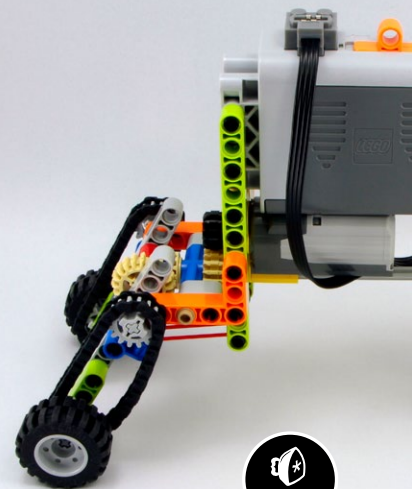
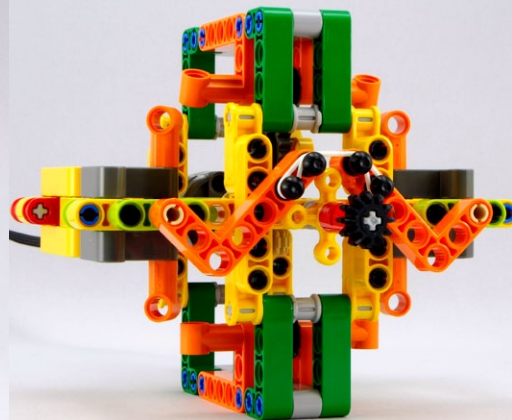
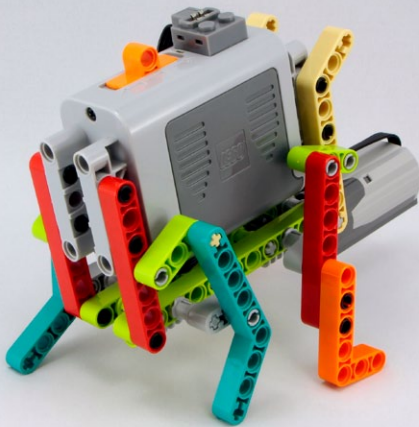


THE LEGO®
POWER
FUNCTIONS
IDEA BOOK

CARS AND
CONTRAPTIONS

YOSHIHITO ISOGAWA



THE LEGO® POWER FUNCTIONS IDEA BOOK
CARS AND CONTRAPTIONS

VOLUME 2

**THE LEGO®
POWER
FUNCTIONS
IDEA BOOK**

**CARS AND
CONTRAPTIONS**

Y O S H I H I T O I S O G A W A



The LEGO® Power Functions Idea Book, Volume 2: Cars and Contraptions.

Copyright © 2016 by Yoshihito Isogawa.

All rights reserved. No part of this work may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or by any information storage or retrieval system, without the prior written permission of the copyright owner and the publisher.

First Printing

19 18 17 16 15 1 2 3 4 5 6 7 8 9

ISBN-10: 1-59327-689-3

ISBN-13: 978-1-59327-689-8

Publisher: William Pollock

Production Editor: Riley Hoffman

Cover Design: Beth Middleworth

Photographer: Yoshihito Isogawa

Author Photo: Sumiko Hirano

Developmental Editor: Tyler Ortman

Technical Reviewer: Sumiko Hirano

Proofreader: Fleming Editorial Services

For information on distribution, translations, or bulk sales, please contact No Starch Press, Inc. directly:

No Starch Press, Inc.

245 8th Street, San Francisco, CA 94103

phone: 415.863.9900; info@nostarch.com

www.nostarch.com

The Library of Congress has cataloged the first volume as follows:

Isogawa, Yoshihito, 1962-

The LEGO power functions idea book / by Yoshihito Isogawa.

pages cm

Summary: "A compilation of small projects to build with LEGO Technic parts, including gears, motors, gadgets, and other moving elements. Contains step-by-step building instructions for rack-and-pinion steering systems, sliding doors, grasping claws, and ball-shooting devices. Explores principles of simple machines, gearing, and power translation"-- Provided by publisher.

ISBN 978-1-59327-688-1 -- ISBN 1-59327-688-5

1. Machinery--Models. 2. Power (Mechanics) 3. LEGO toys. I. Title.

TJ248.L863 2016

621.8--dc23

2015021881

No Starch Press and the No Starch Press logo are registered trademarks of No Starch Press, Inc. Other product and company names mentioned herein may be the trademarks of their respective owners. Rather than use a trademark symbol with every occurrence of a trademarked name, we are using the names only in an editorial fashion and to the benefit of the trademark owner, with no intention of infringement of the trademark.

LEGO®, MINDSTORMS®, the brick and knob configurations, and the minifigure are trademarks of the LEGO Group, which does not sponsor, authorize, or endorse this book.

The information in this book is distributed on an "As Is" basis, without warranty. While every precaution has been taken in the preparation of this work, neither the author nor No Starch Press, Inc. shall have any liability to any person or entity with respect to any loss or damage caused or alleged to be caused directly or indirectly by the information contained in it.

Contents

Introduction 1

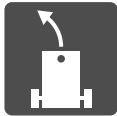
PART 1 • Vehicles



Driving wheels with a motor 4



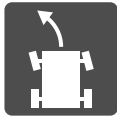
4WD cars 22



Each motor turns a wheel 32



Caster wheels 44



Steering with the servo motor 50



Differential gears 68



Crawlers 82



Cars that spin something 92



Cars that move something 104



Cars with suspension 114



Five different bases for a small car 132



Cars that react 148



Cool cars 172

PART 2 • Moving Without Tires



Two-legged walkers 196



Four-legged walkers 208



Six-legged walkers 220



Cool walkers 224



Moving like an inchworm 234



Moving through vibration 240

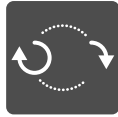


Moving in other ways 244

PART 3 • Special Mechanisms



Intermittent motion 250



Smooth changes of rotation speed 256



Switching rotational direction 264



Changeover mechanisms using a switch 272



Transmissions 288



Changeover mechanisms using rotational direction 308

Parts list 314

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.

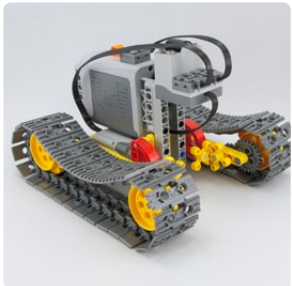
For example, there are many types of LEGO tires. If you don't have the tires shown in a particular project, try using any tires you have that are a similar size. Also, there are several types of Power Functions motors. In this book, the commonly available Medium (M) motors are used most frequently. It's 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

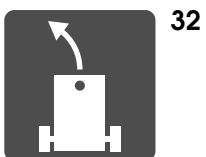
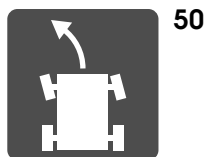
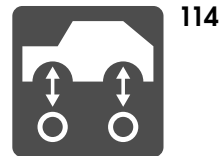
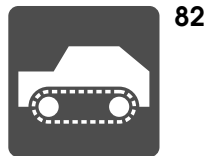
Look at the models you build closely. By thinking about how they move and why they are designed that way, you will greatly improve your building skills.

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

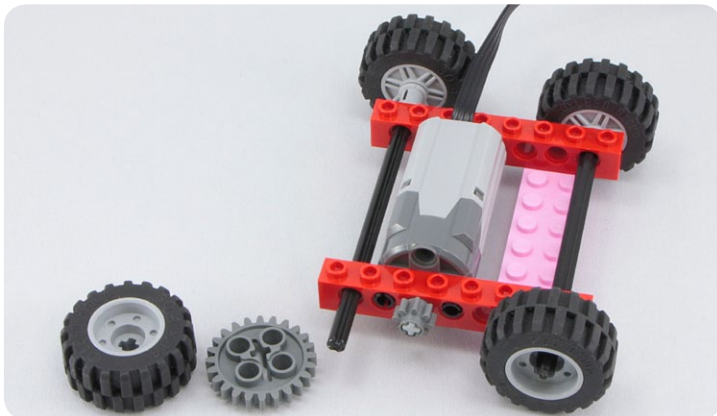
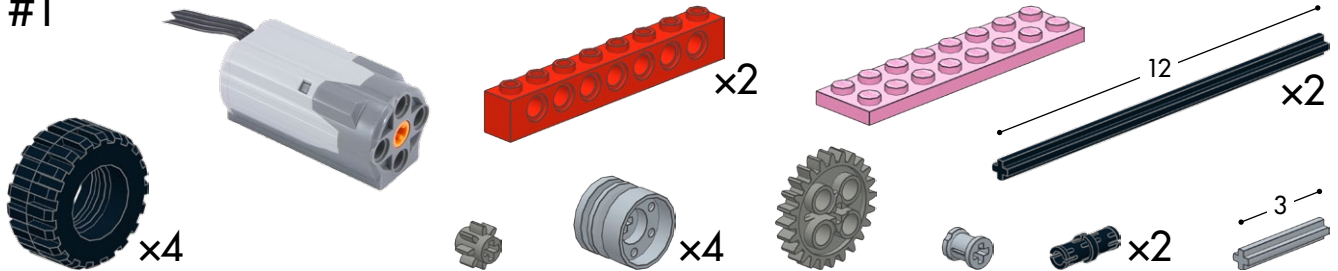
Vehicles



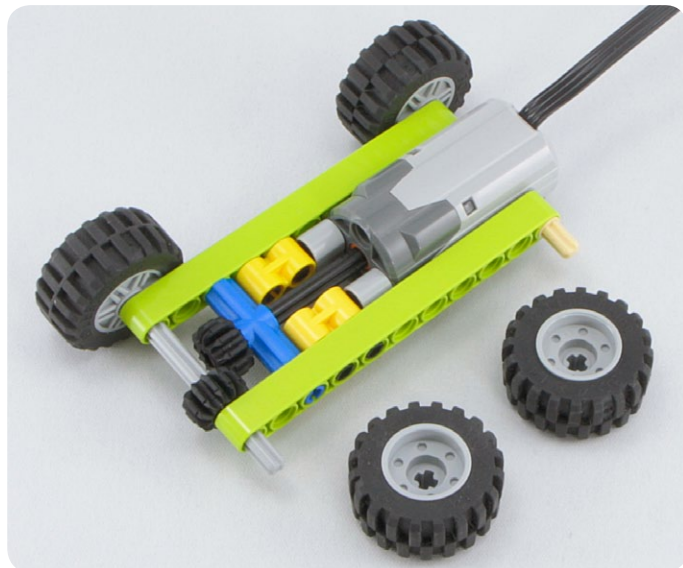
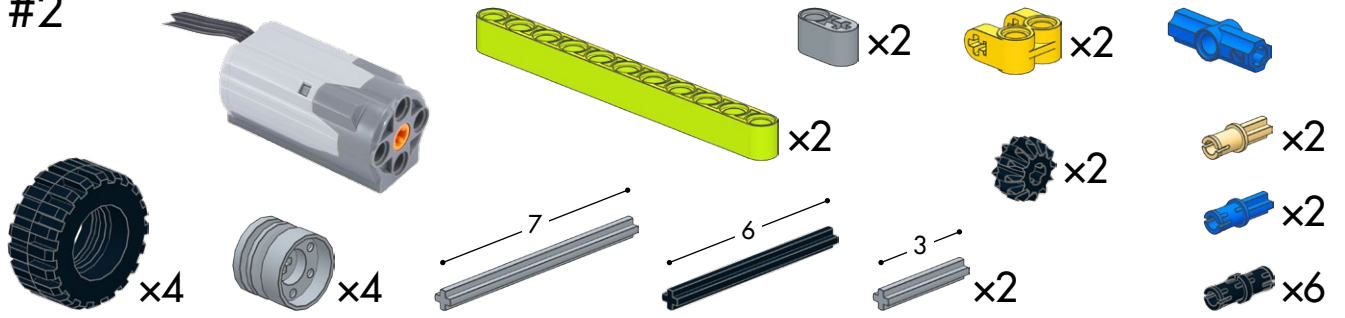


Driving wheels with a motor

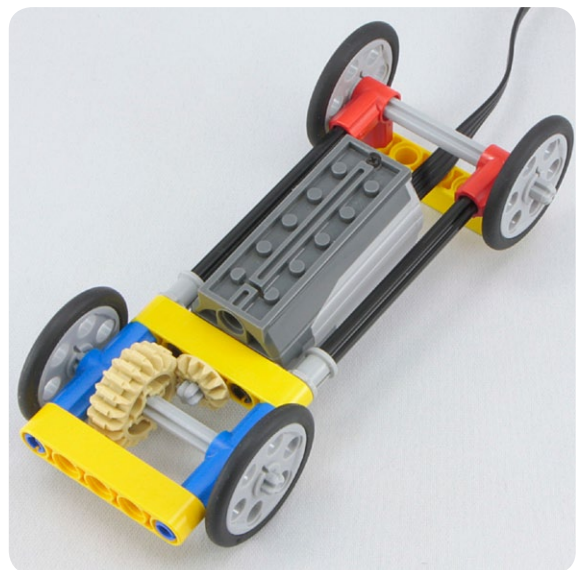
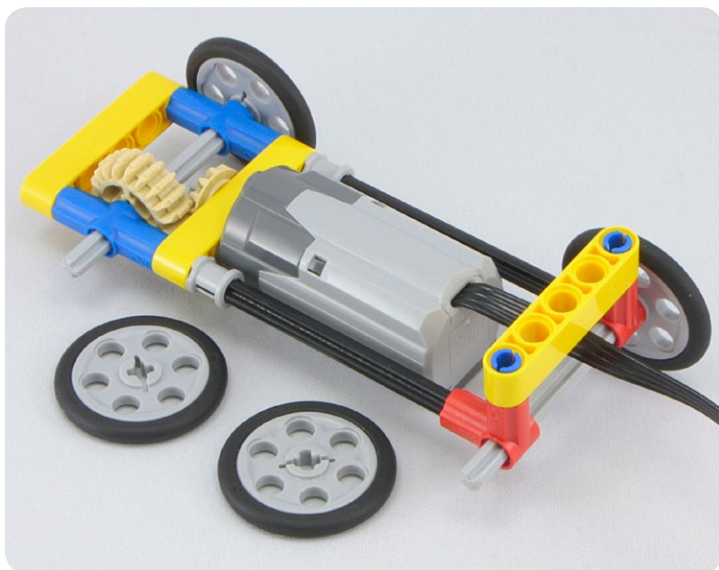
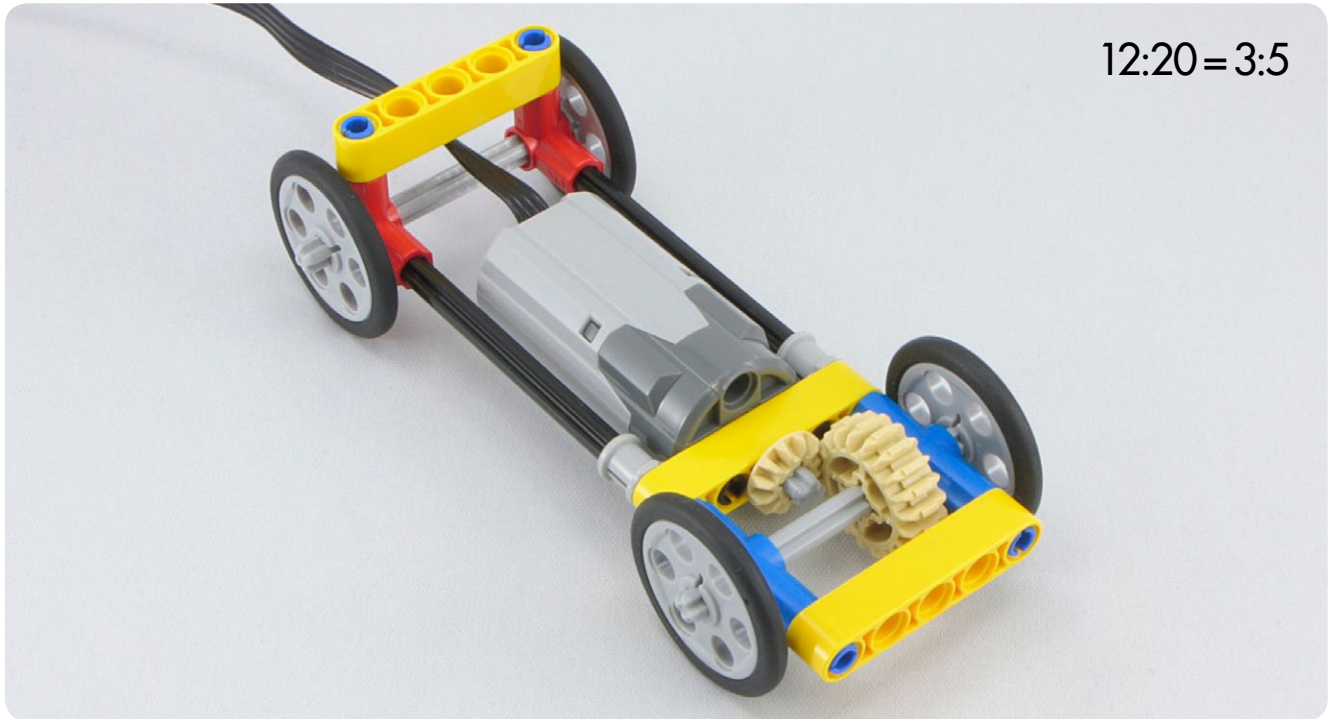
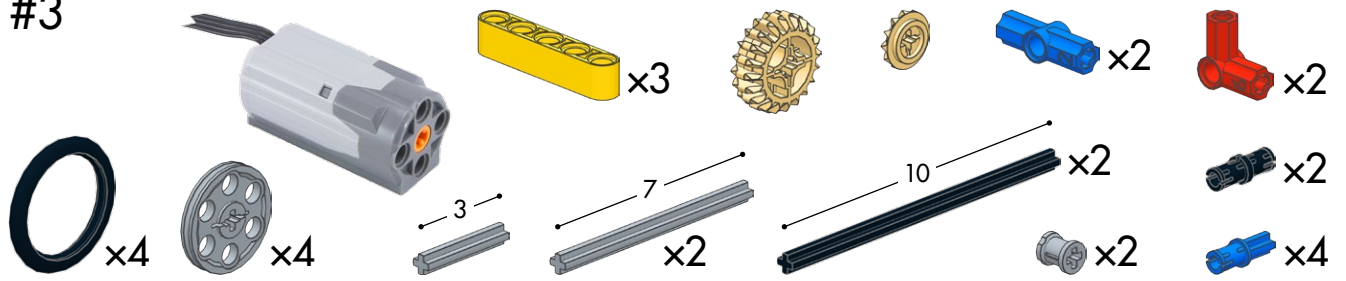
#1



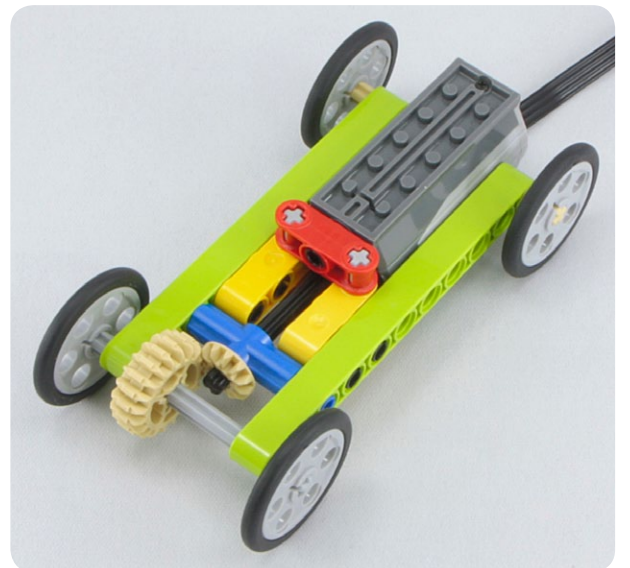
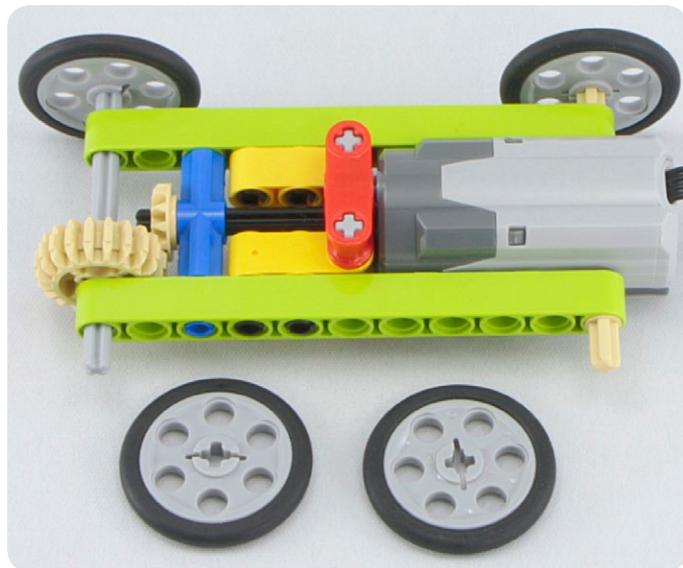
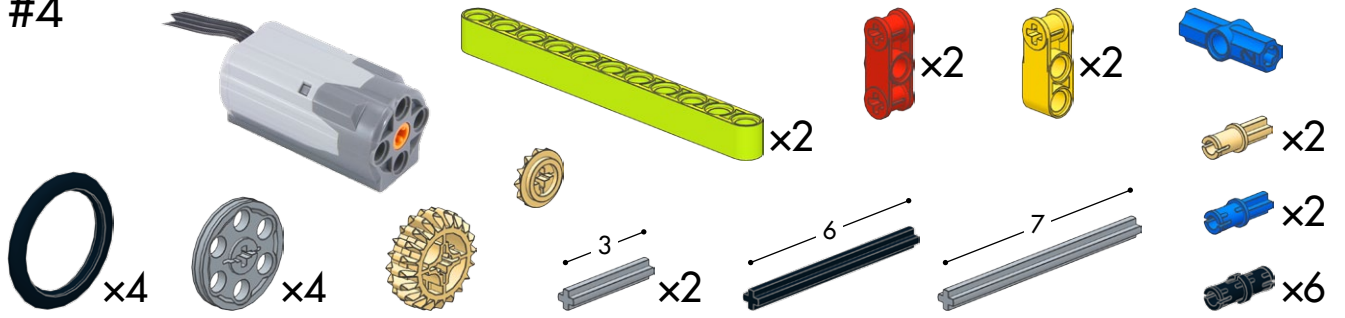
#2



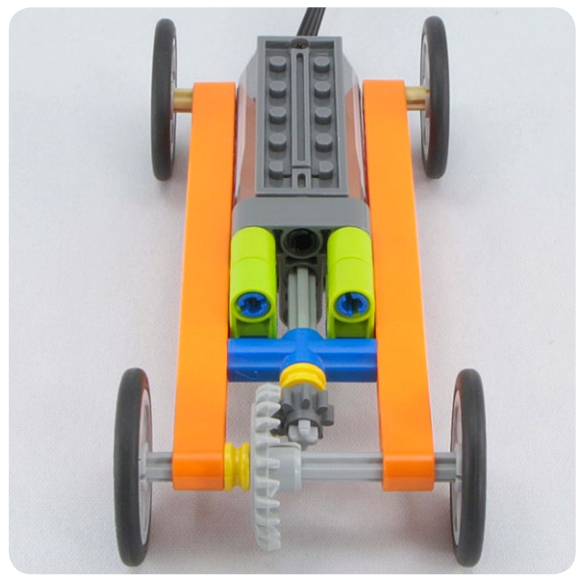
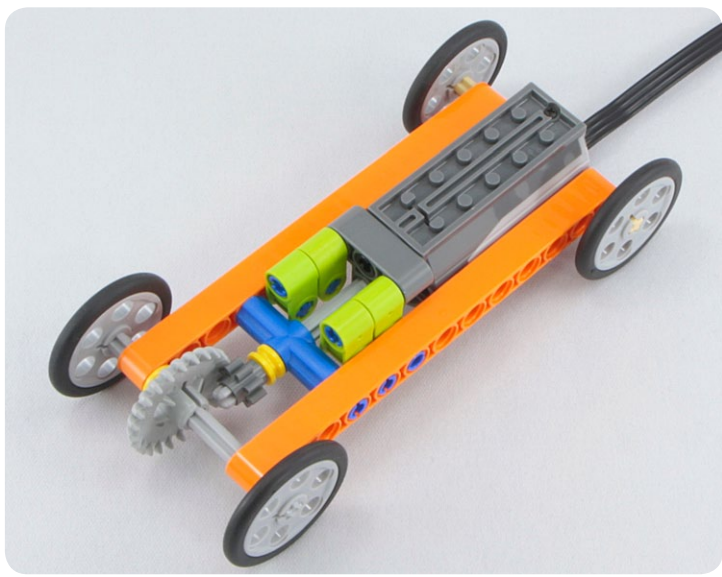
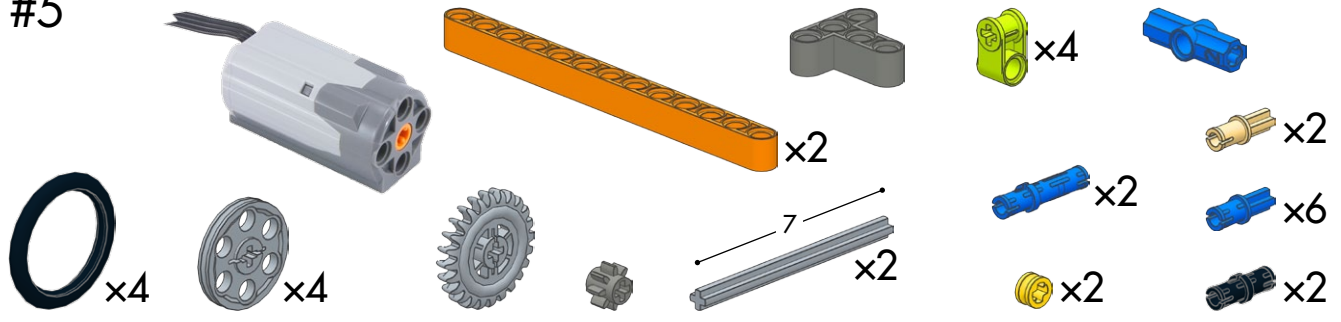
#3



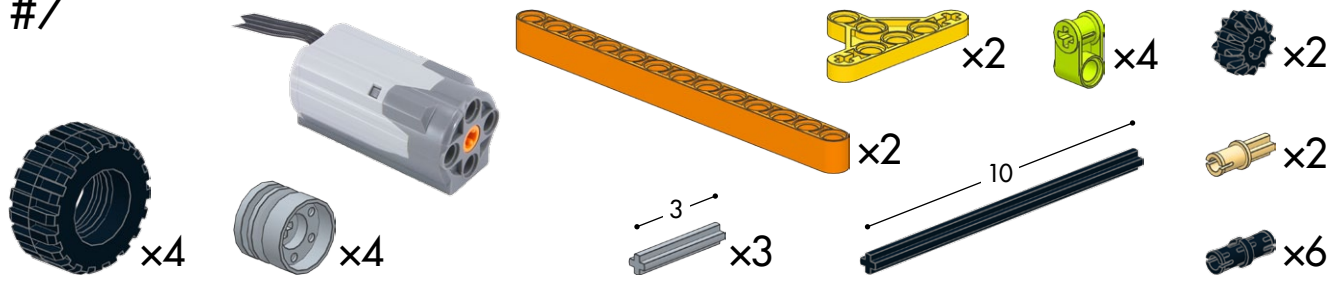
#4



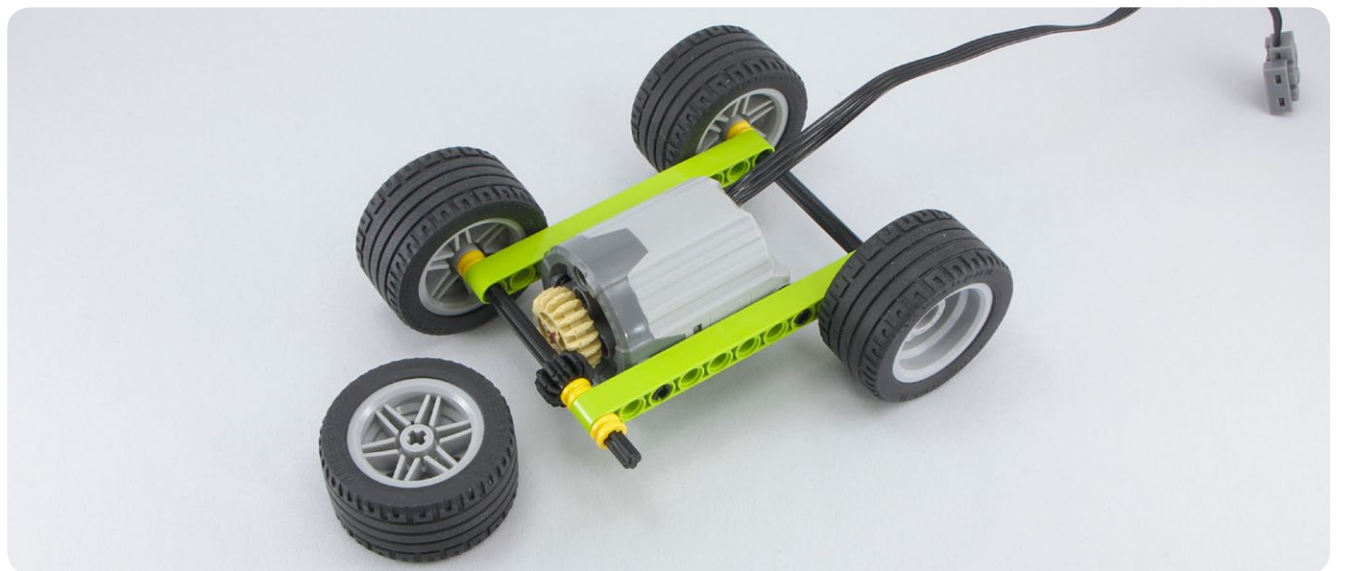
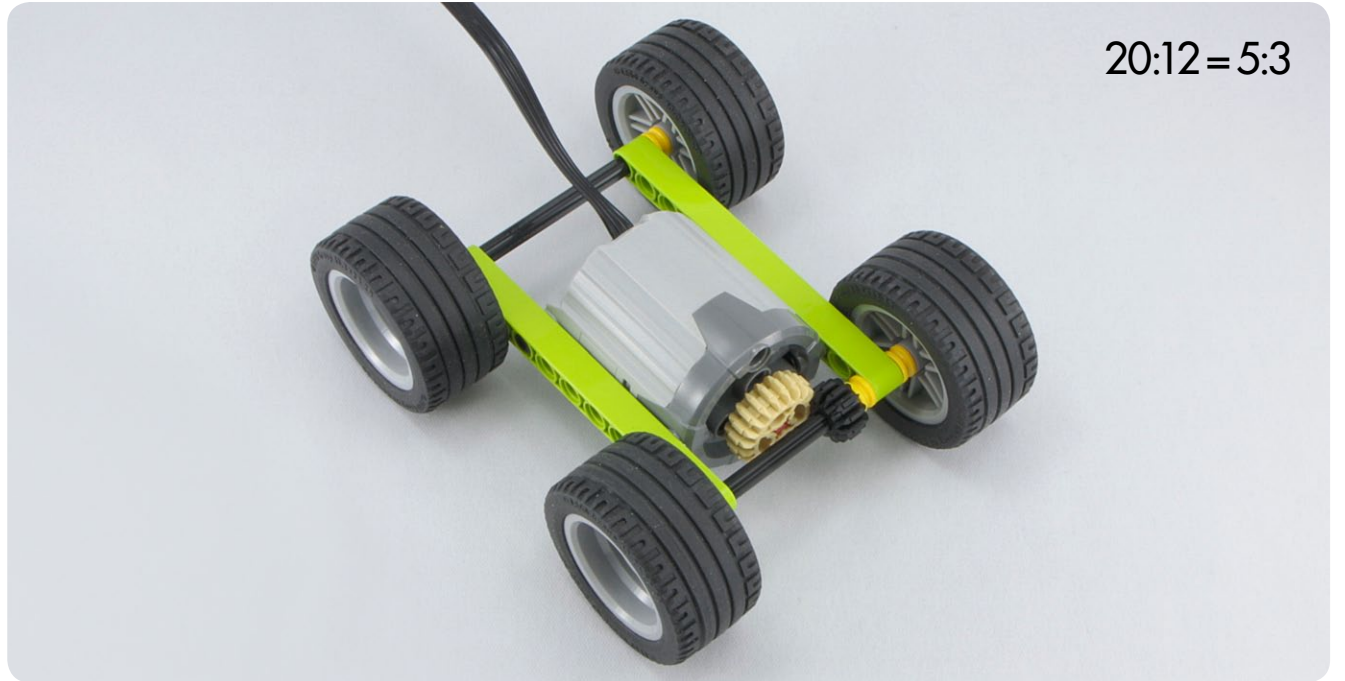
#5



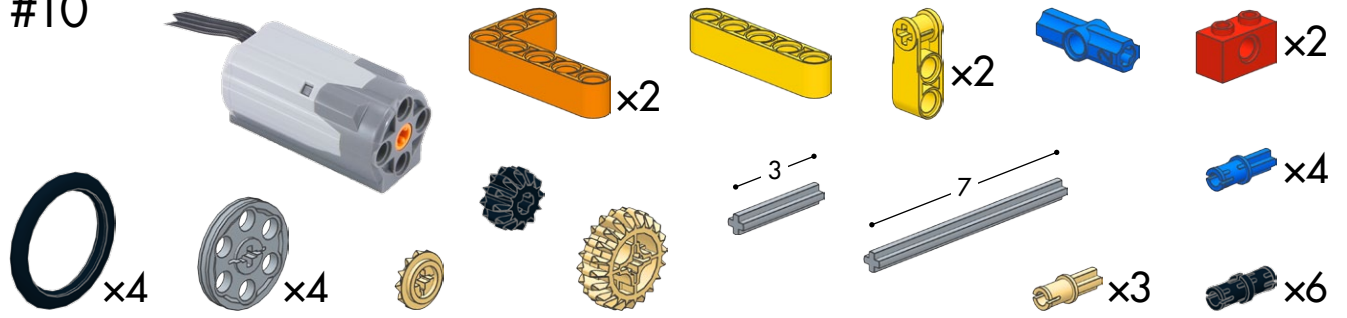
#7



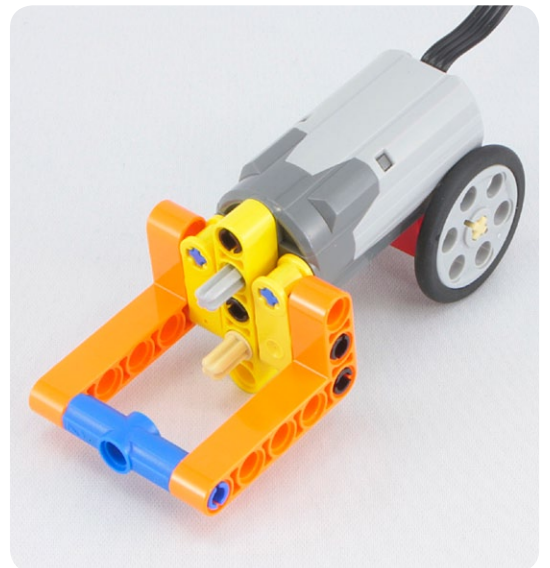
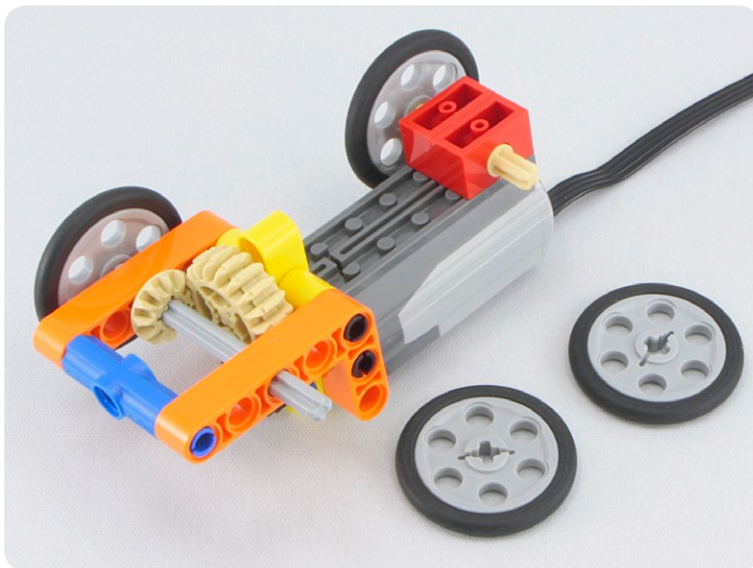
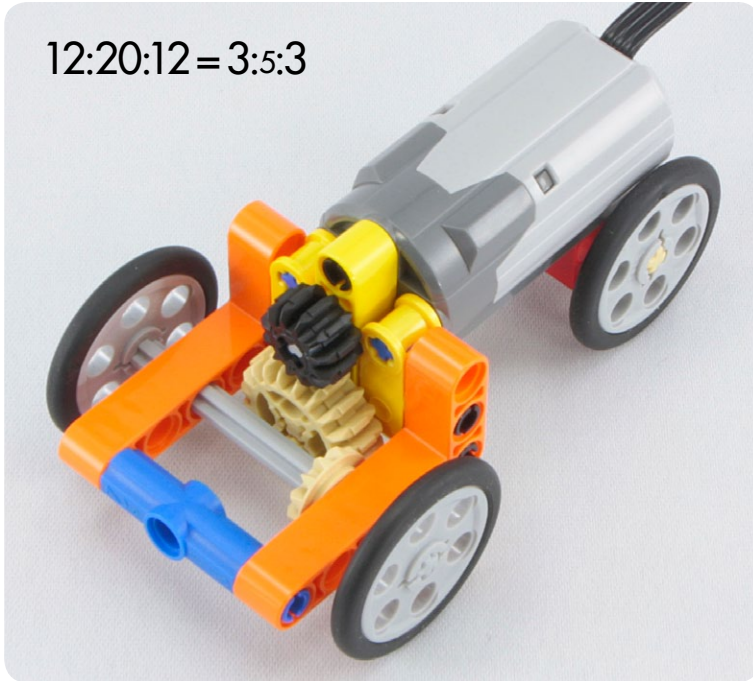
#8



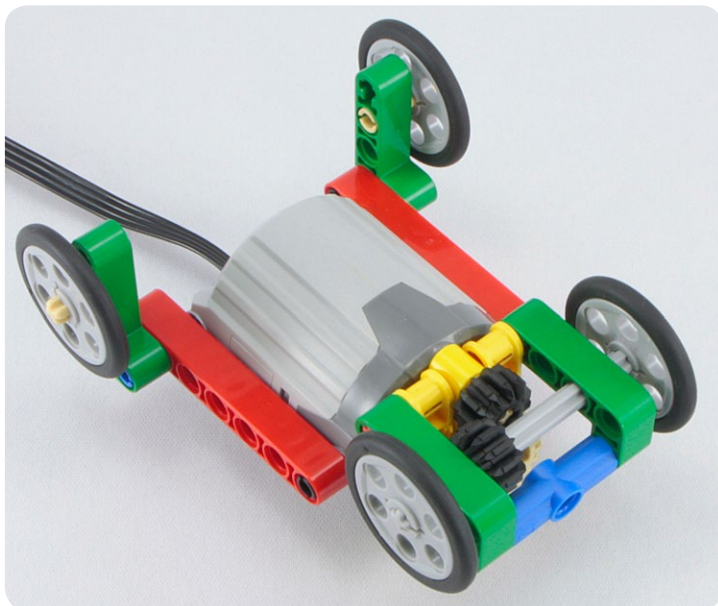
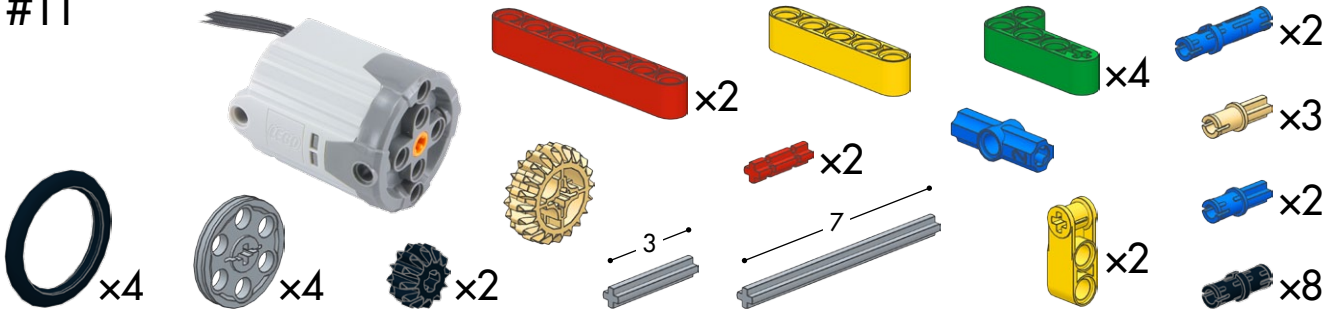
#10



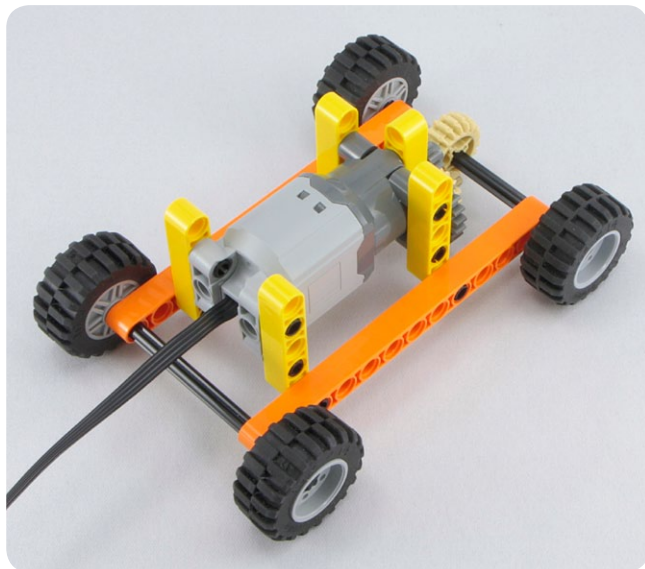
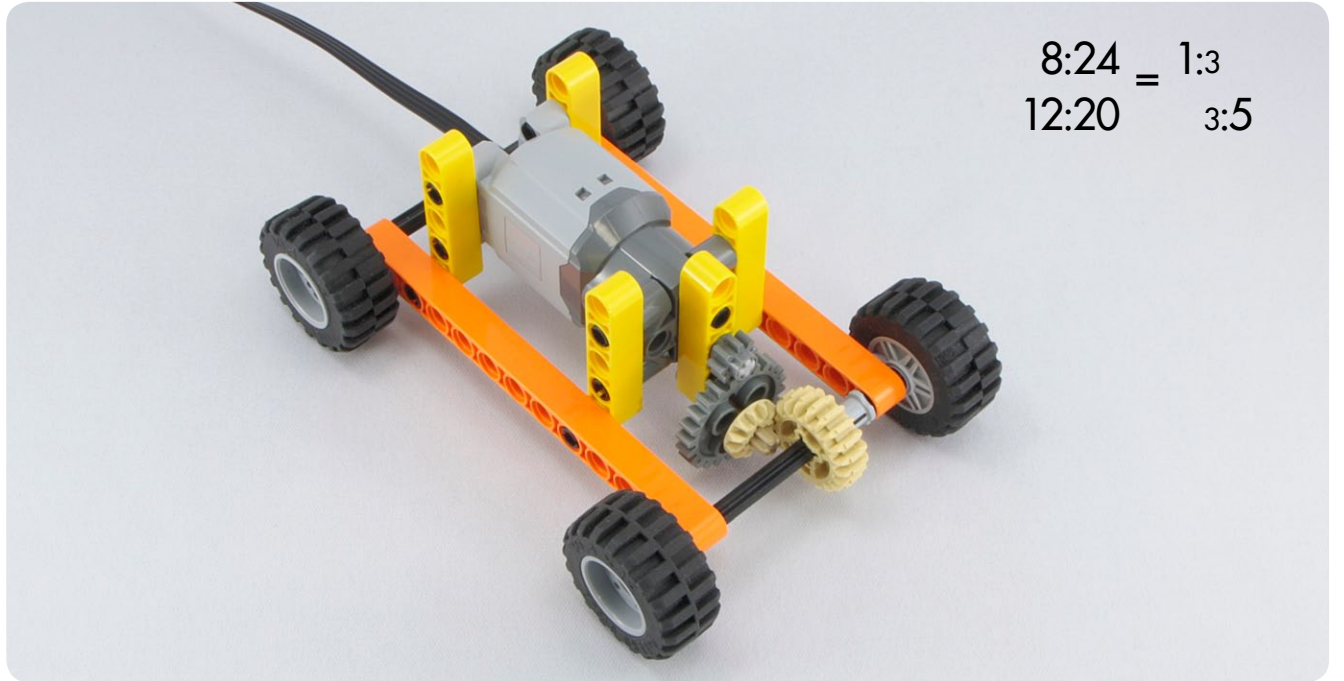
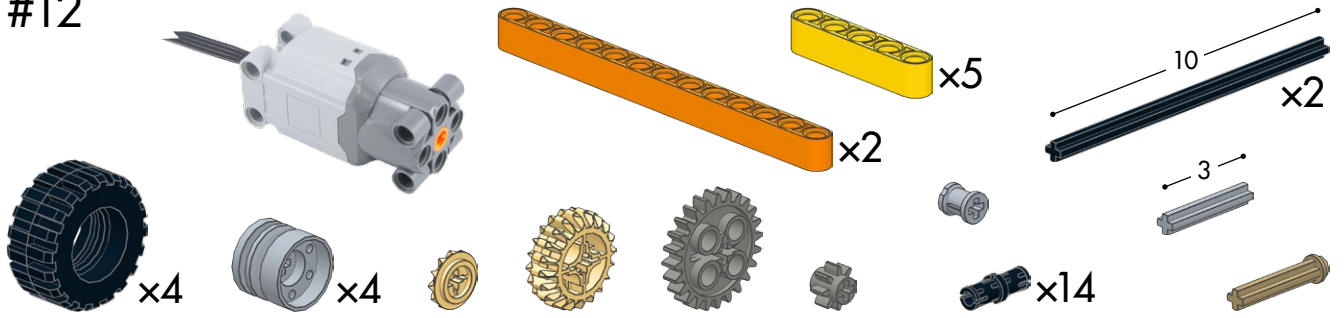
12:20:12 = 3:5:3



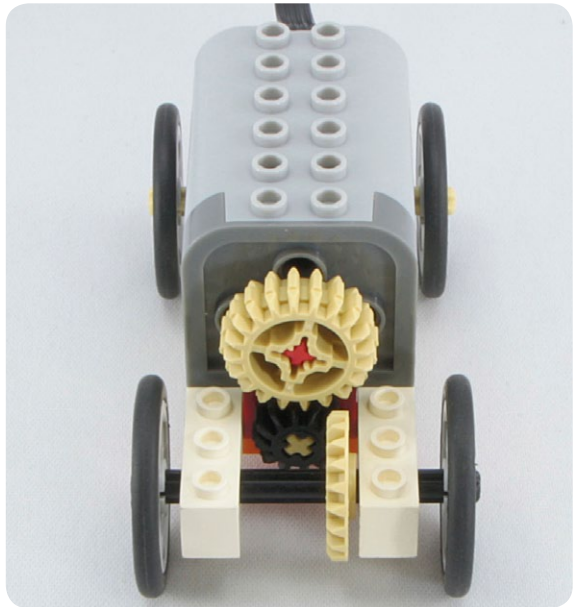
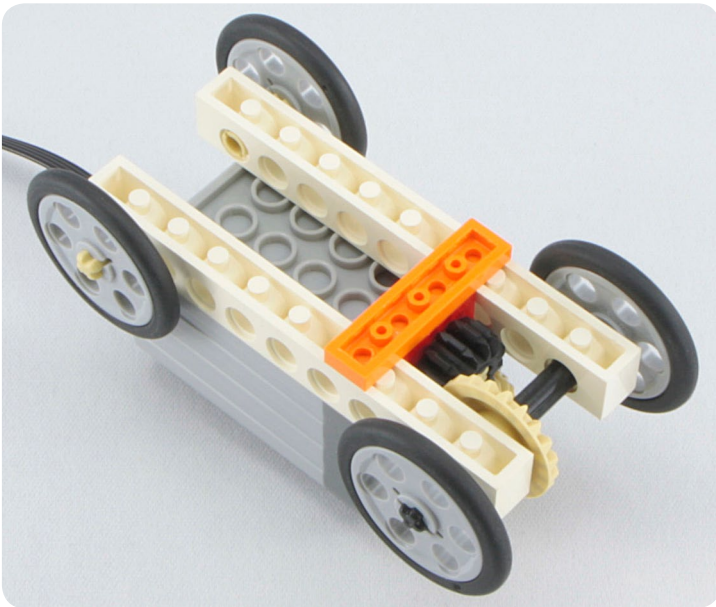
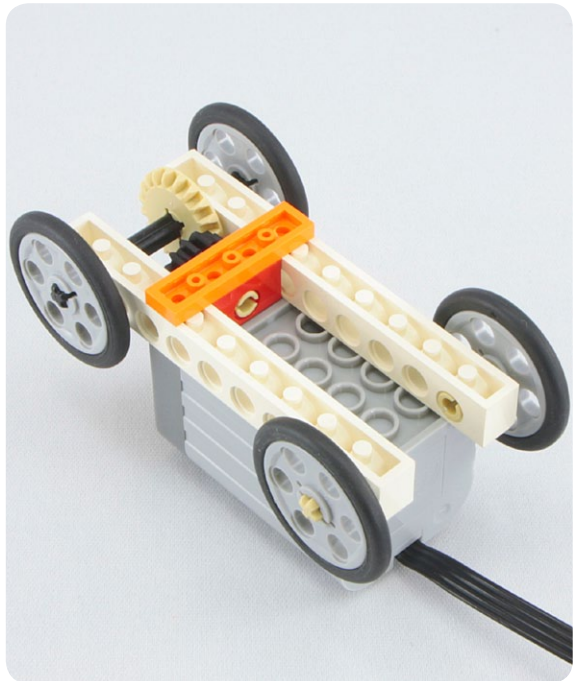
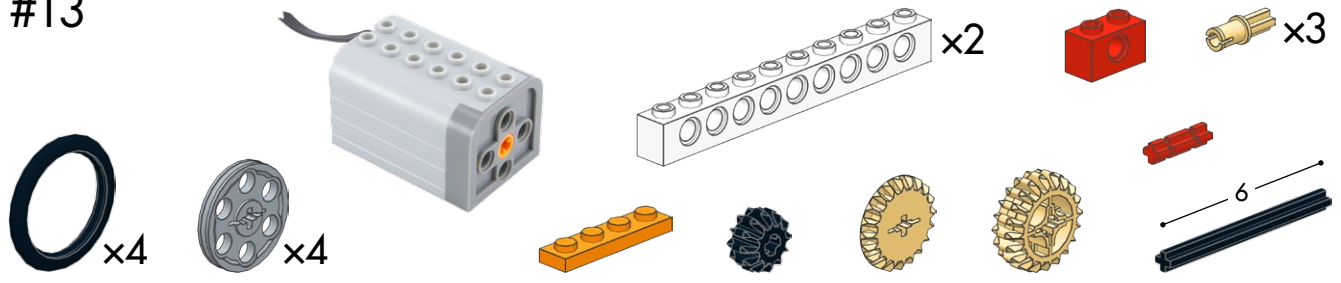
#11



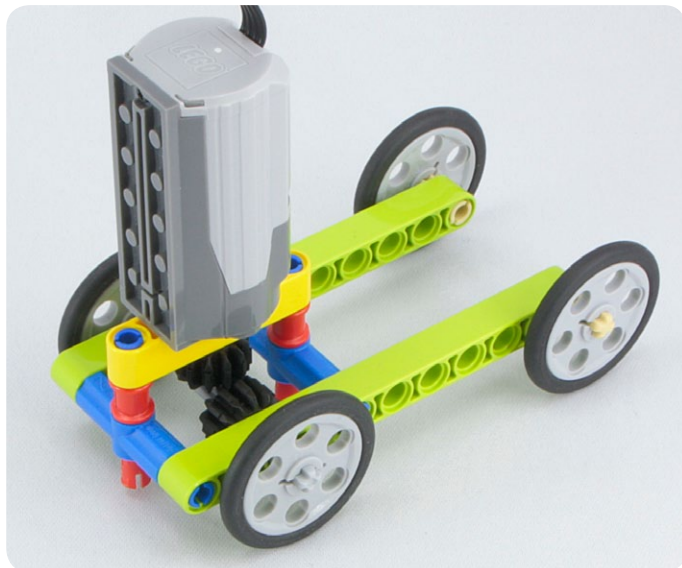
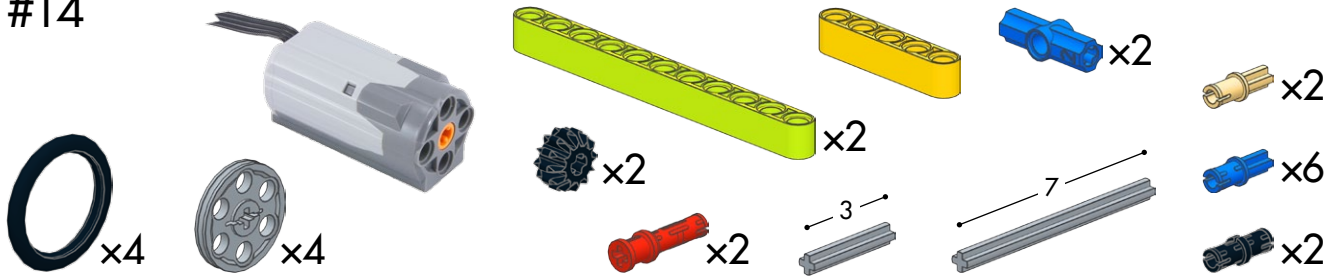
#12



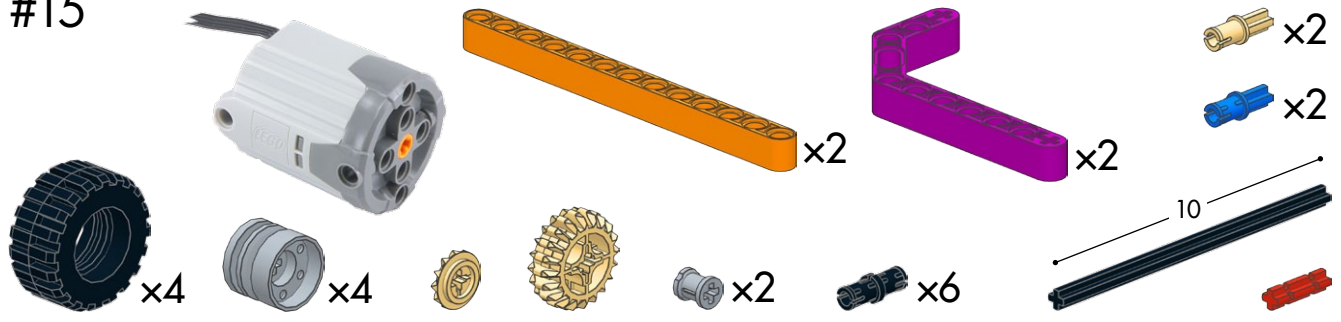
#13



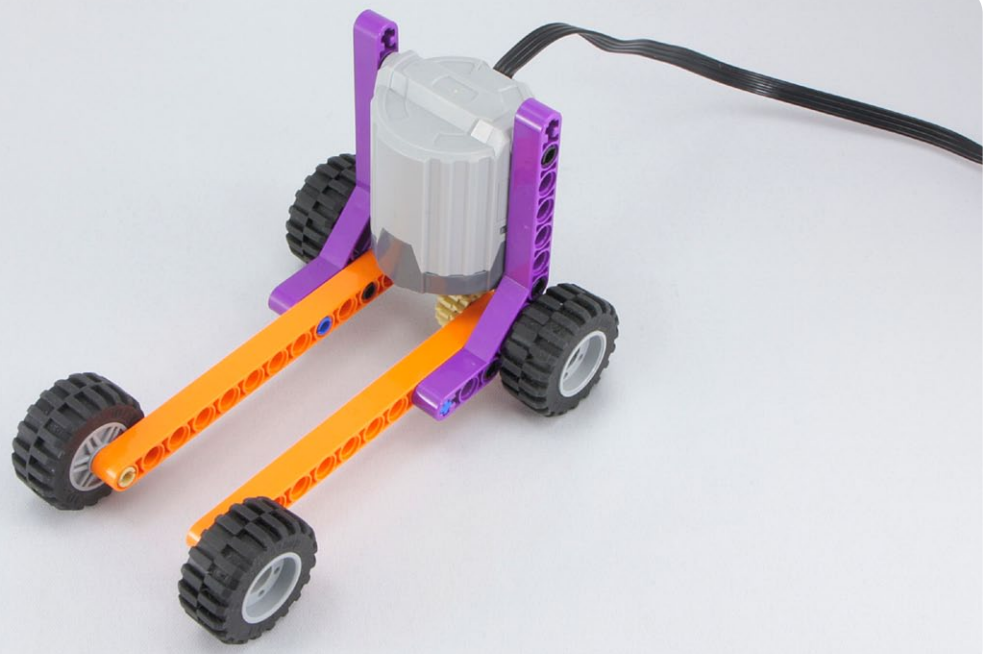
#14



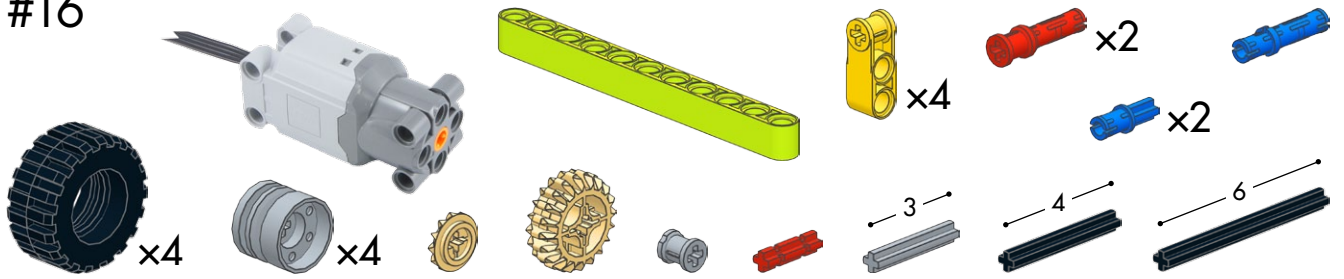
#15



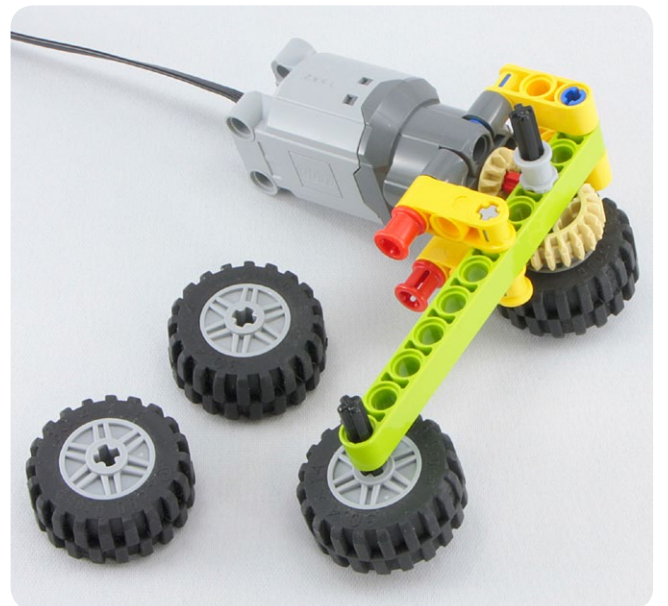
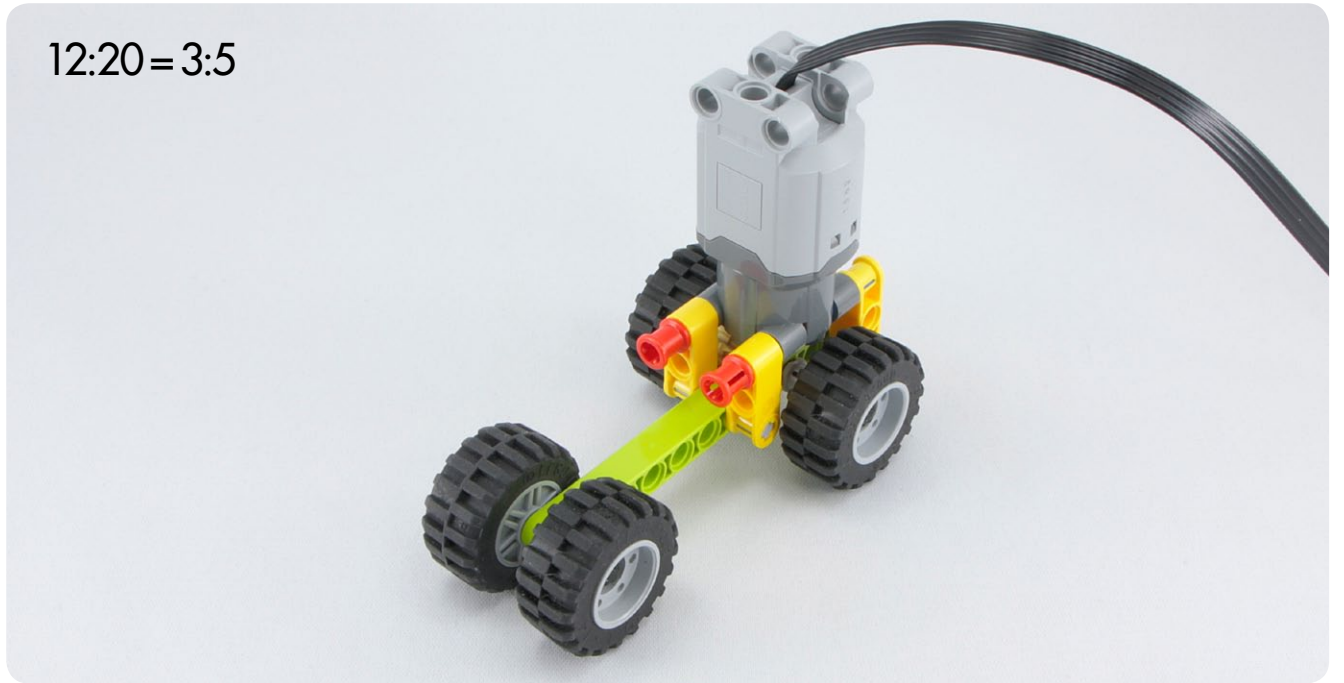
12:20 = 3:5



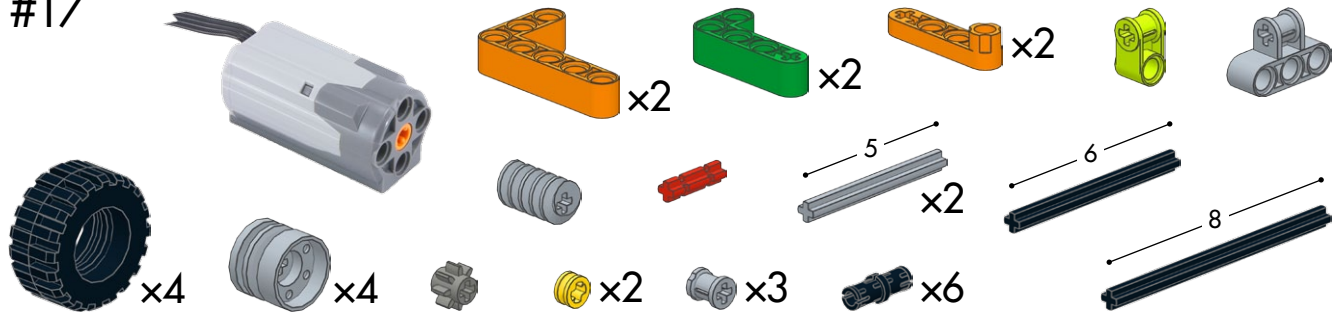
#16



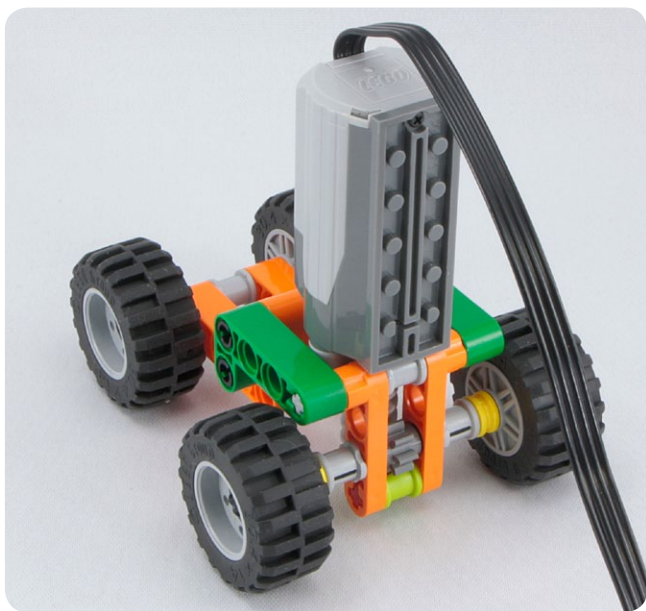
12:20 = 3:5



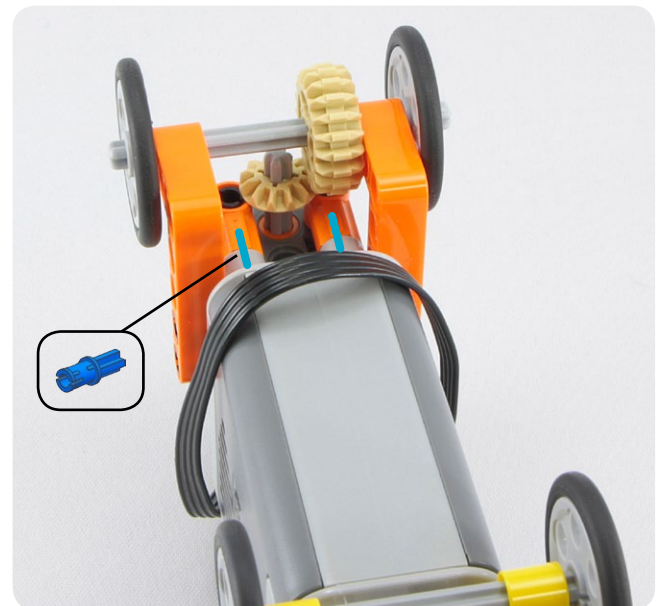
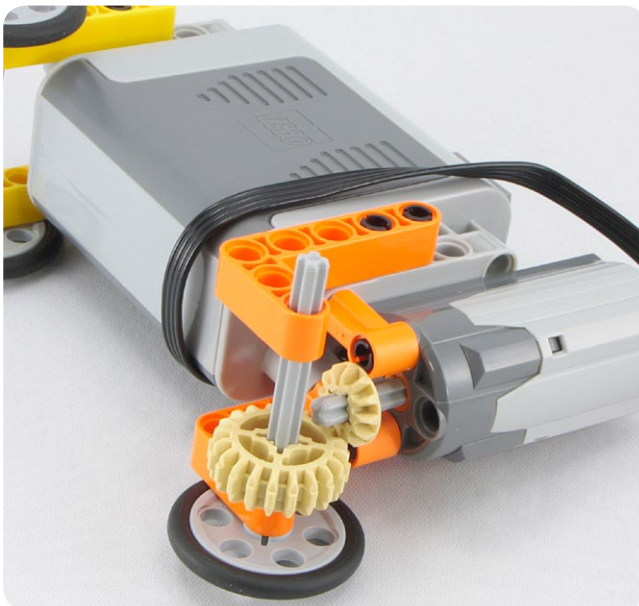
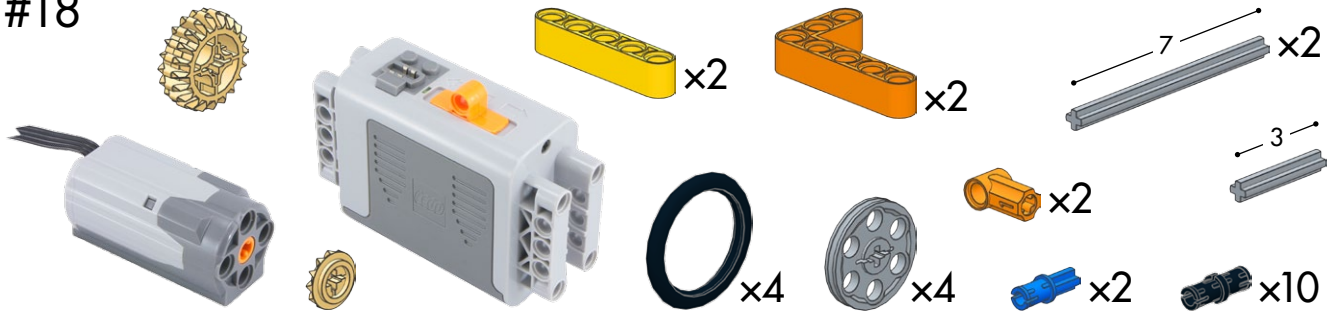
#17



