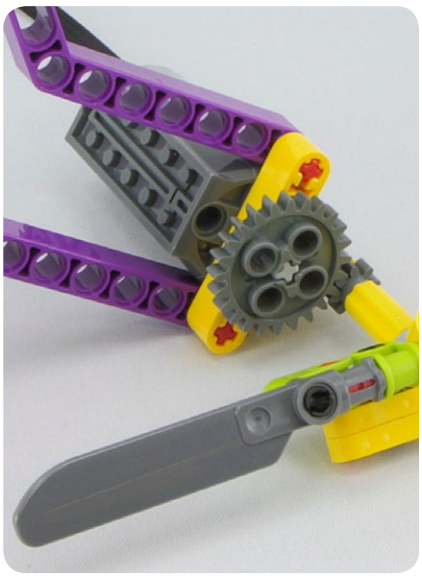

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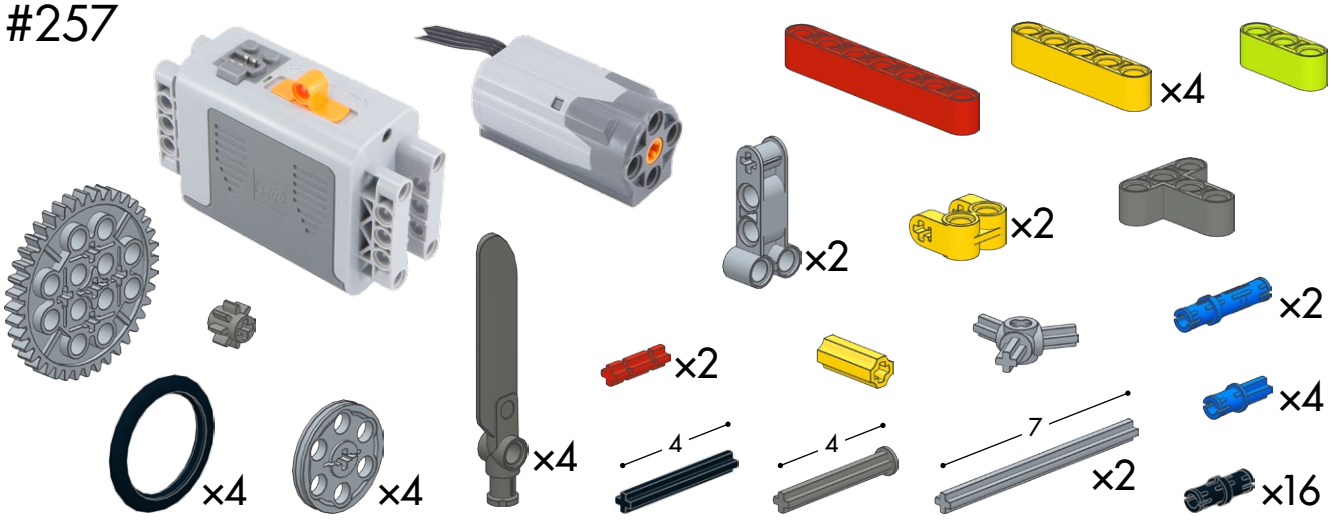

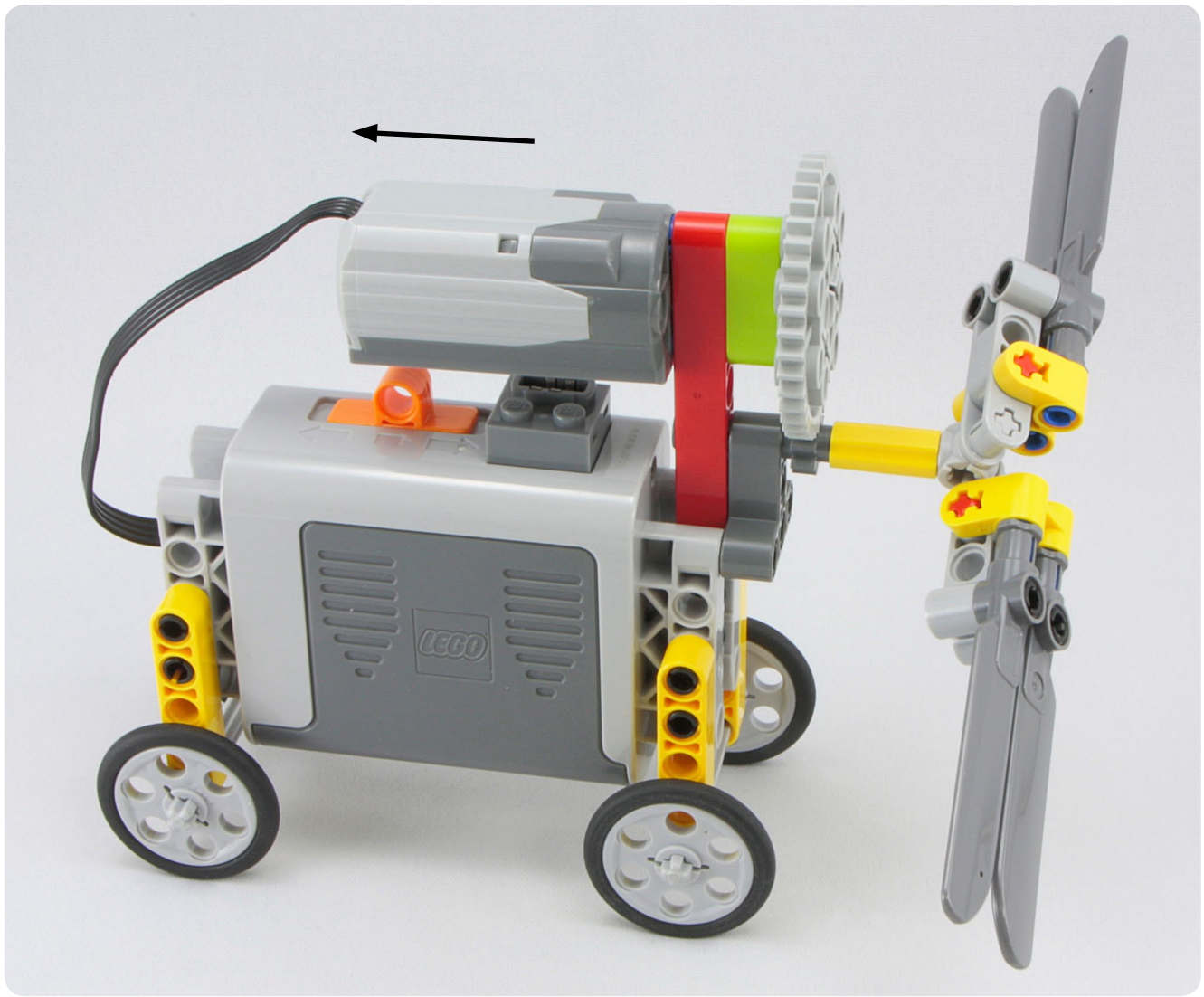

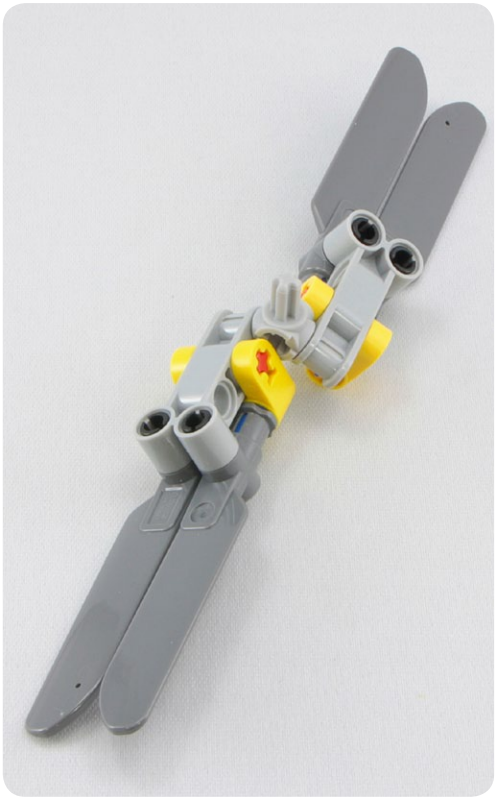

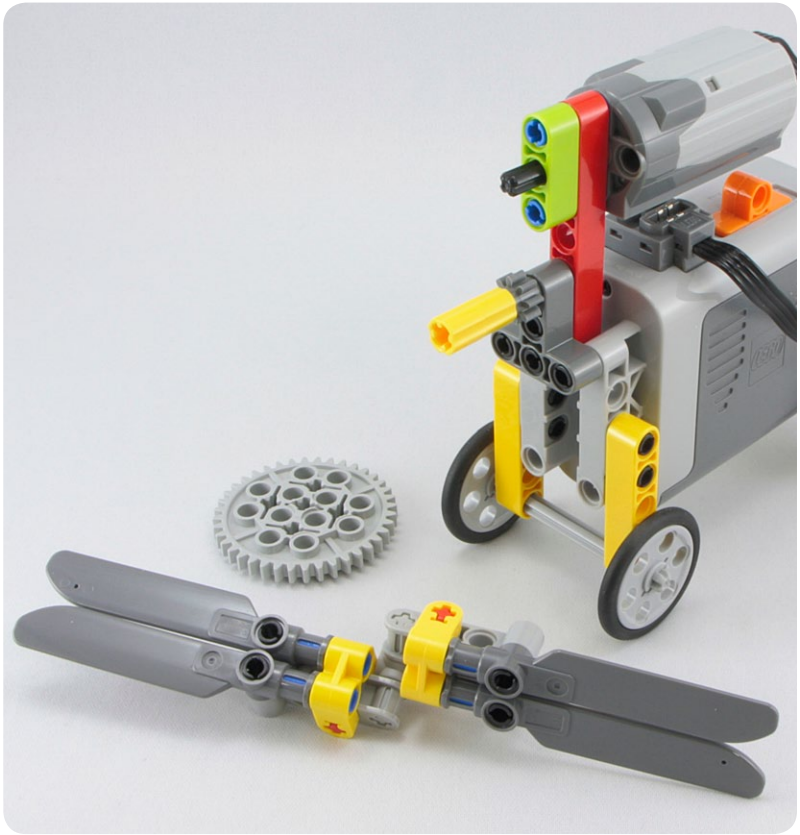

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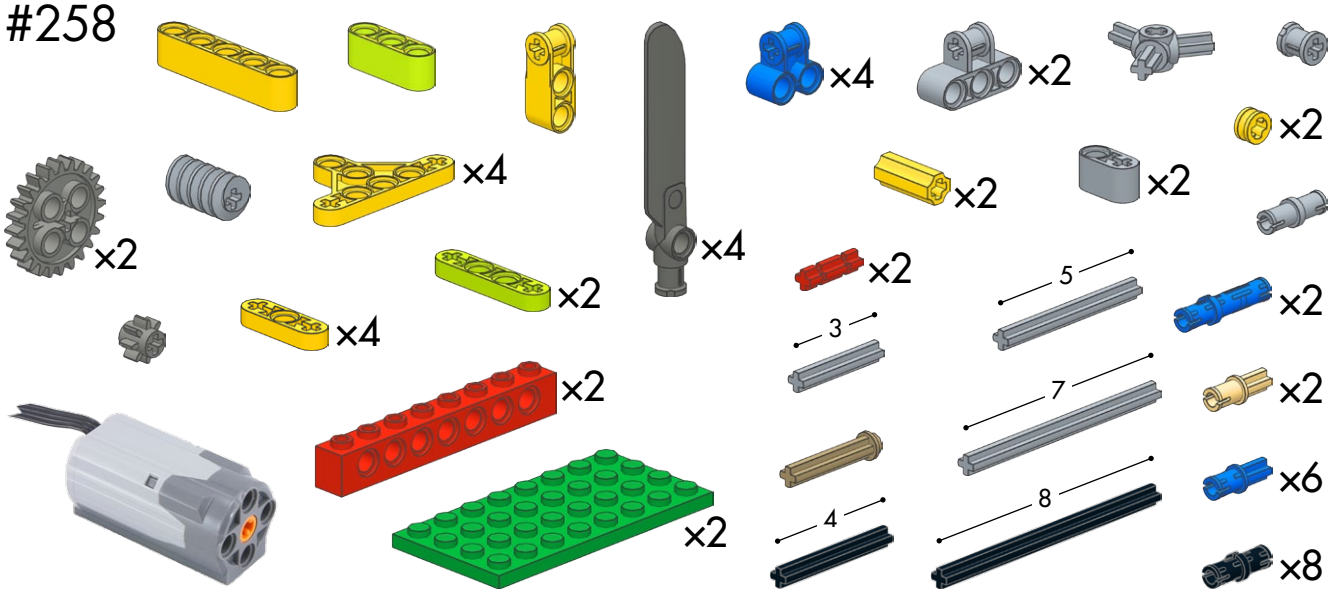

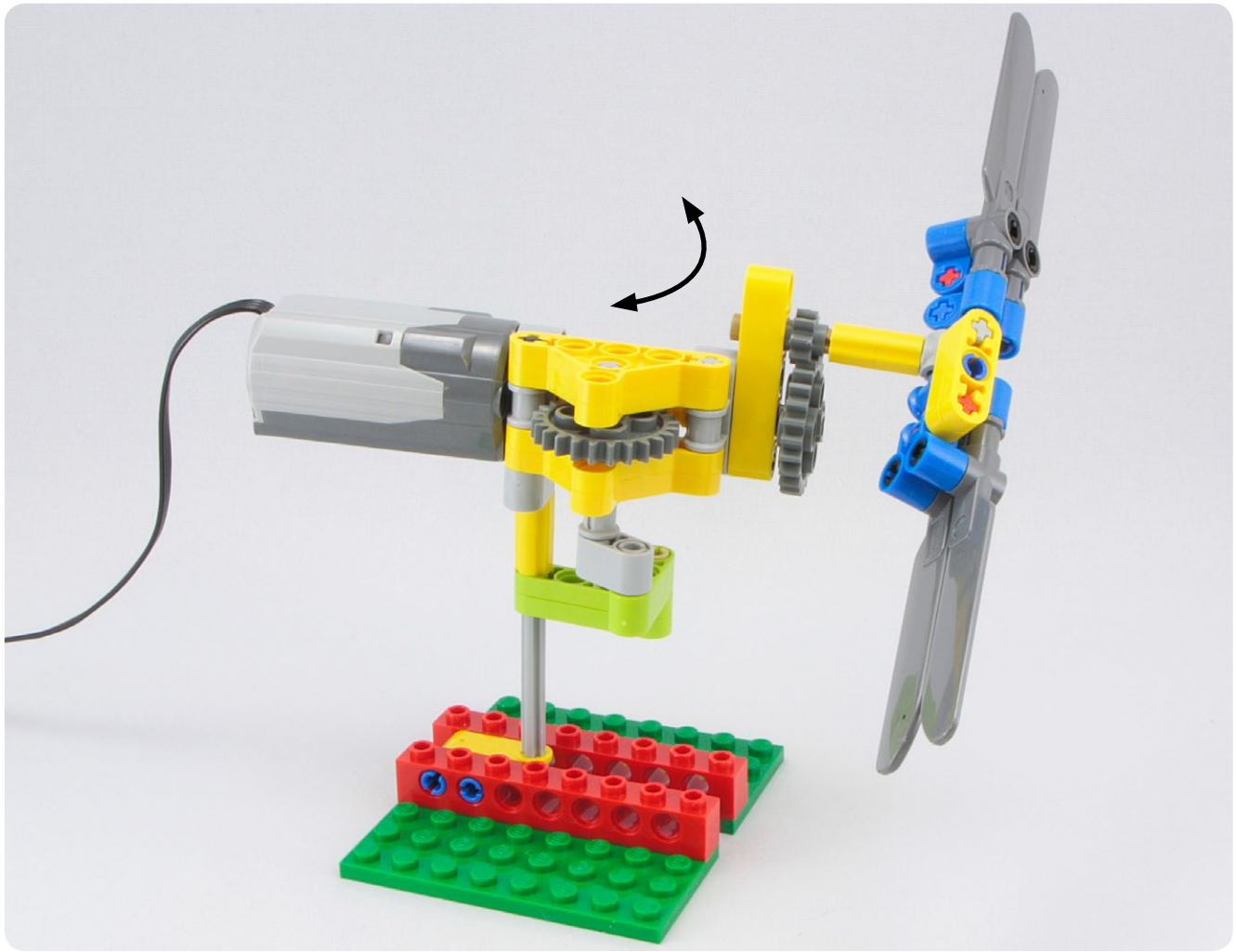

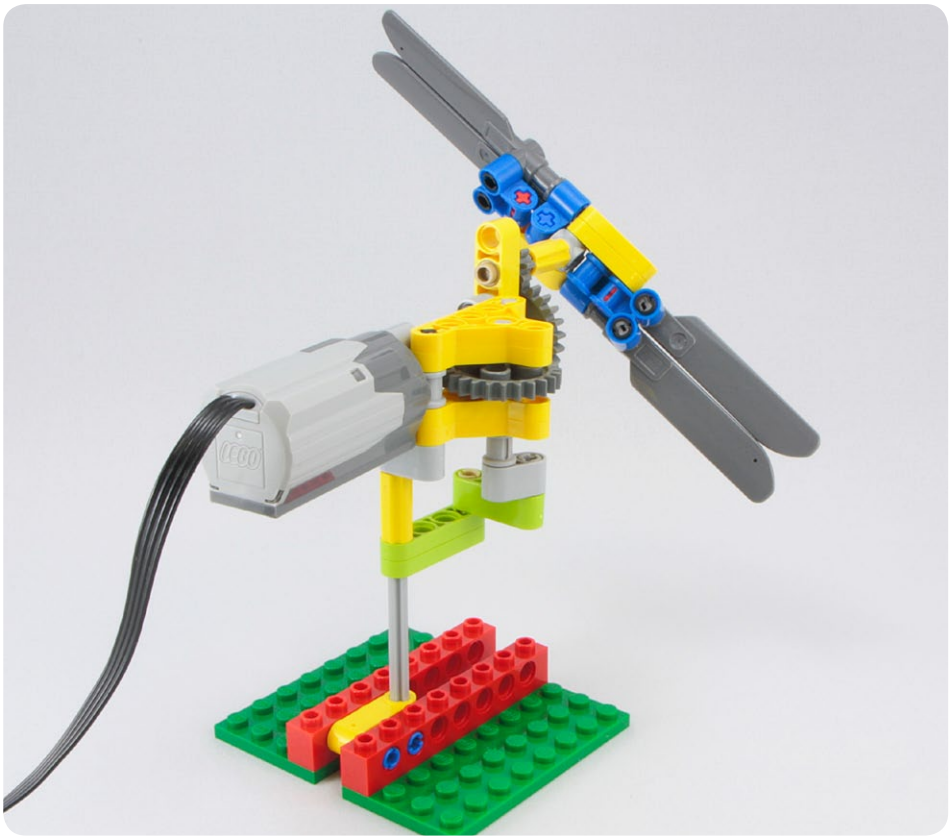

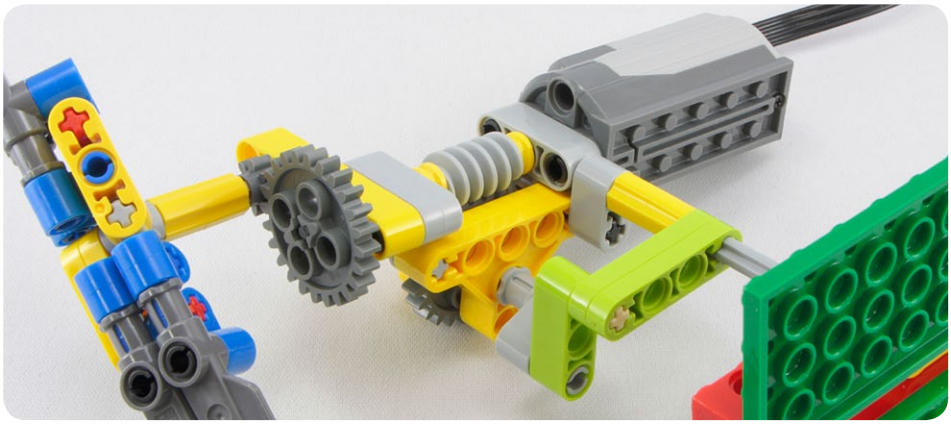

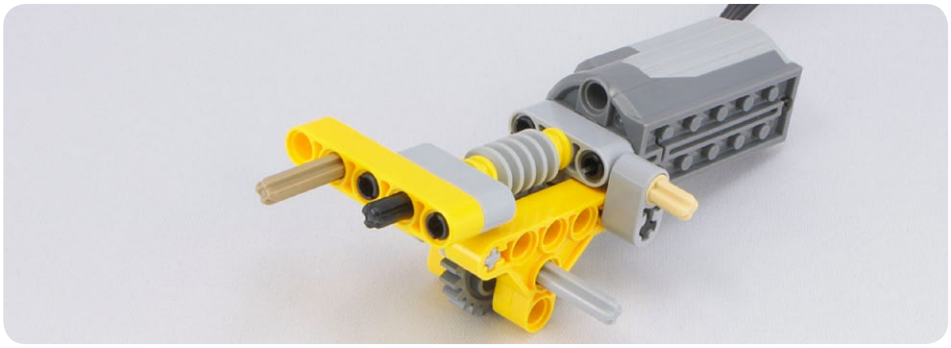

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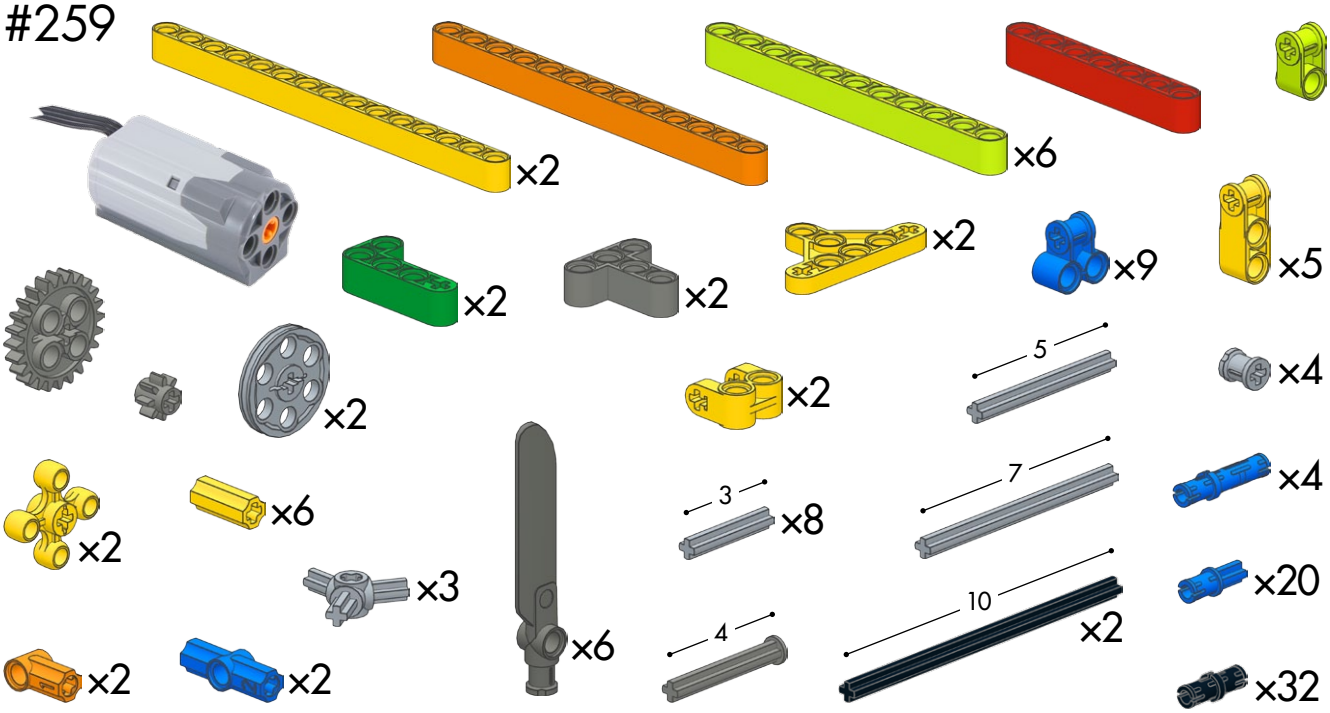
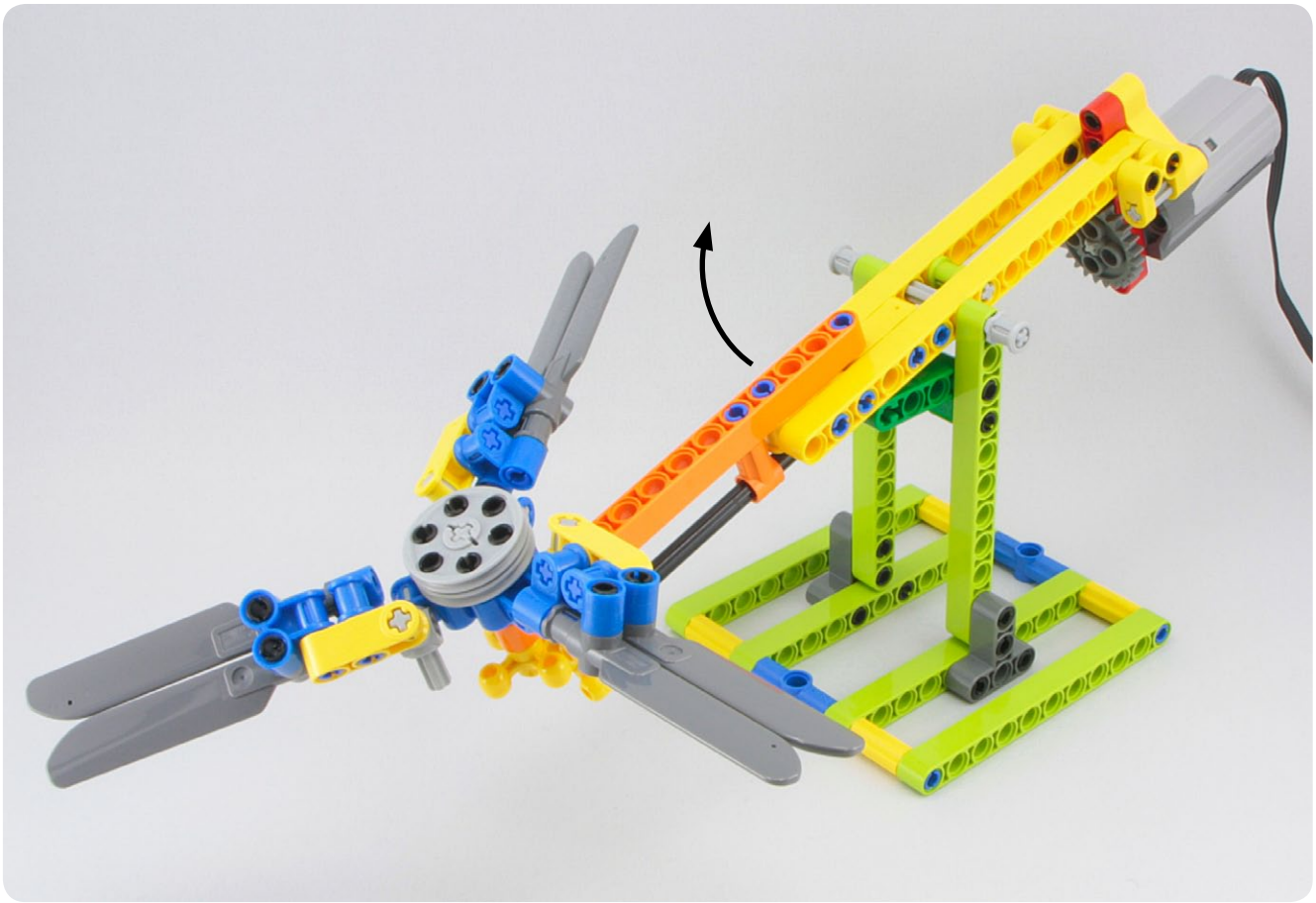
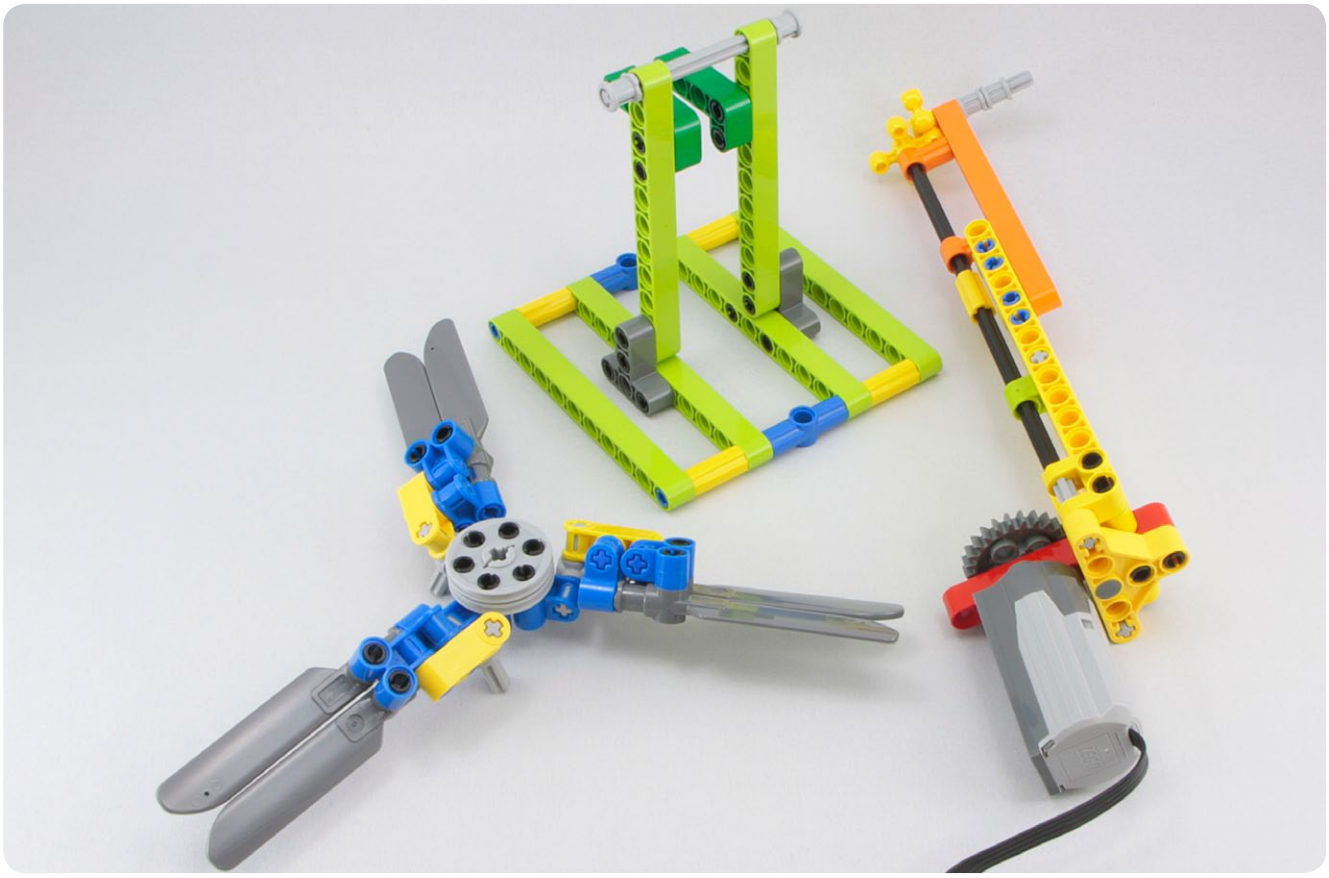
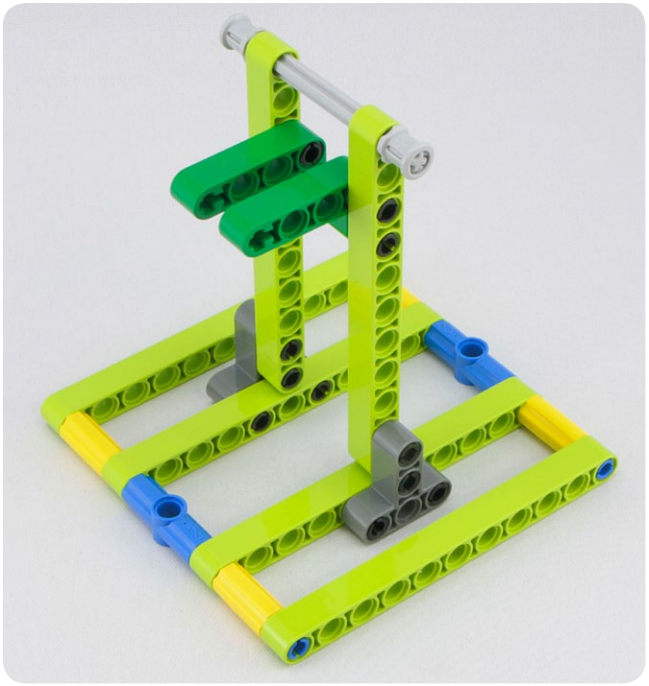
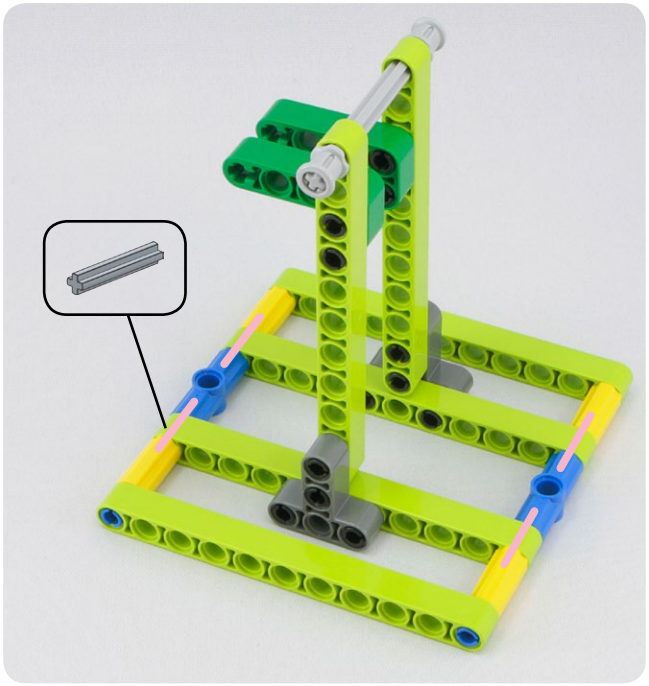
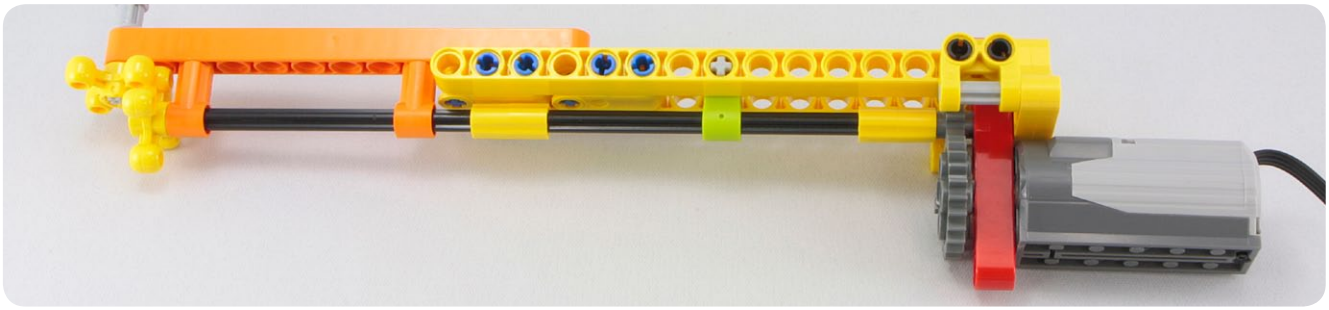