1:8



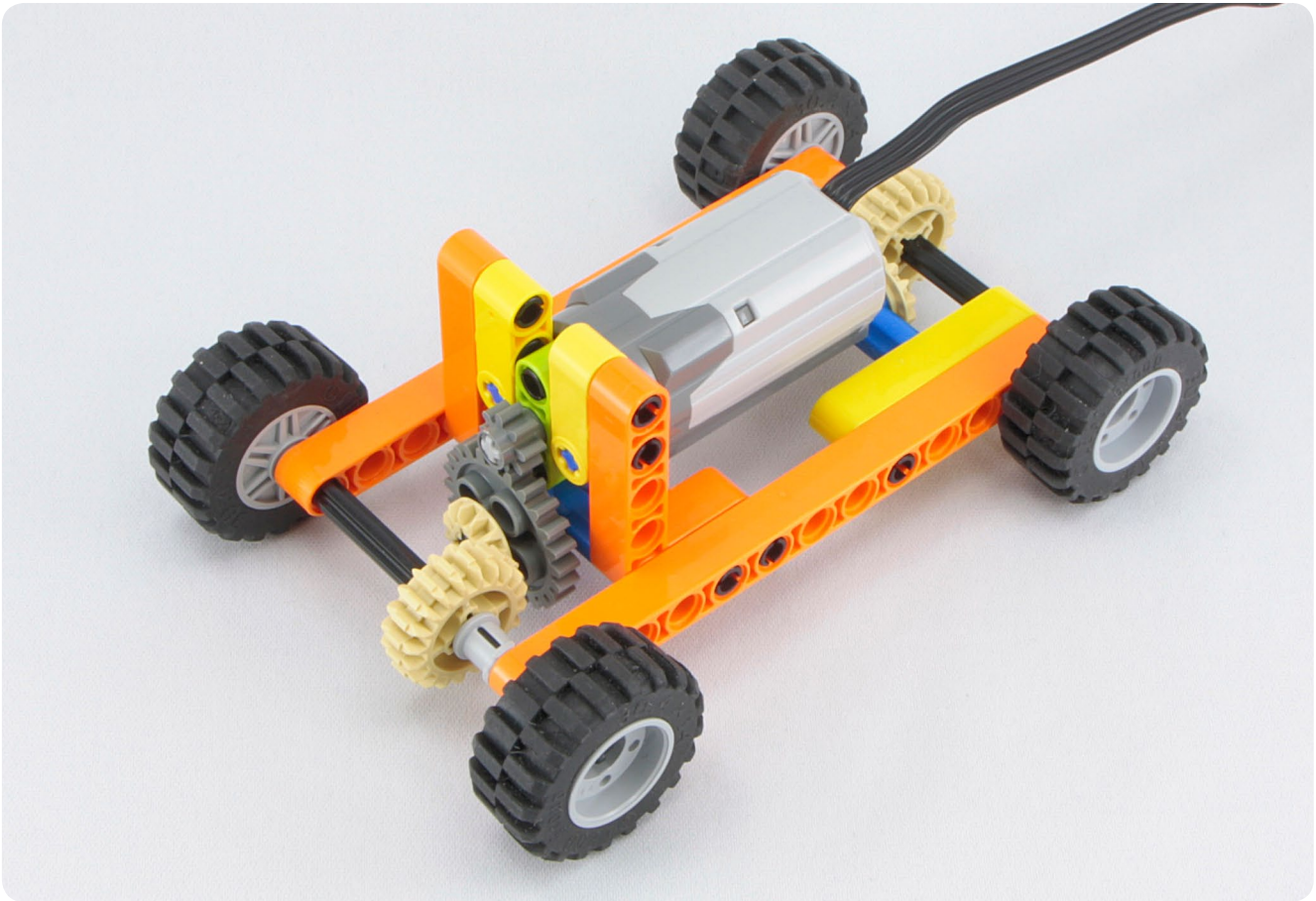
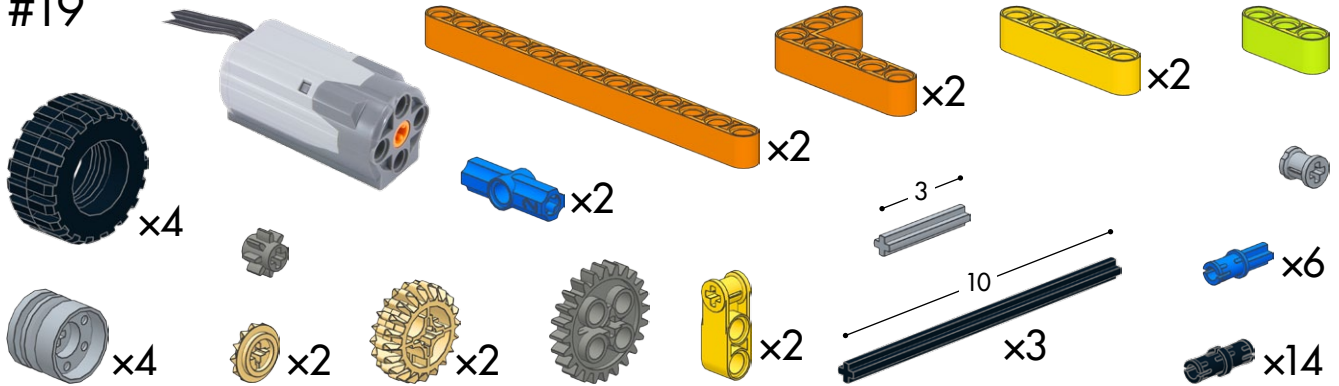
#18

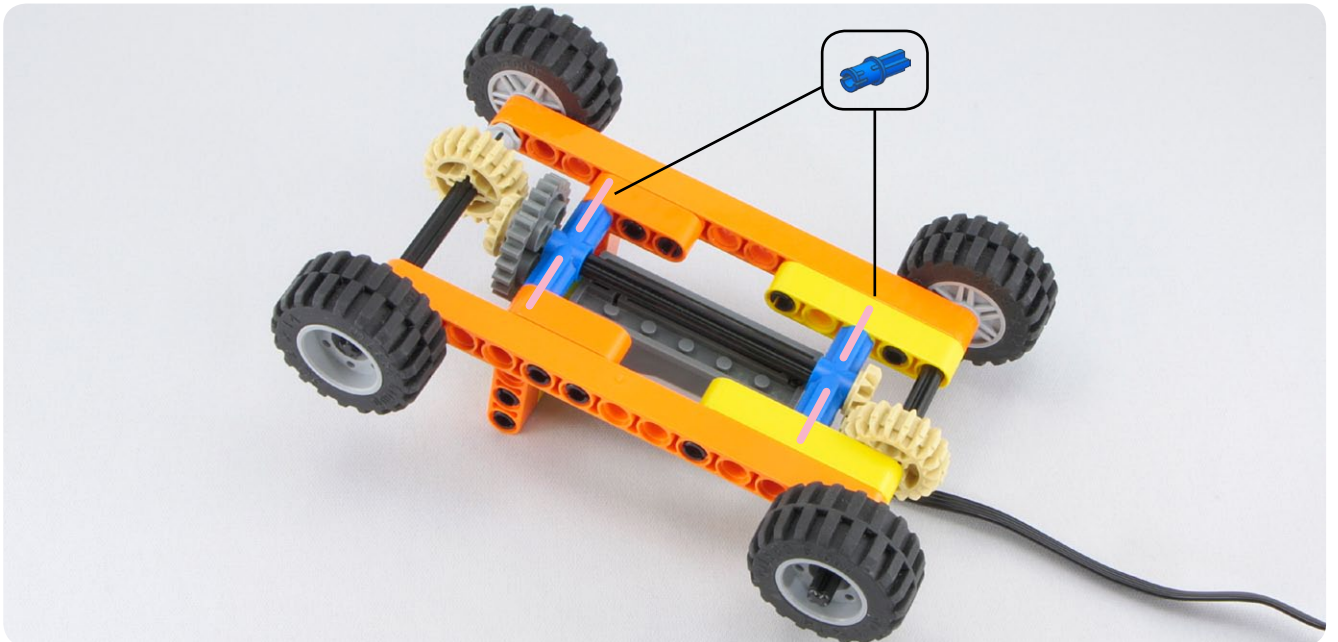
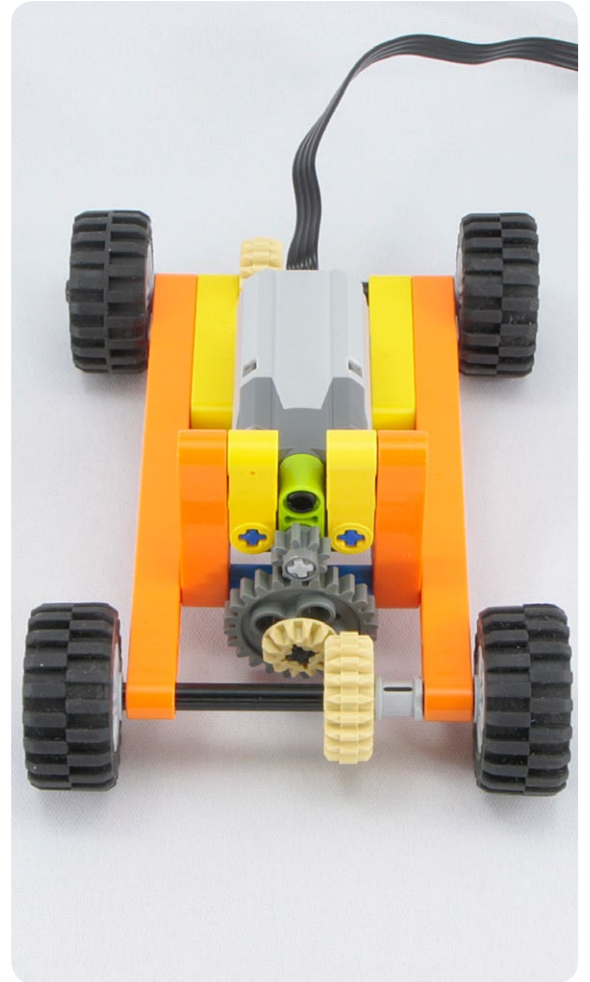




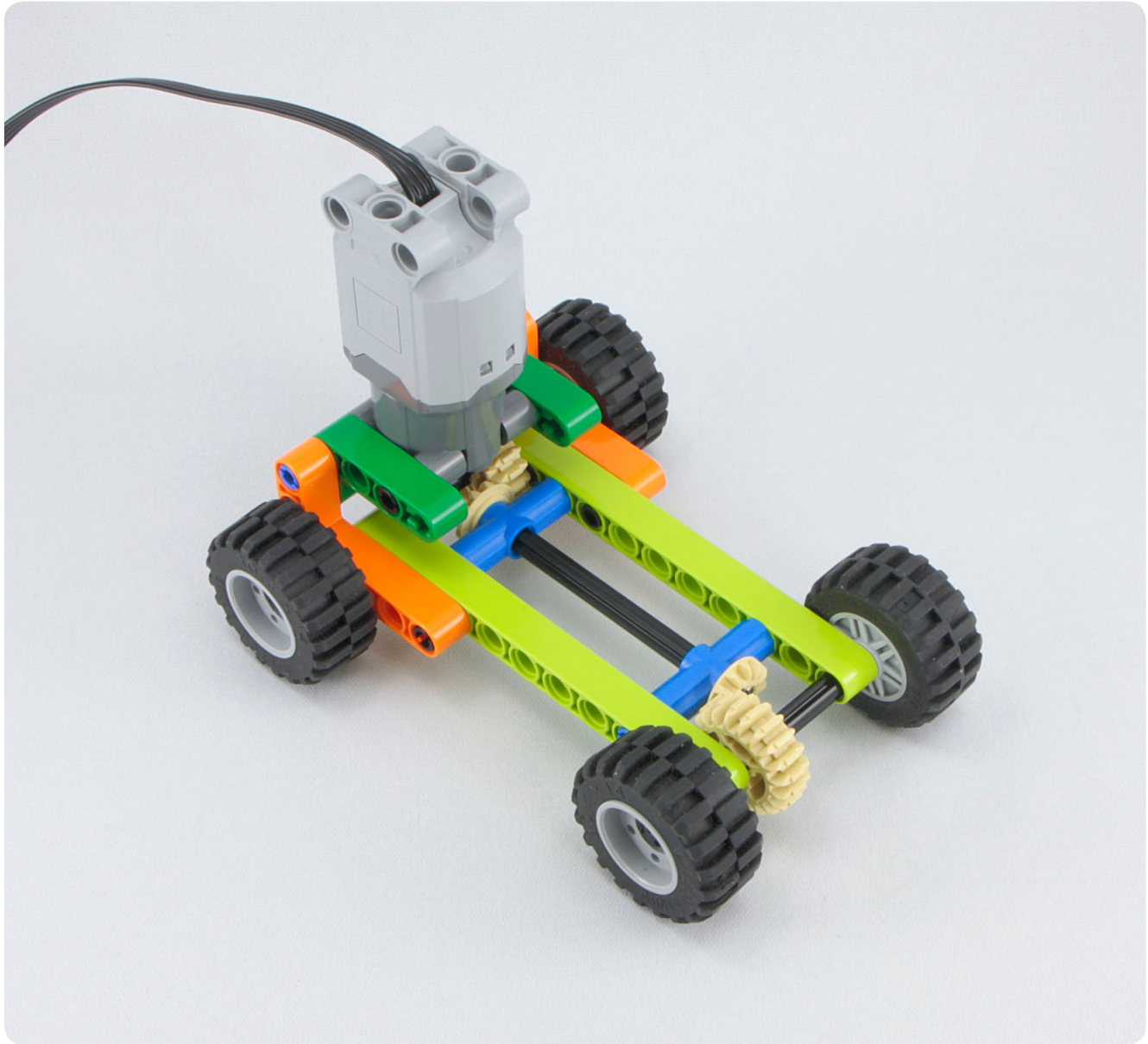
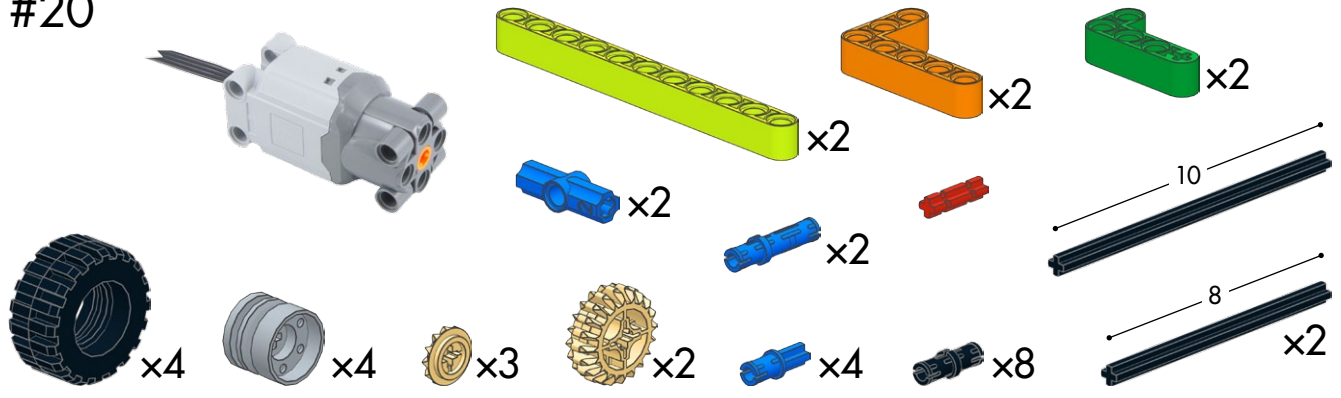
4WD cars

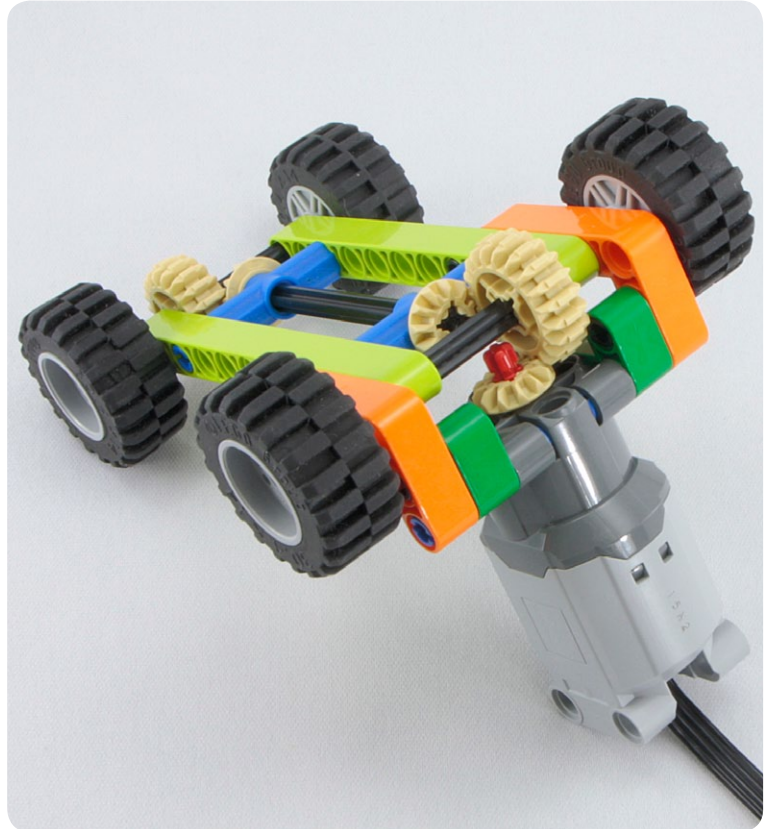
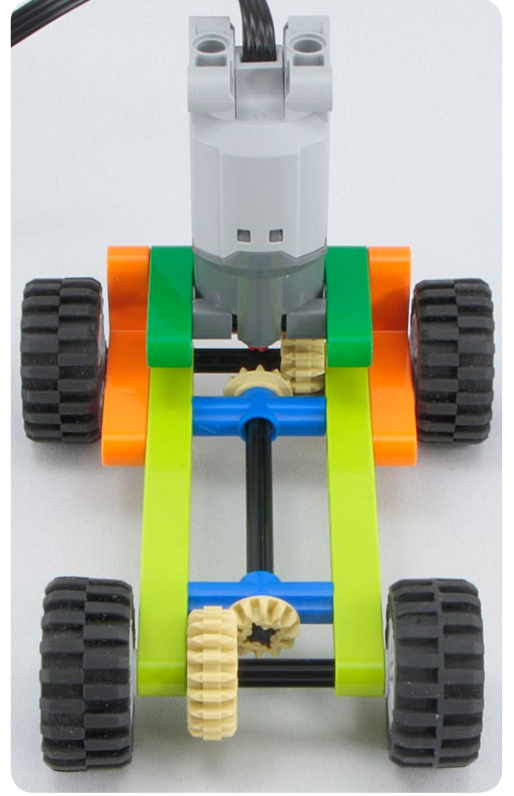
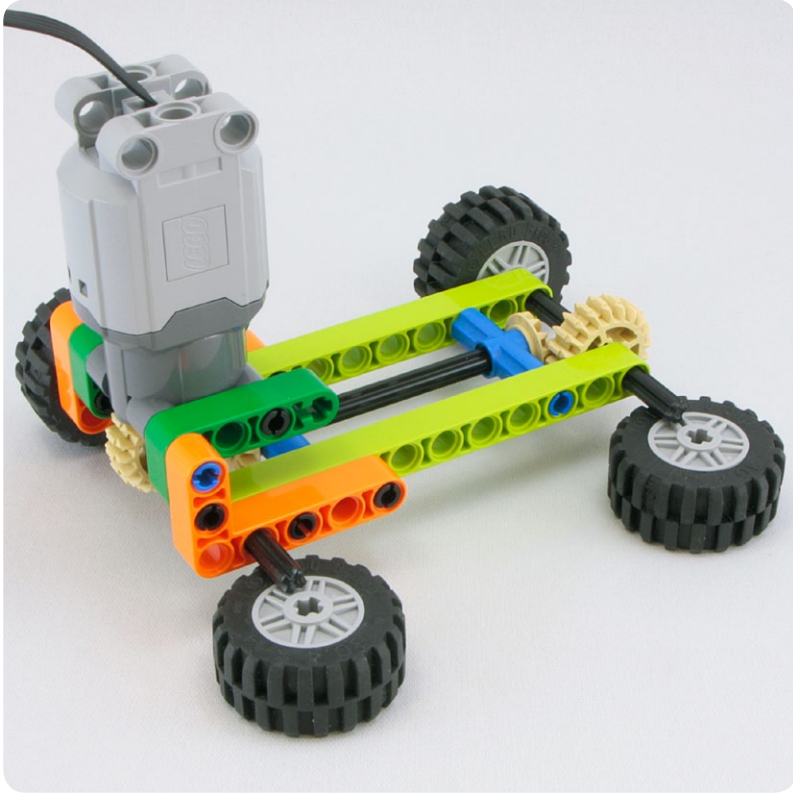
#19



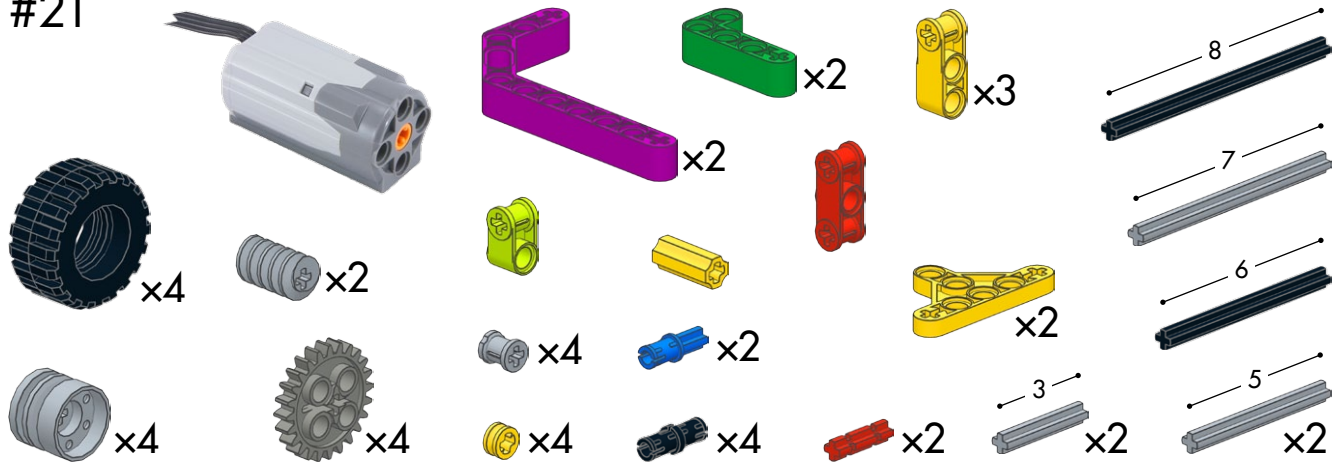


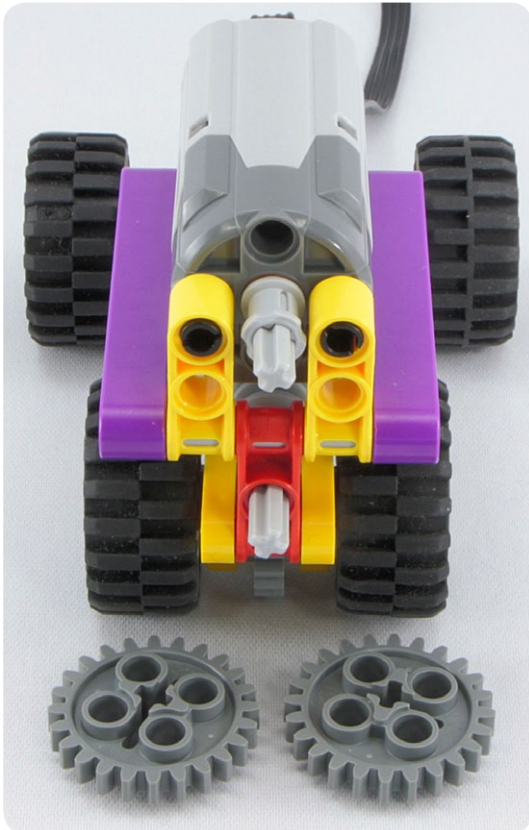
#20










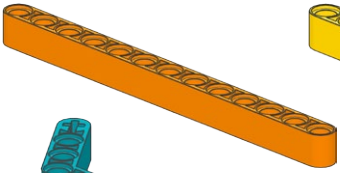
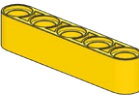
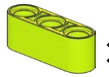
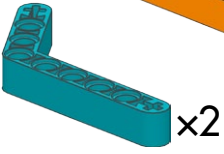

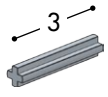
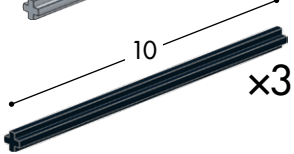
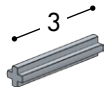


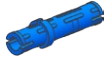




#21

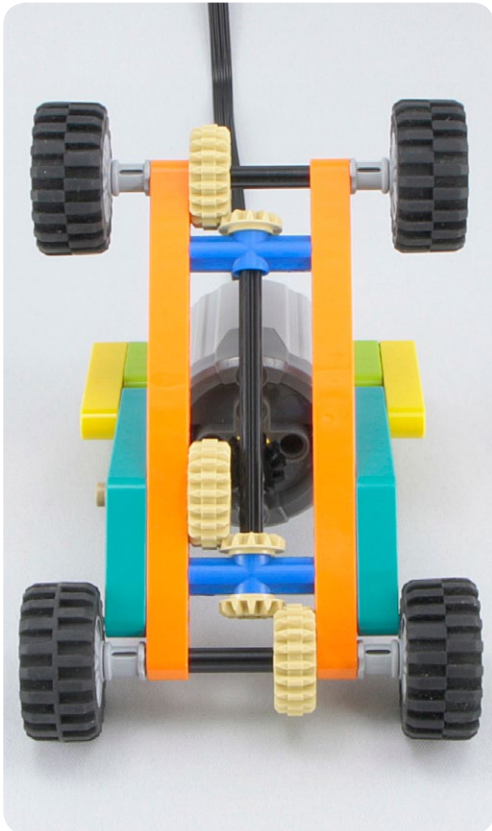
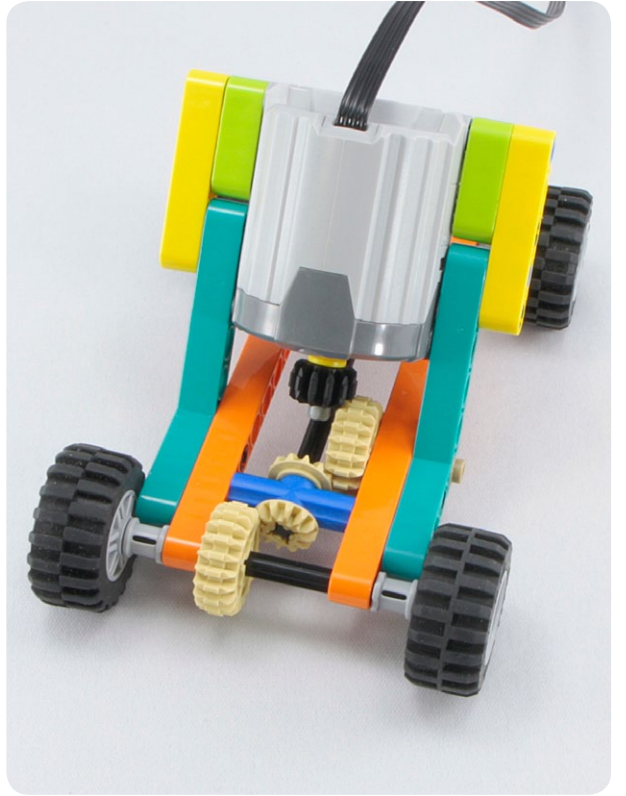


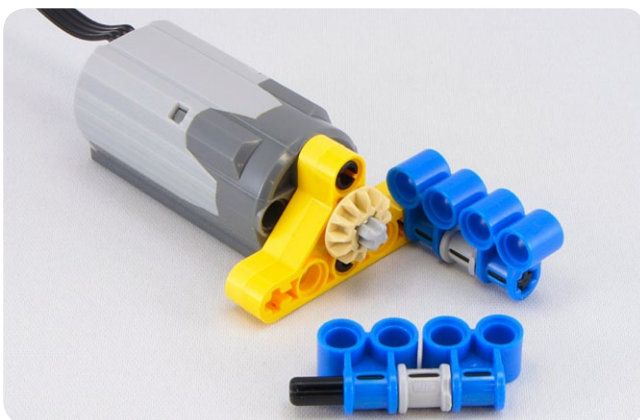
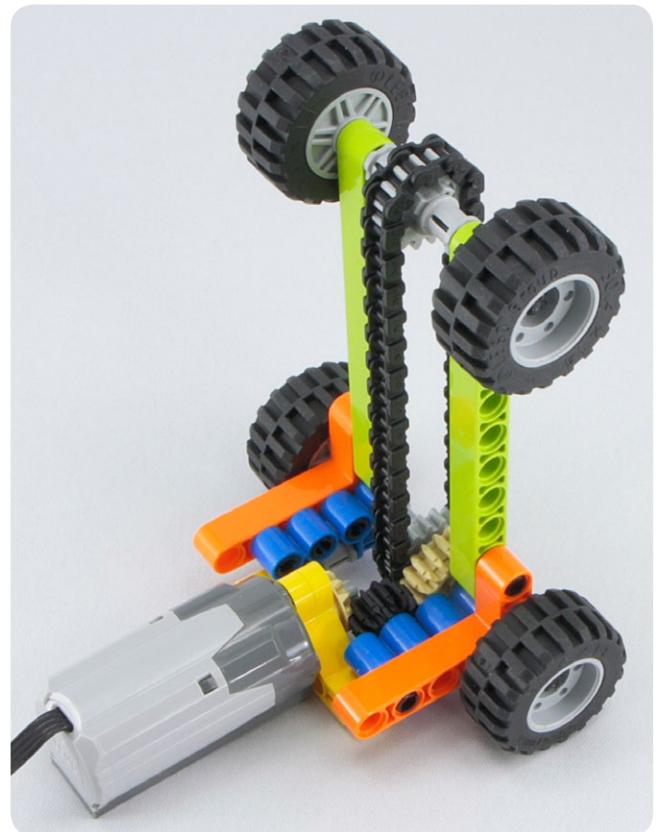
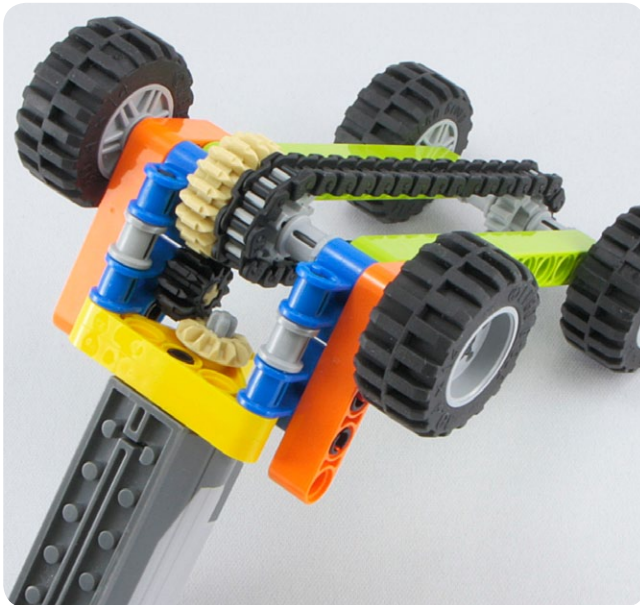
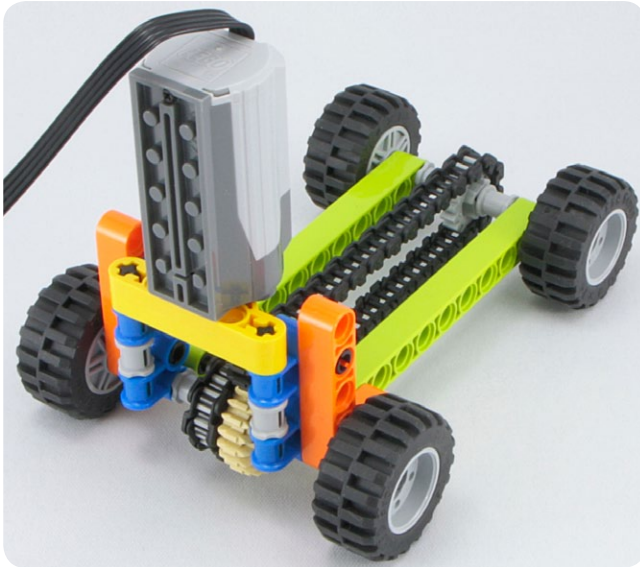


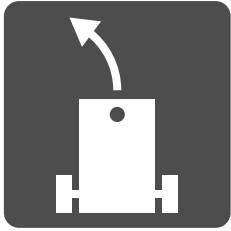
#22

-  Motor
-  x4
-  x4
-  x1
-  x3
-  x3
-  x1
-  x2
-  x2
-  x2
-  x2
-  x1
-  x3
-  10 x3
-  3 x1
-  x4
-  x2
-  x2
-  x8
-  x8







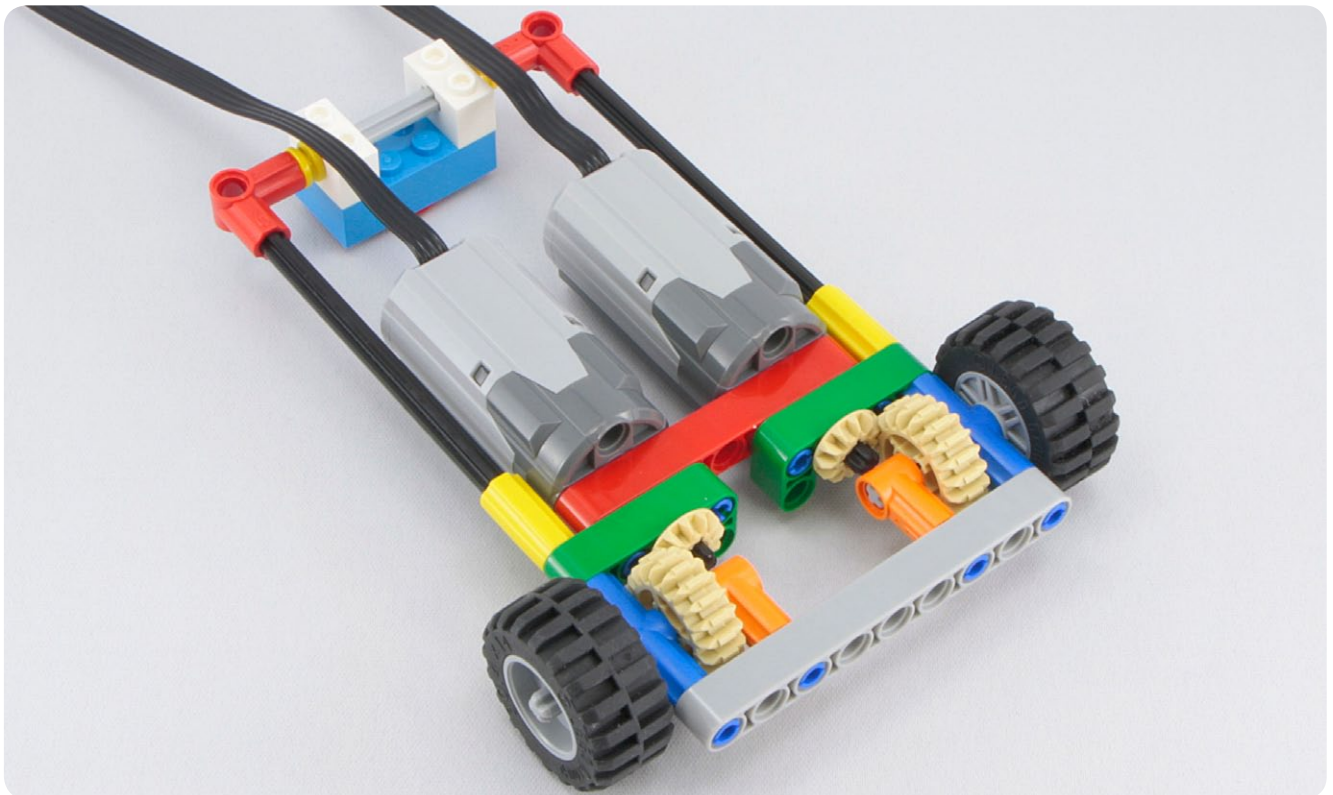
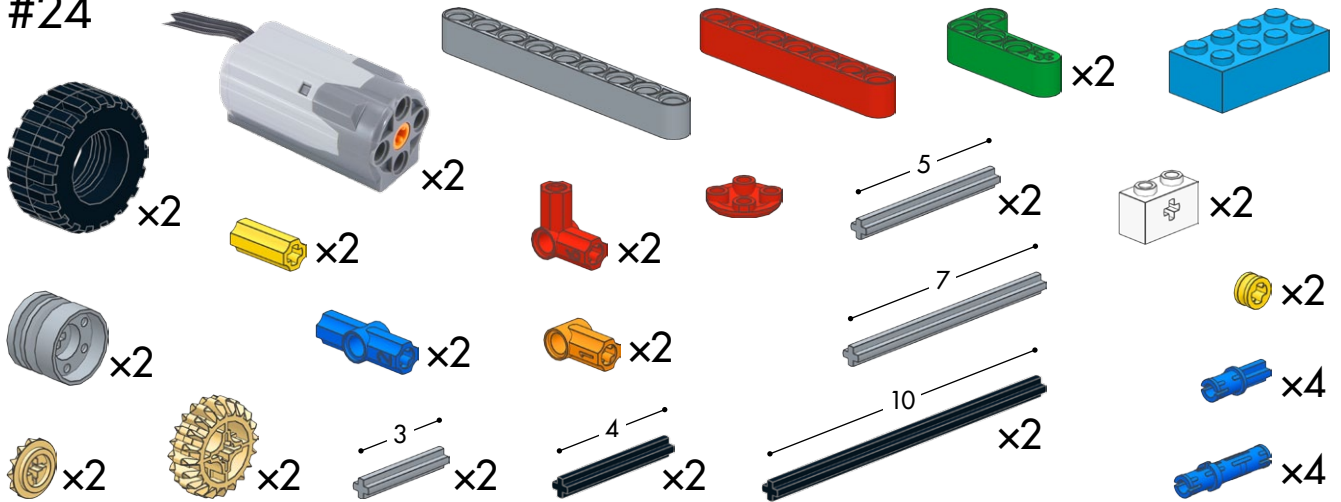


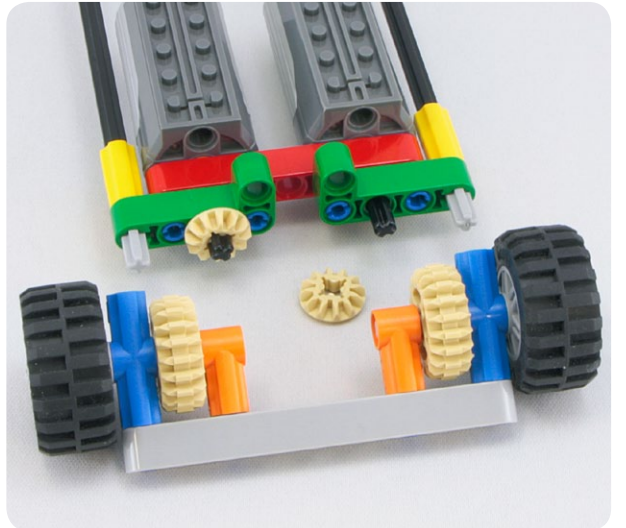
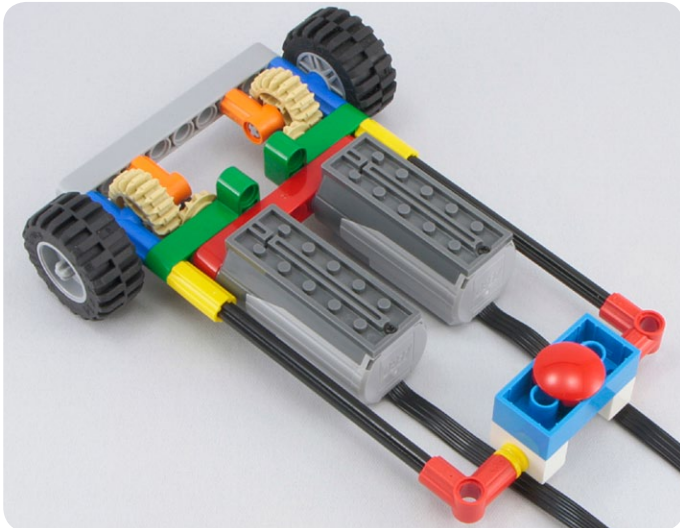
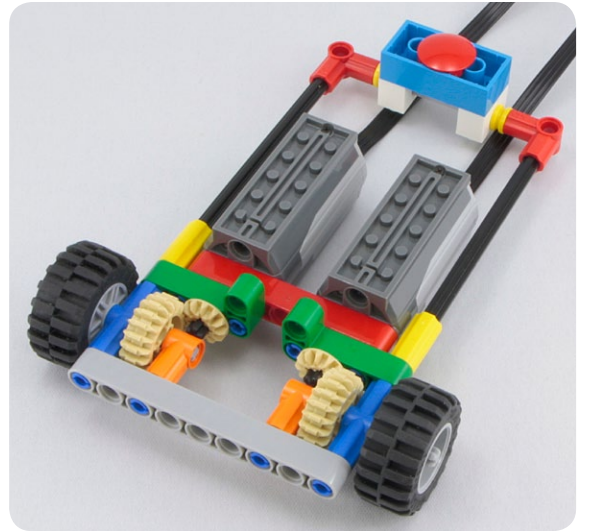
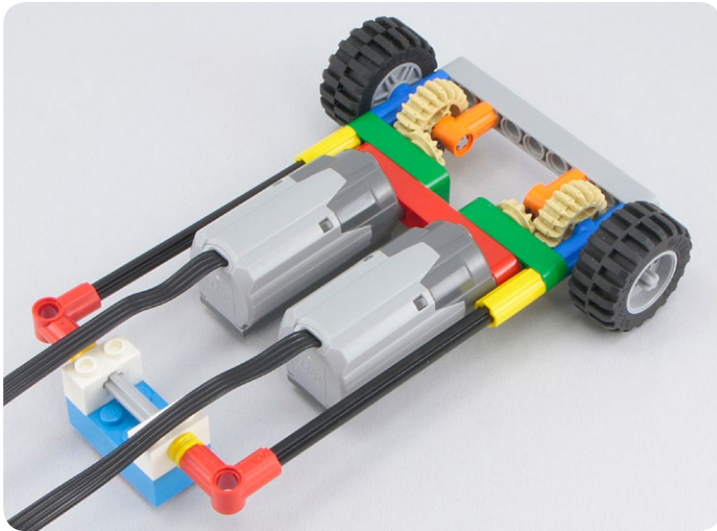
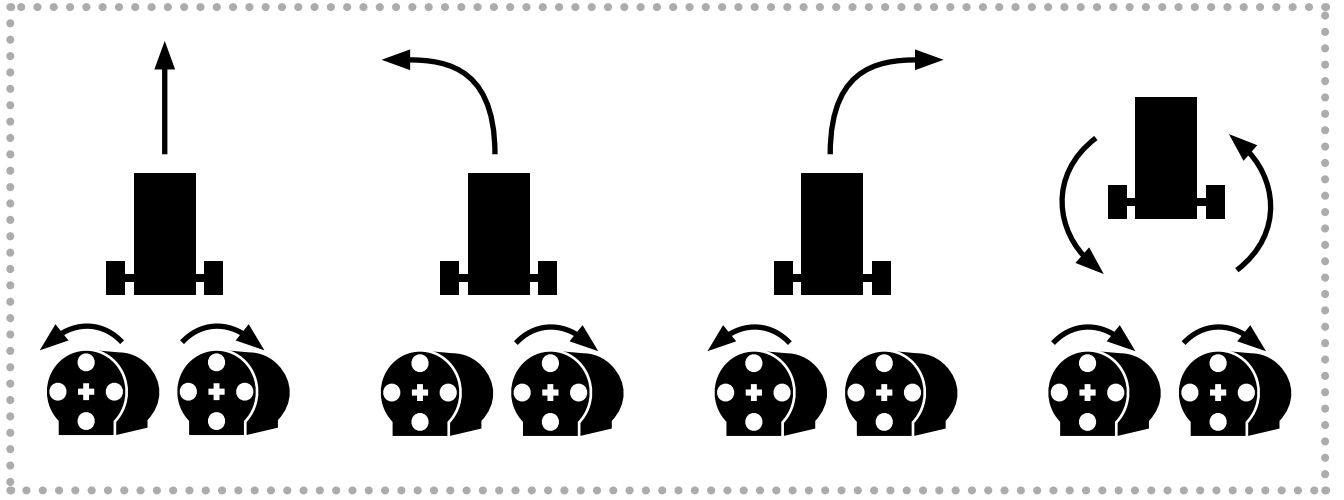
You can build cars that steer by combining these with the models in **Caster wheels** (page 44).



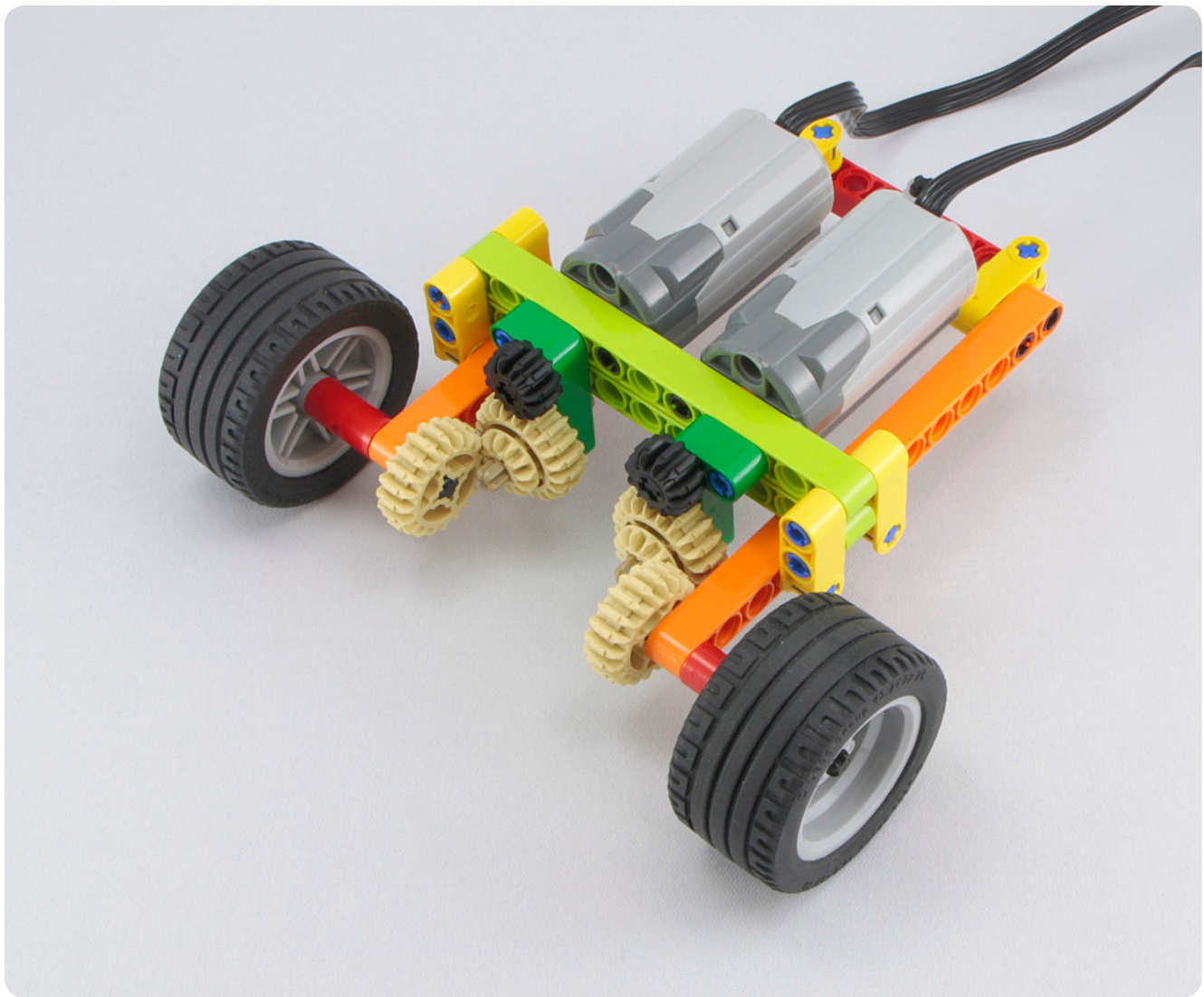
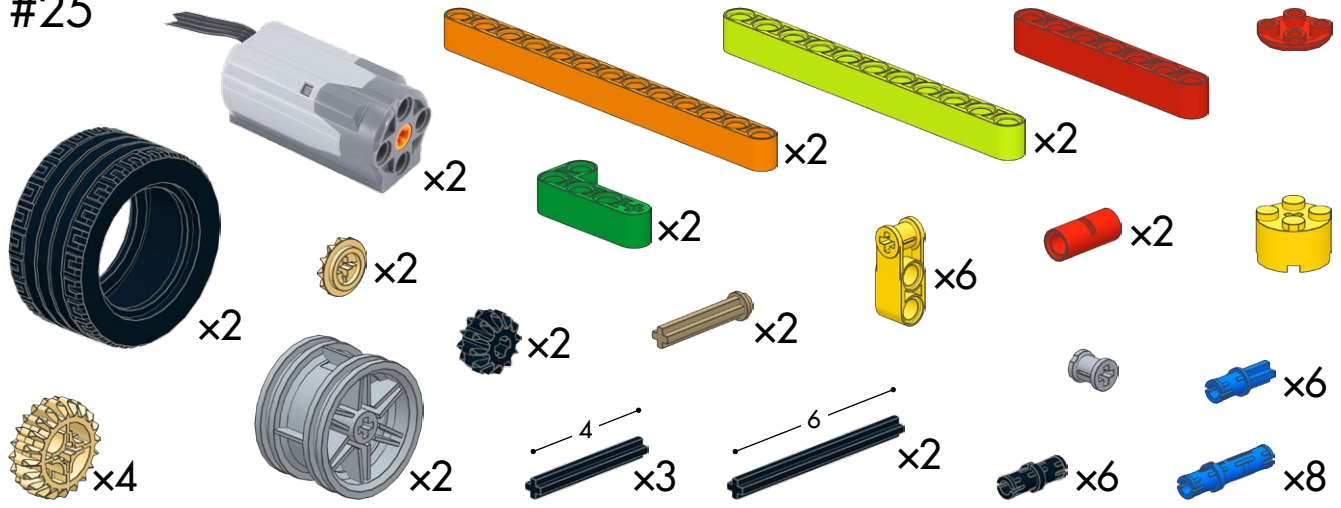
Each motor turns a wheel

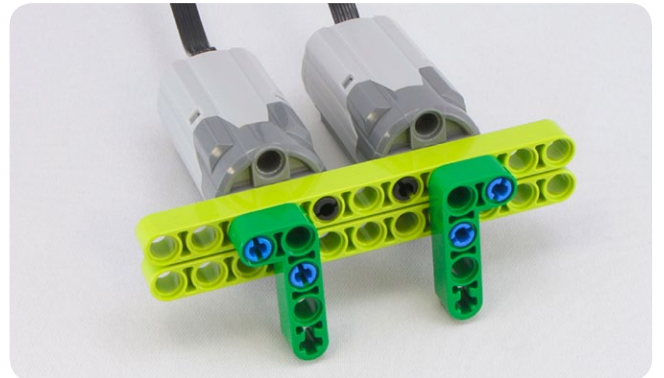
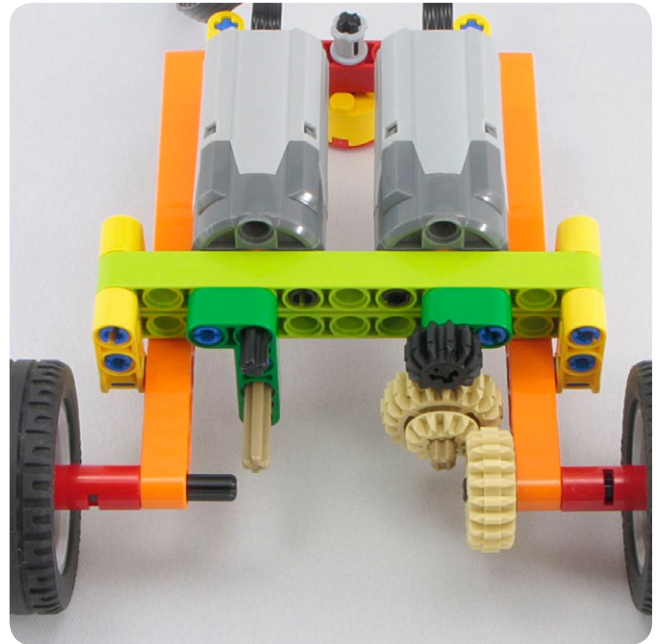
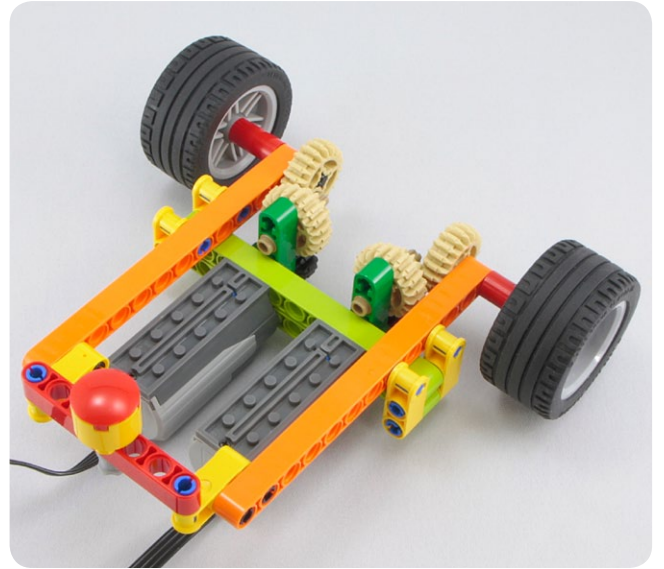
#24



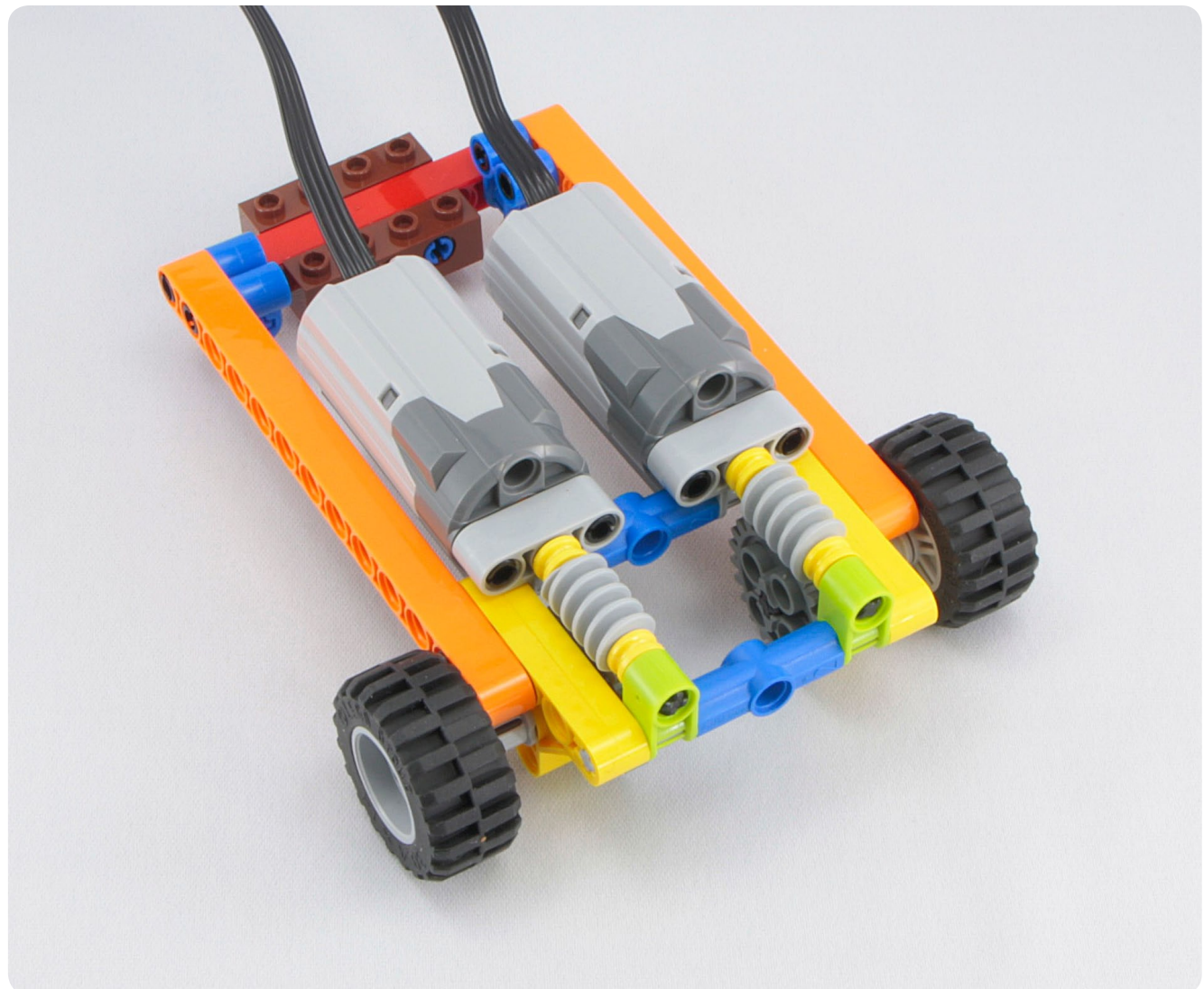
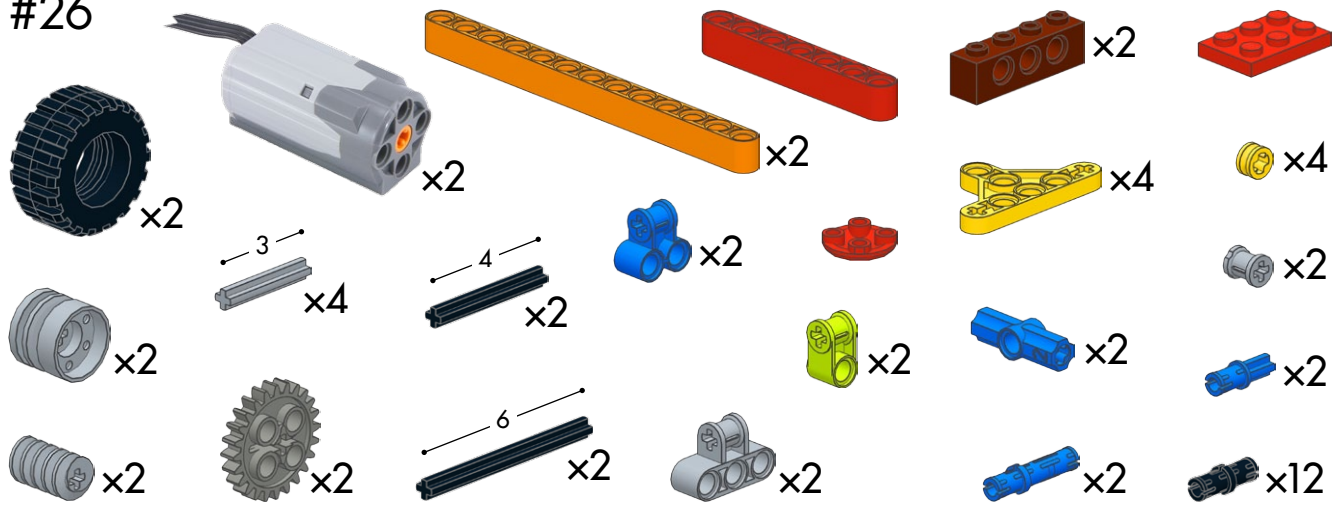


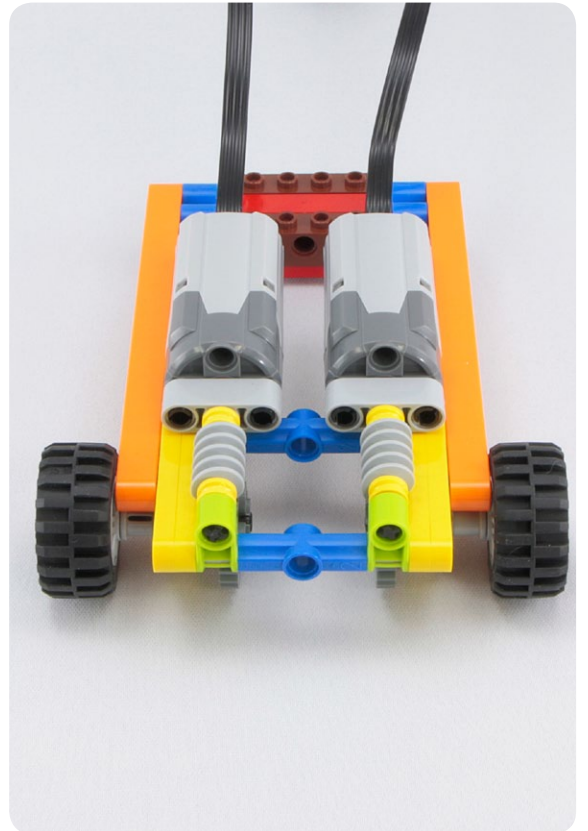
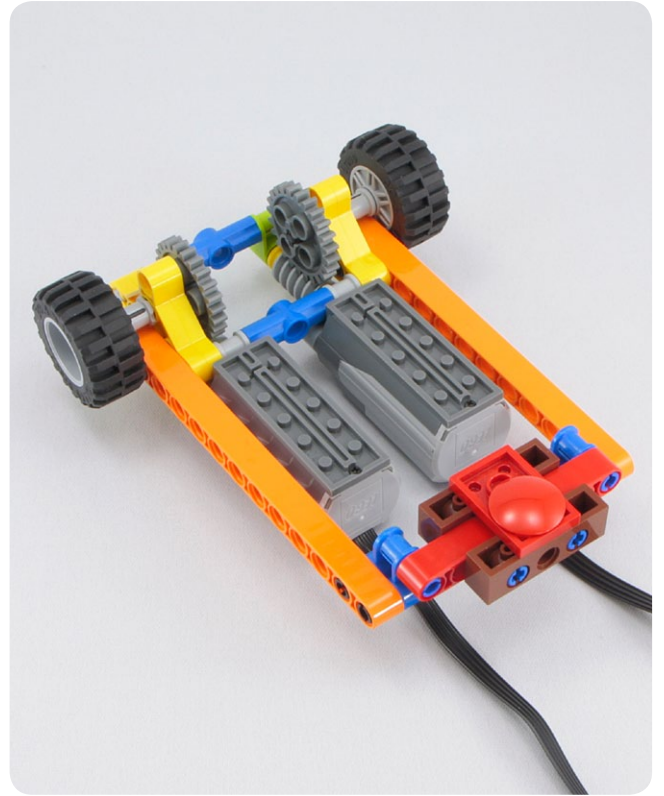
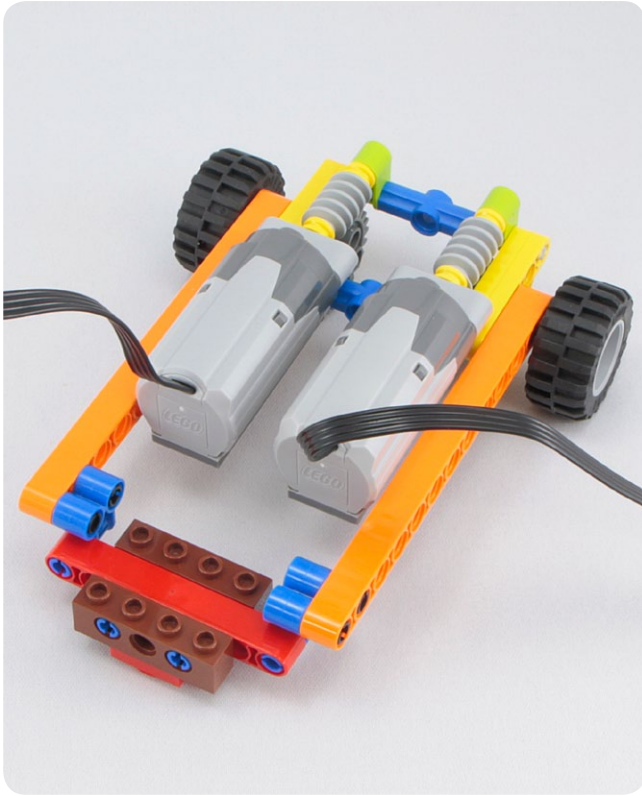
#25



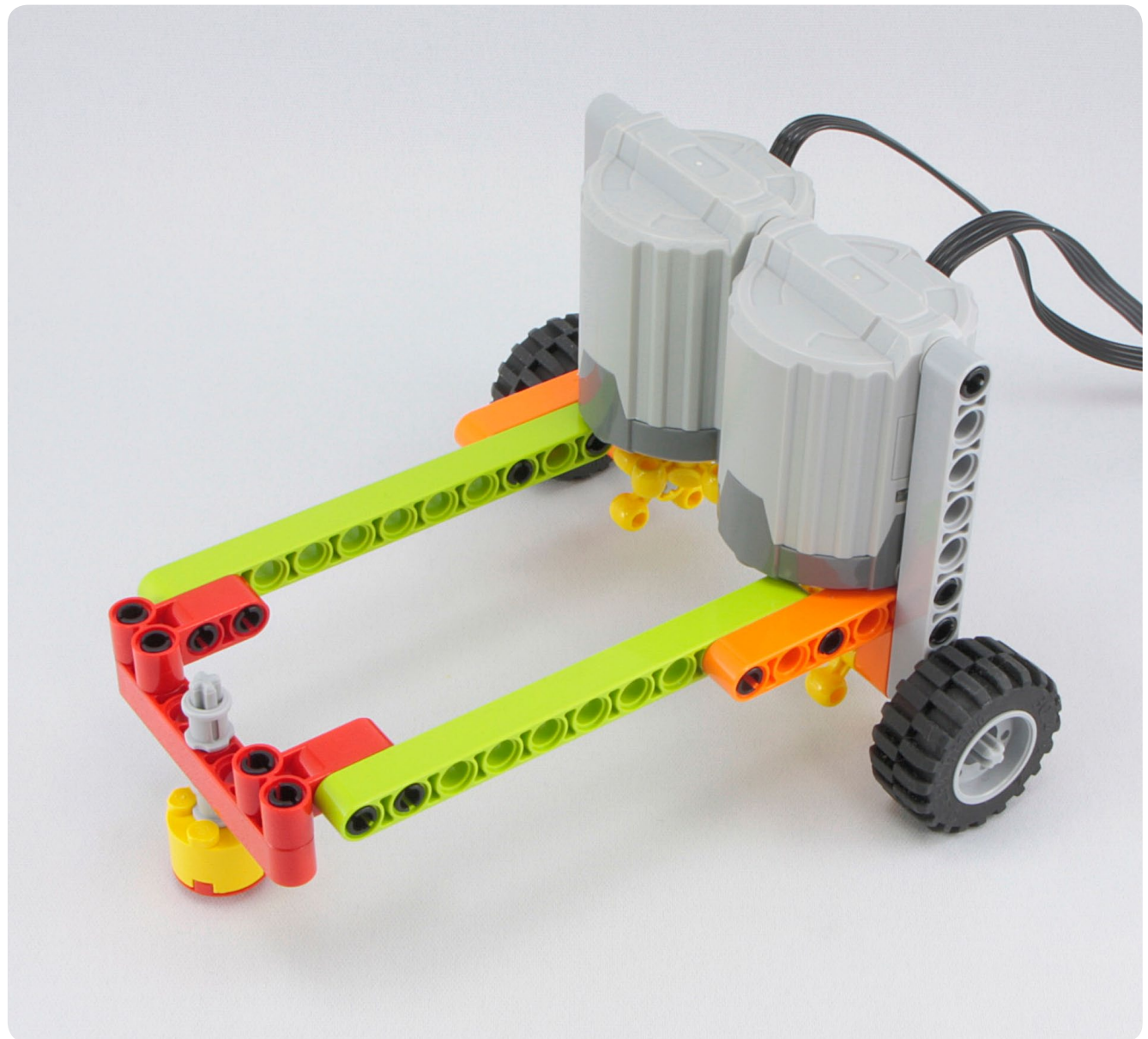
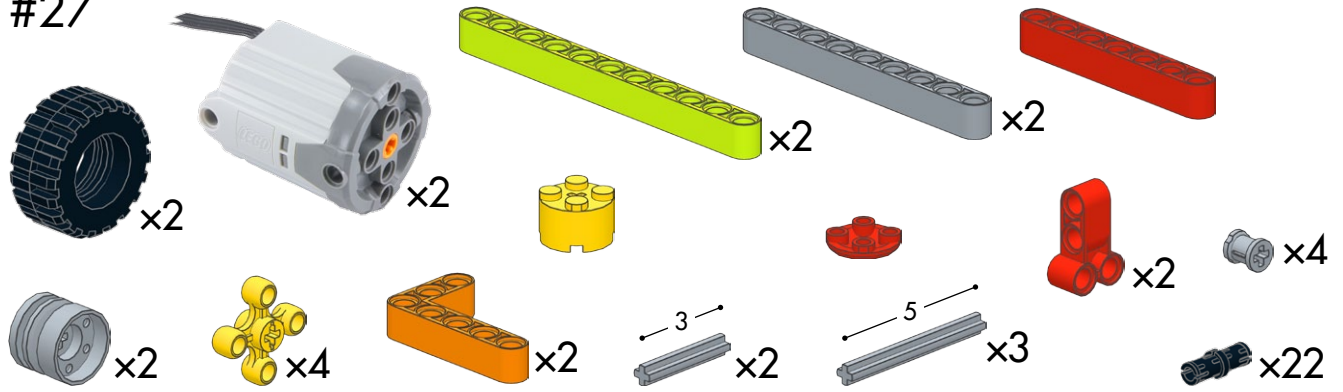


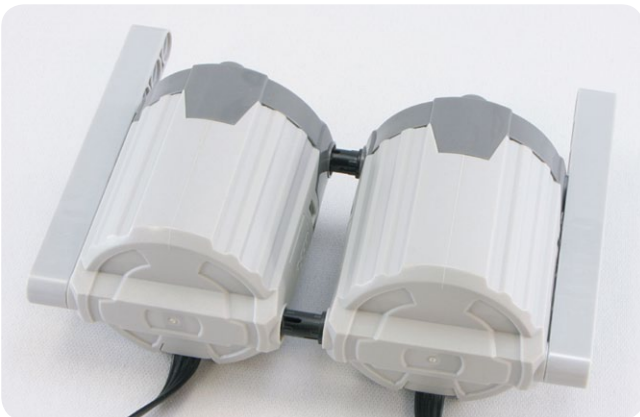
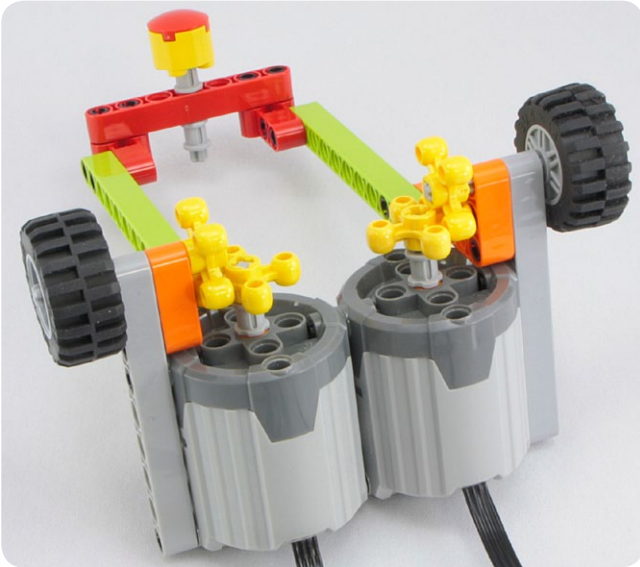
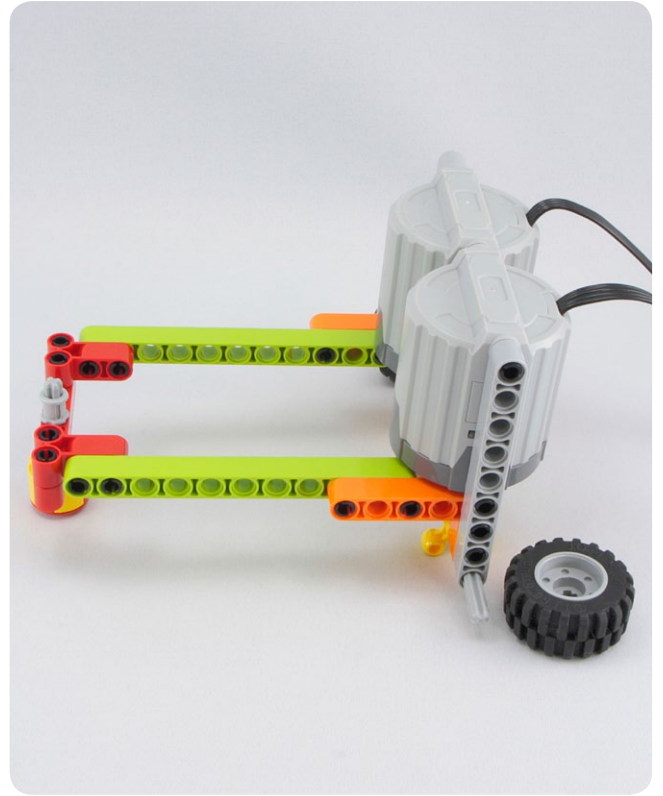
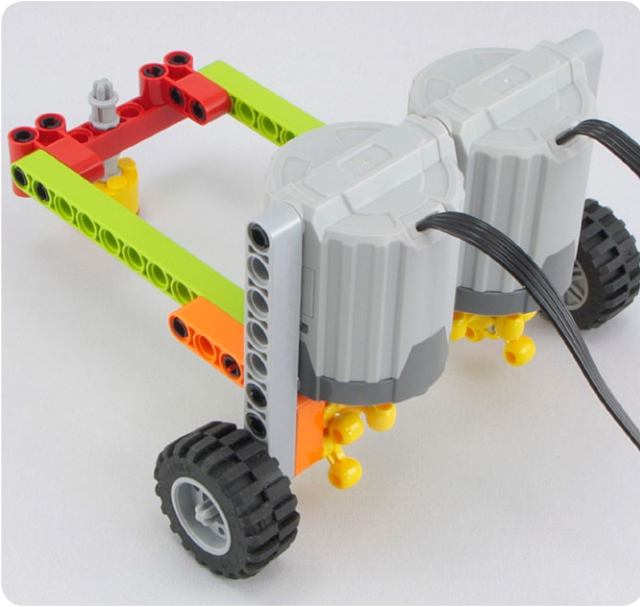
#26

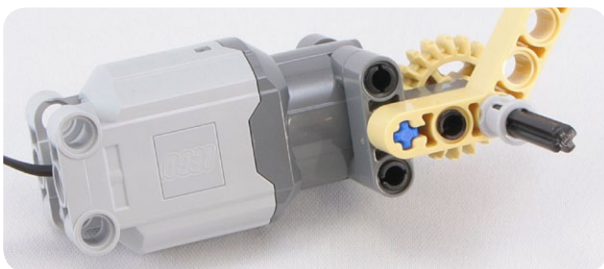
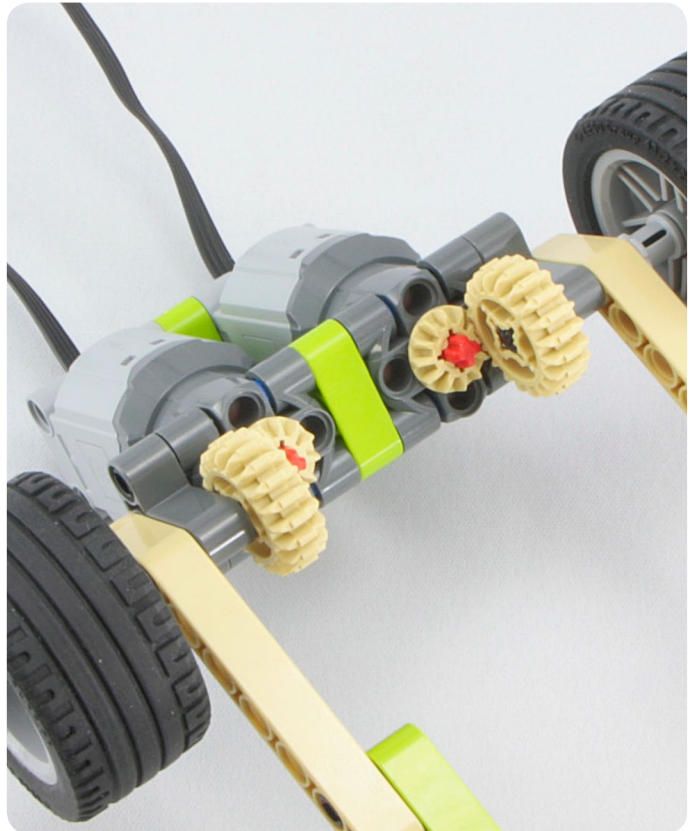
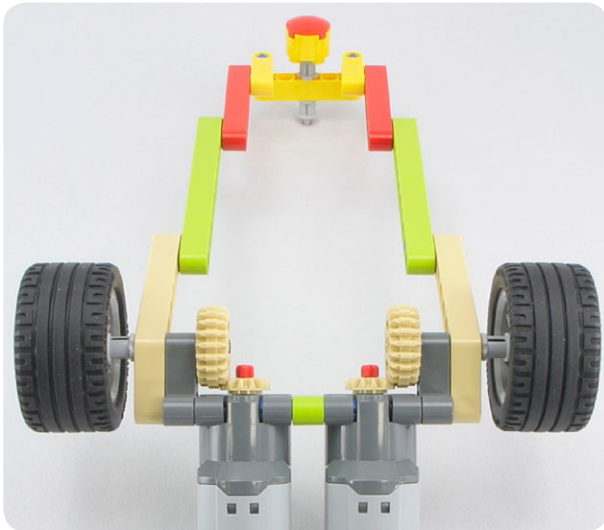
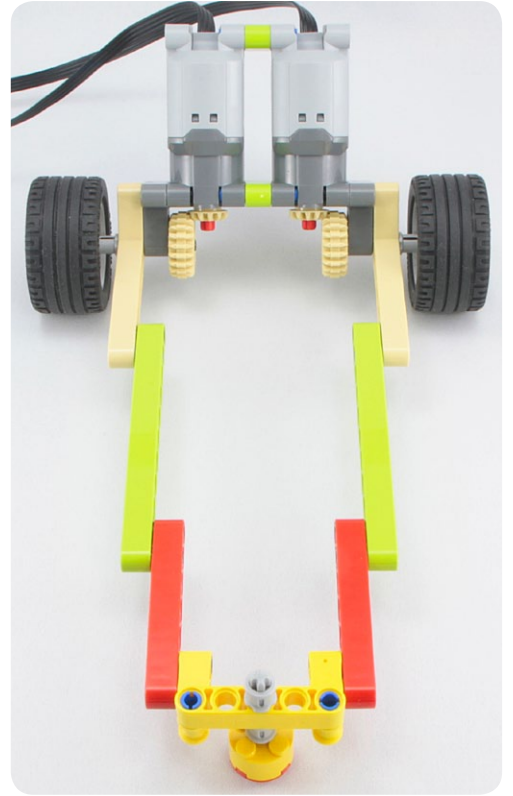




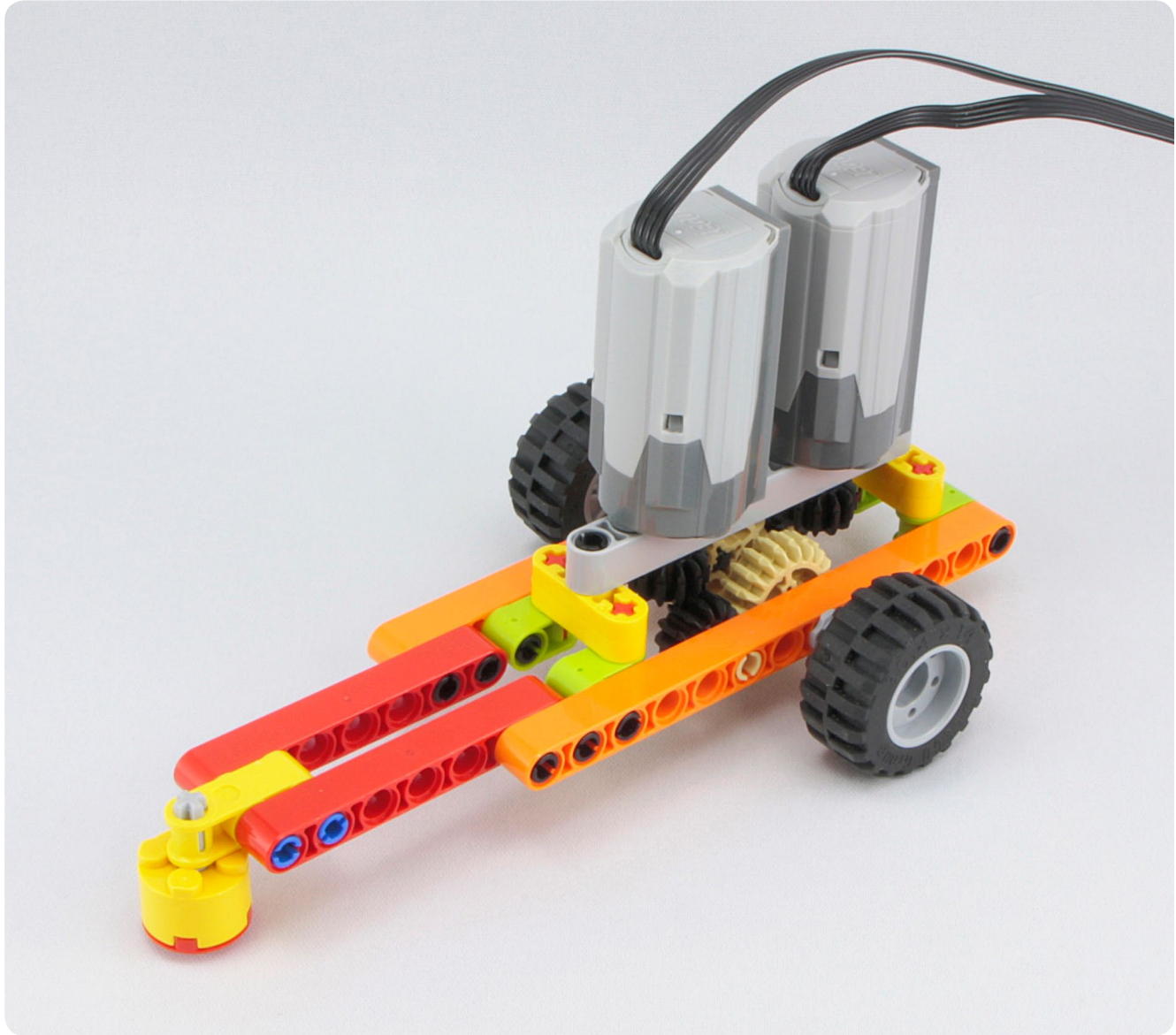
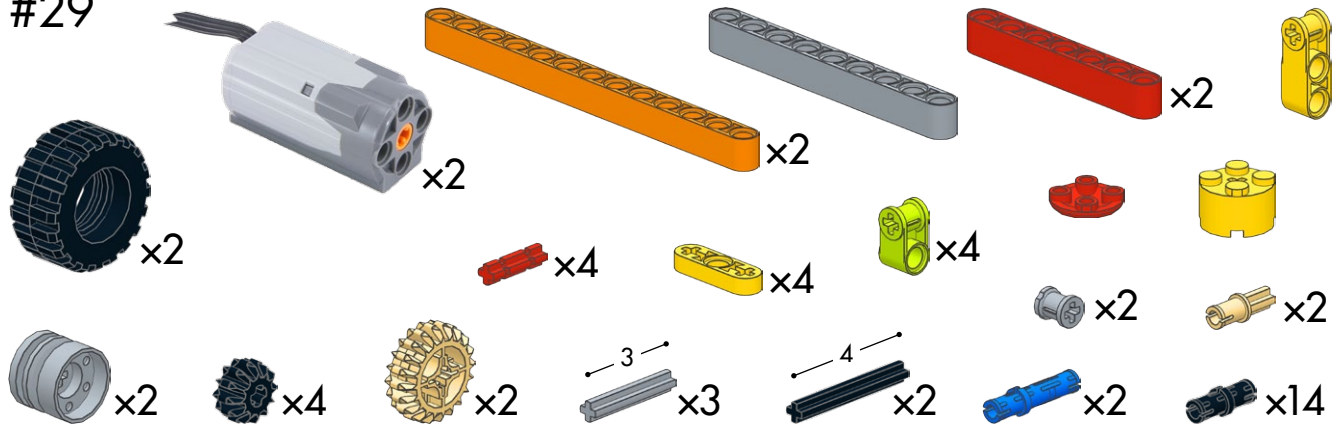
#27



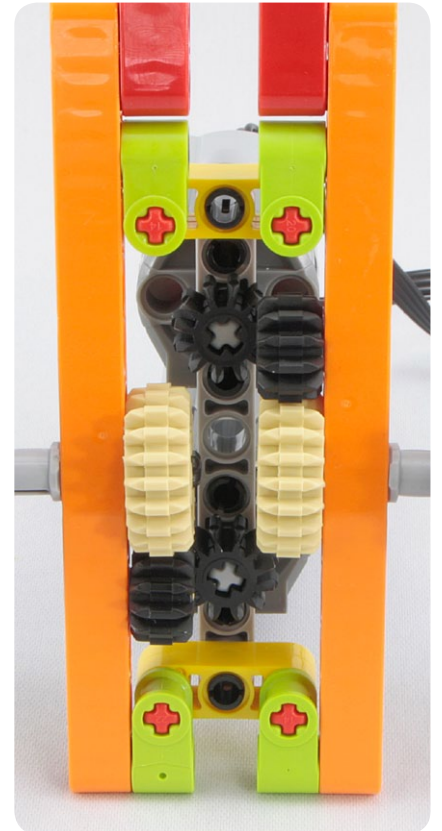
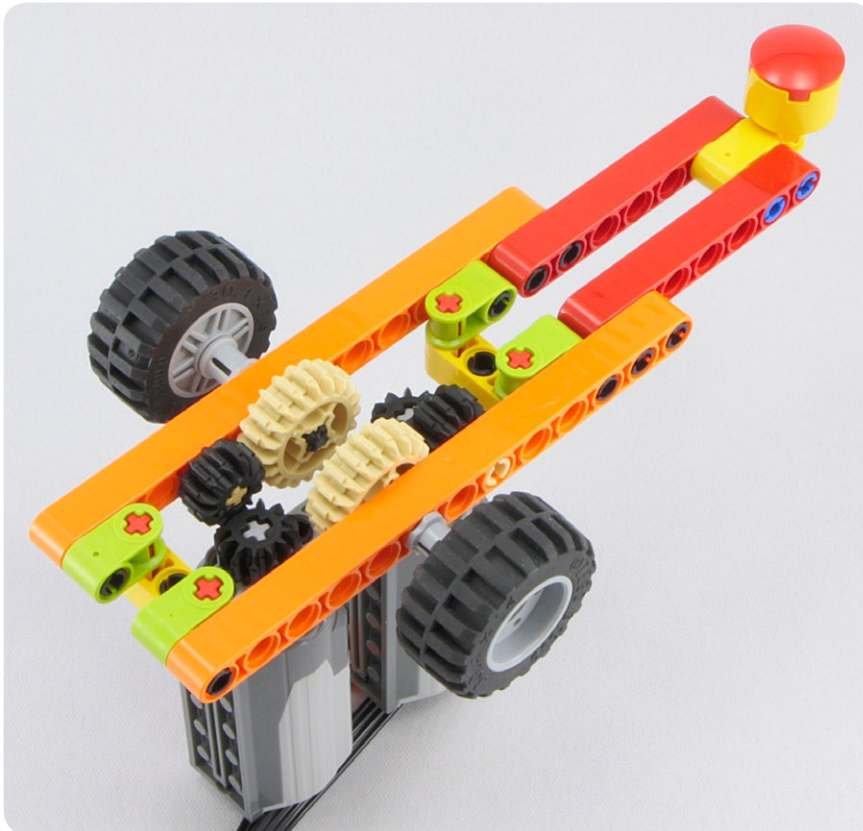


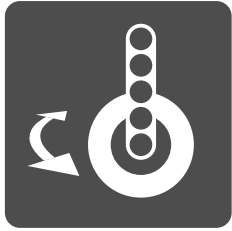


#29



42 Each motor turns a wheel



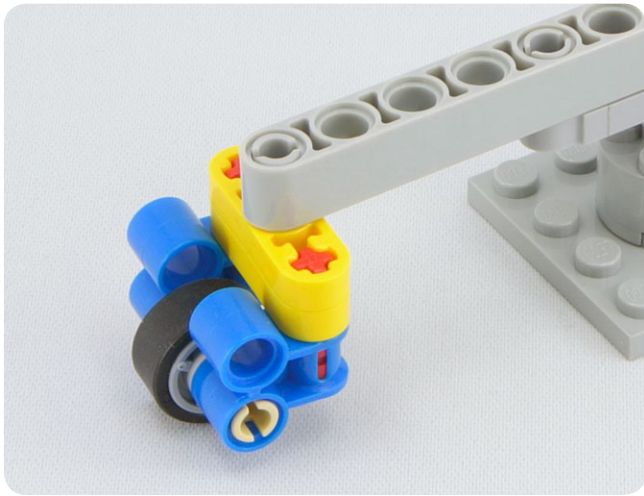


You can build cars that steer by combining these with the models in **Each motor turns a wheel** (page 32).

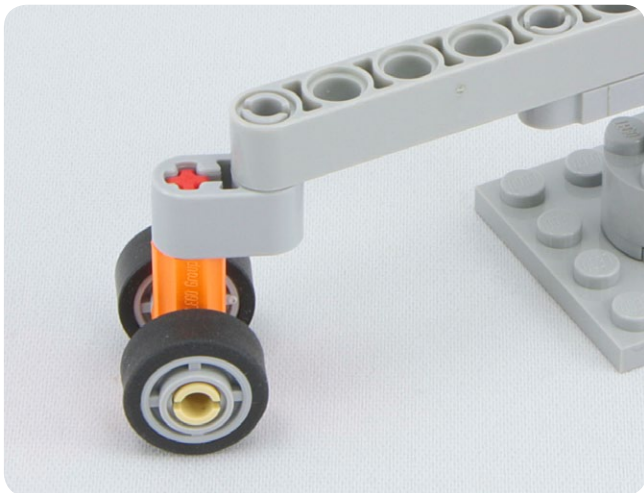


Caster wheels

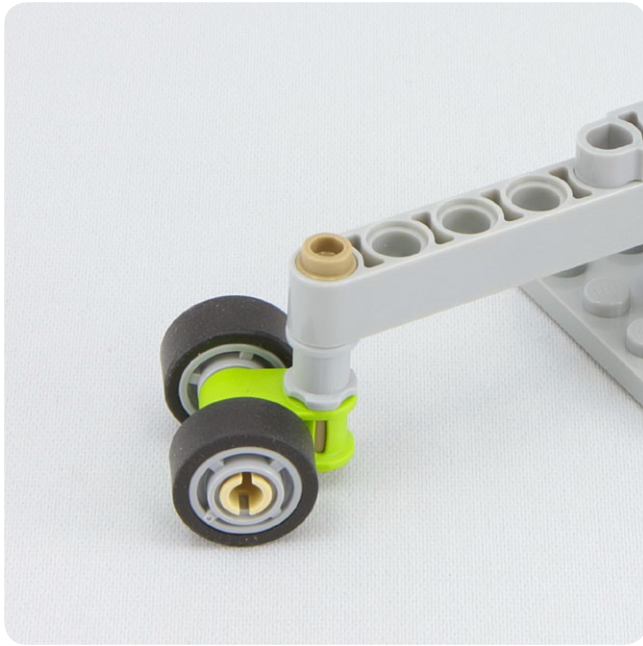
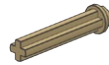
#30



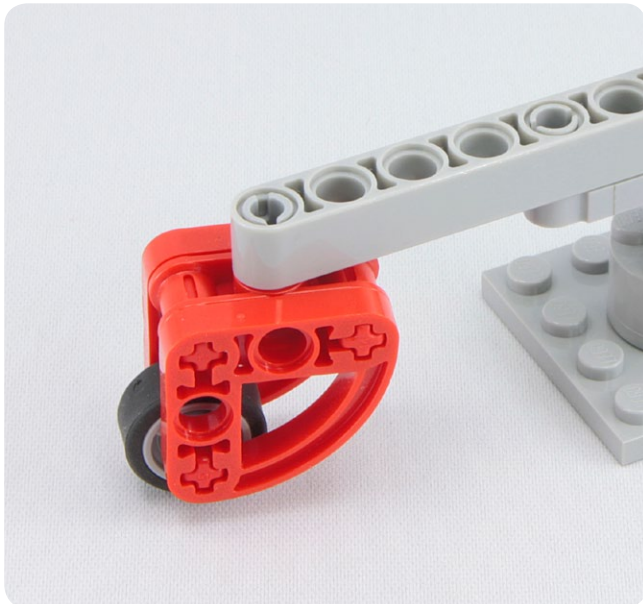
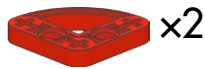
#31



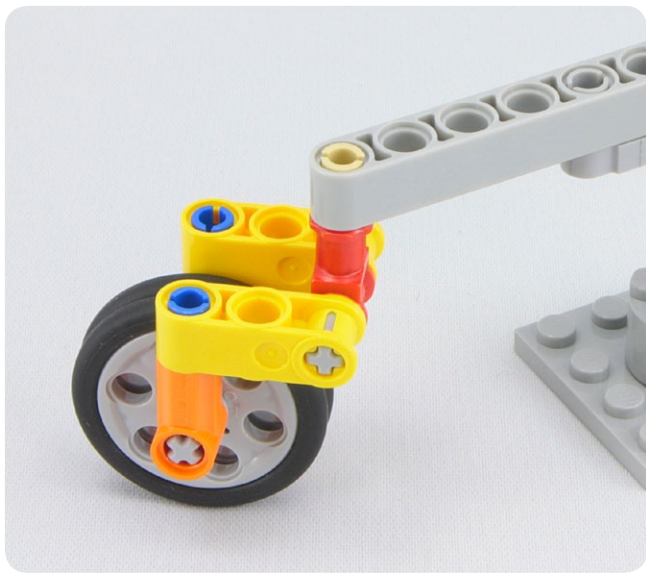
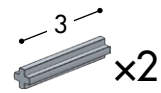
#32



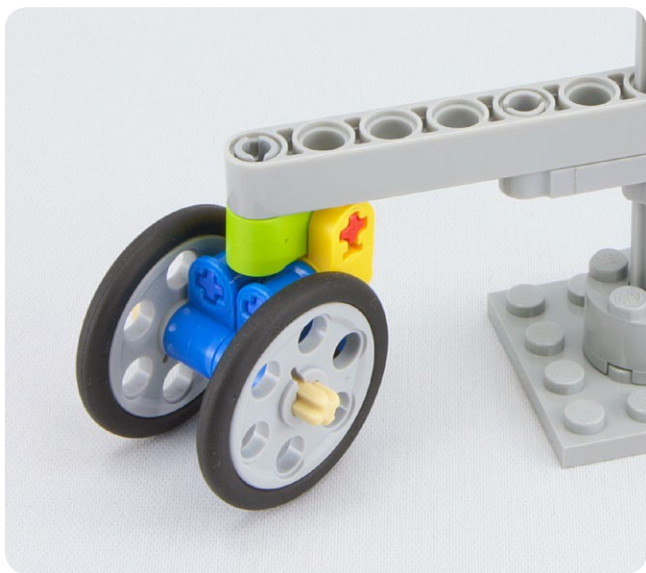
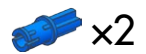
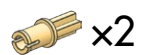
#33



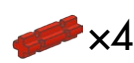
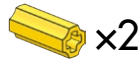
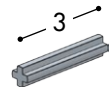
#34



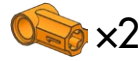
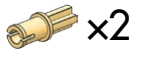
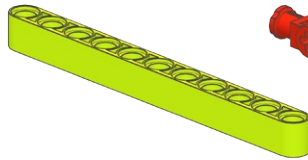
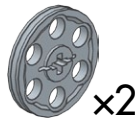
#35



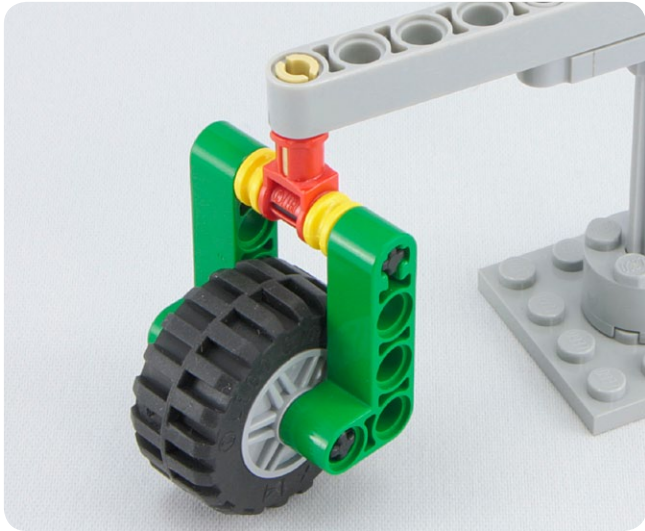
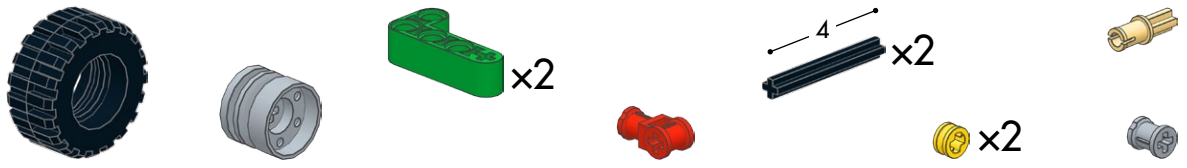
#36



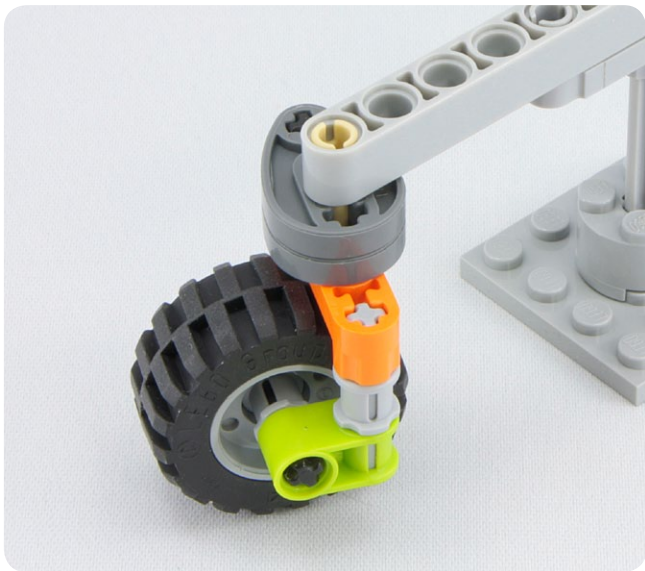
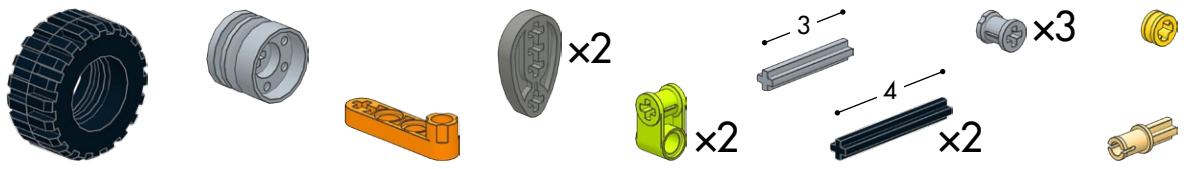
#37



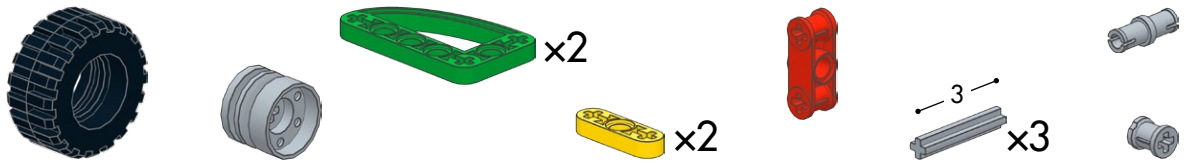
#38



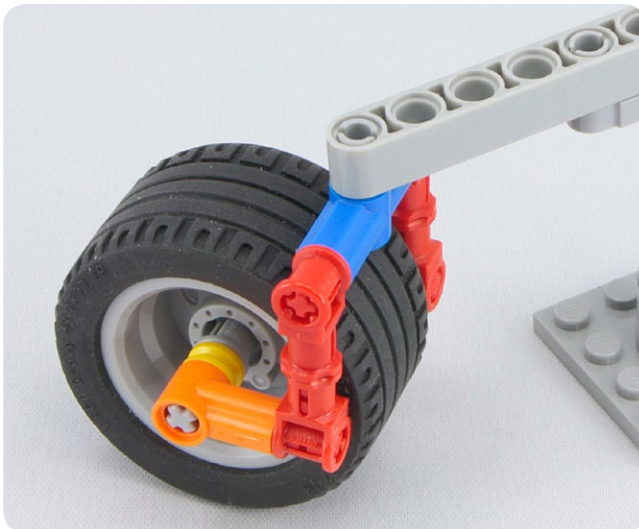
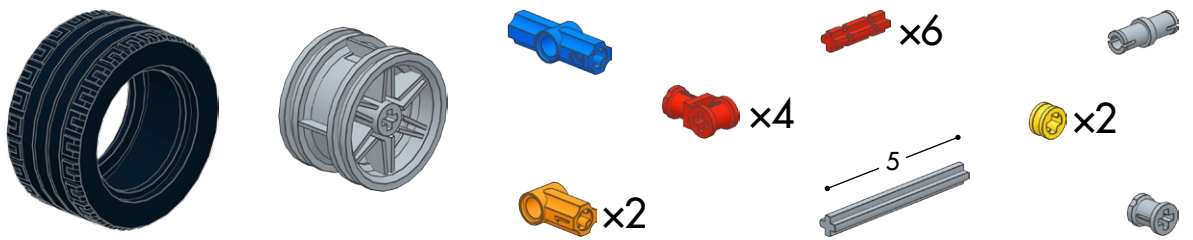
#39

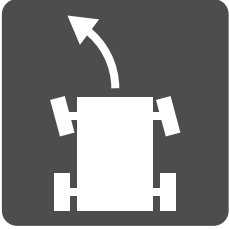


#40



#41





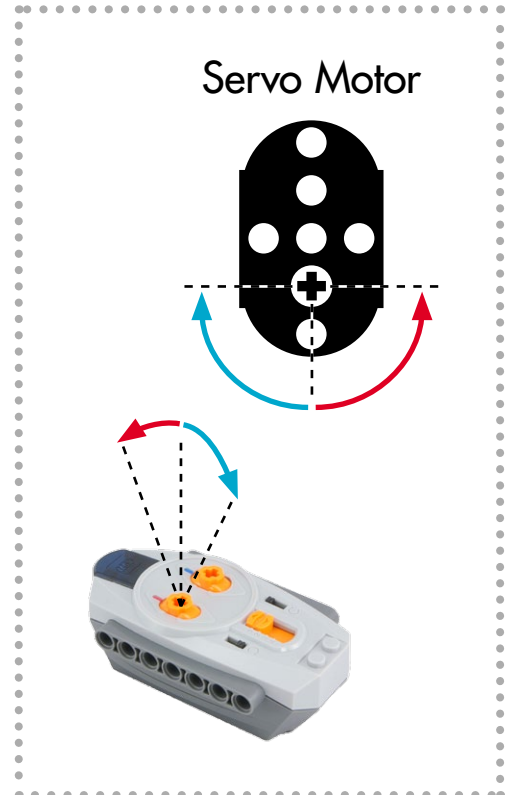
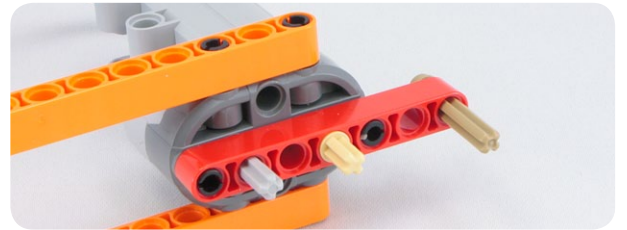
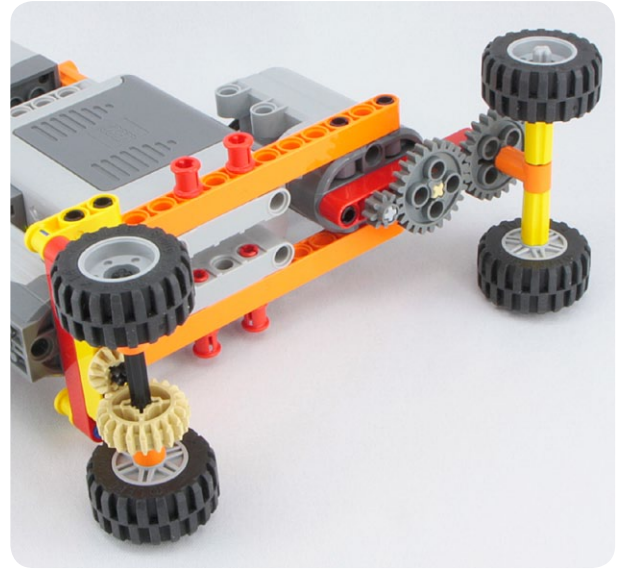
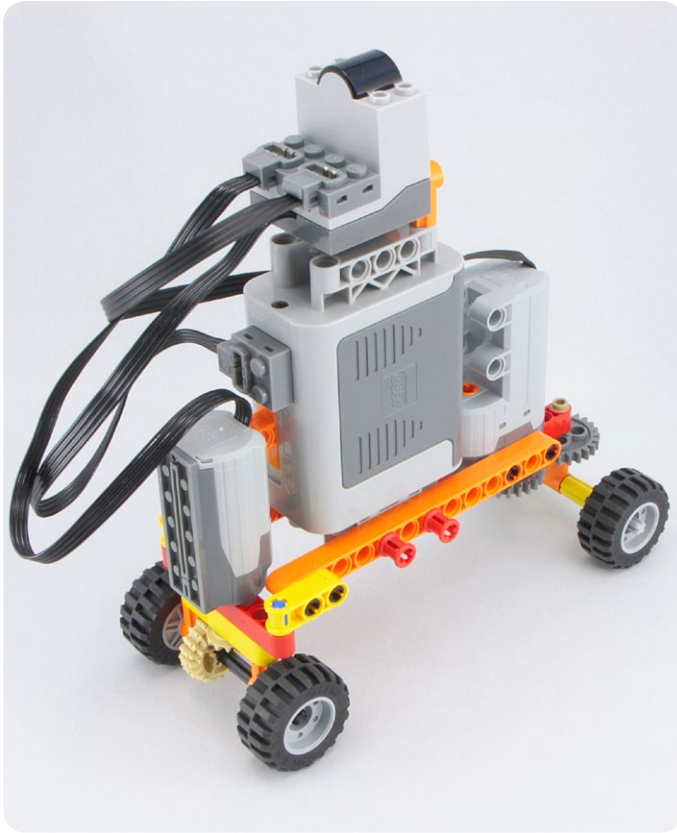
You can combine these models with those in **Differential gears** (page 68).



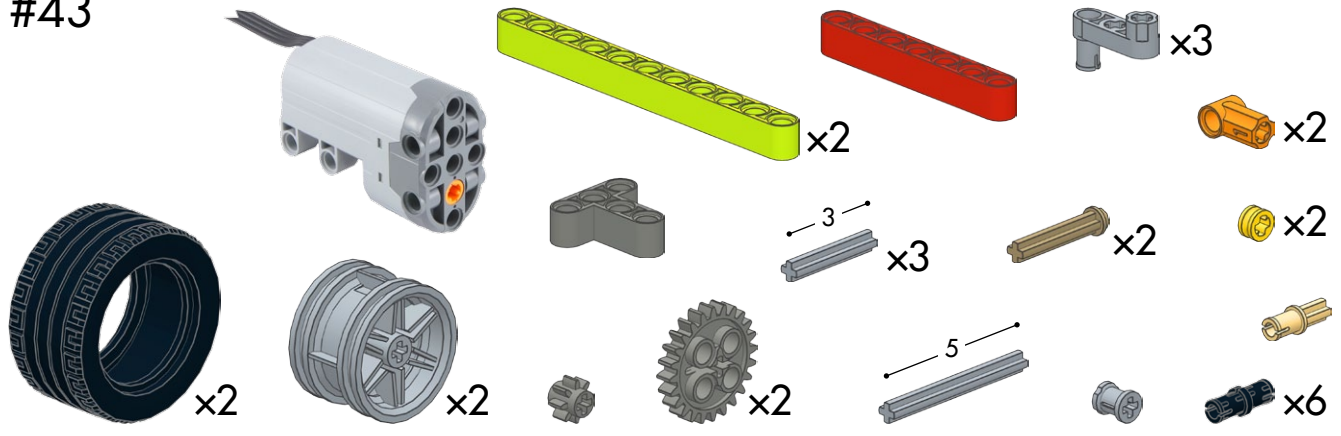
Steering with the servo motor

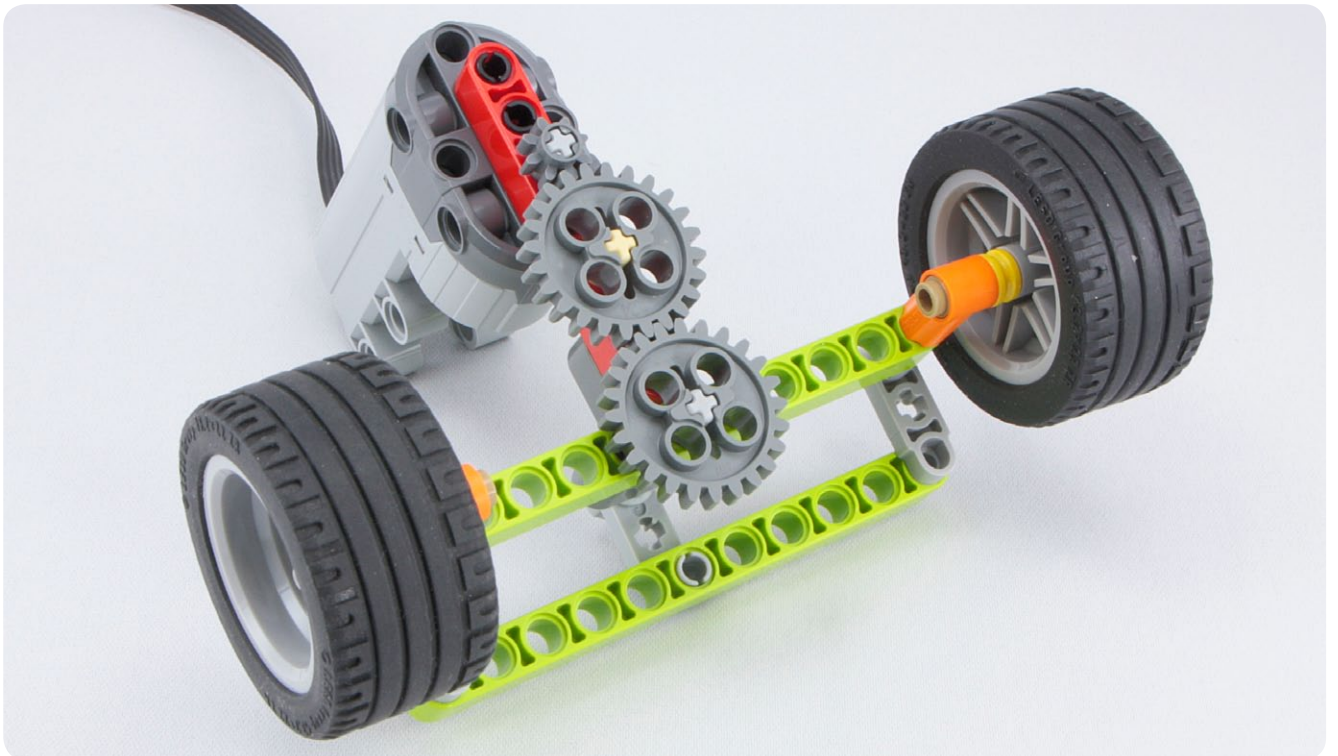
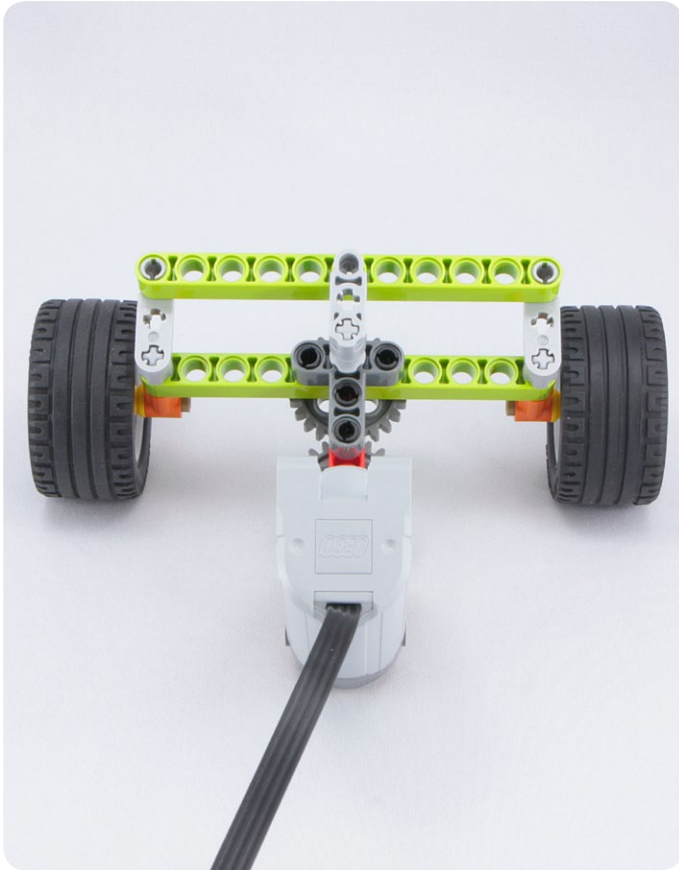
#42

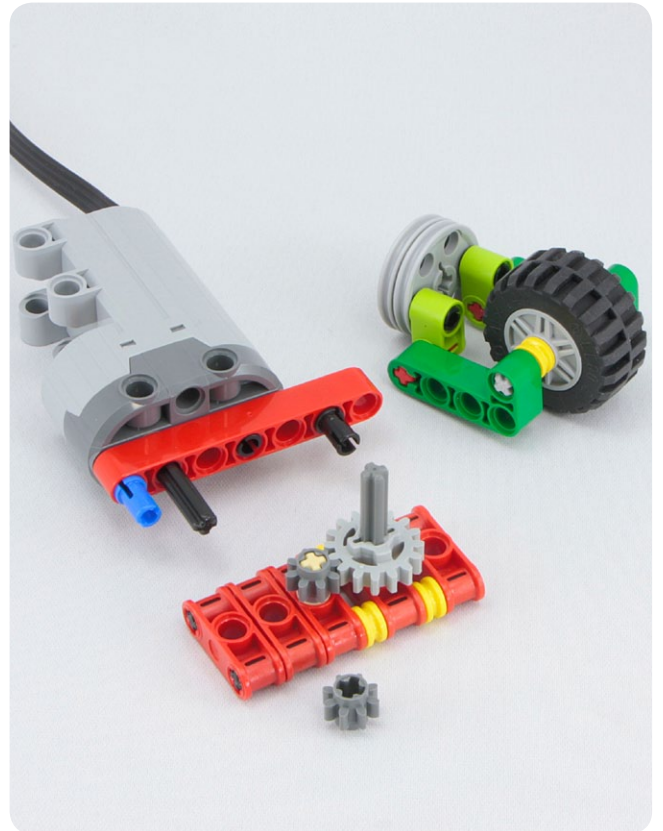
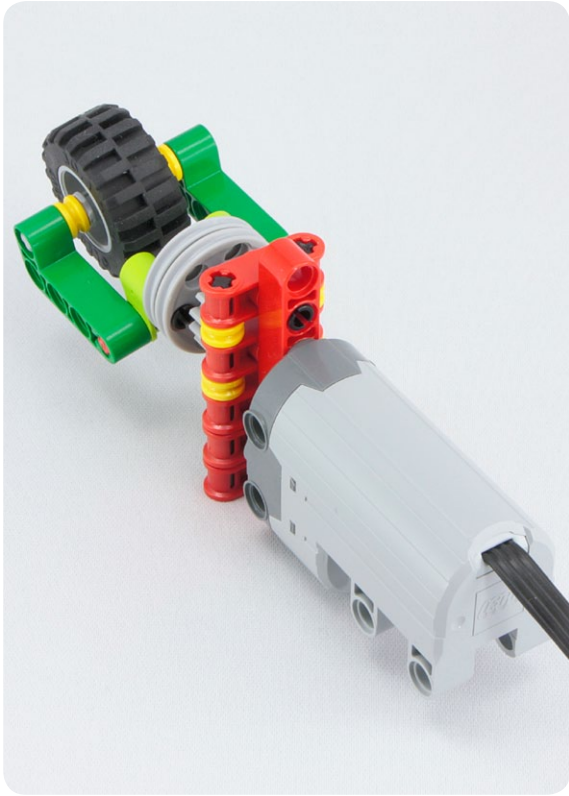


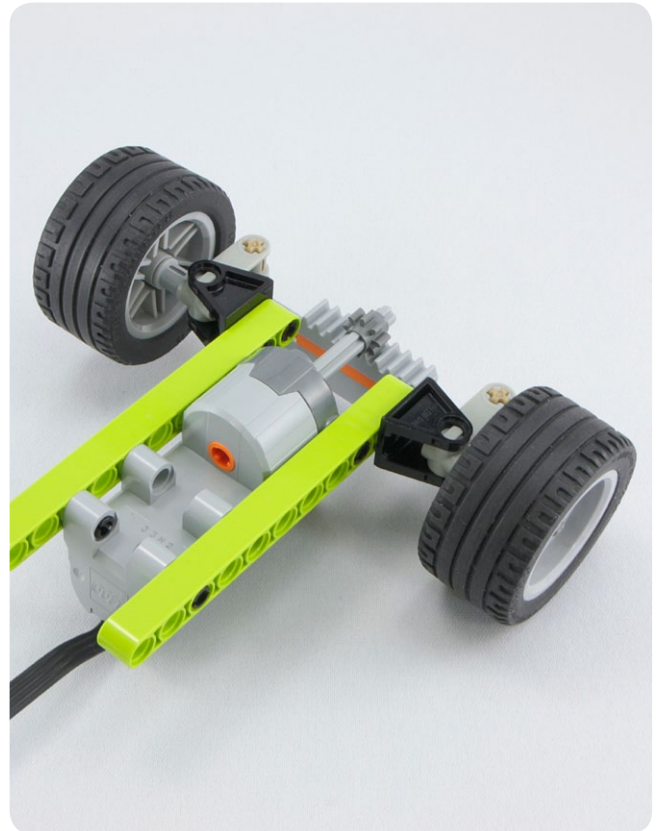
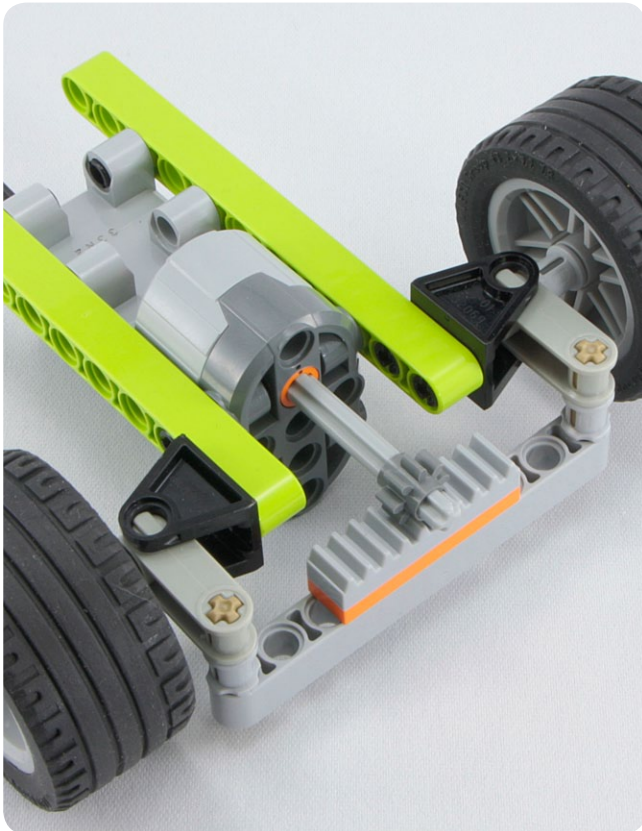


#43

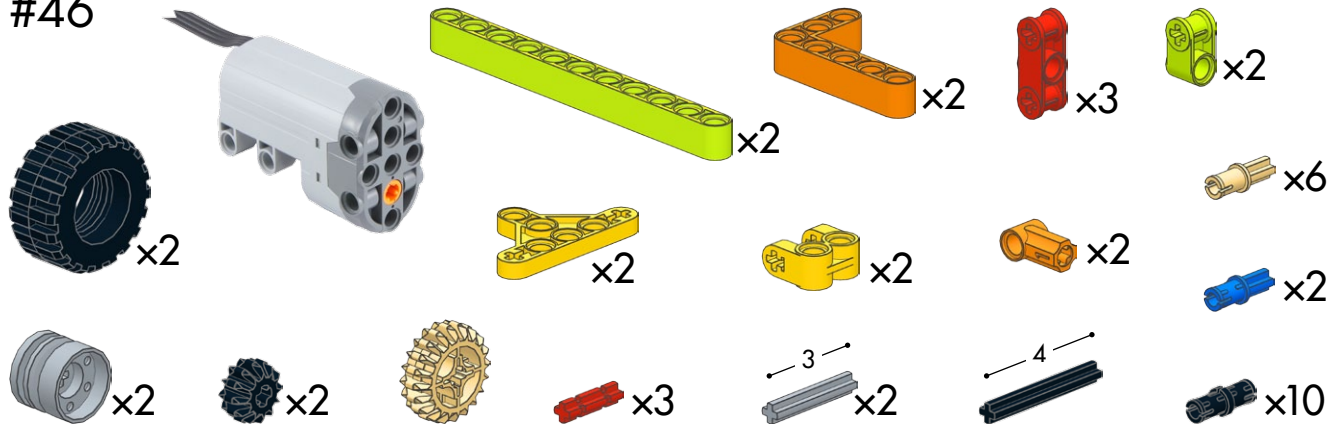


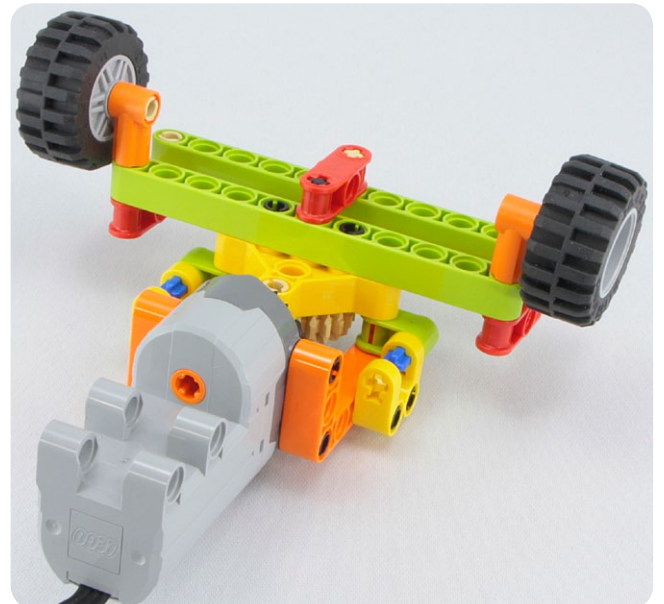


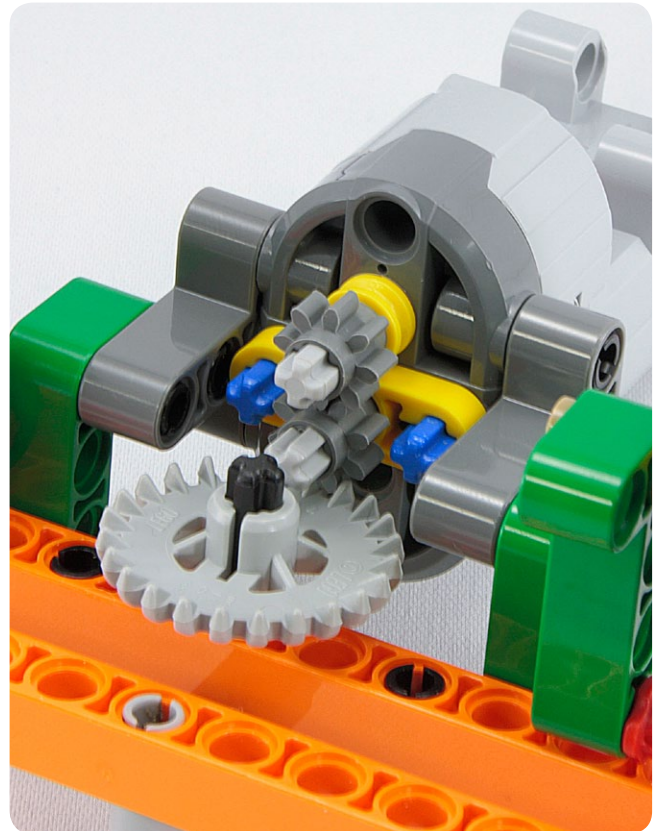
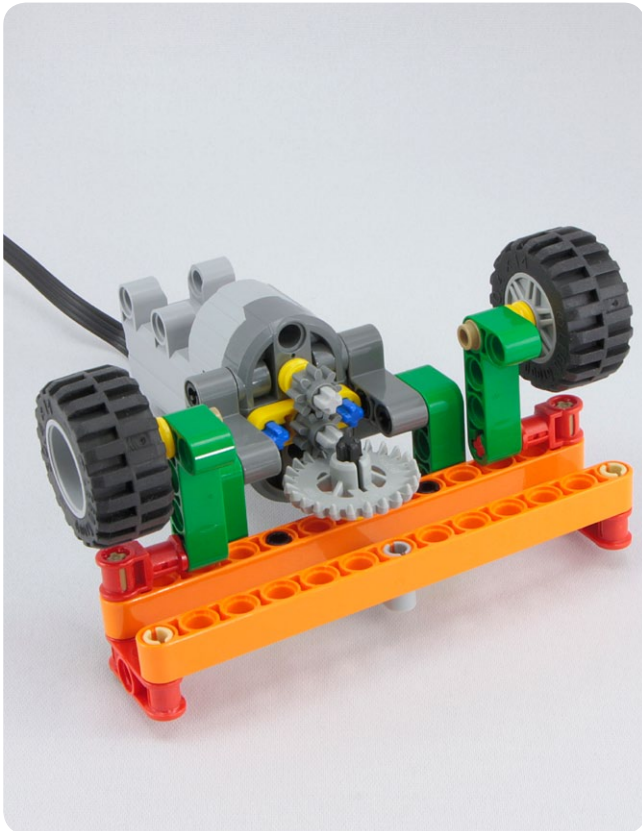
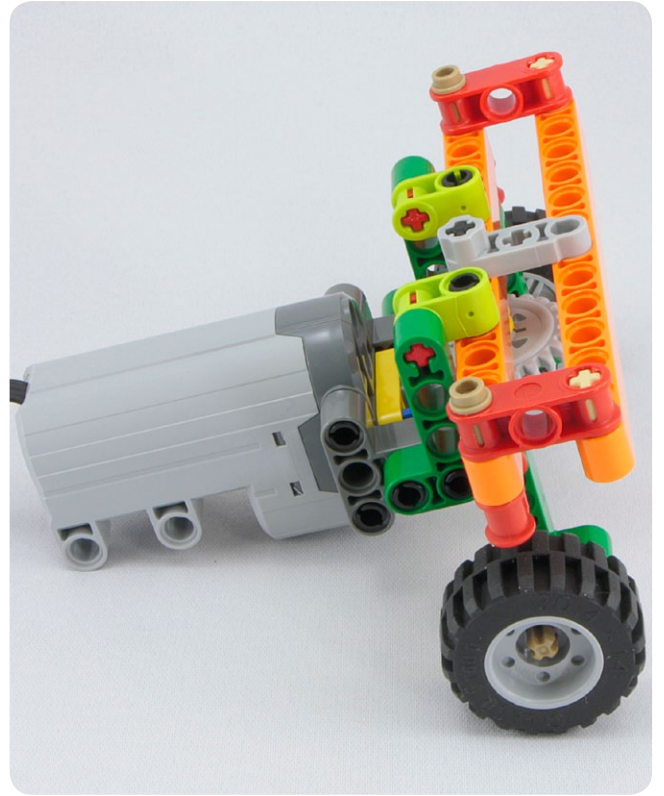
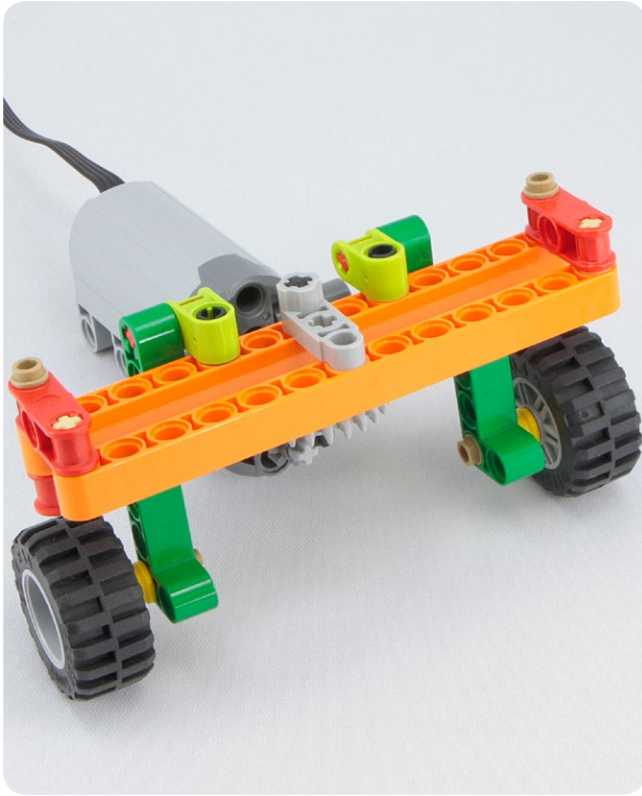




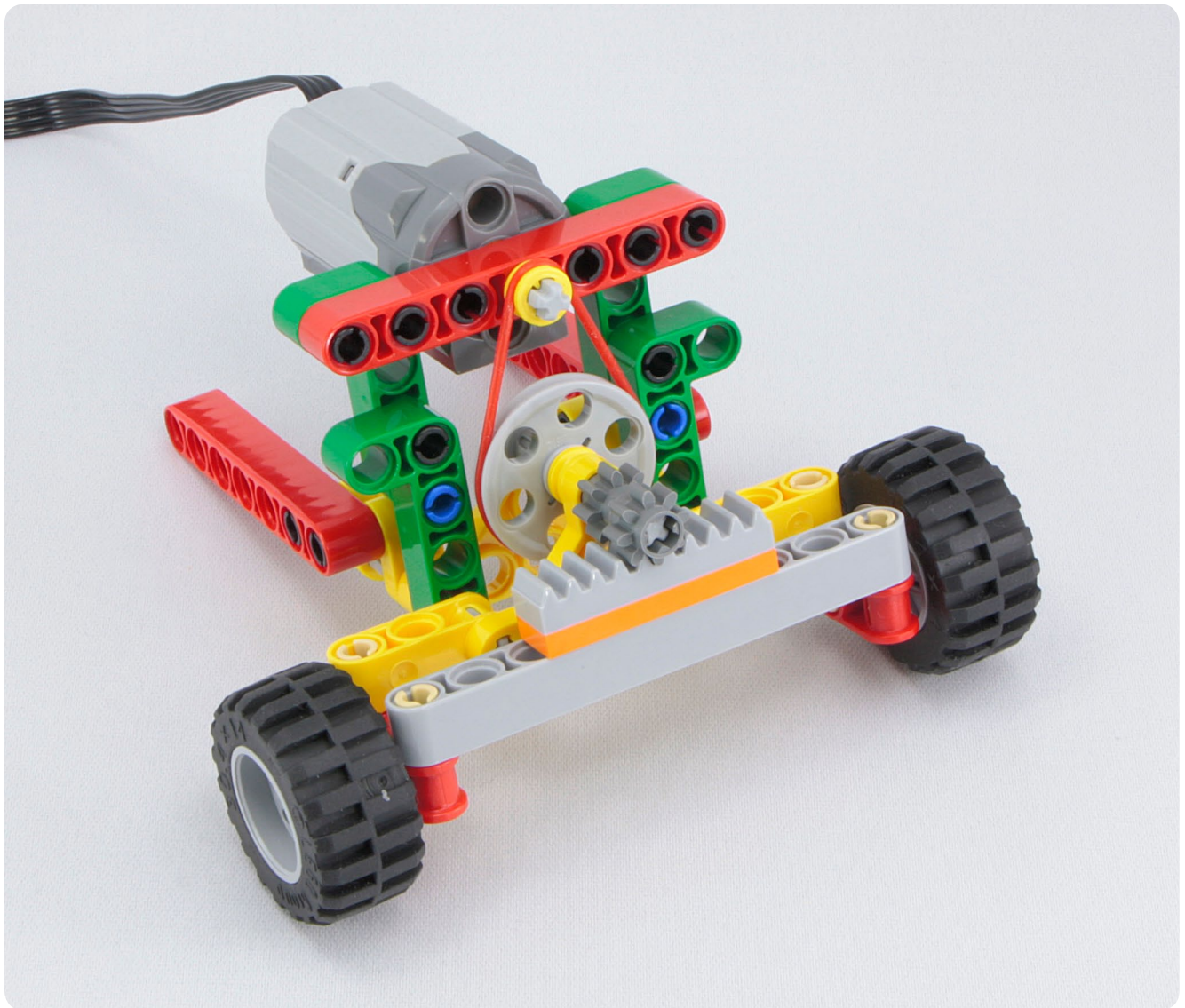
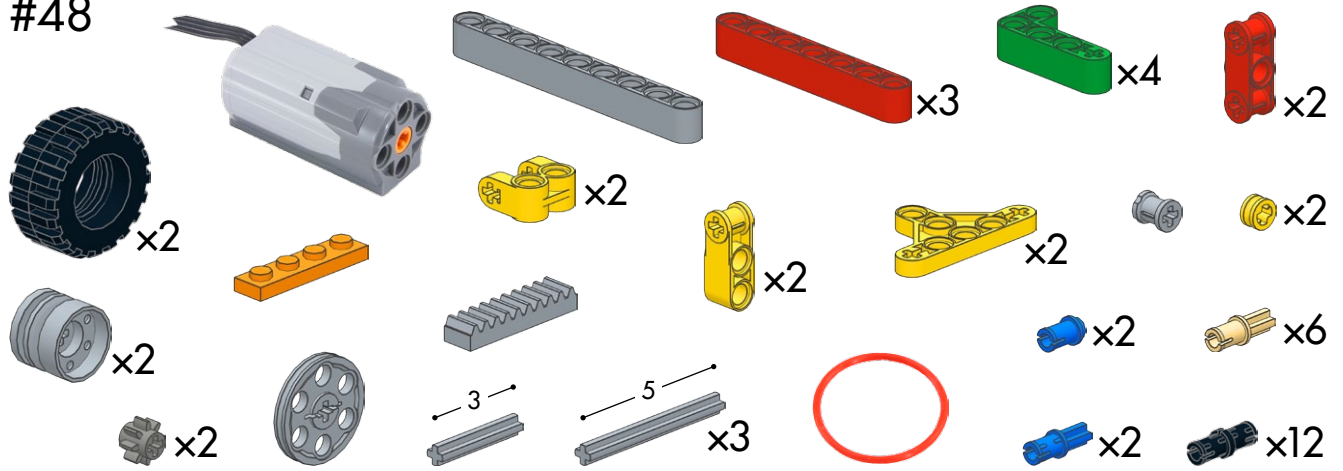
#46

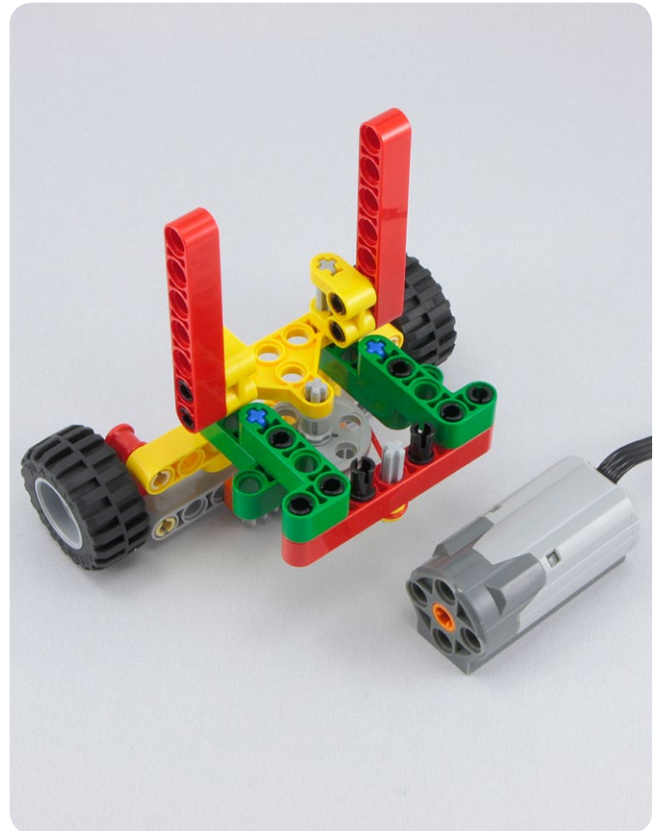
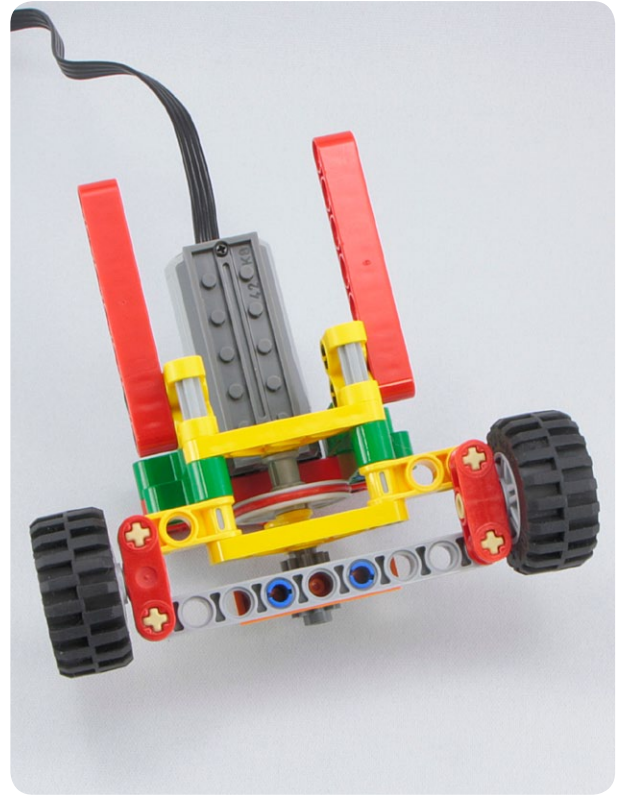
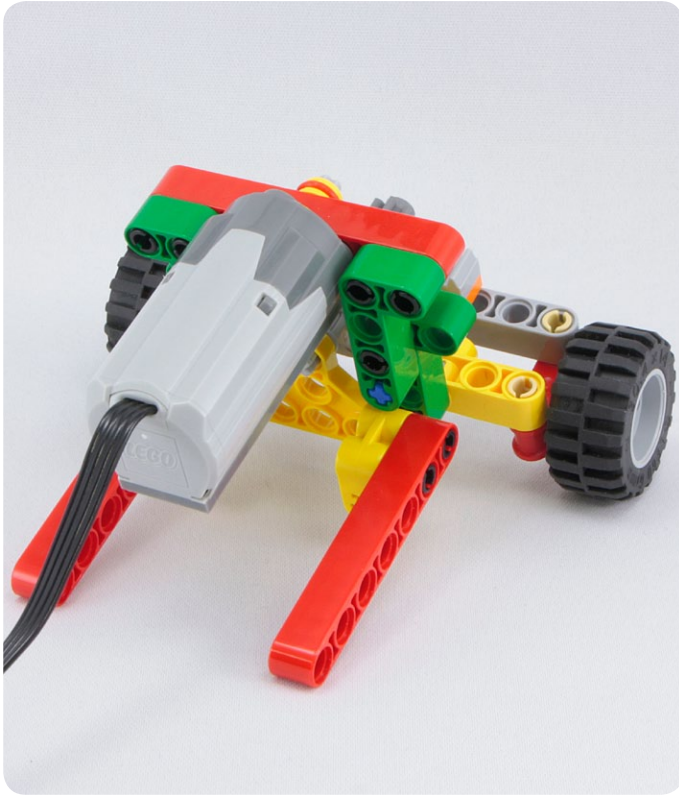