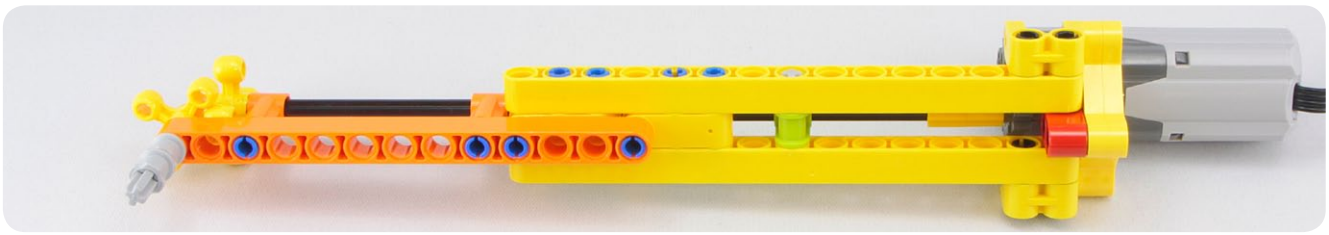


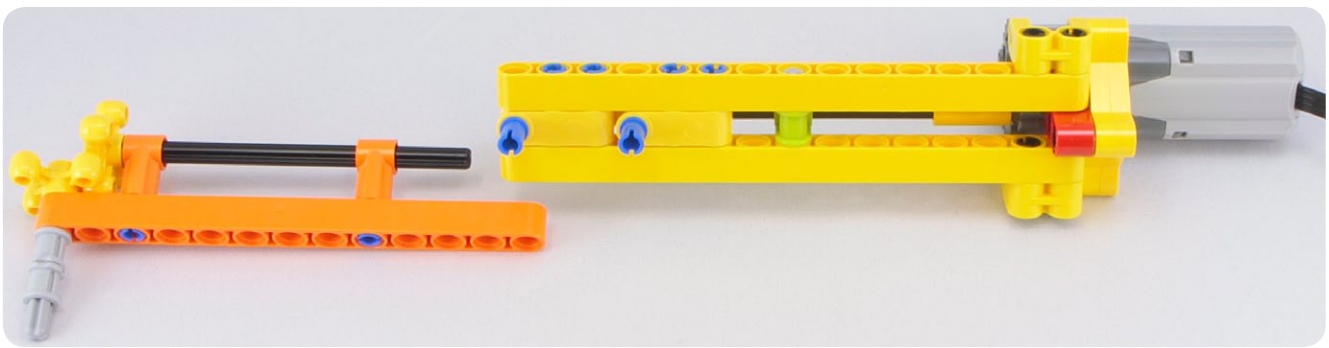


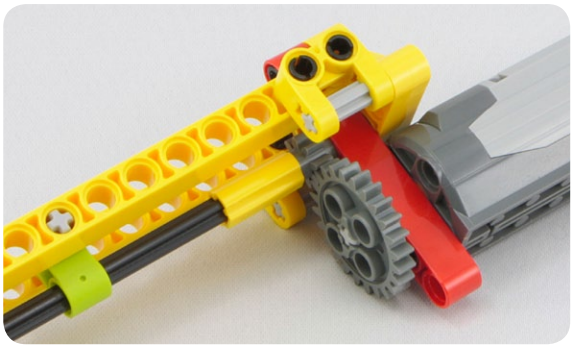


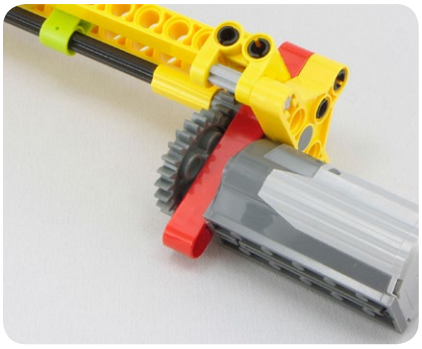


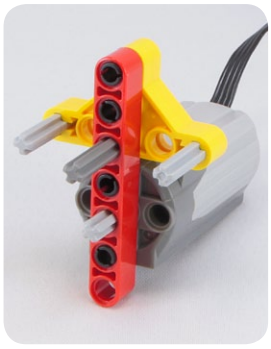


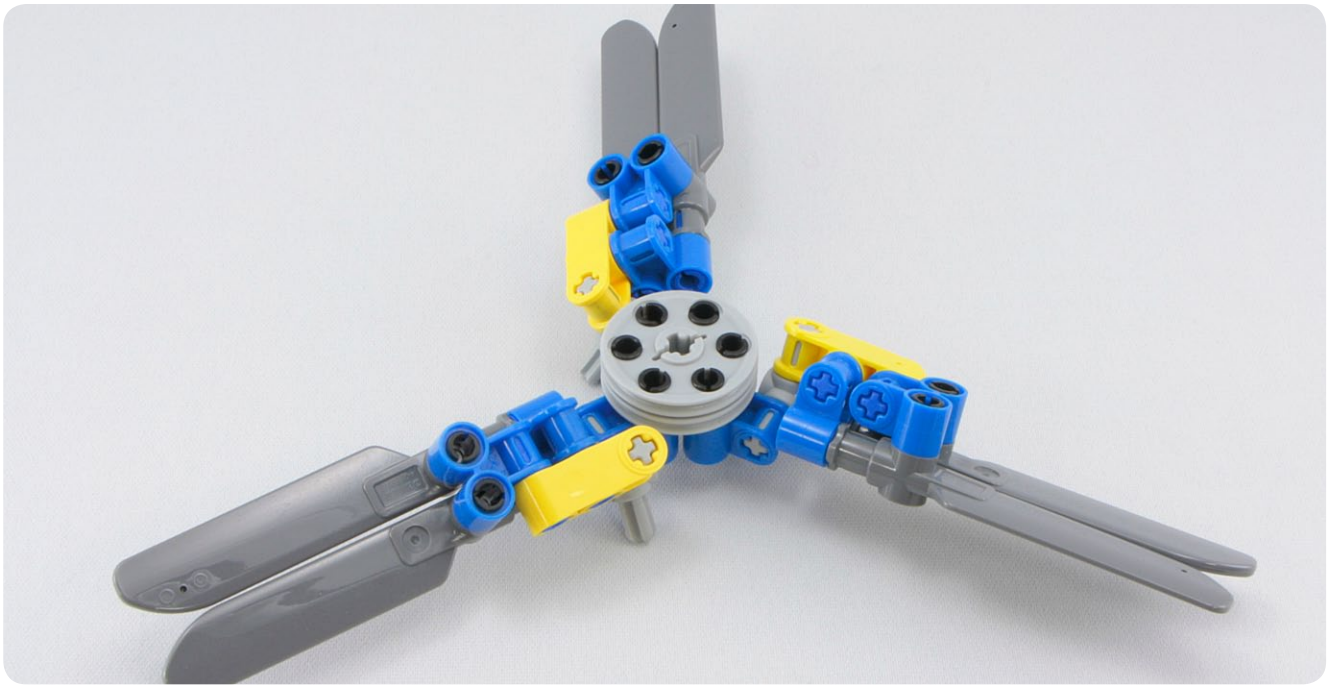


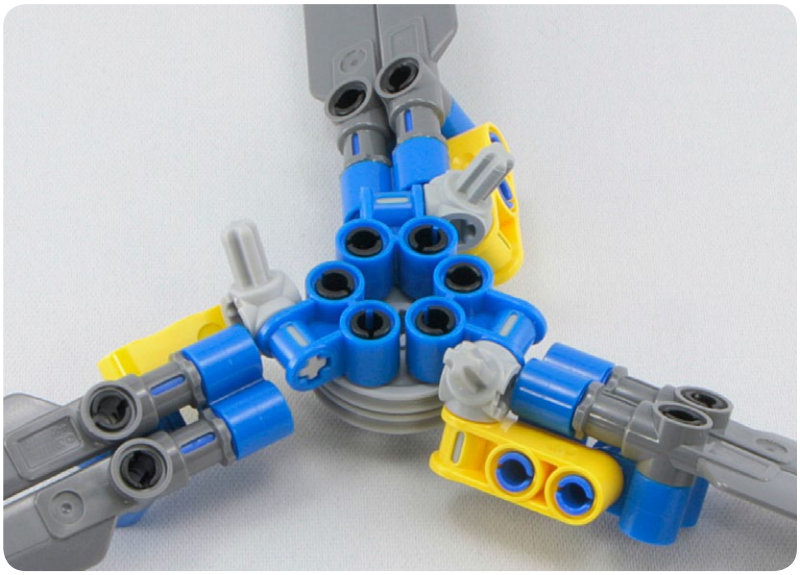






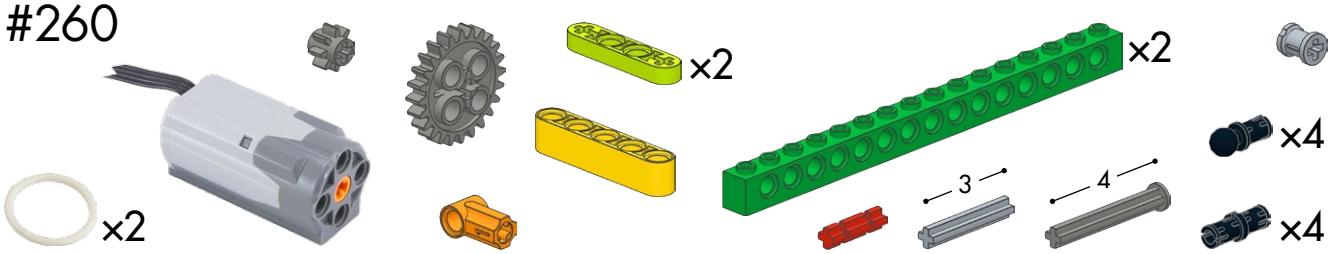


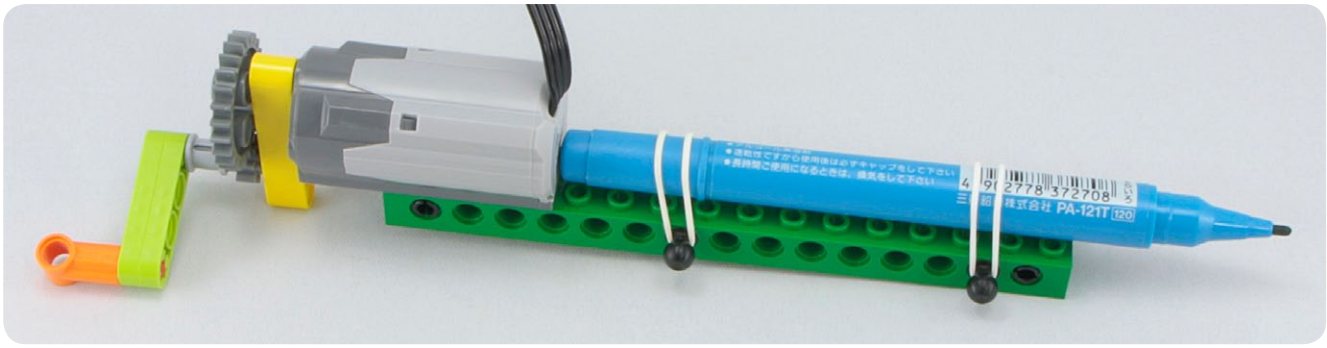


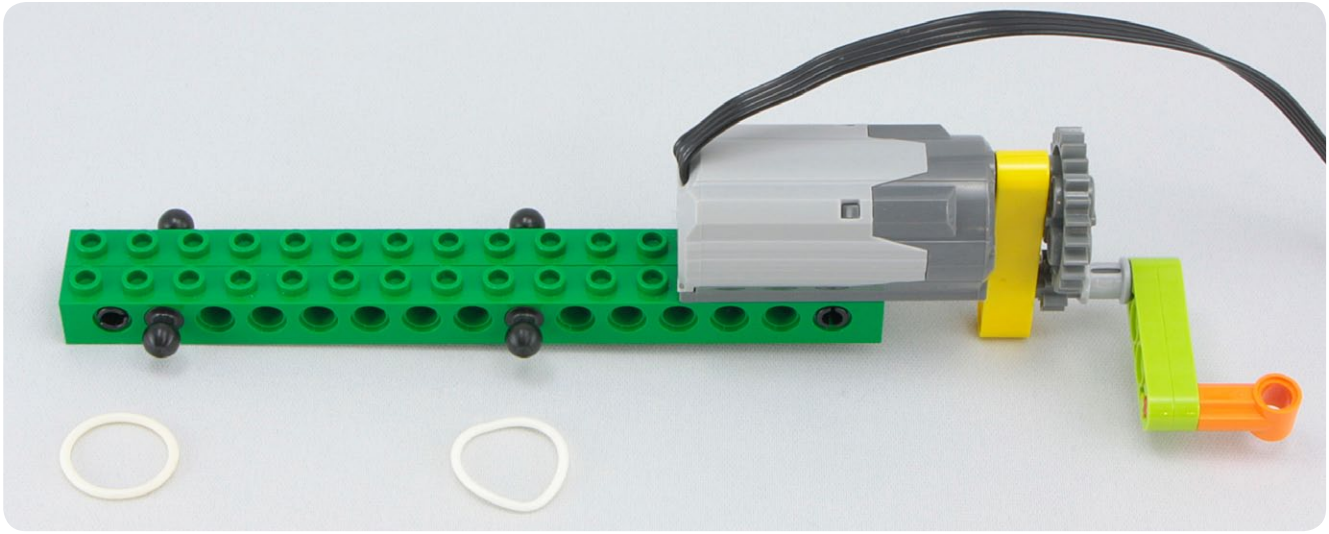


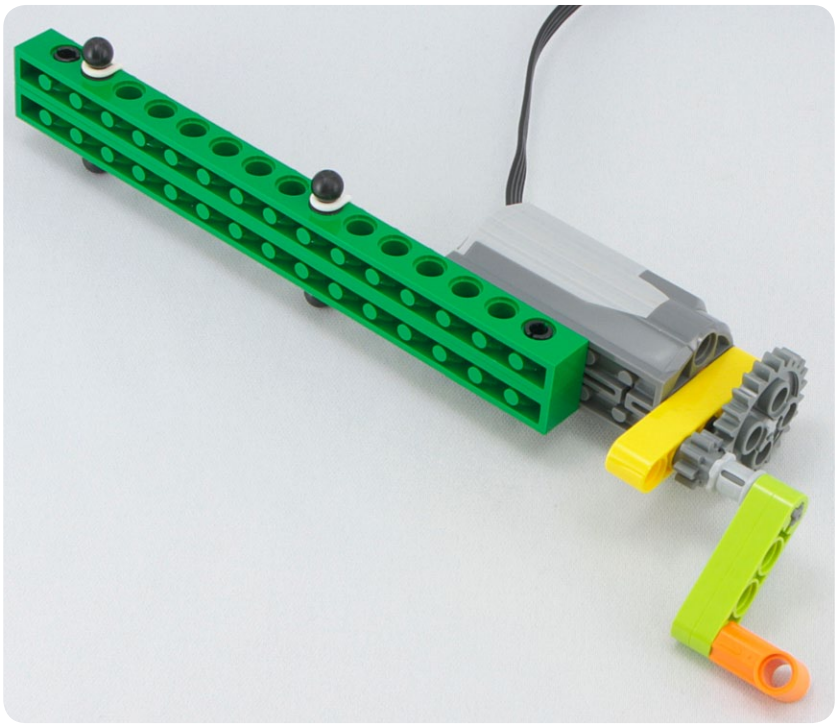
Drawing pictures

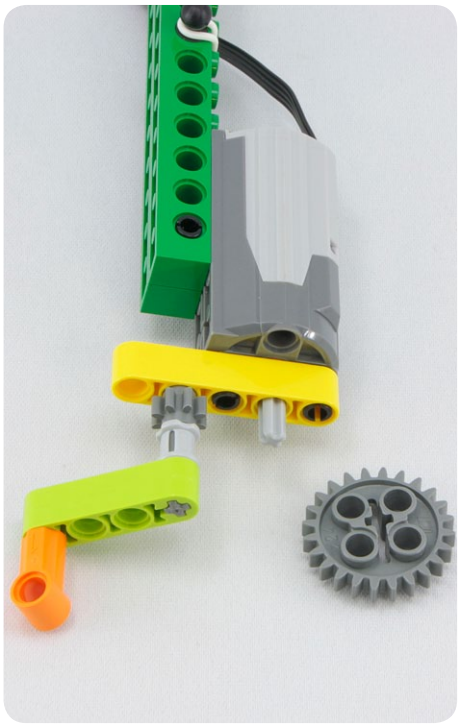
#260




PA-121T







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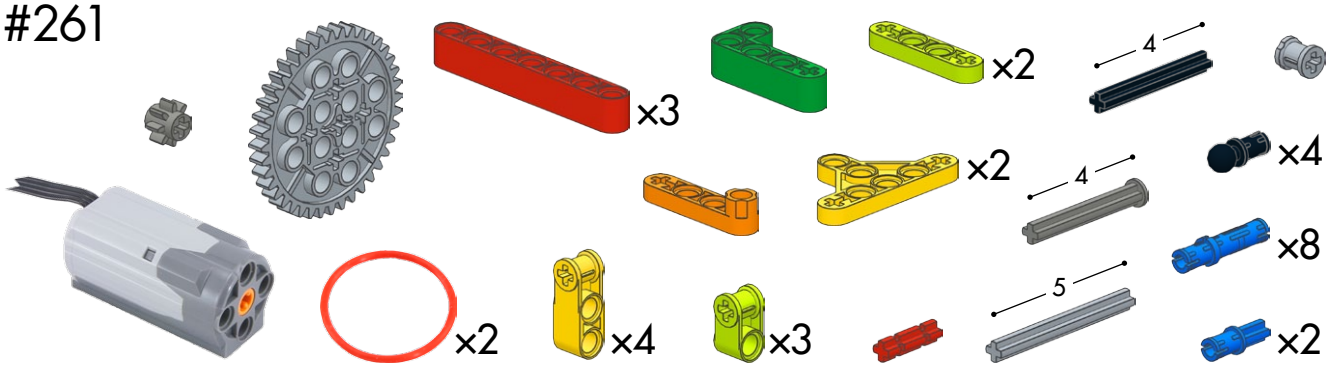
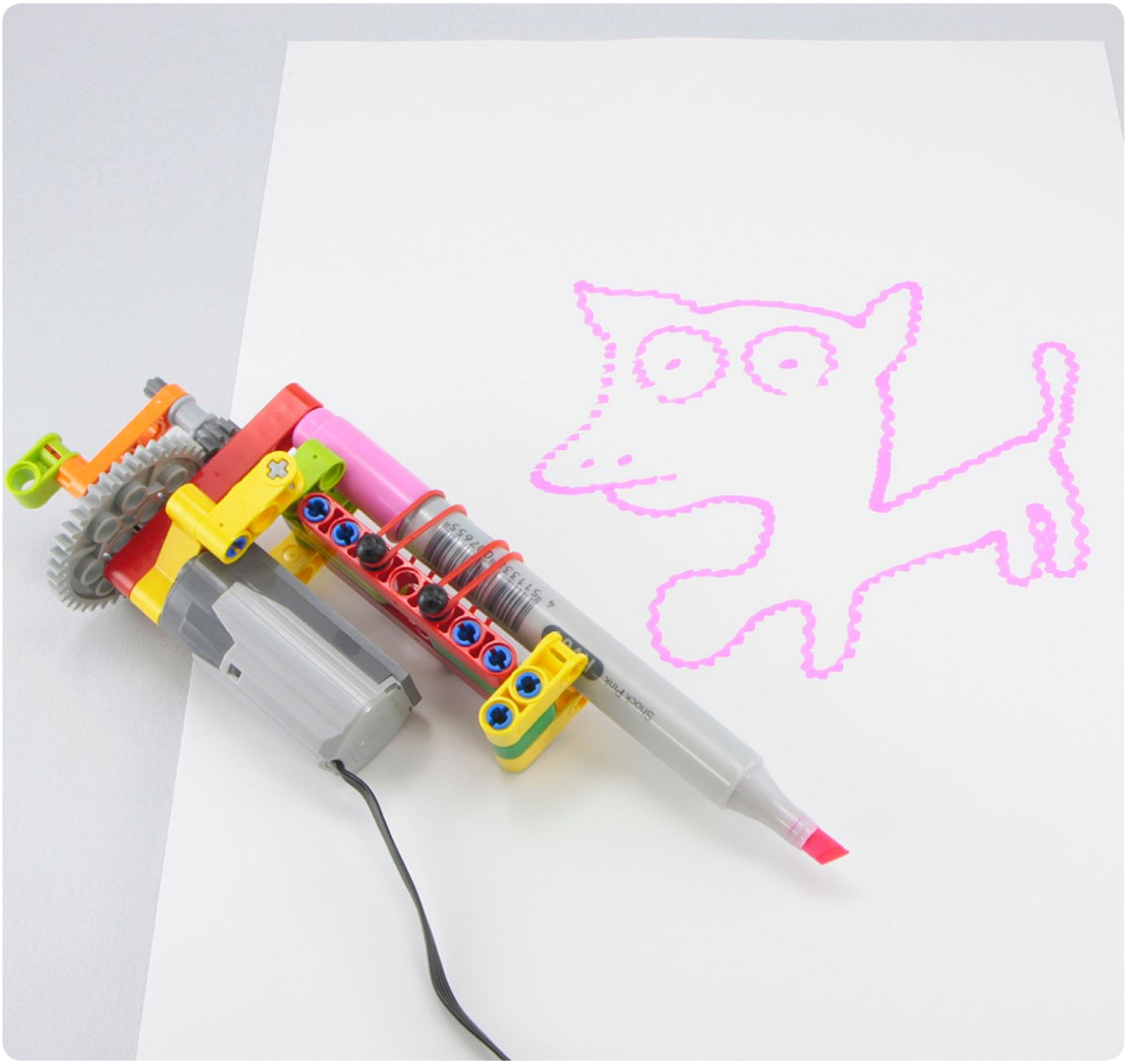
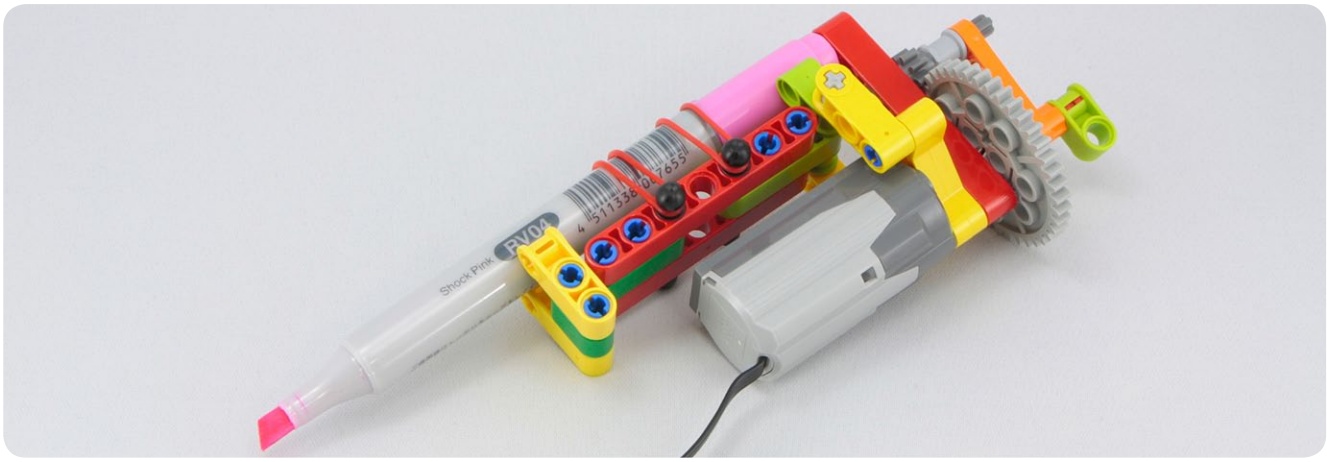
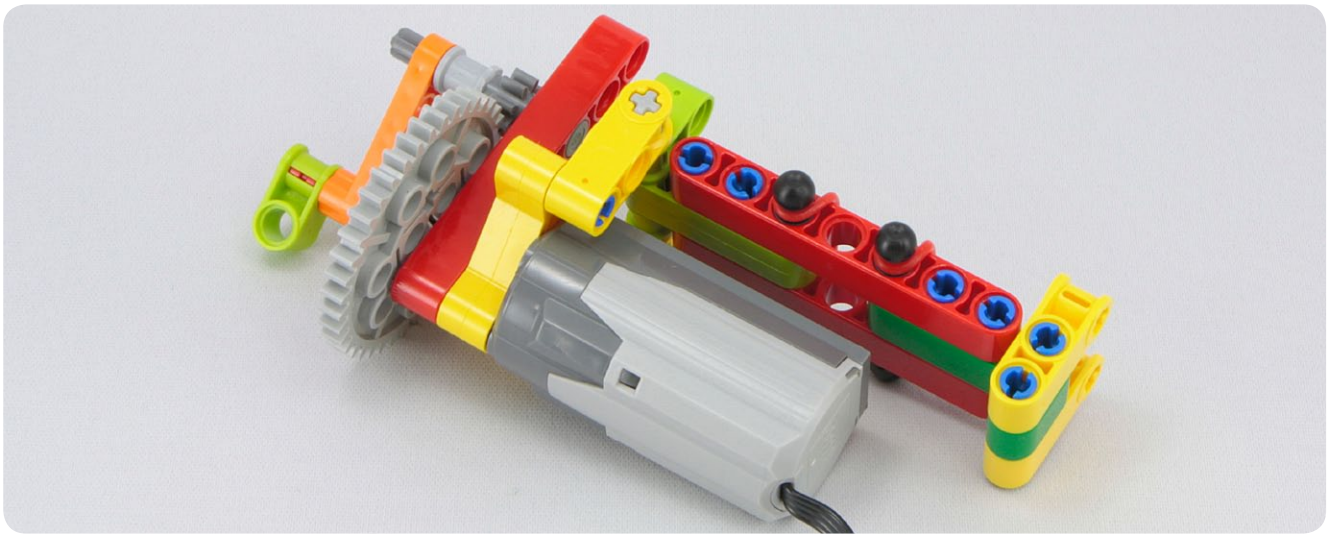
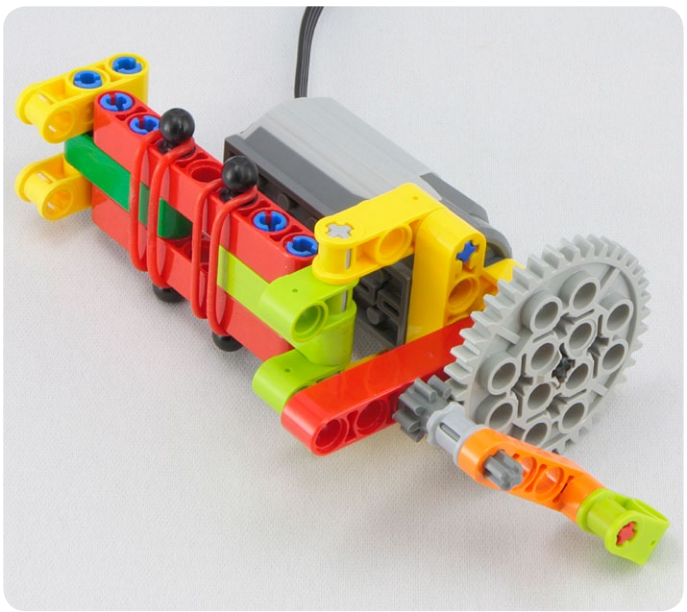





Shock Pink
RV01





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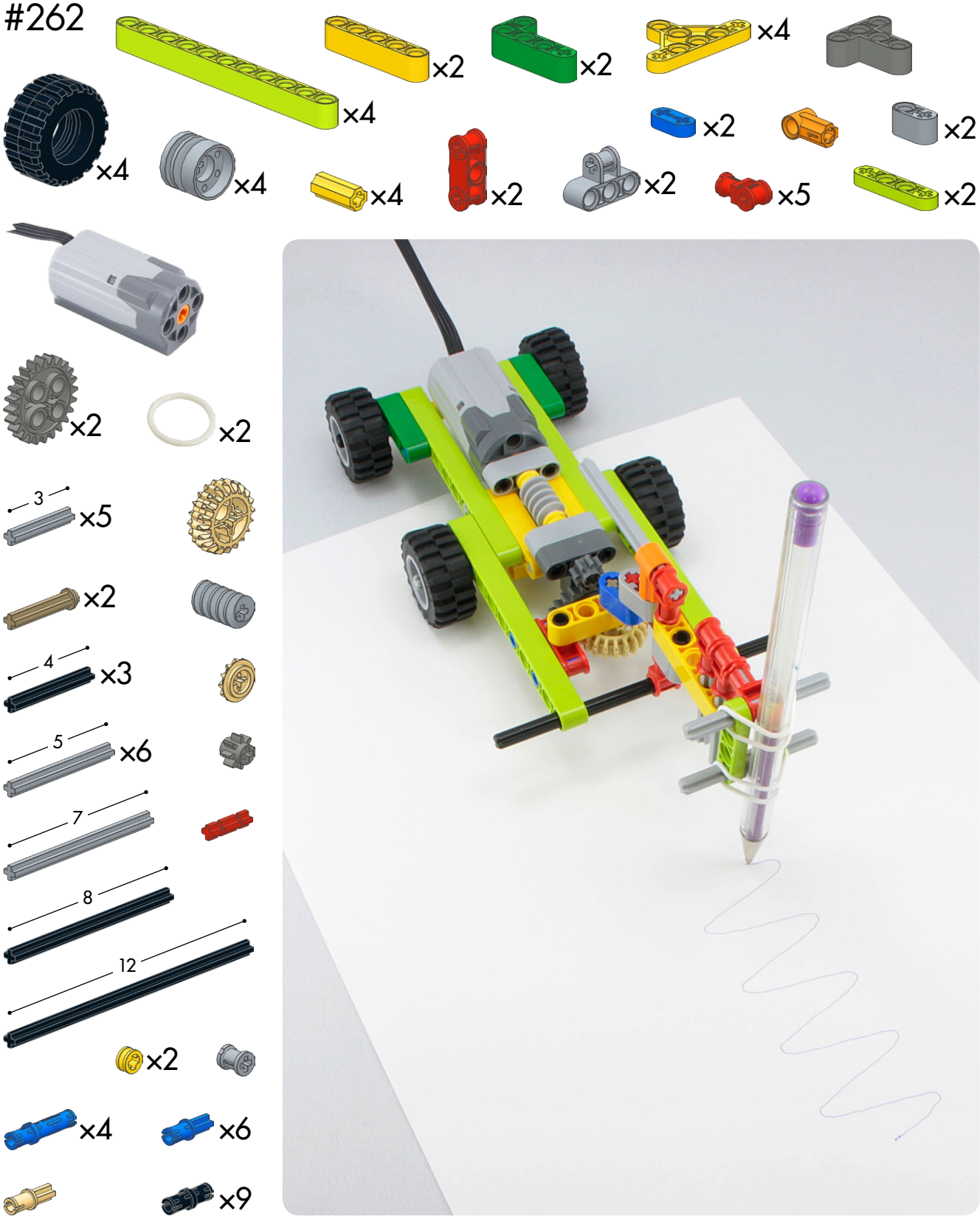