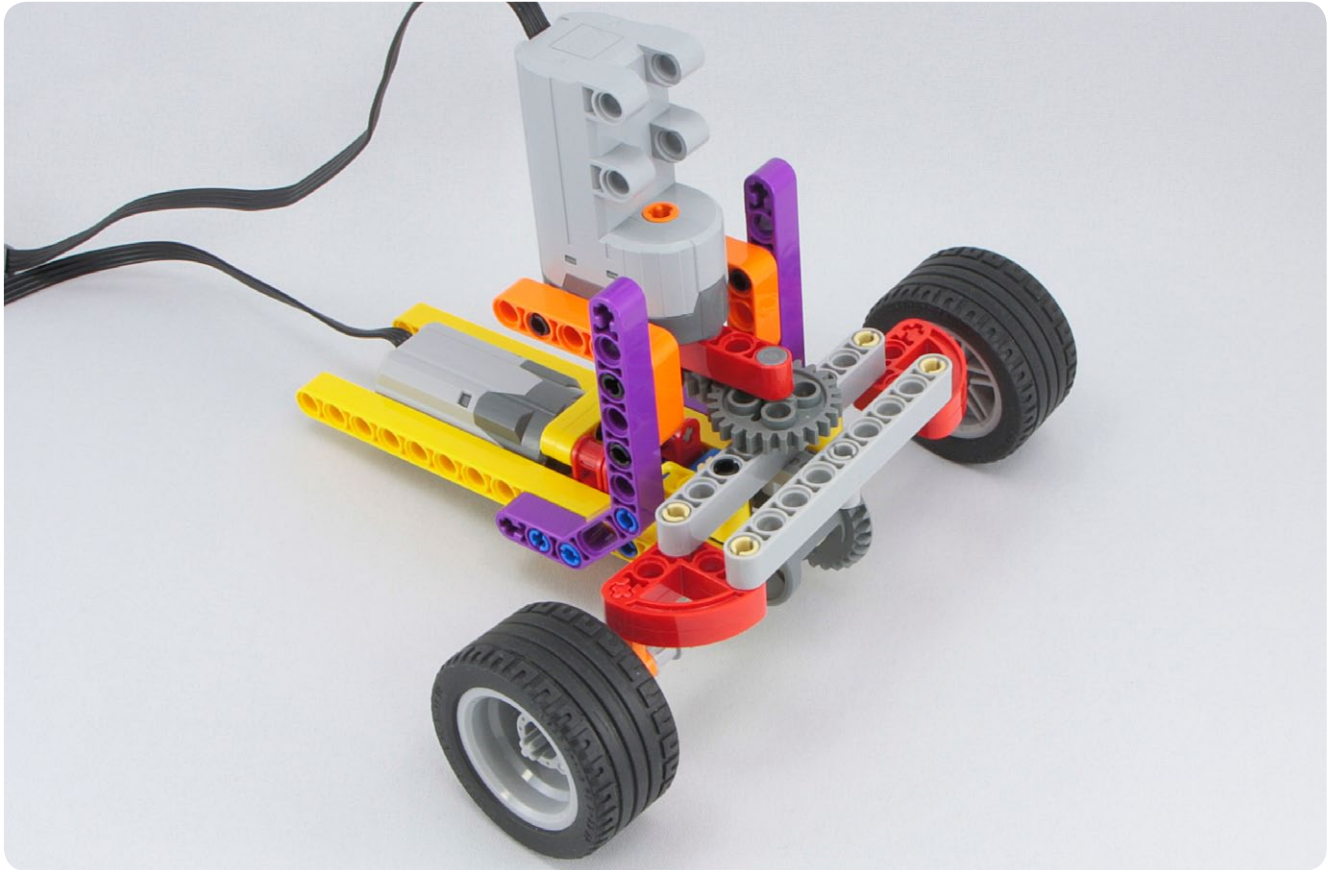
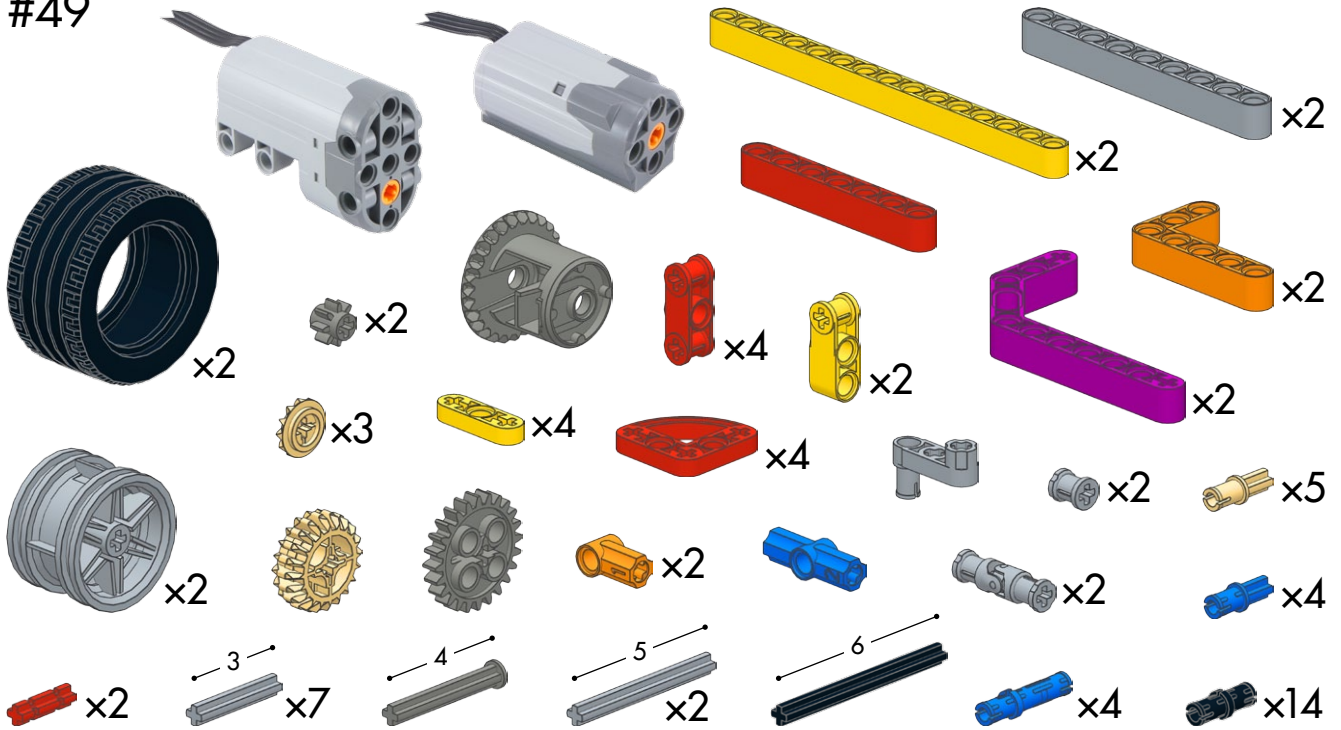


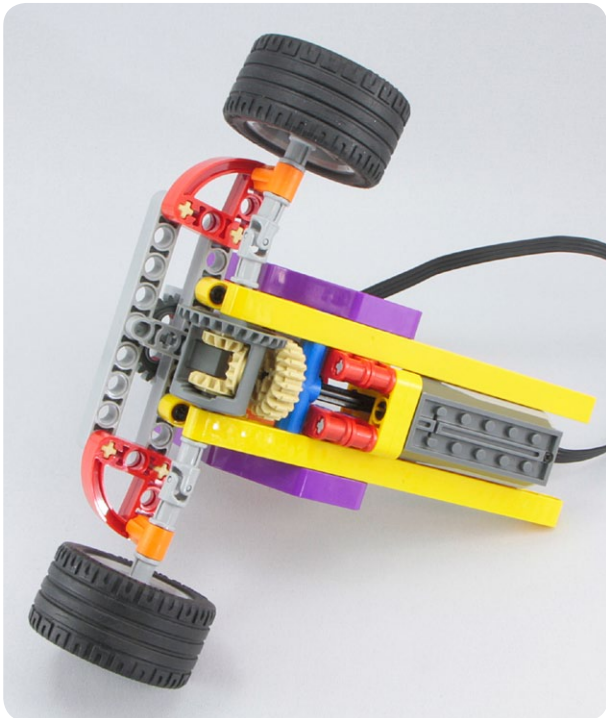
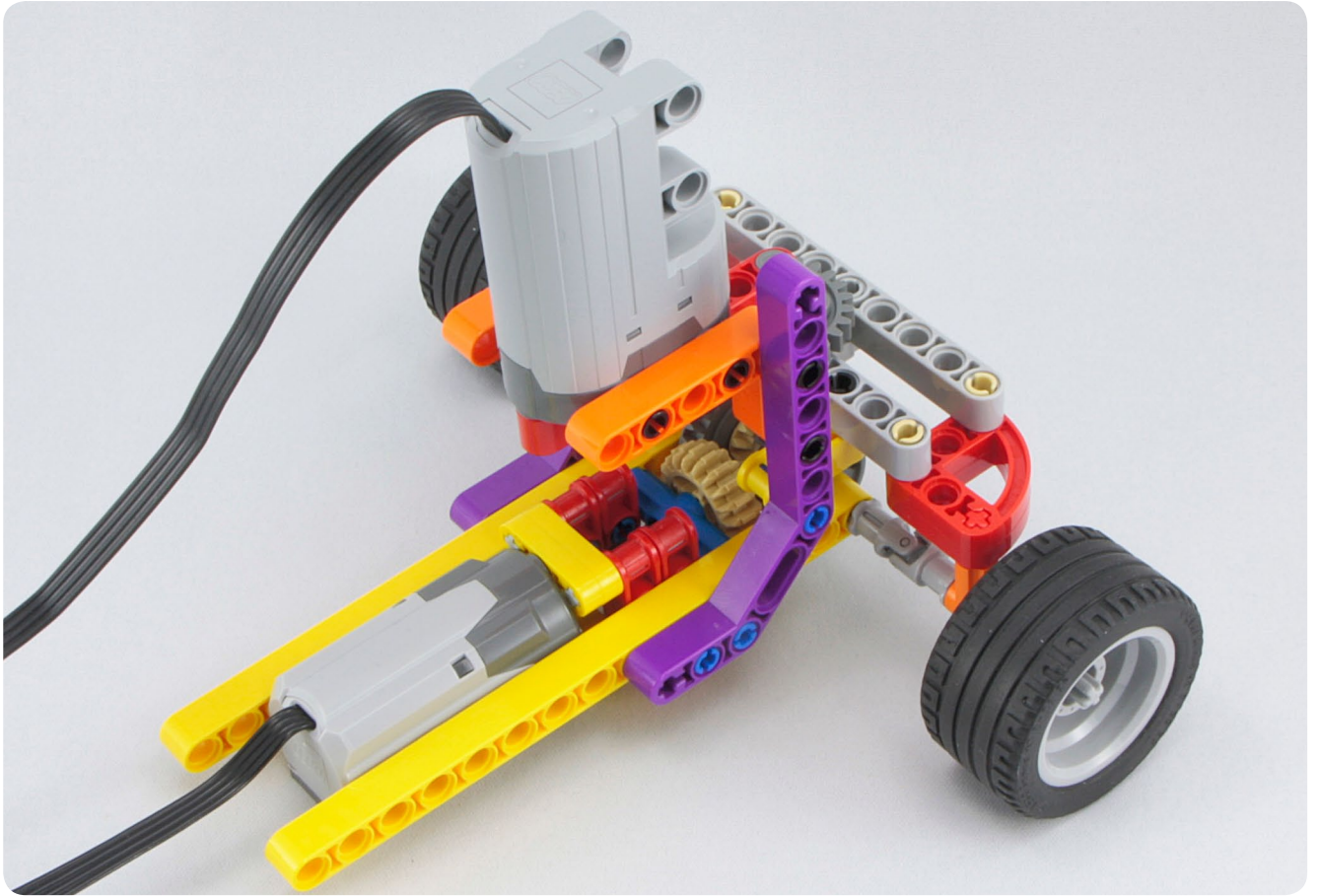
#48

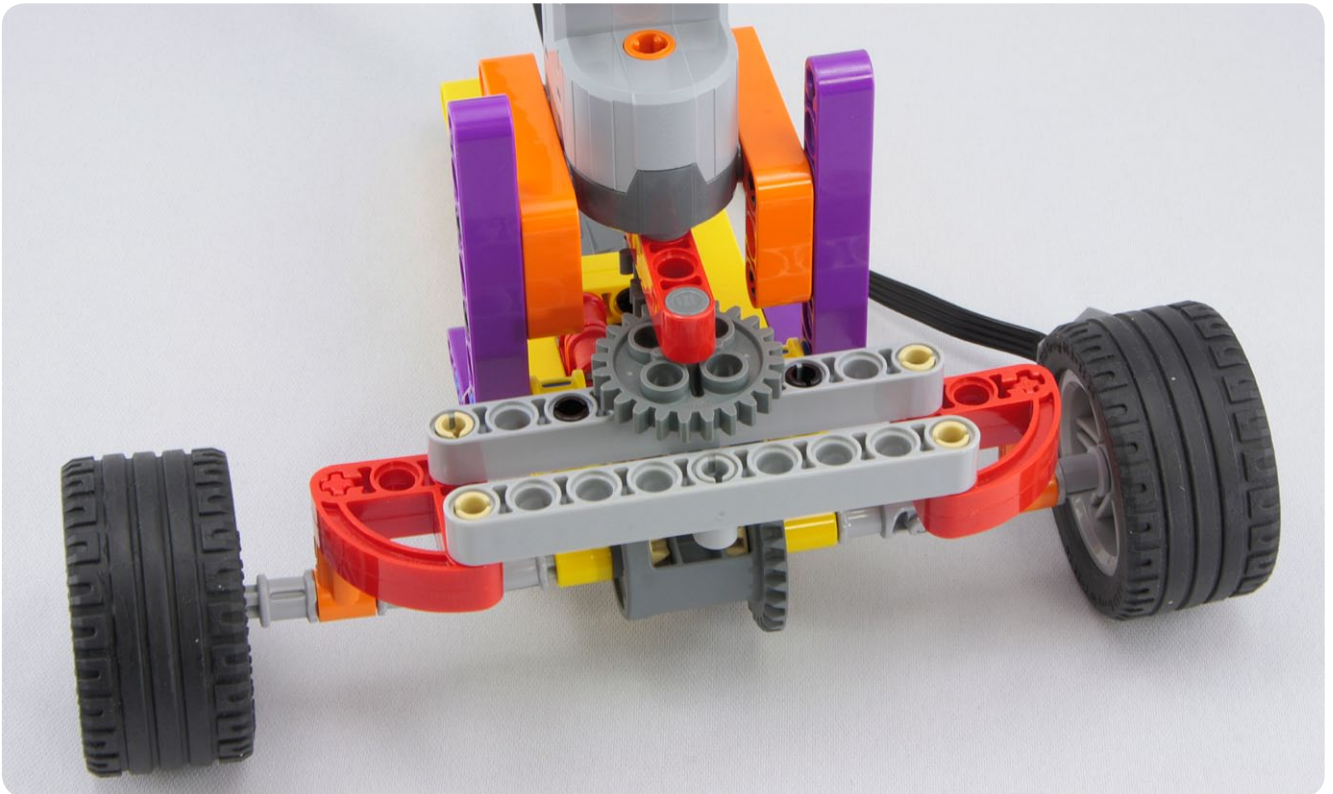
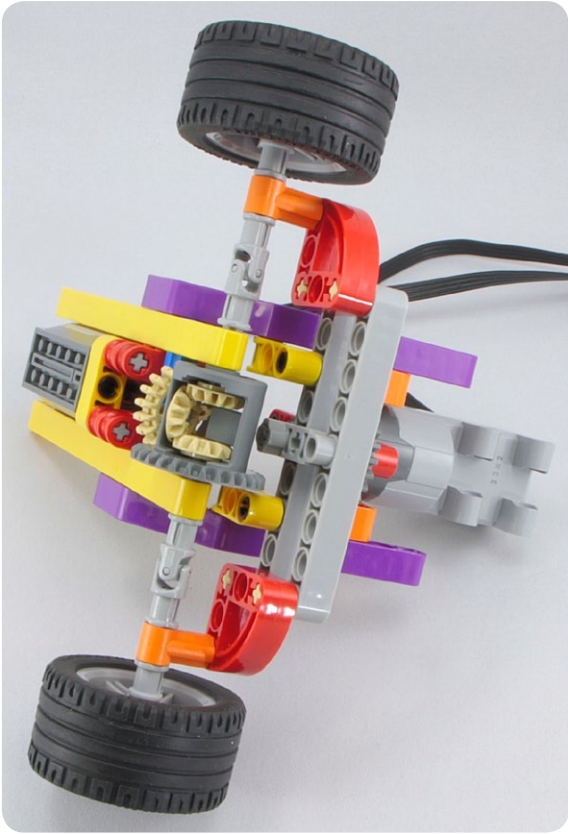


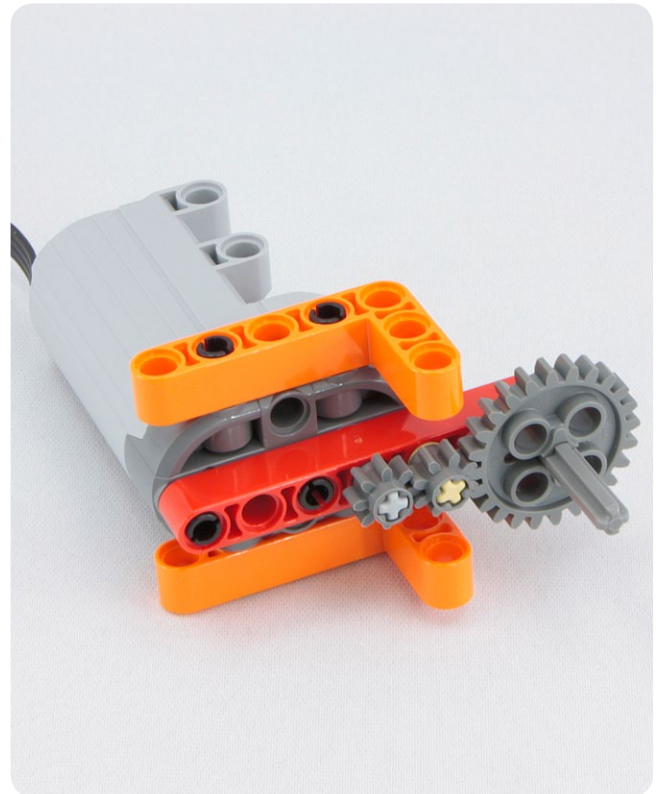
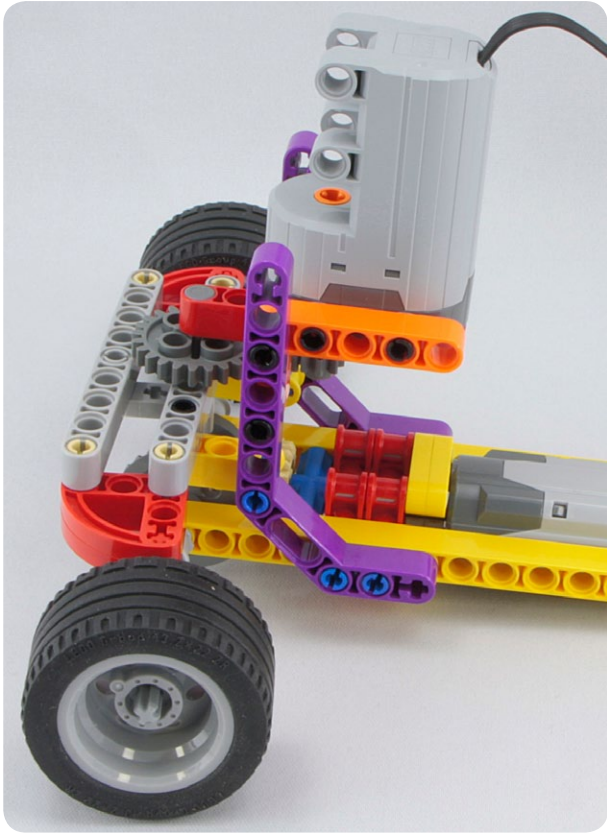


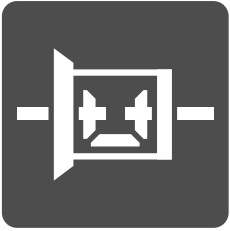
#49









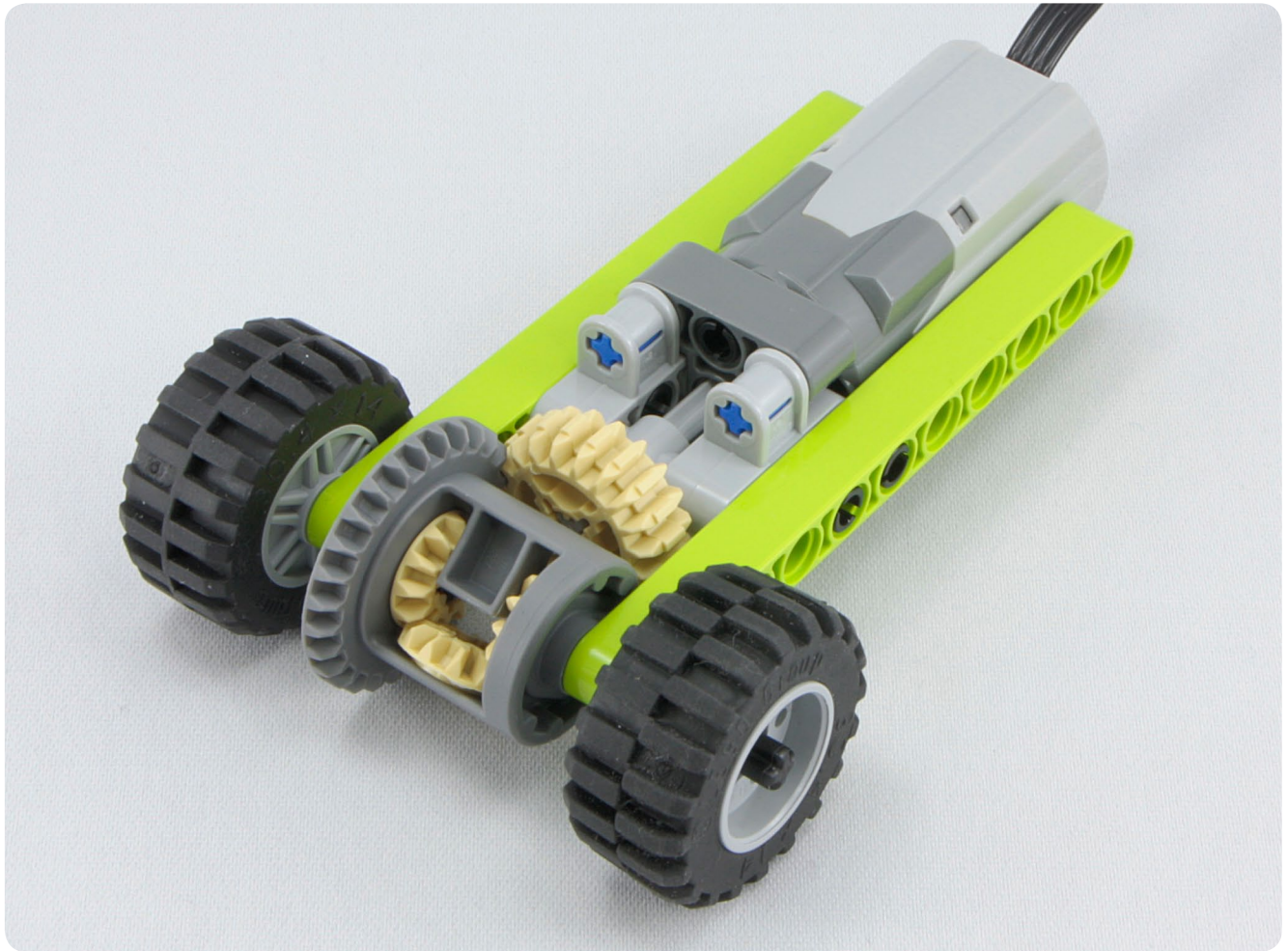
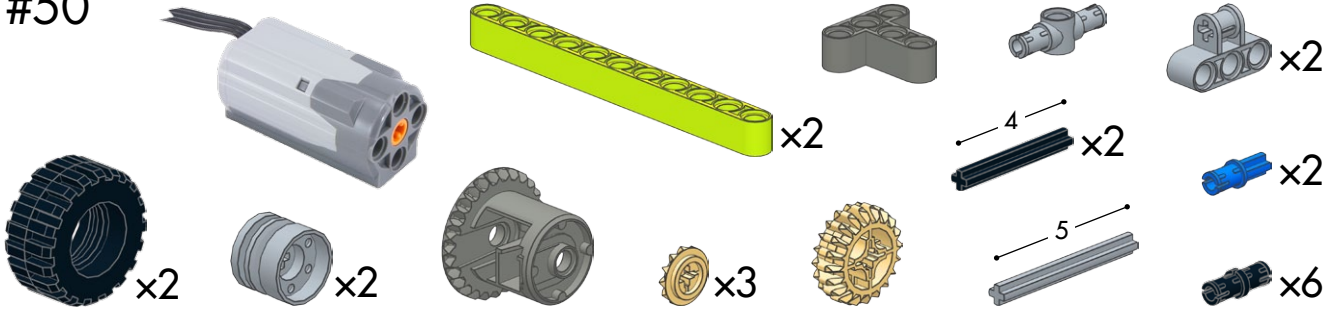


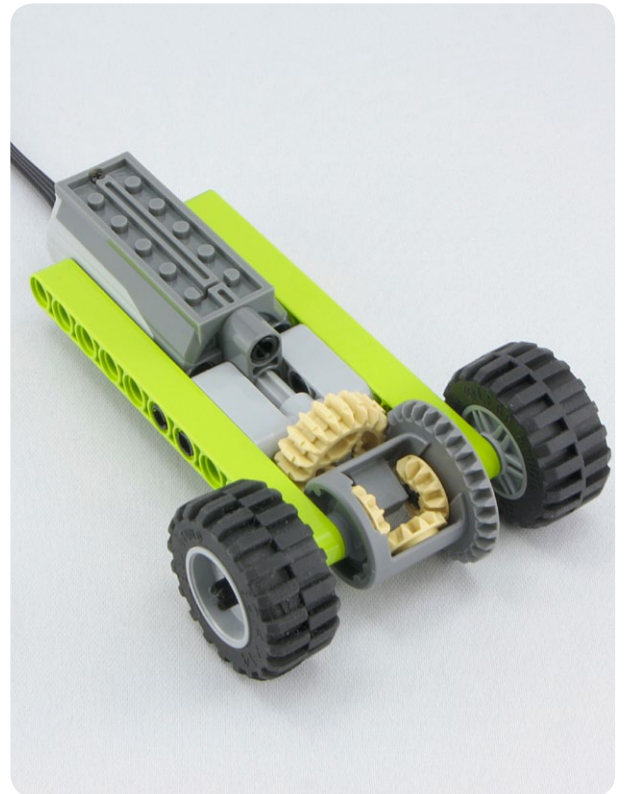
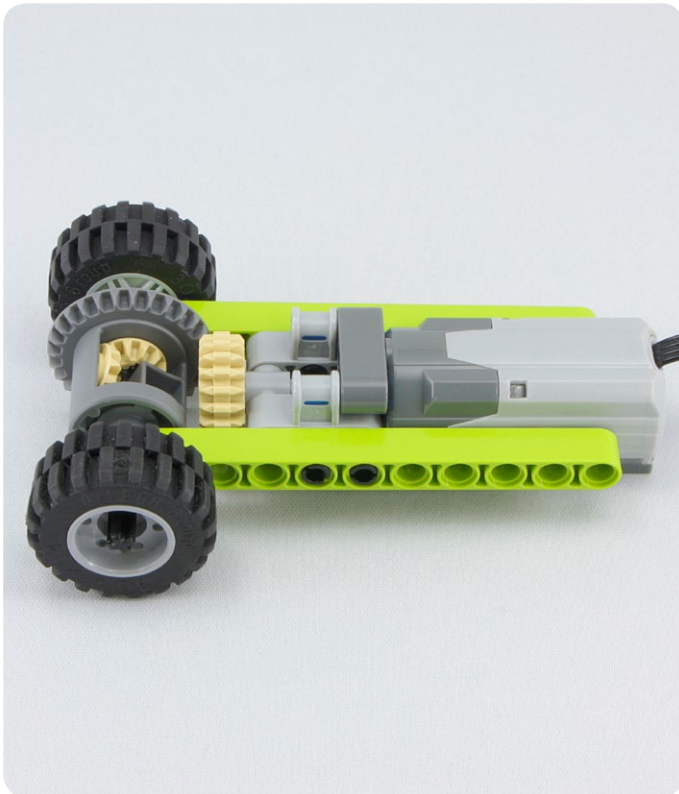
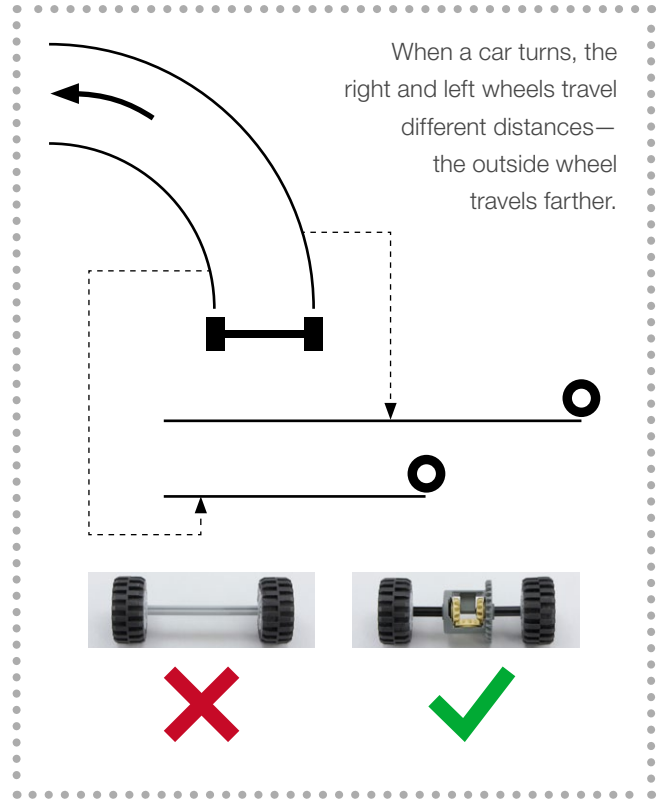
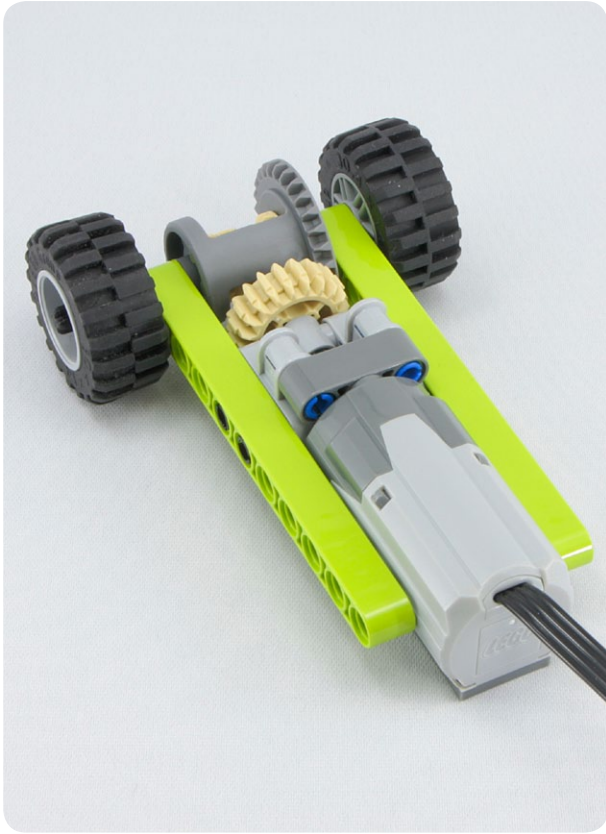
You can combine these models with those in **Steering with the servo motor** (page 50).



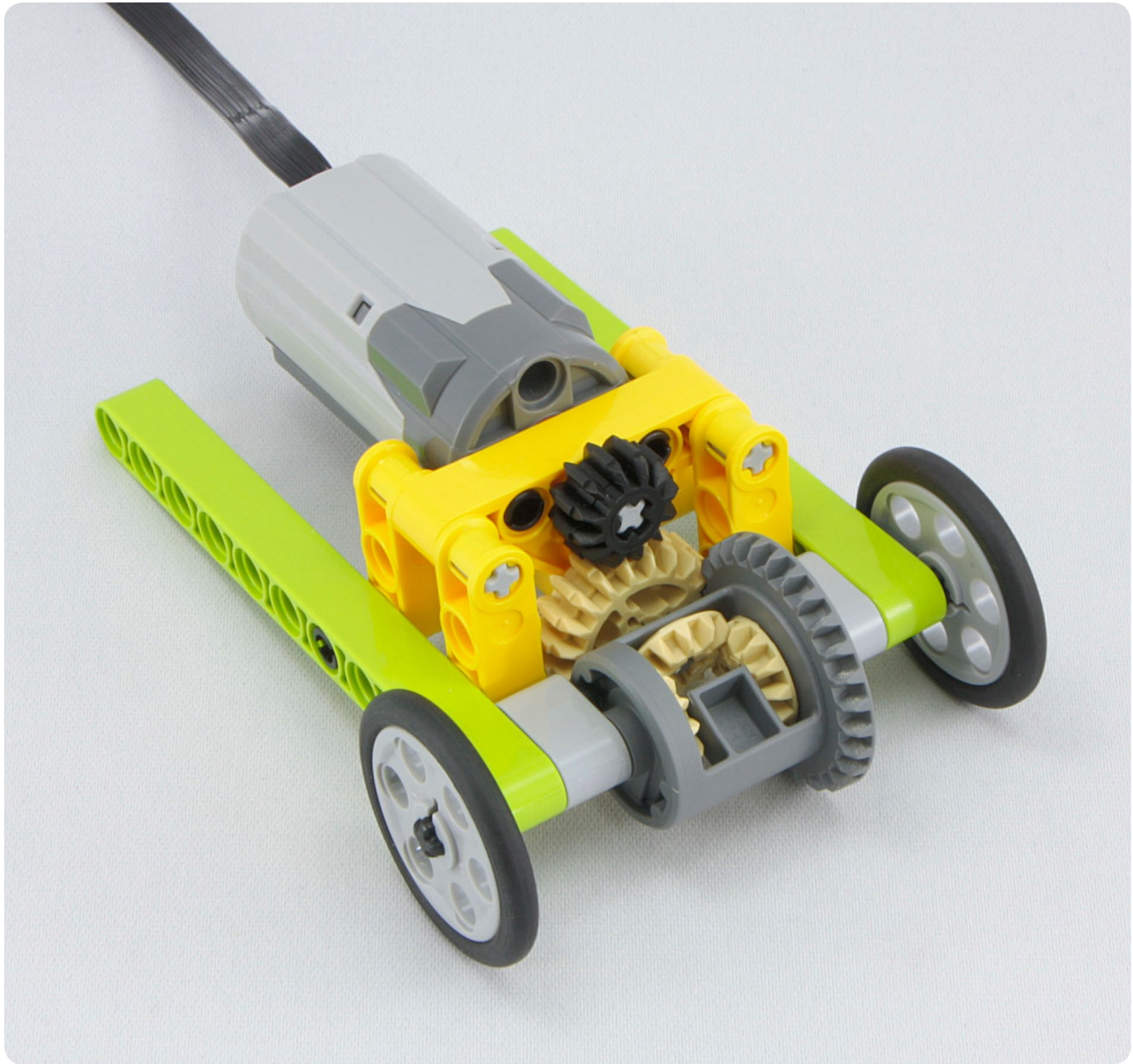
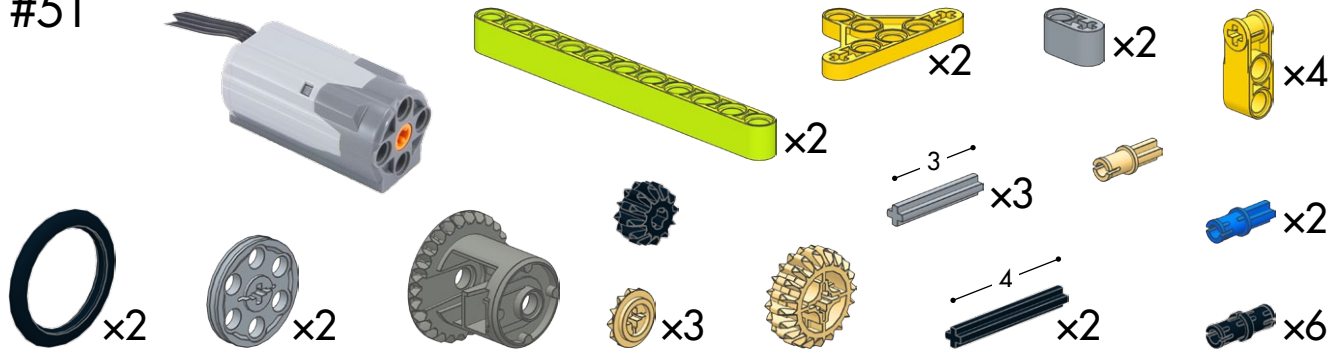
Differential gears

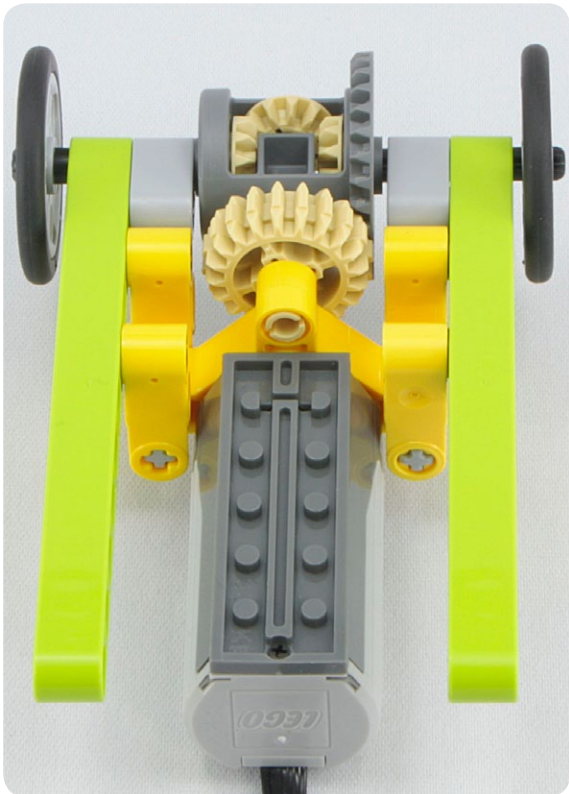
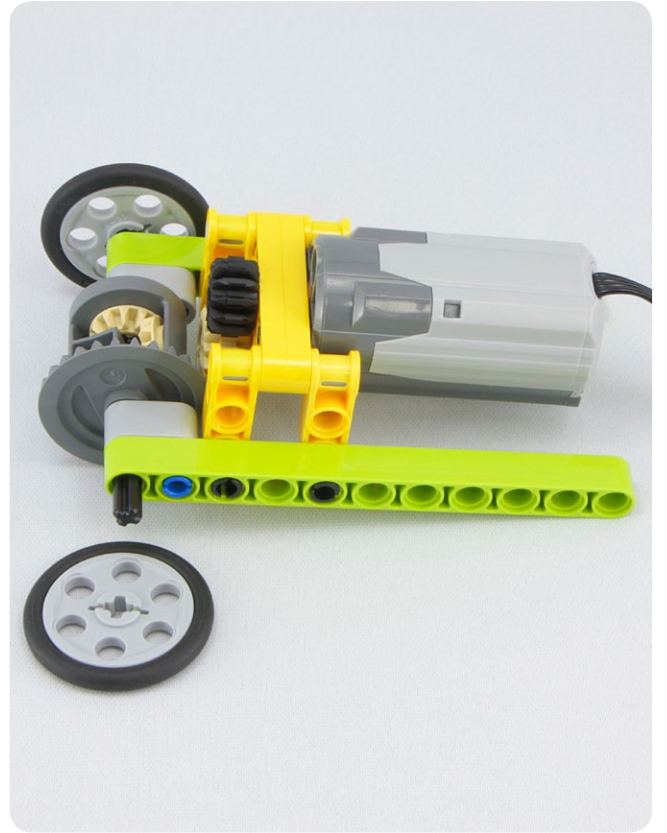
#50



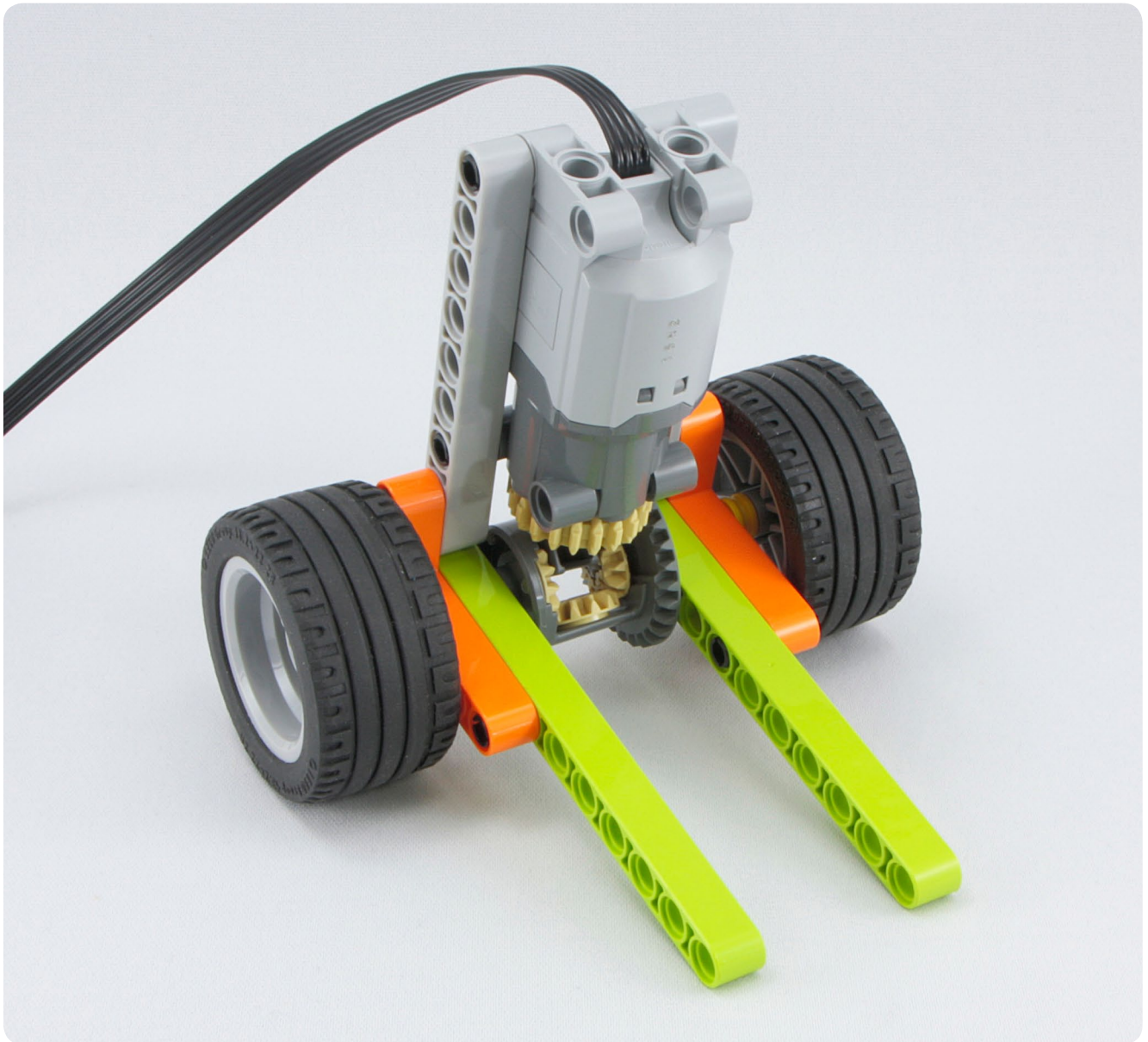
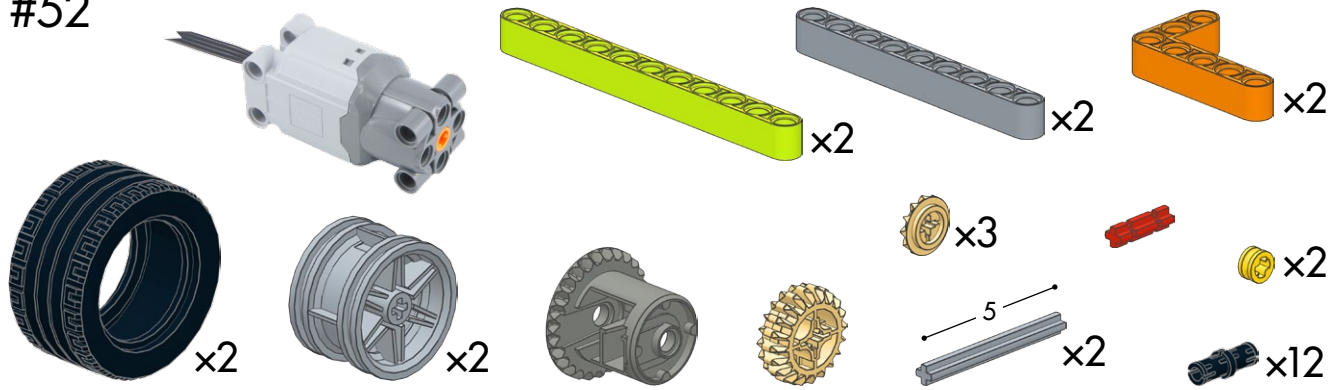


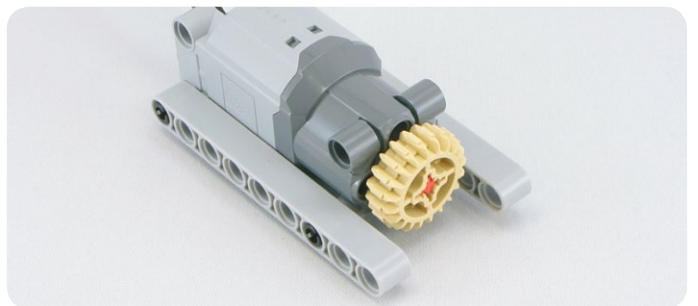
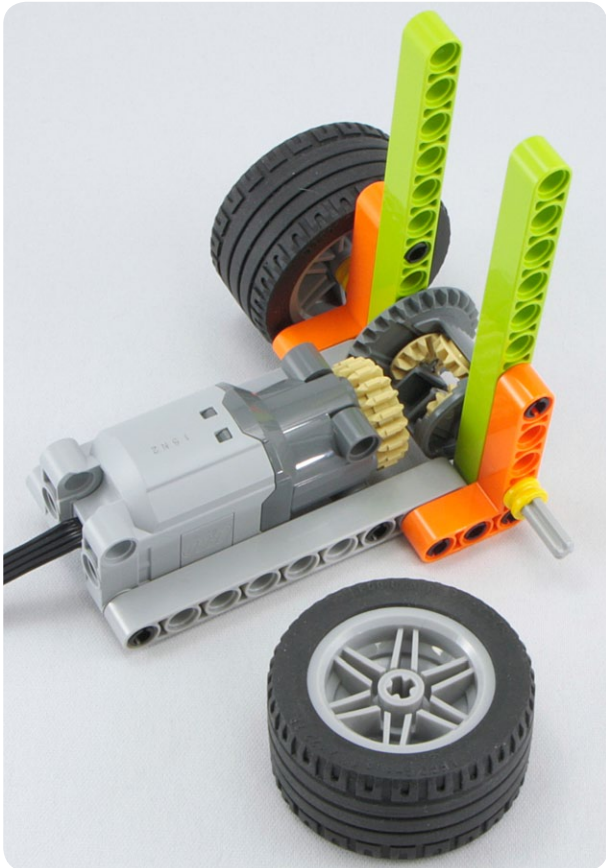
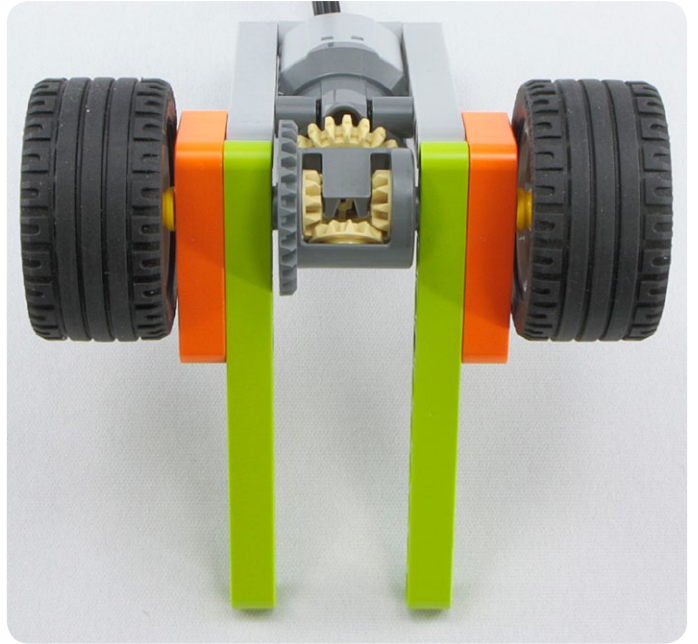
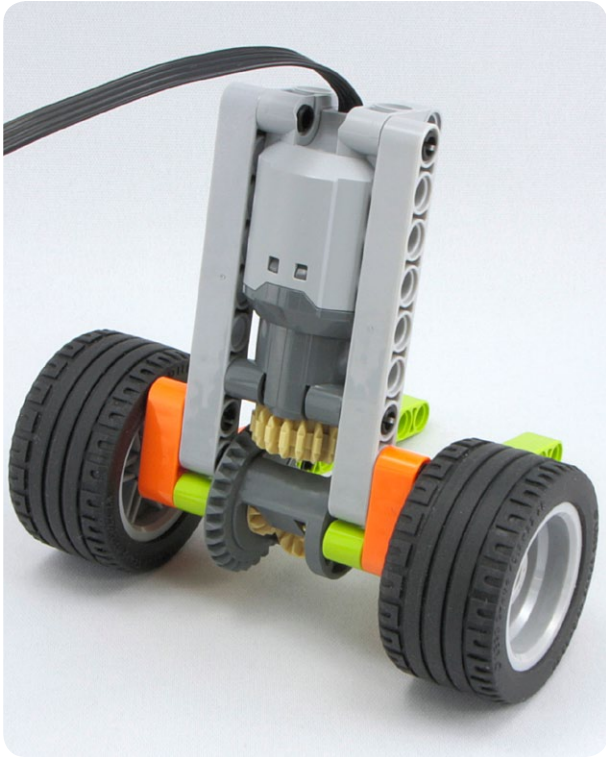
#51



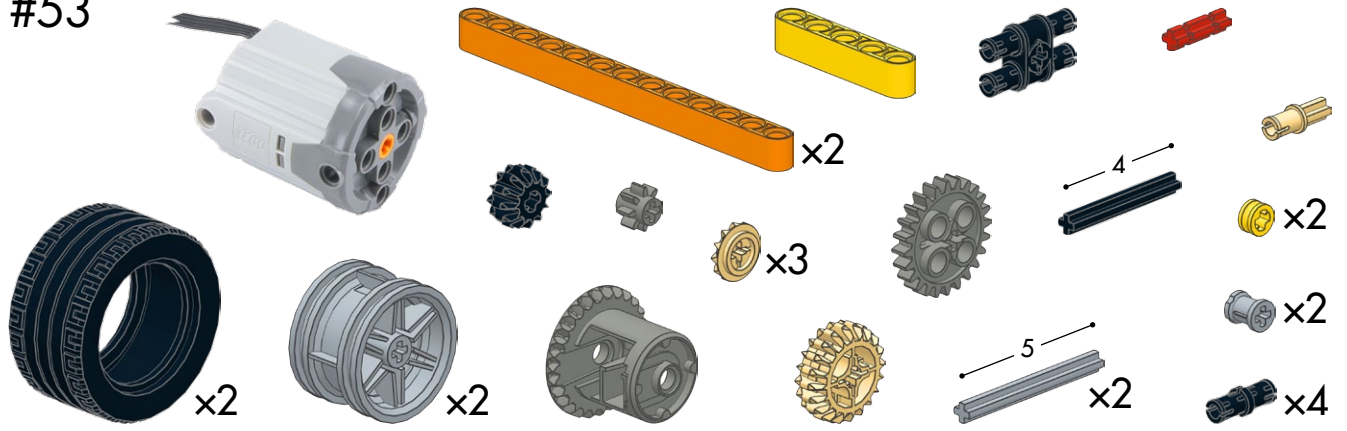


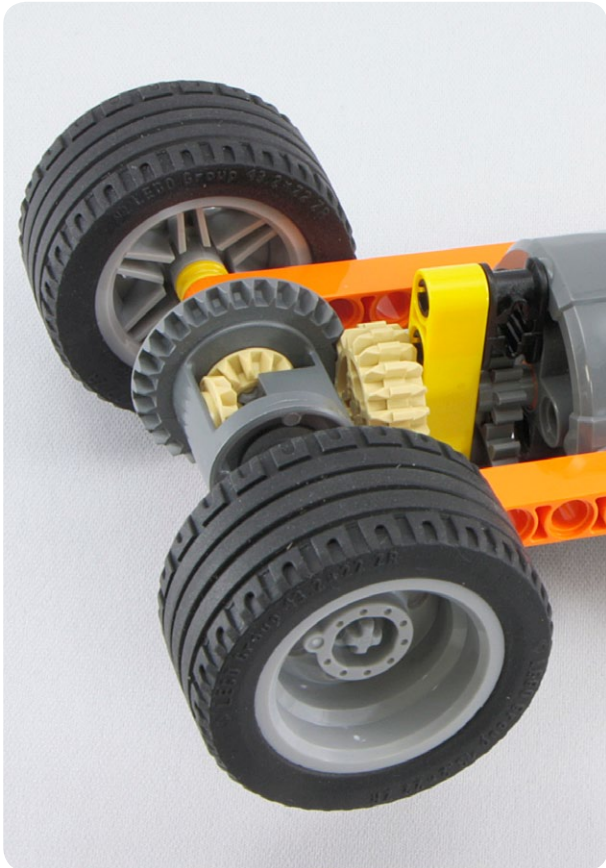
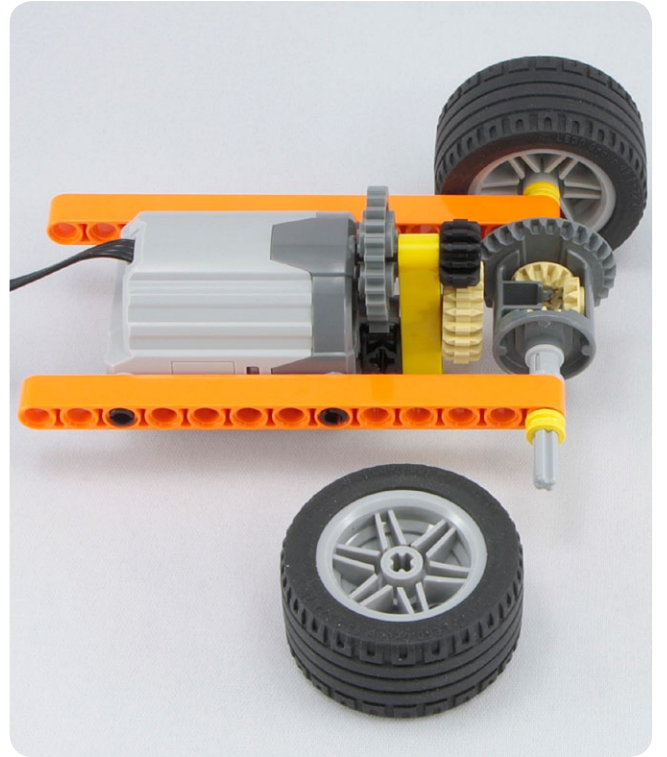
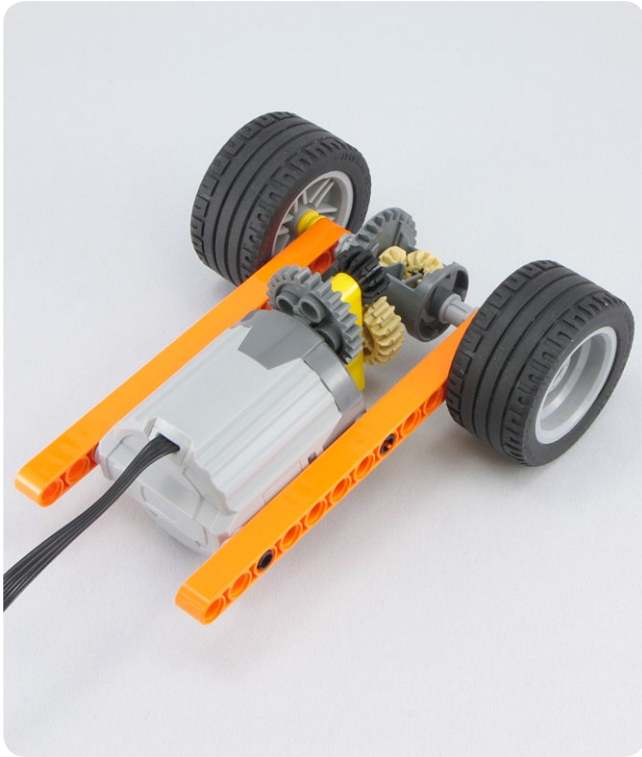
#52



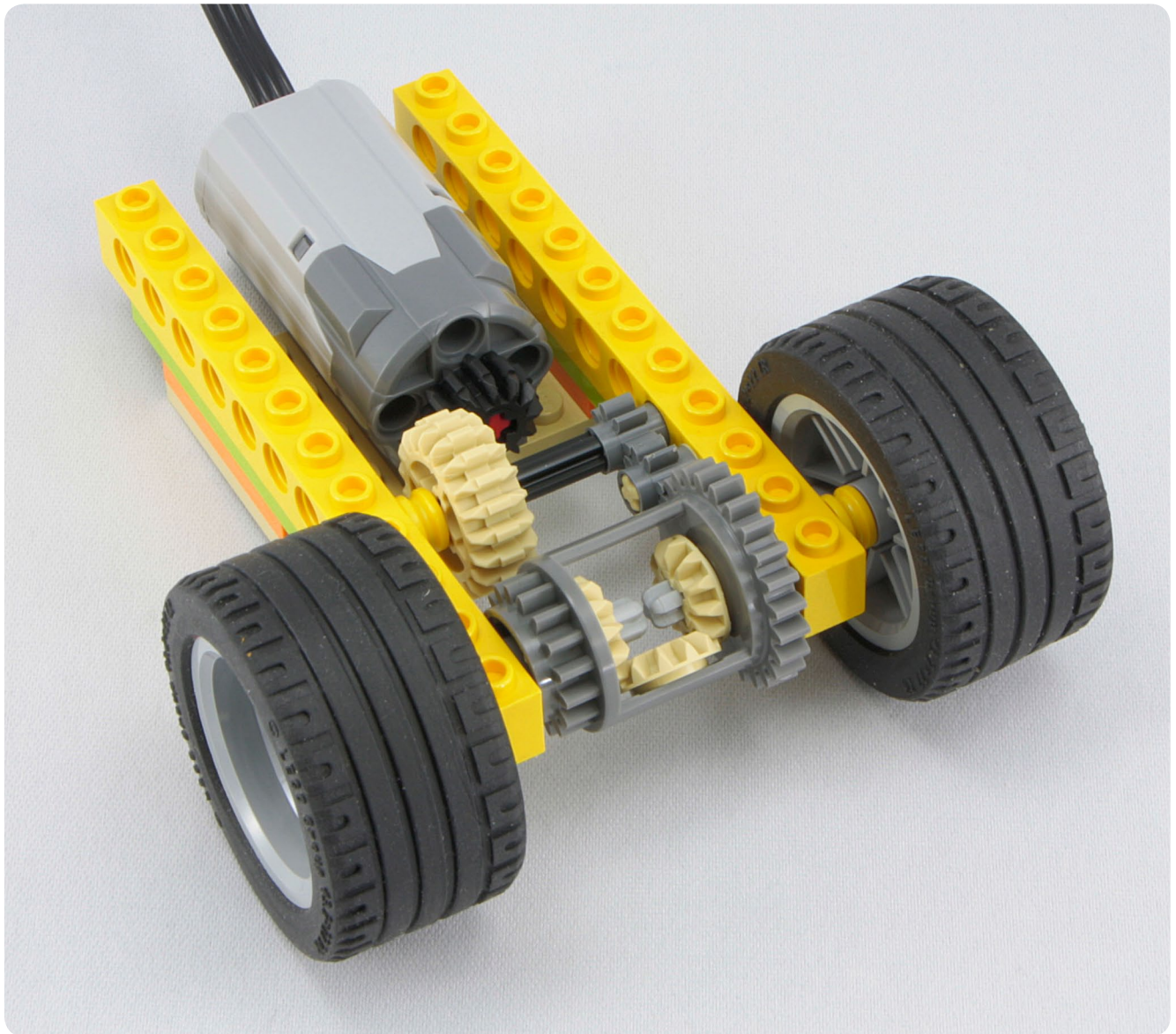
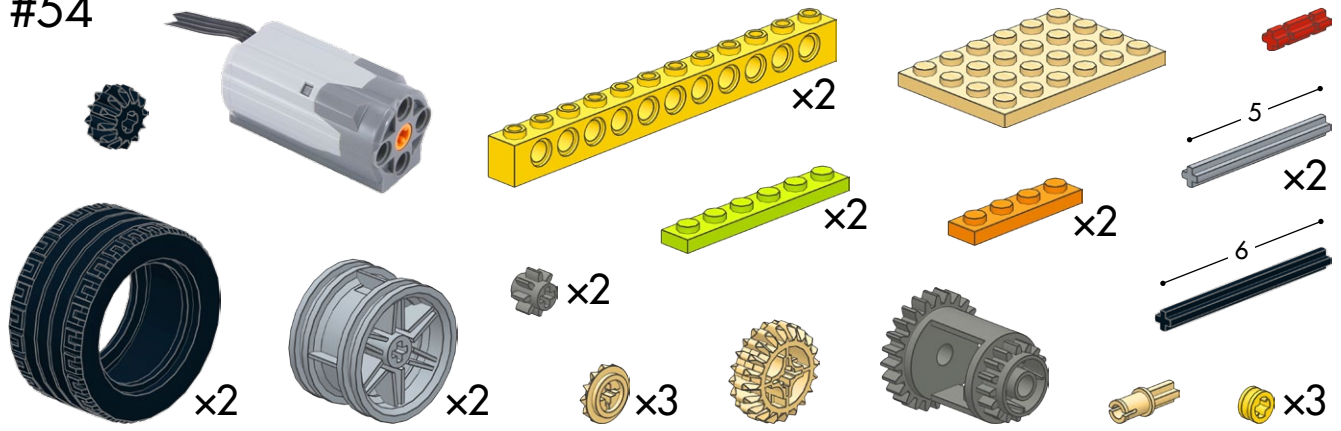


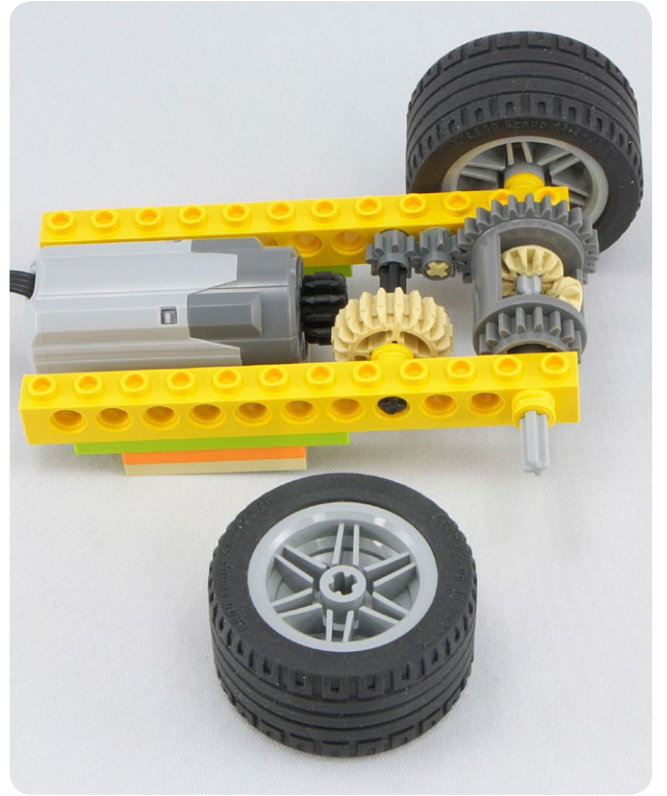
#53

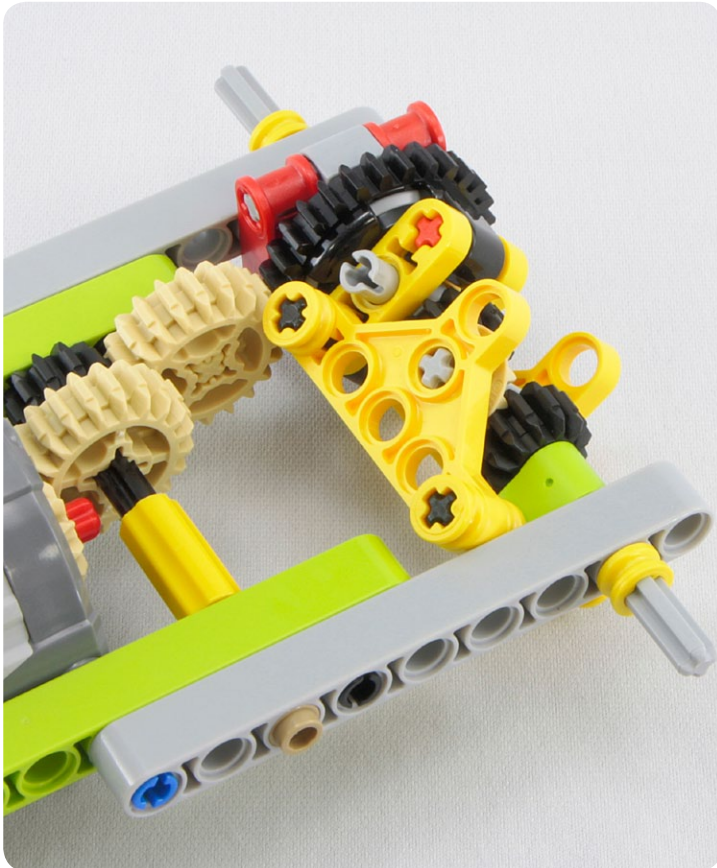




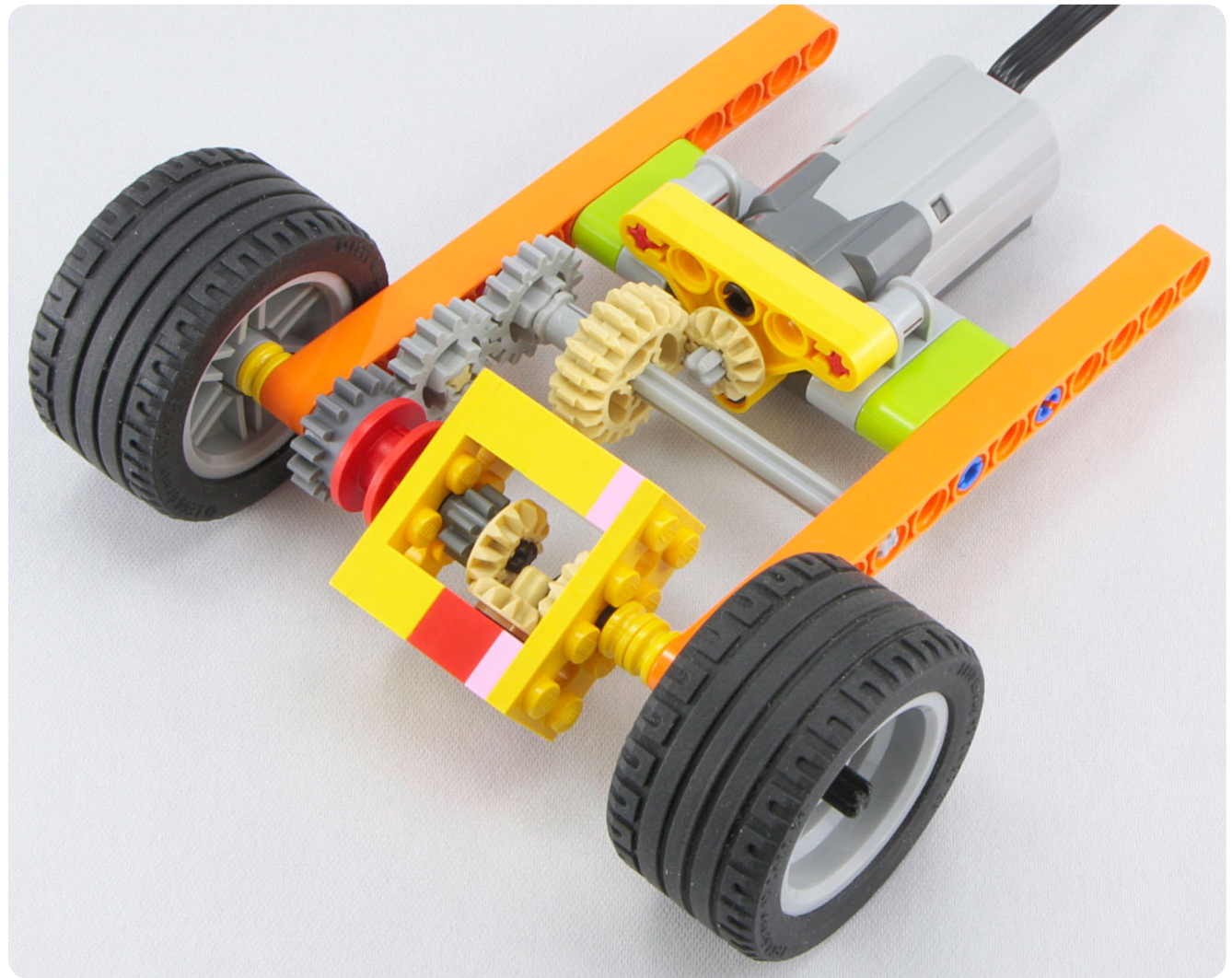
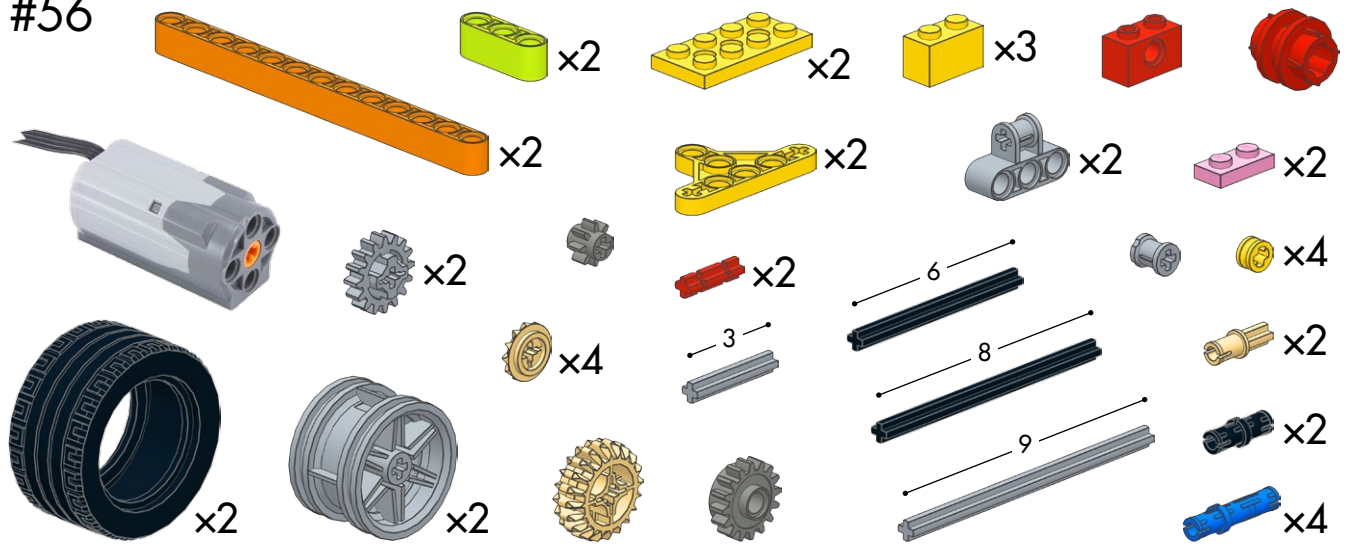
#54

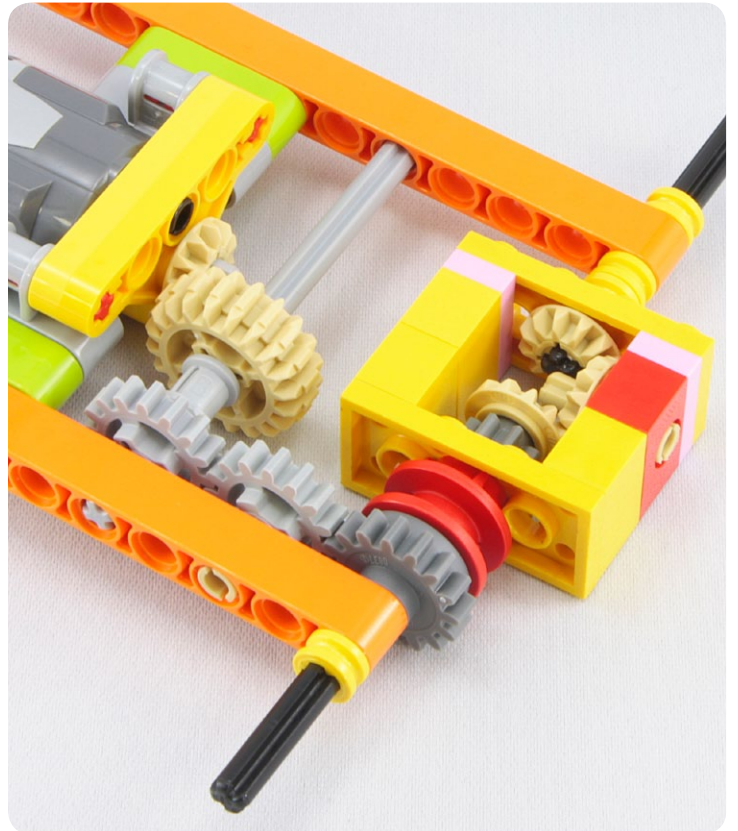
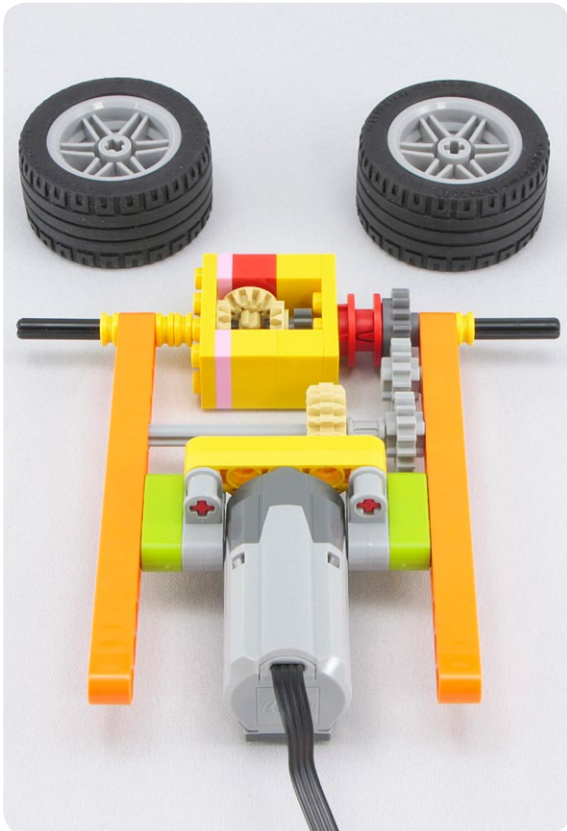


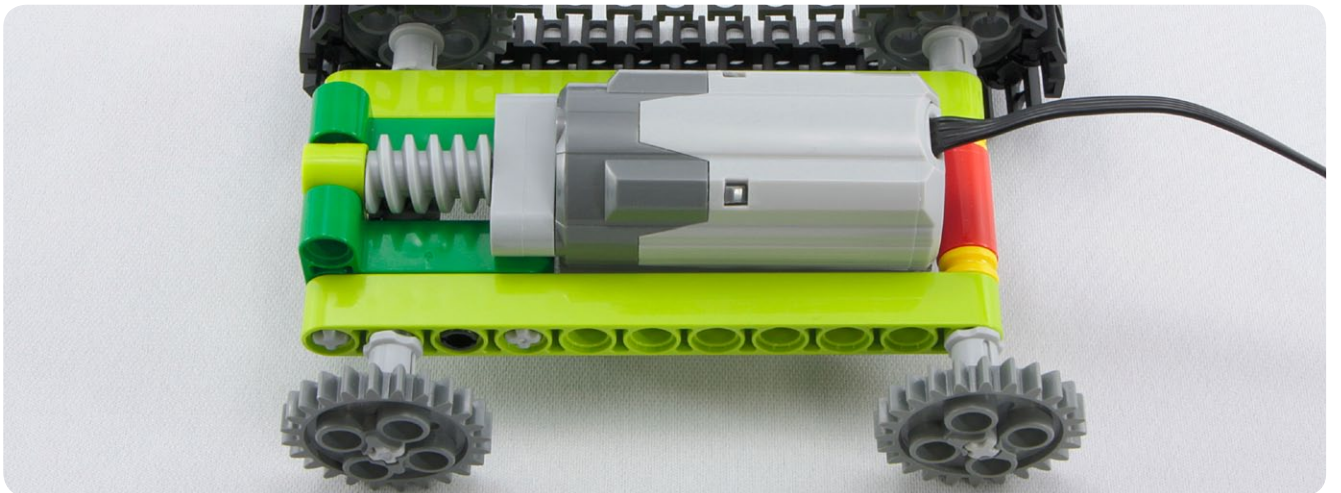
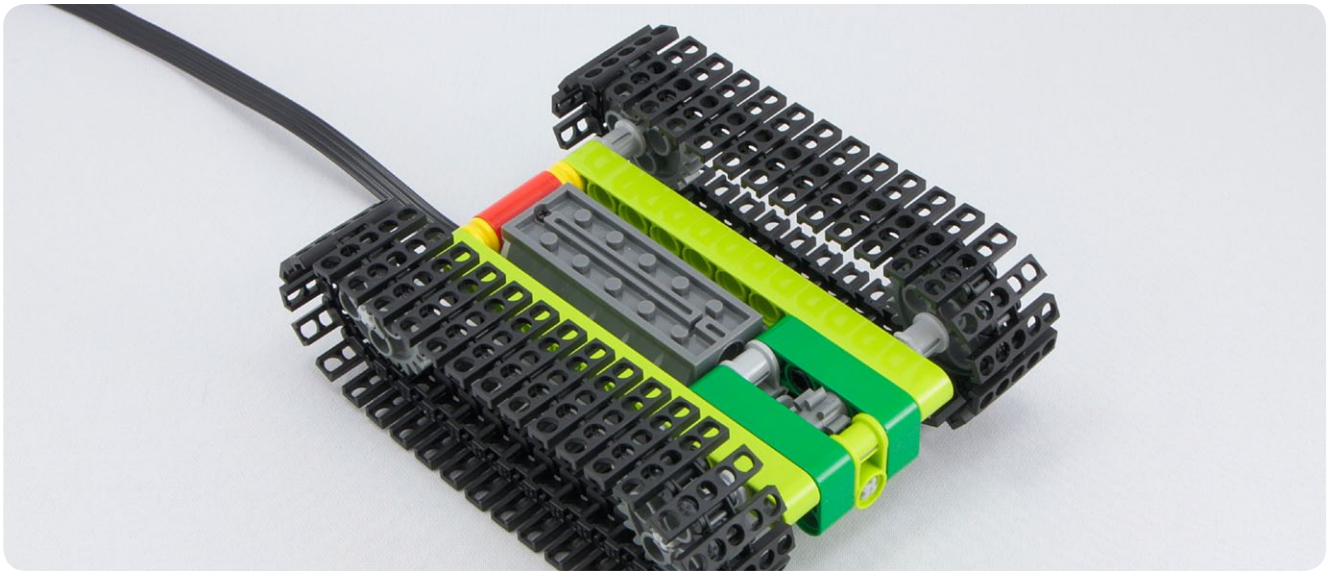
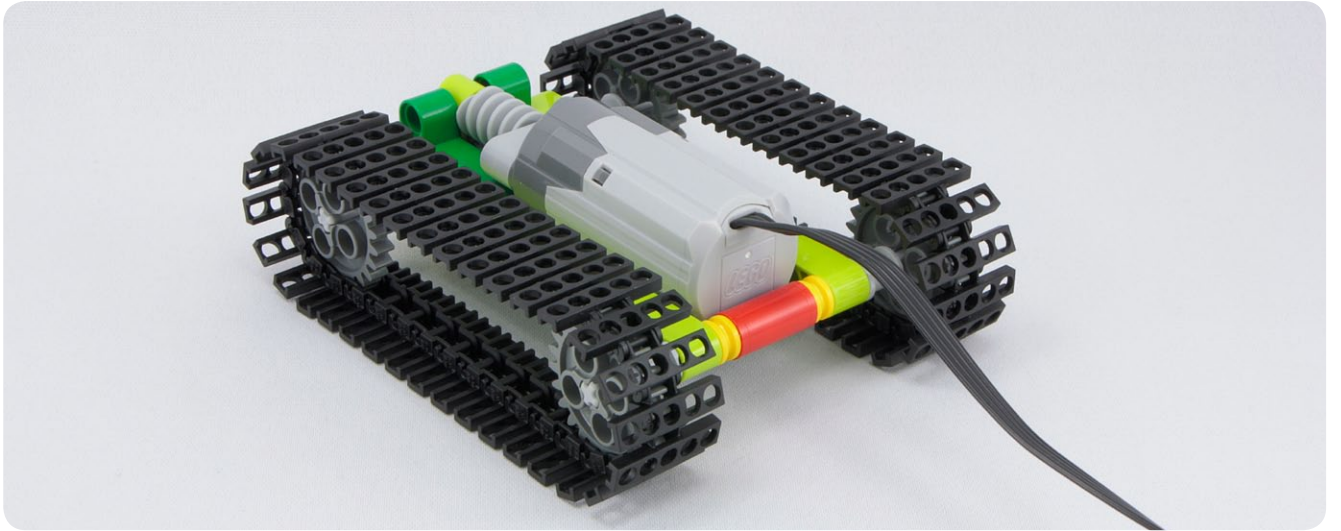




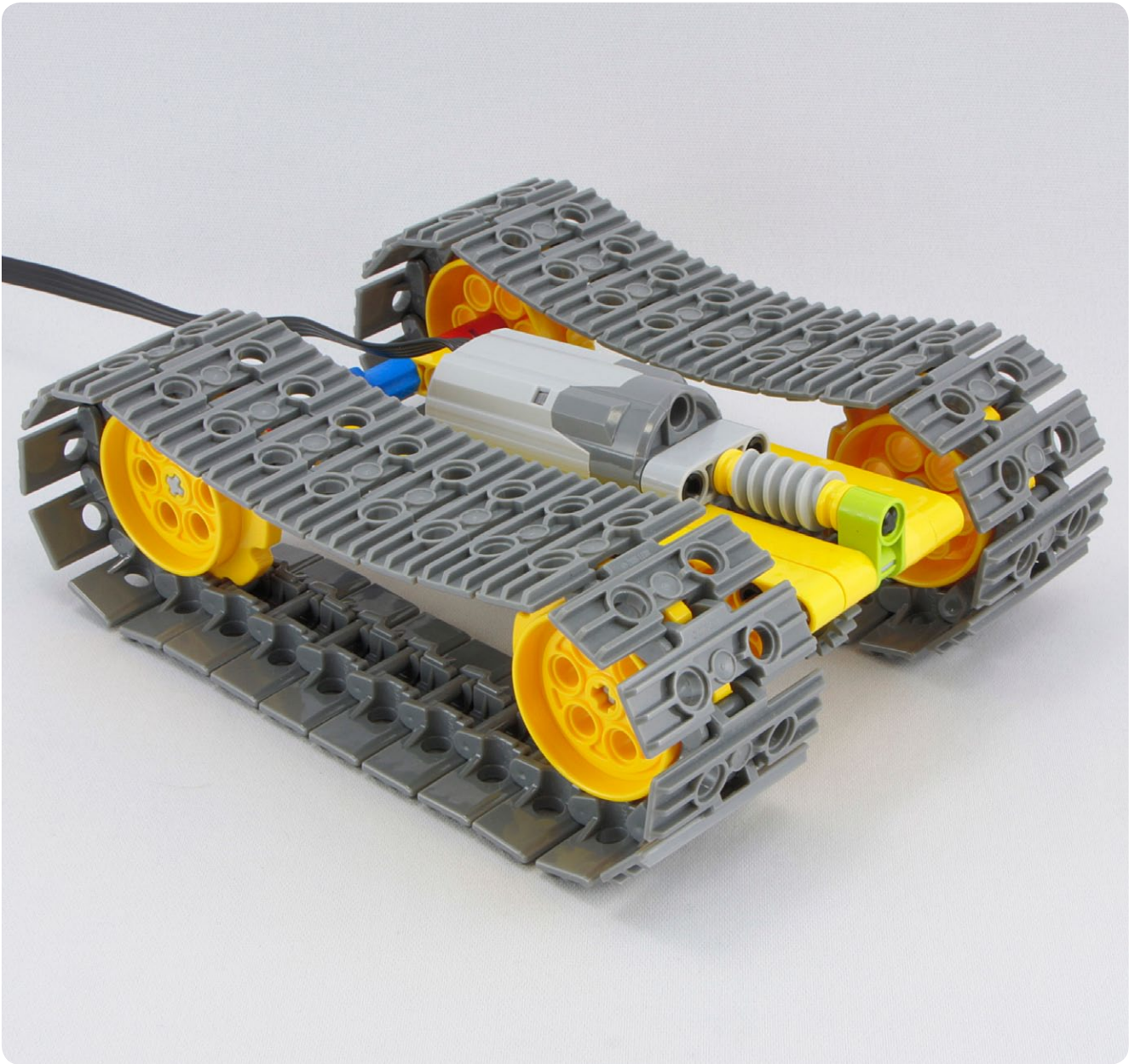
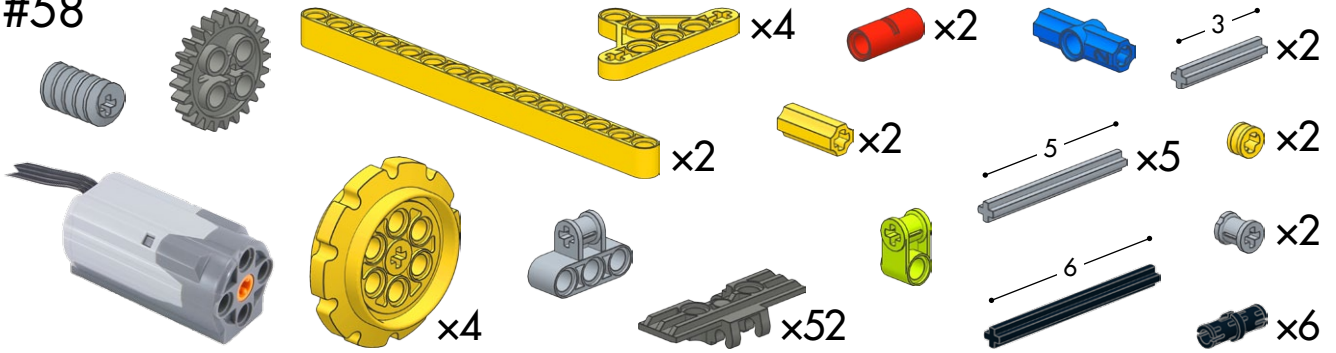
#56

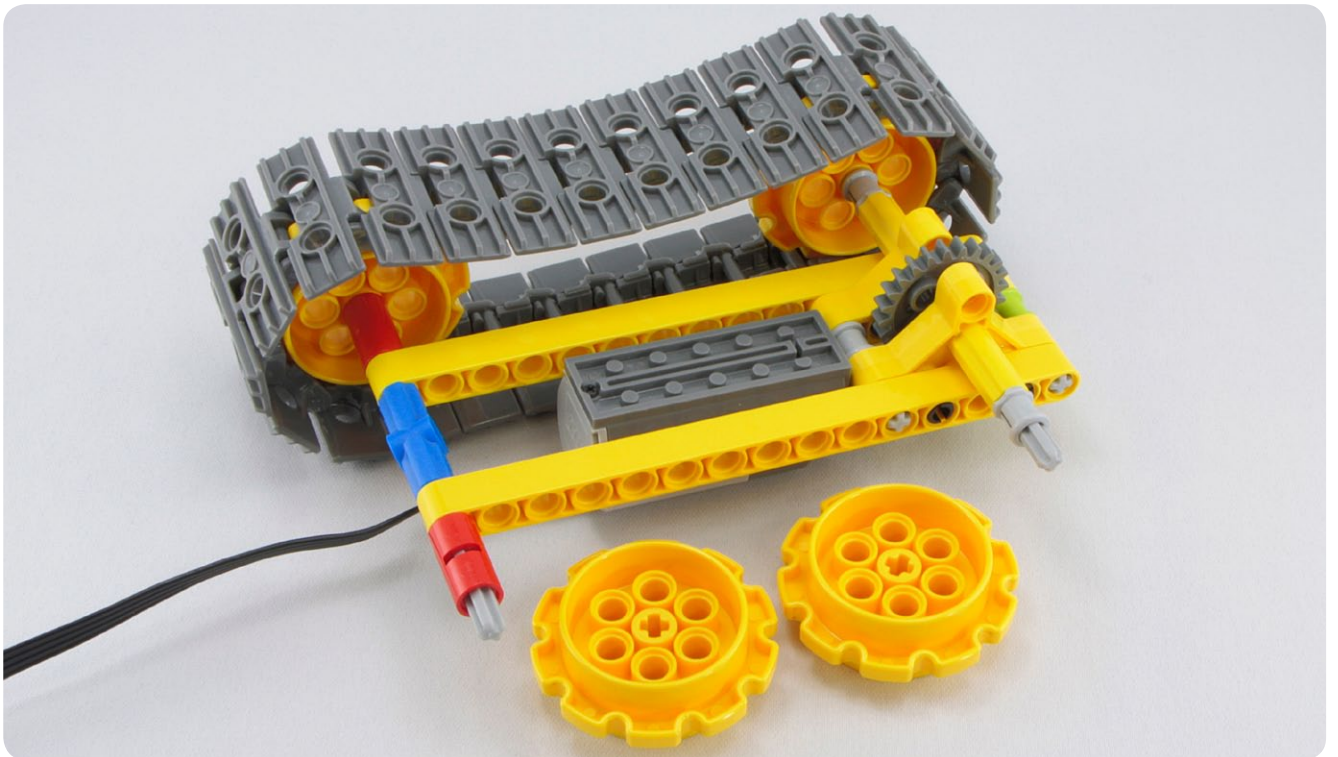
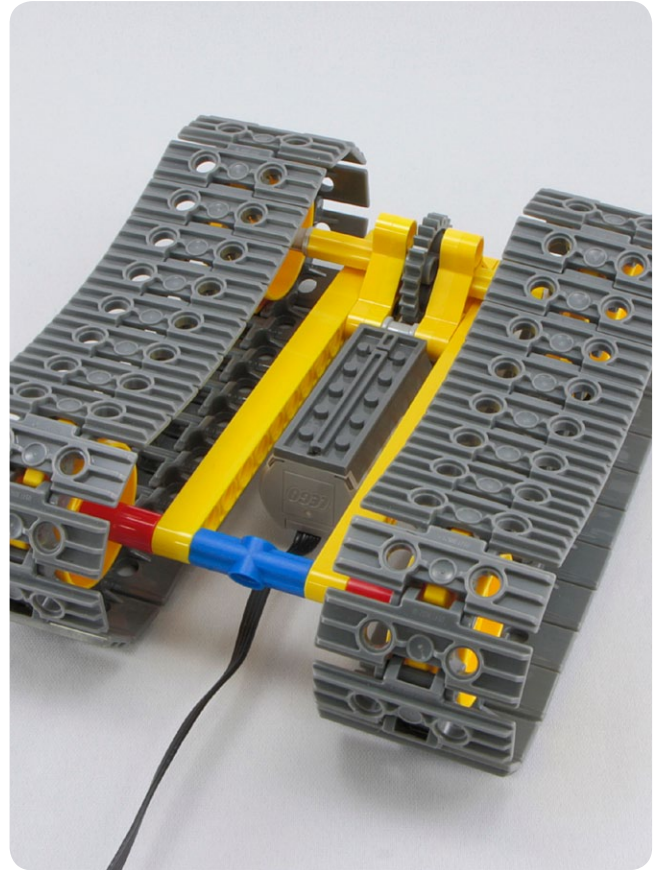
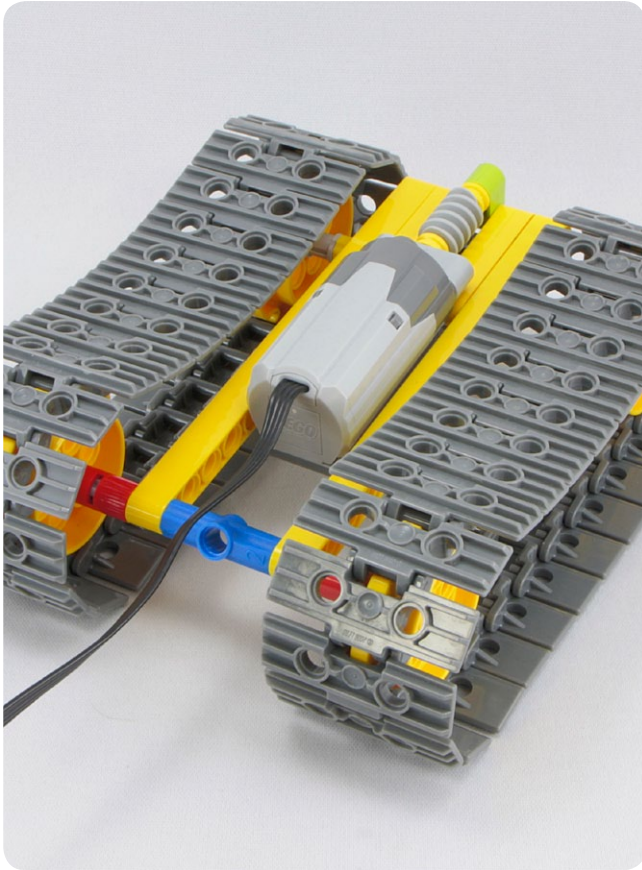







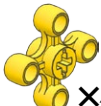





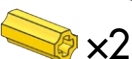

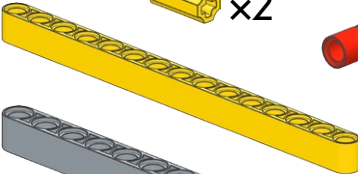
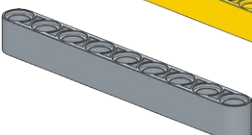




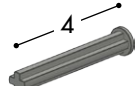
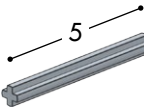
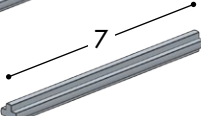






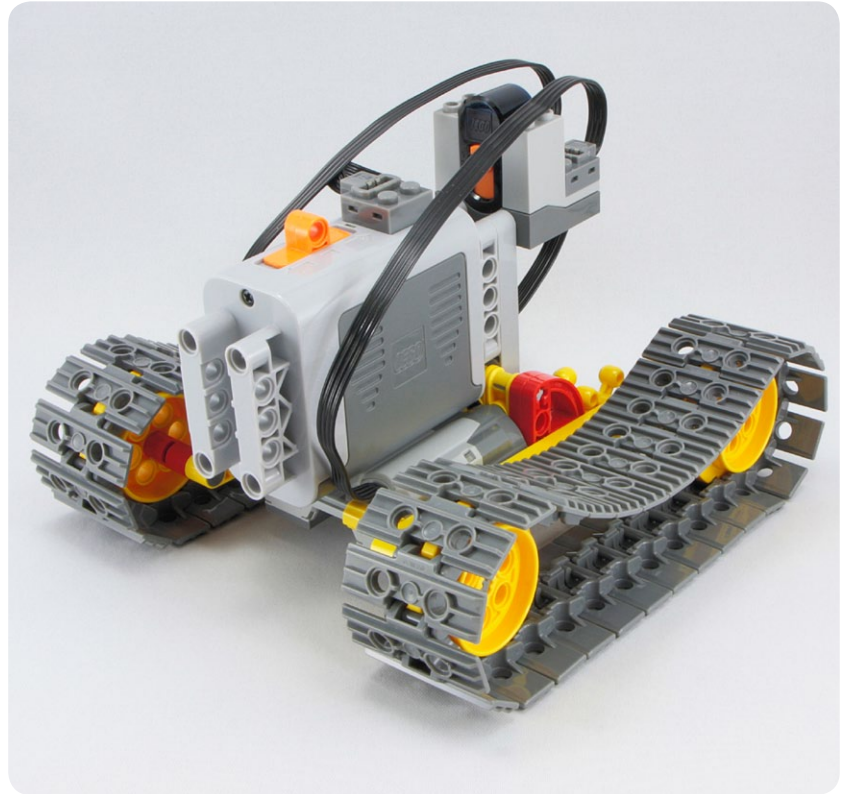
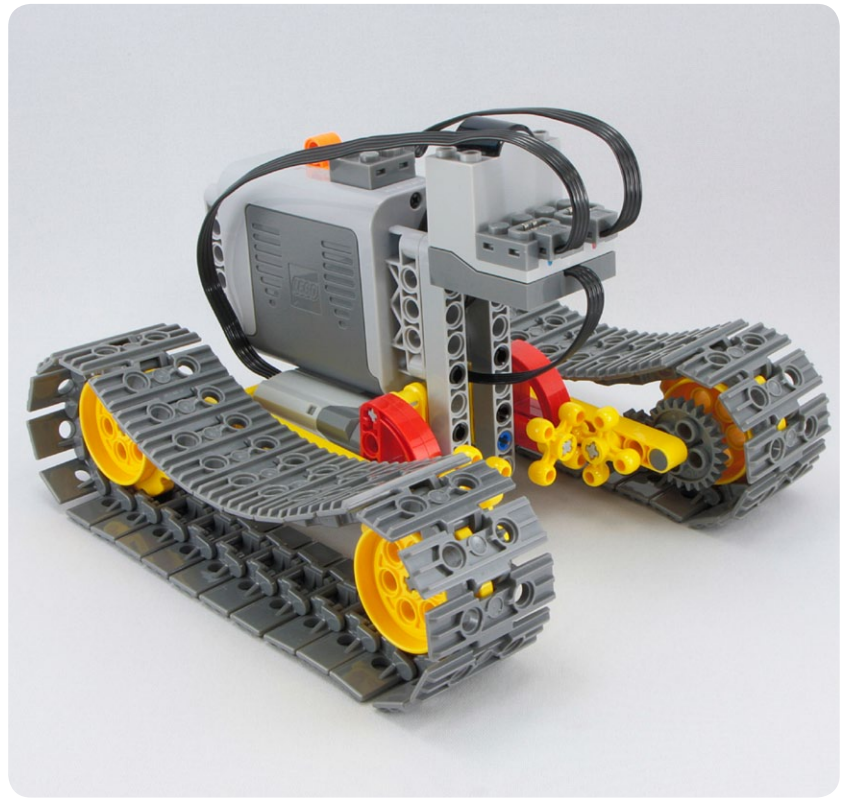
#58

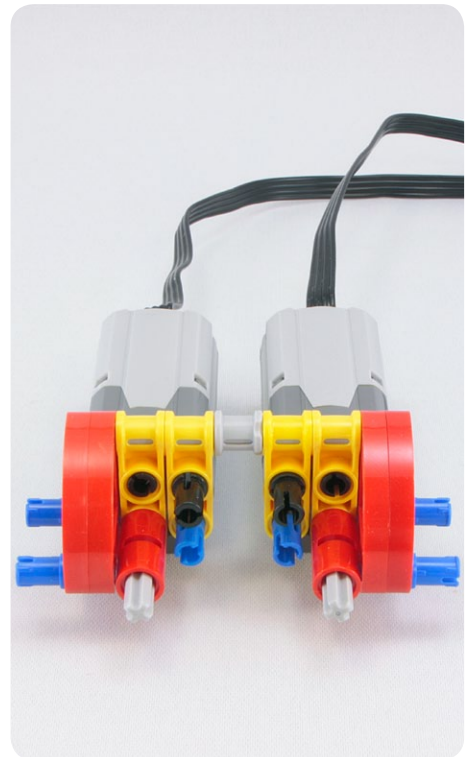
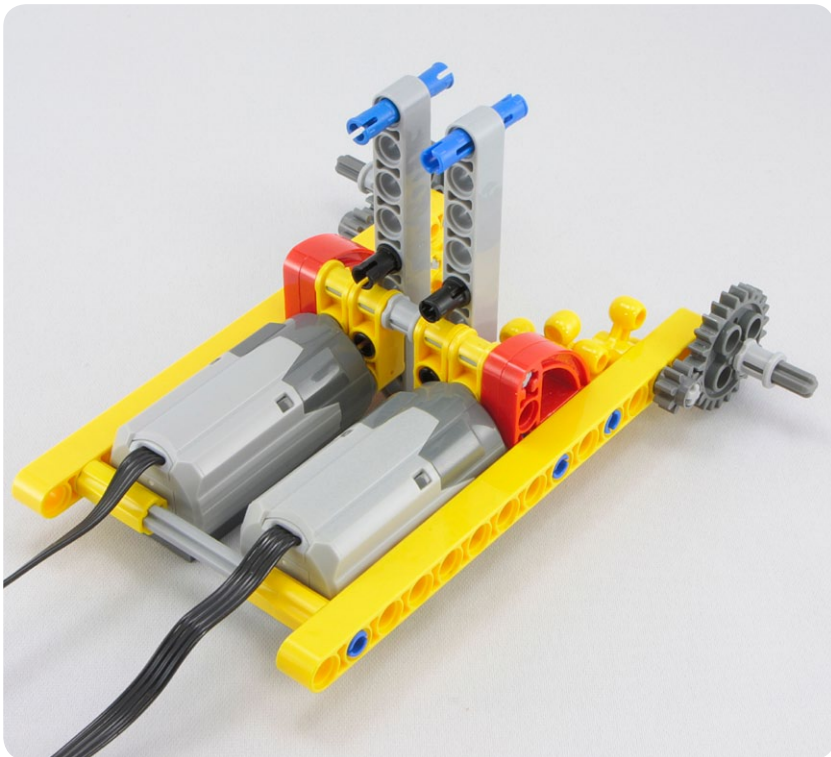
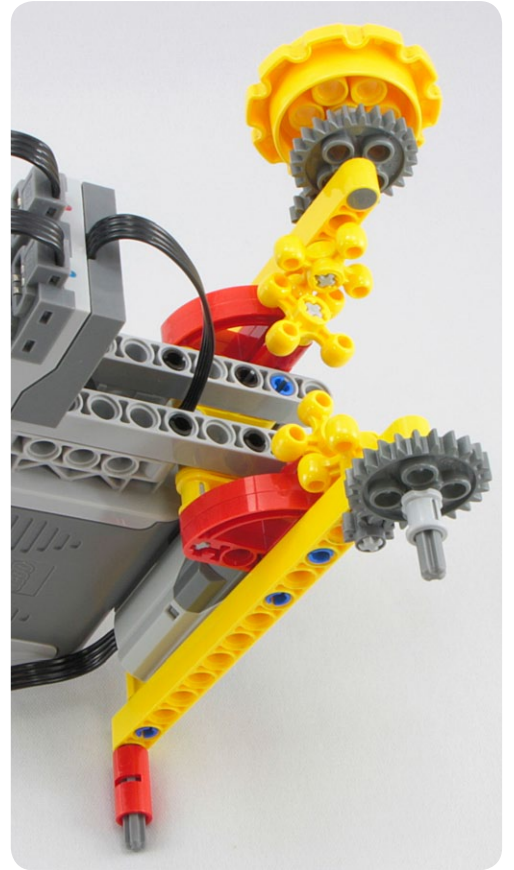




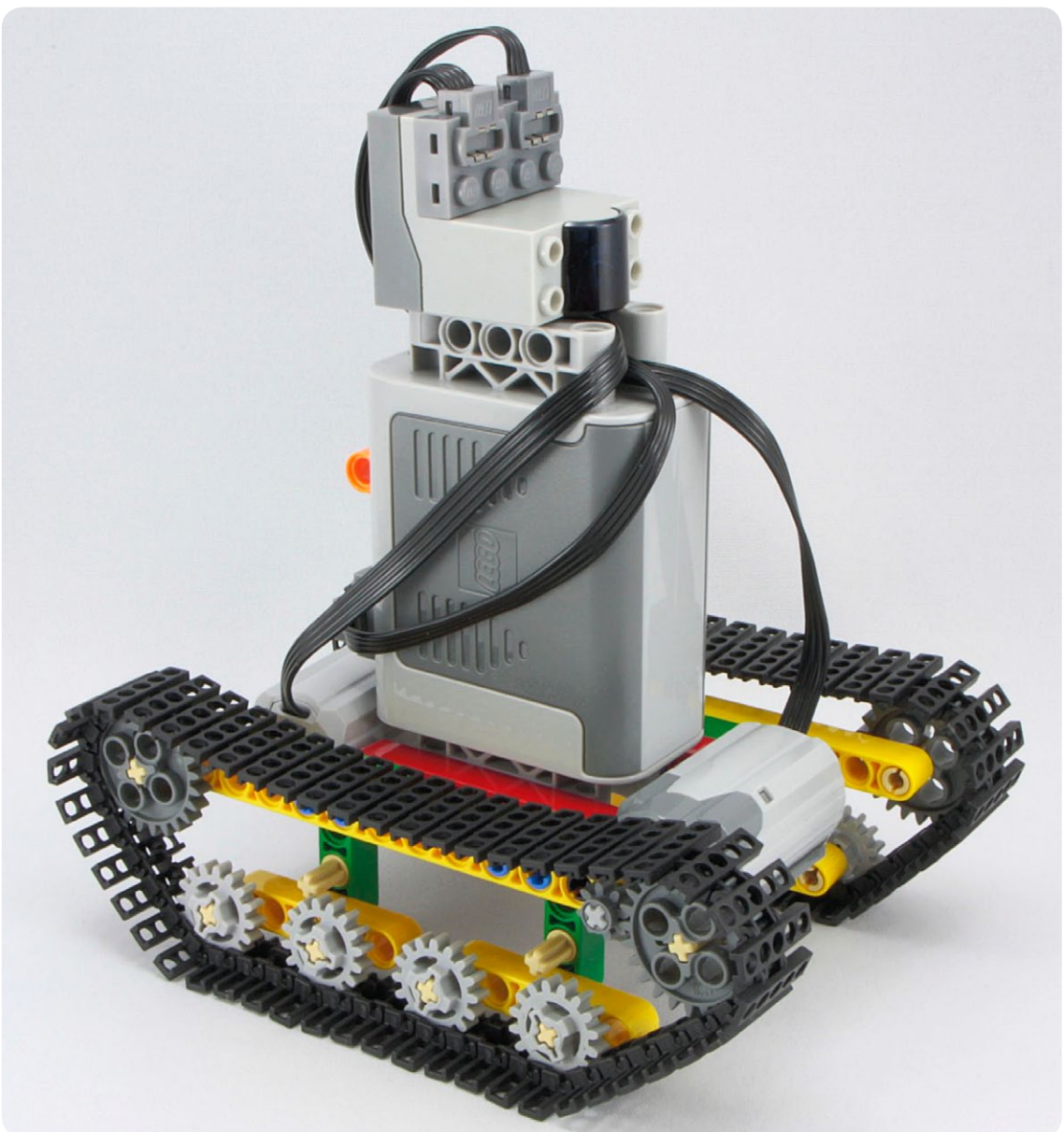
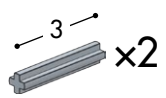
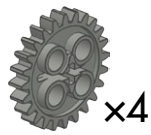
#59

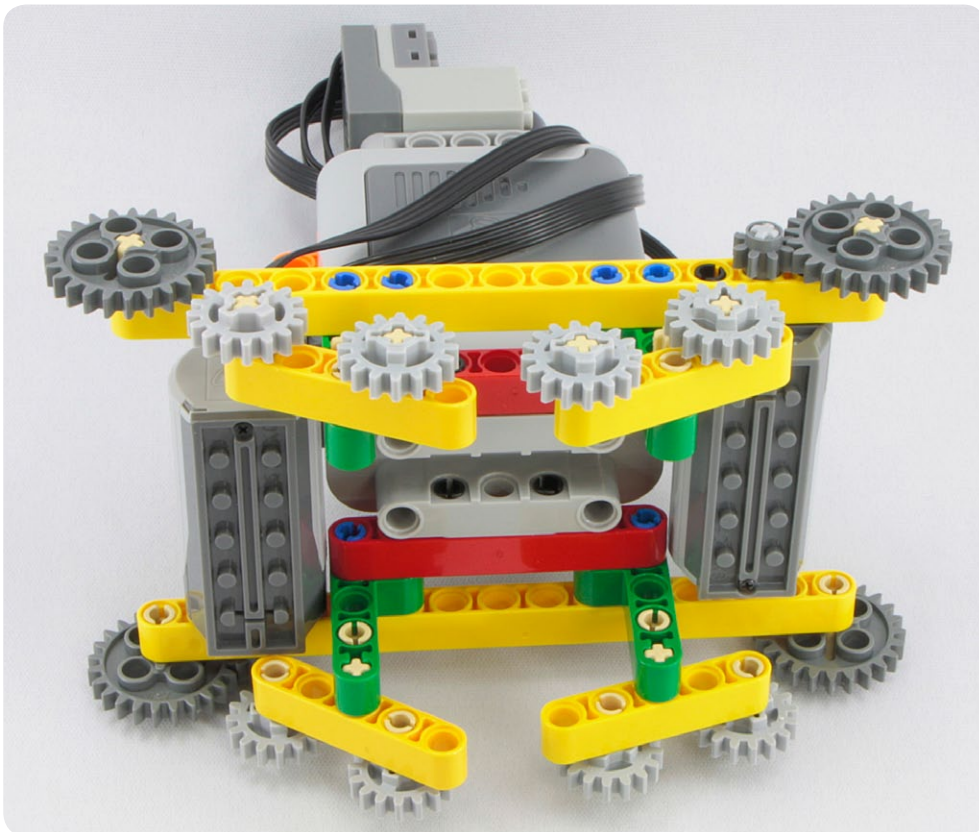
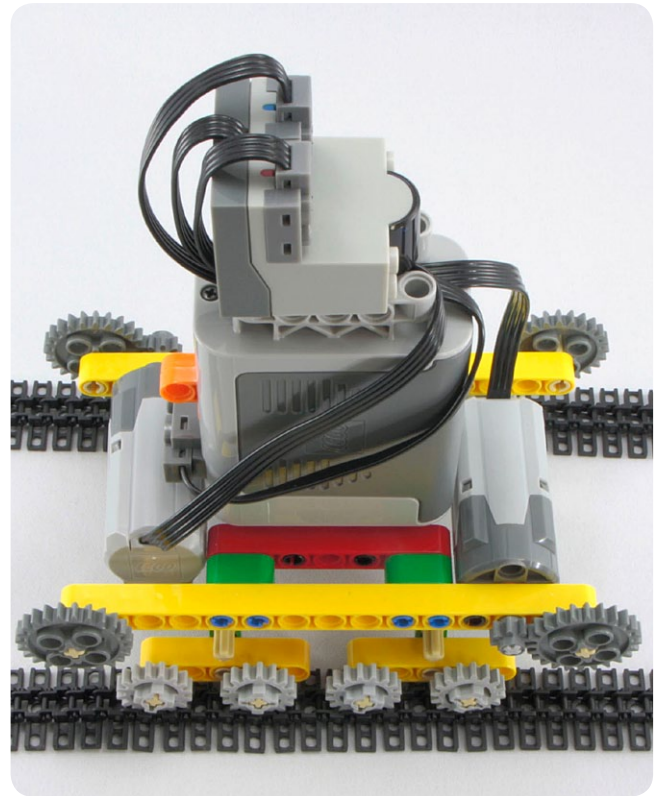
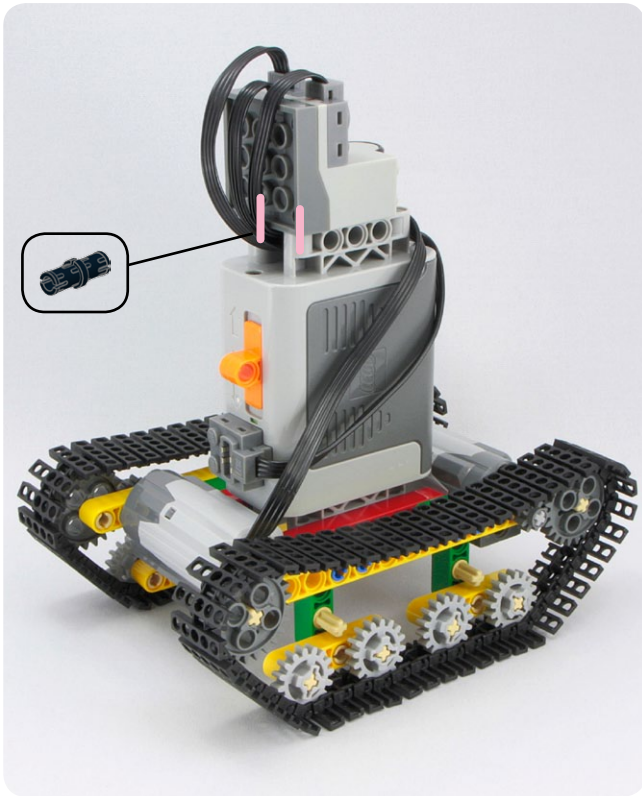
-  x2
- 
-  x2
-  x4
- 
-  x2
- 
-  x4
-  x58
-  x2
-  x4
-  x2
-  x2
-  x2
-  x4
-  x4
-  x2
-  x4
-  x3
-  x4
-  x4
-  x3
-  x6
-  x6

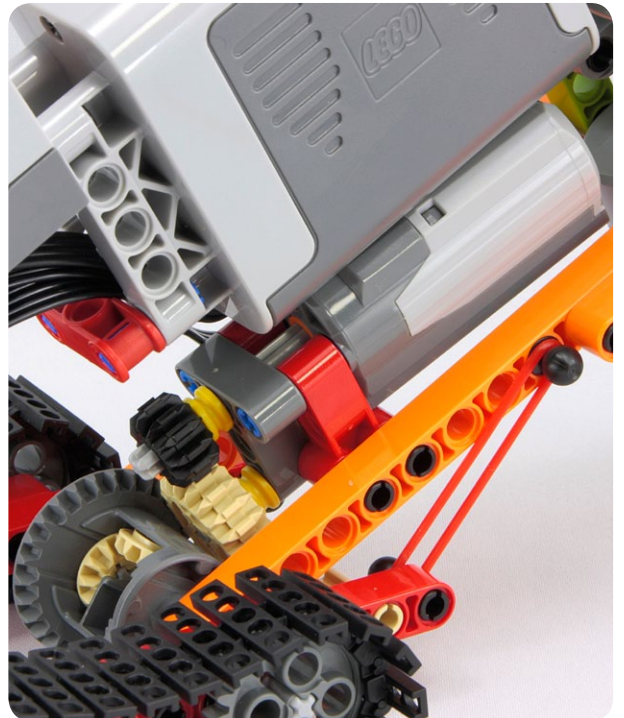
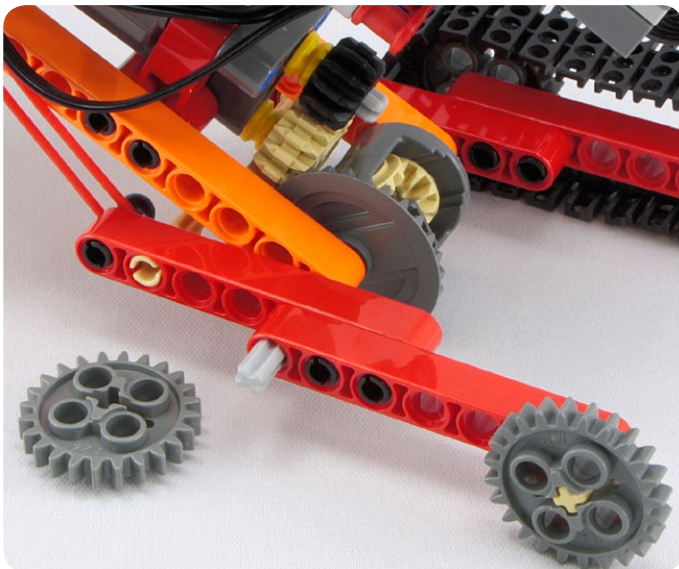
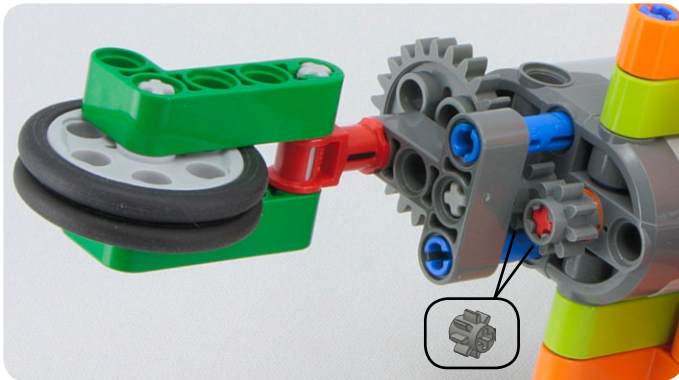


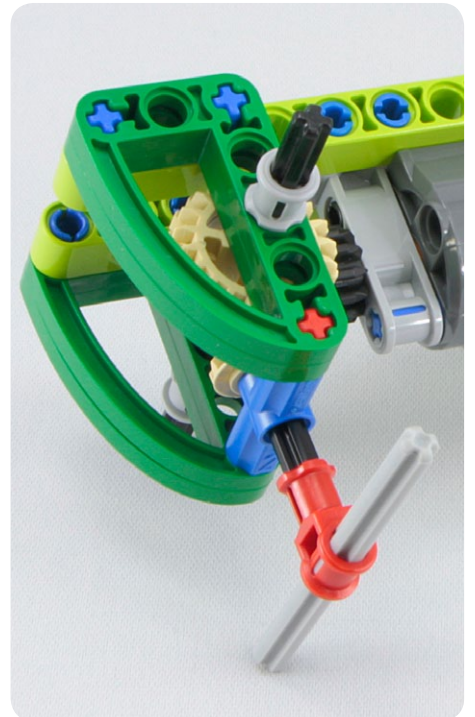
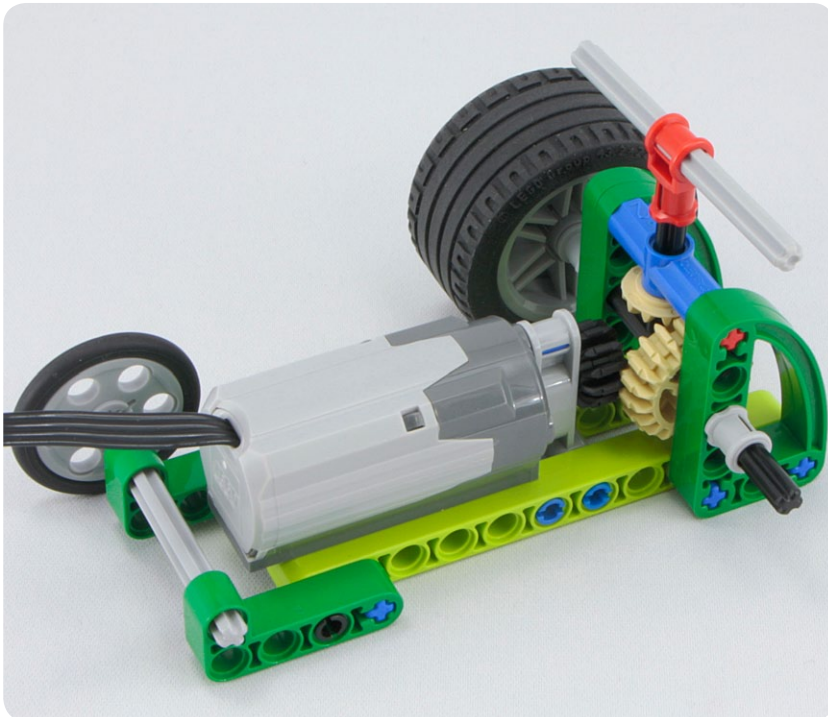
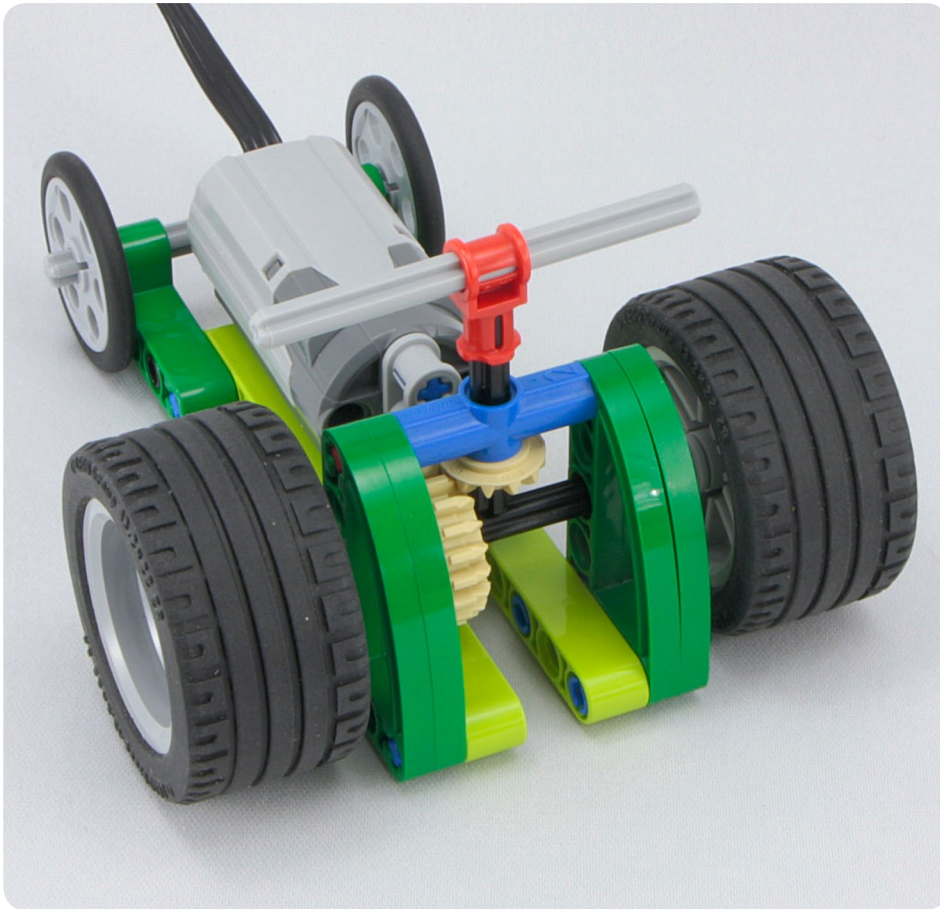


#60

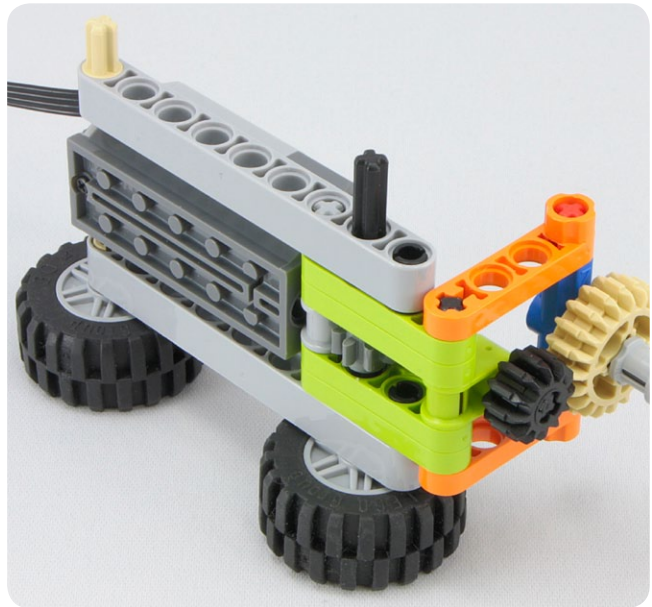
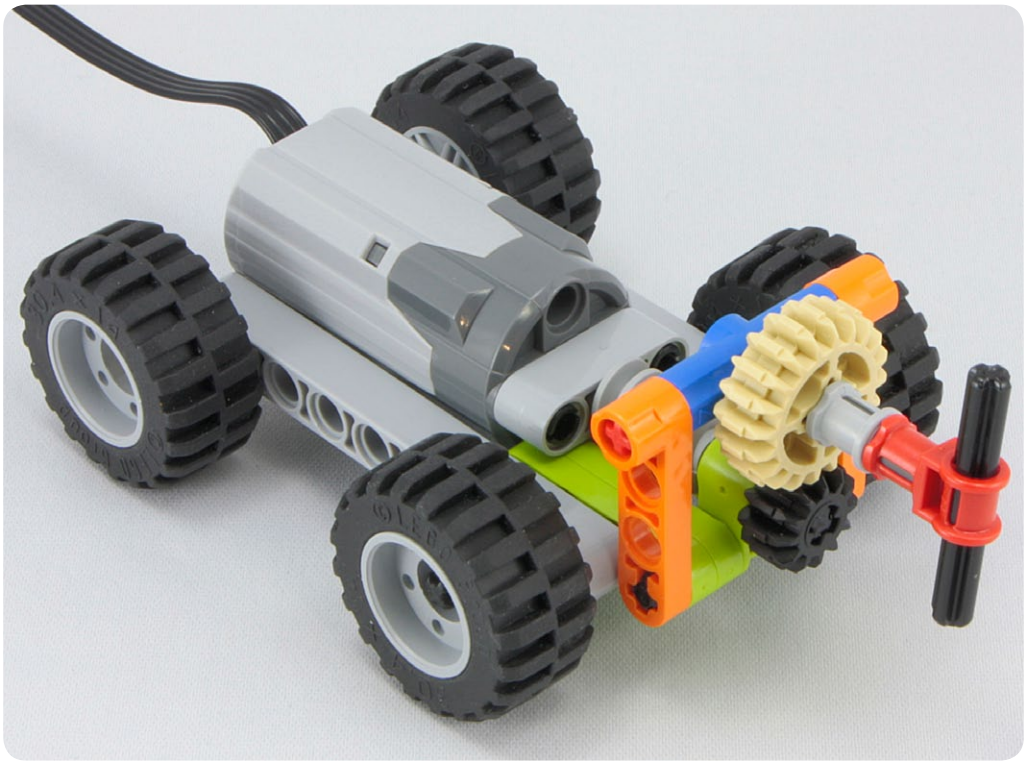
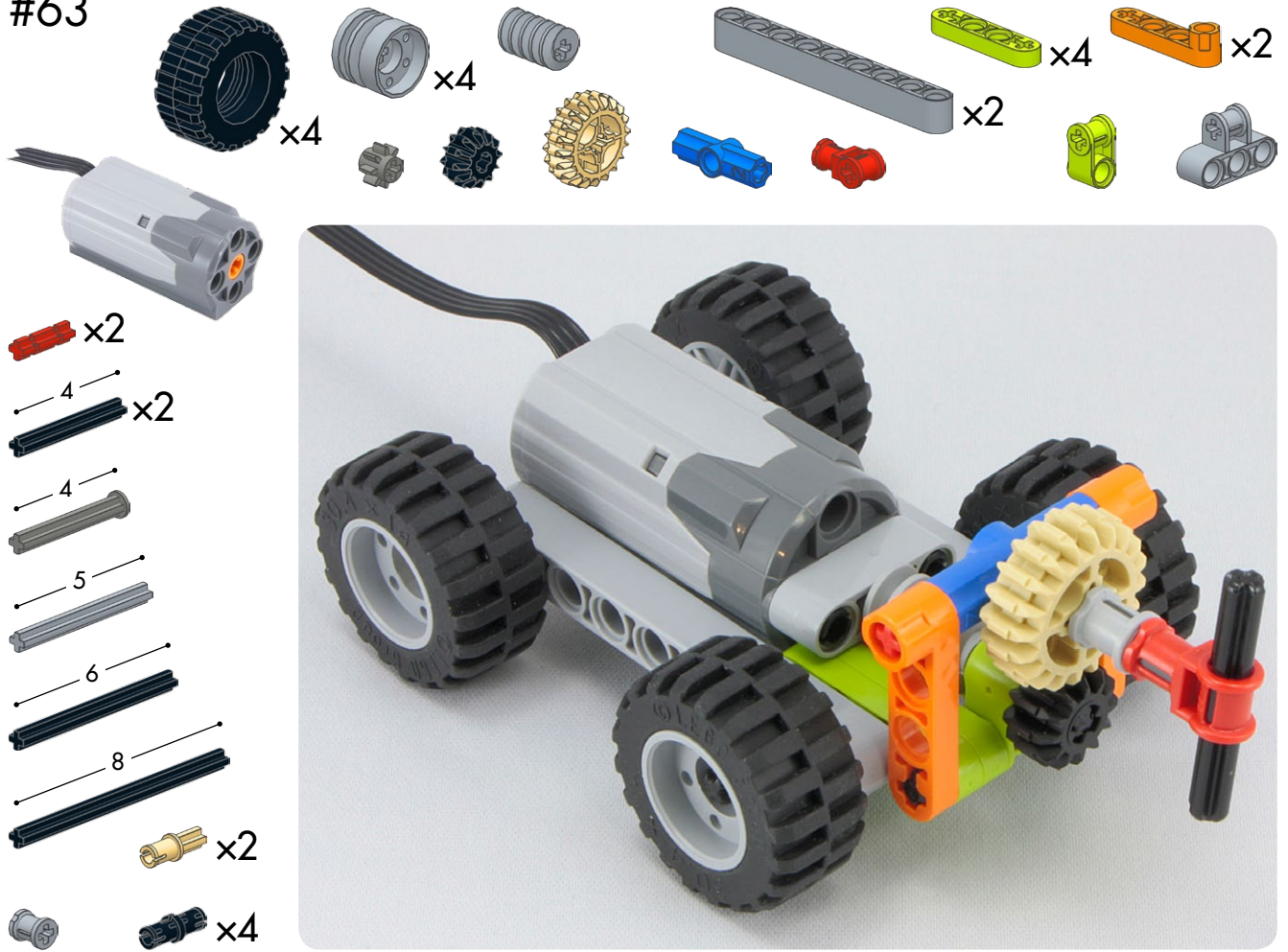






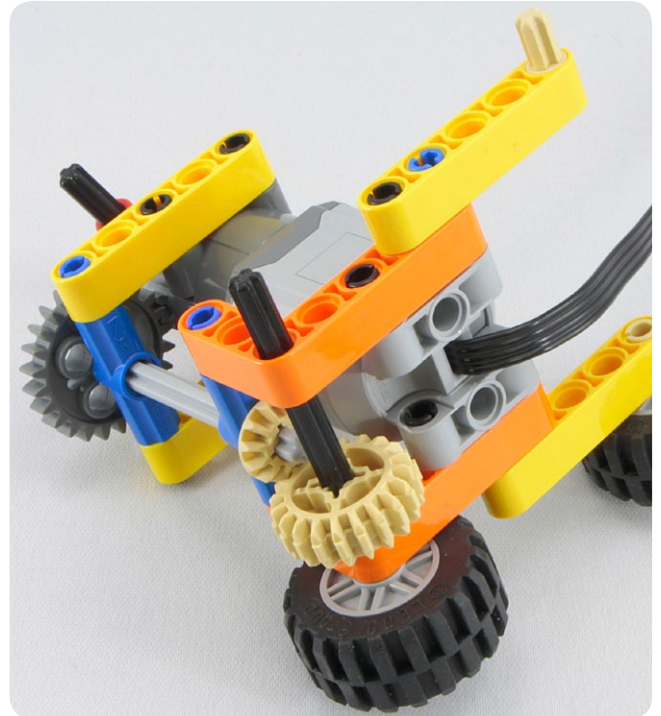


#63







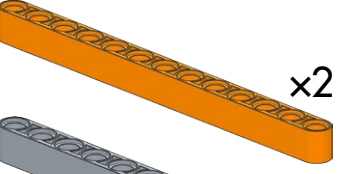
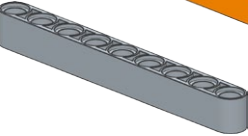






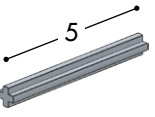
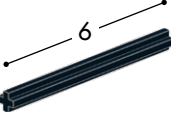
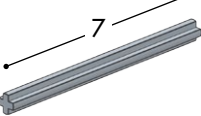




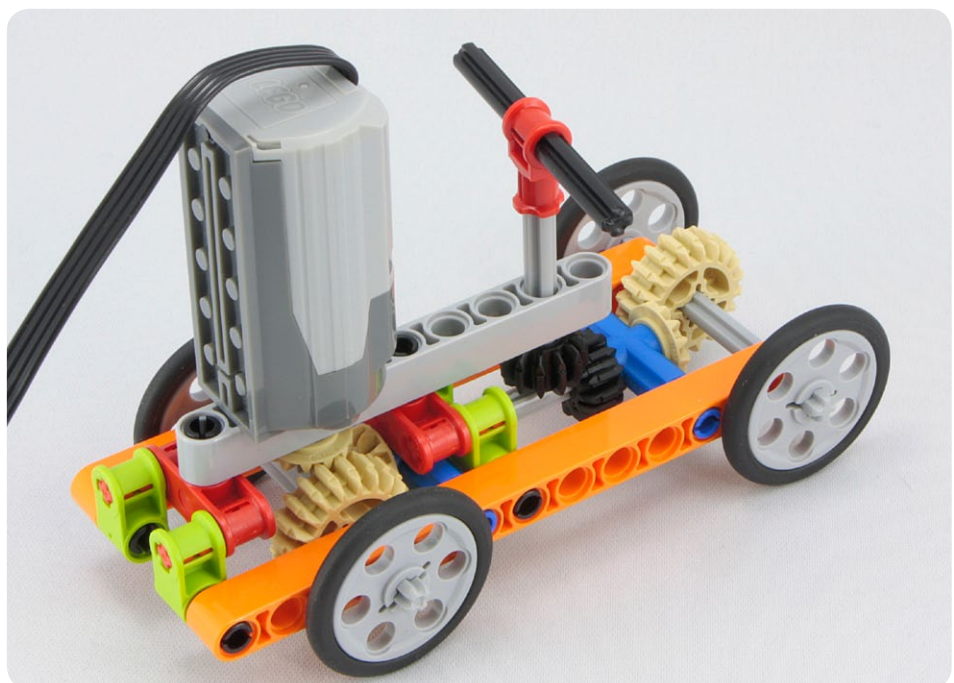
#64

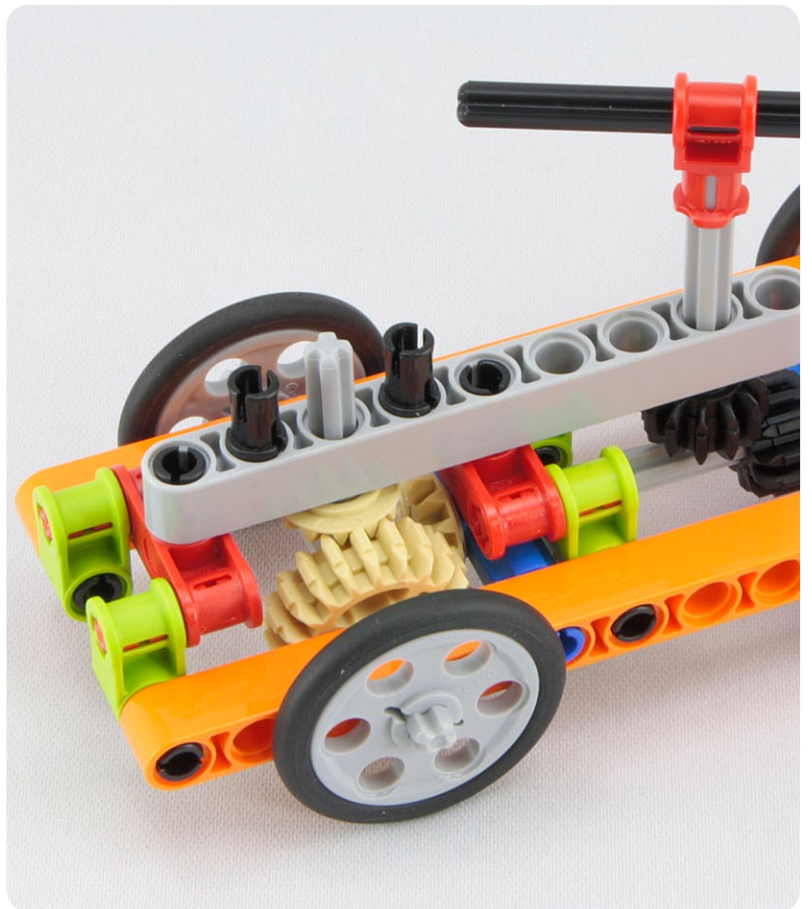
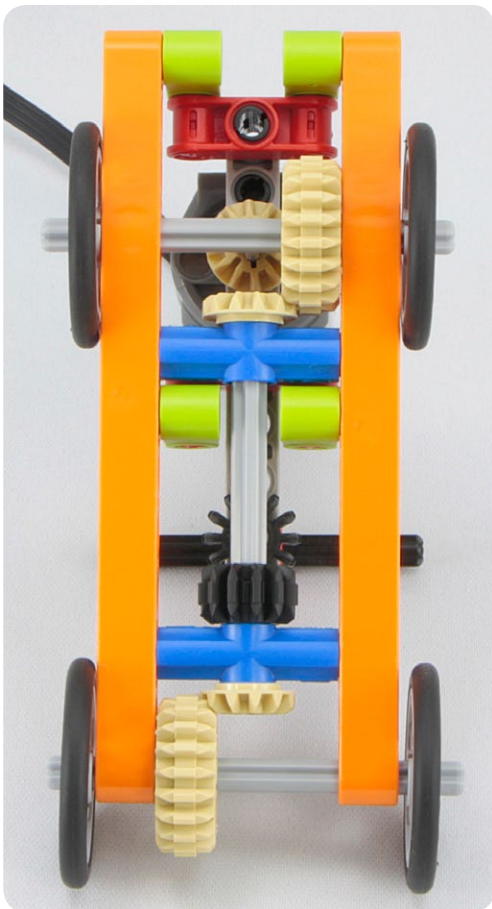
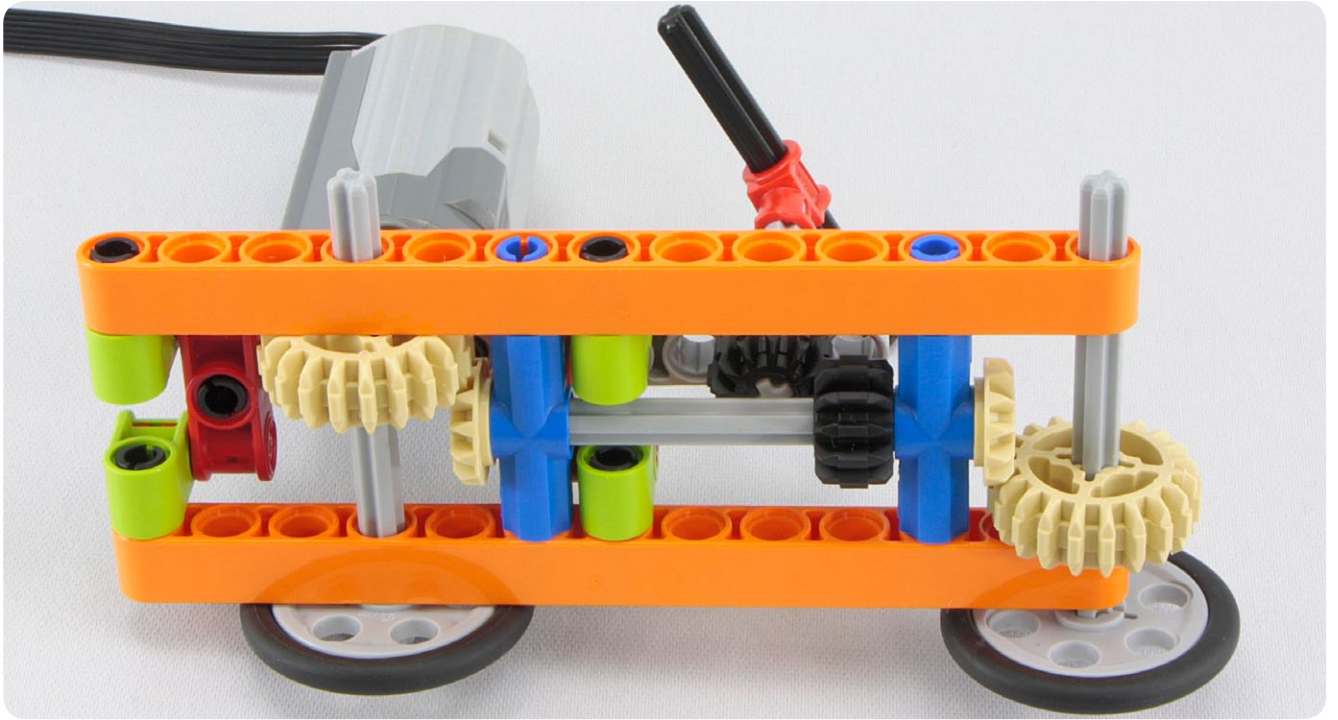
- x4
- x4
- x1
- x1
- x4
- x1
- x2
- x1
- x2
- x2
- x2
- x2
- x2
- x2
- x2
- x3
- x4
- x8