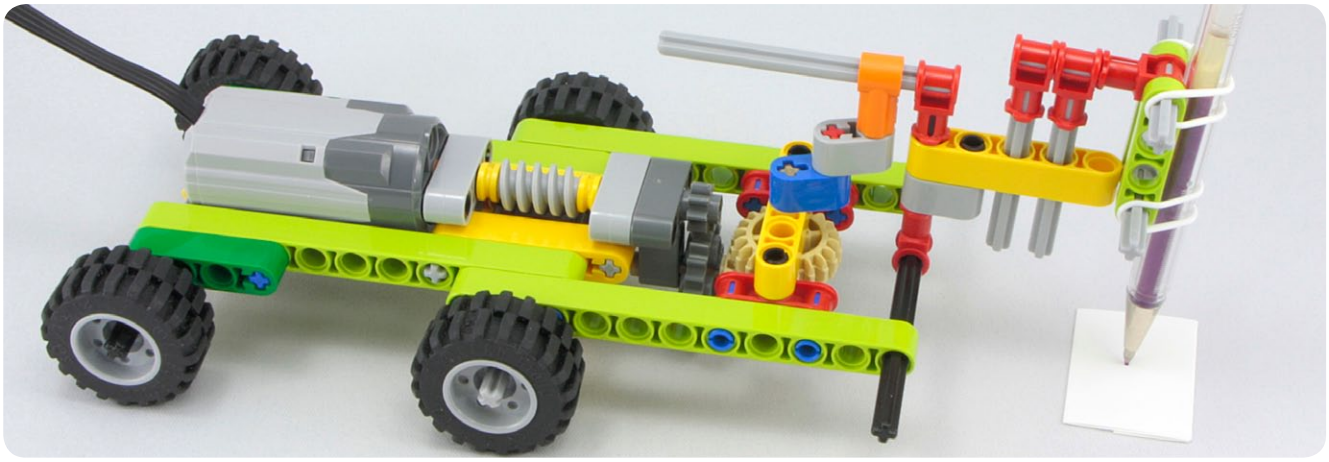

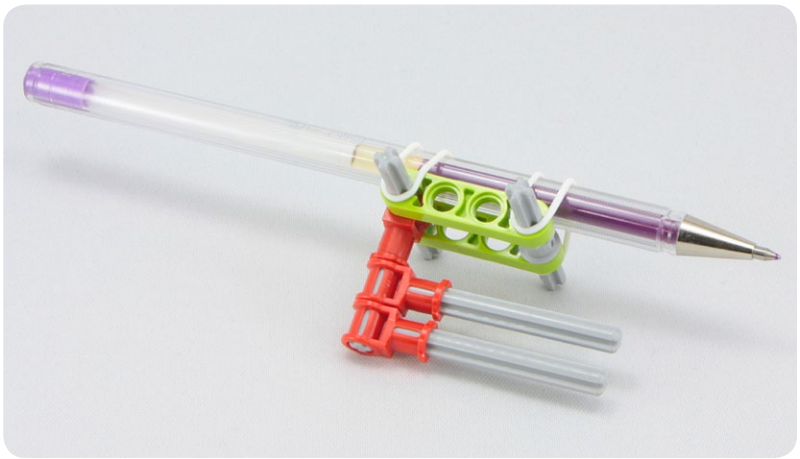

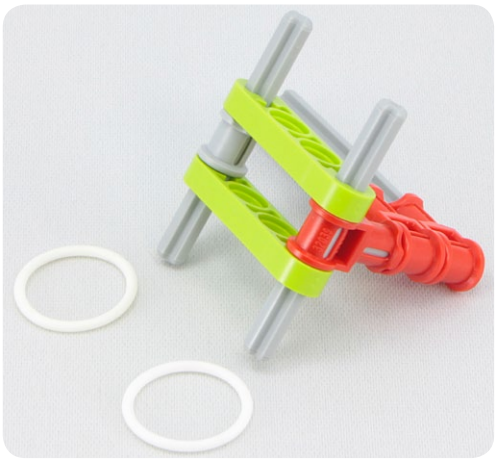

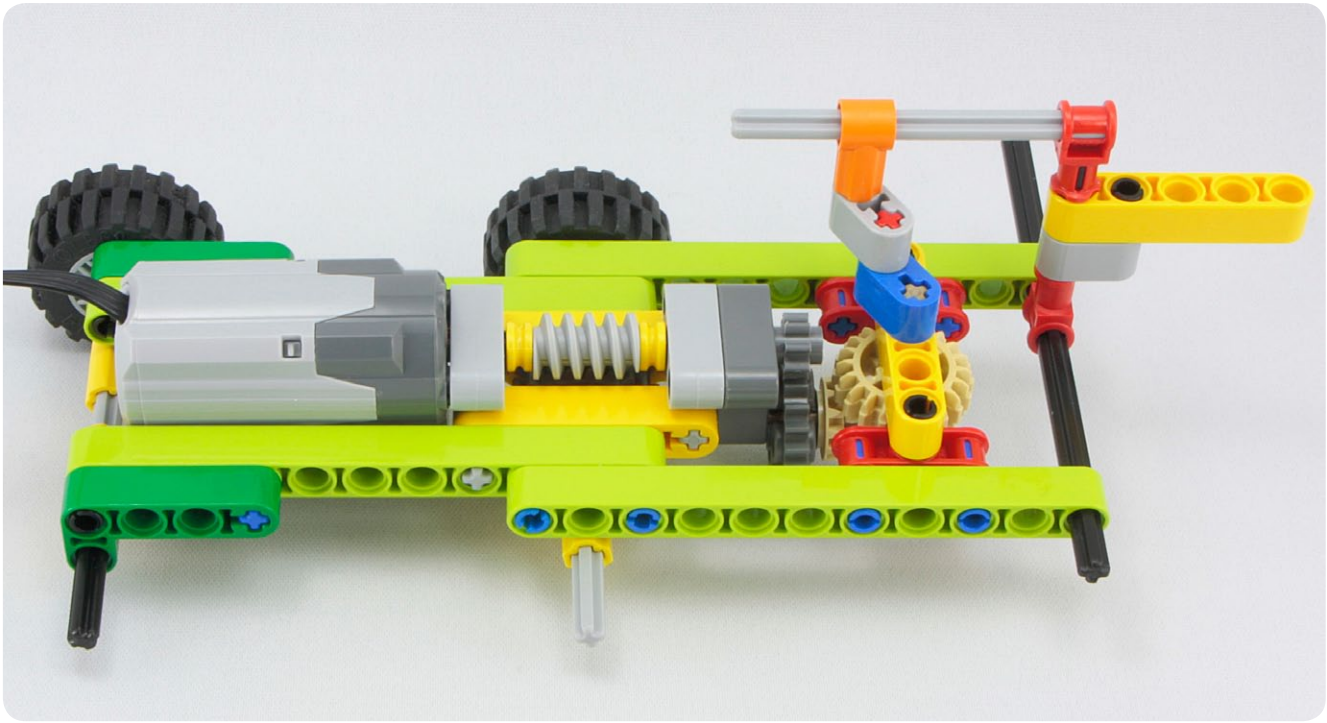

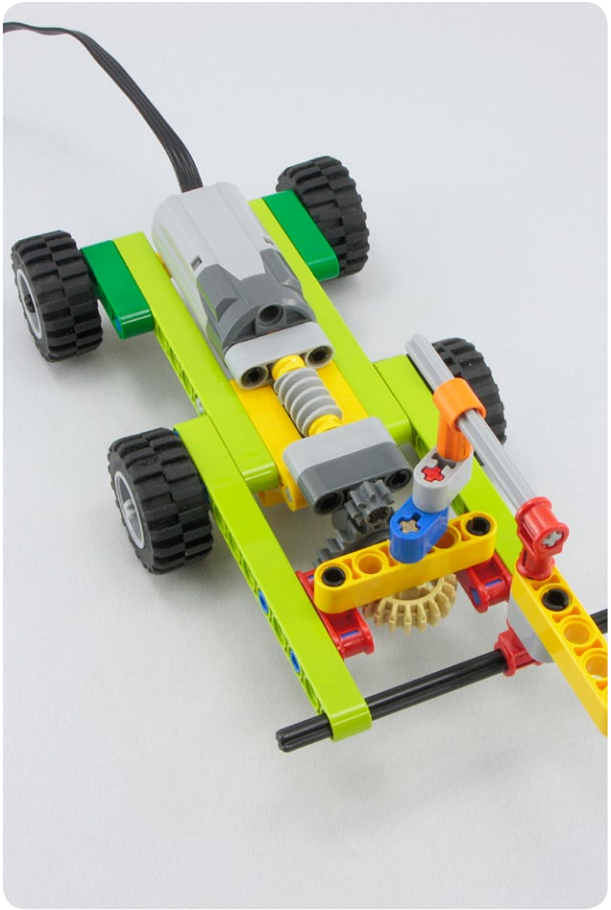

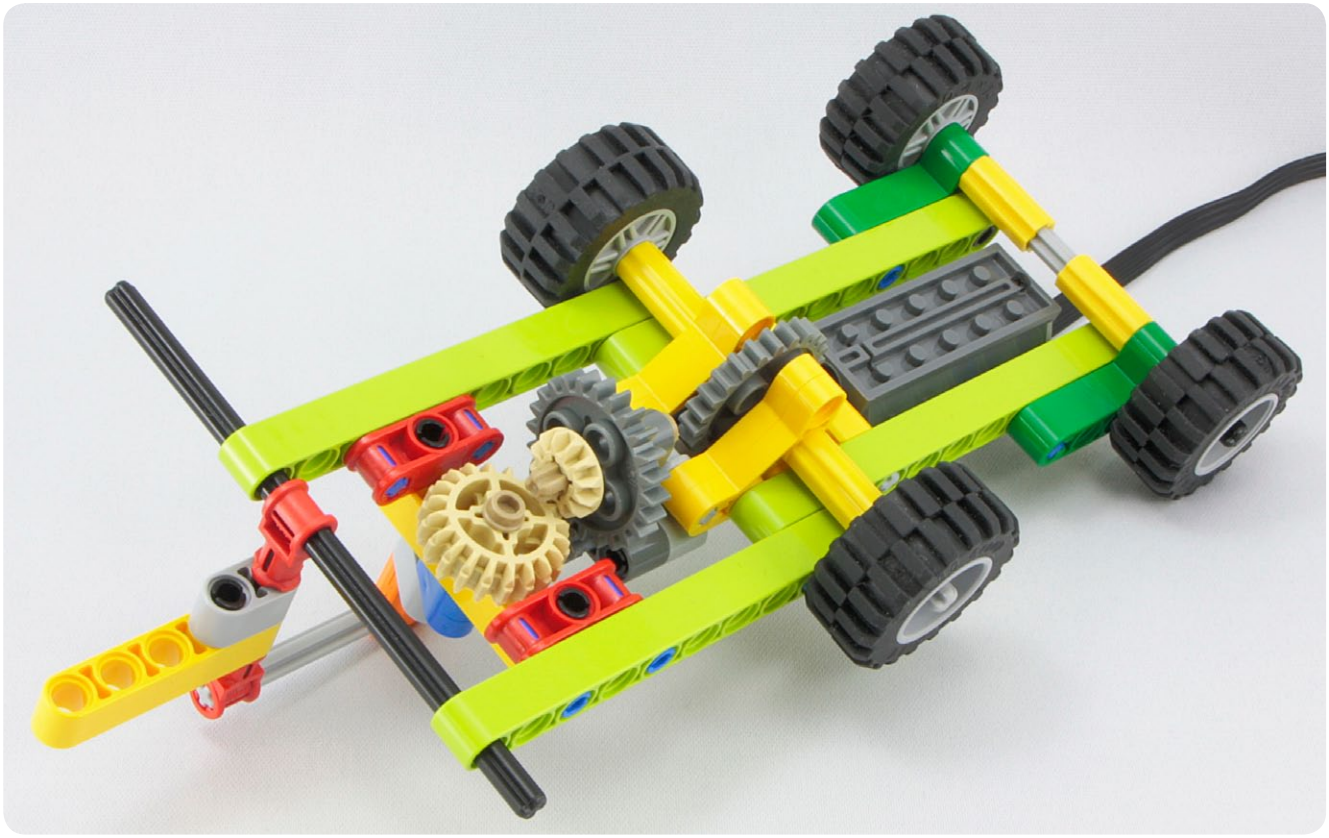

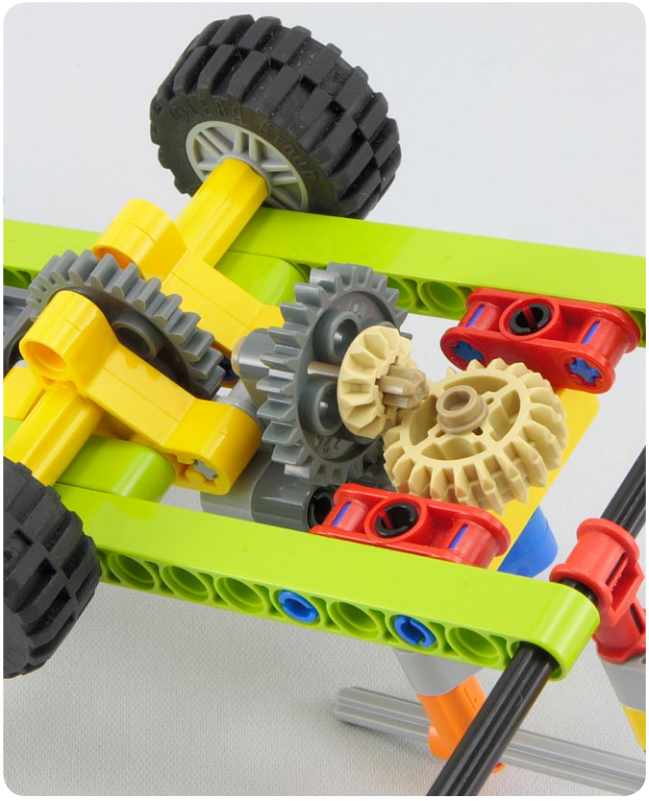

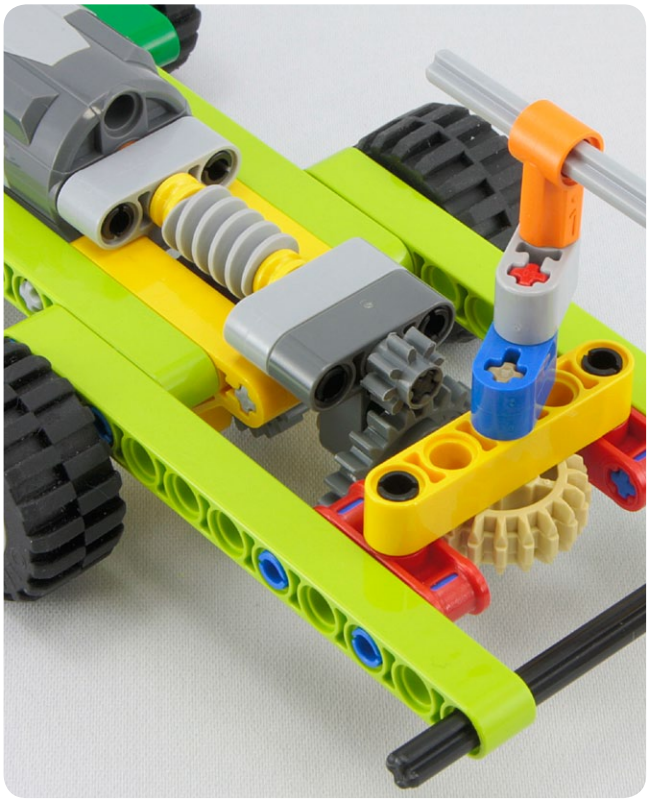

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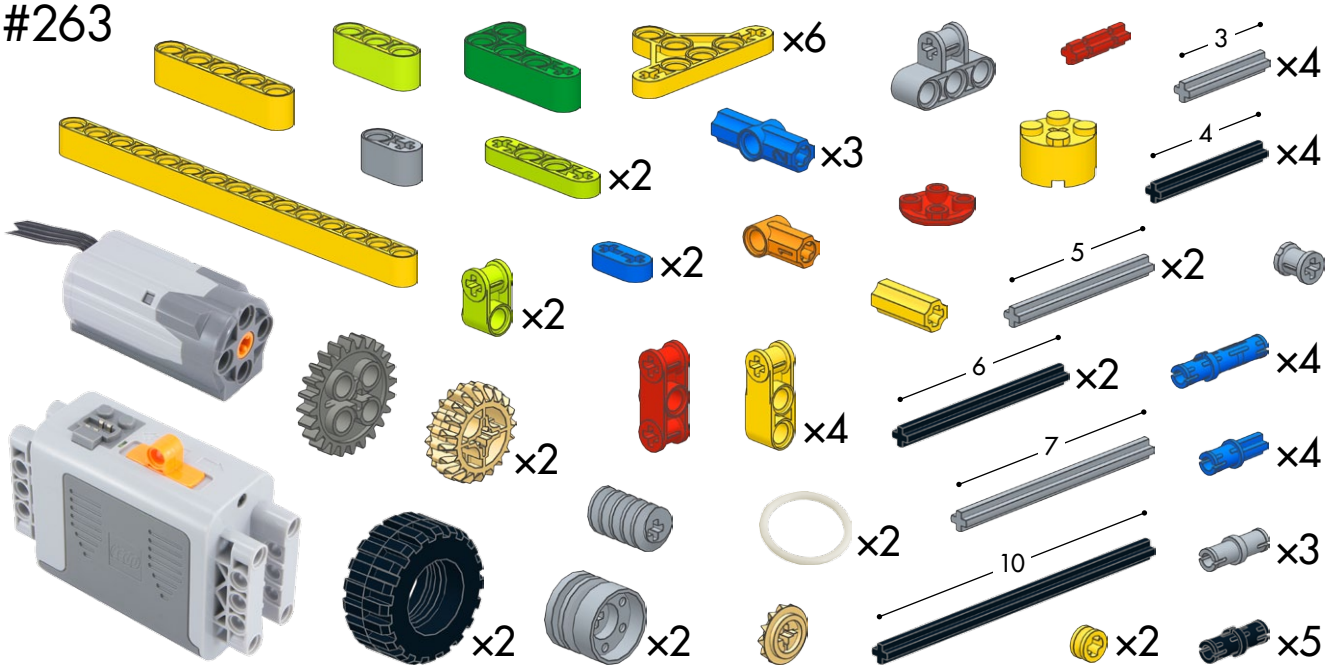

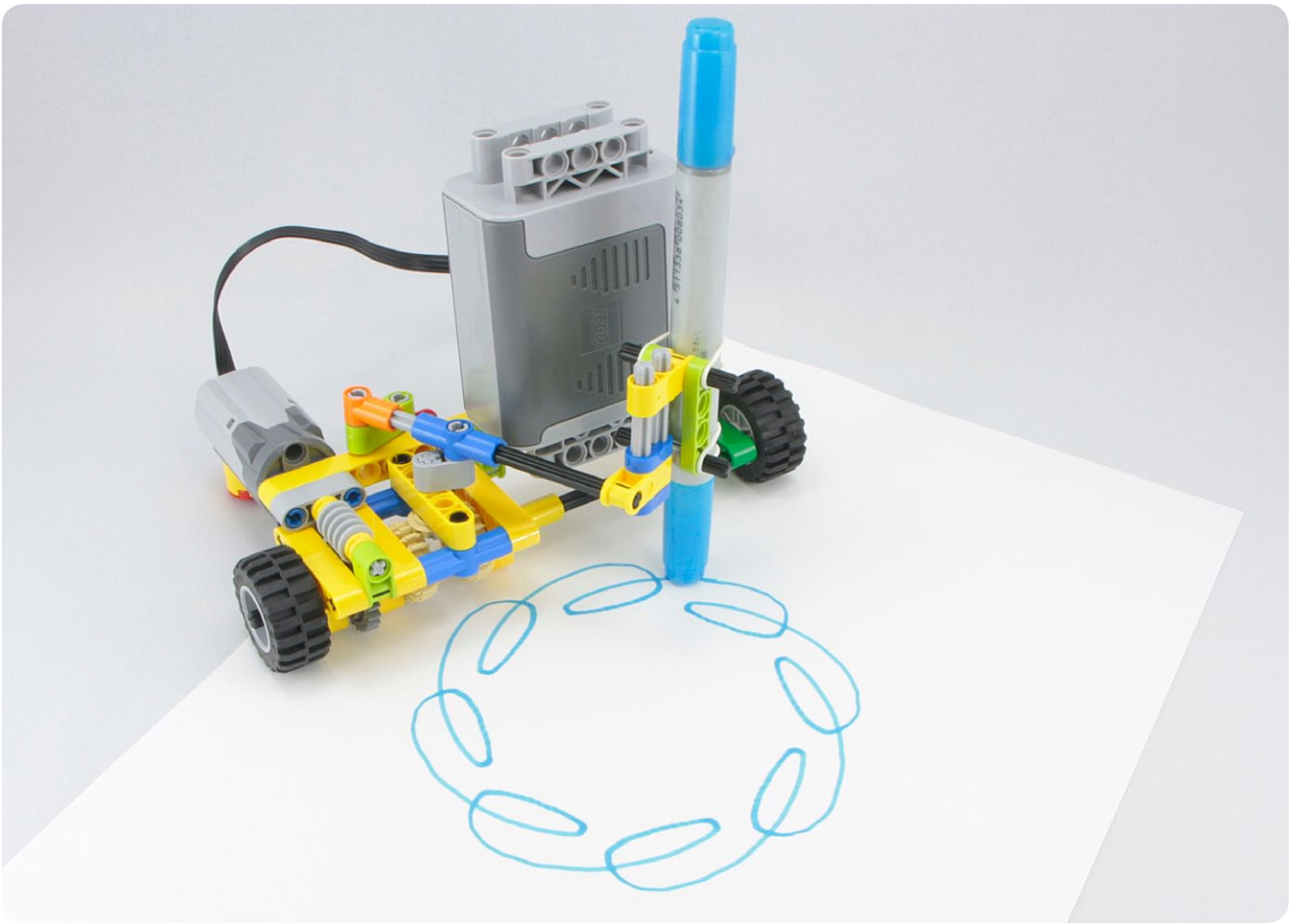

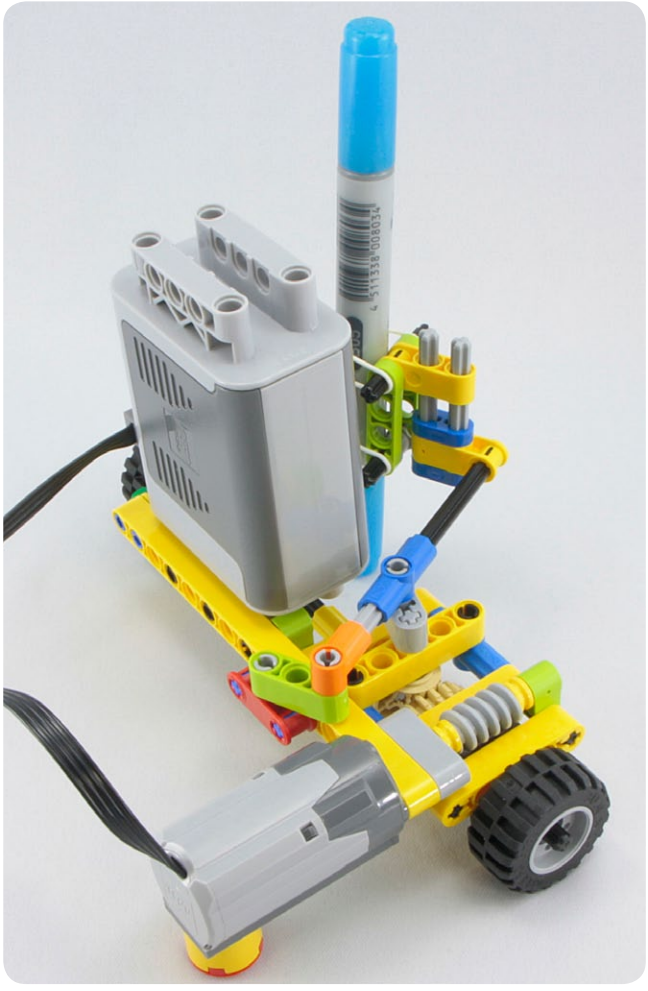

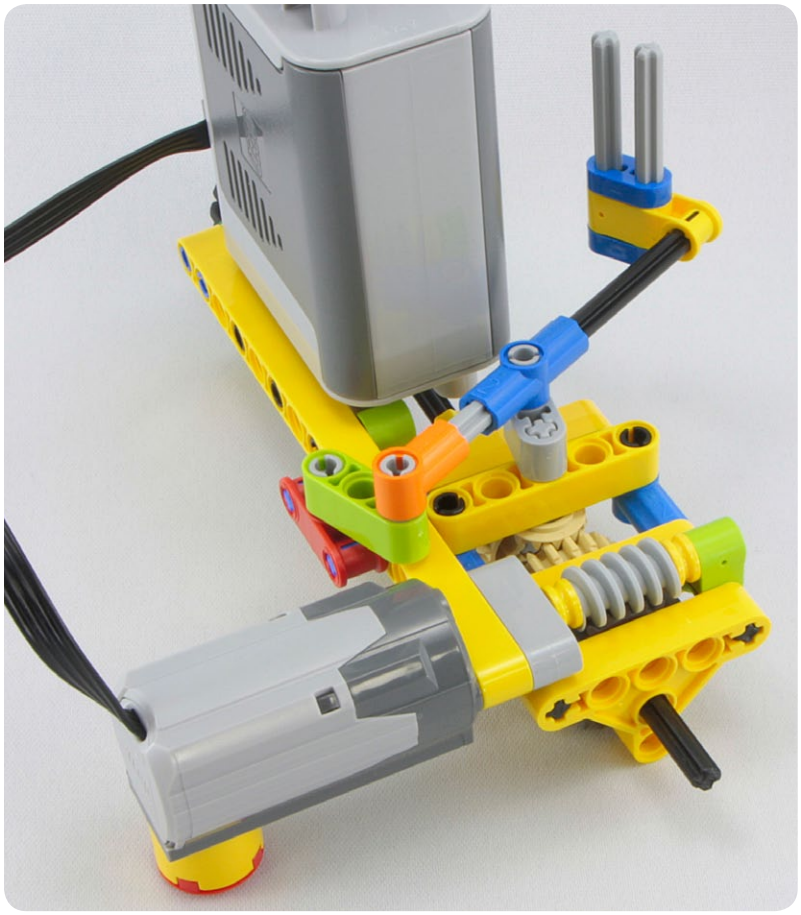


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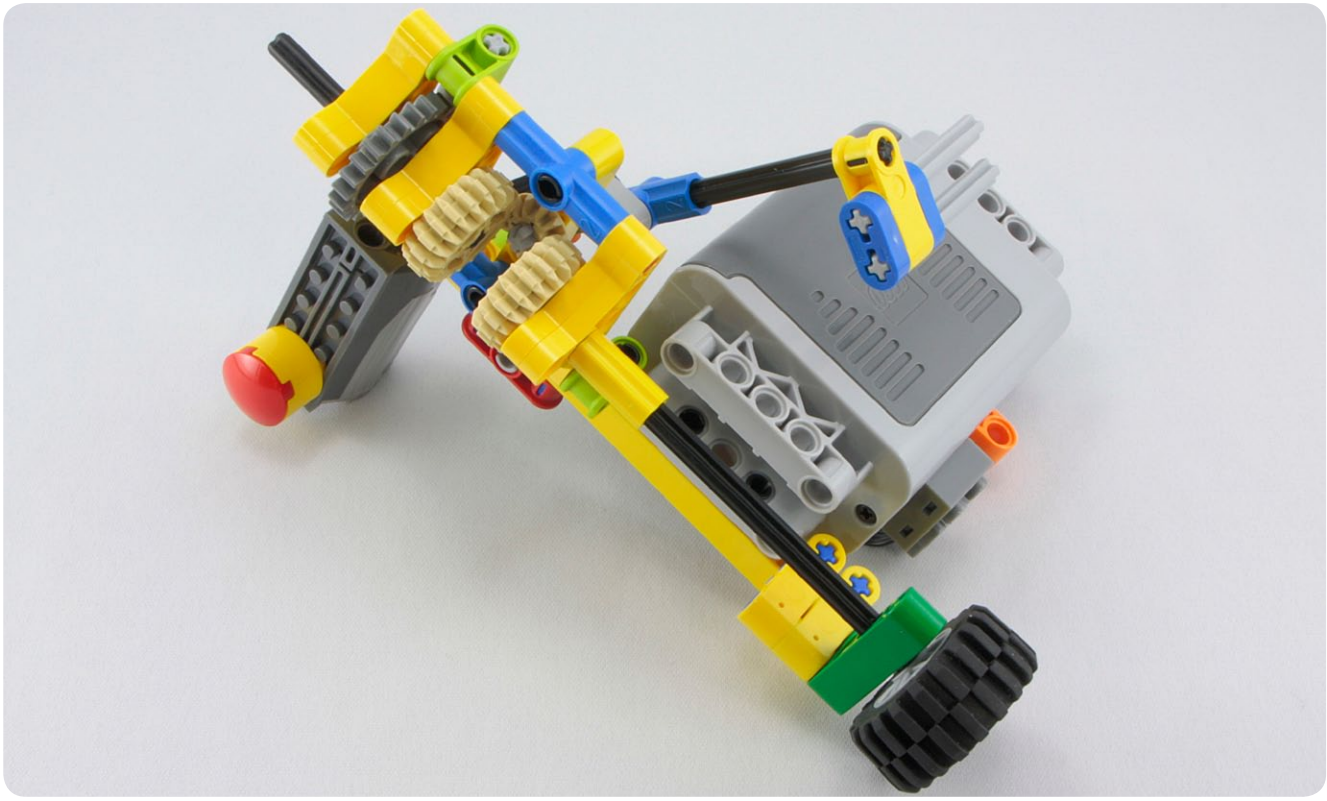

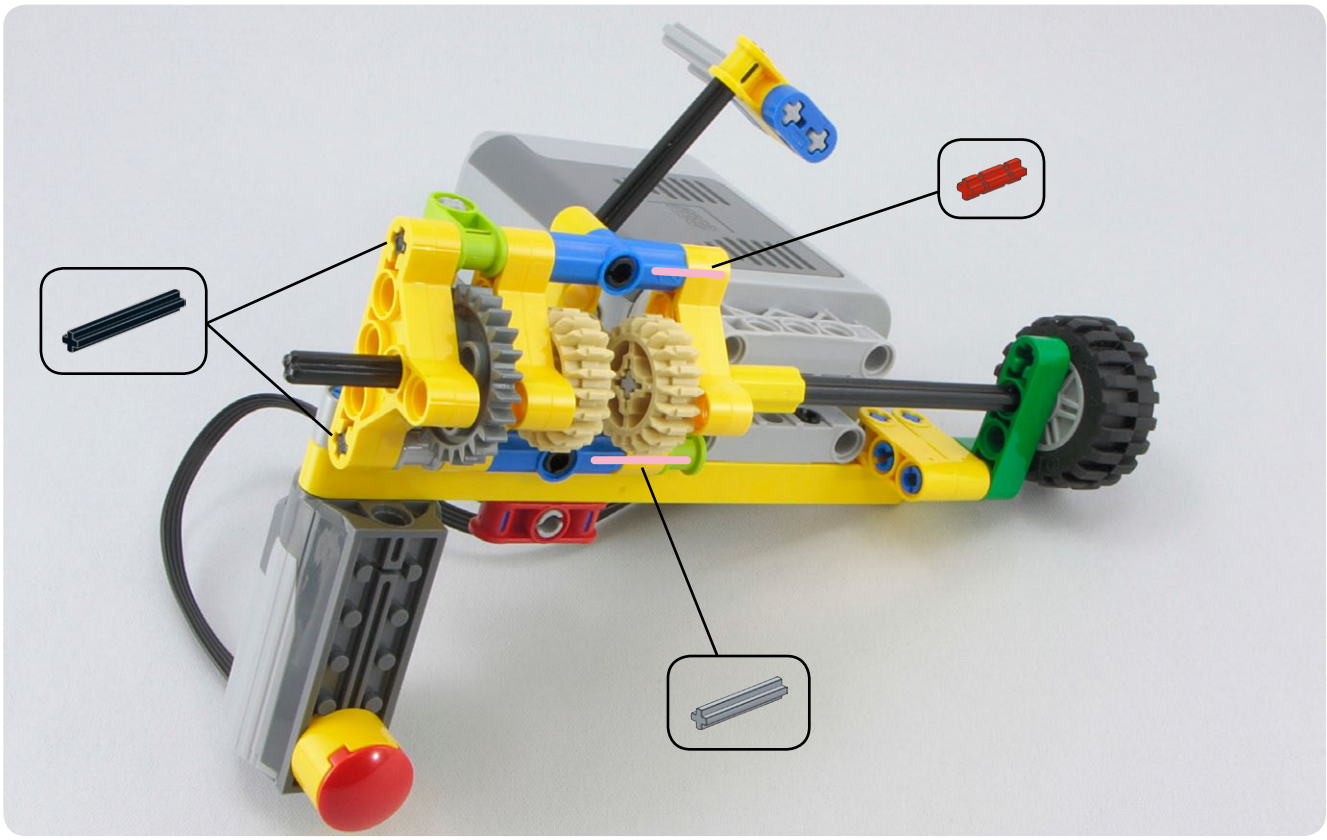

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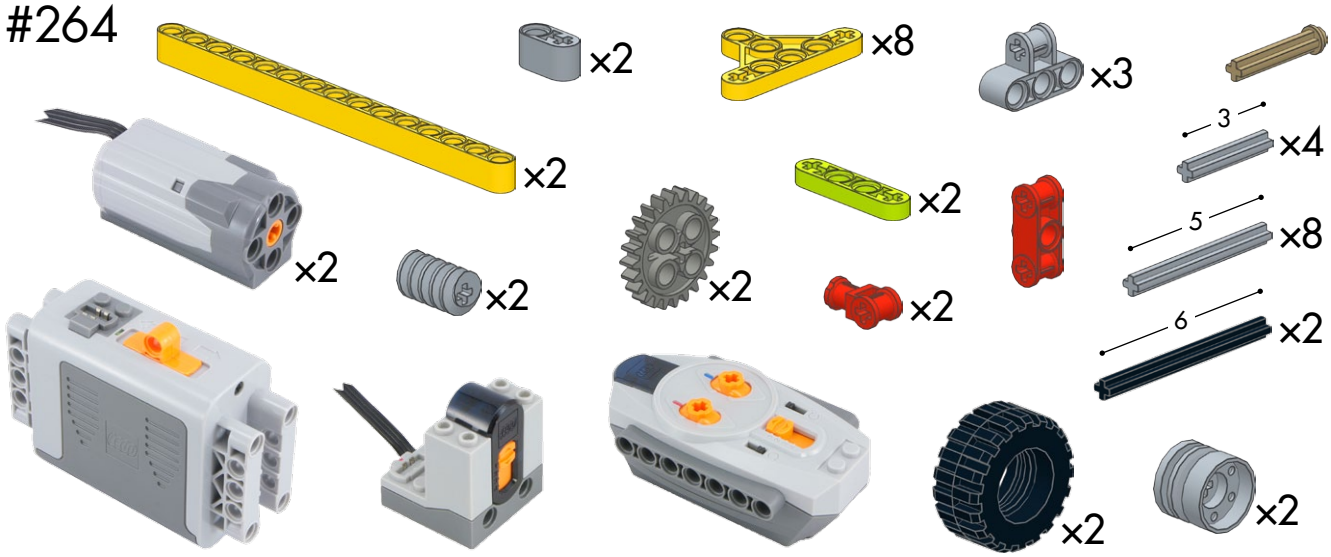