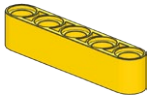
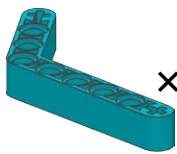

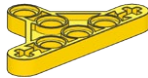






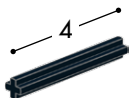
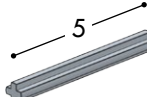
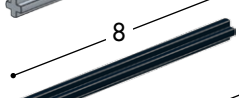





#65

-   x2
-  x3  x2
-  x4  x4
-  x2
- 
-  x2 
-  x4  x2
-  3  x4
-  5
-  6
-  7 x3
-  x4  x8

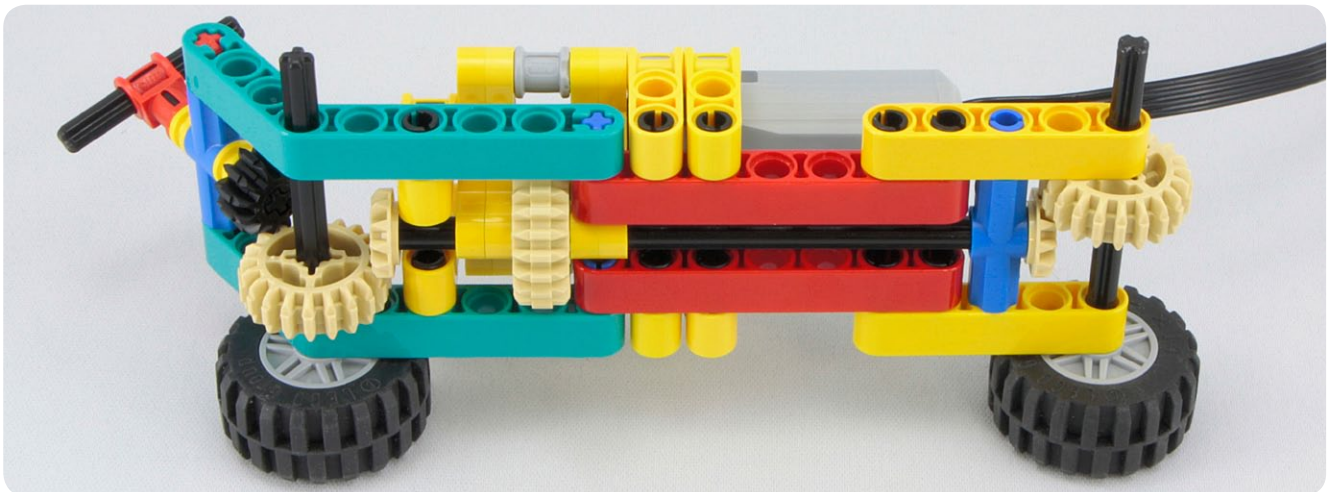
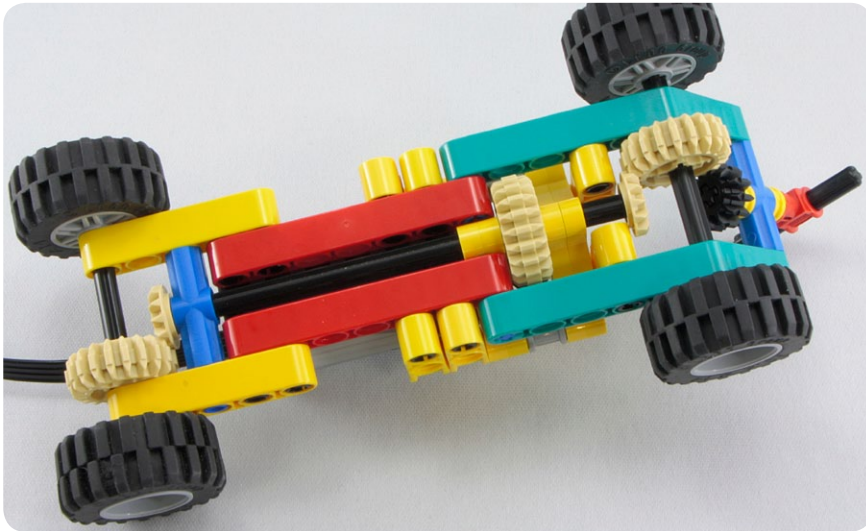
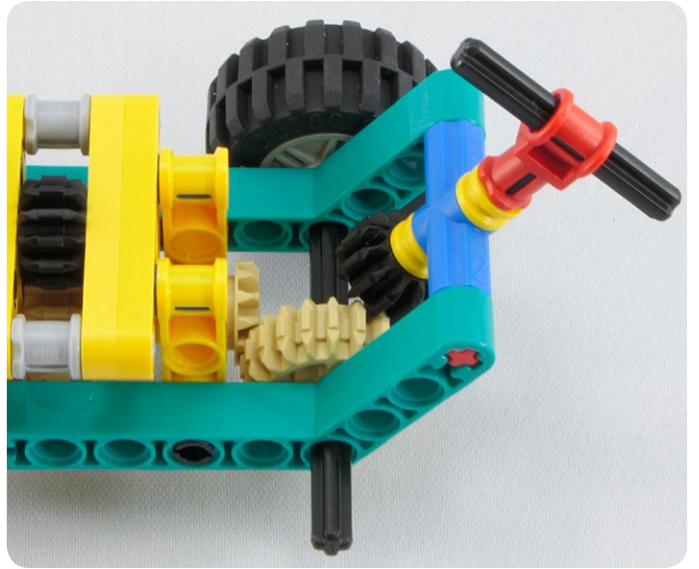
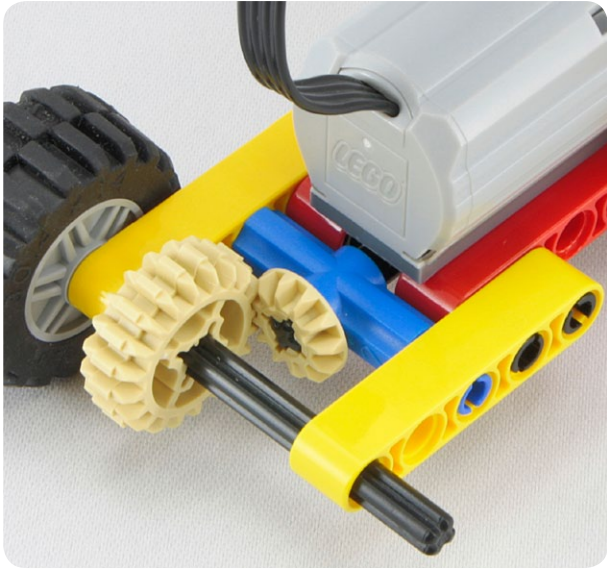


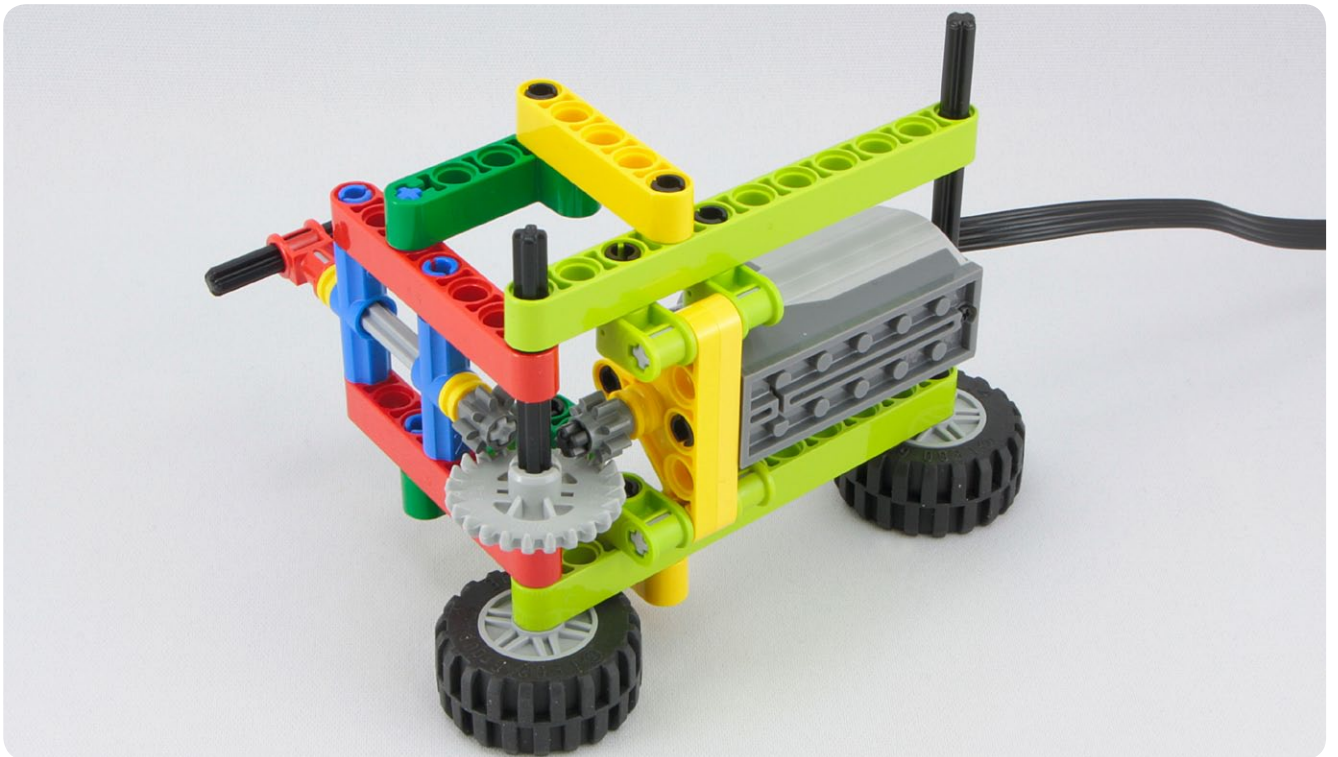
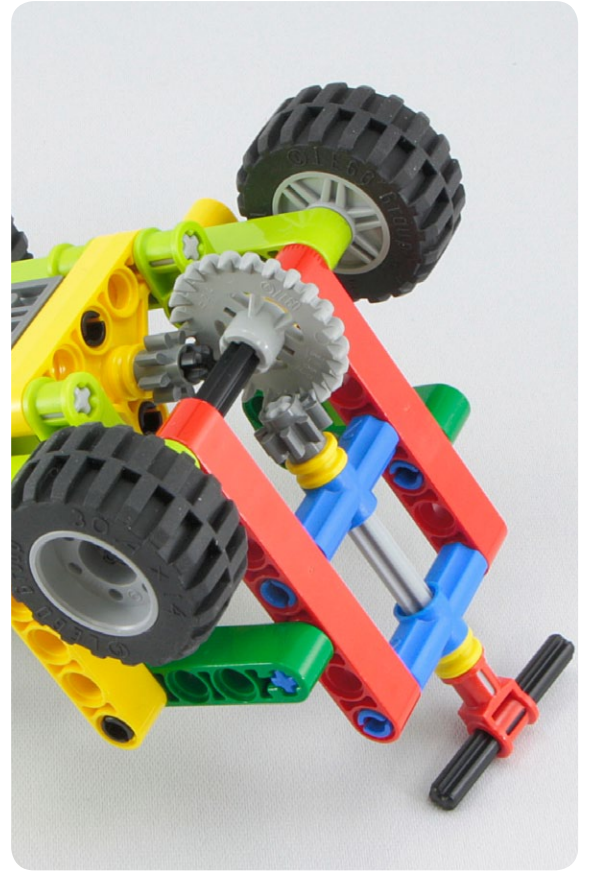
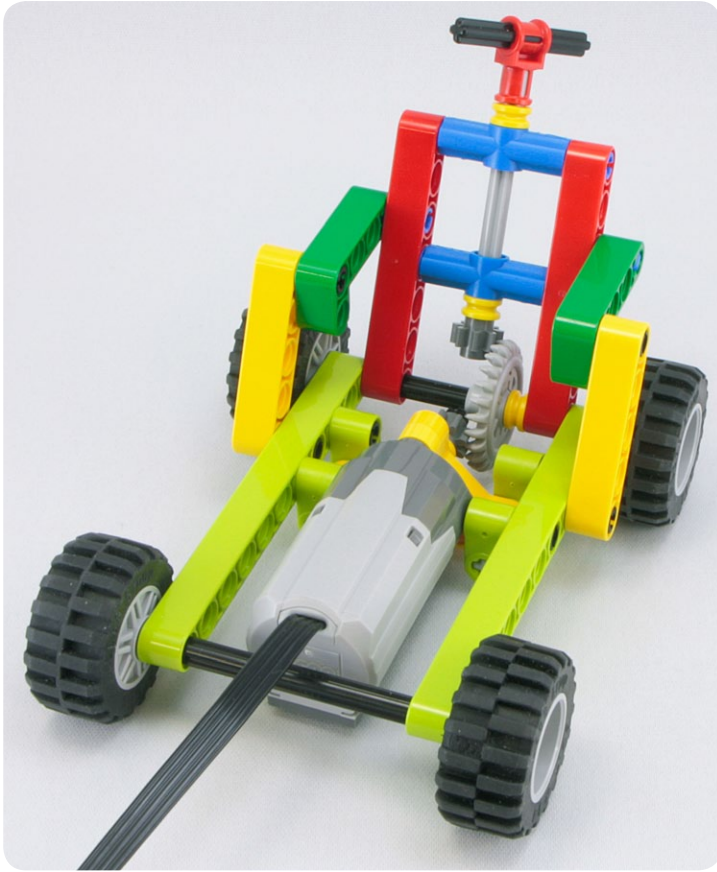


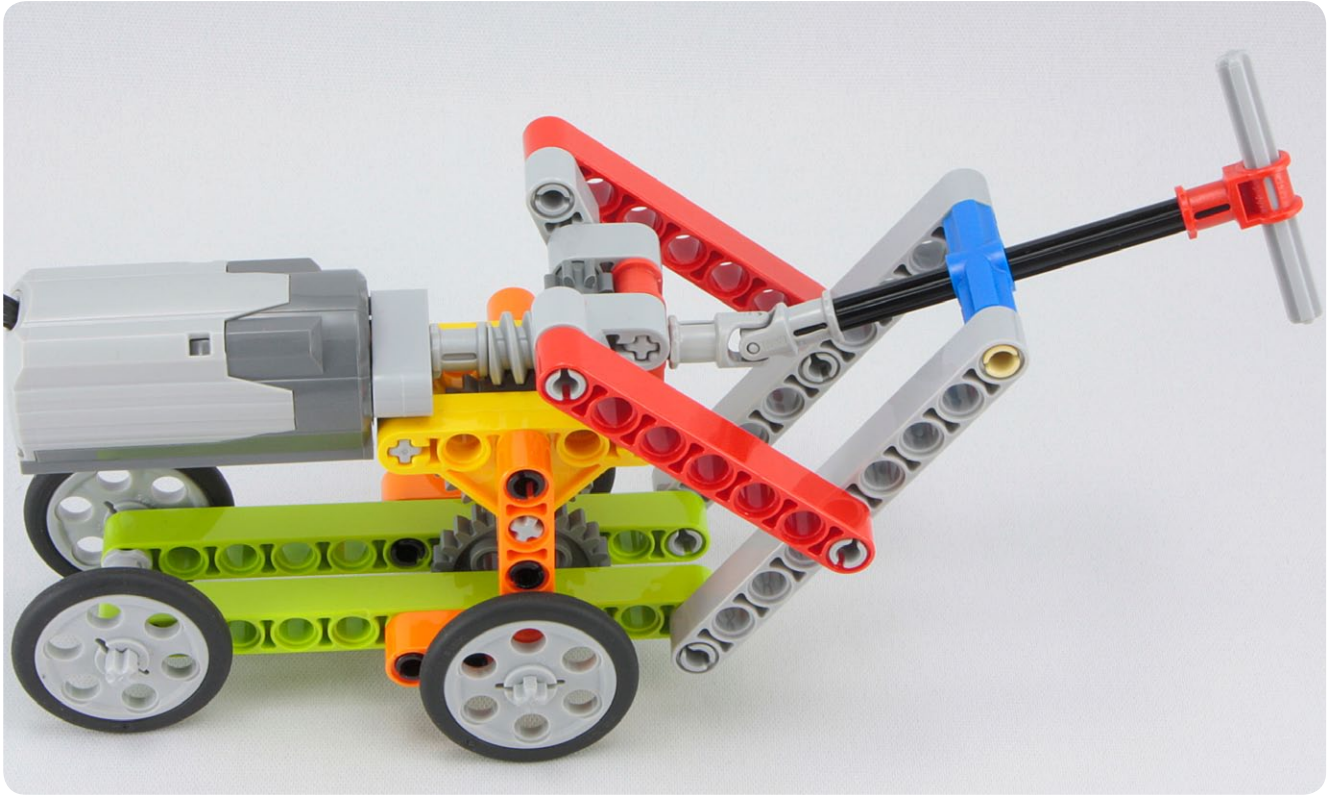
#66

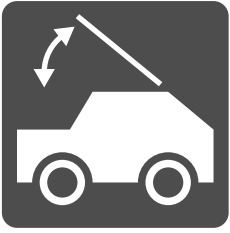
-  x1
-  x4
-  x4
-  x2
-  x2
-  x2
-  x1
-  x4
-  x6
-  x2
-  x3
-  x2
-  x2
-  x2
-  x3
-  x2
-  x2
-  x2
-  x2
-  x2
-  x6
-  x13





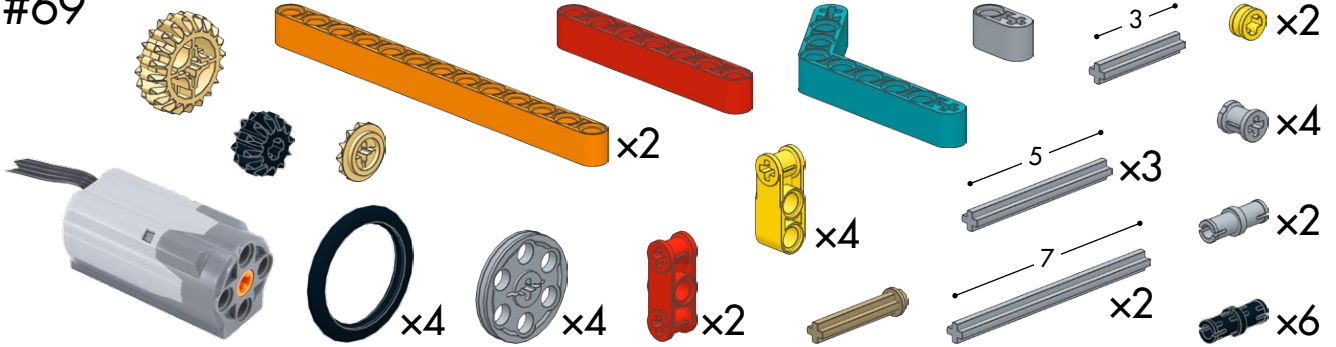


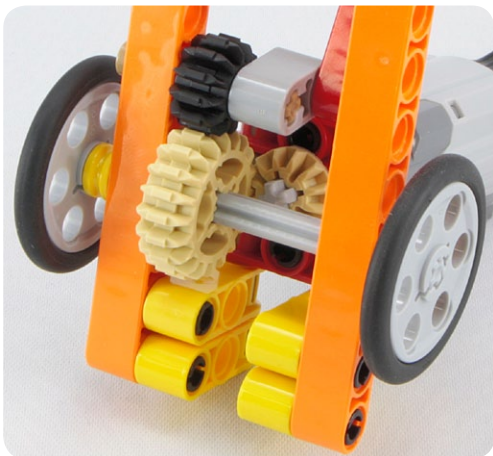
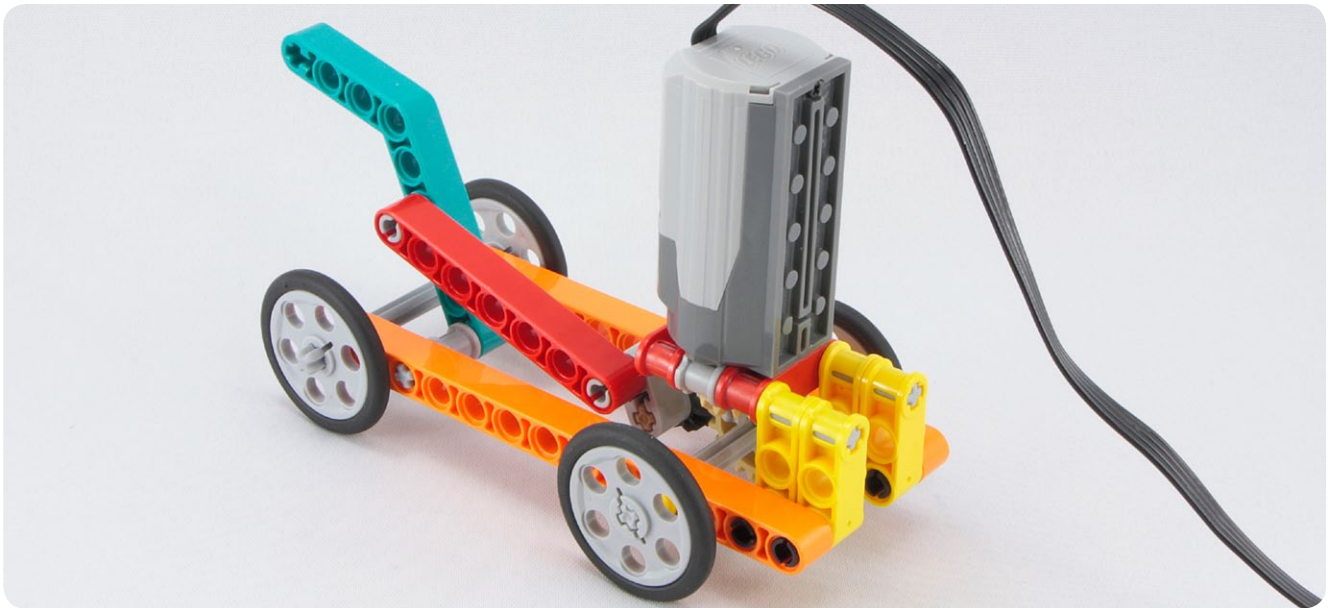
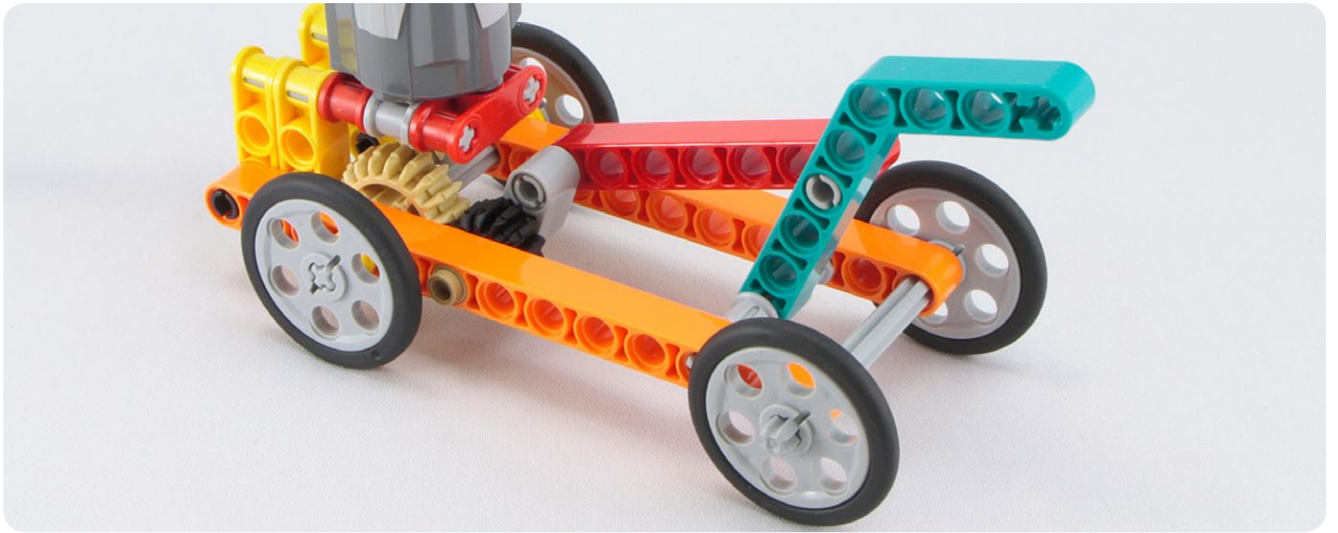




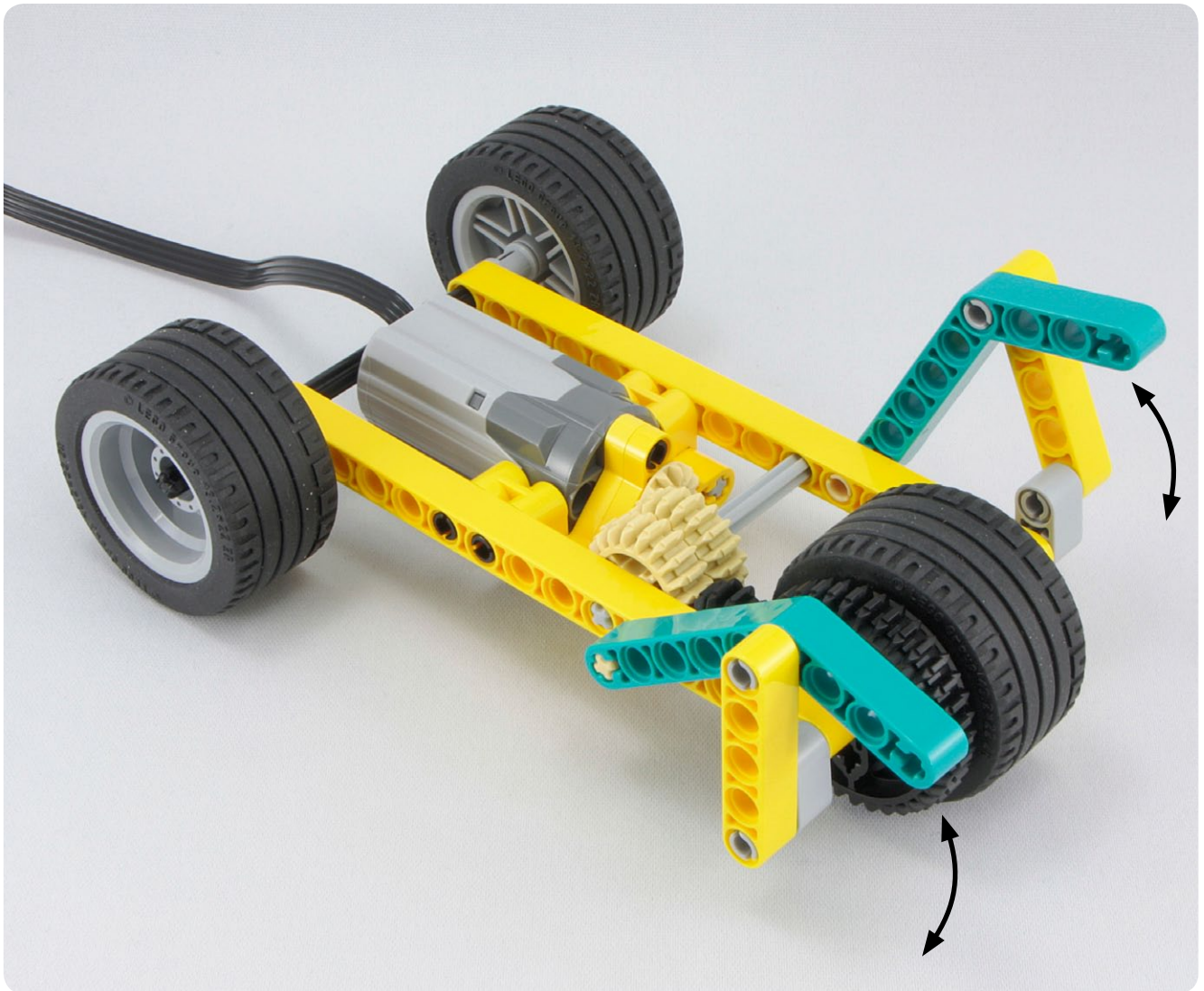
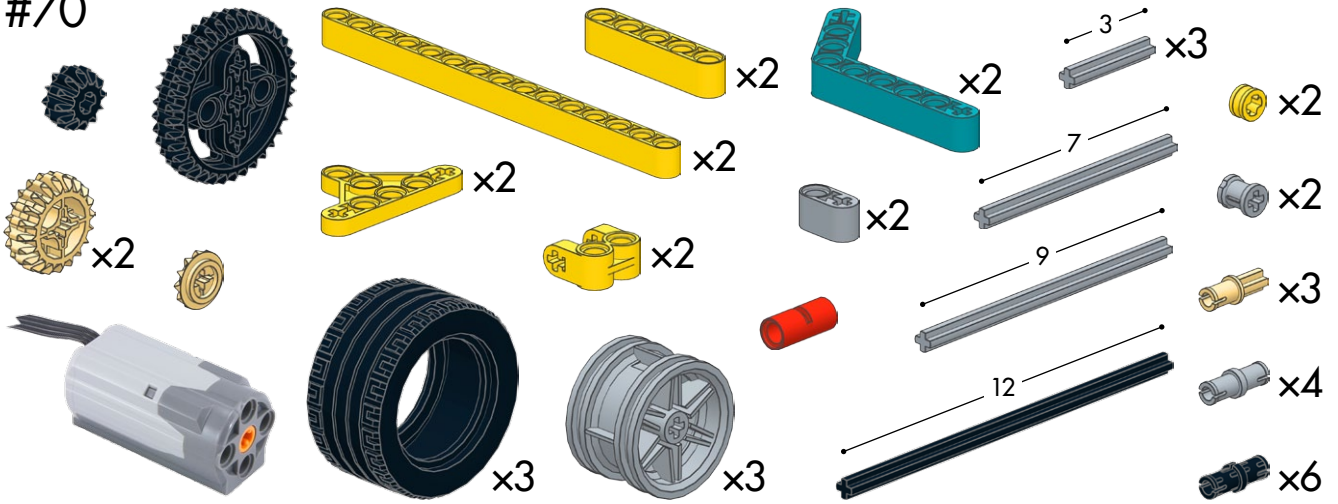
Cars that move something

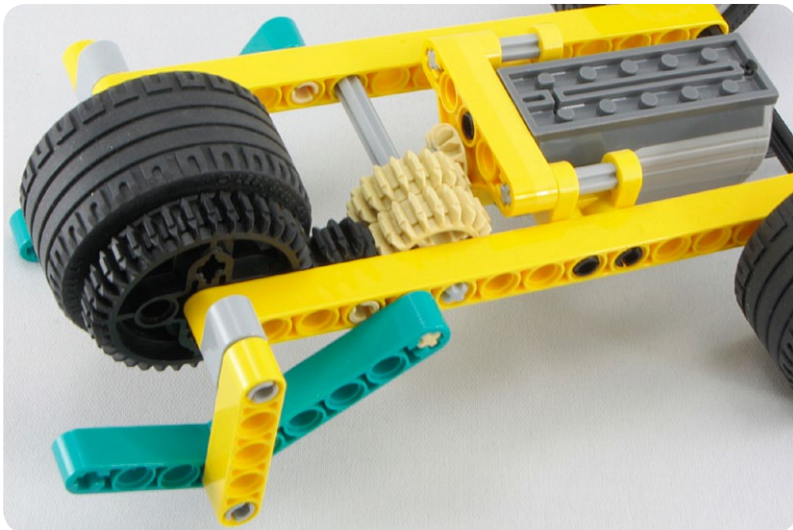
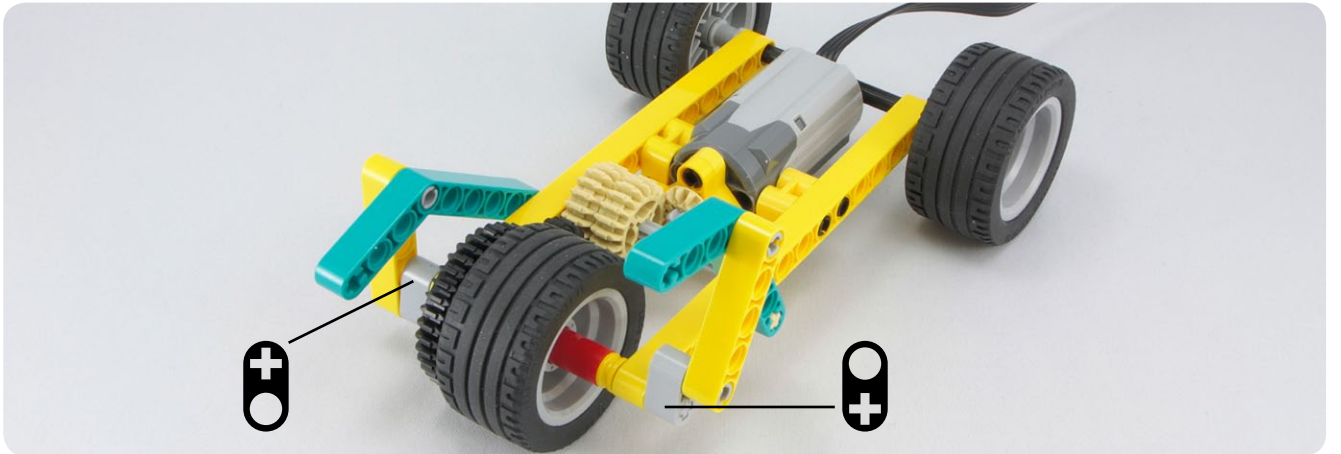
#69

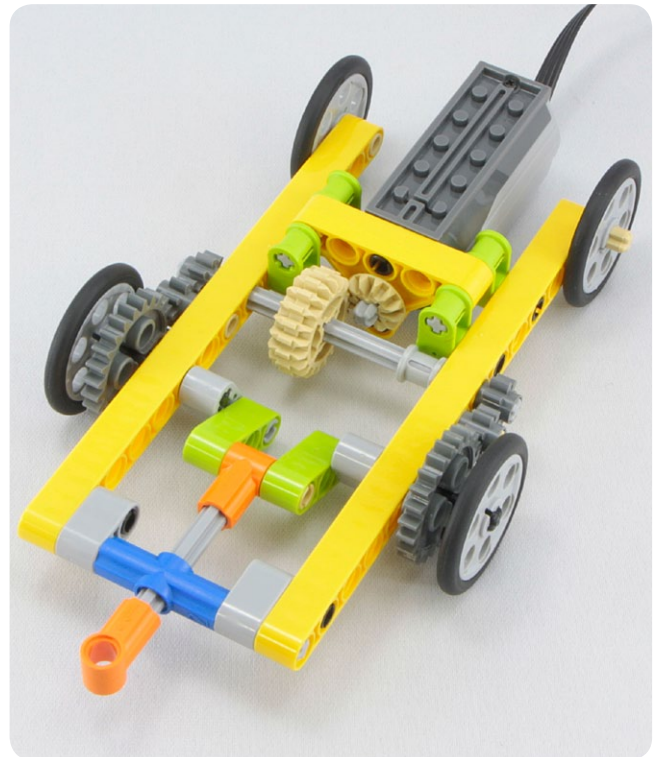
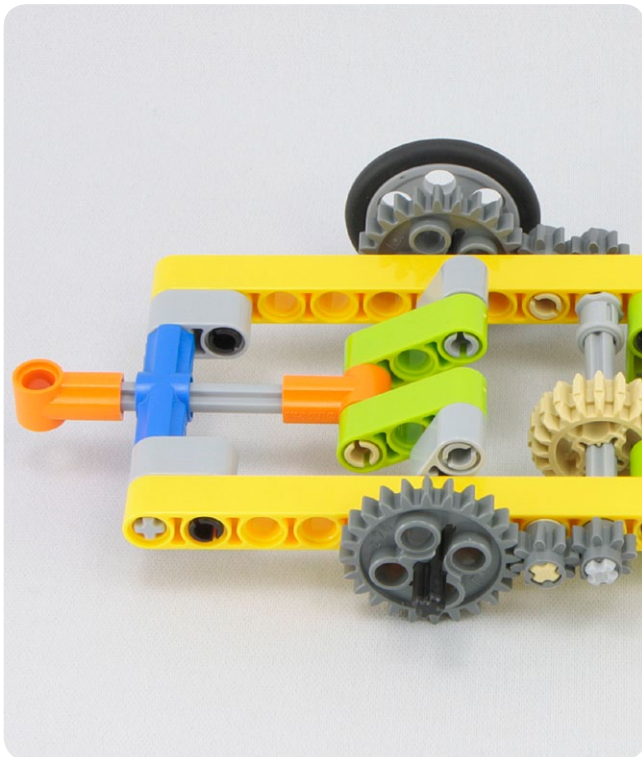


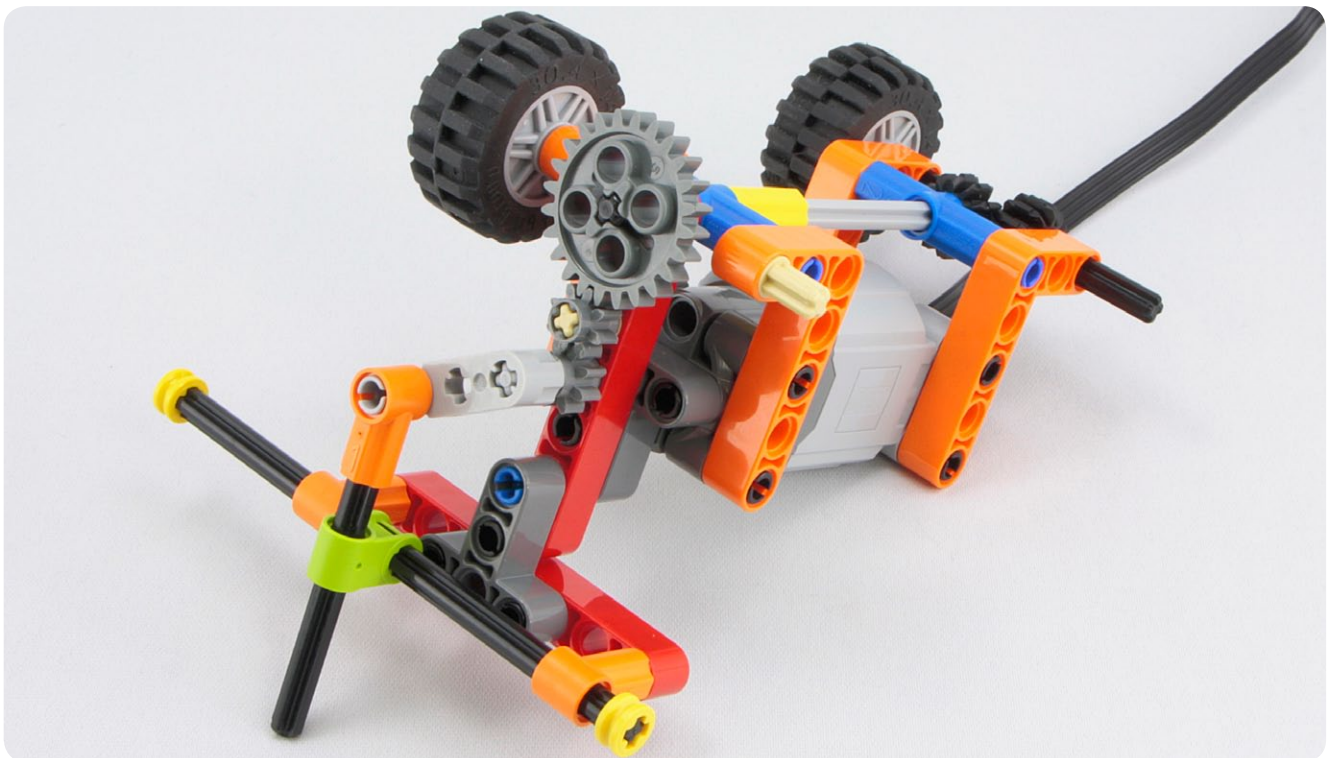
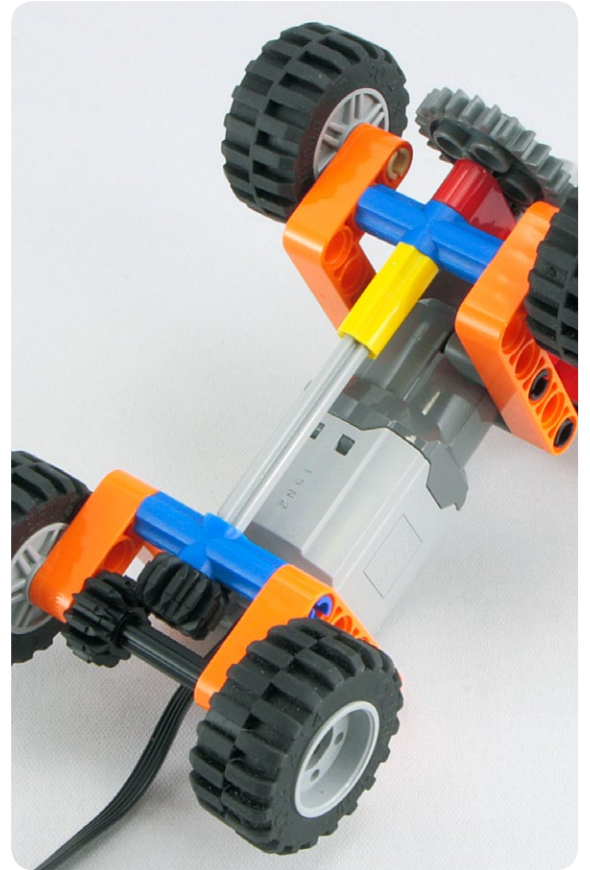


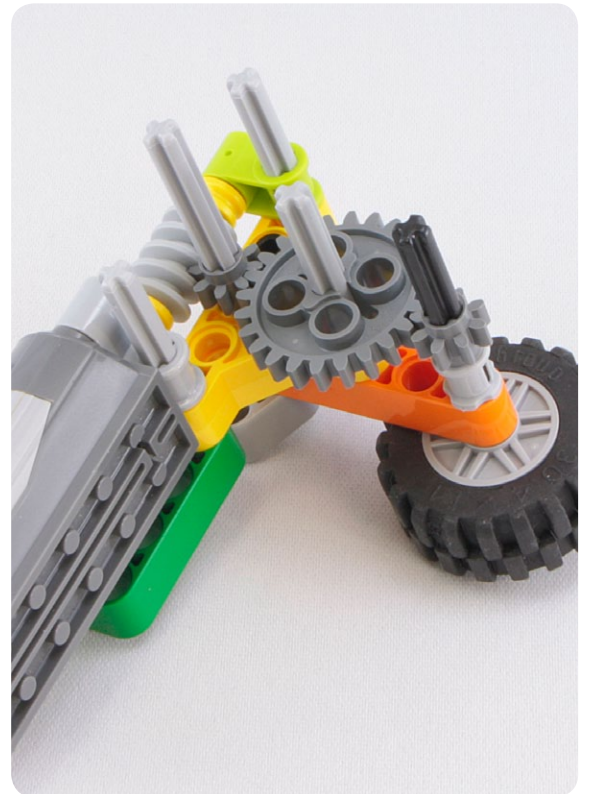
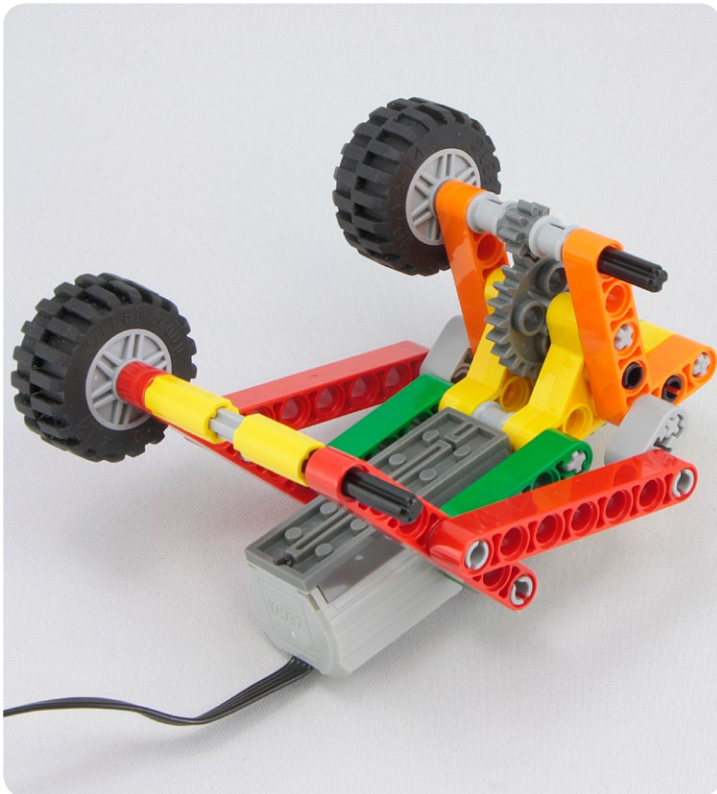
#70







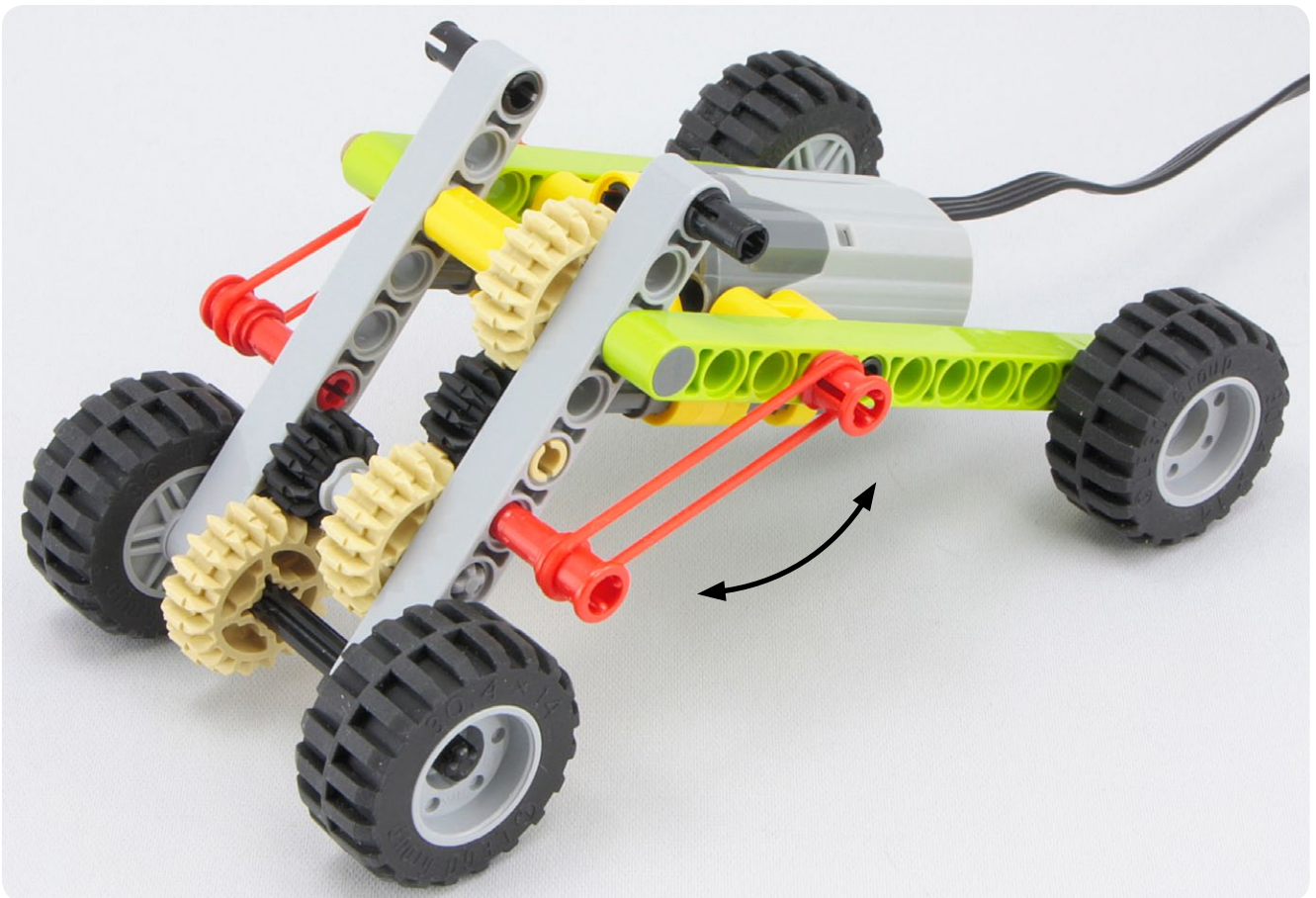
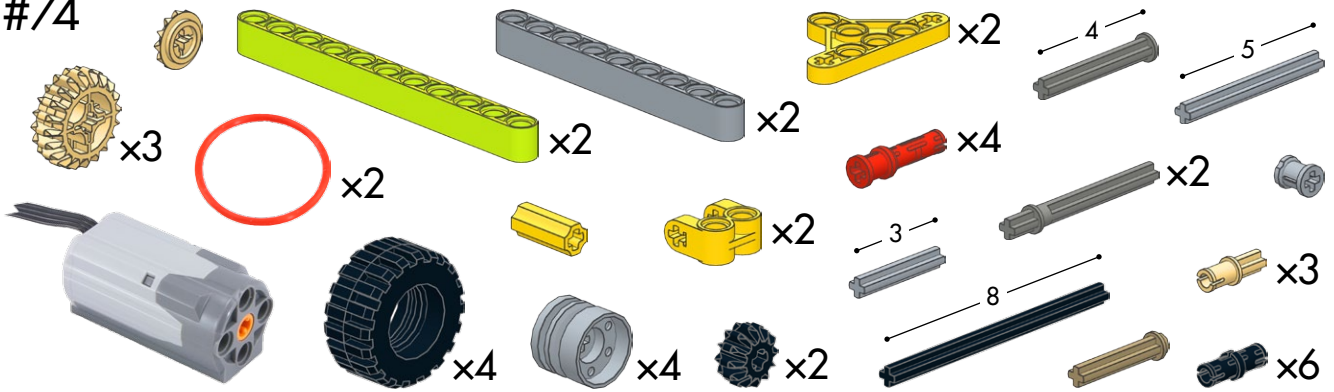


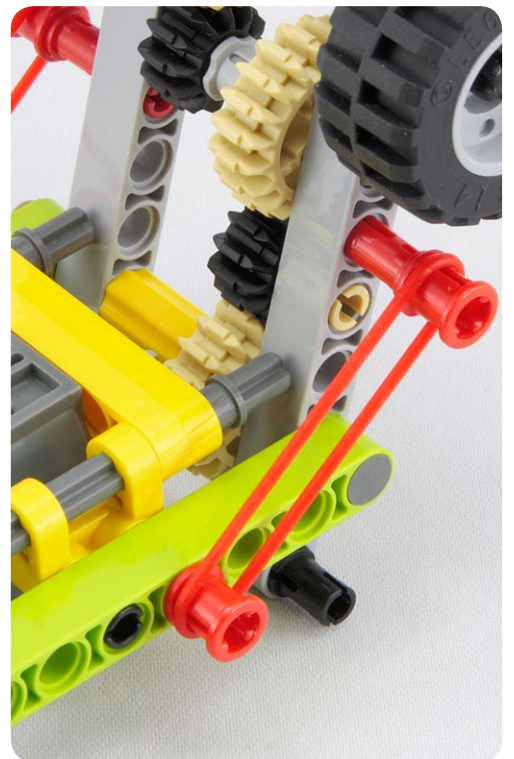
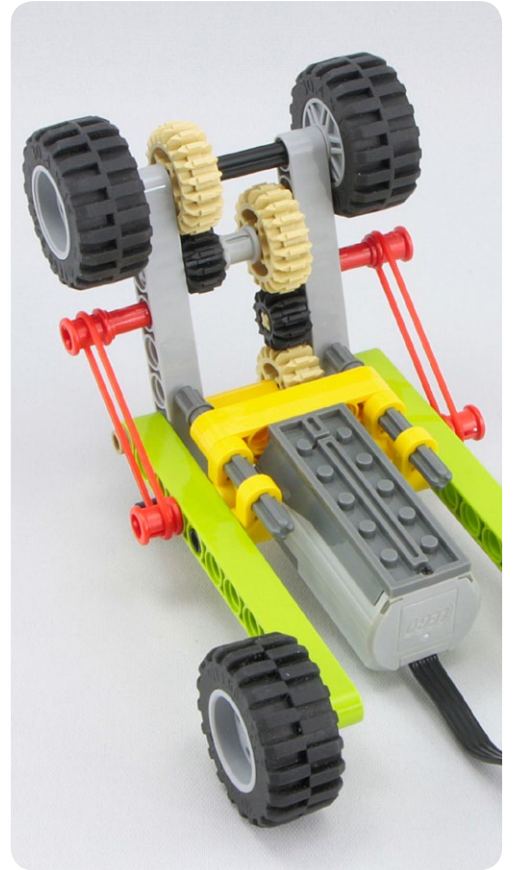


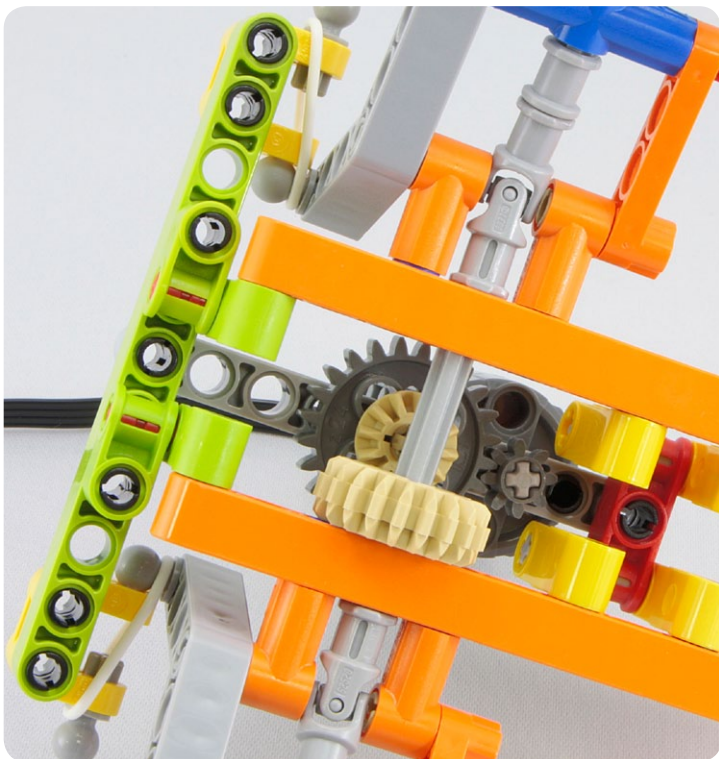


Cars with suspension

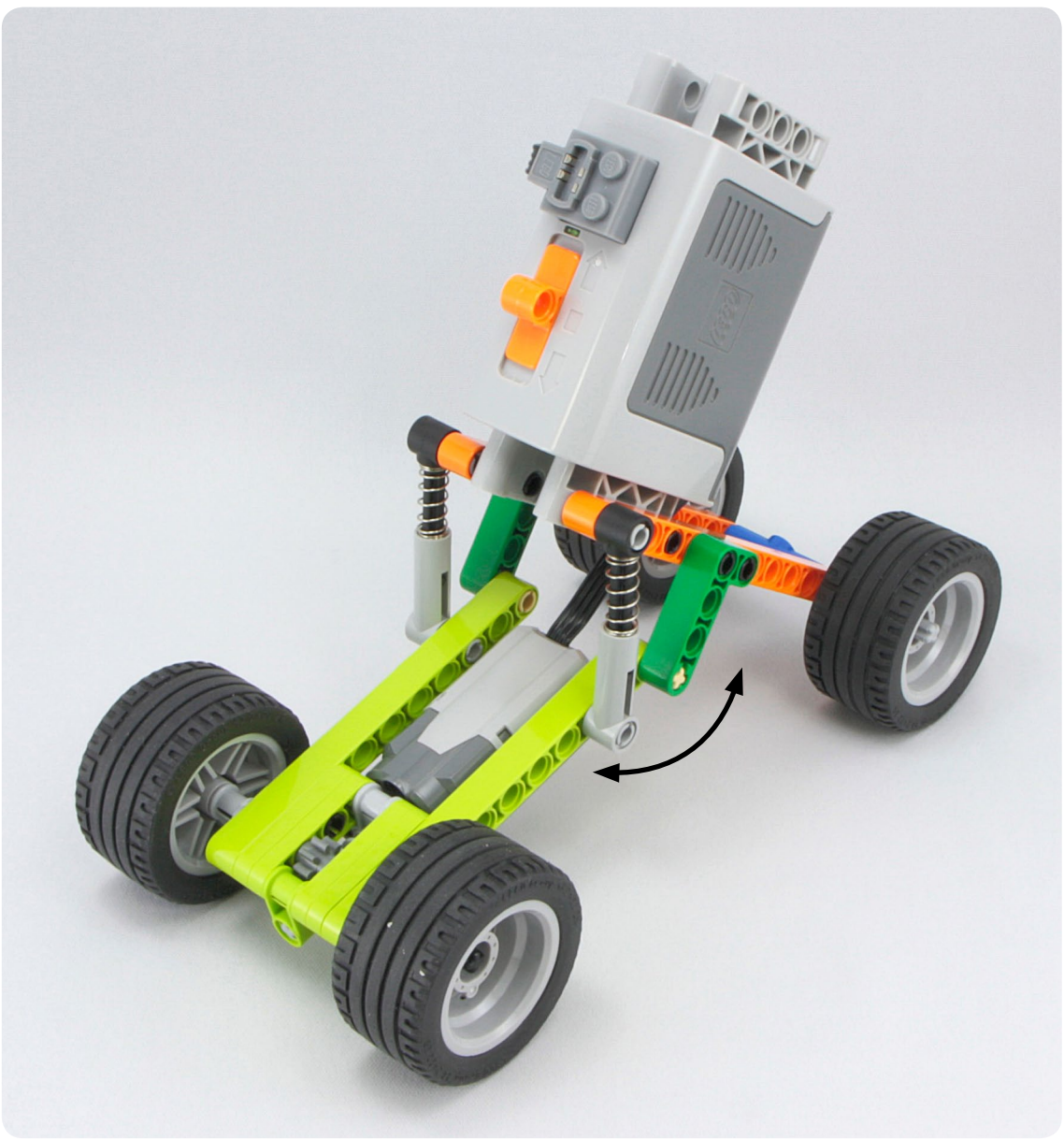
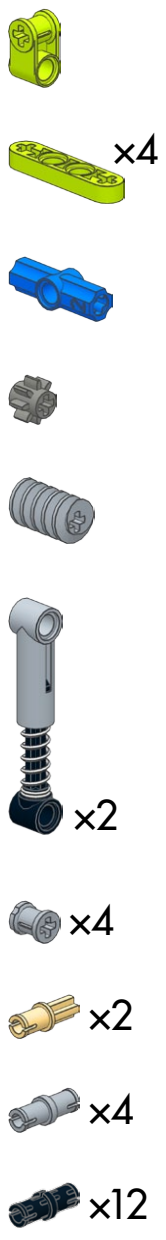
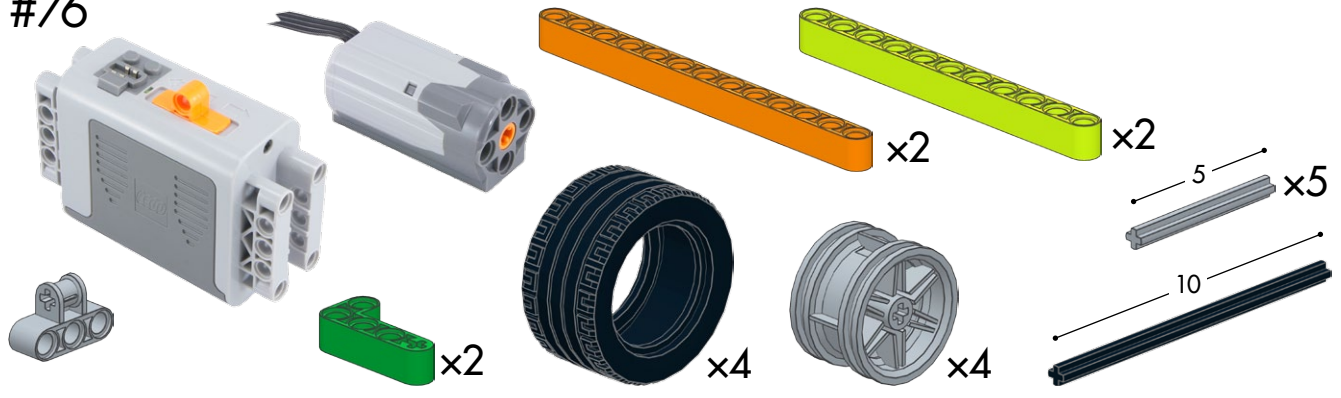
#74

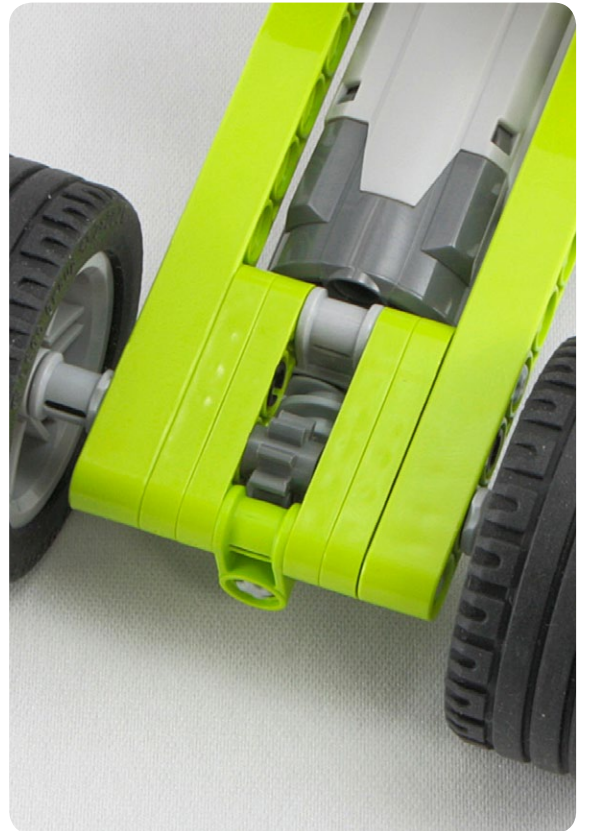
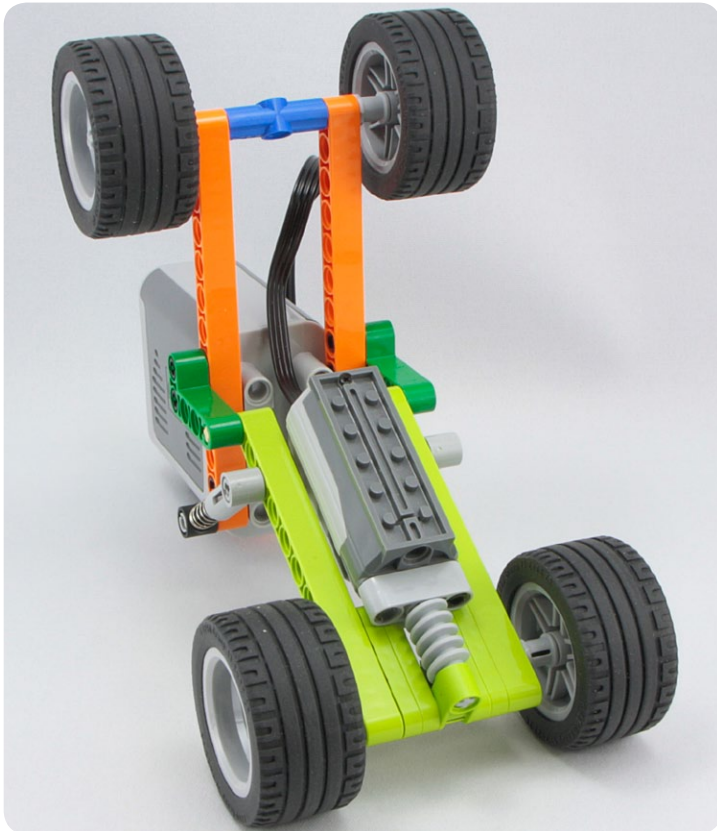
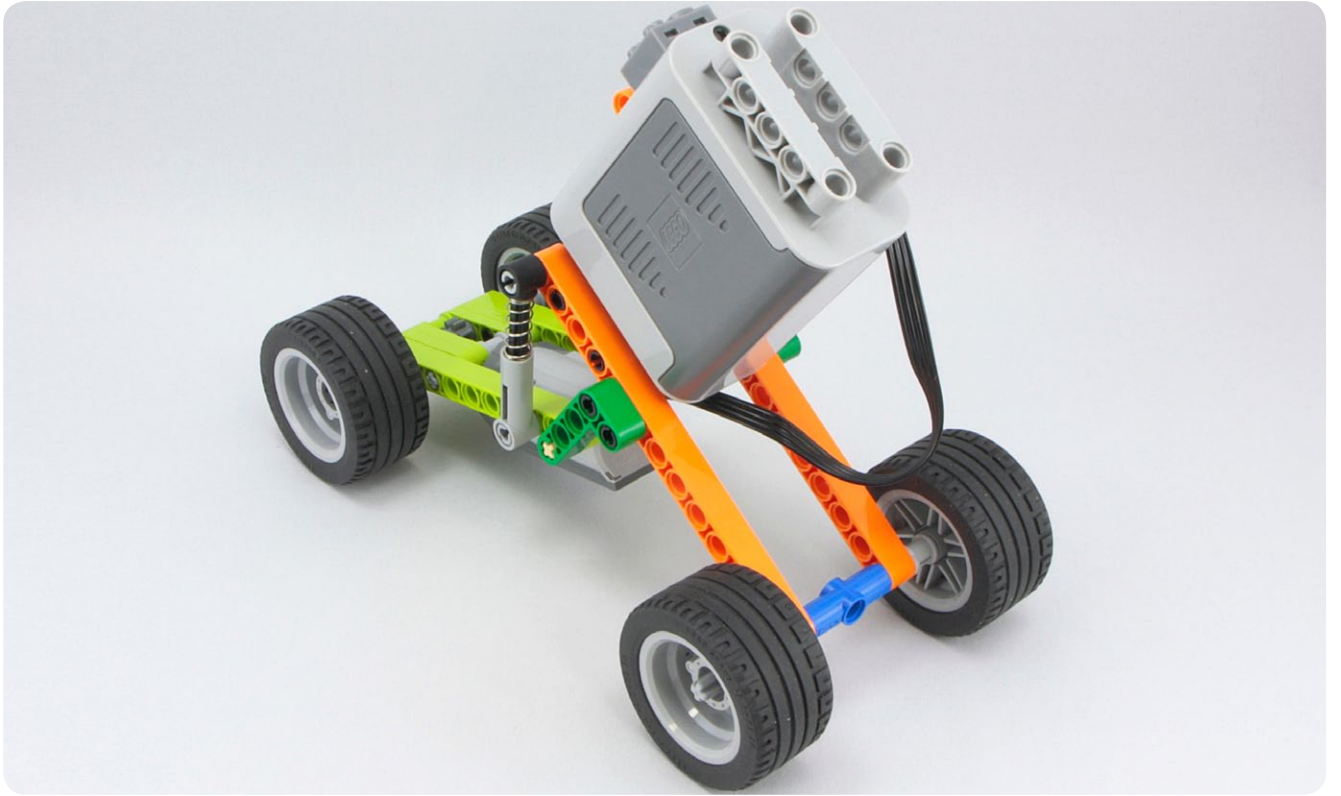