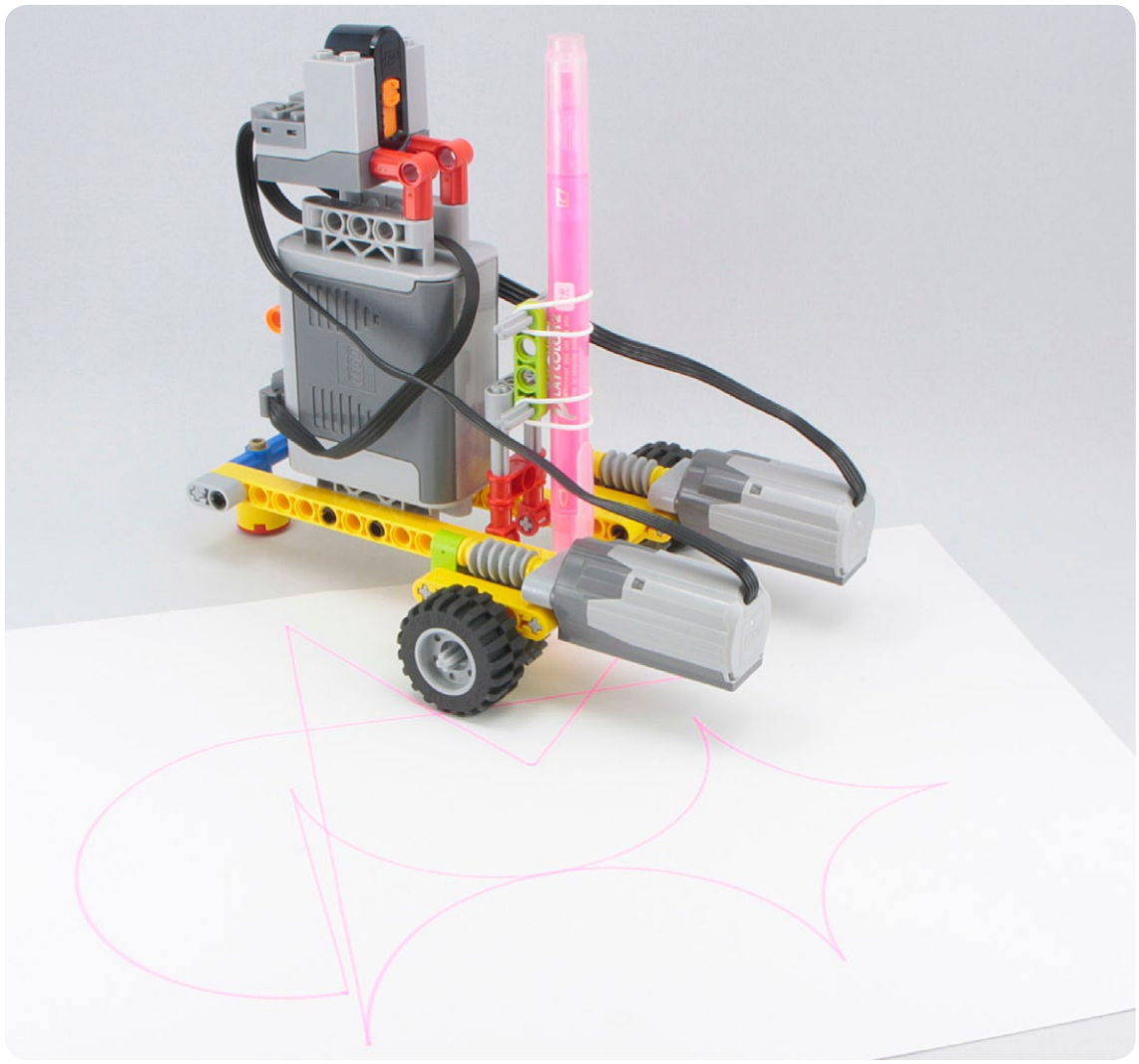

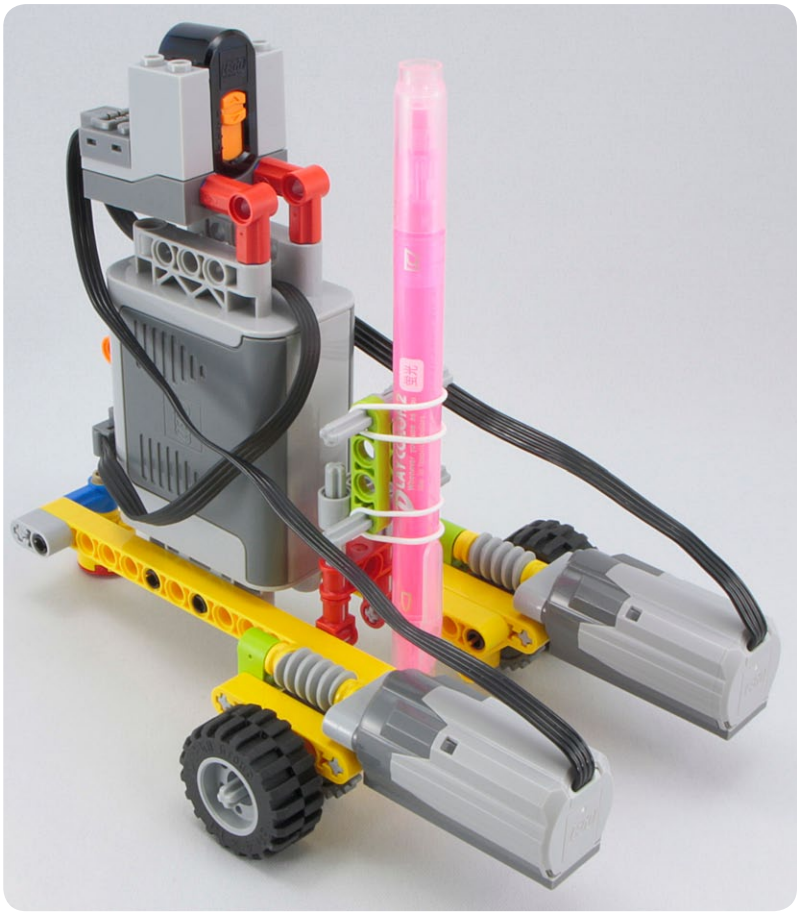

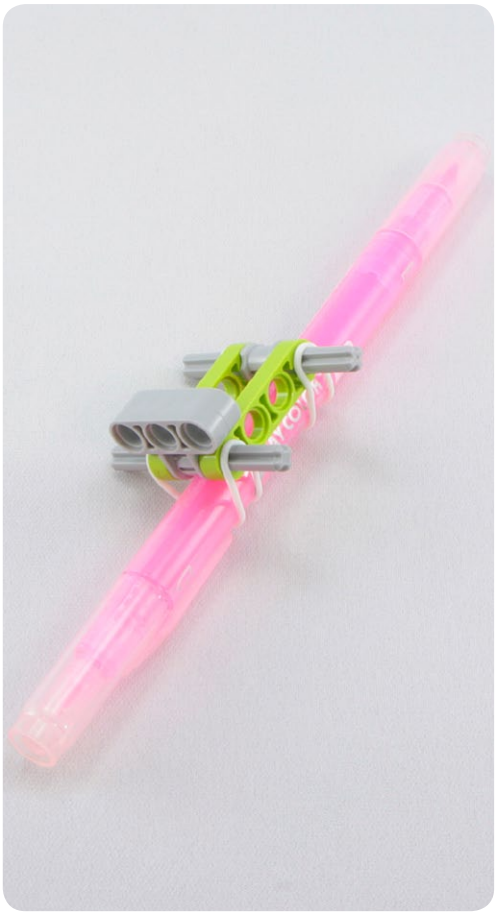

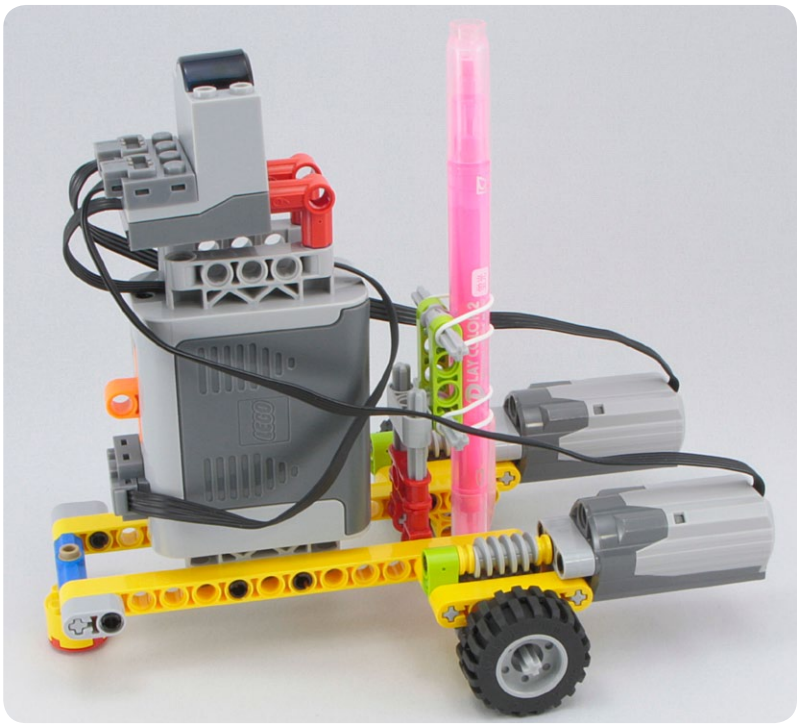

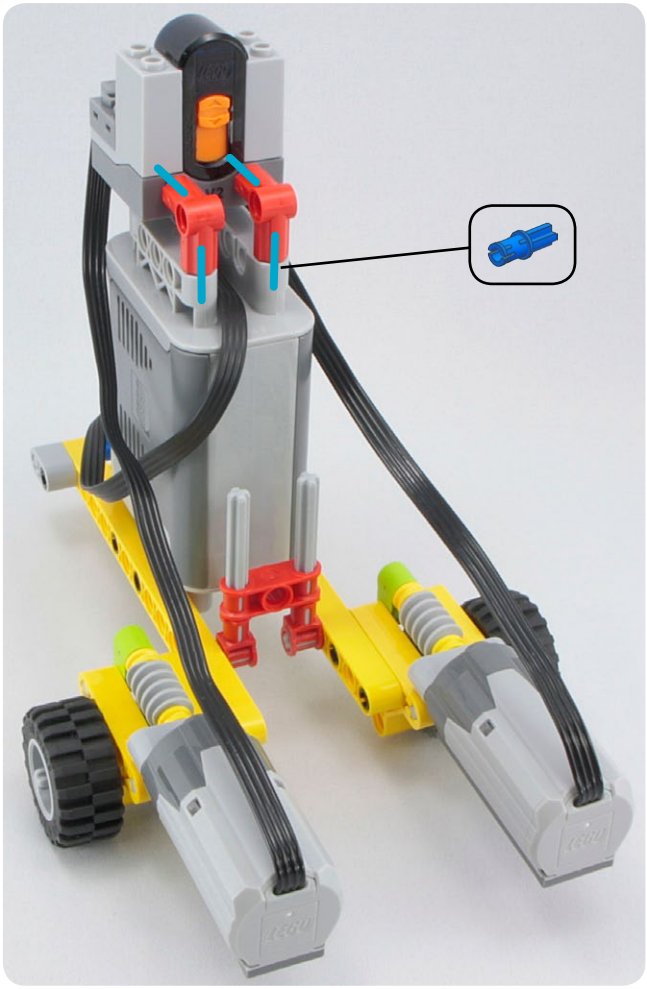

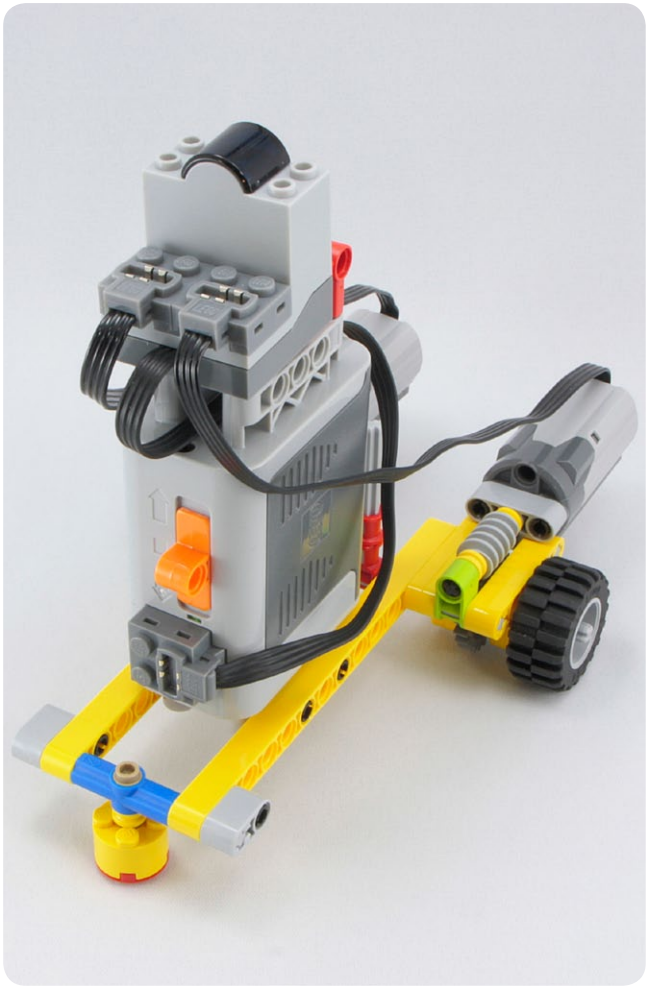

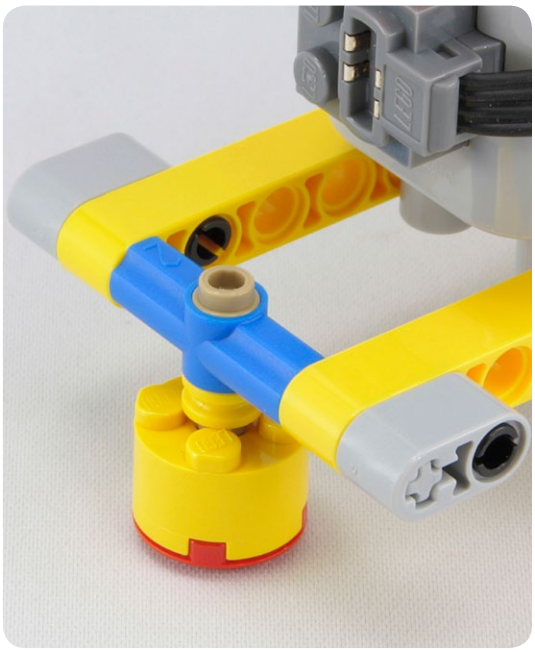

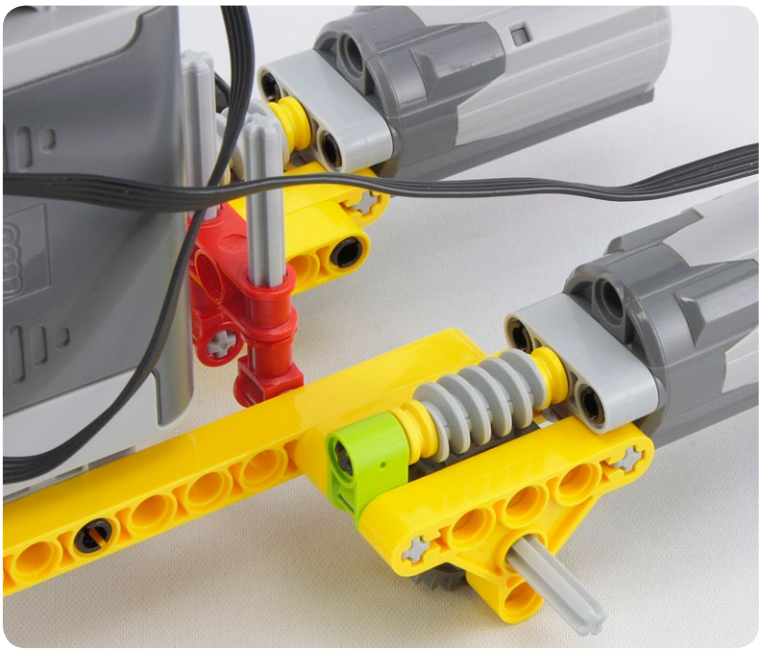

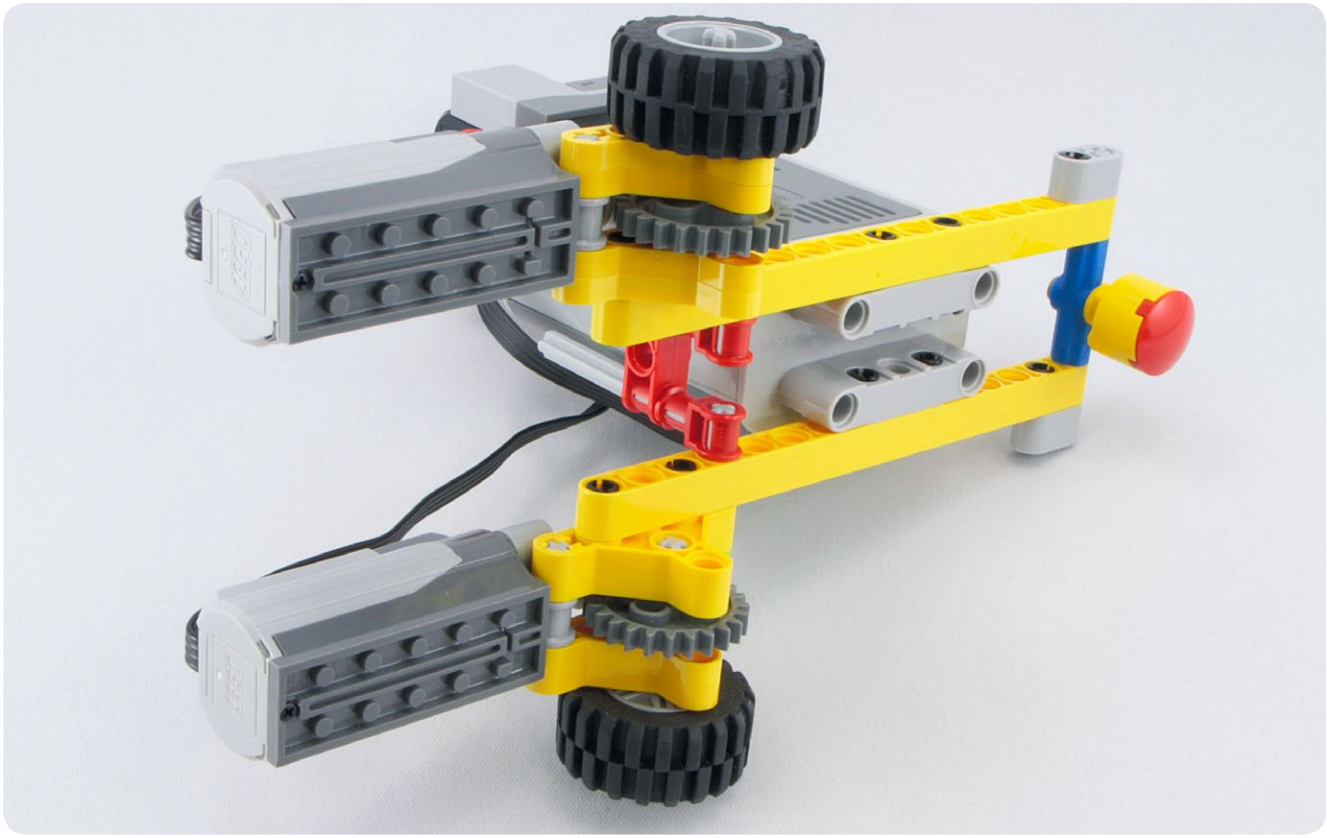

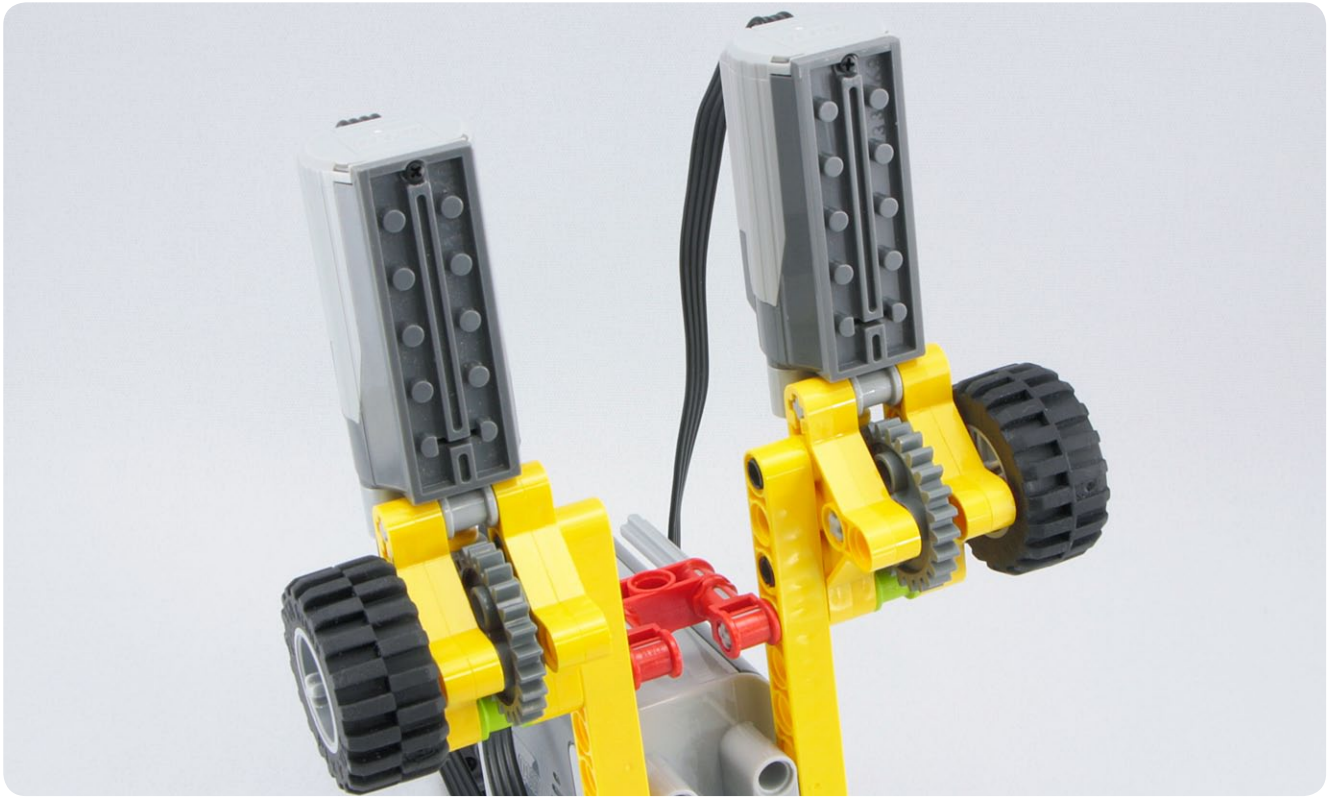

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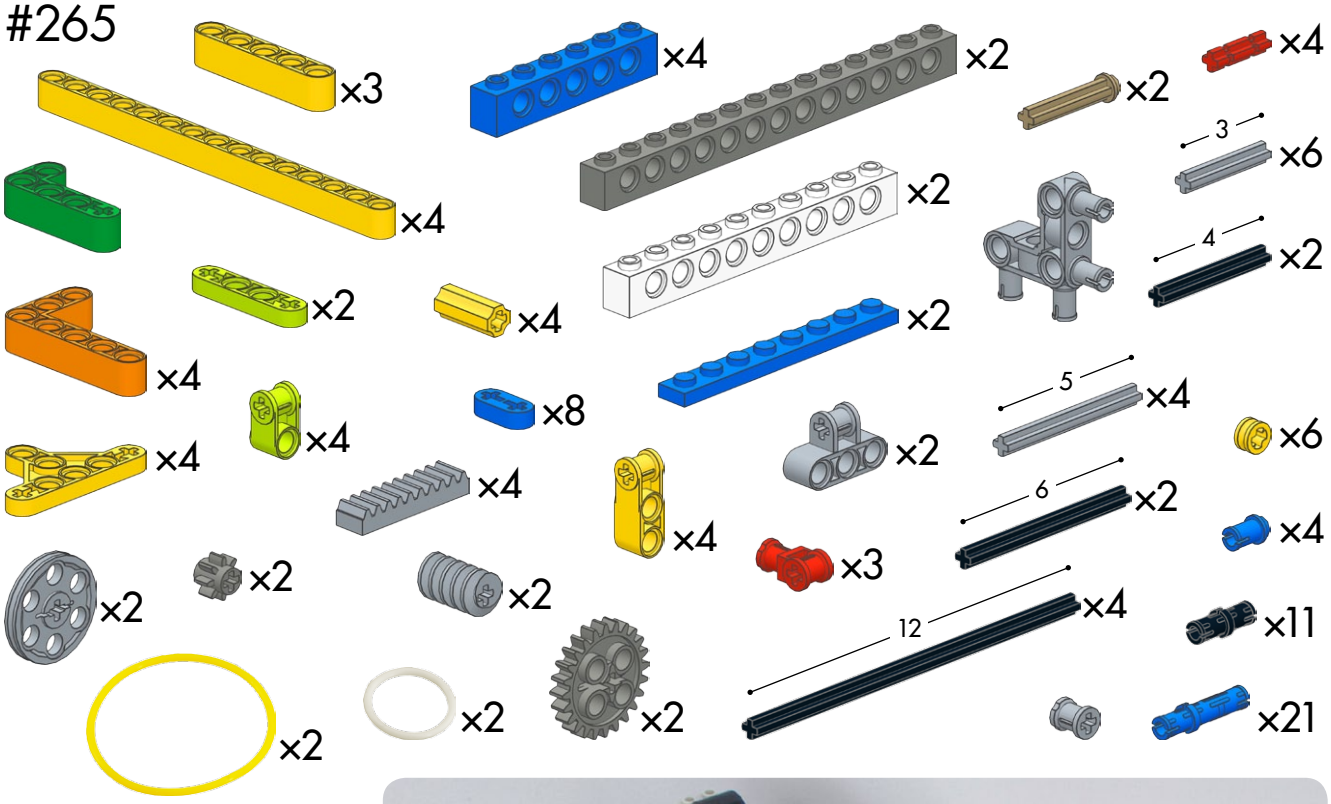
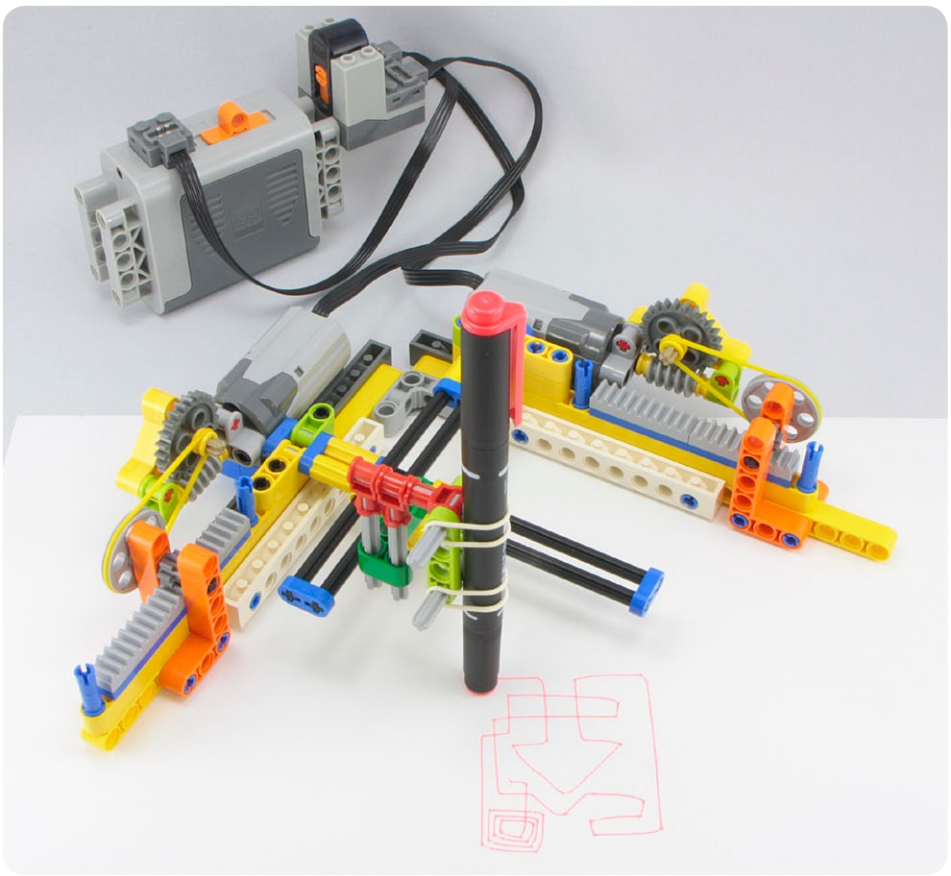
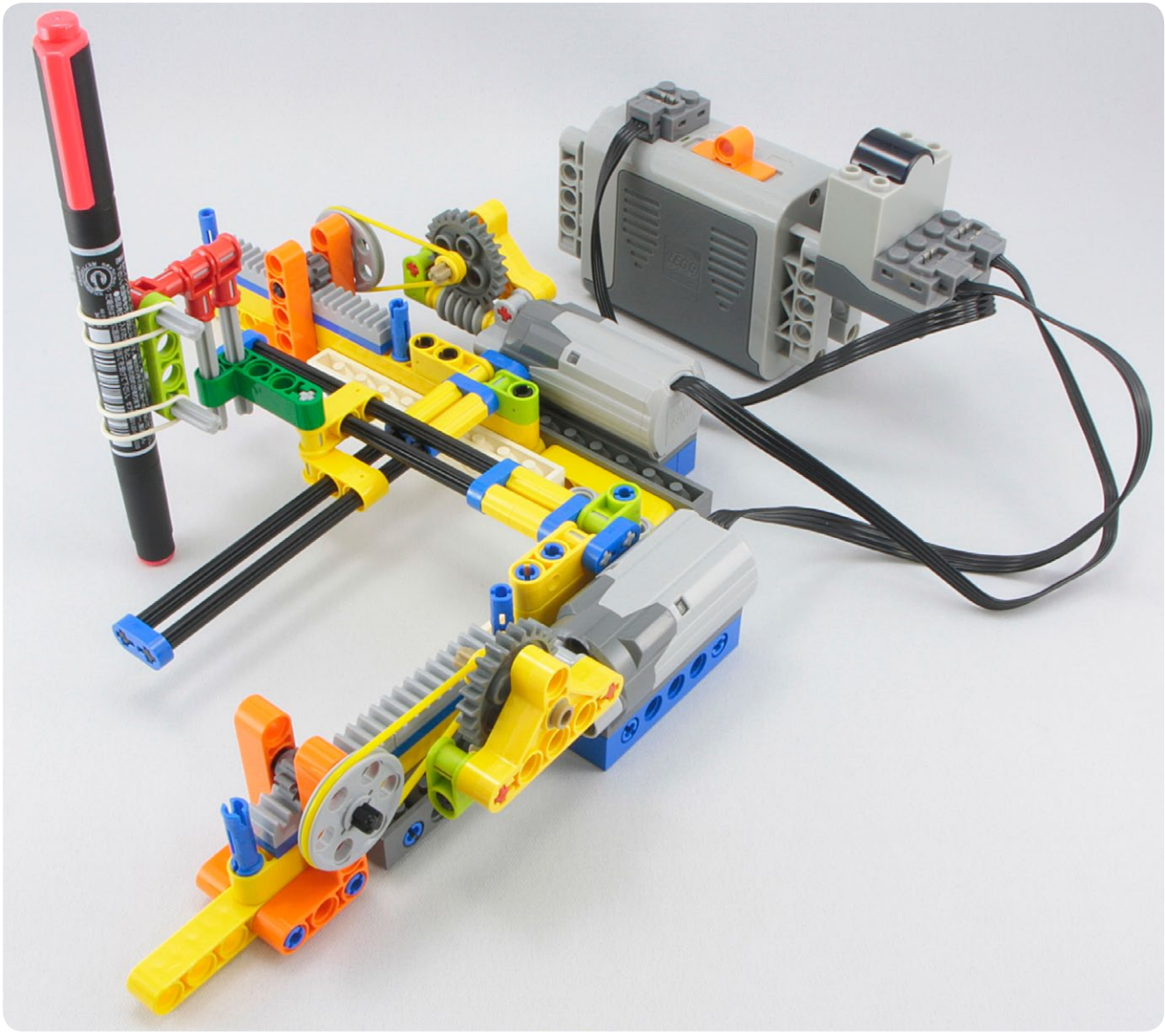
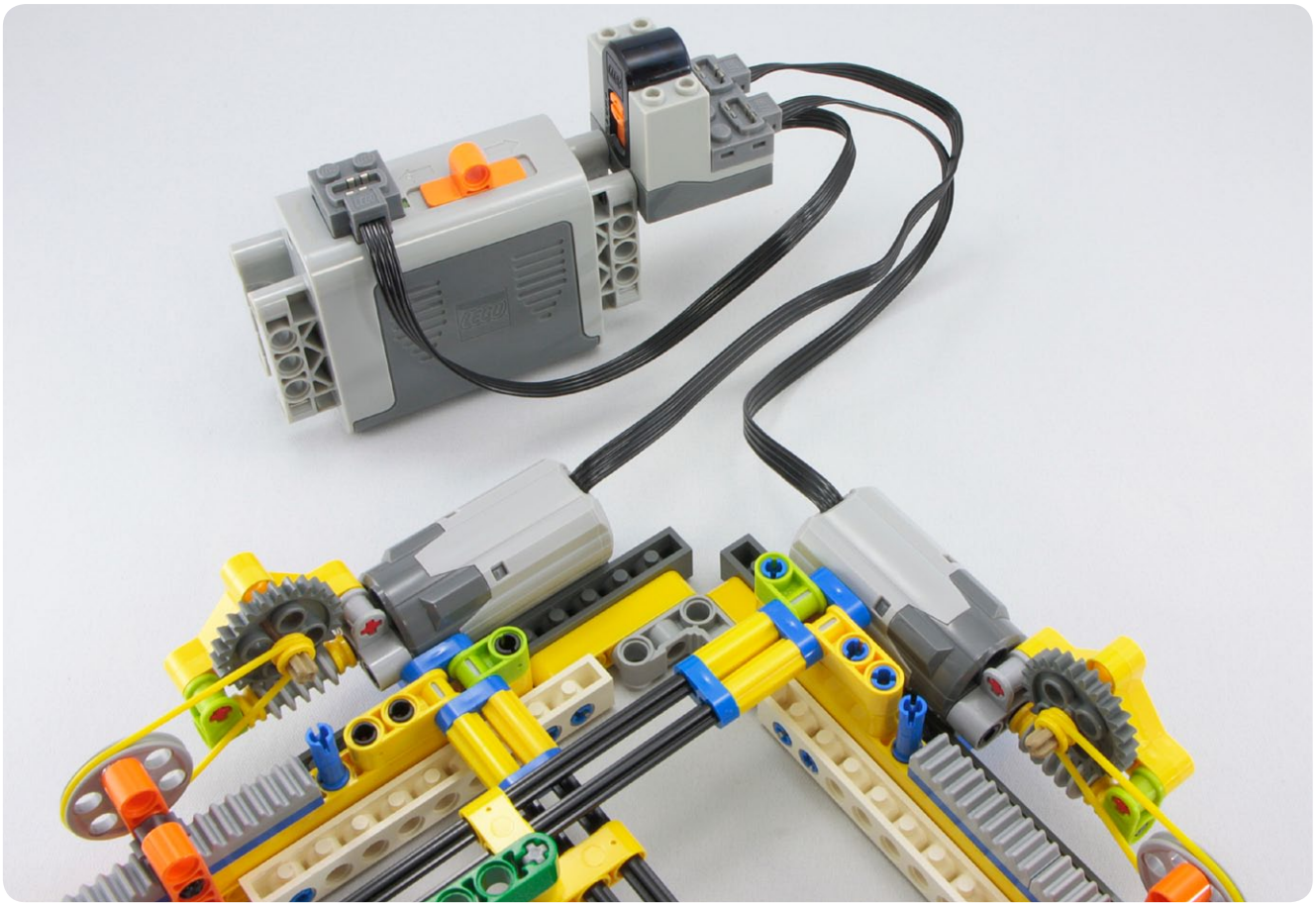
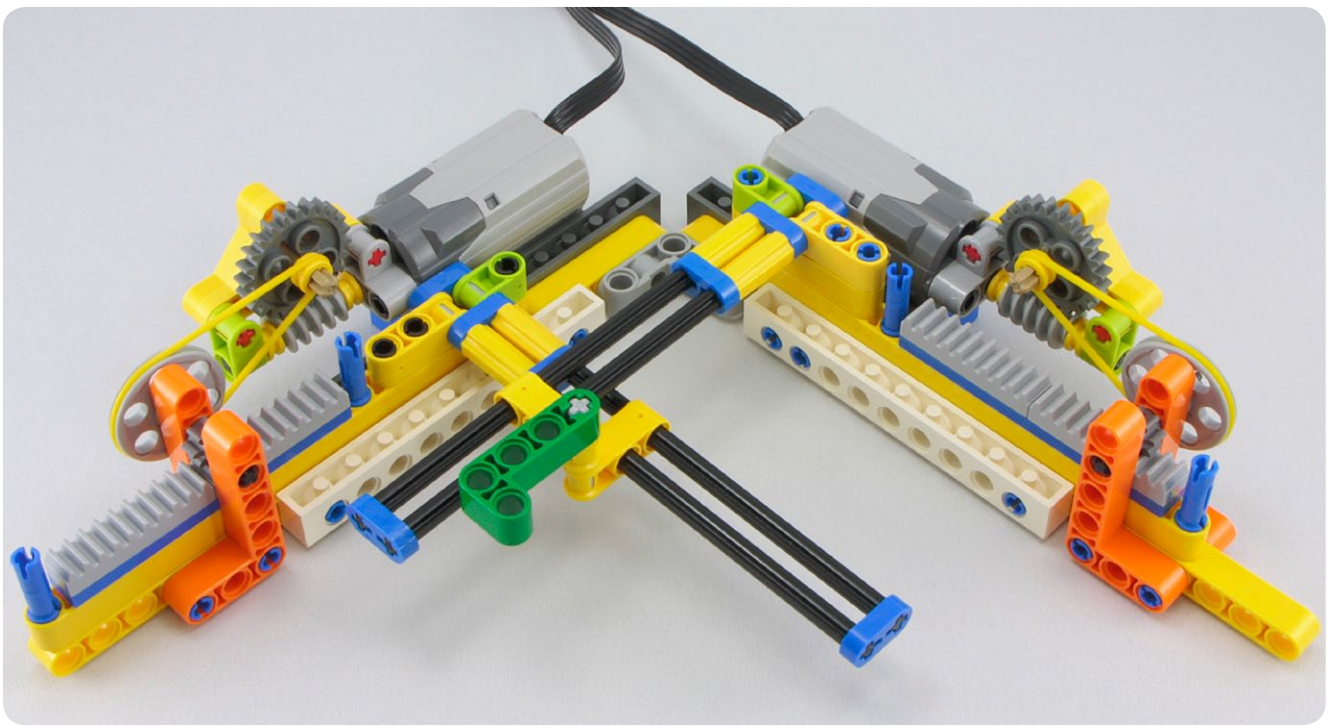
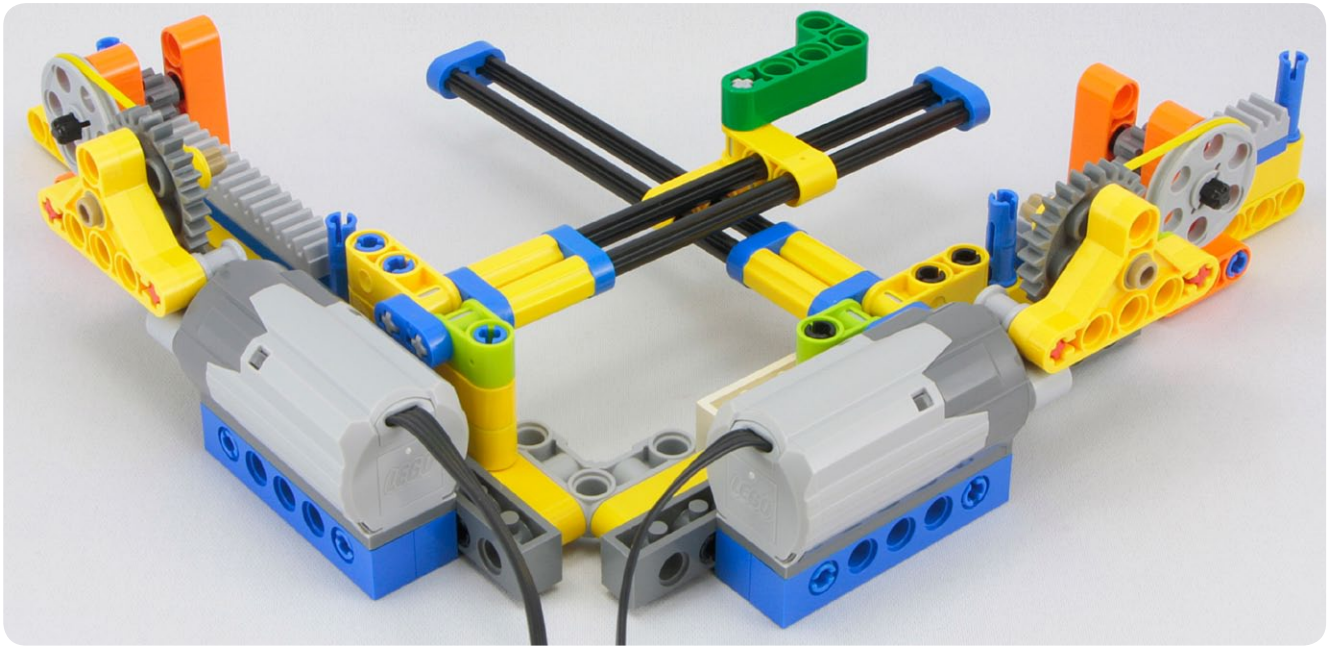


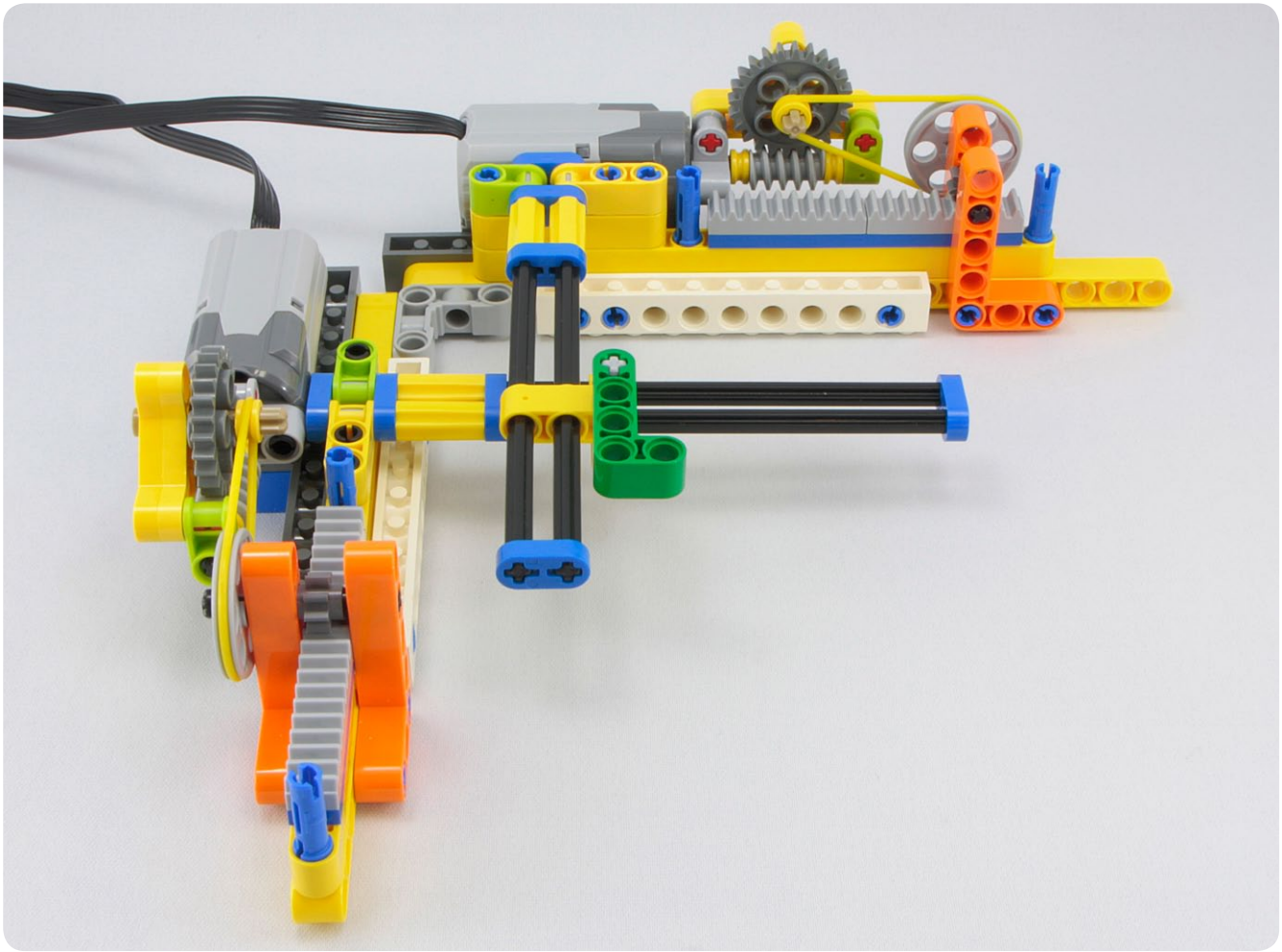


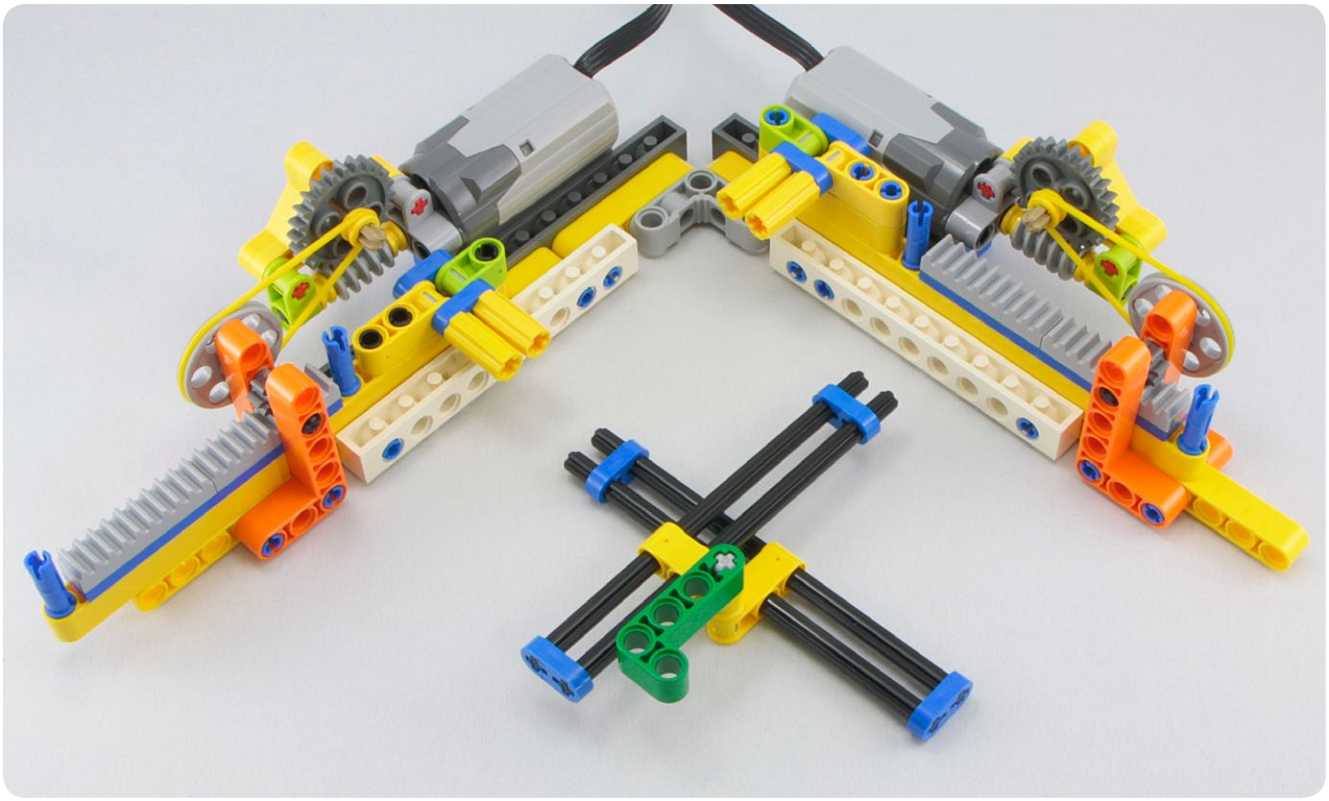


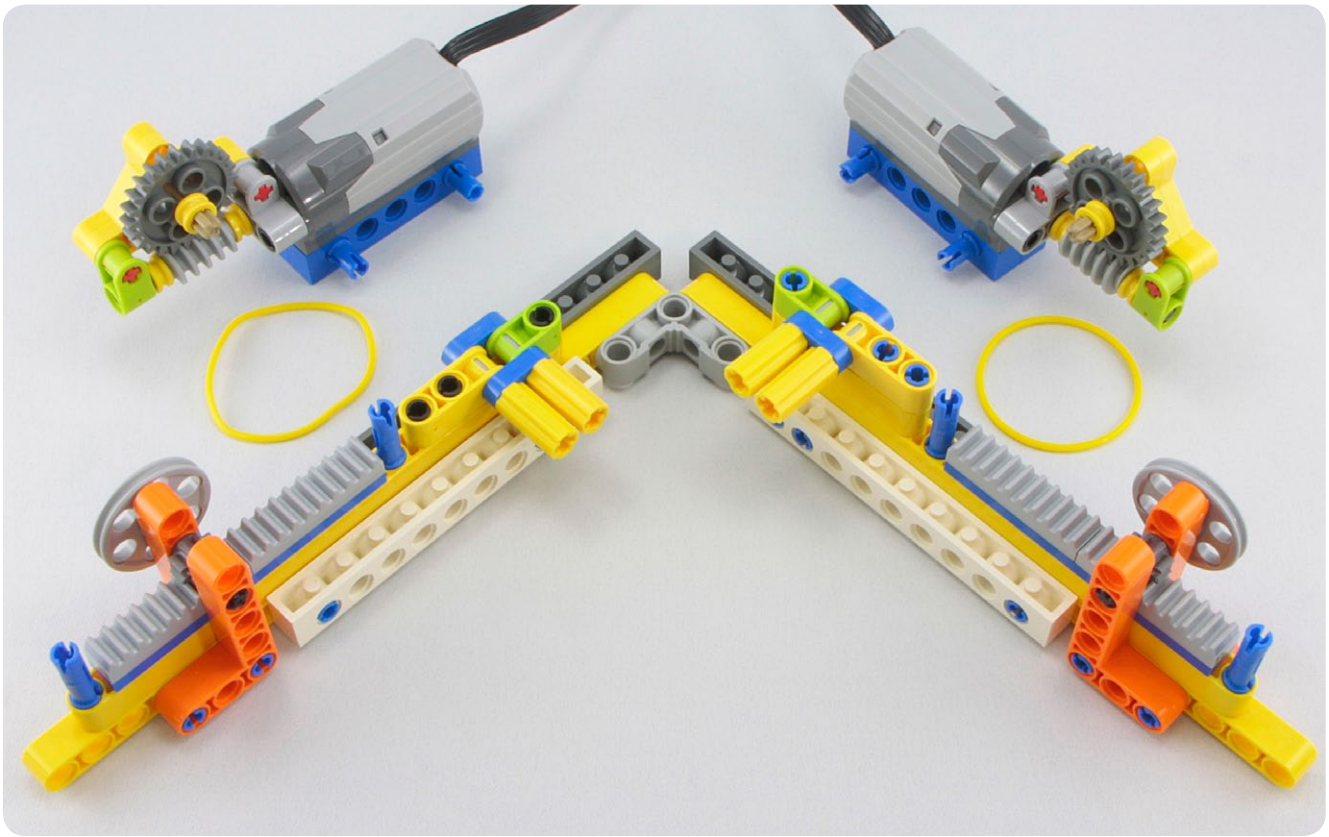


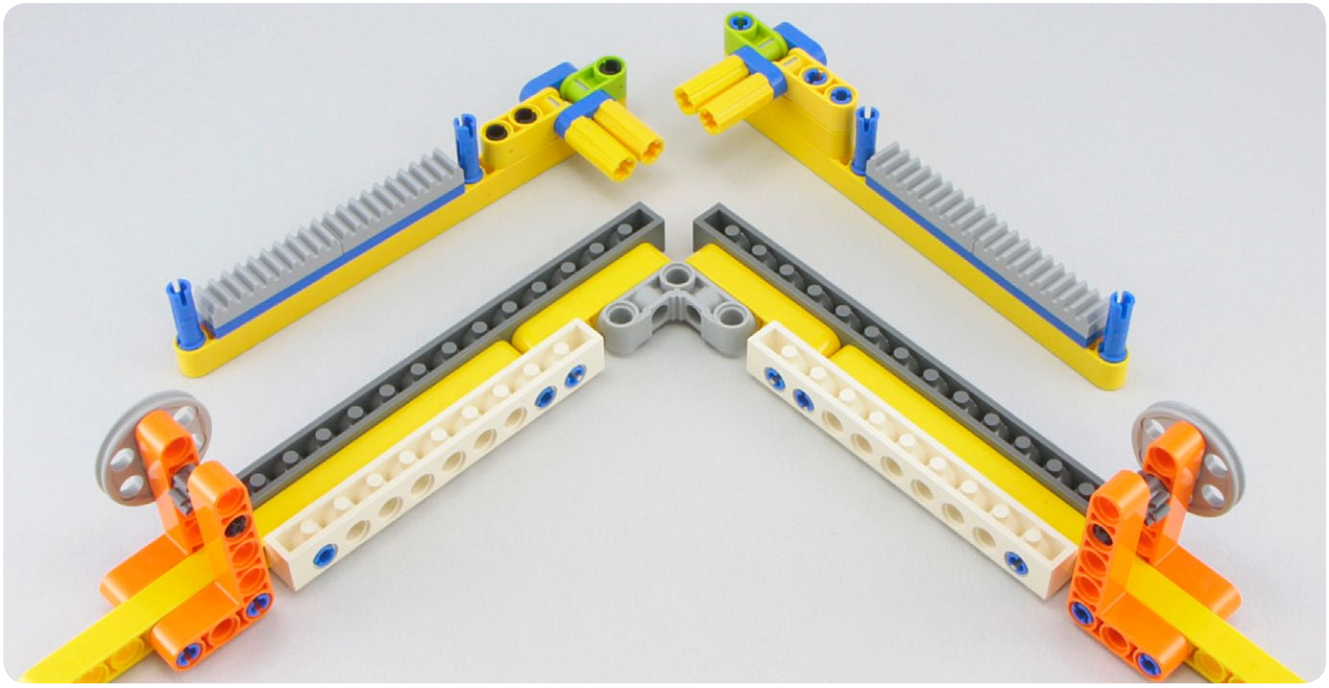


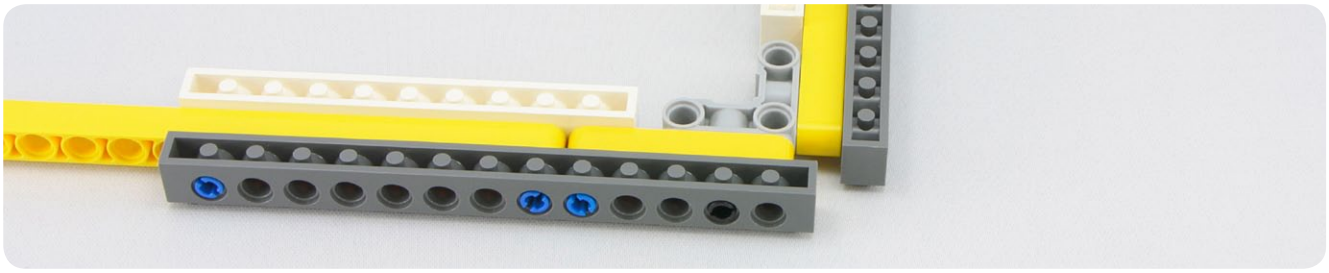


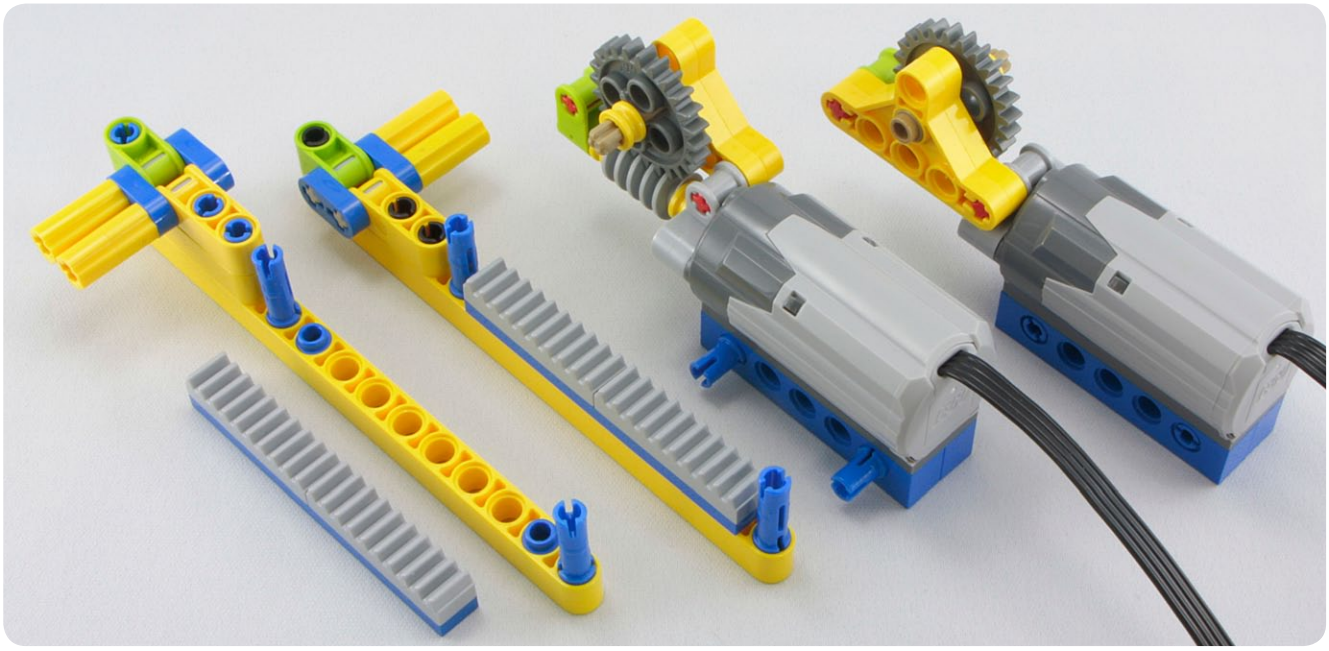






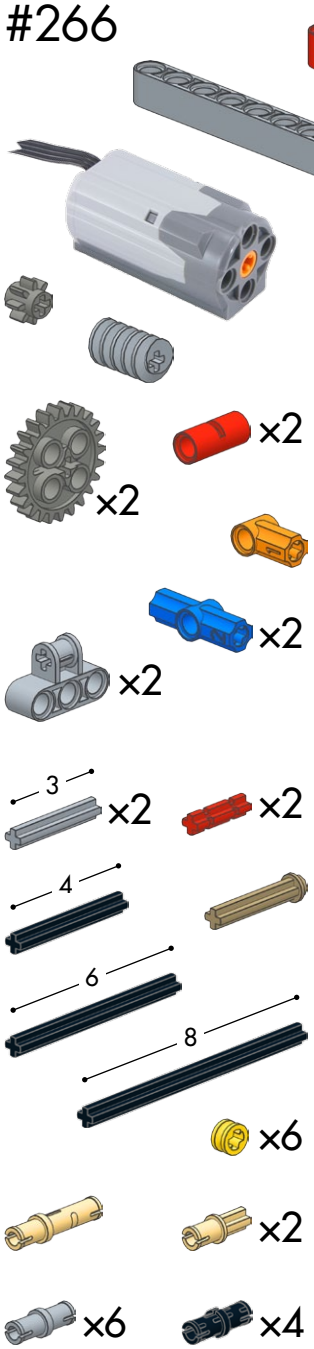


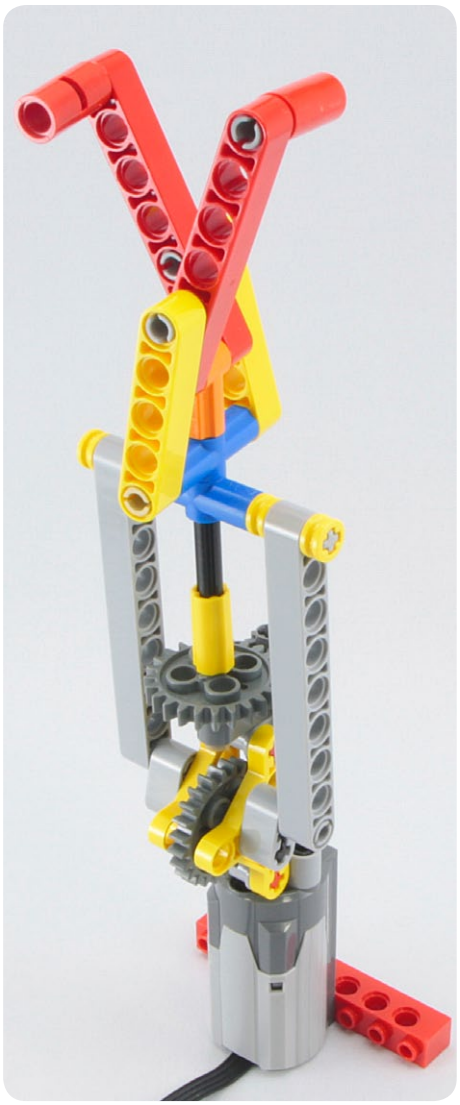


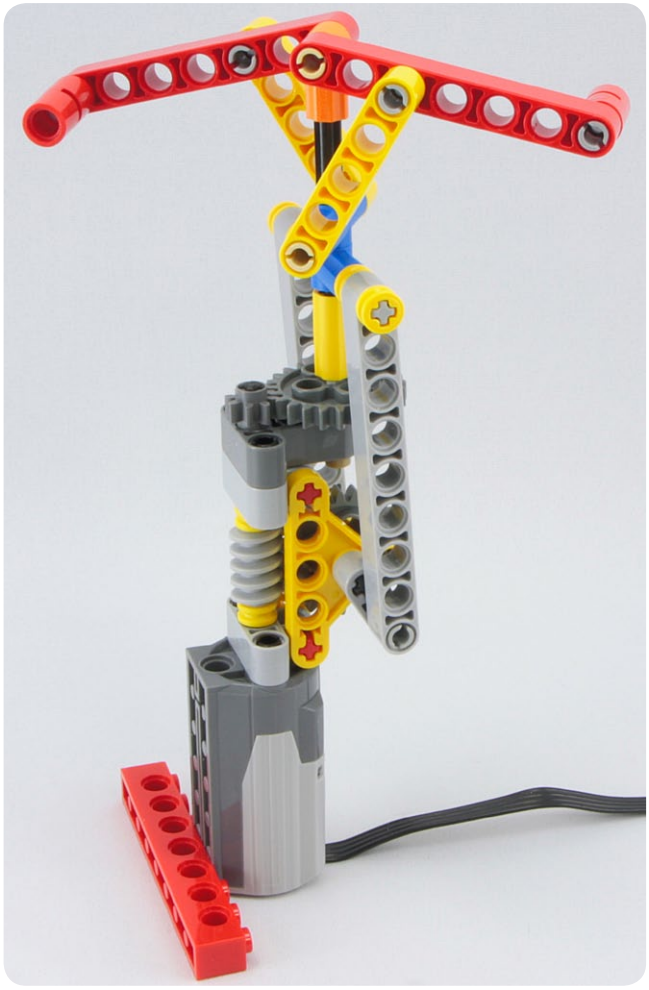


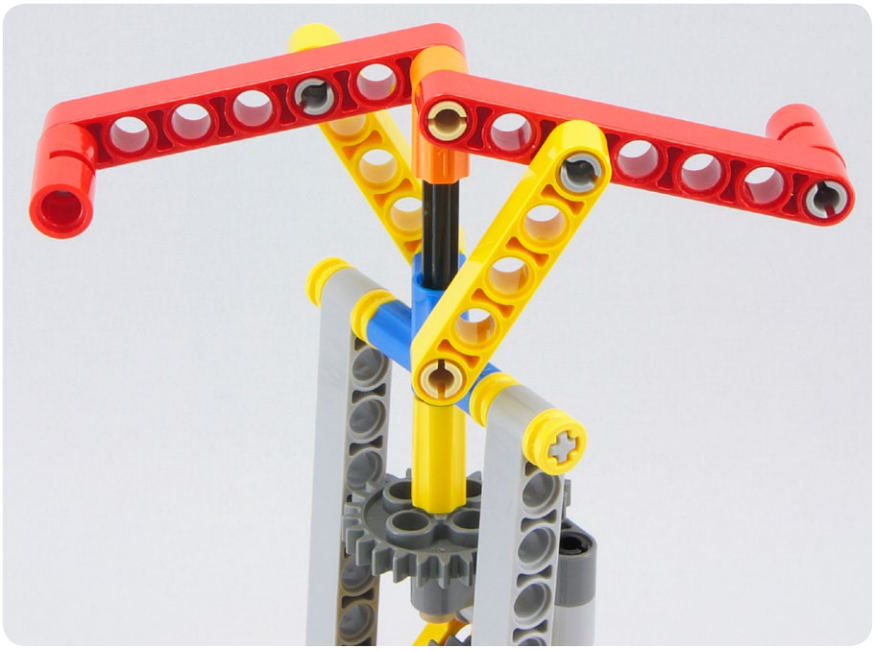
Complex movements via rotation

#266









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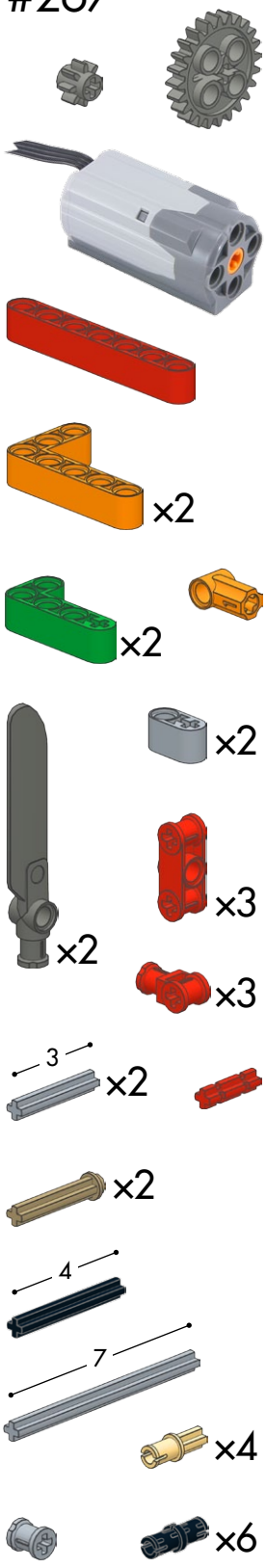

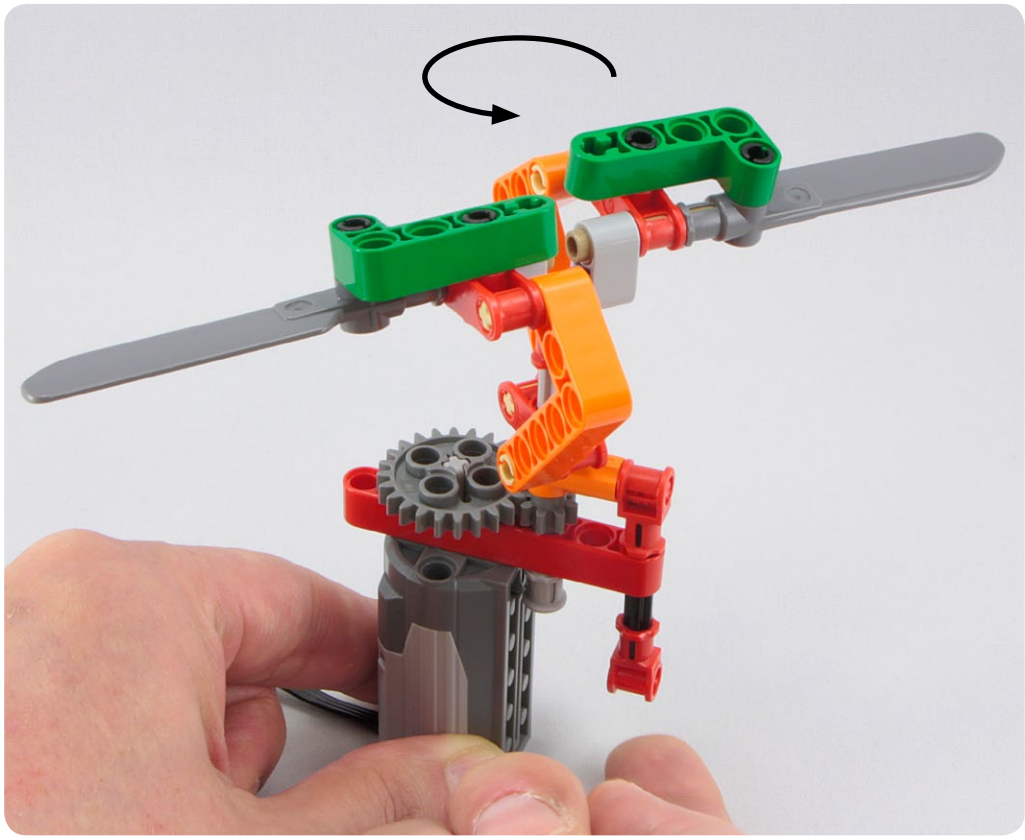

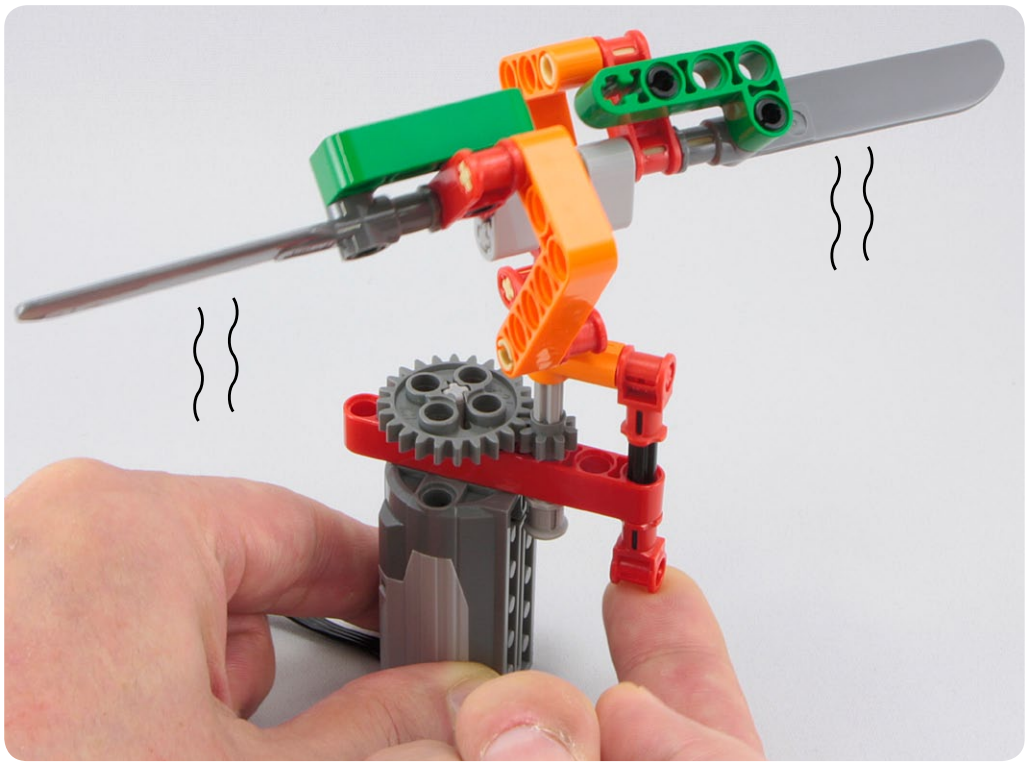

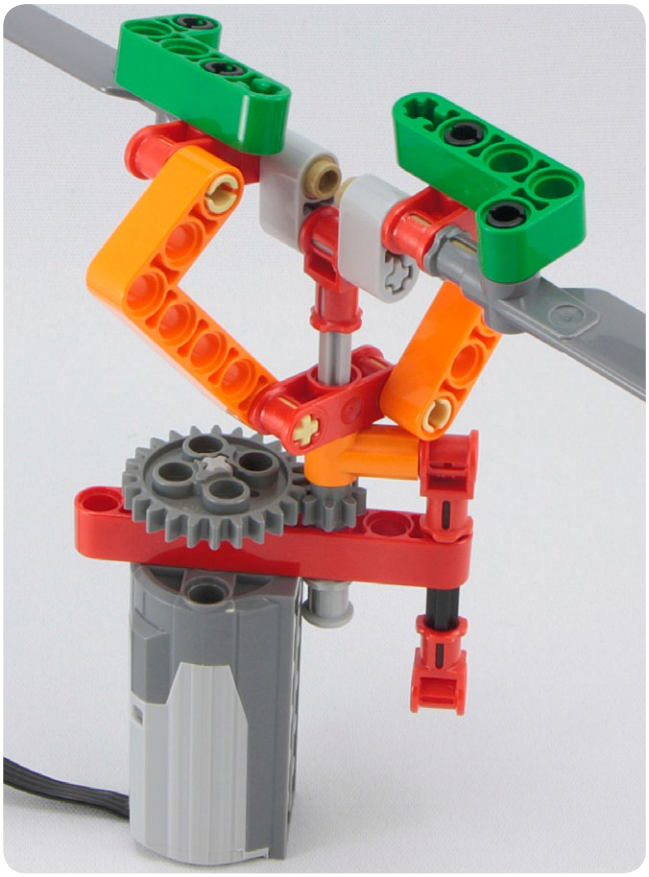

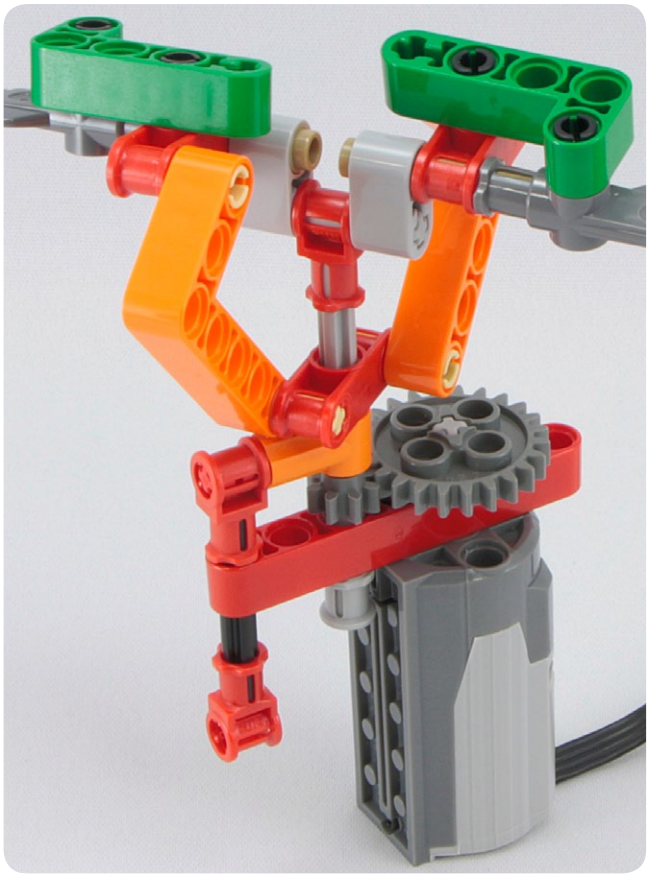

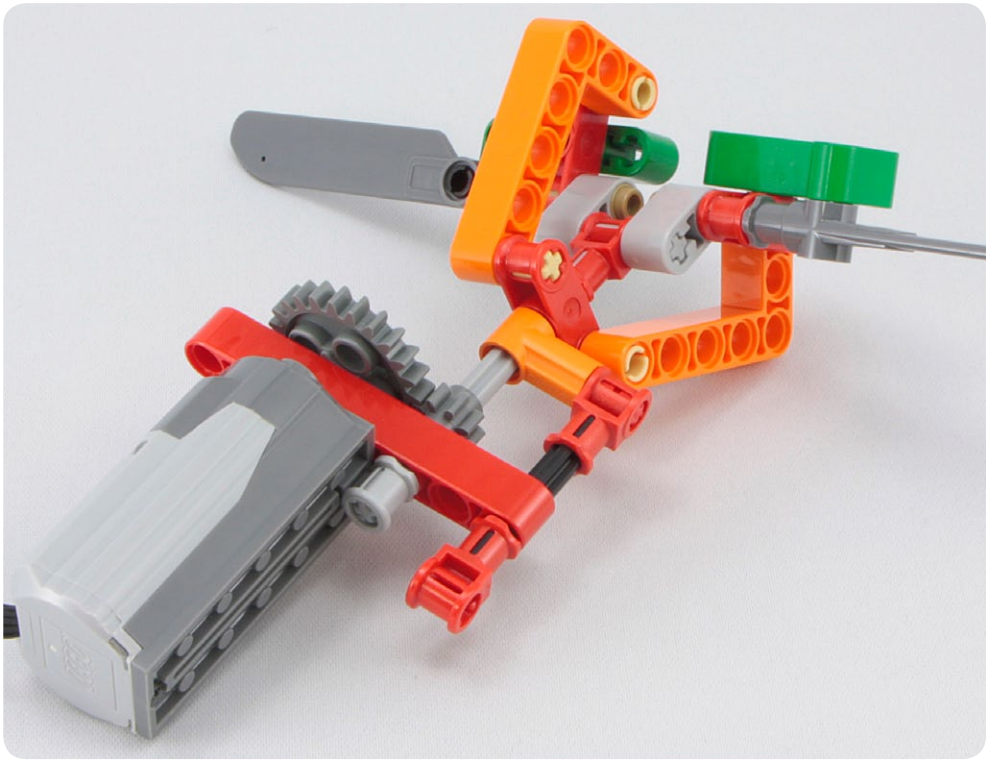

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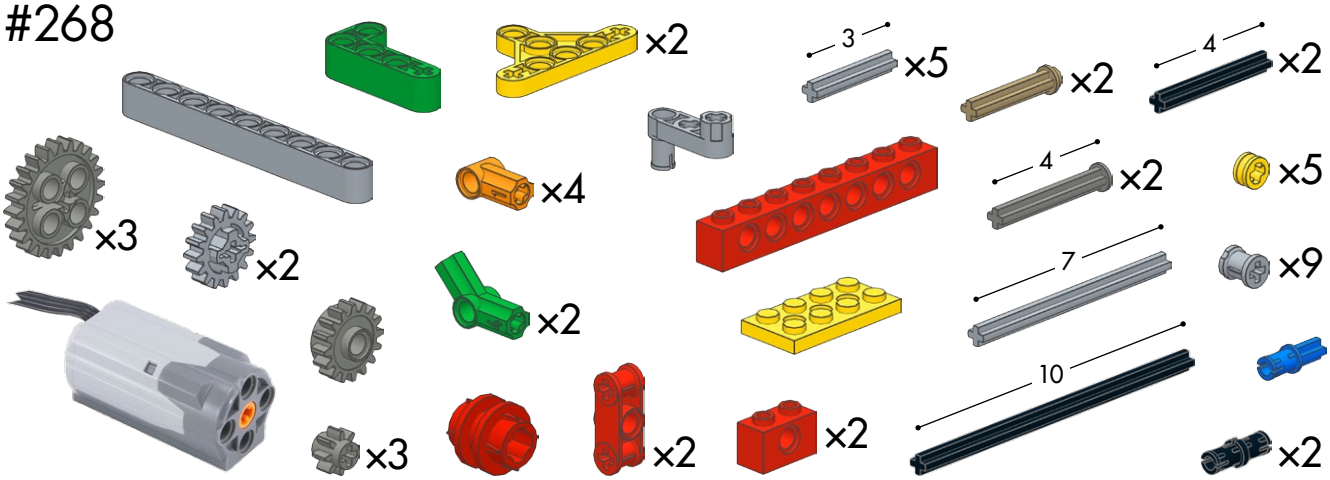