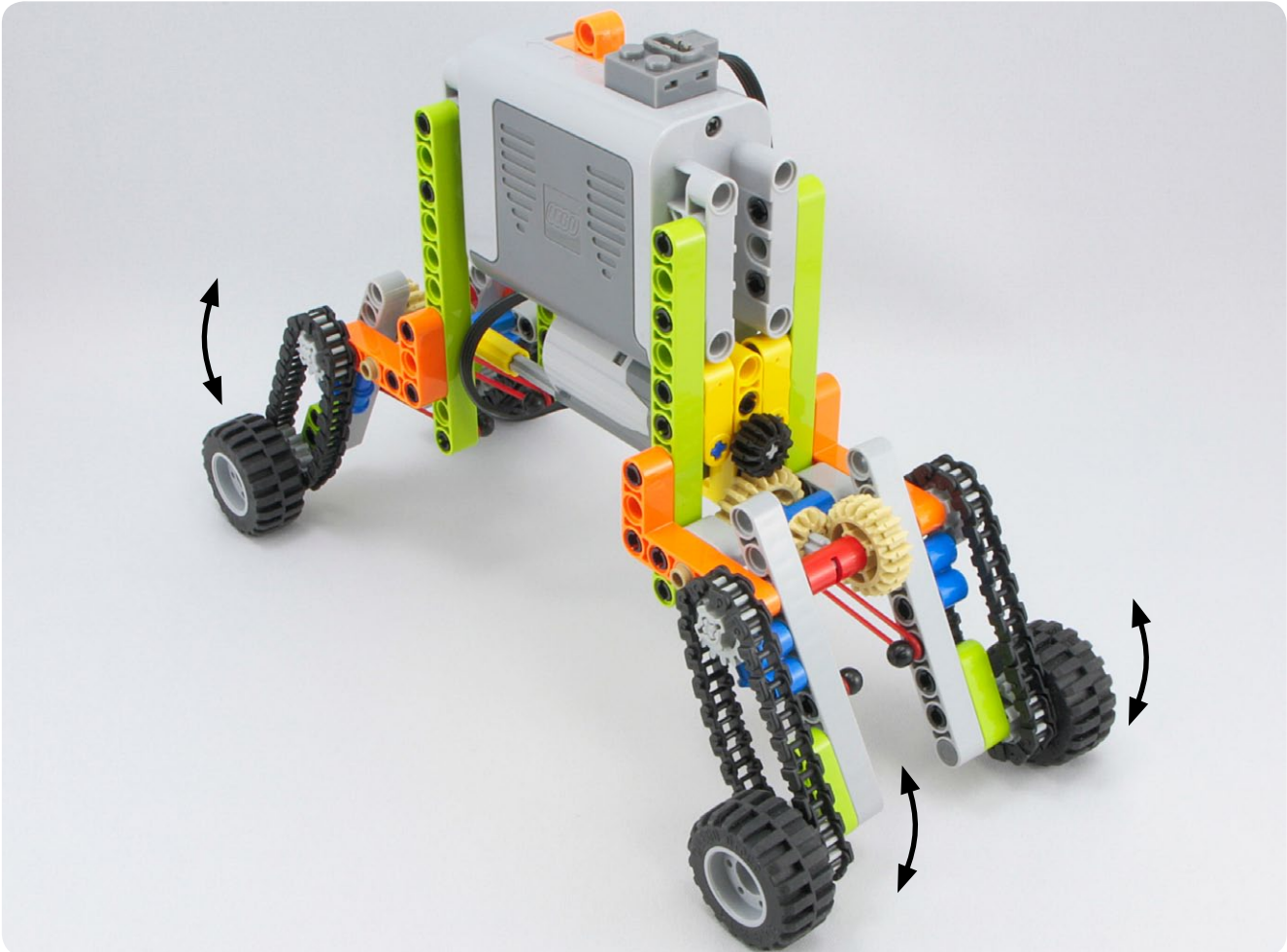
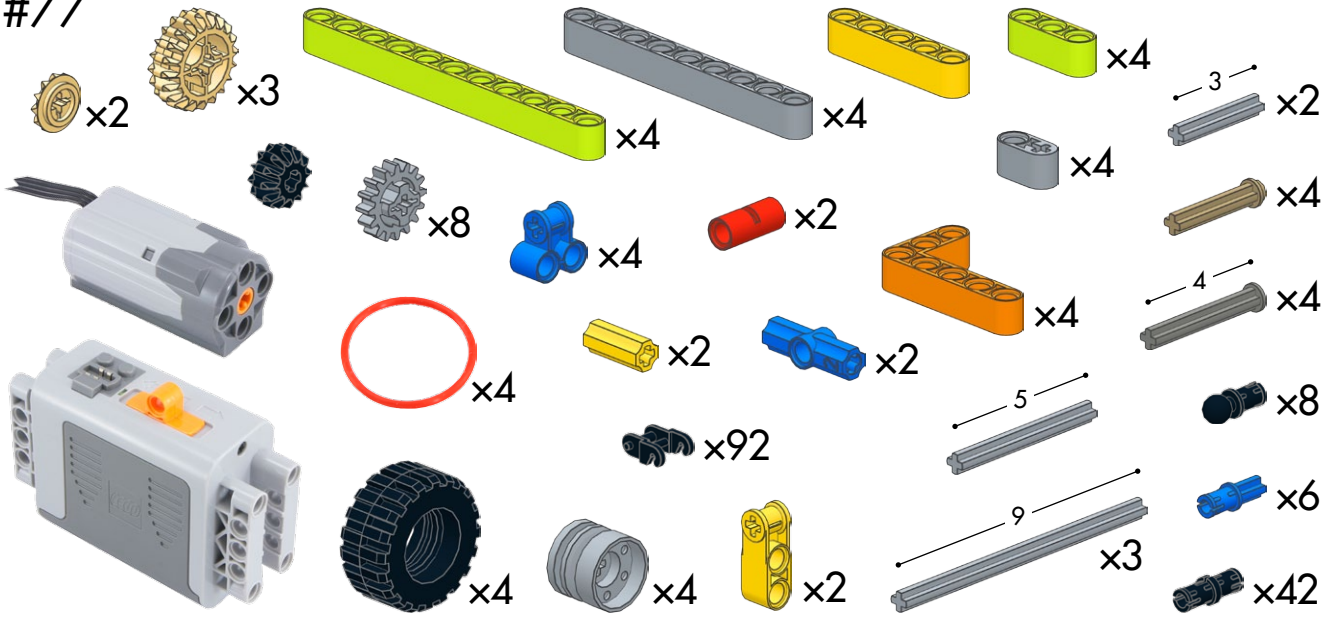


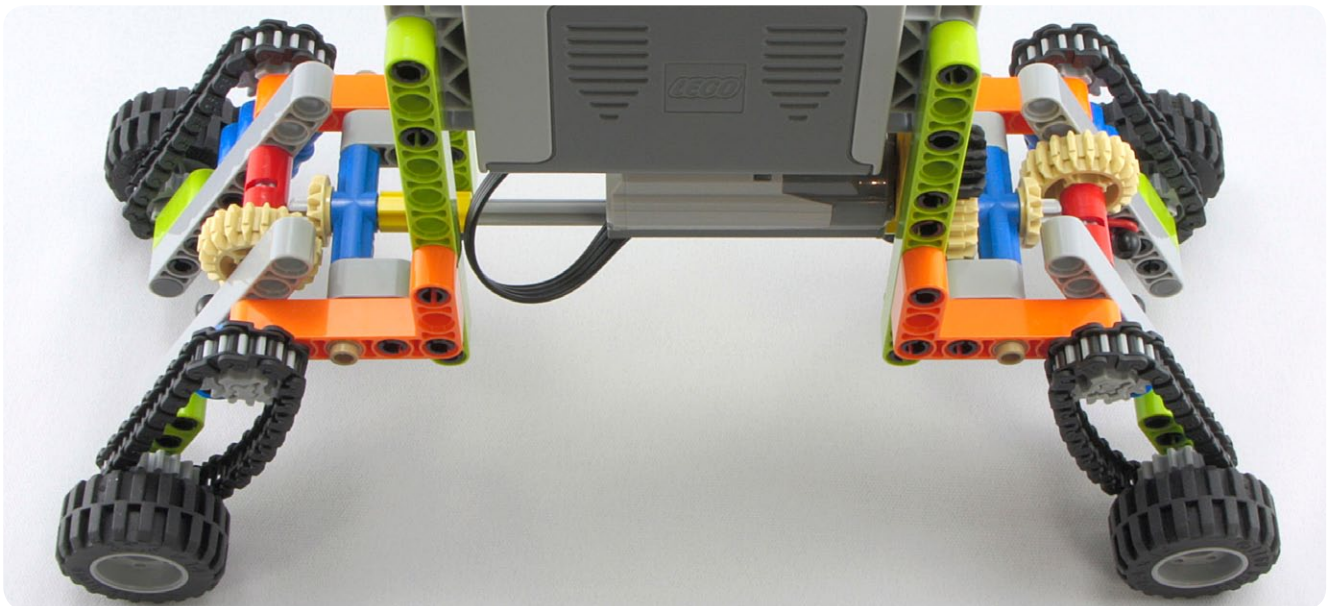
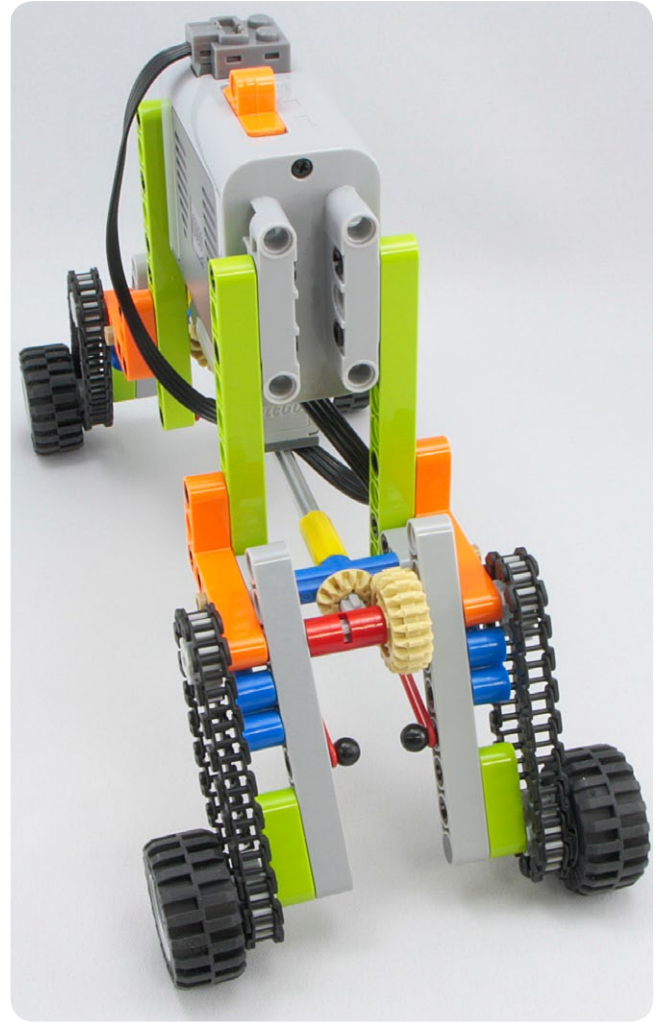
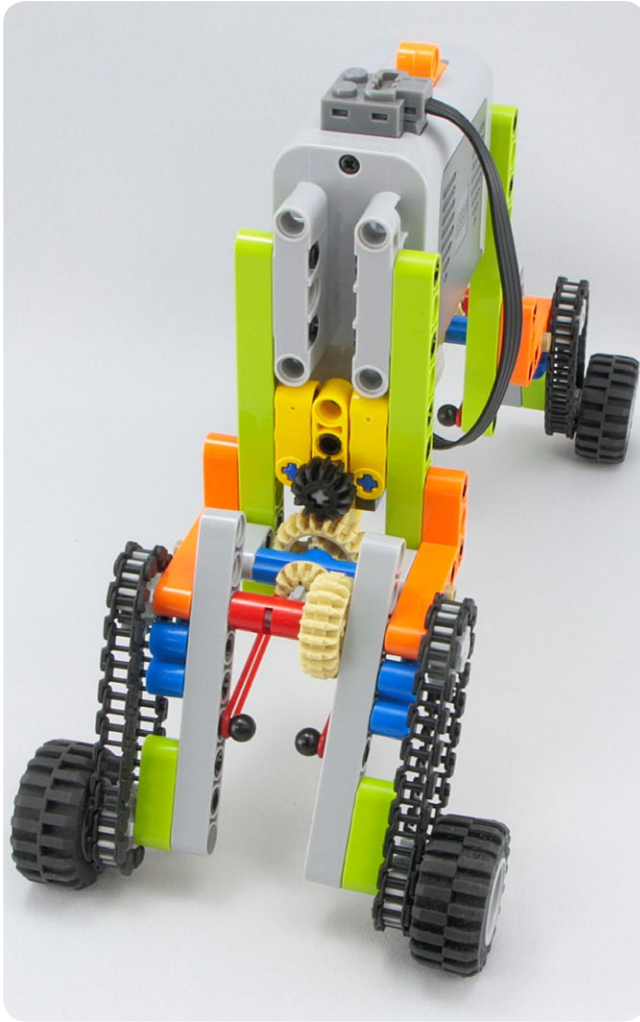
#76

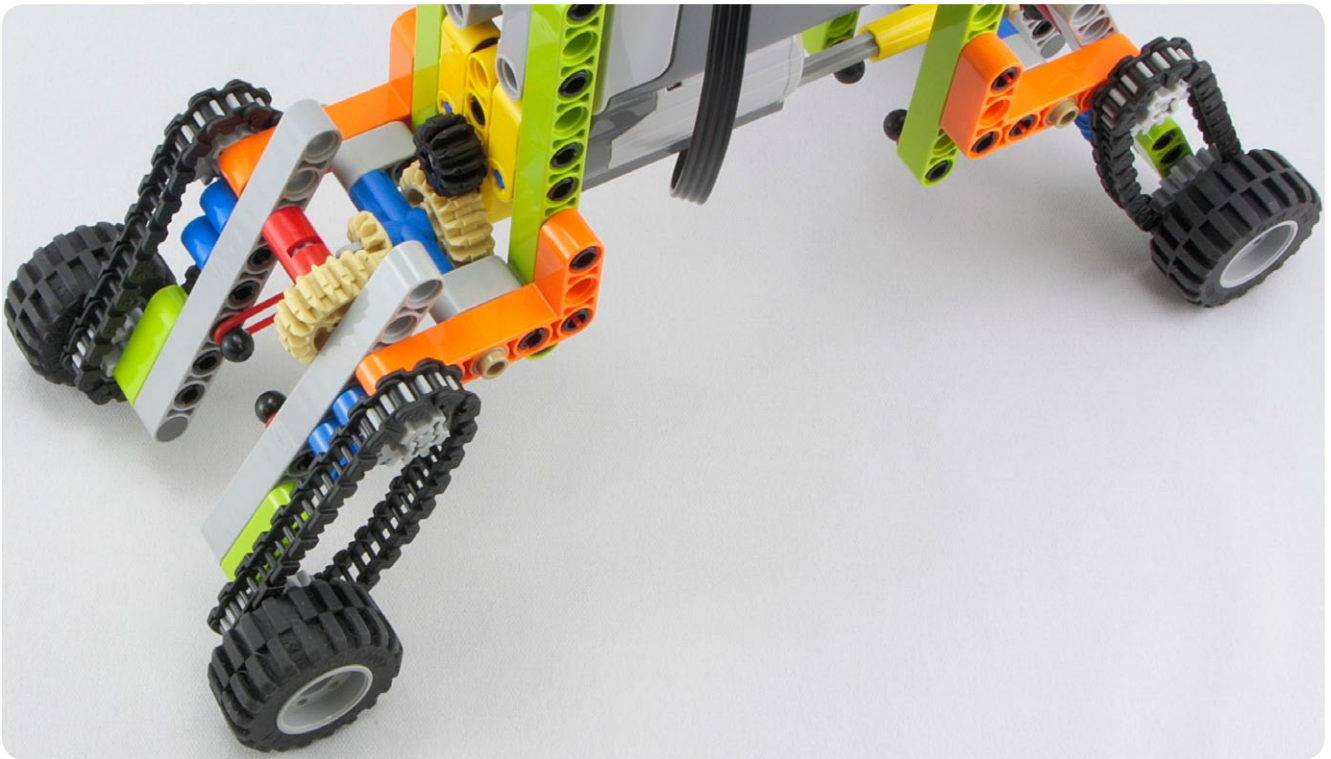


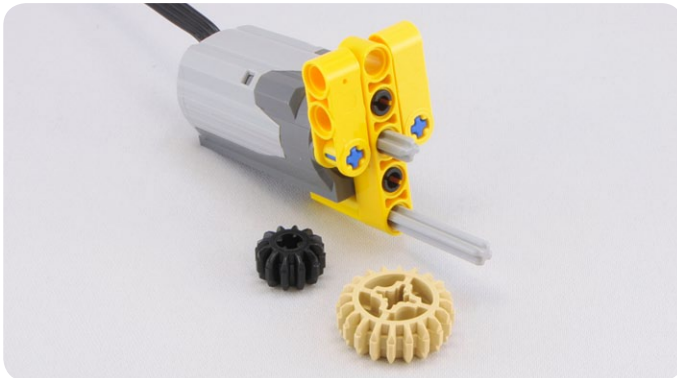
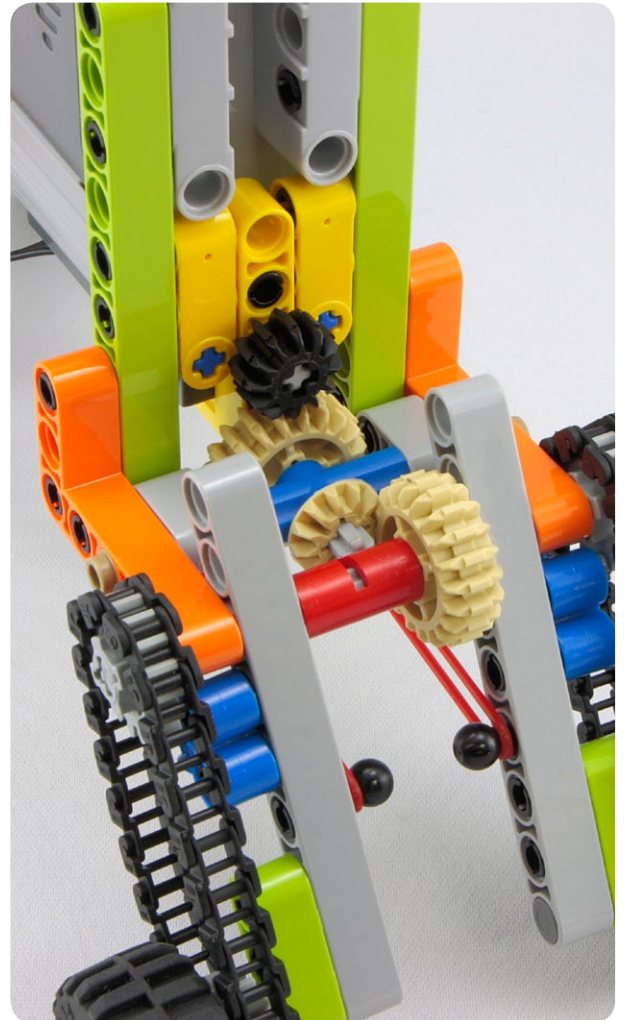
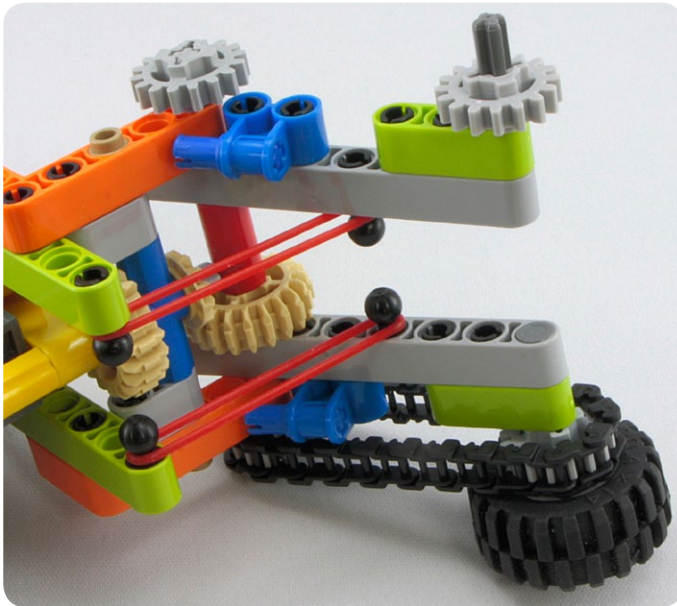
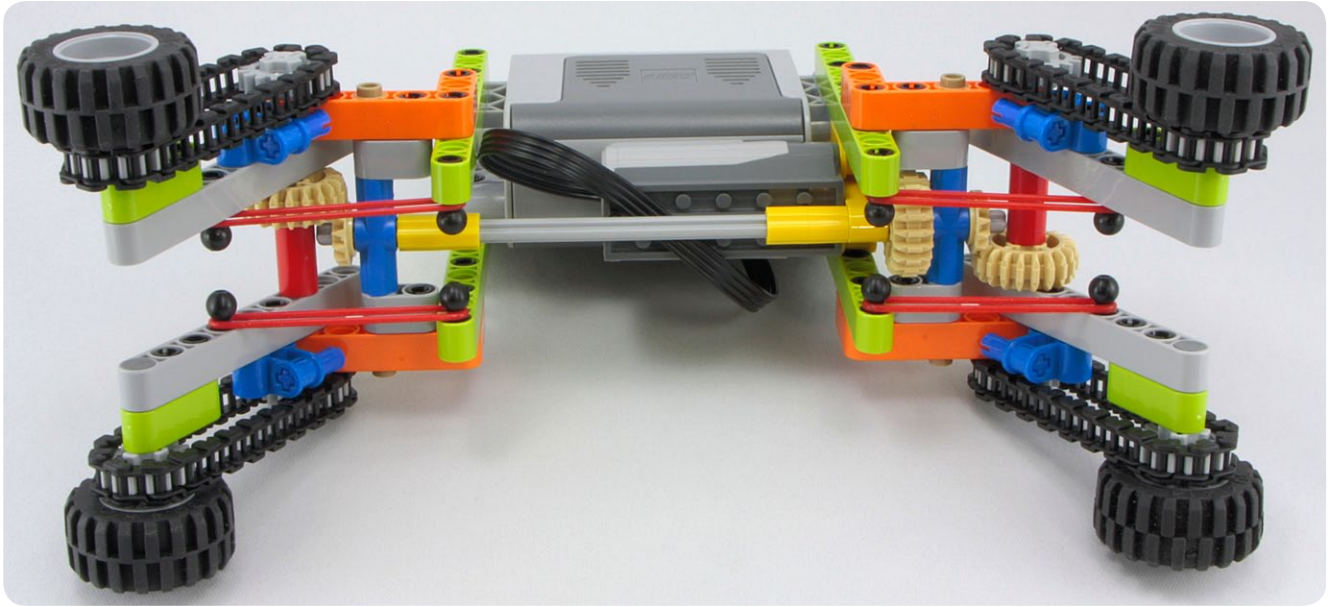


#77

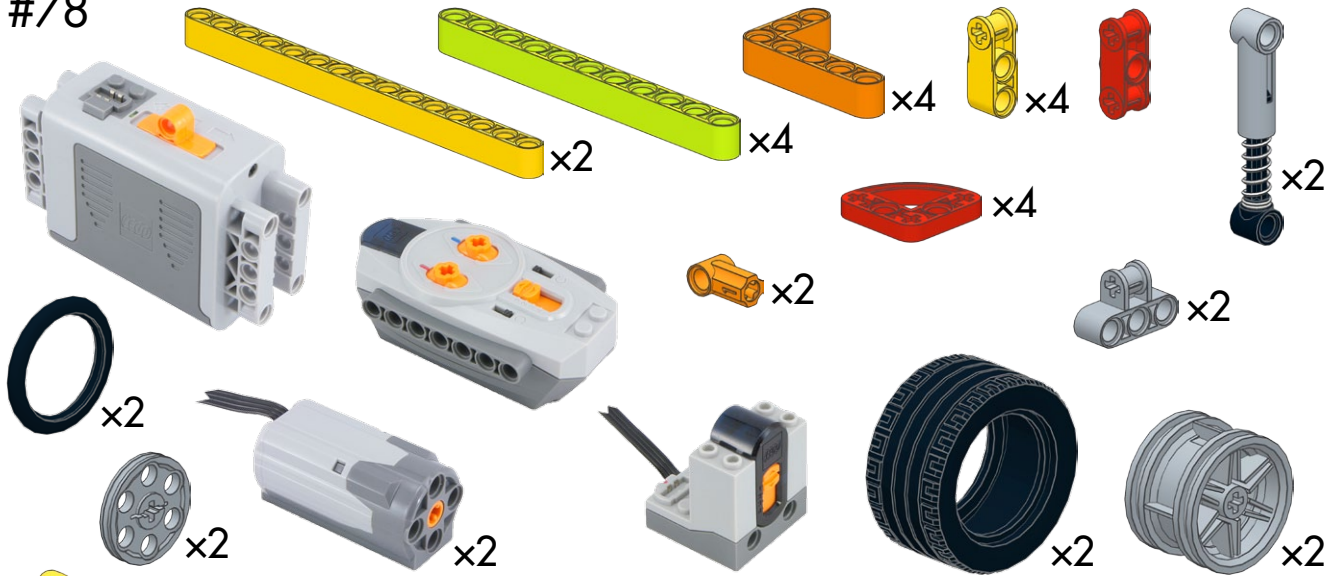


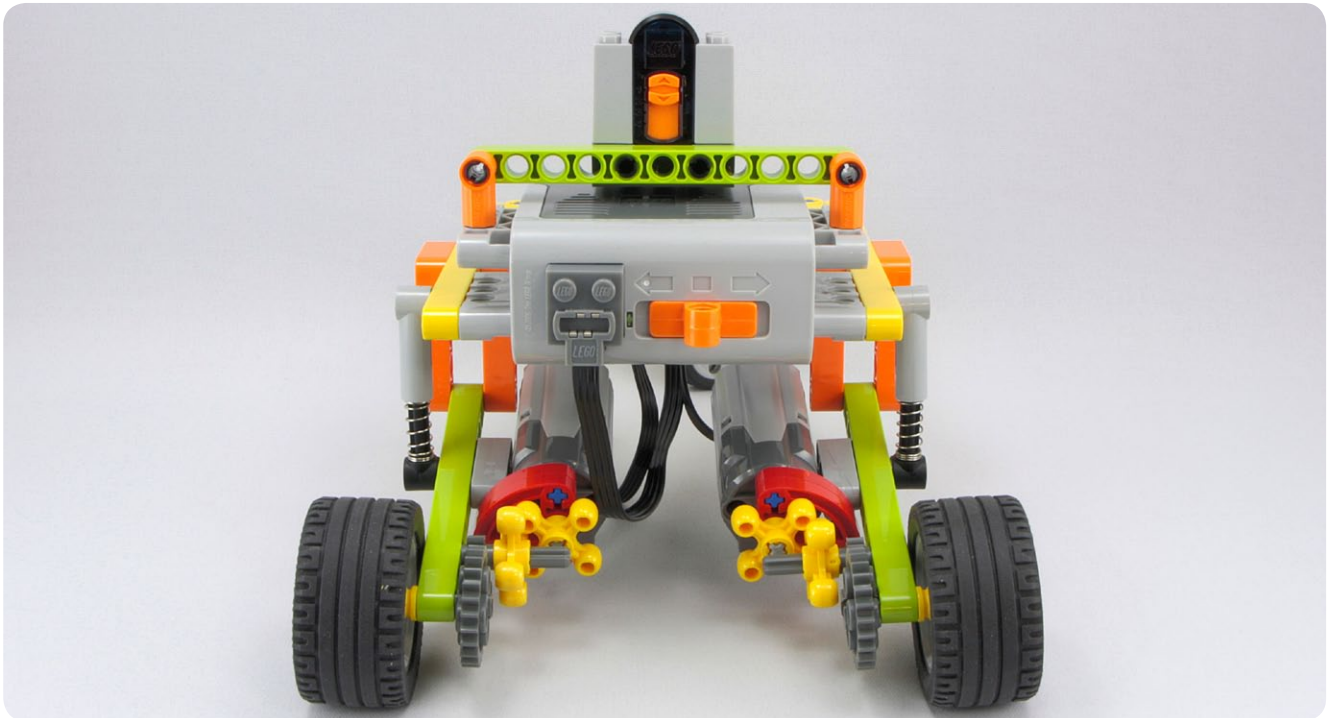
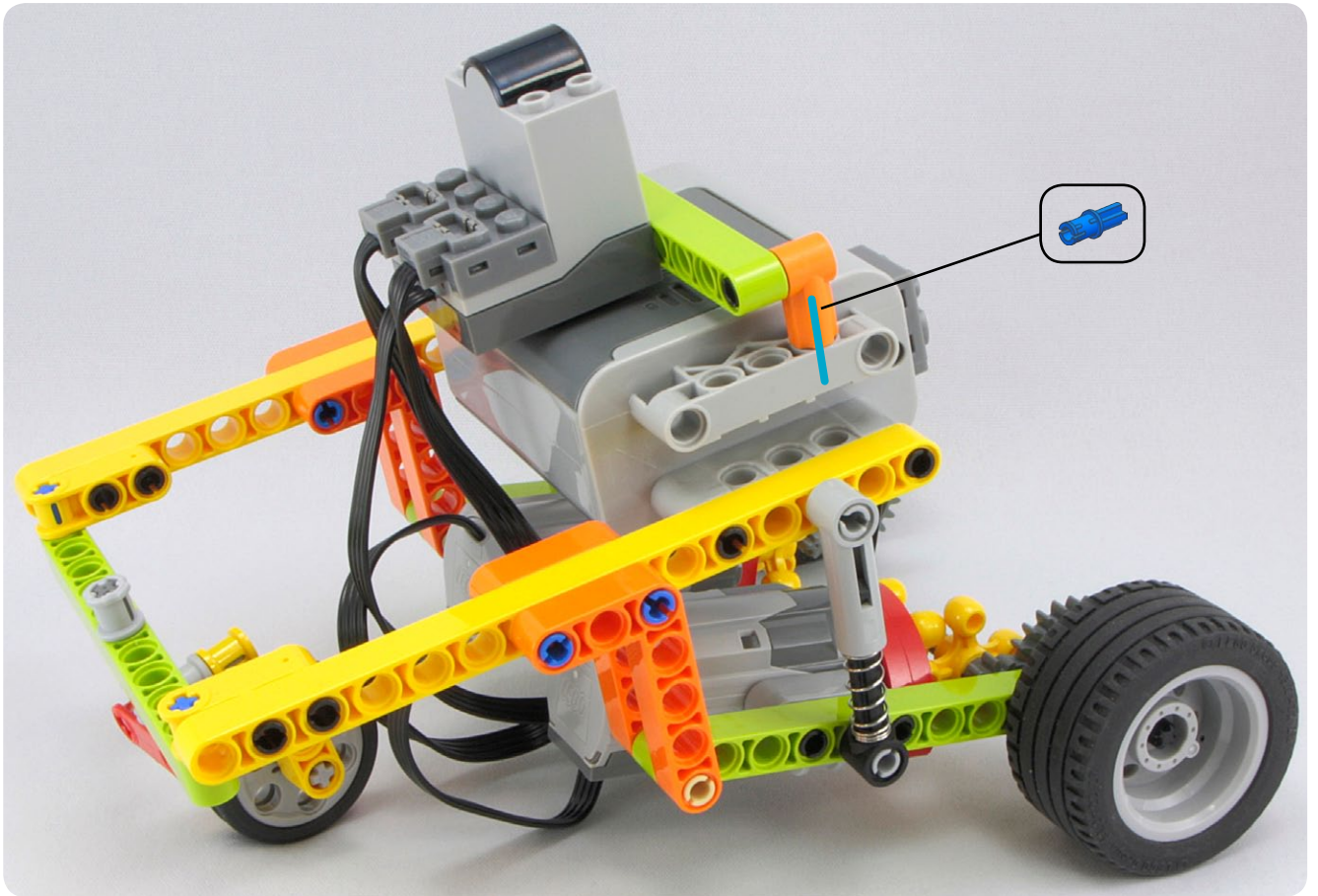


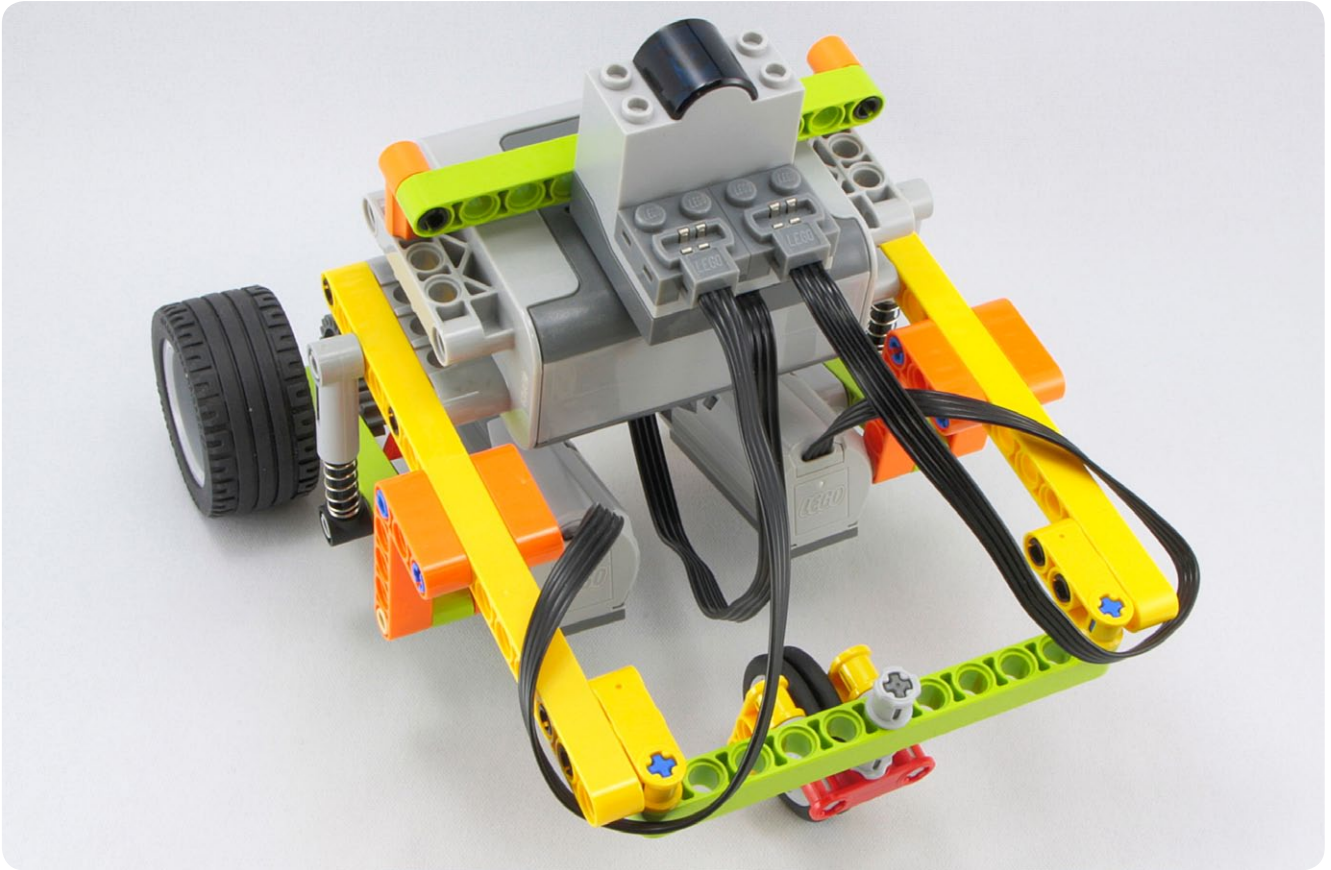




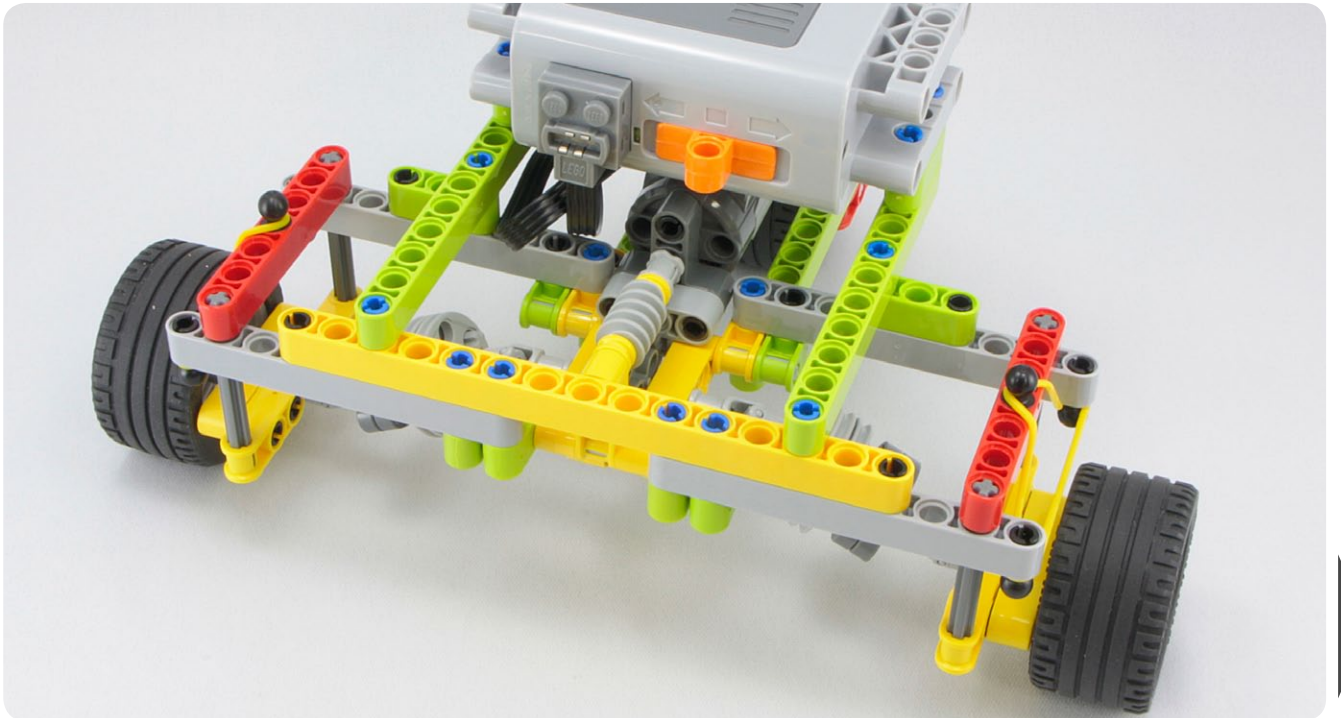
#78

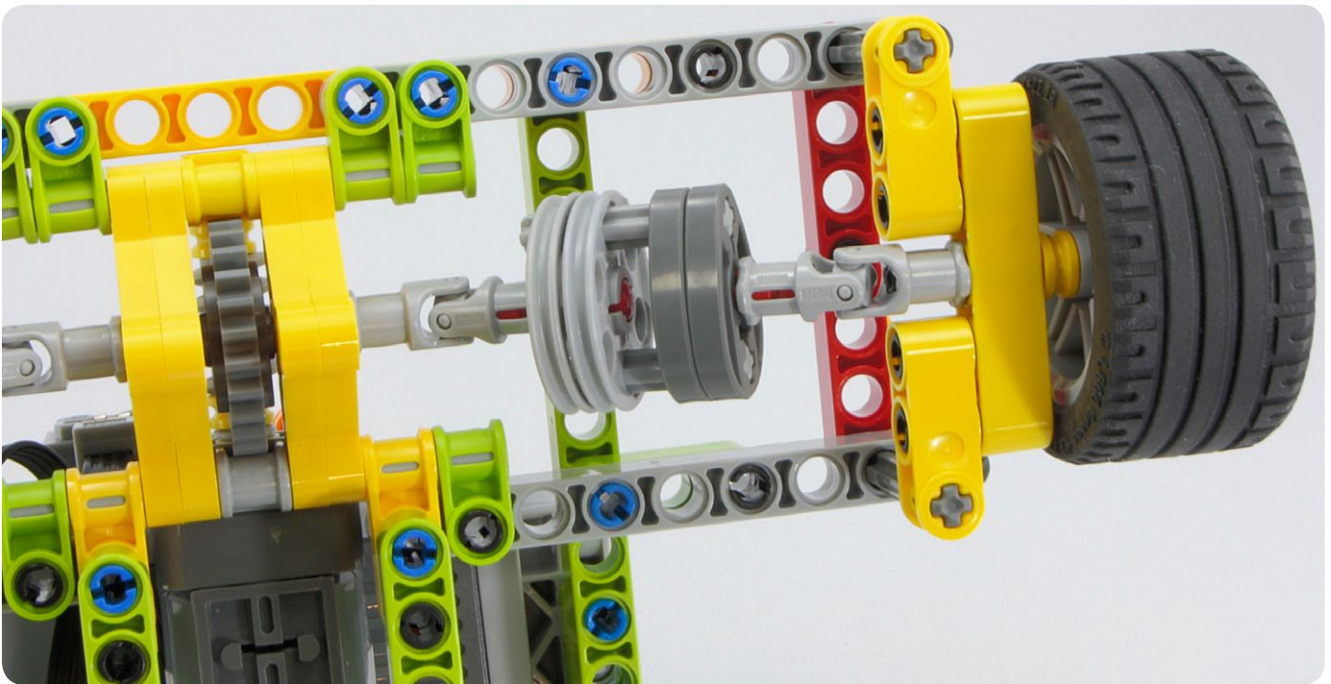


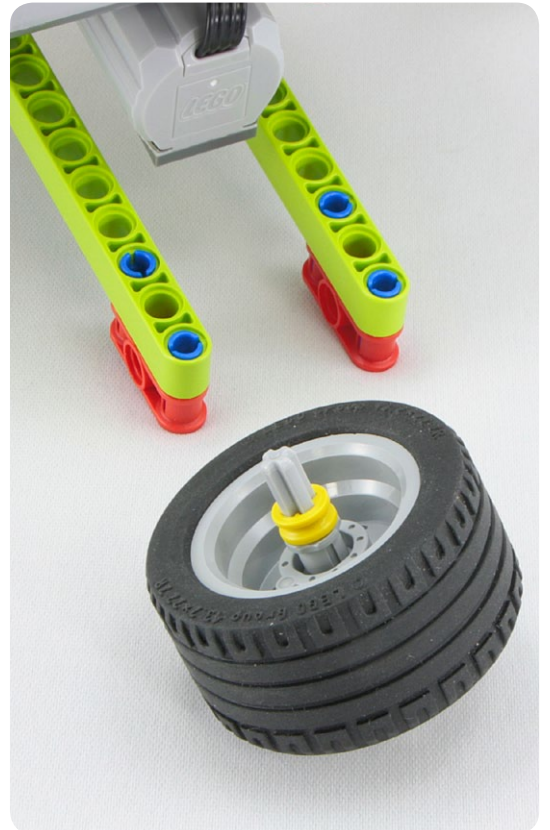
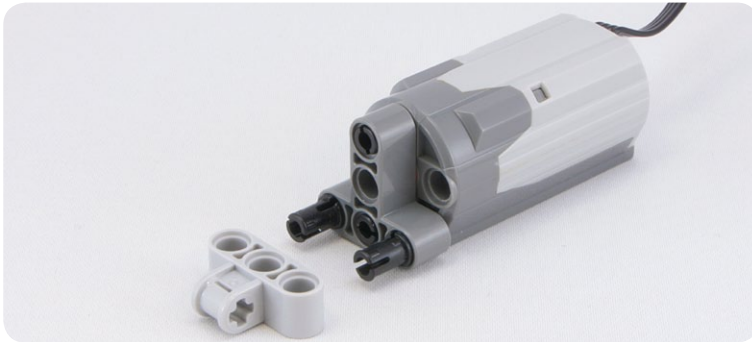
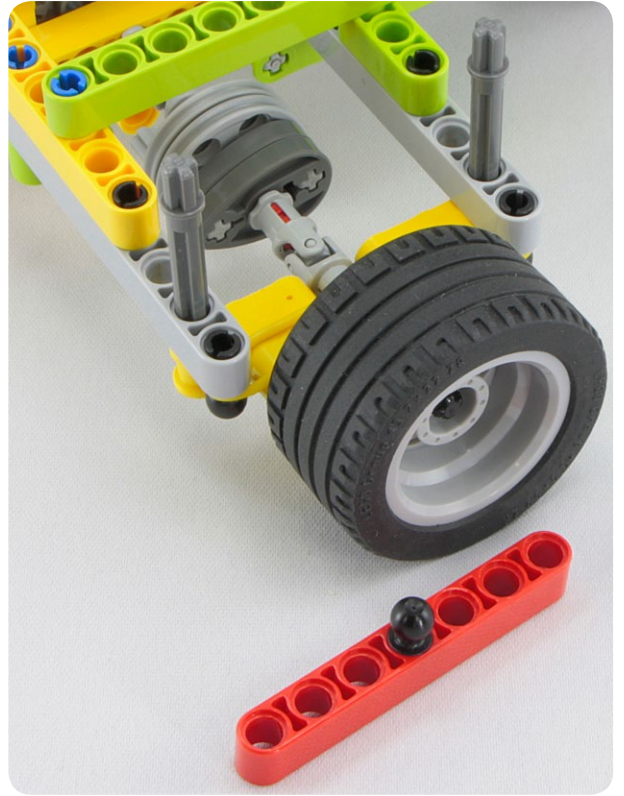






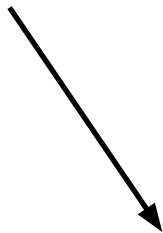
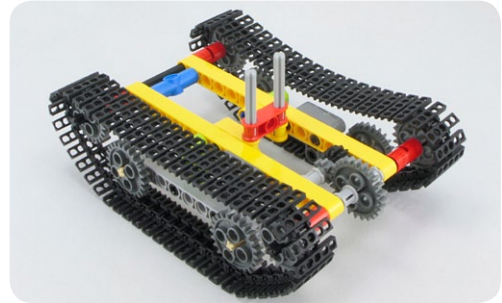


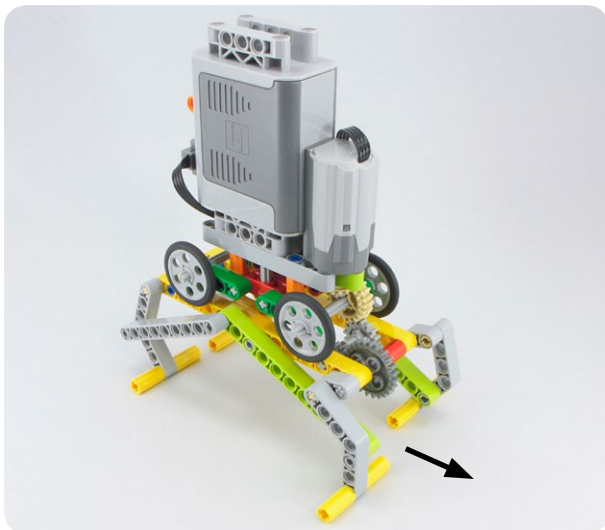
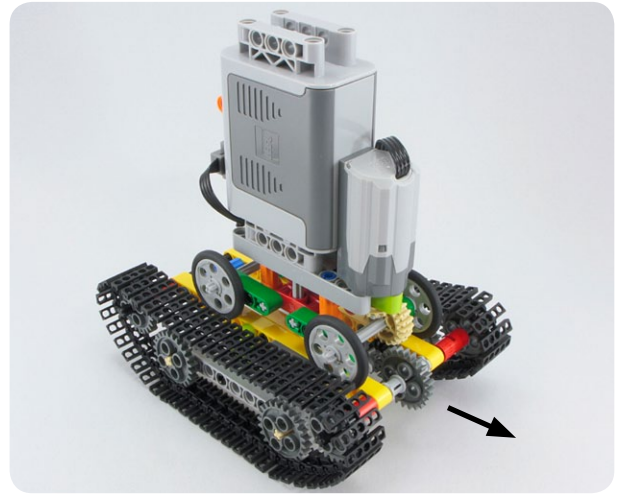
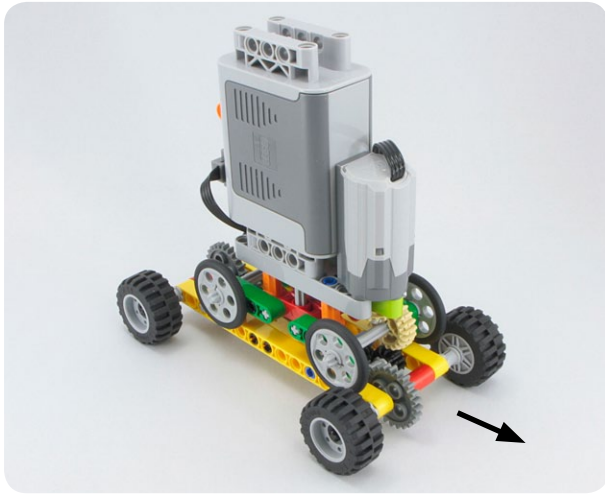




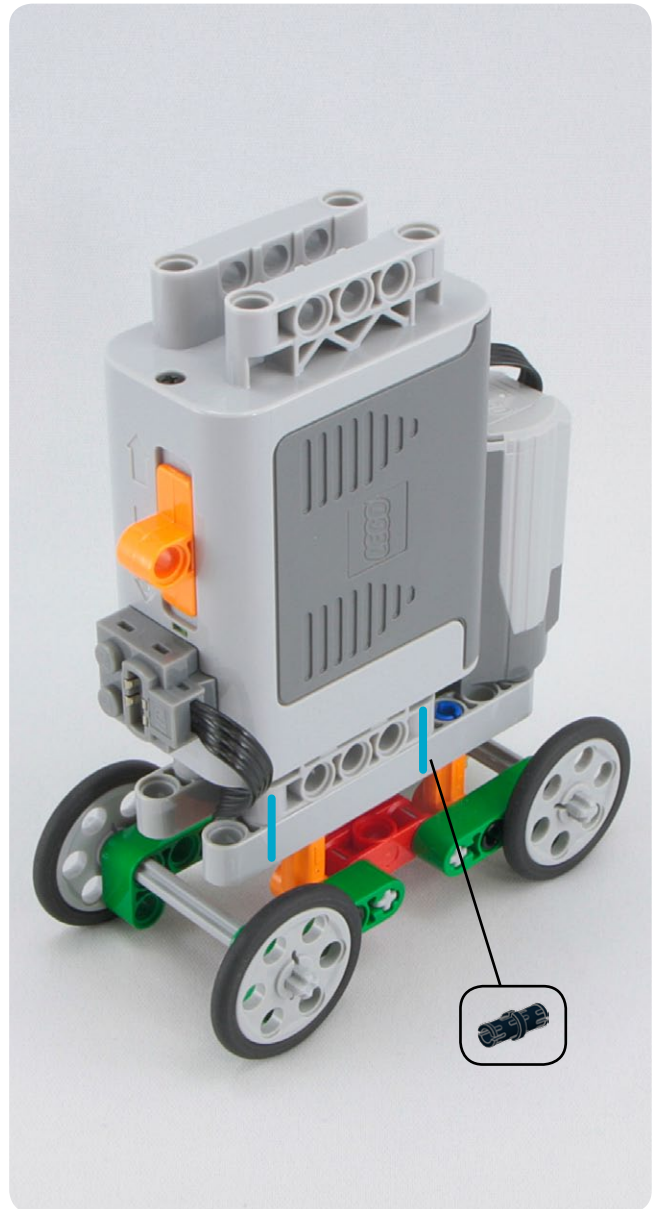
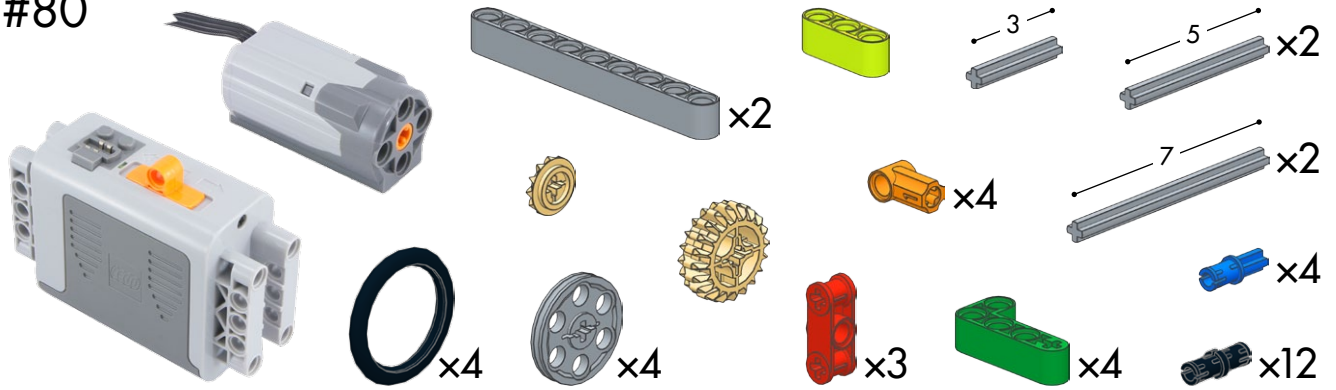


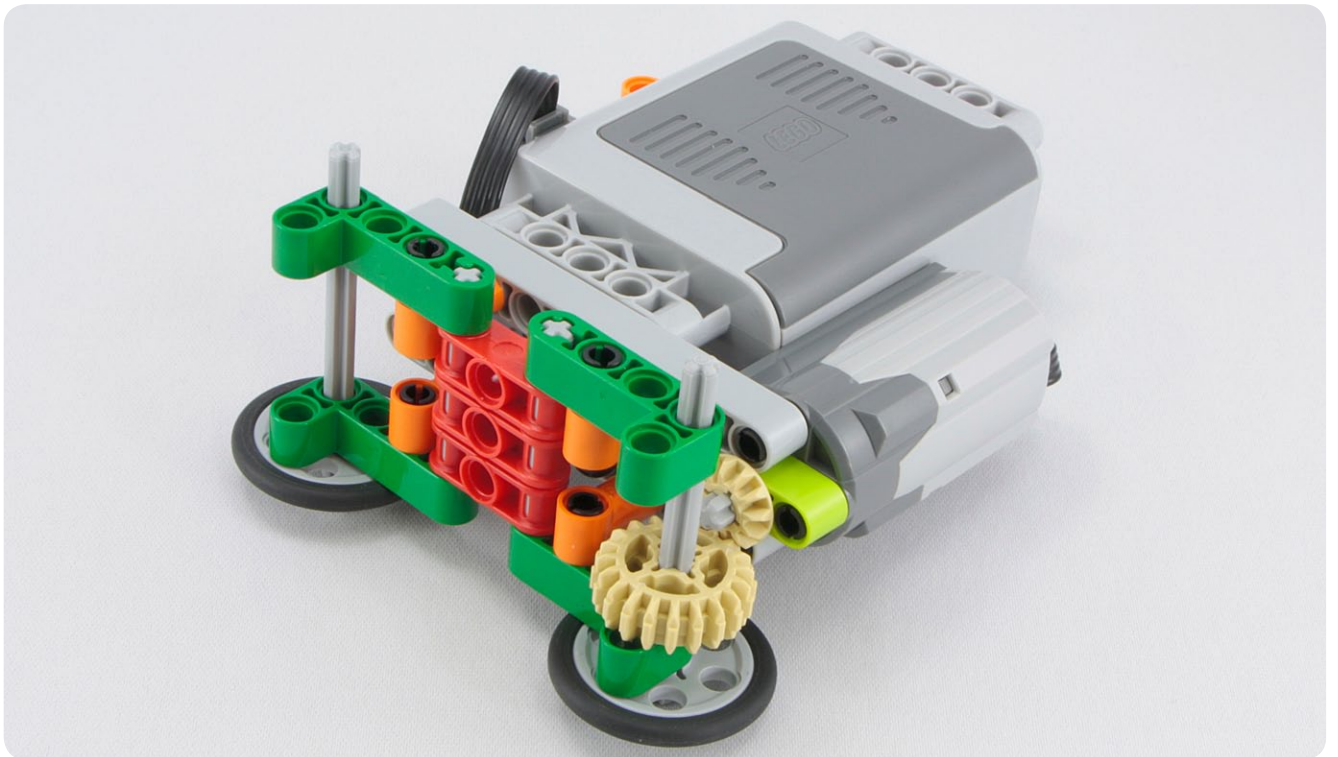
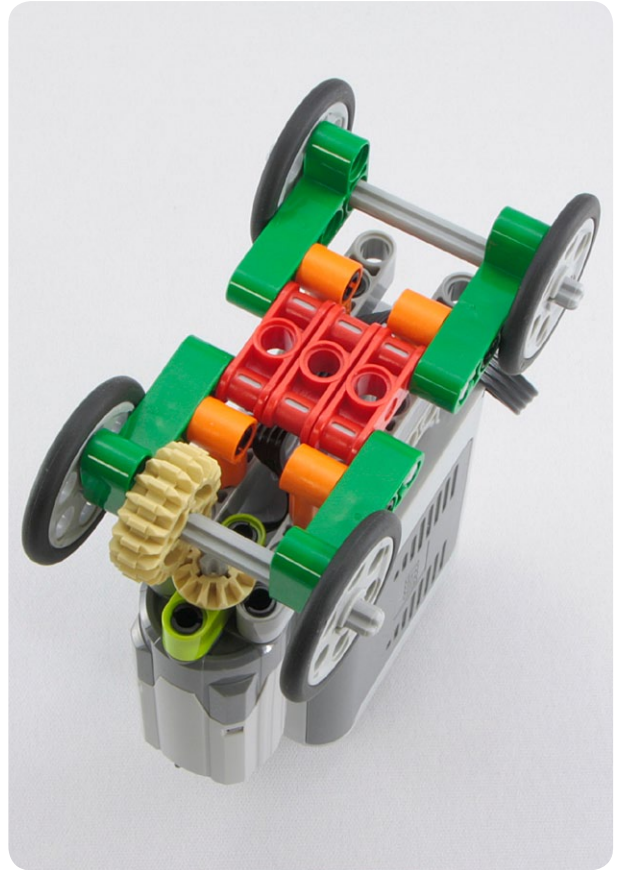
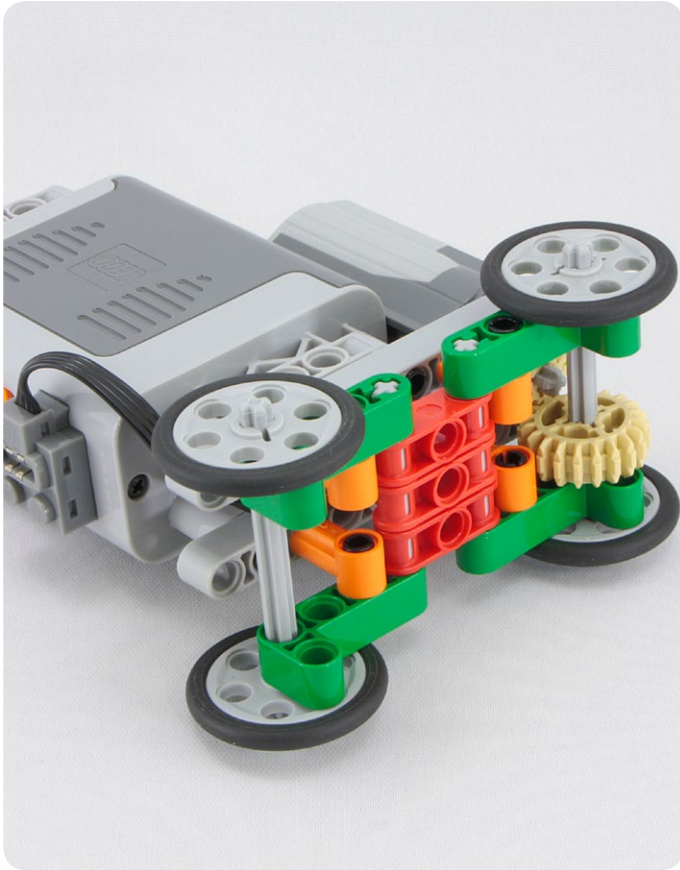
Five different bases for a small car



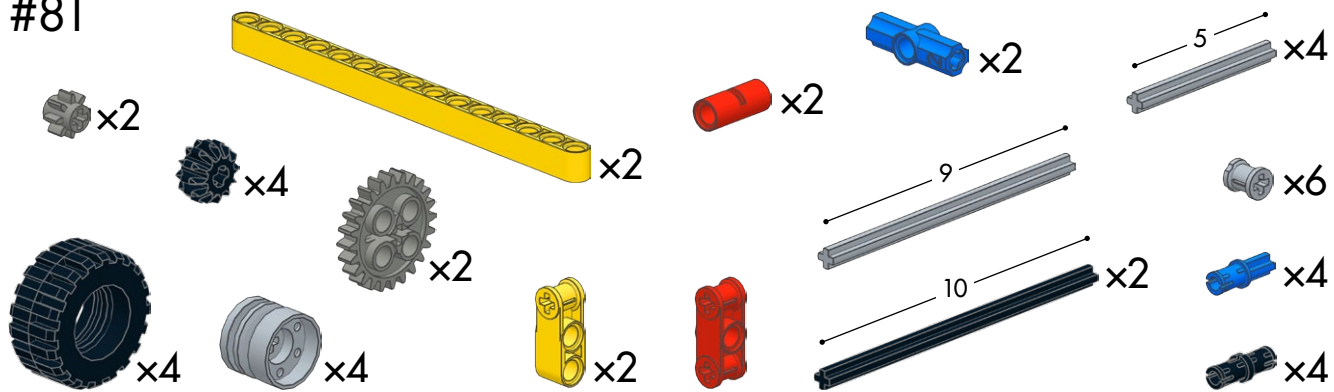


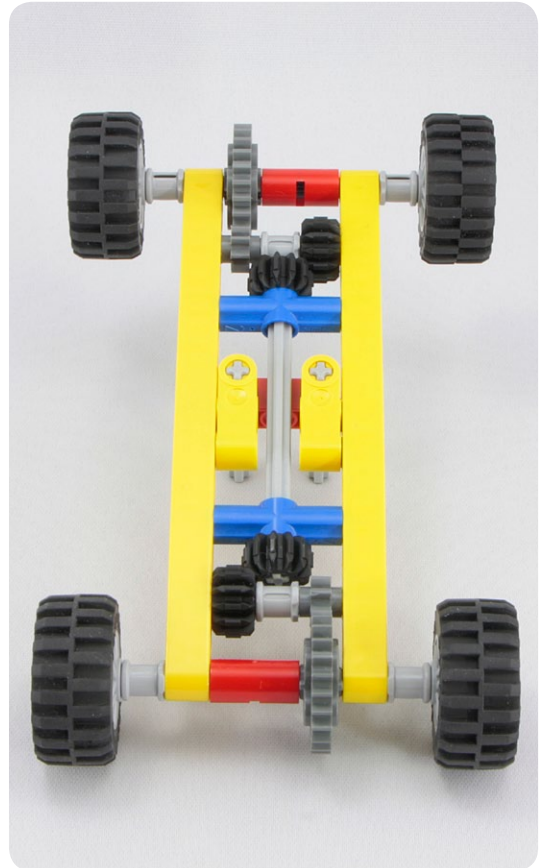
#80



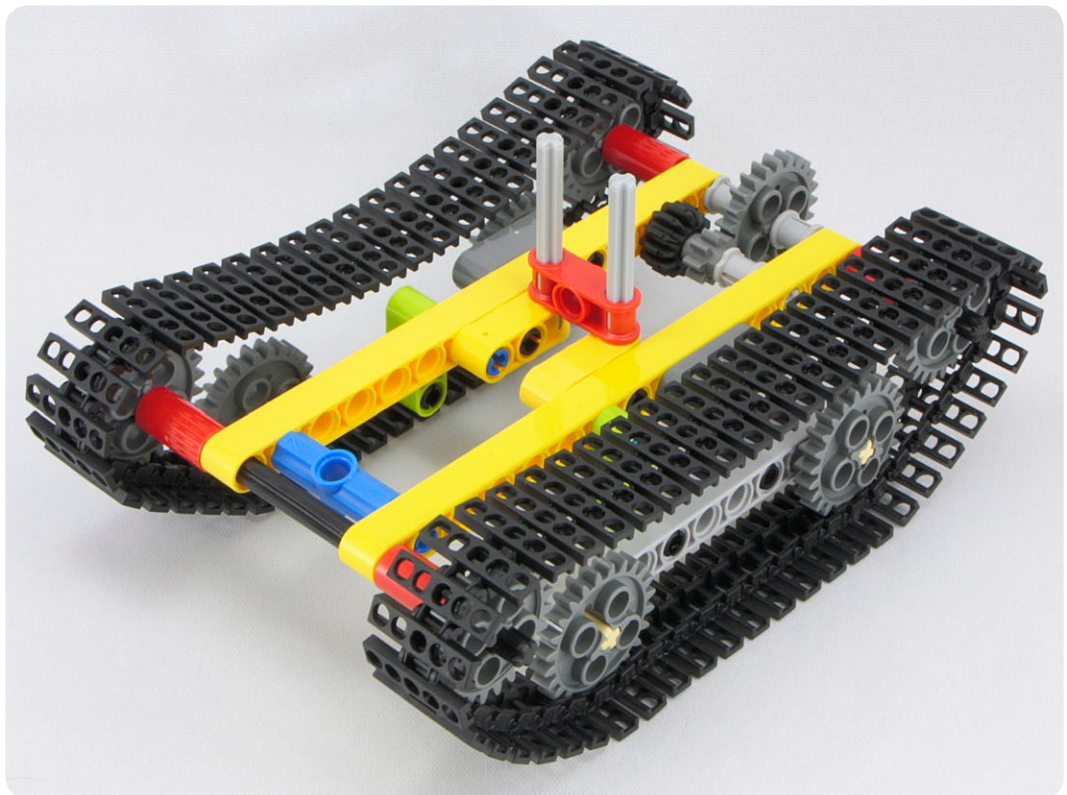
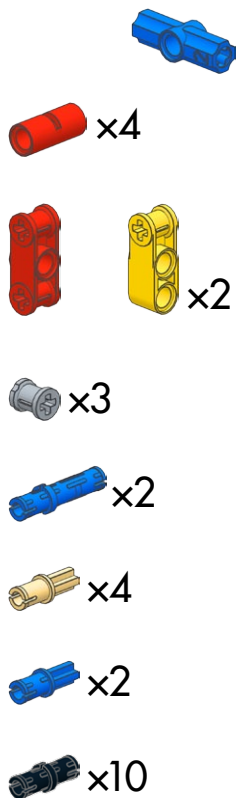
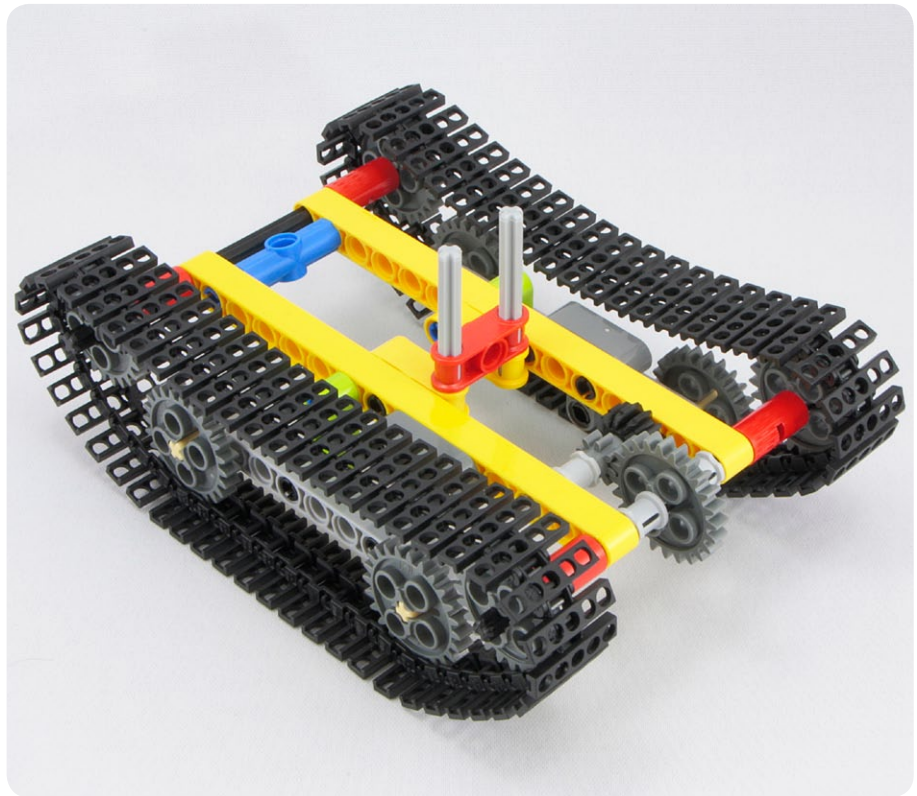
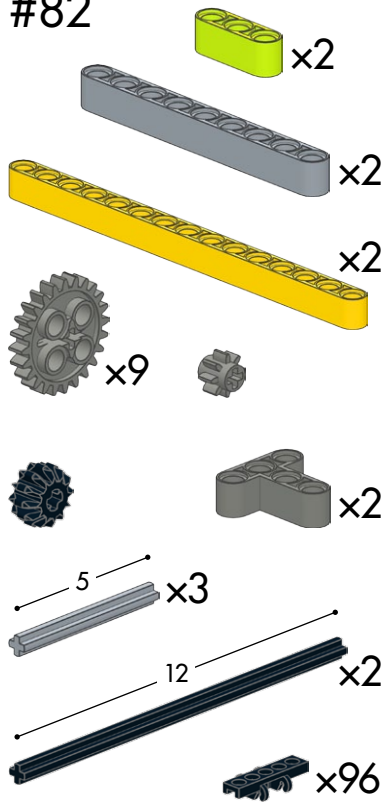