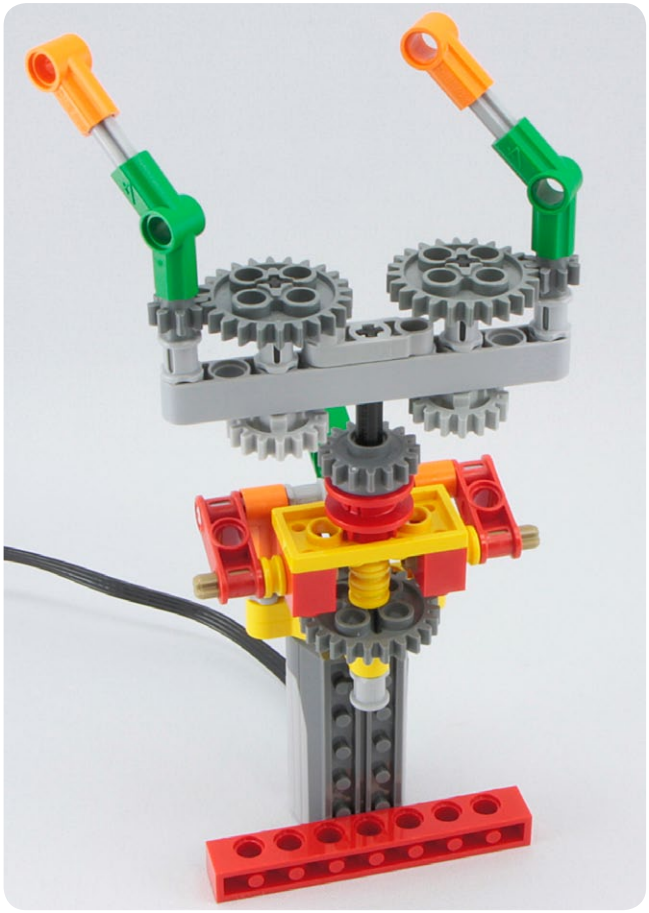

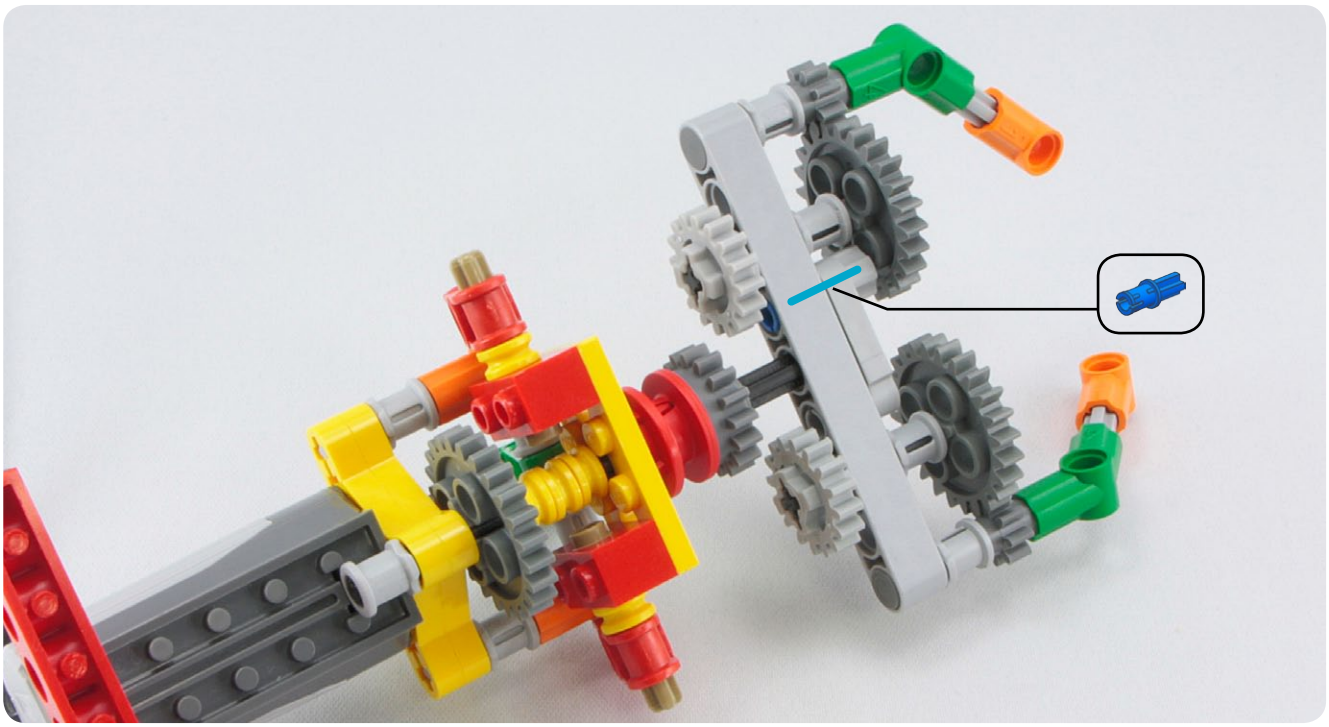

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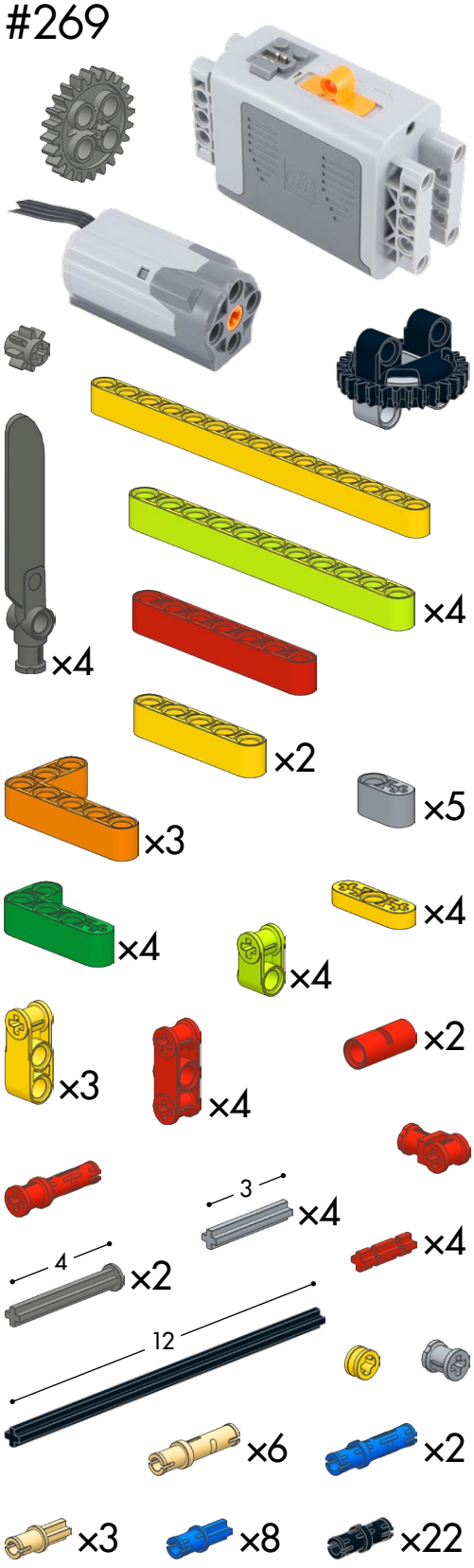
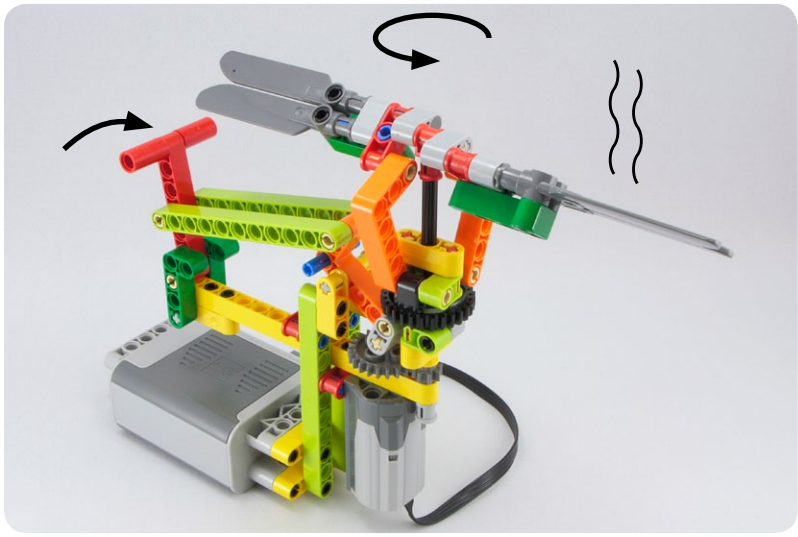
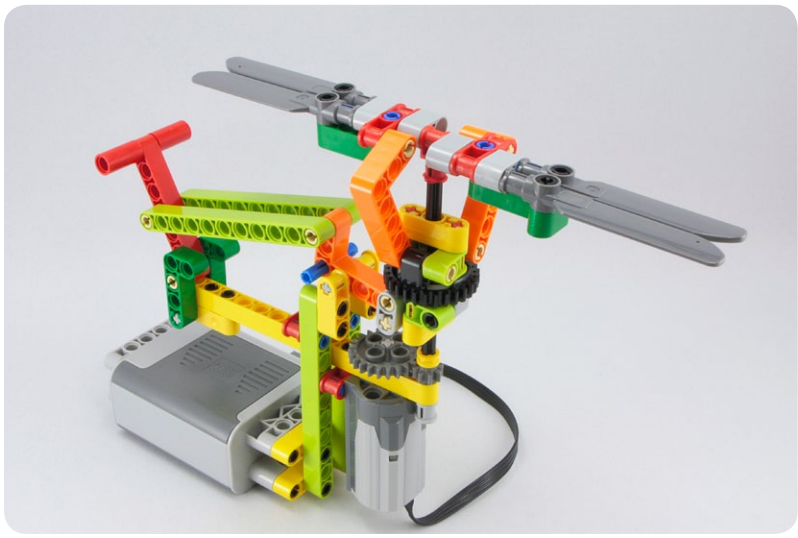
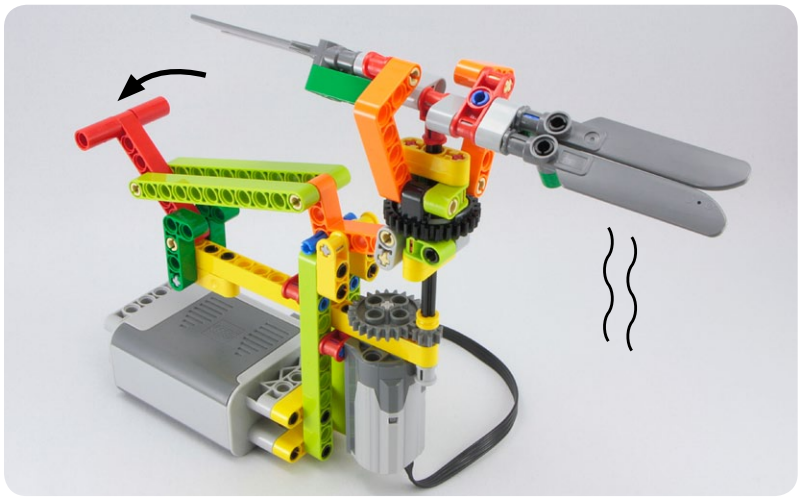
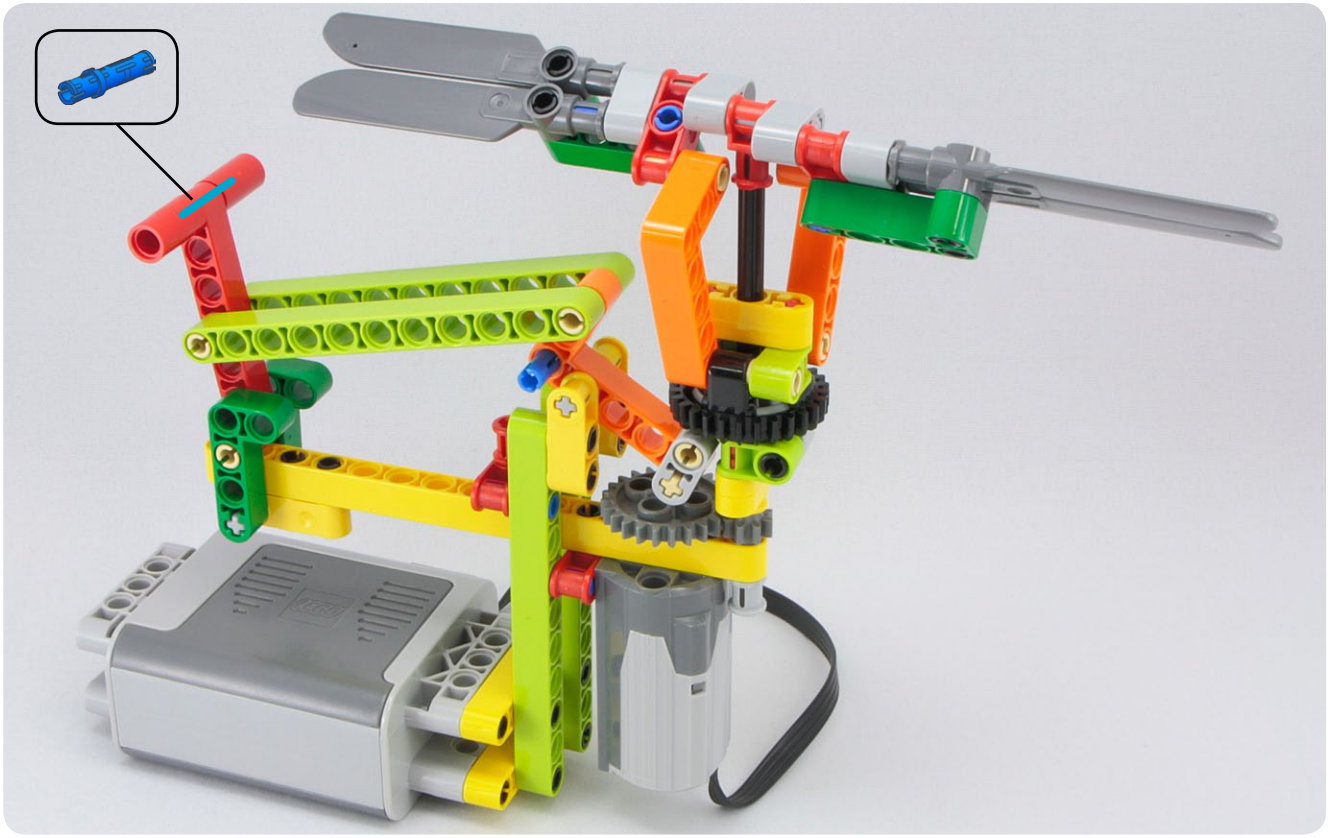
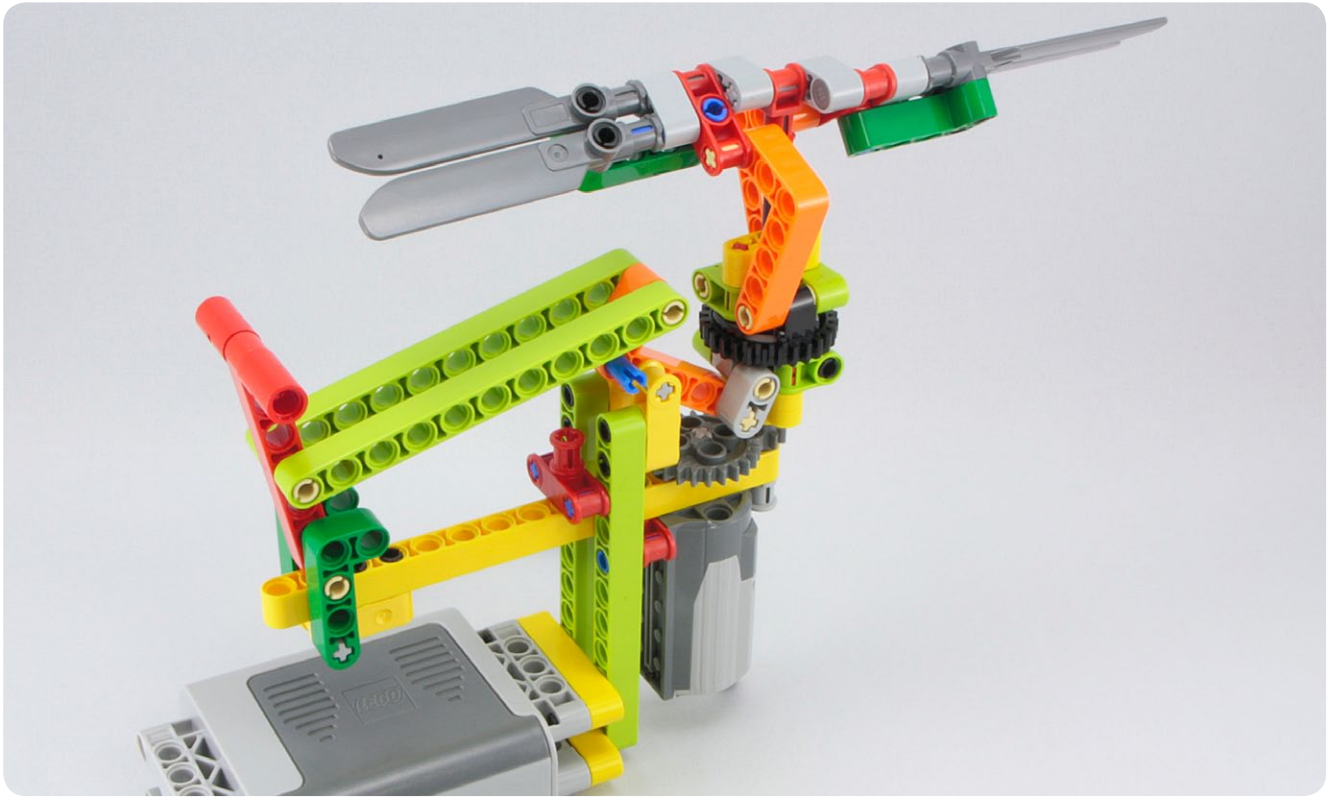


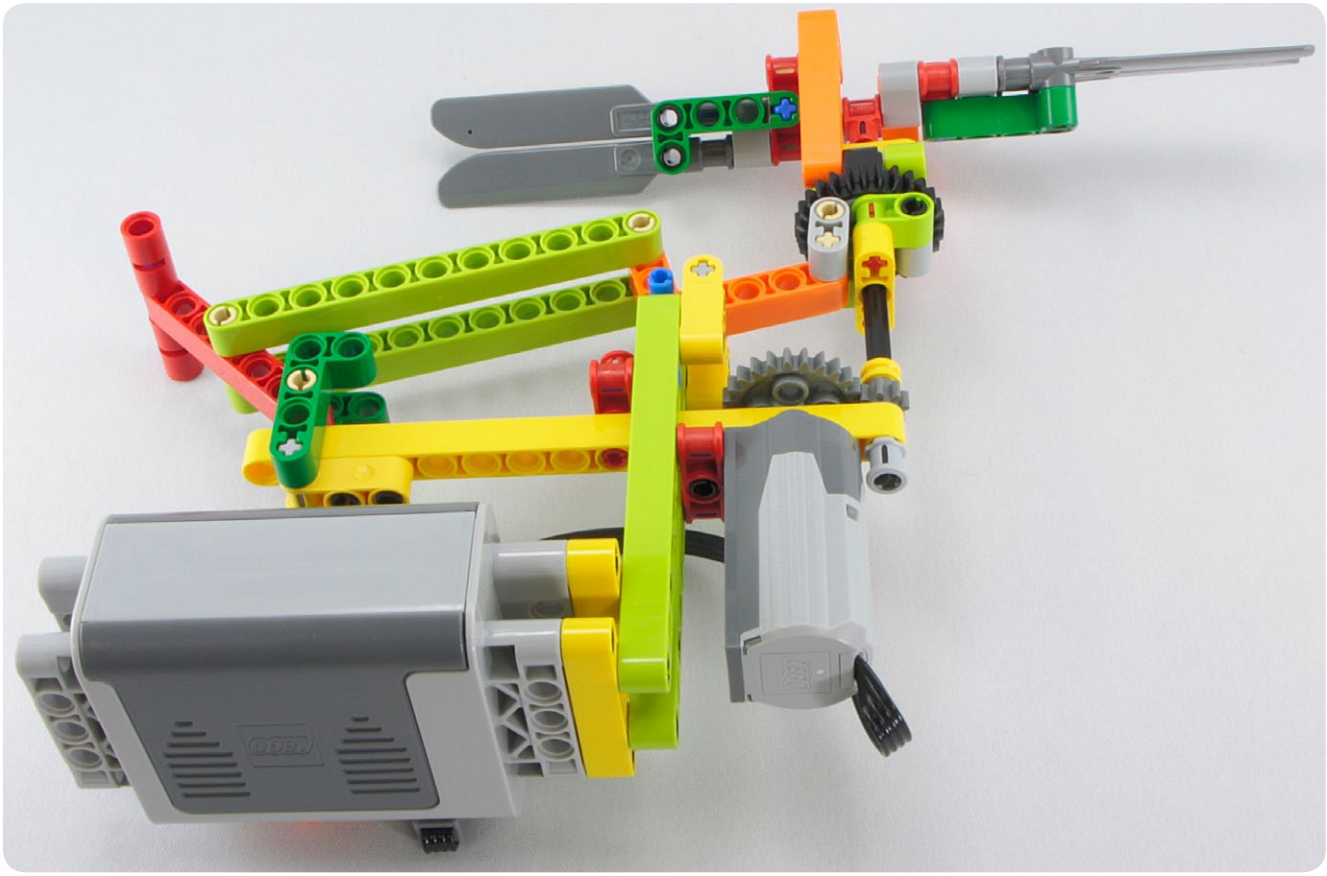


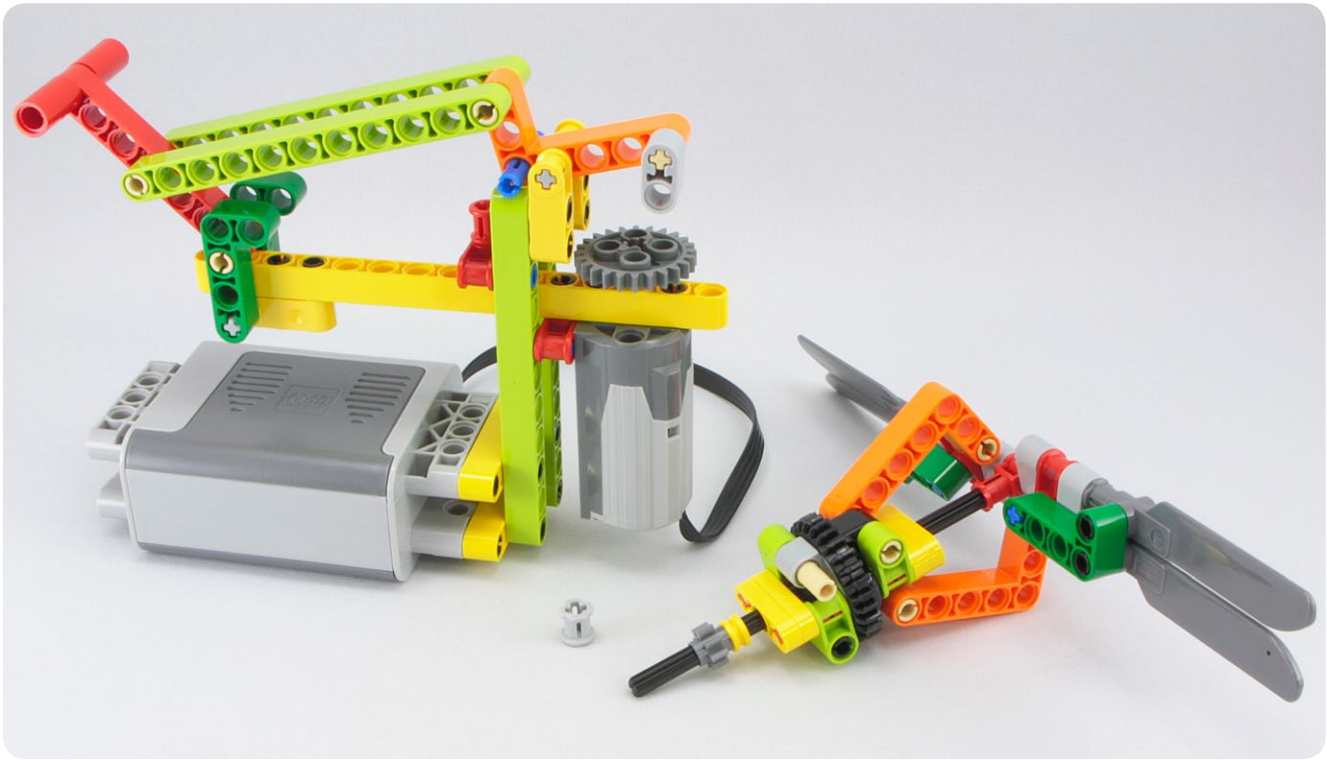


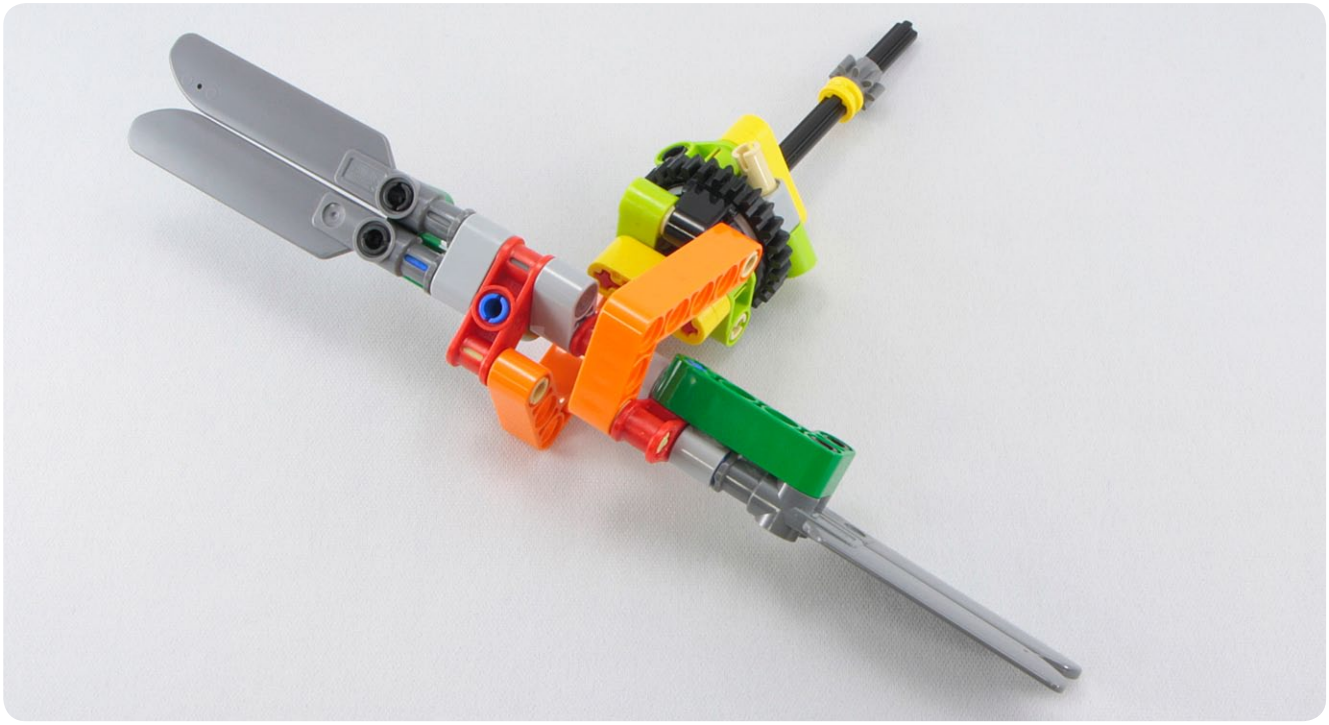


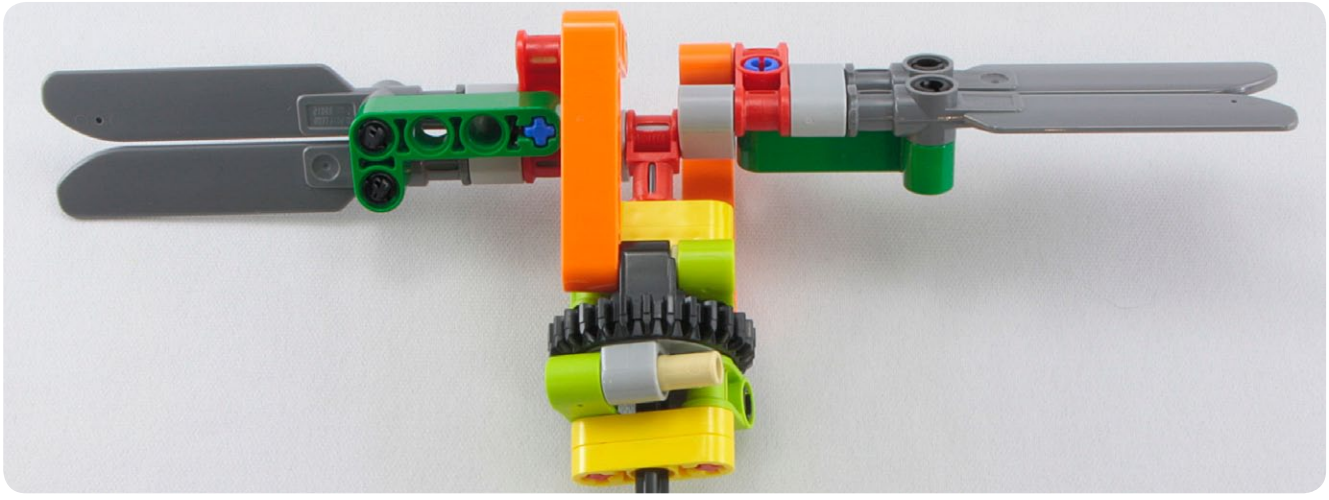


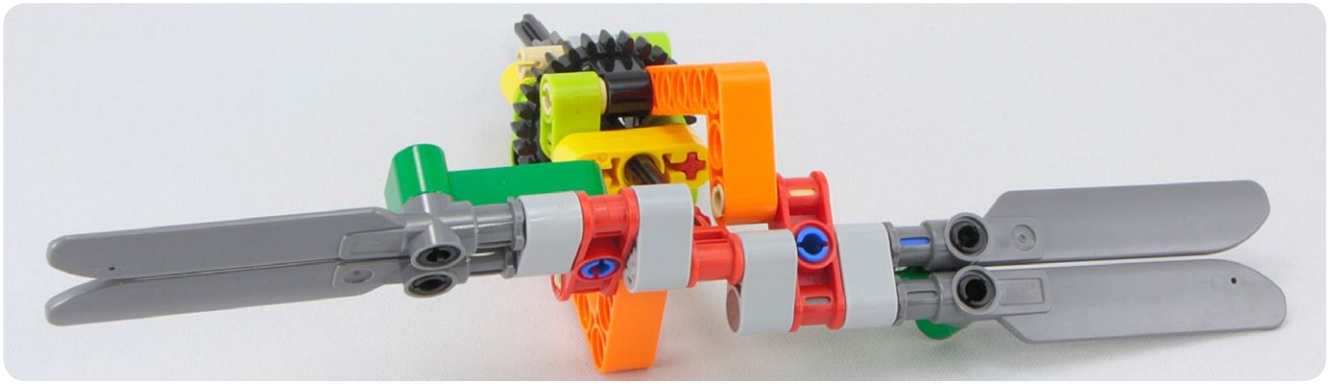




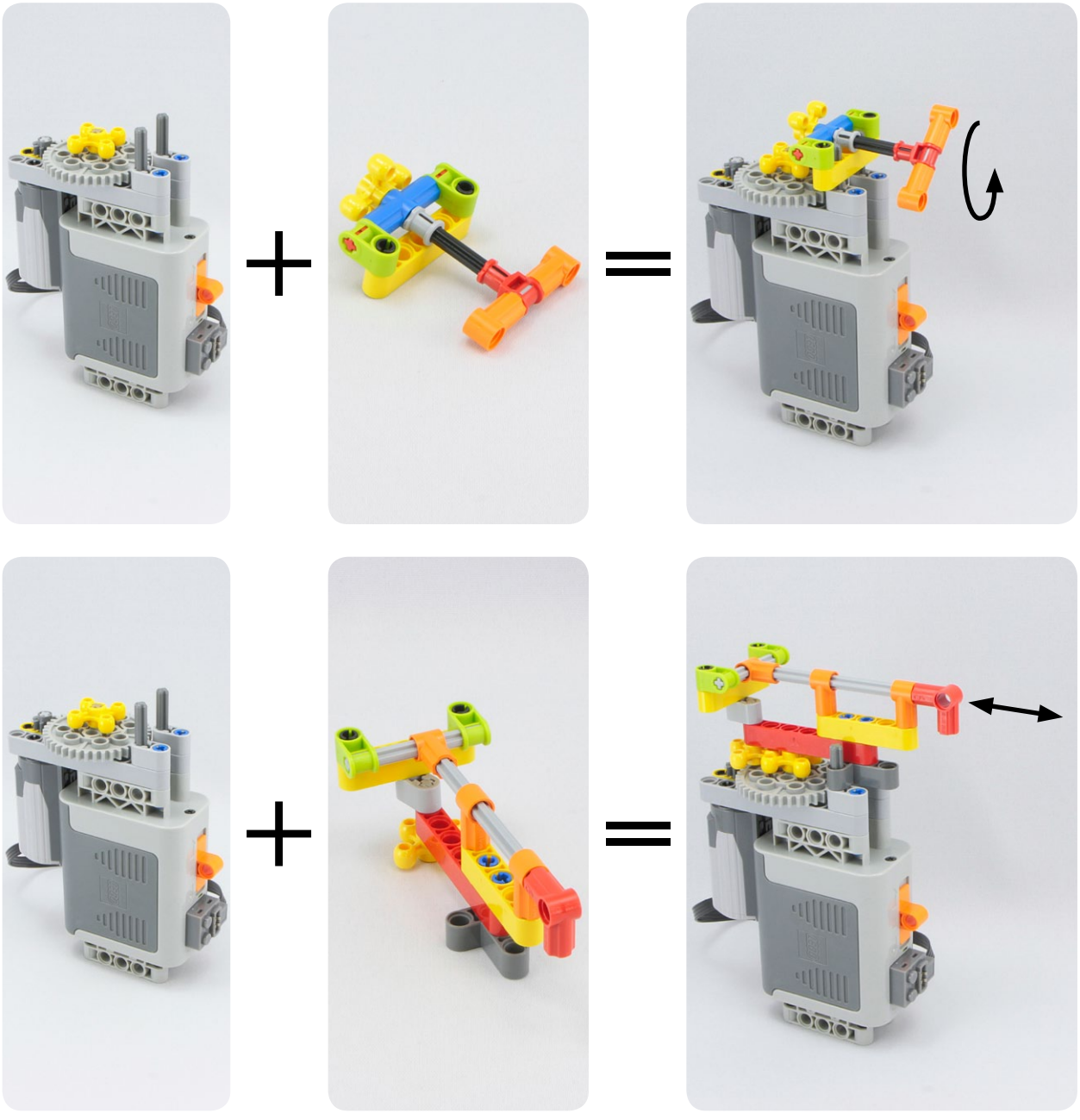


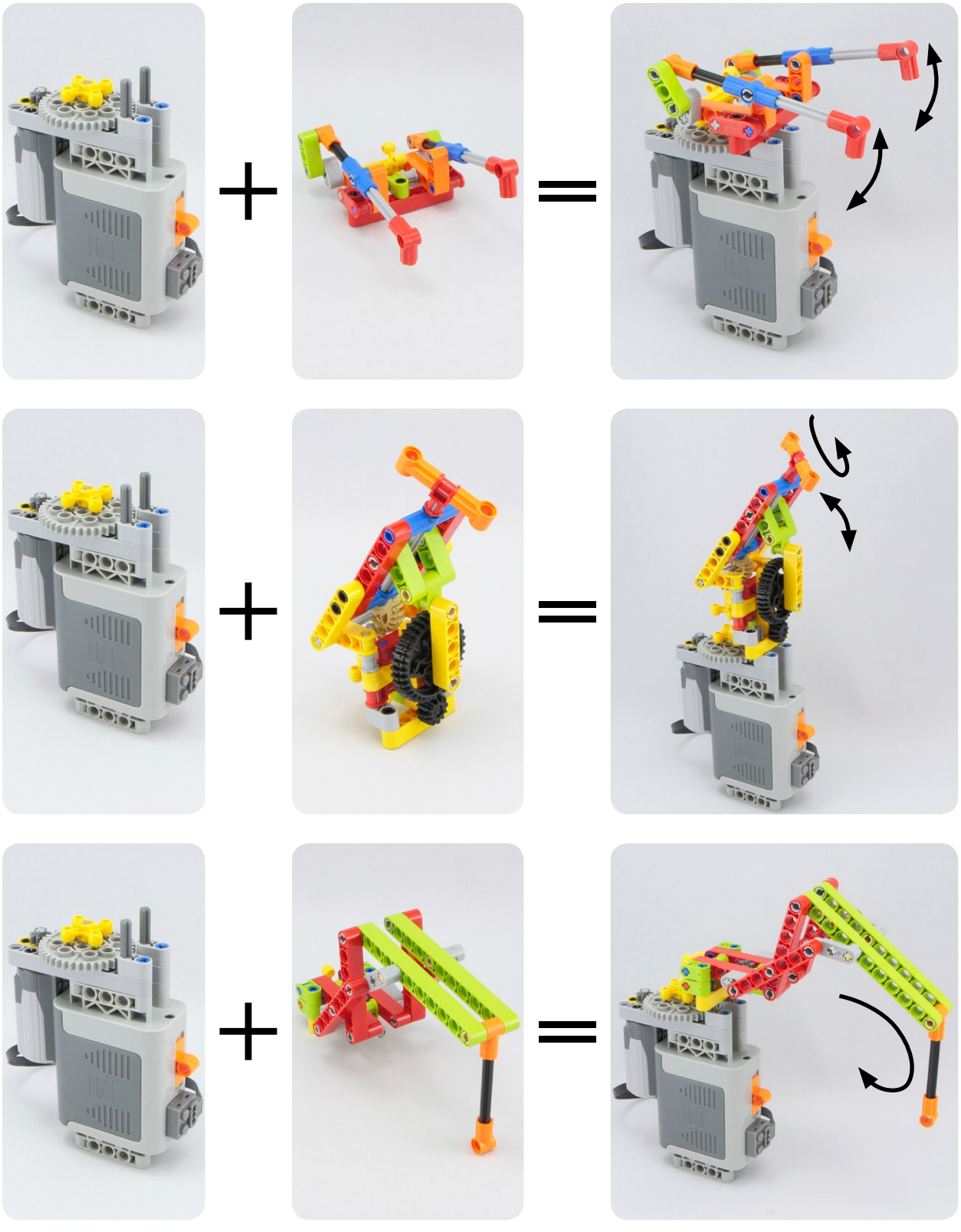






Using attachments to change motion





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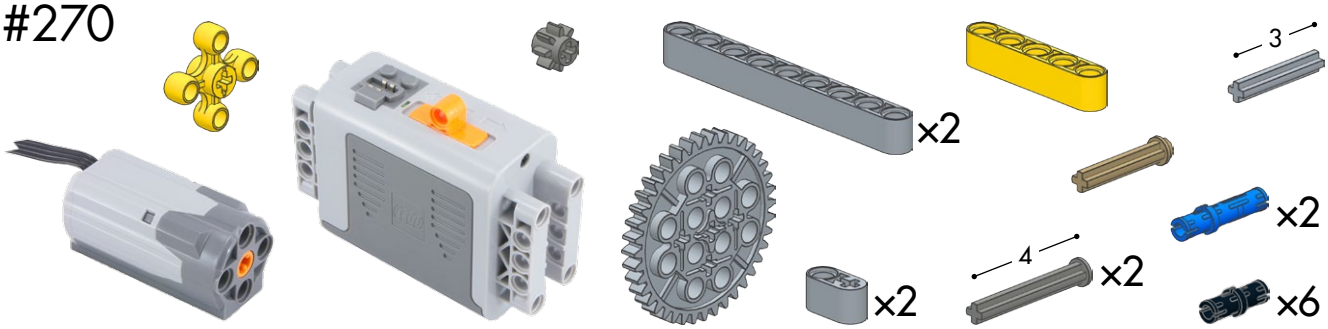

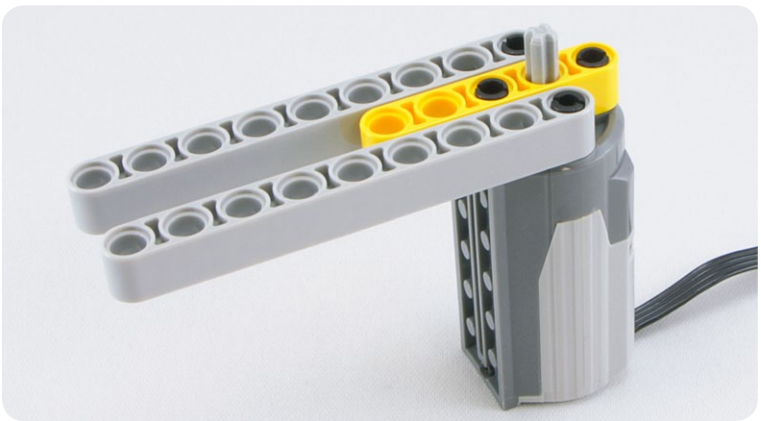

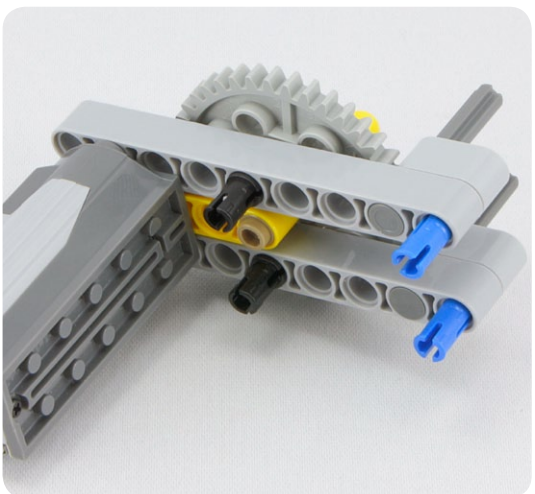

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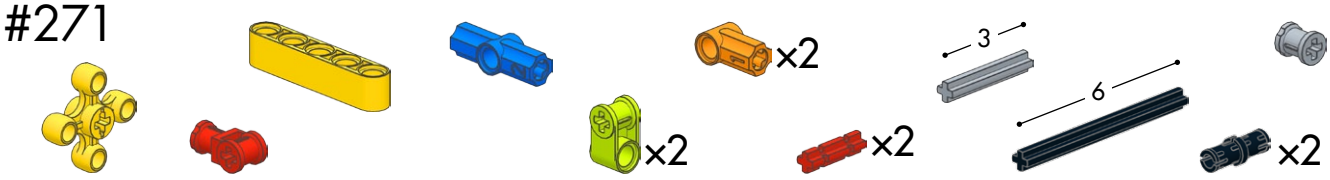

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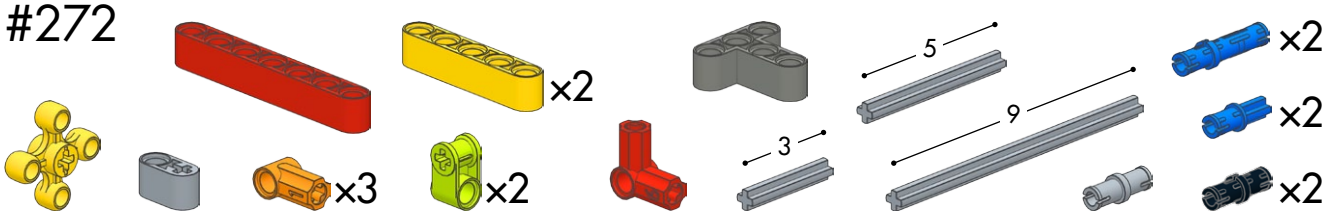

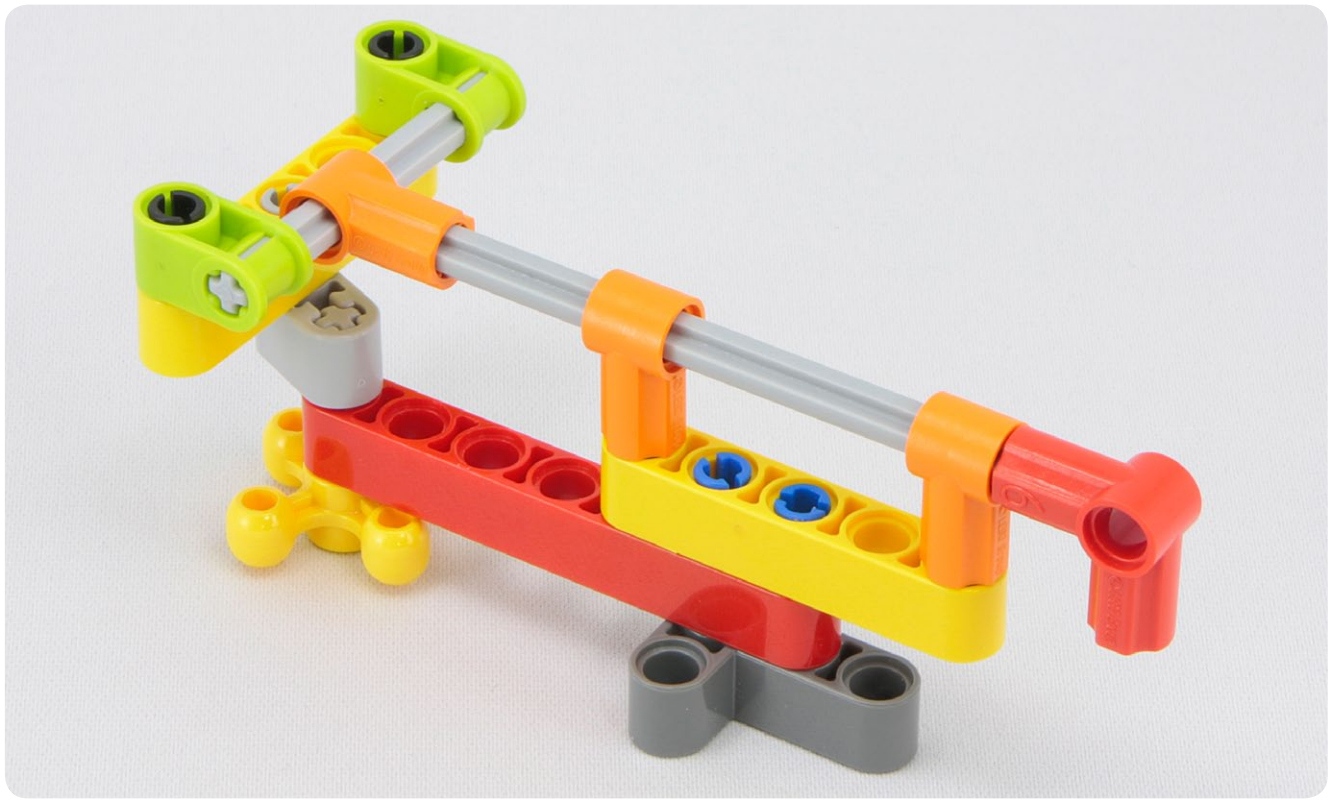

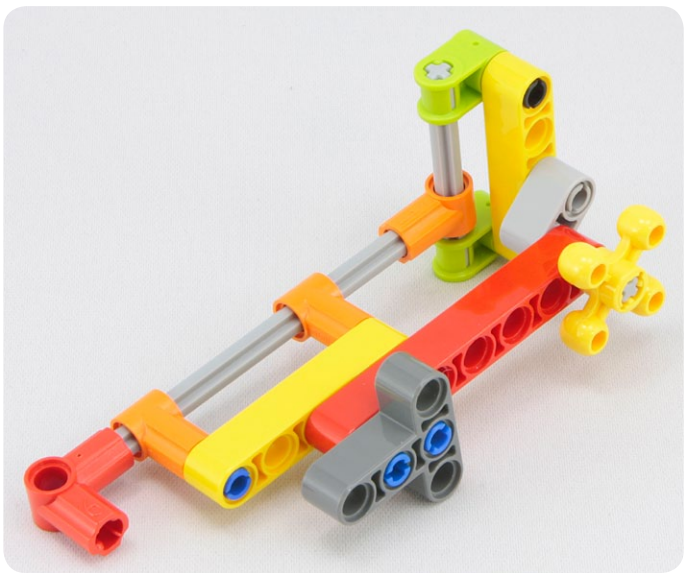

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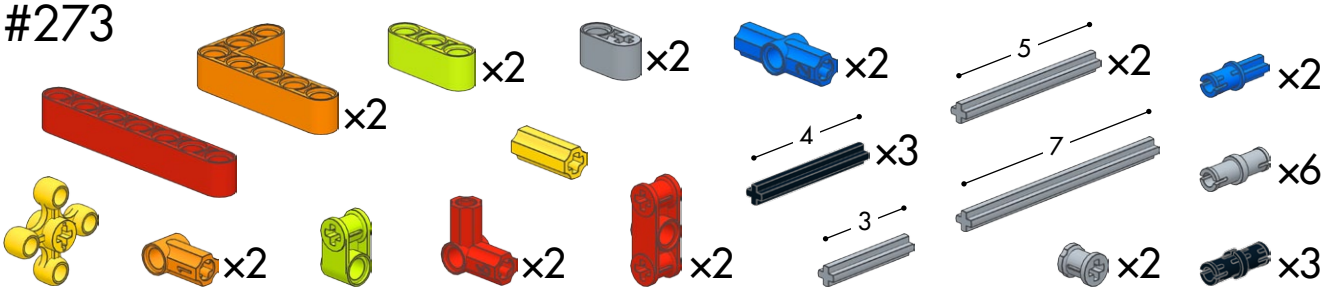

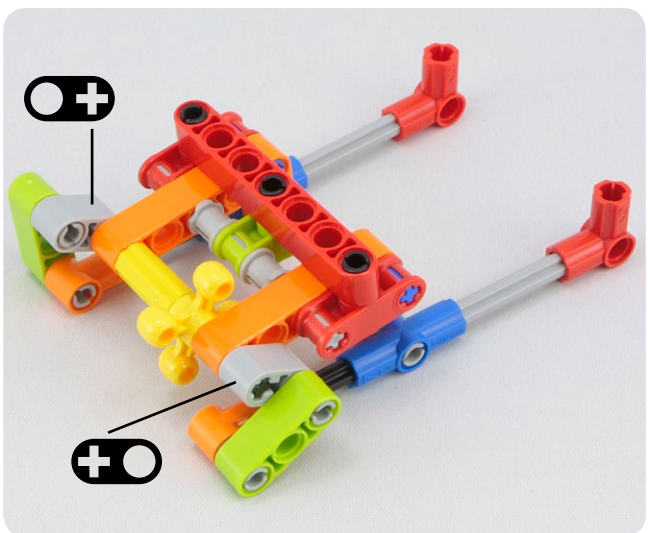

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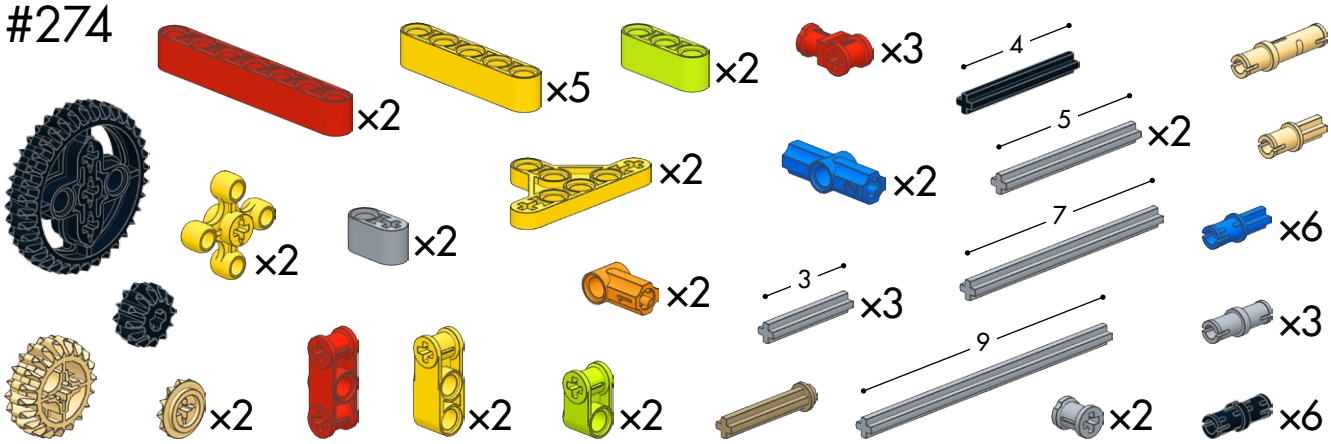

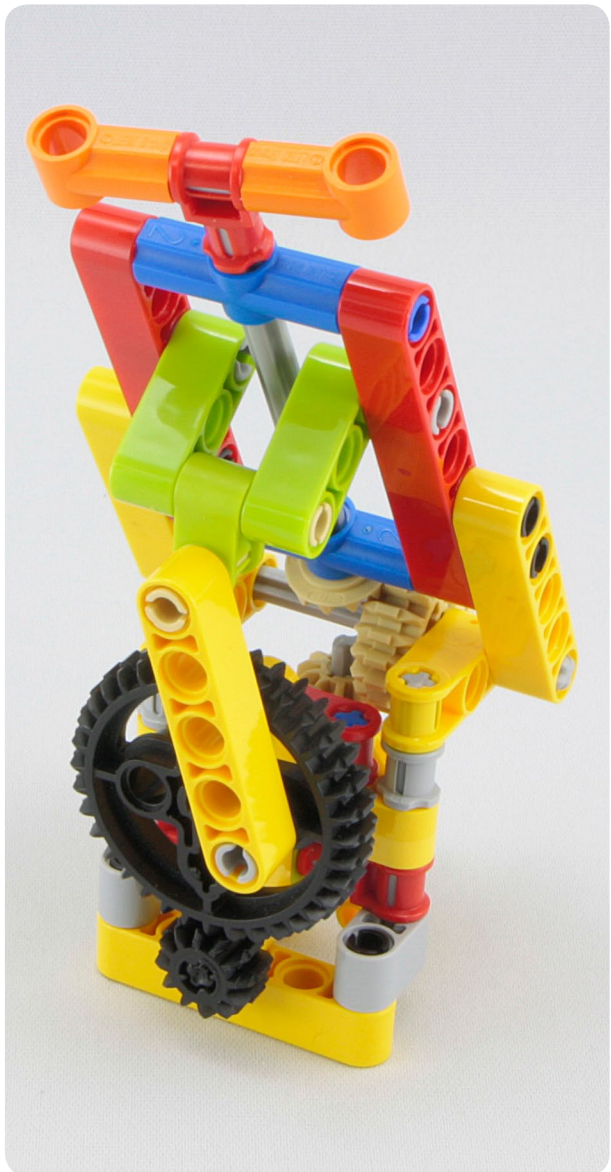

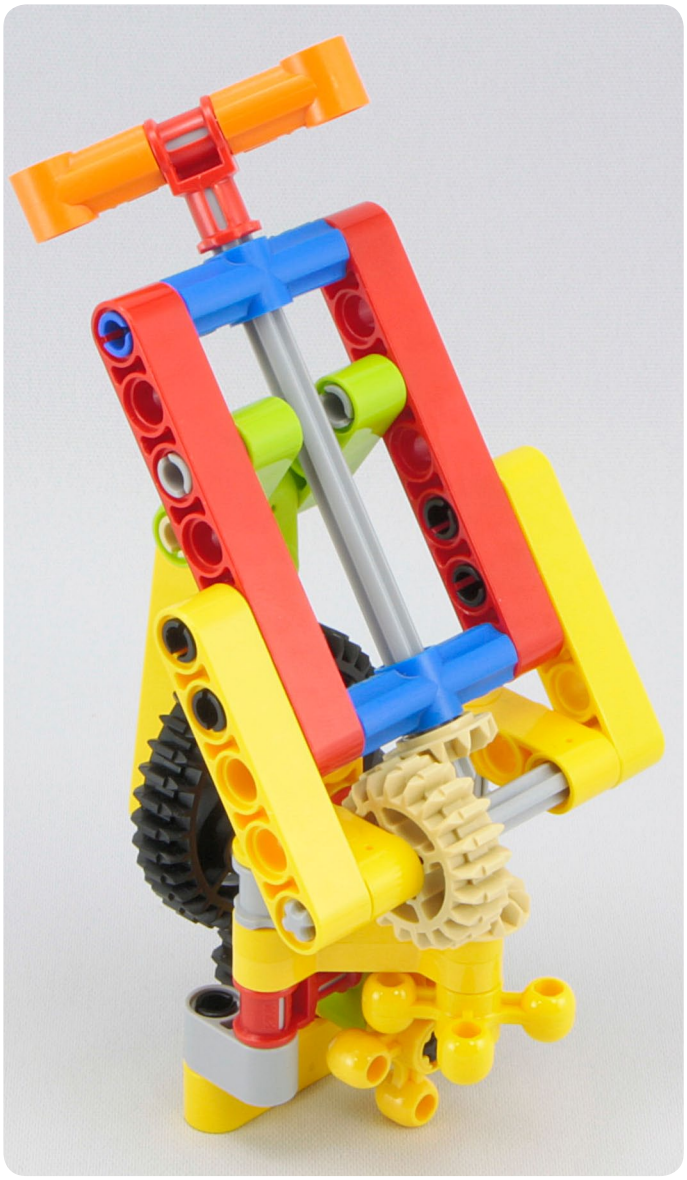

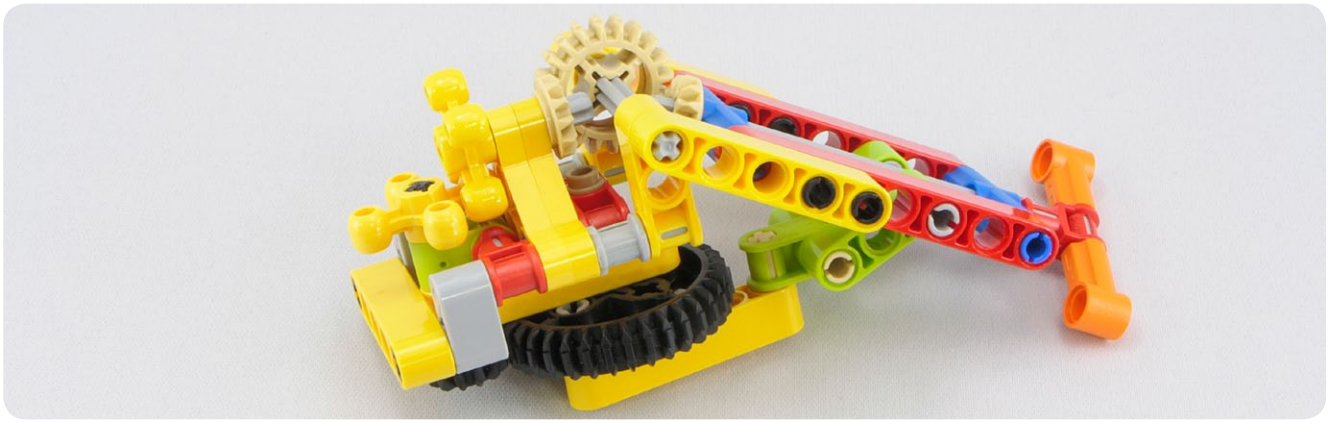

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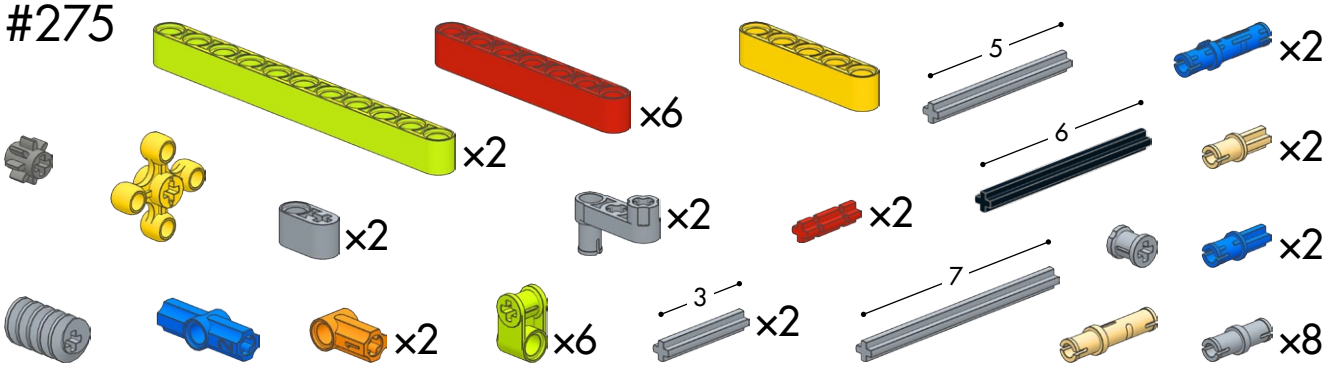
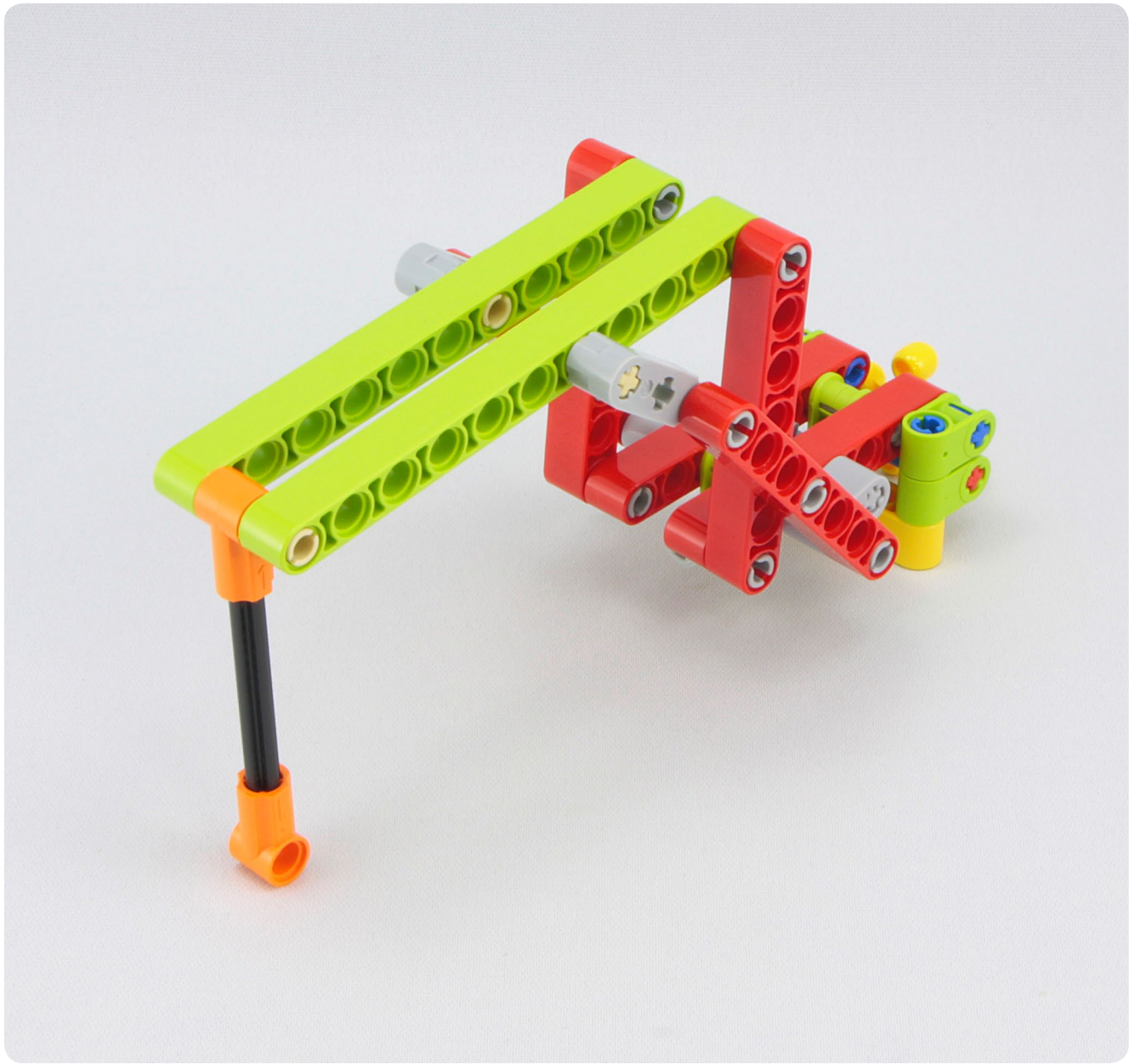
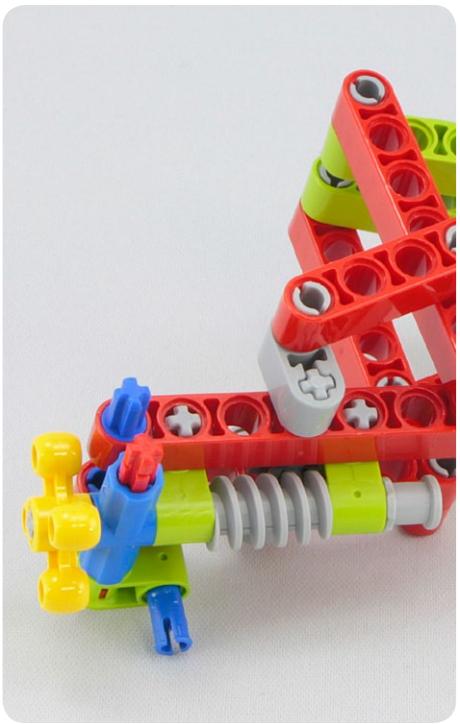
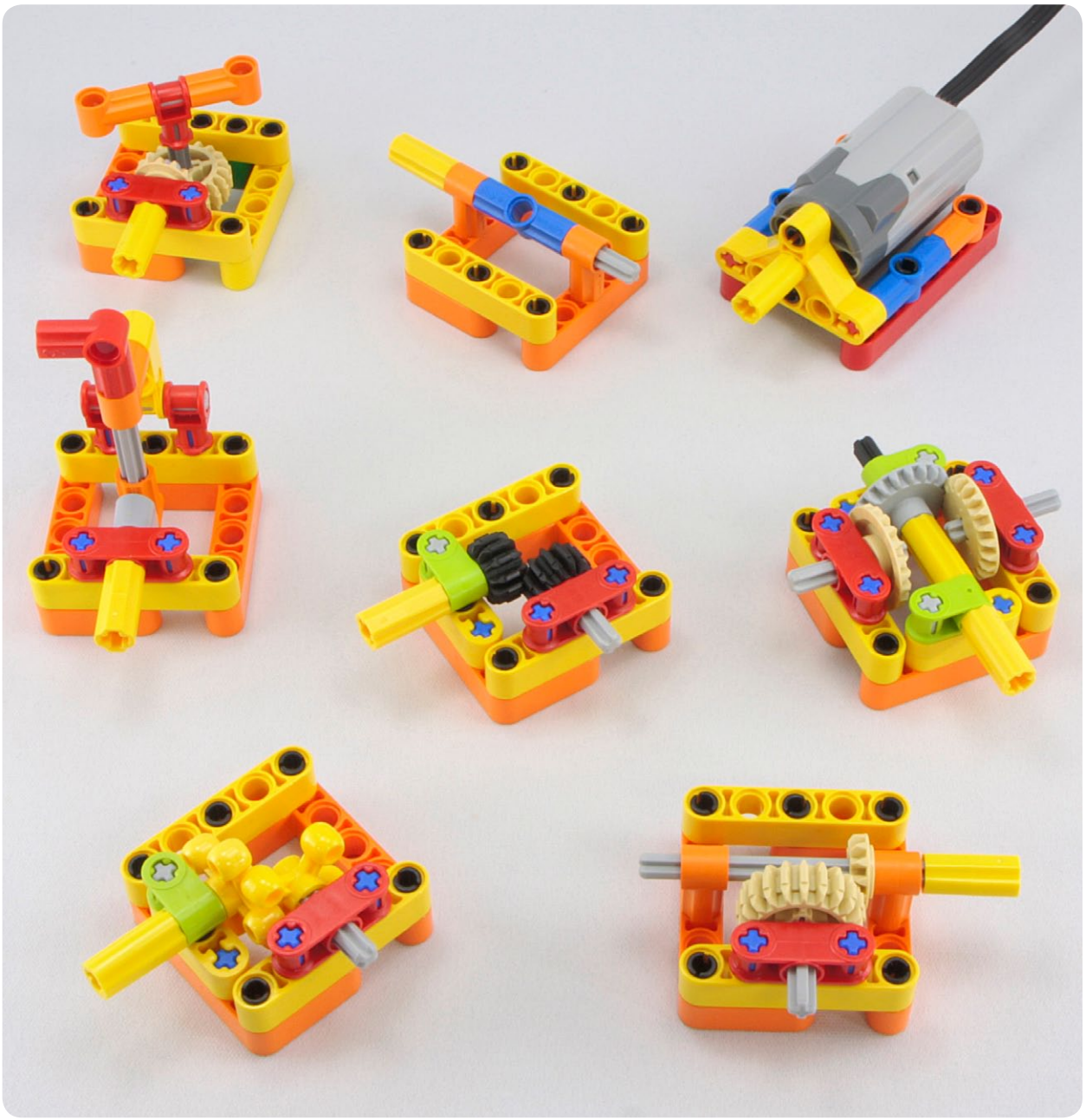
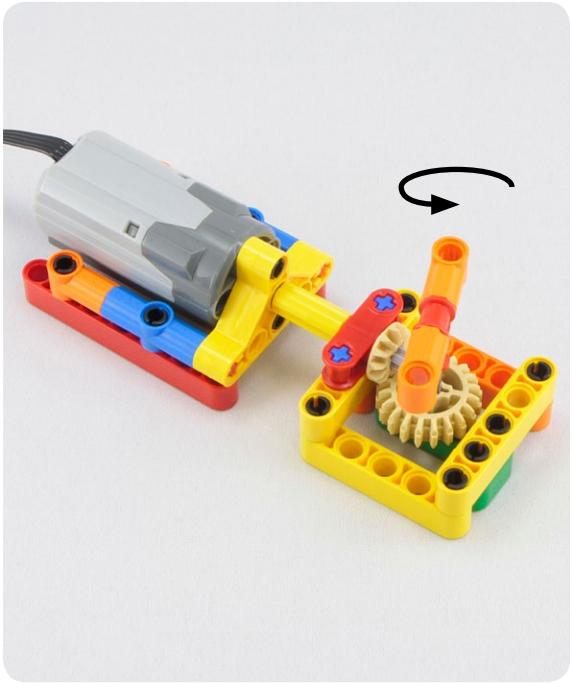


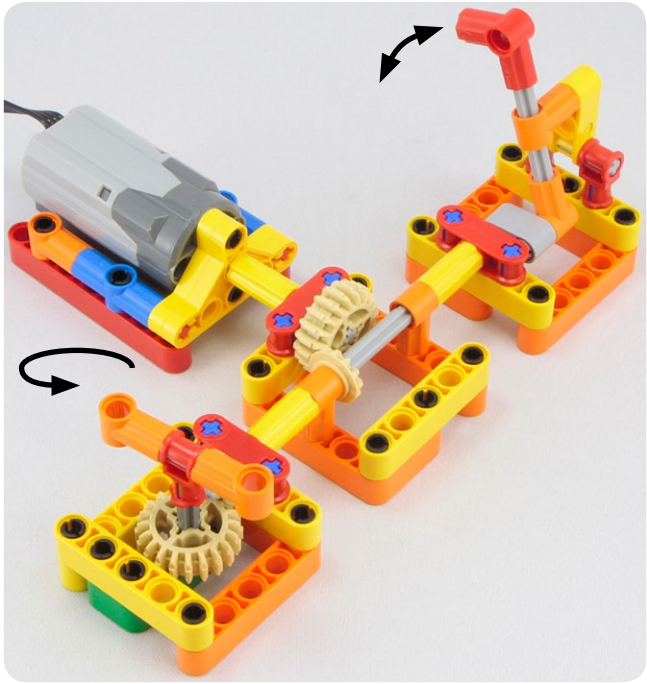


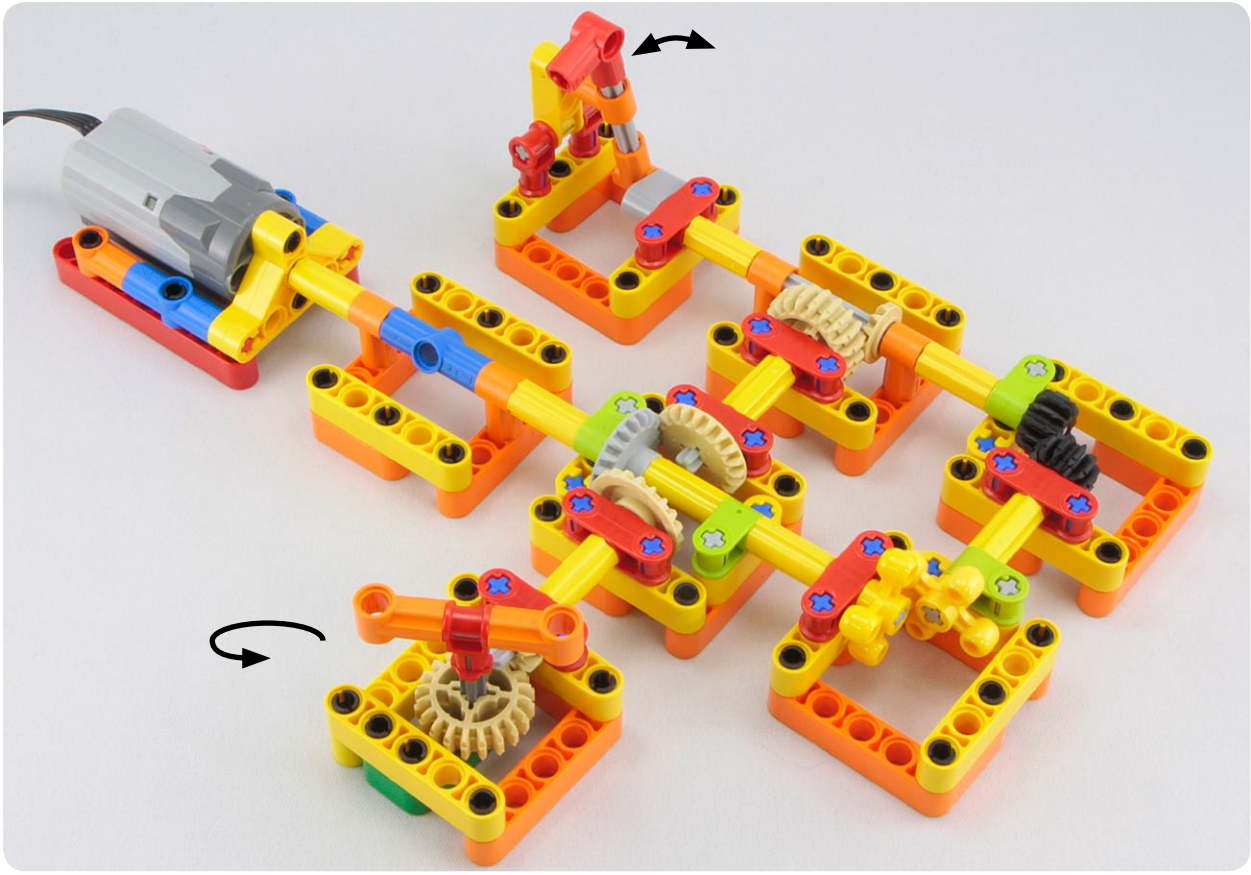


Combining modules









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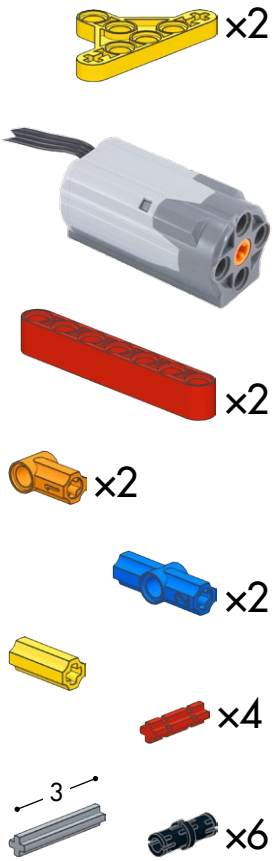

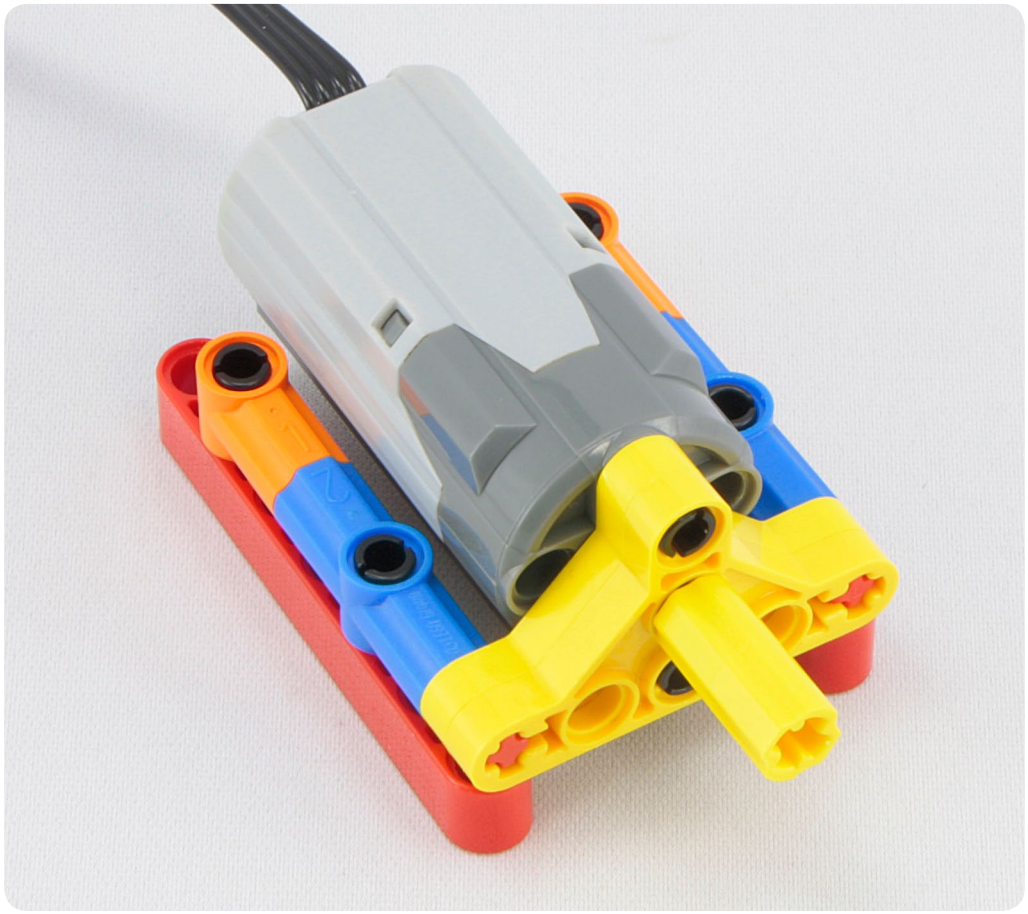

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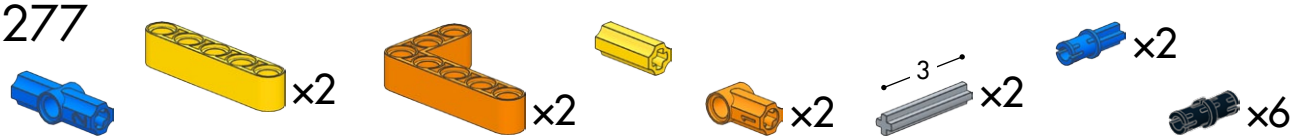

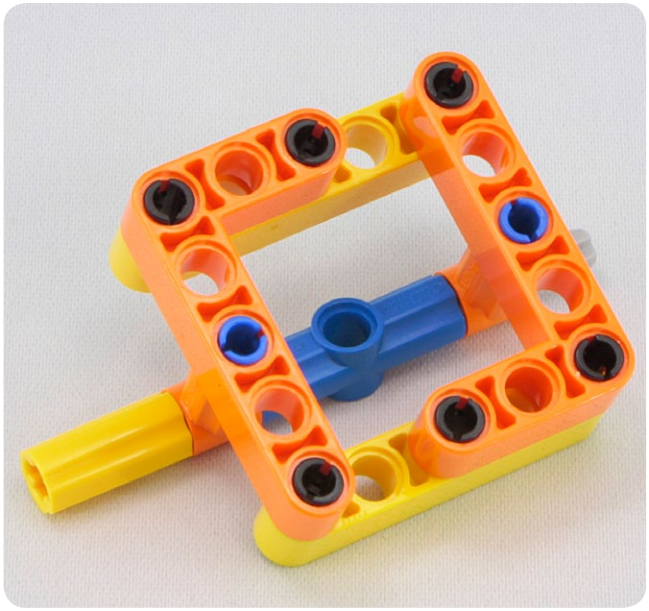

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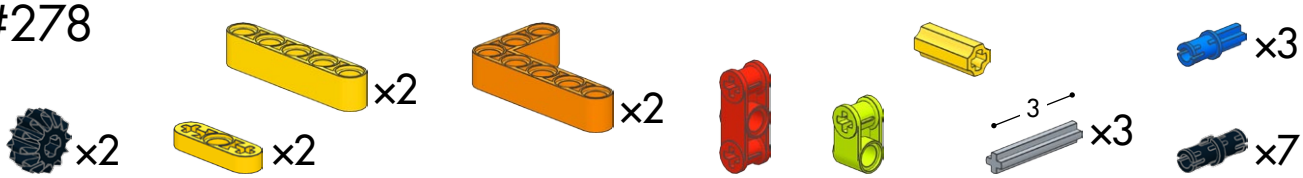

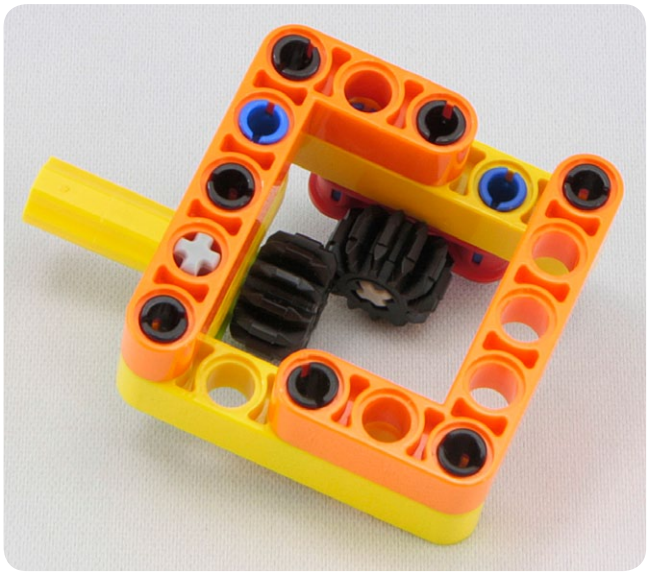

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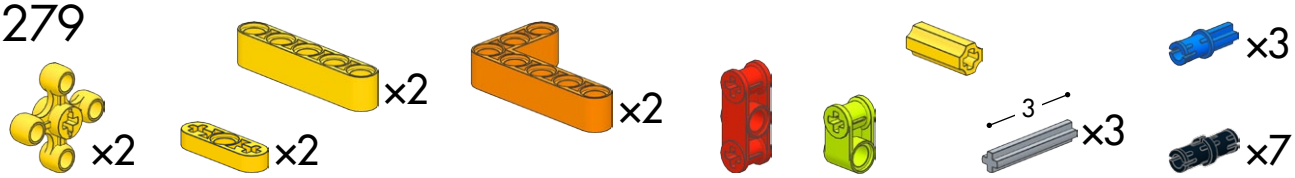

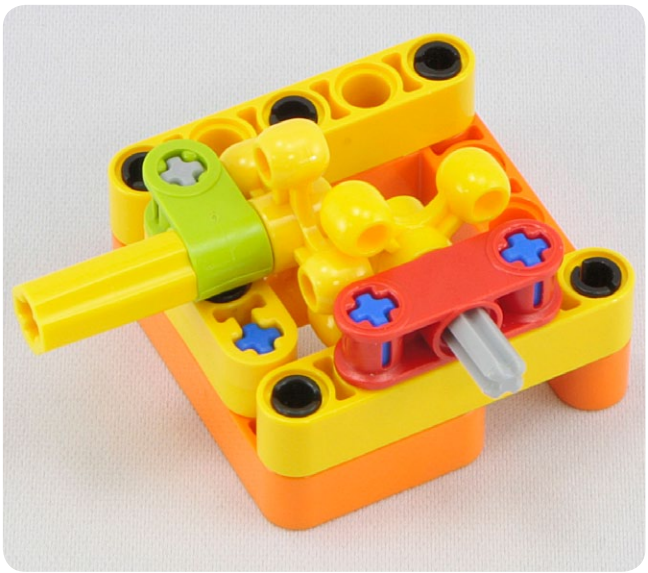

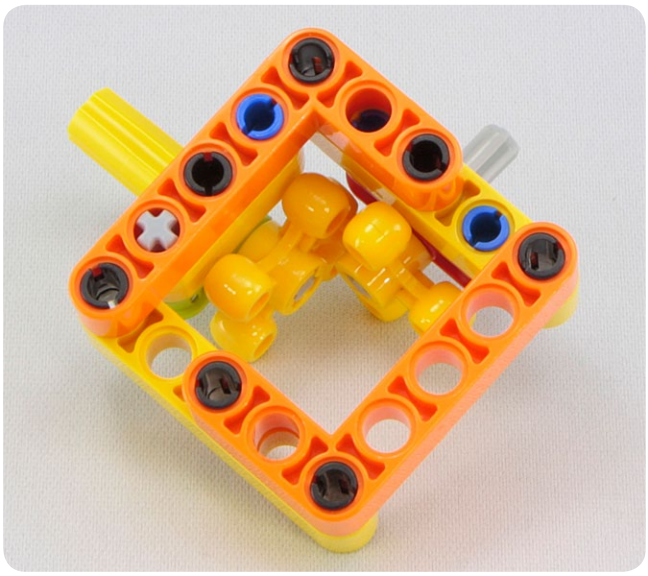

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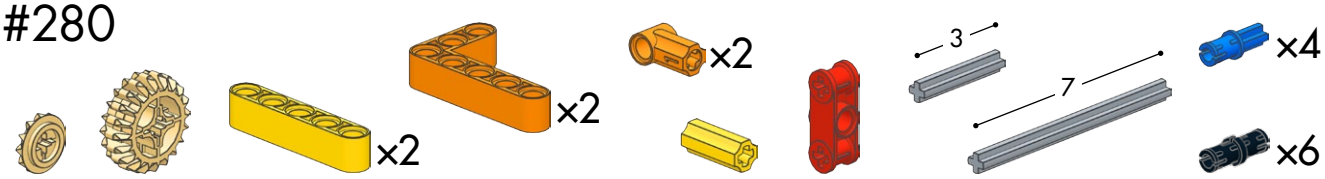

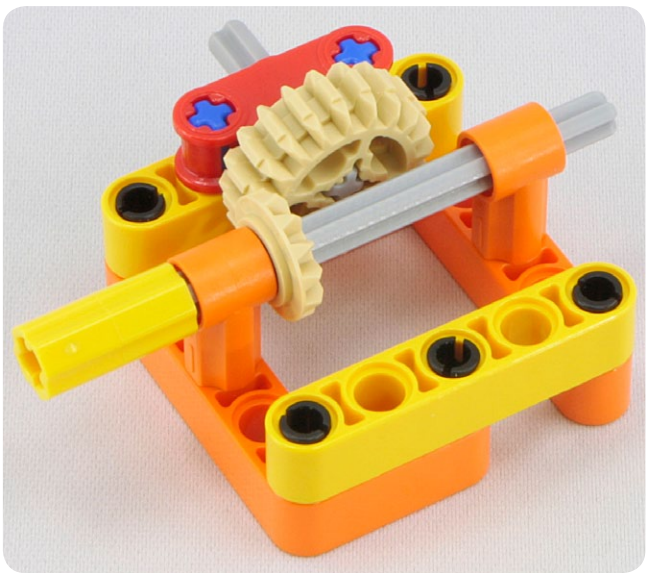

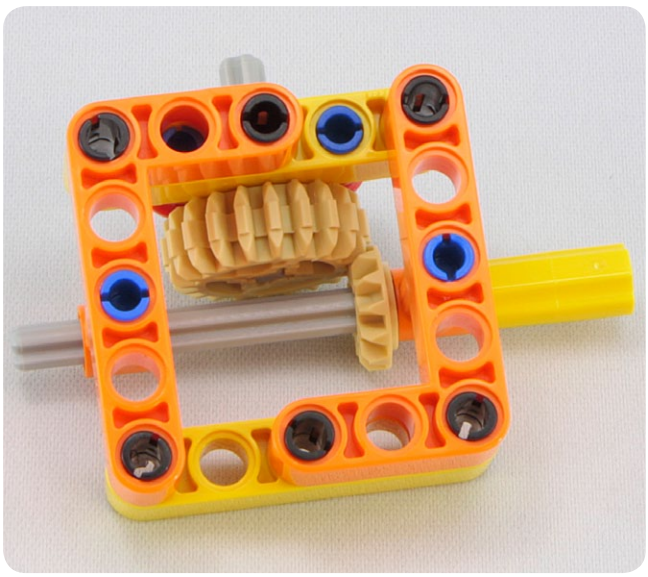

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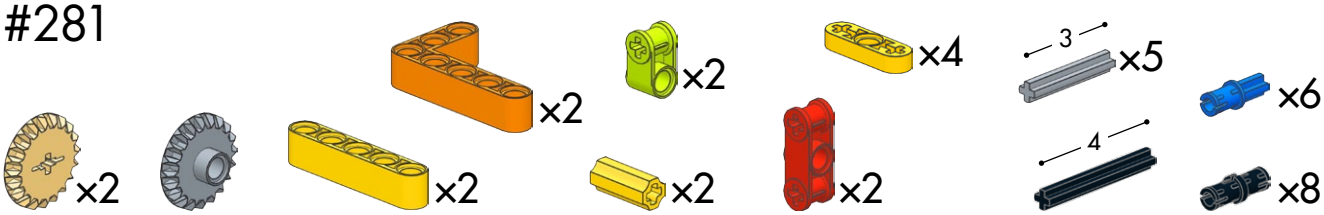

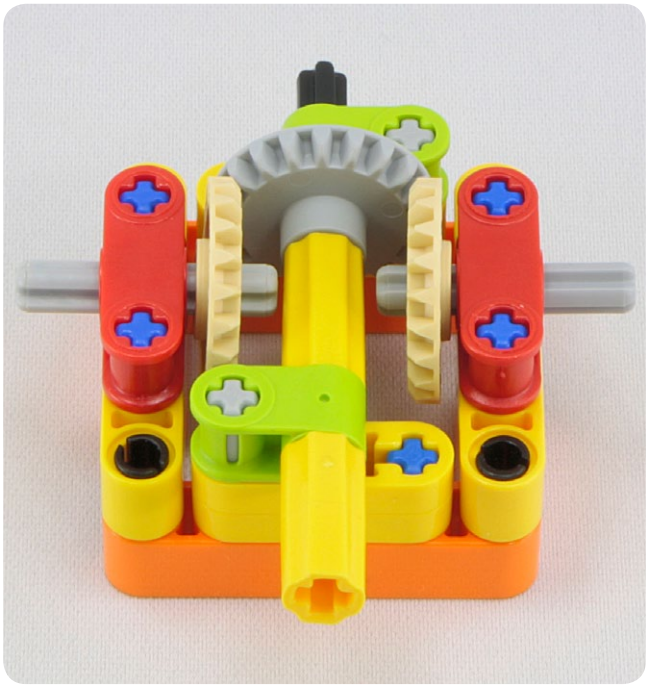

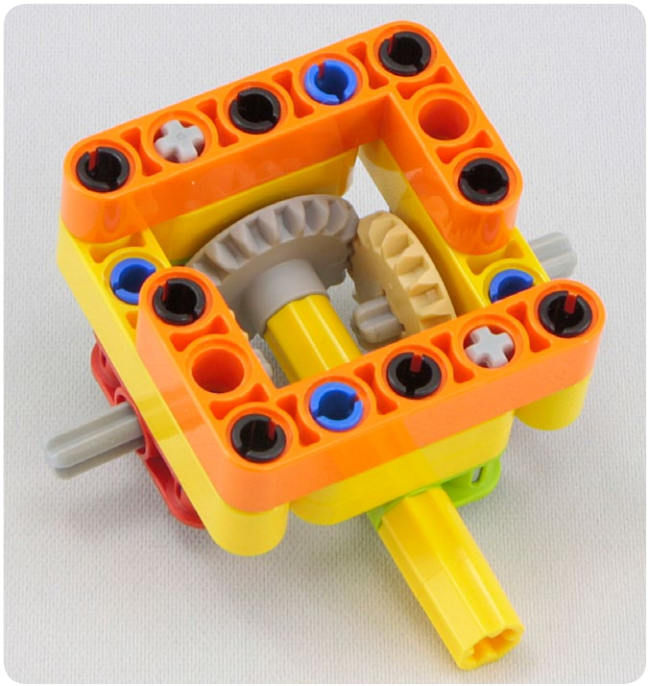

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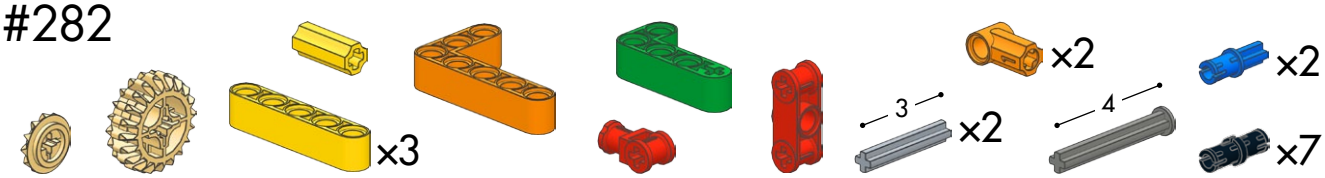

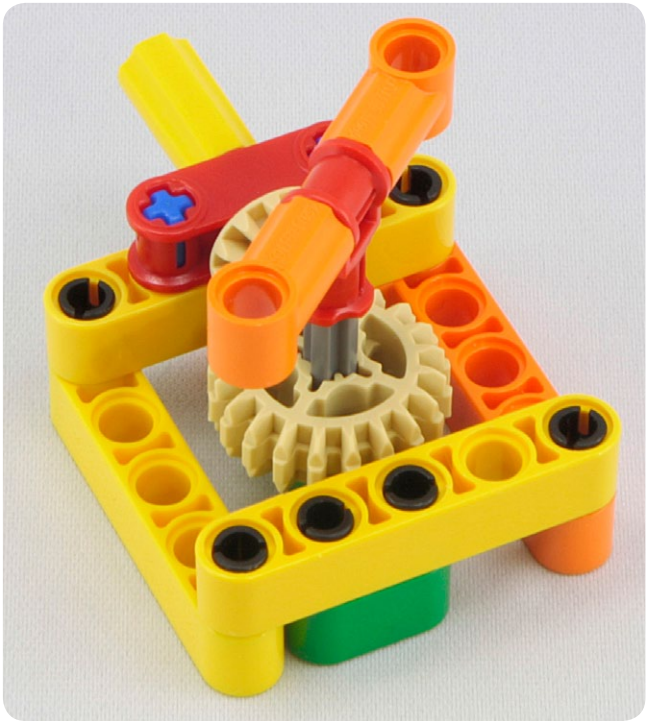

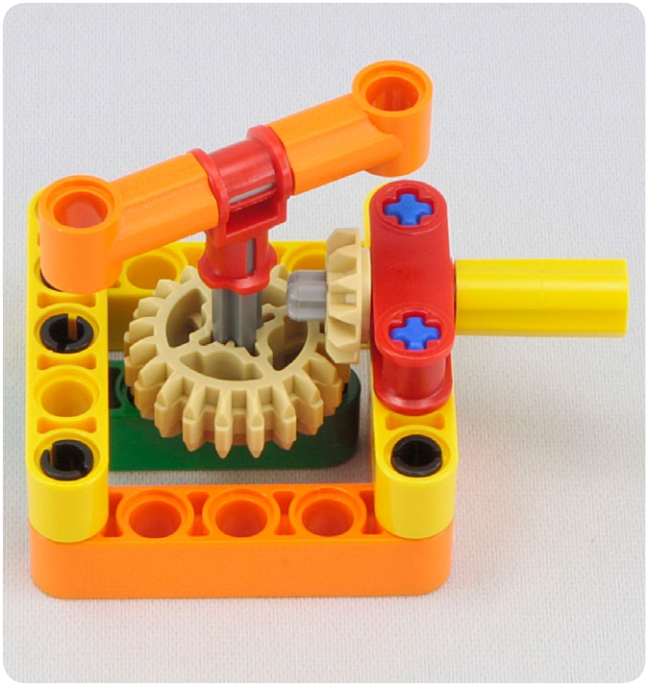

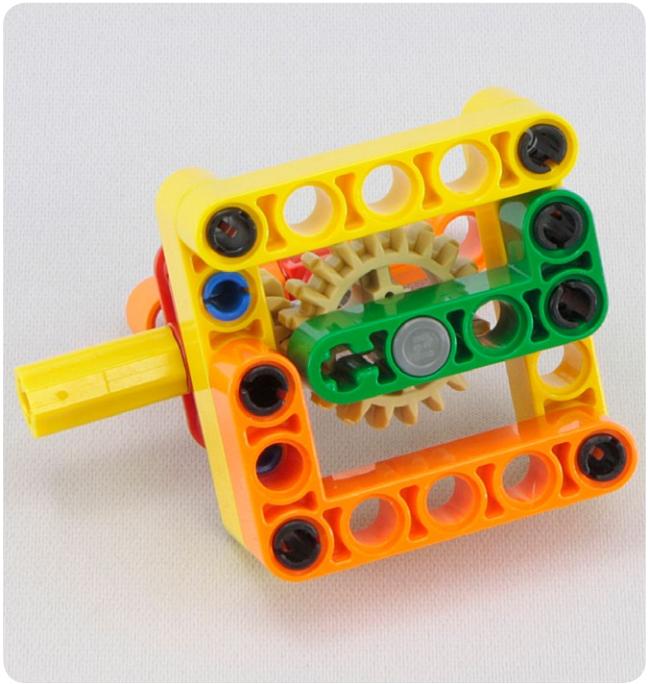

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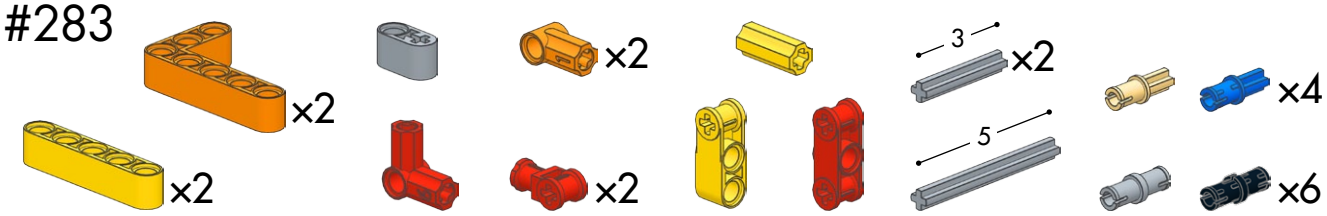

Parts list

This is the maximum number of this part needed to build any single model in this book.

This is the maximum number of this part needed to build any single model in *both* volumes of *The LEGO Power Functions Idea Book* (*Machines and Mechanisms* and *Cars and Contraptions*).


×2 (×2)


×1 (×2)


×1 (×2)


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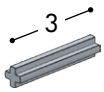
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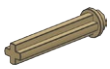
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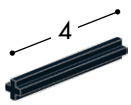
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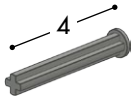
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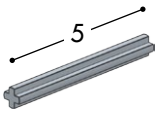
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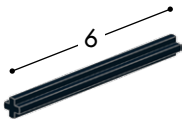
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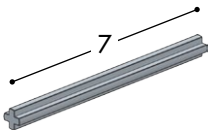
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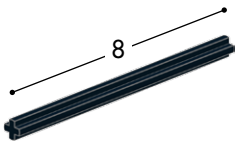
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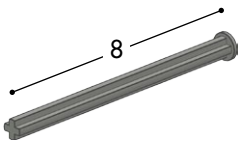
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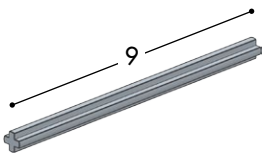
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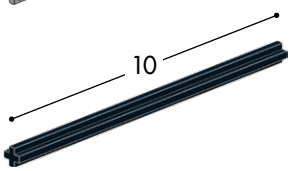
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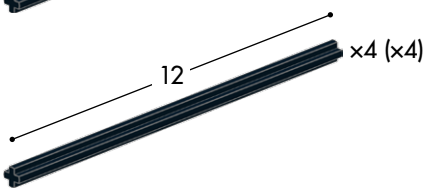
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×4 (×5)


×4 (×6)


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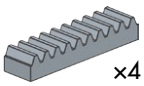
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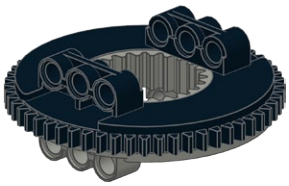
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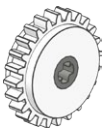
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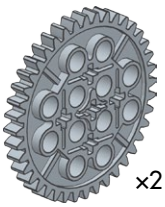
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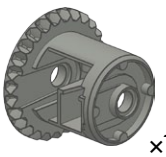
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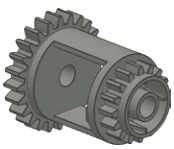
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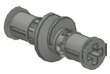
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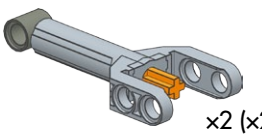
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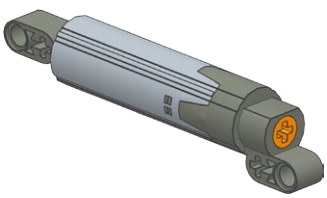
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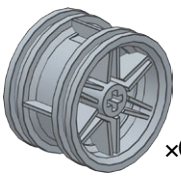
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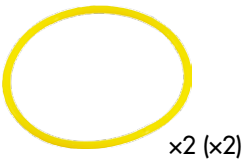
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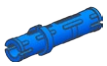
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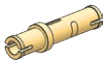
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×2 (×2)


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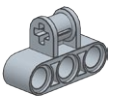
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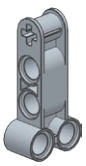
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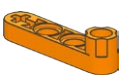
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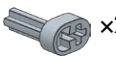
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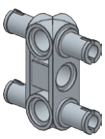
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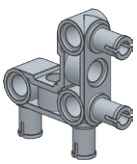
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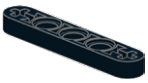
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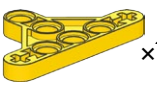
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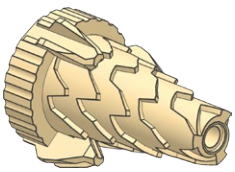
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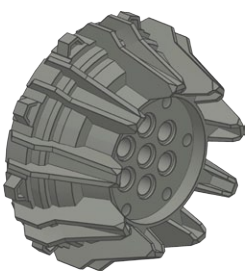
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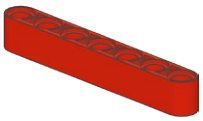
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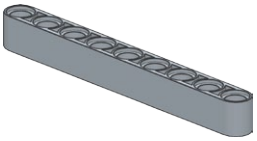
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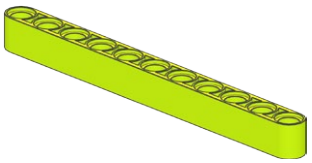
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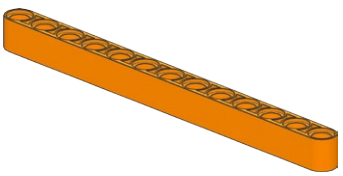
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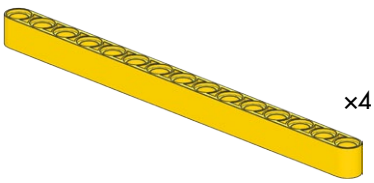
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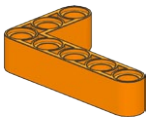
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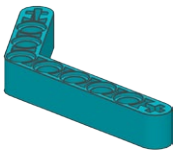
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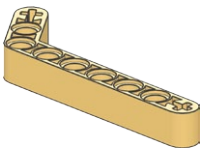
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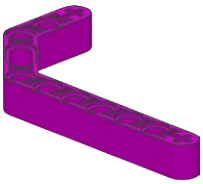
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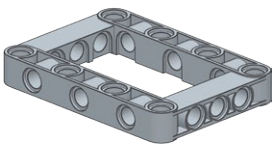
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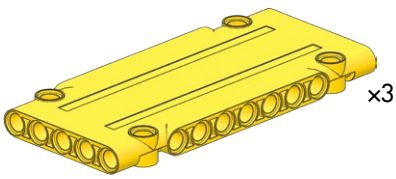
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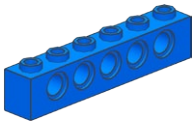
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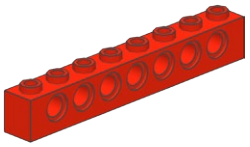
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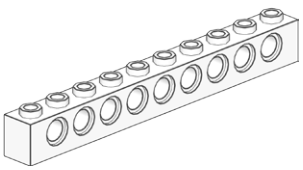
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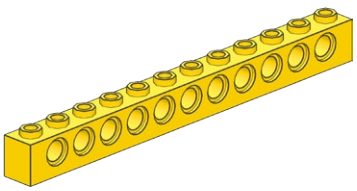
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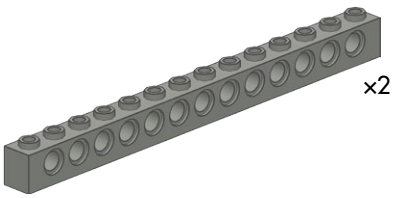
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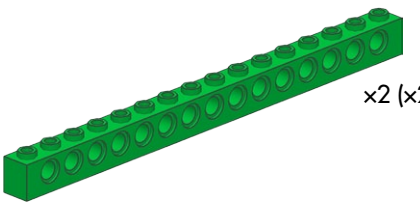
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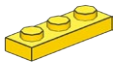
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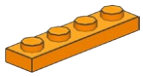
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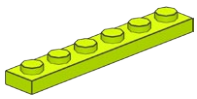
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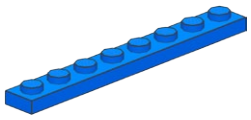
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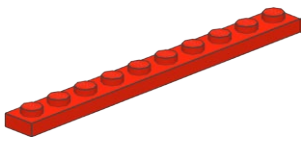
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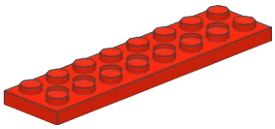
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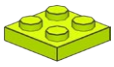
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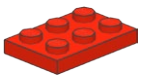
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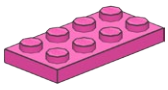
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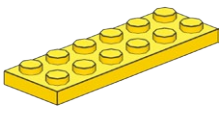
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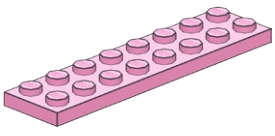
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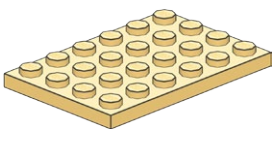
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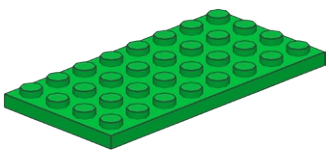
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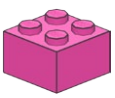
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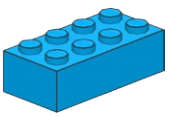
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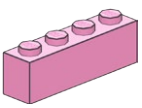
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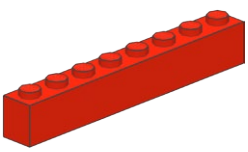
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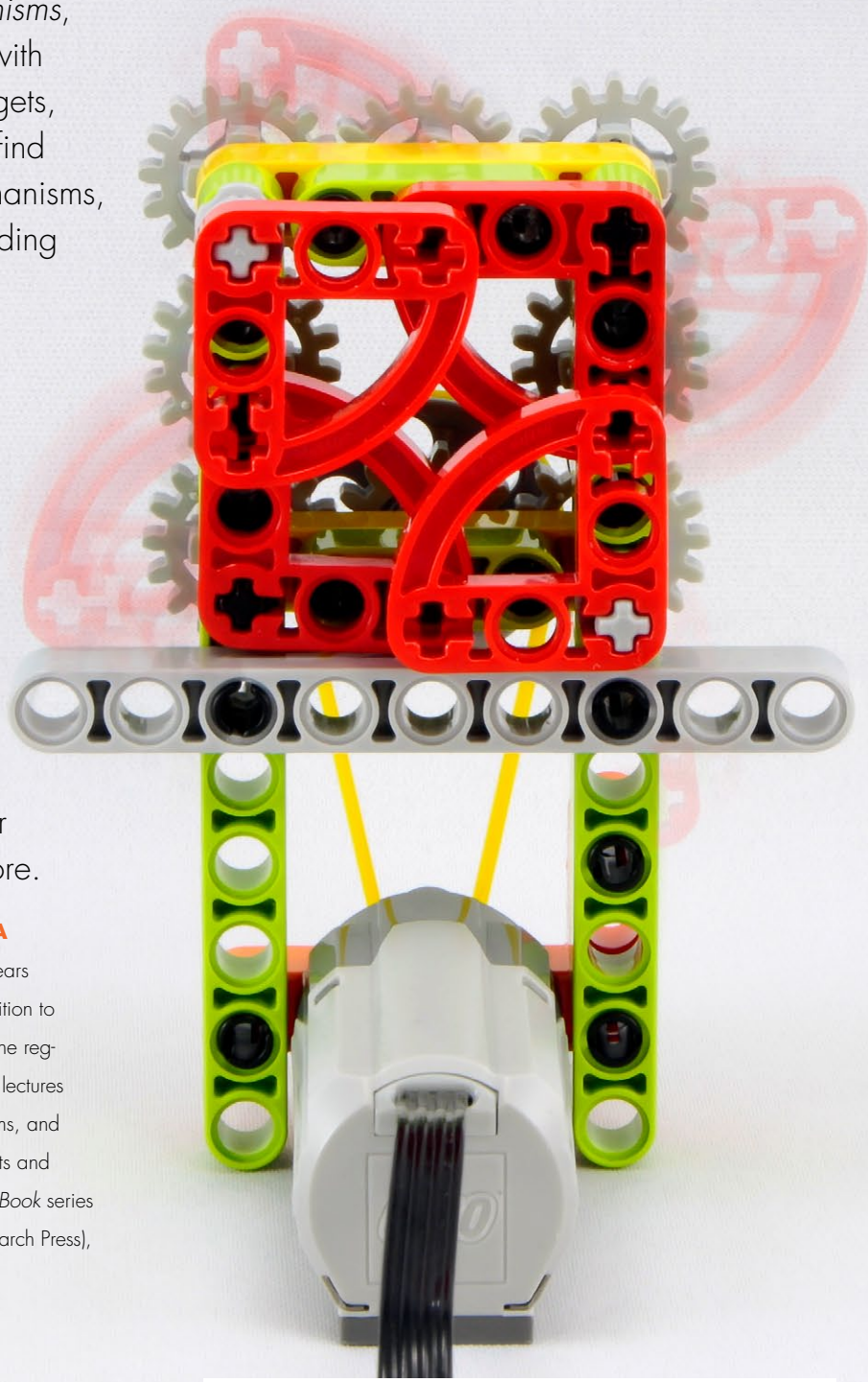
IMAGINE. CREATE. INVENT. NOW, WHAT WILL YOU BUILD?

This first volume of *The LEGO® Power Functions Idea Book, Machines and Mechanisms*, showcases small projects to build with LEGO Technic gears, motors, gadgets, and other moving elements. You'll find hundreds of clever, buildable mechanisms, each one demonstrating a key building technique or mechanical principle.

You'll learn to build sliding doors, grasping claws, rack-and-pinion mechanisms, and ball-shooting devices of every sort!

Each model includes a list of required parts and colorful photographs that guide you through the build without the need for step-by-step instructions. As you build, you'll explore the principles of simple machines, gear systems, power translation, and more.

YOSHIHITO ISOGAWA is a LEGO luminary with 46 years of building experience. In addition to running Isogawa Studio, Inc., he regularly holds LEGO workshops, lectures at schools and science museums, and creates LEGO models for events and exhibitions. He is the author of the *LEGO® Technic Idea Book* series and *The LEGO® MINDSTORMS® EV3 Idea Book* (No Starch Press), as well as many Japanese-language LEGO titles.



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