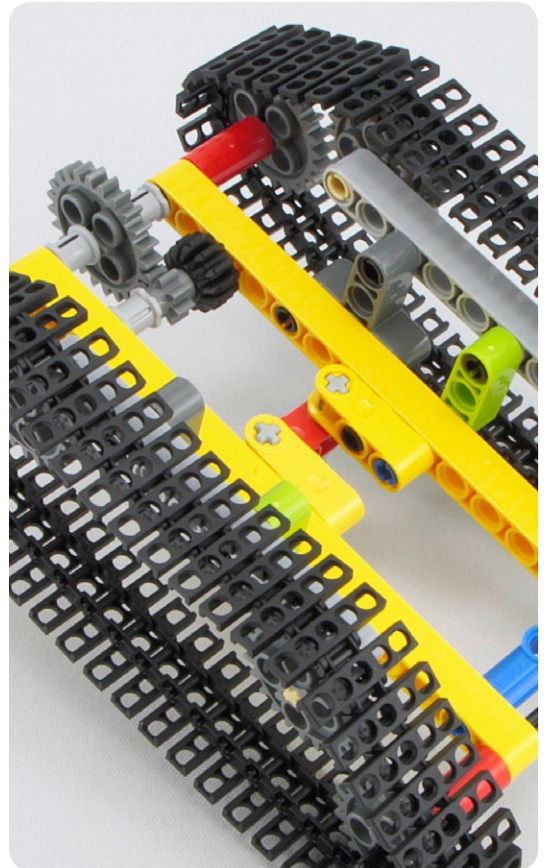
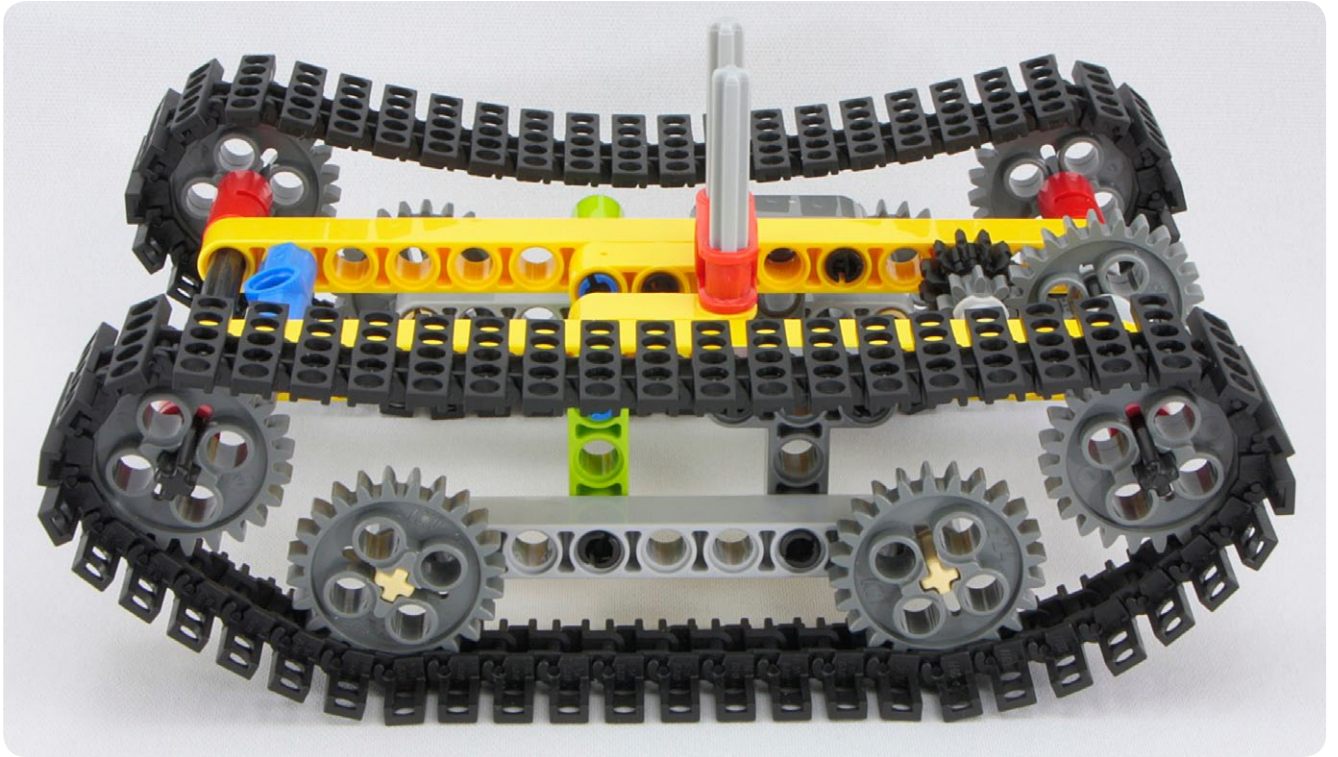
#81



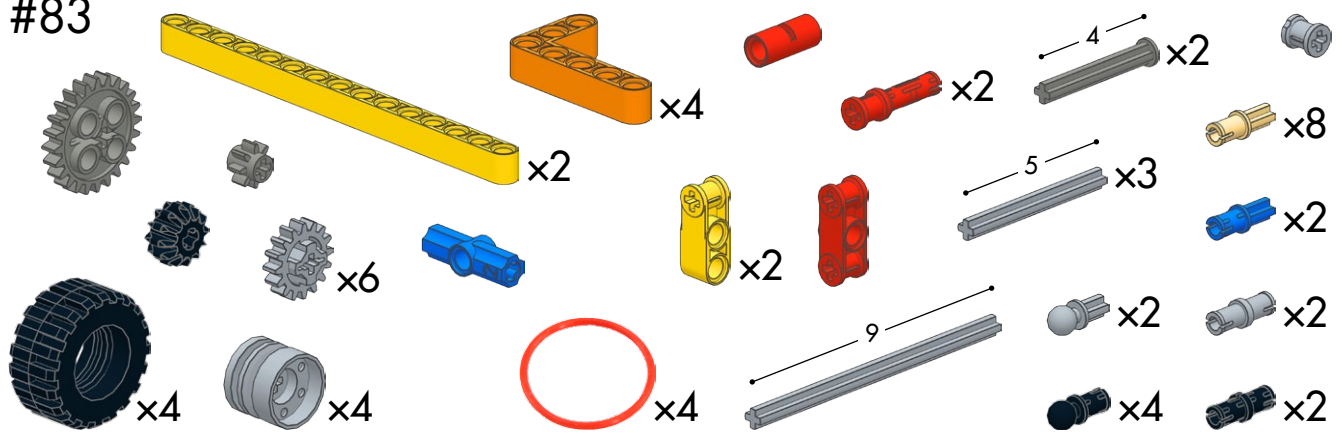


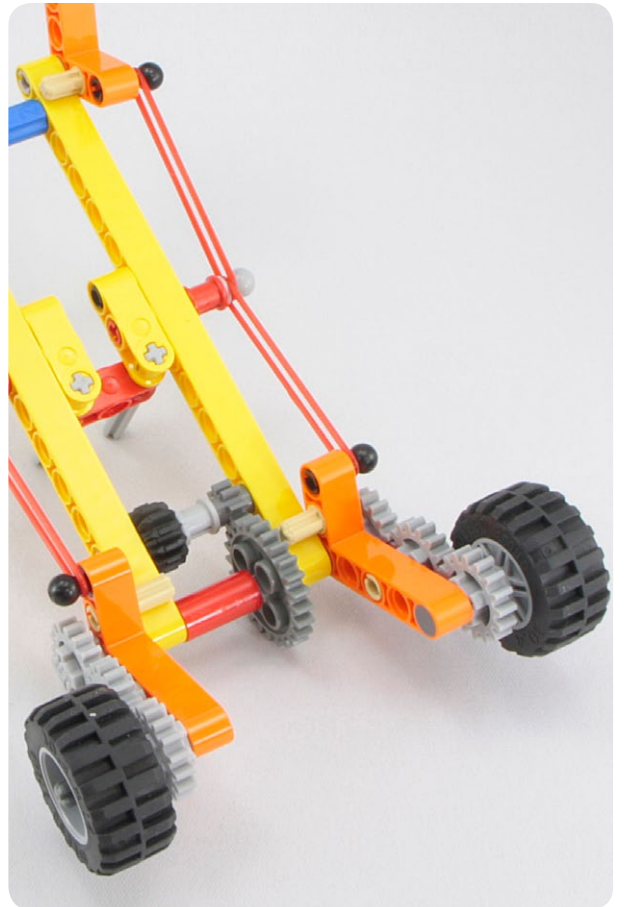
#82

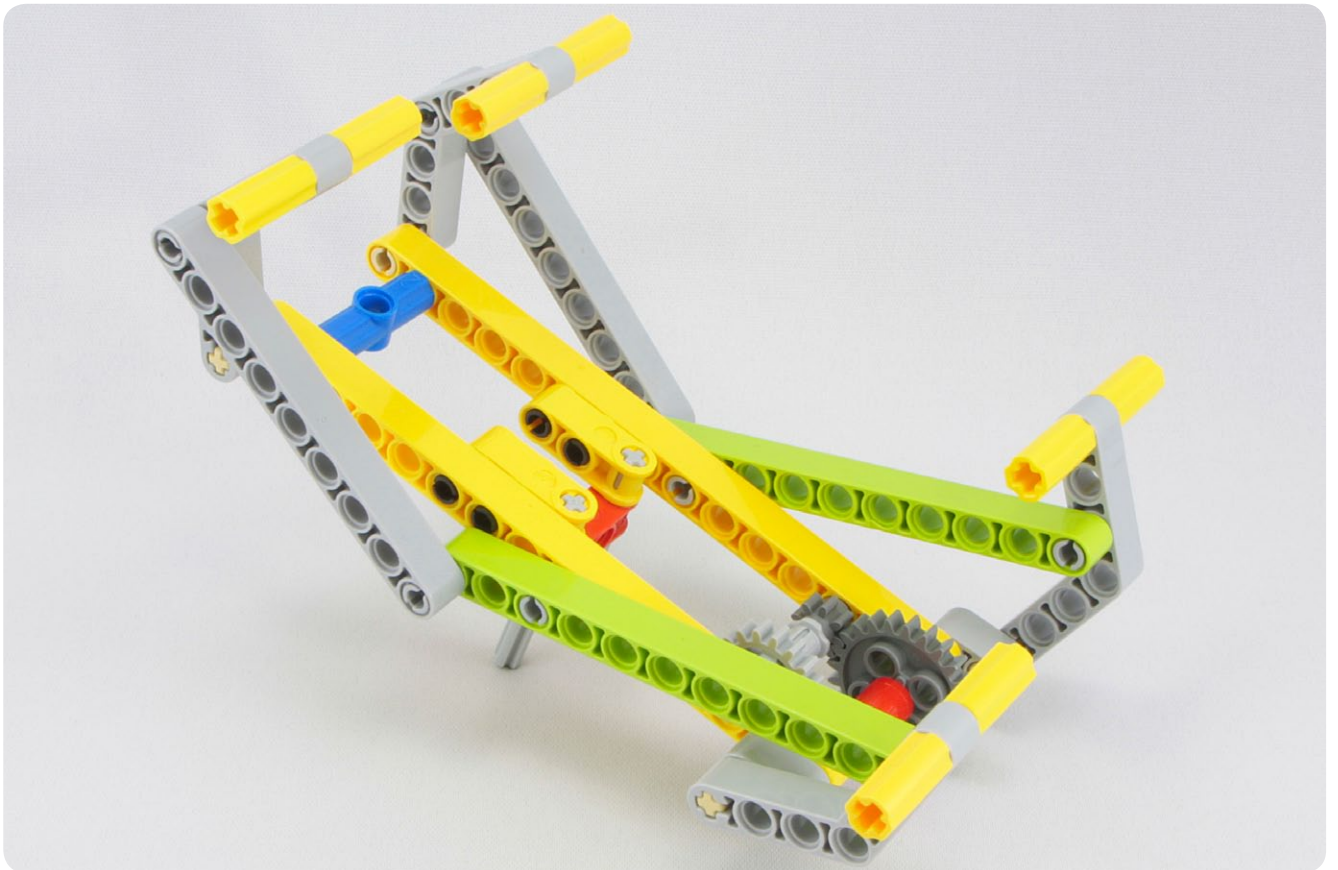
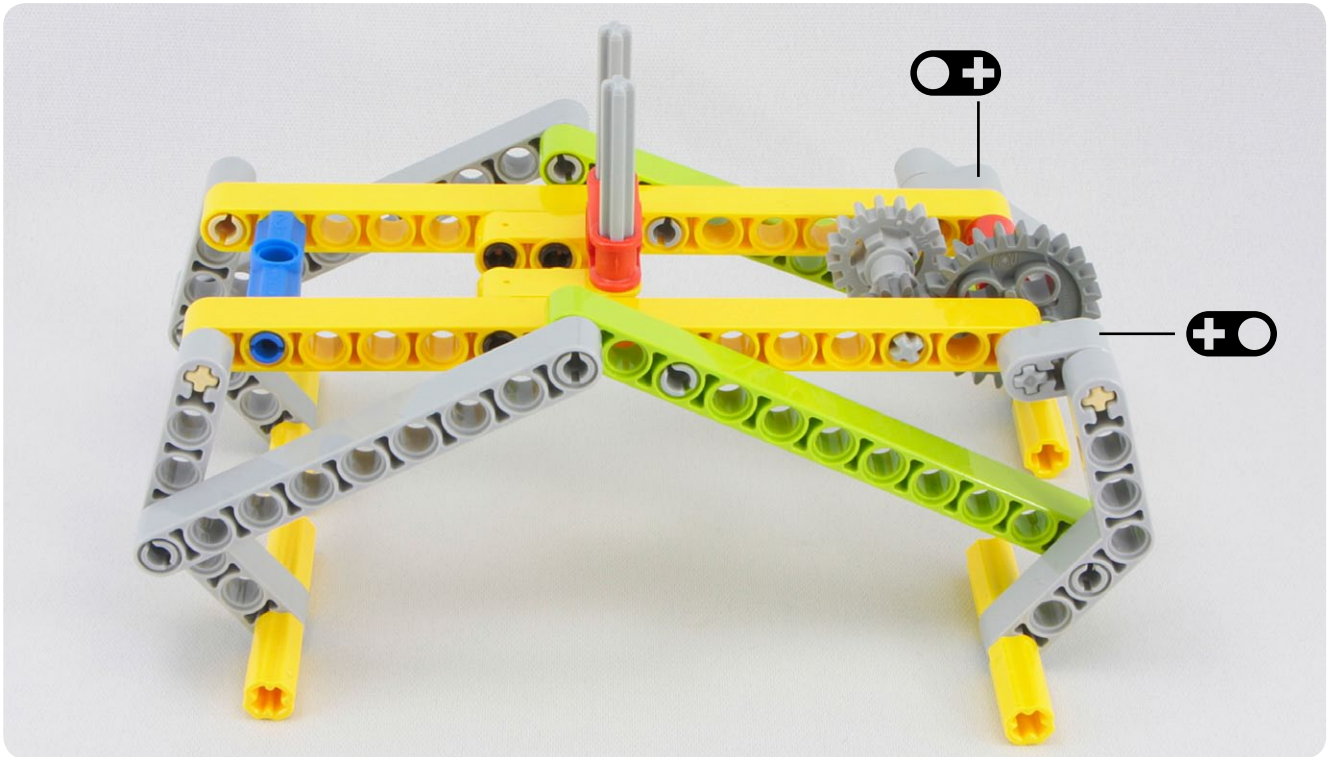




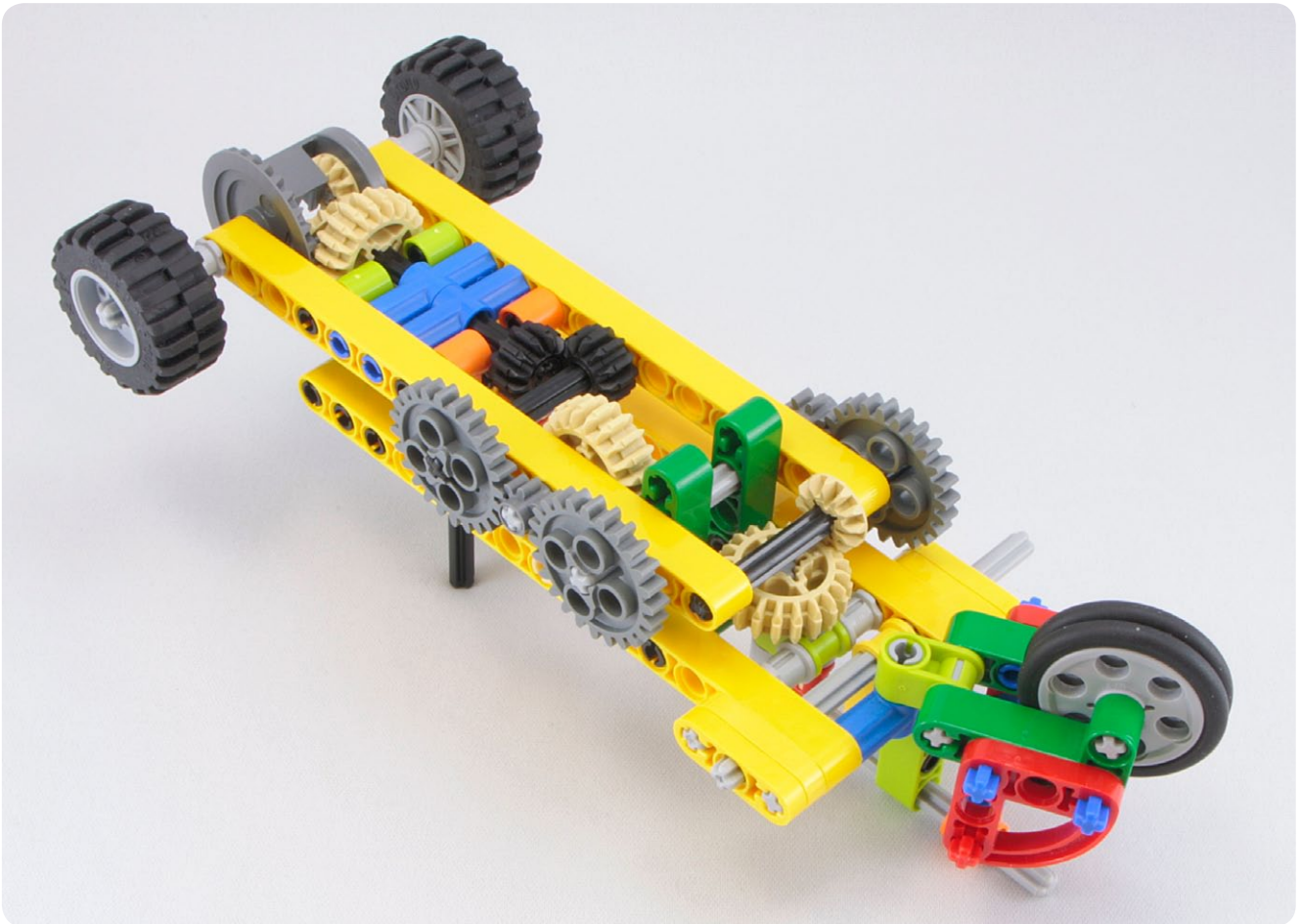
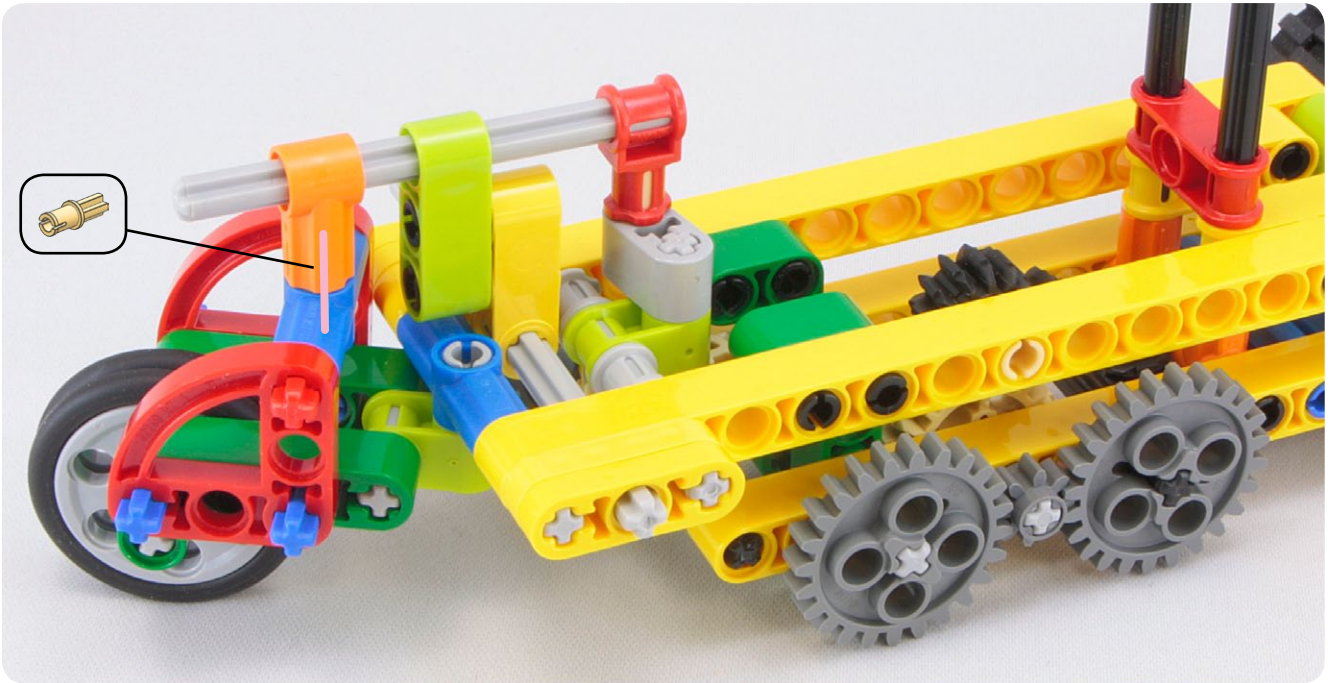
#83

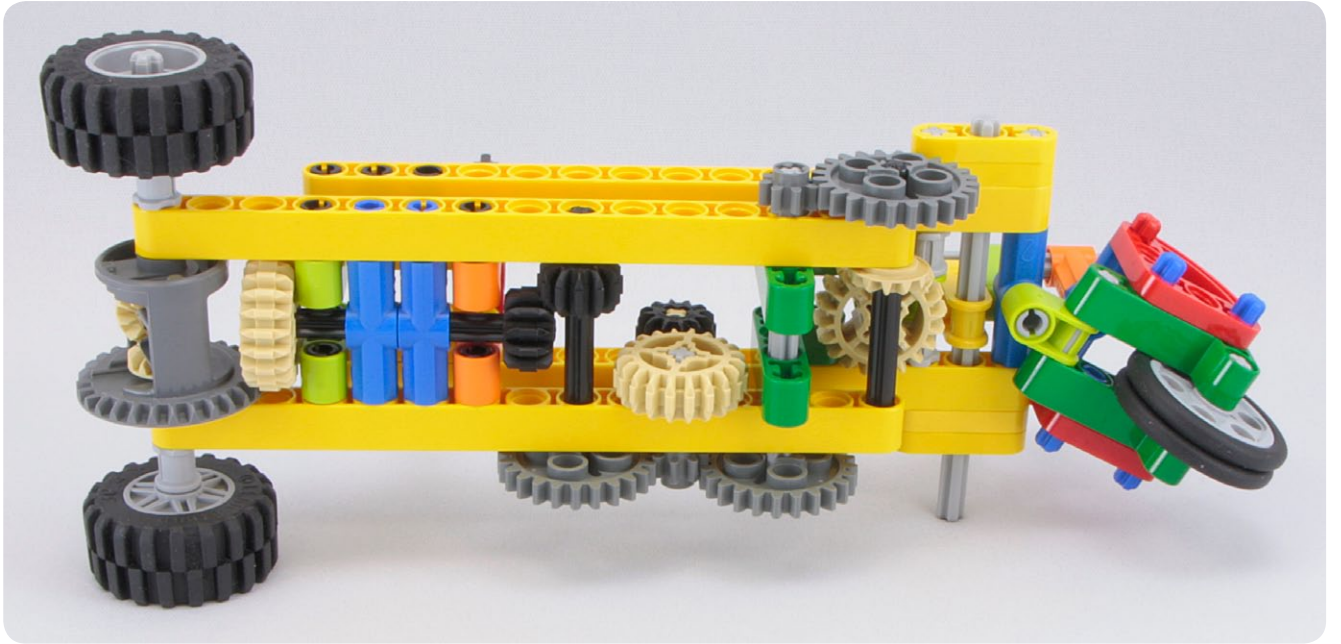




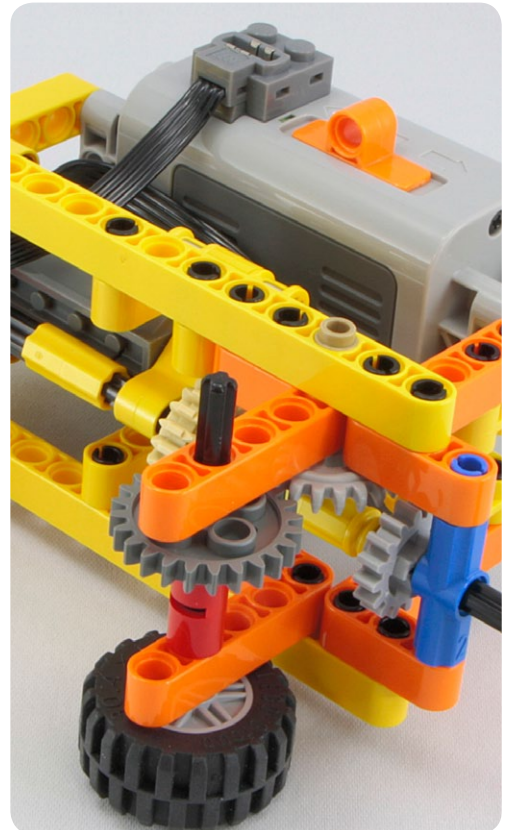
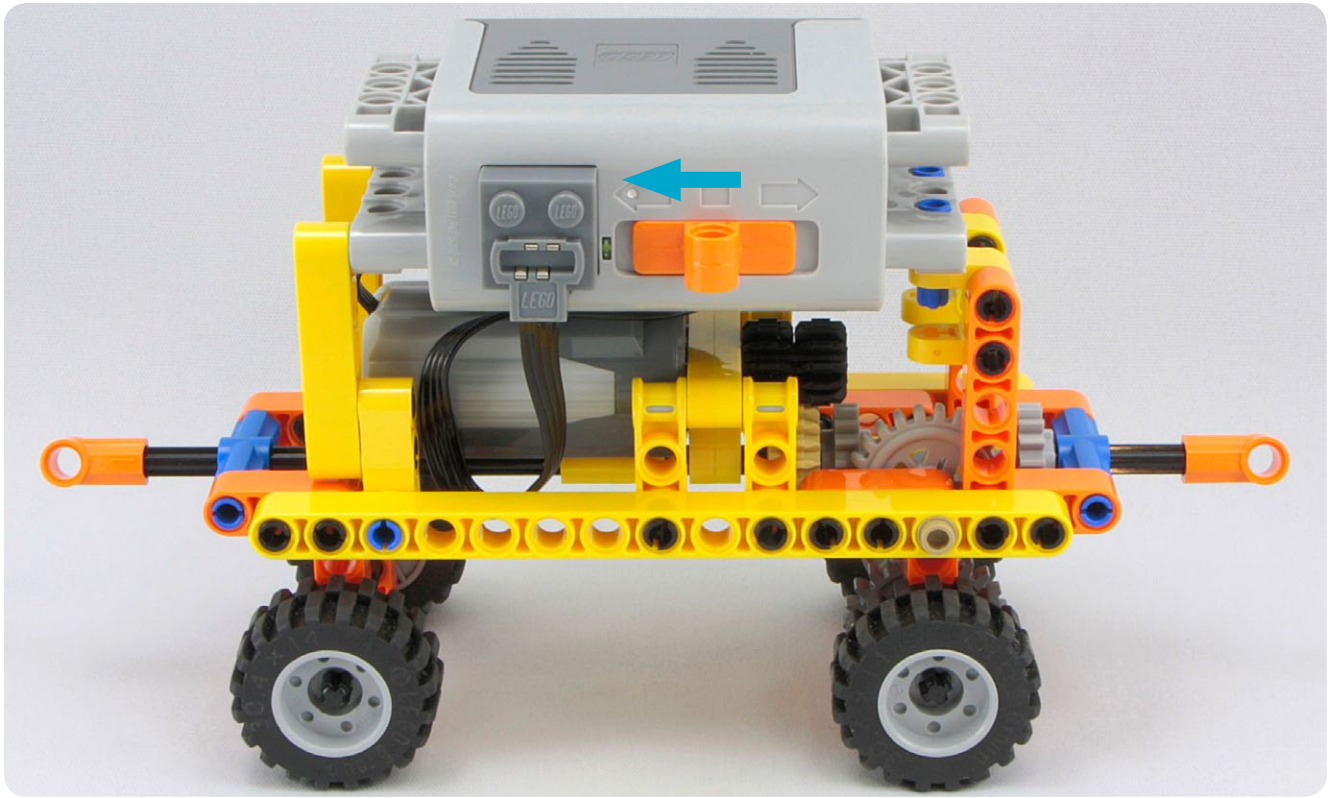


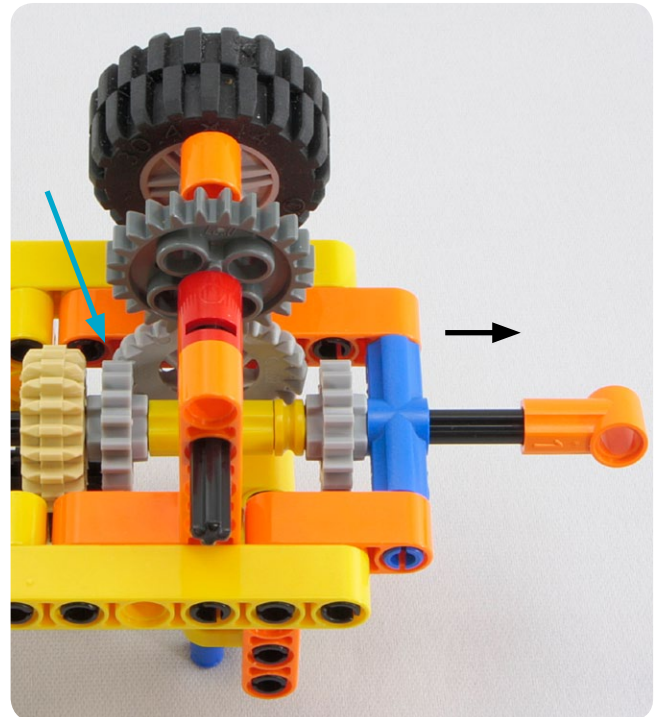
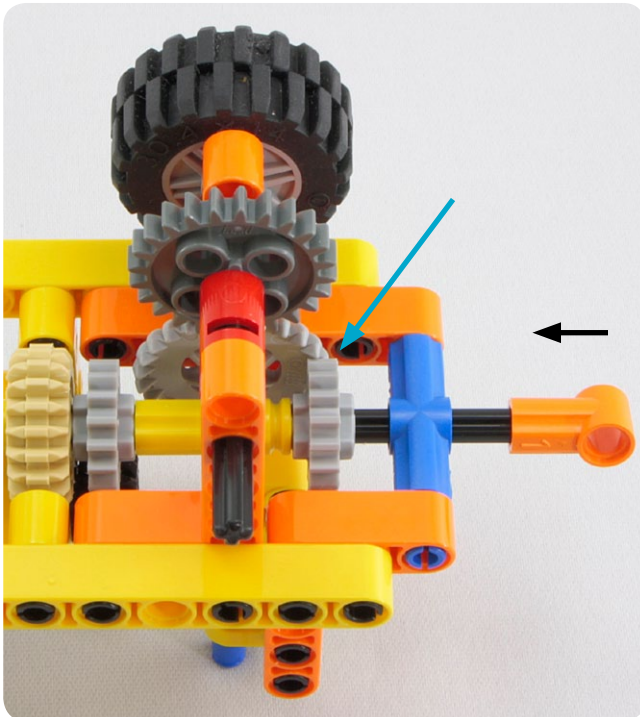
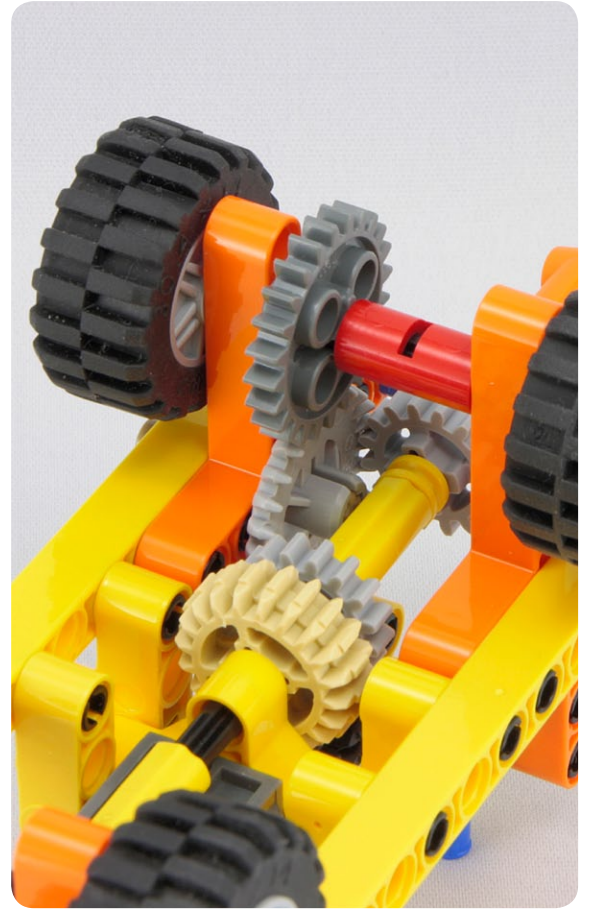




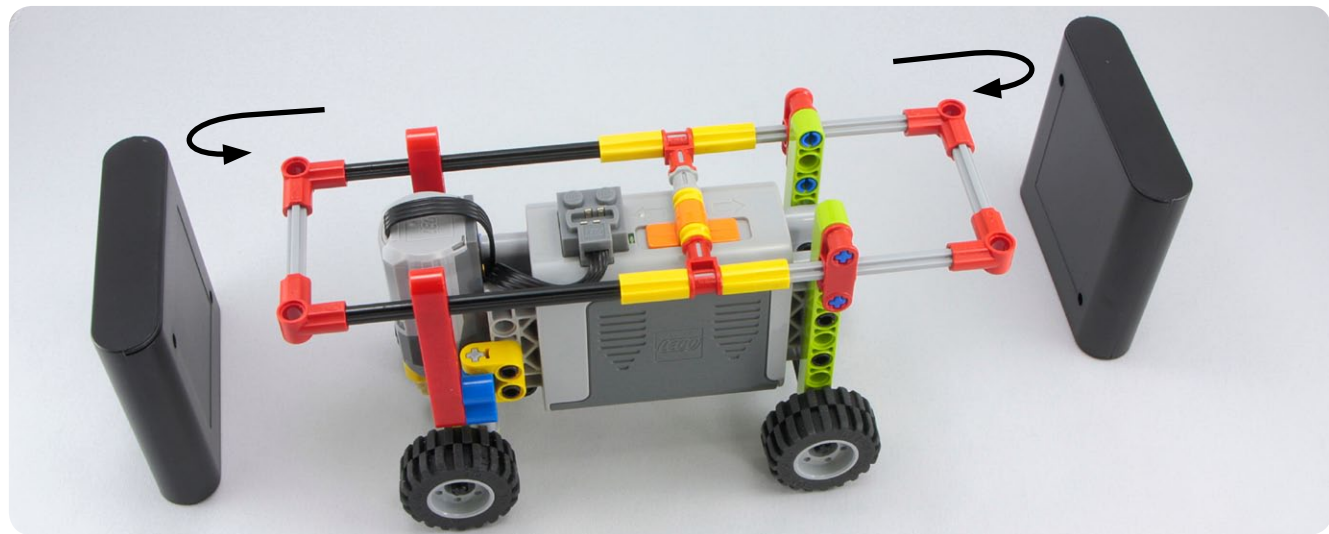
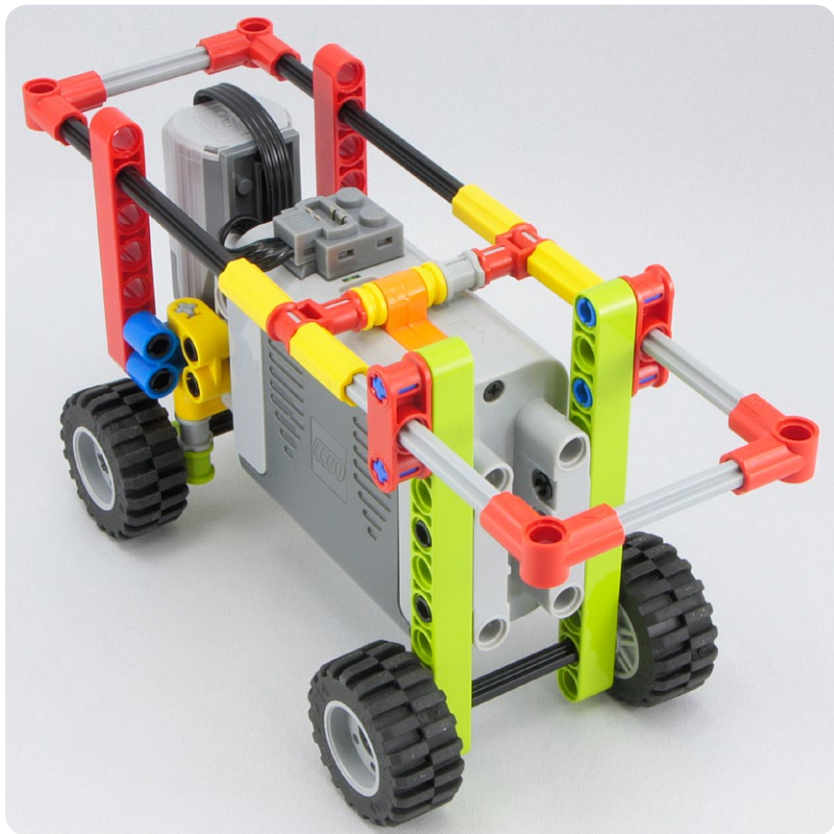
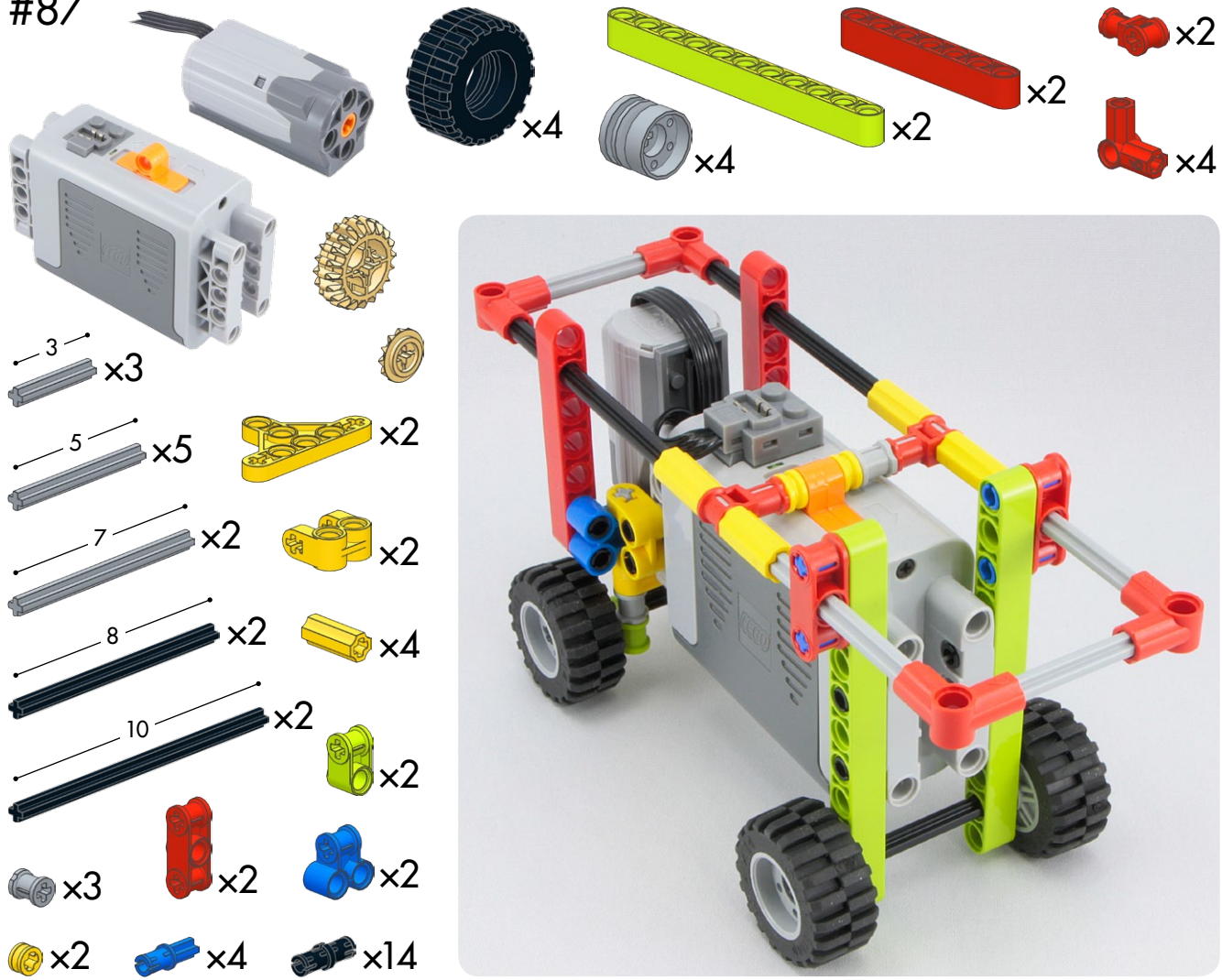


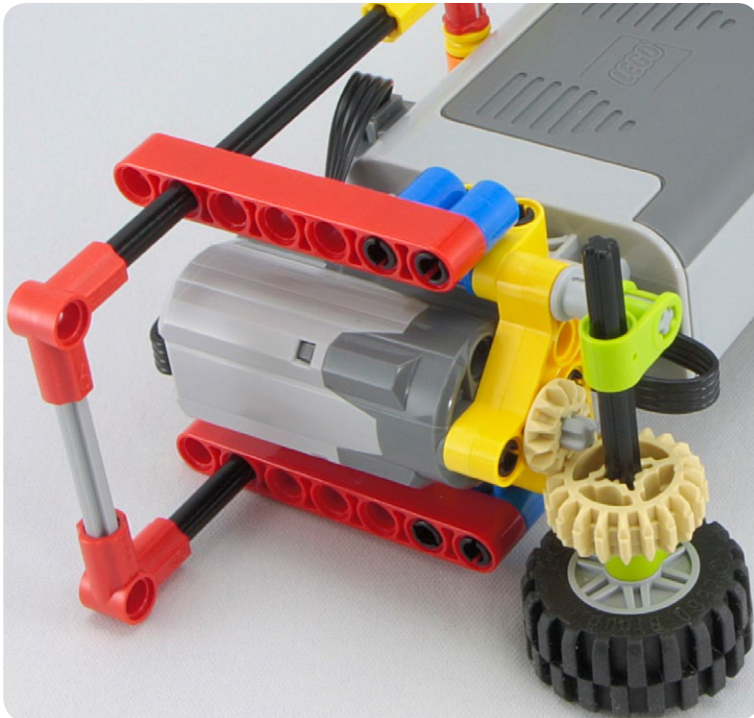
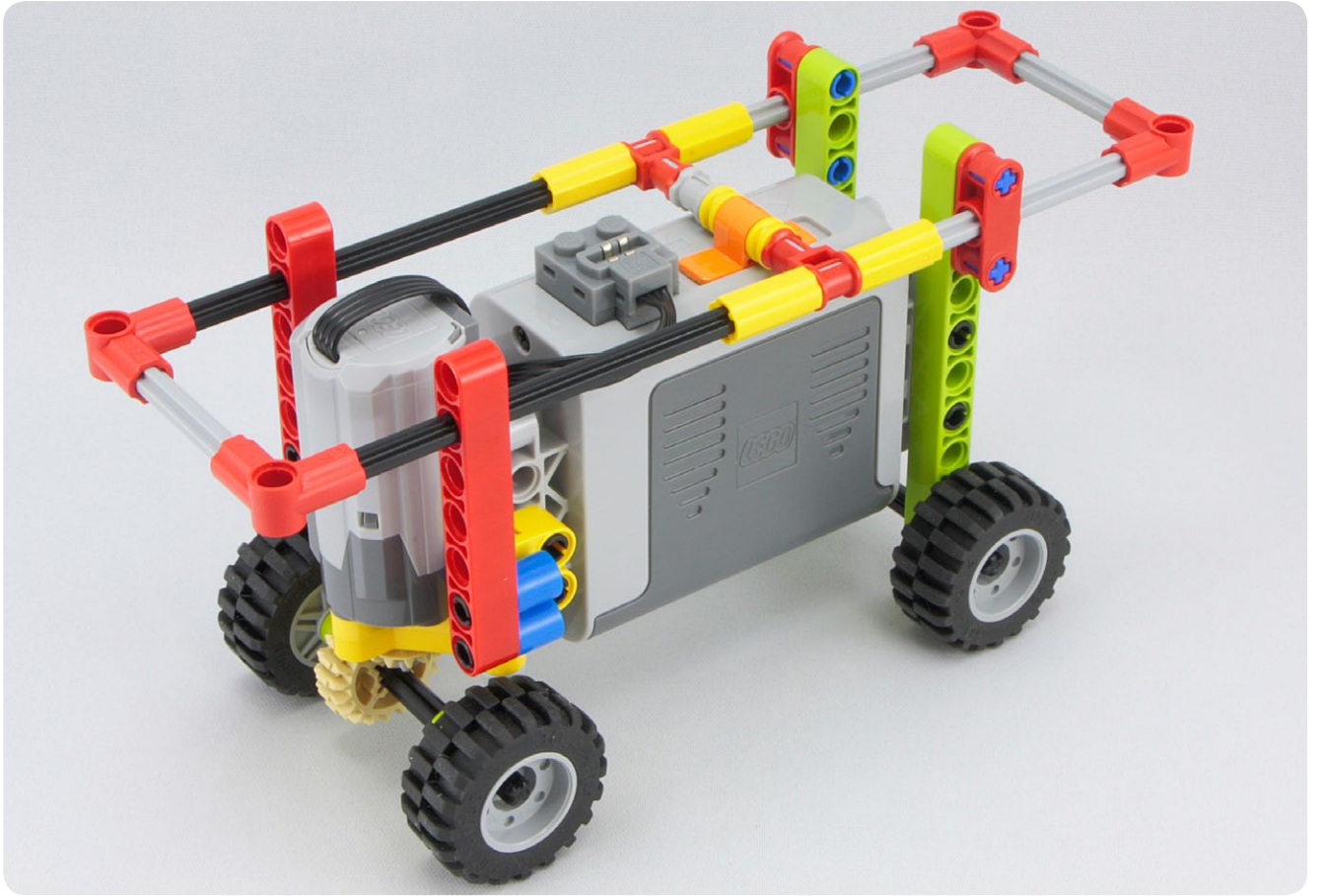




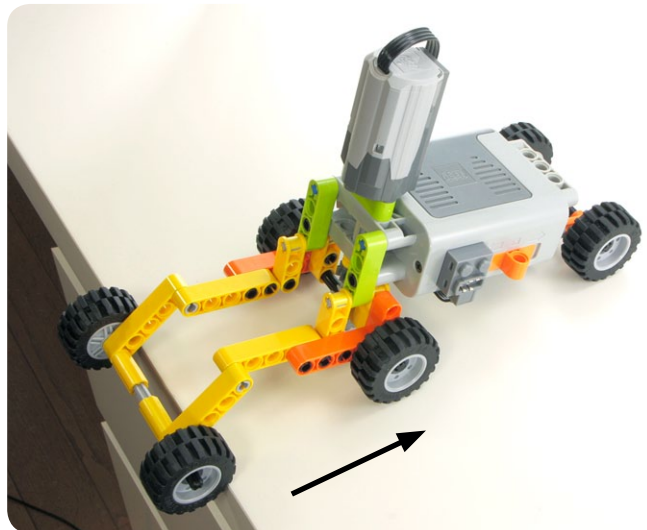
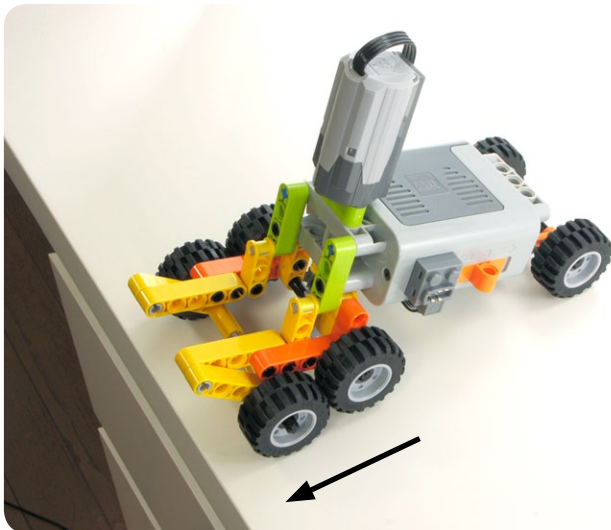
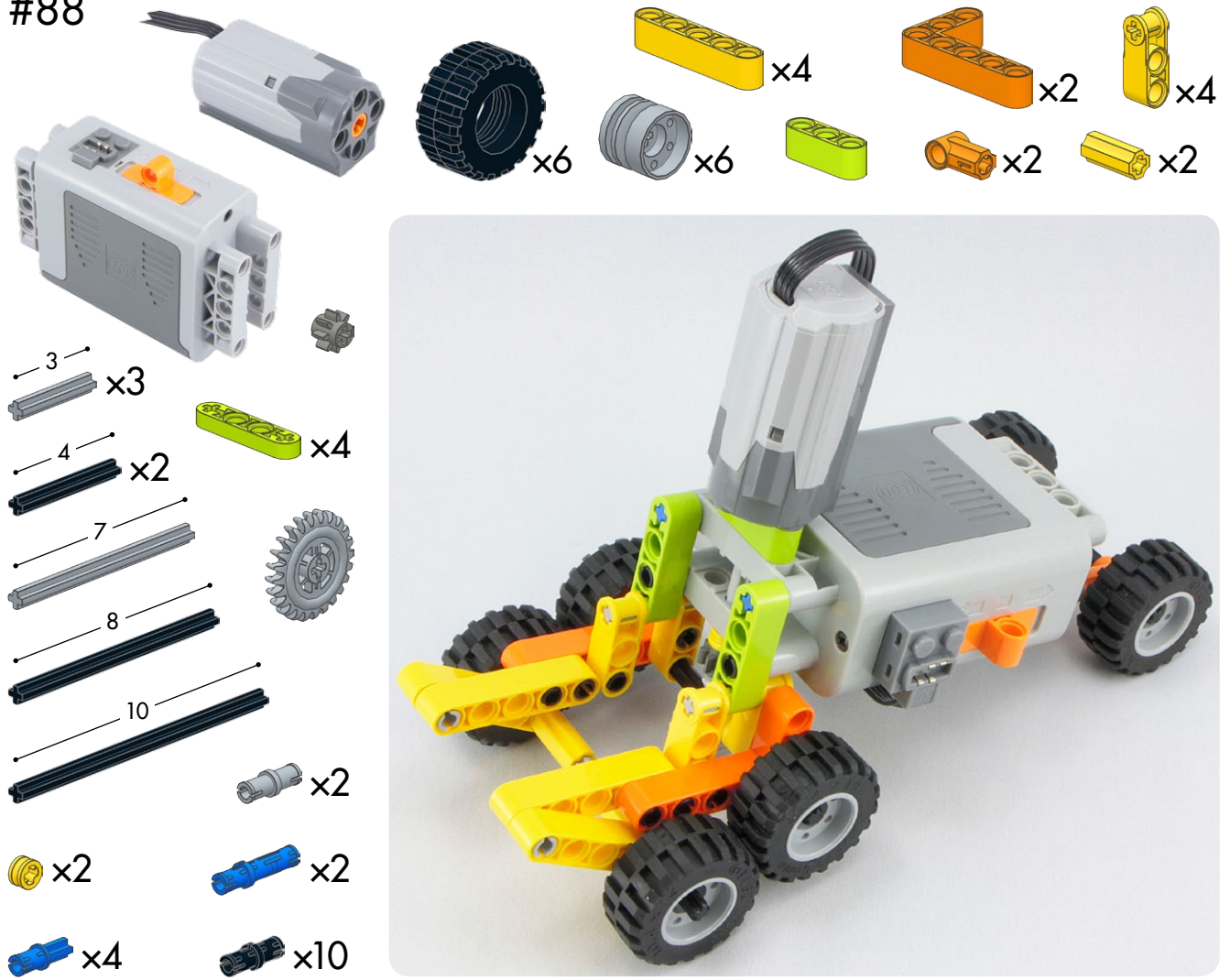


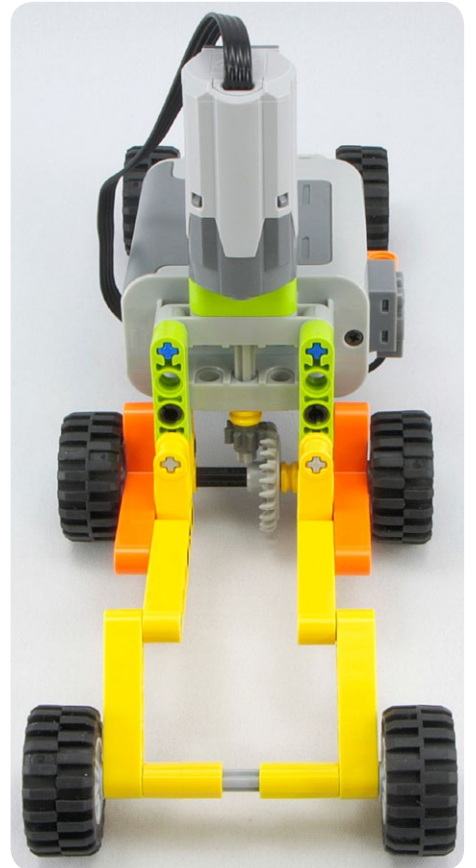
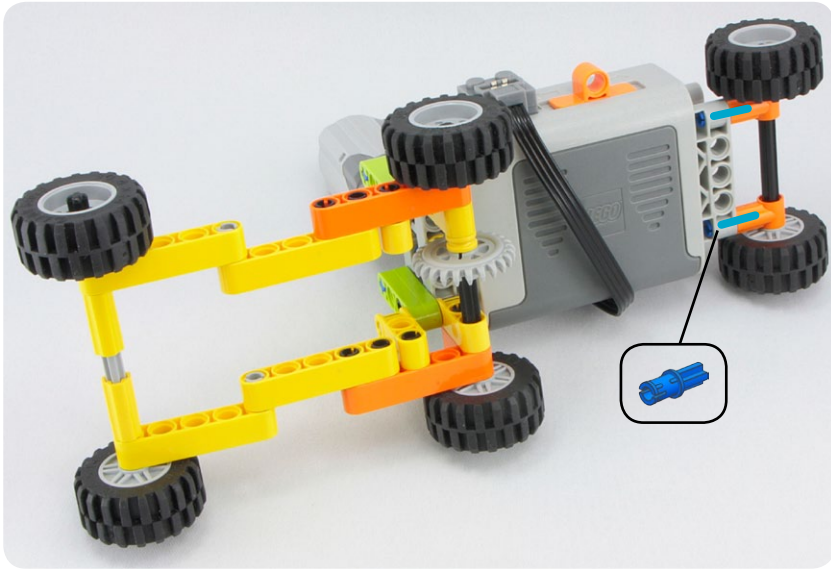
#87

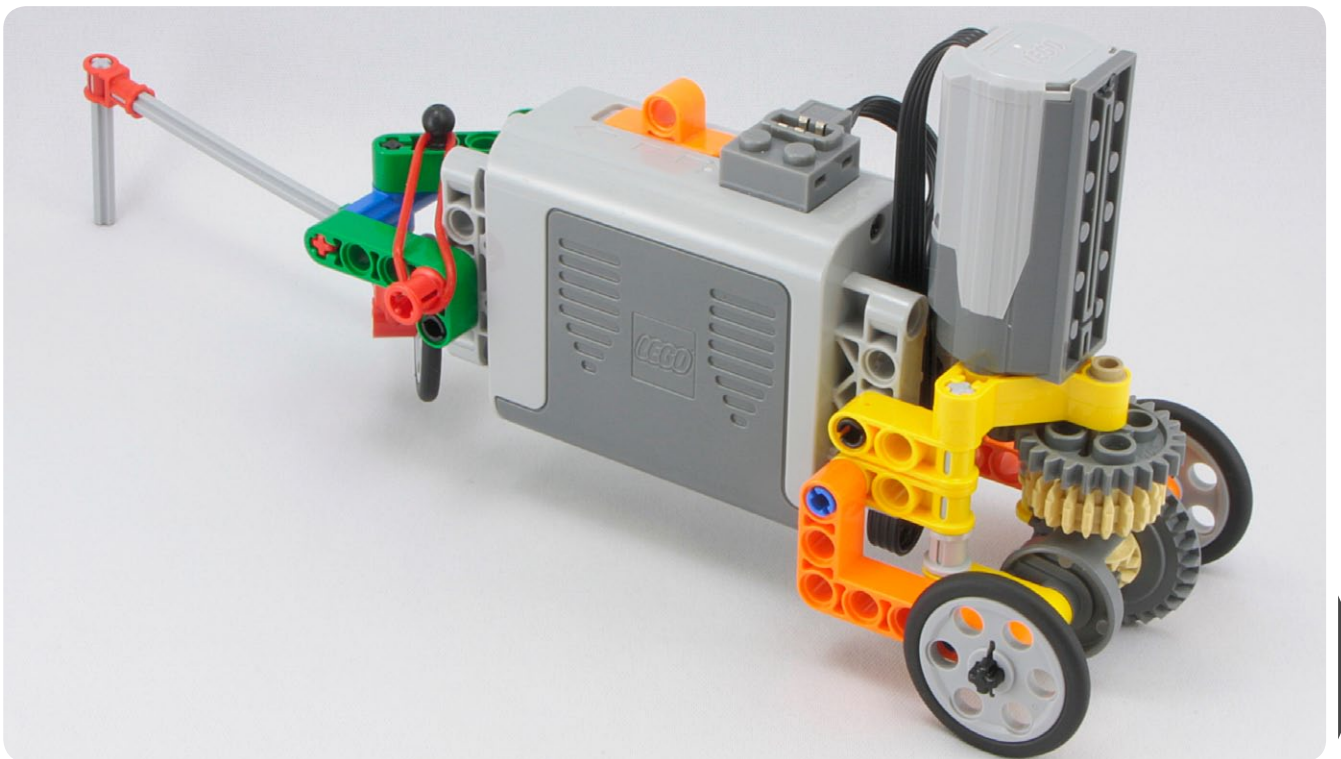
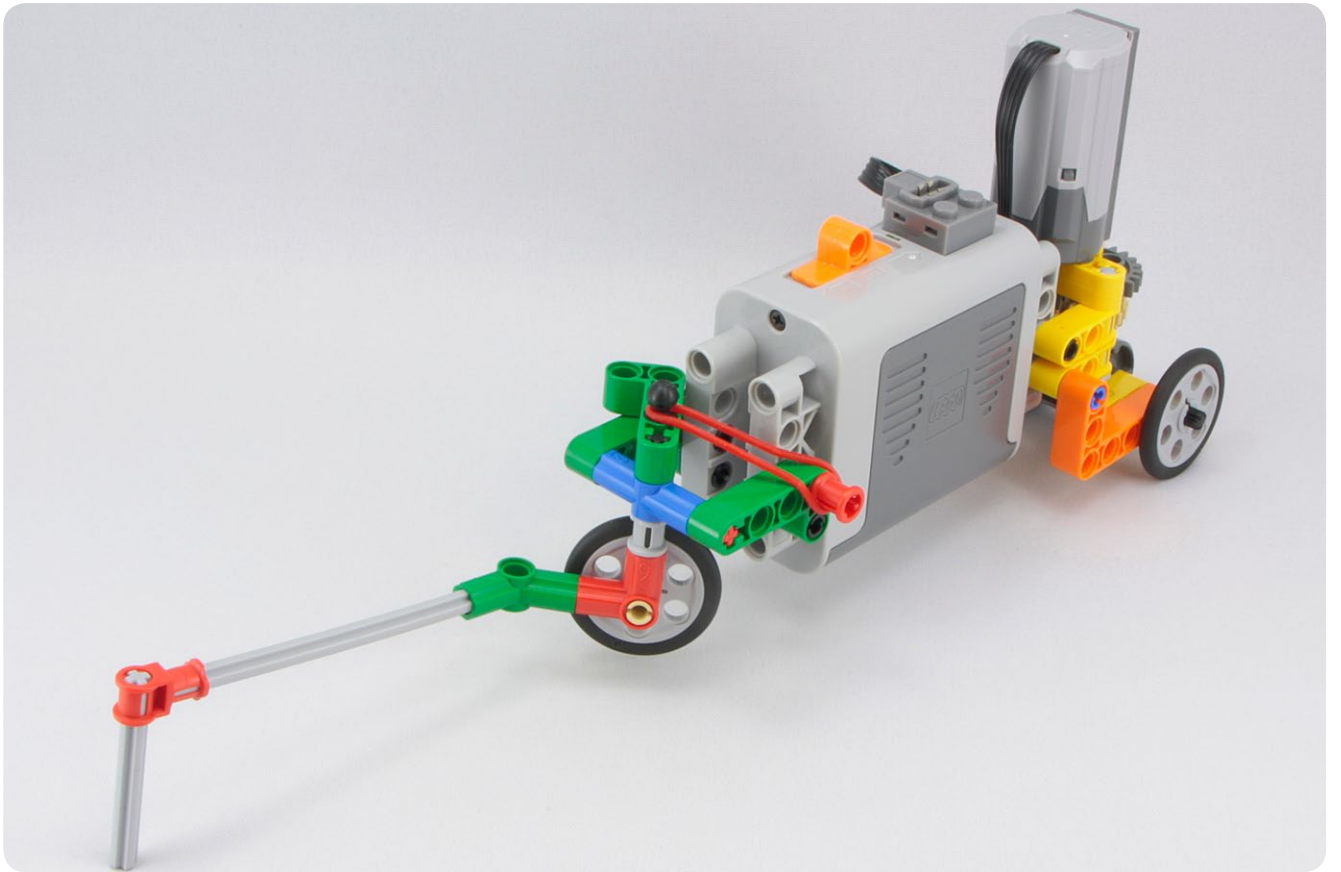


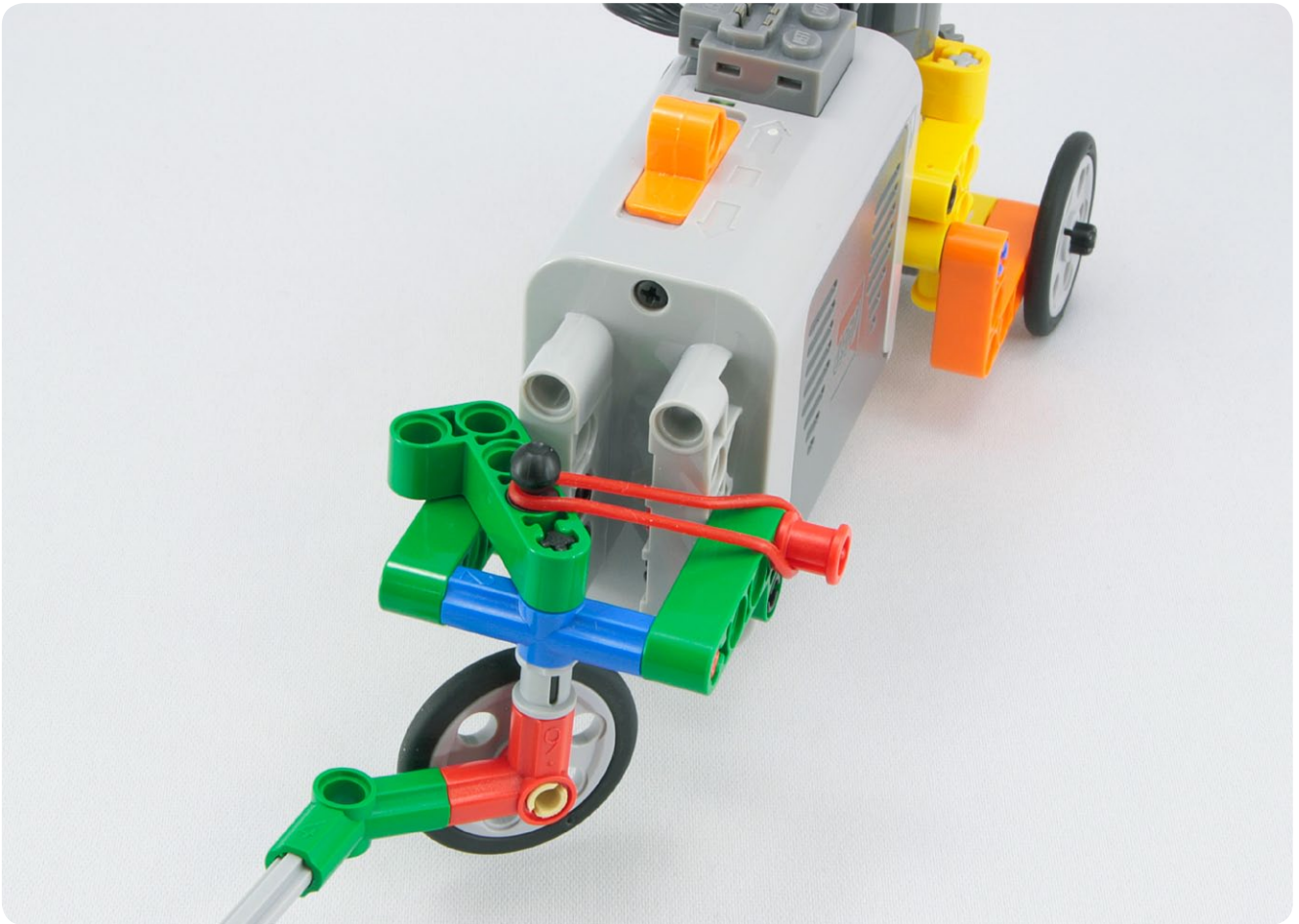
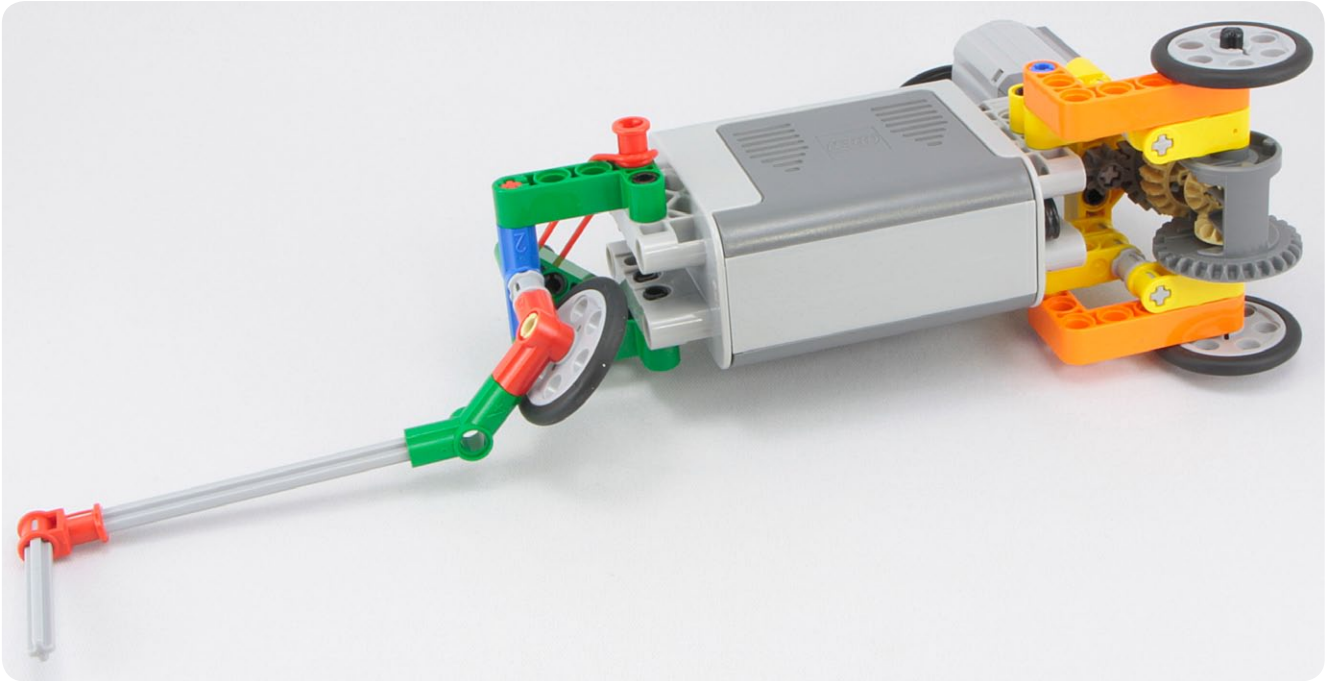


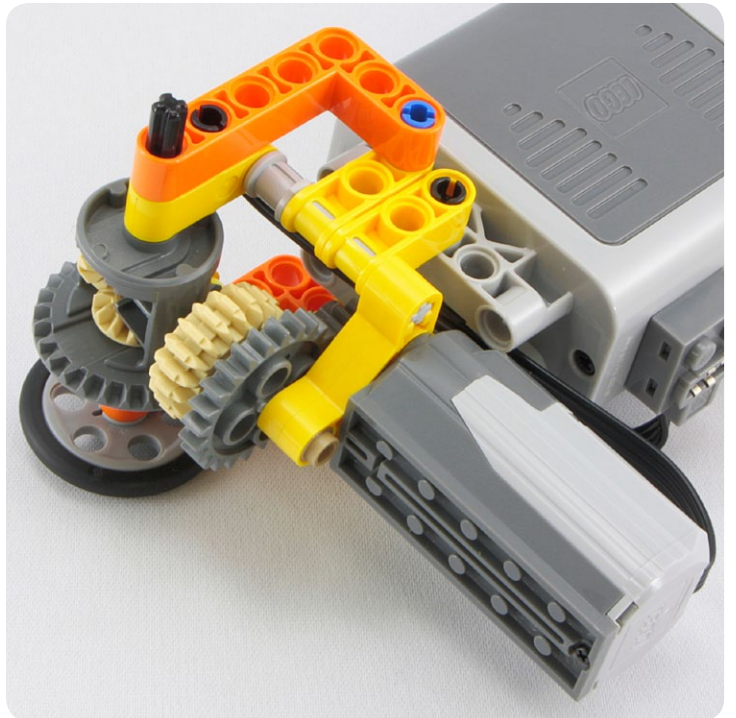
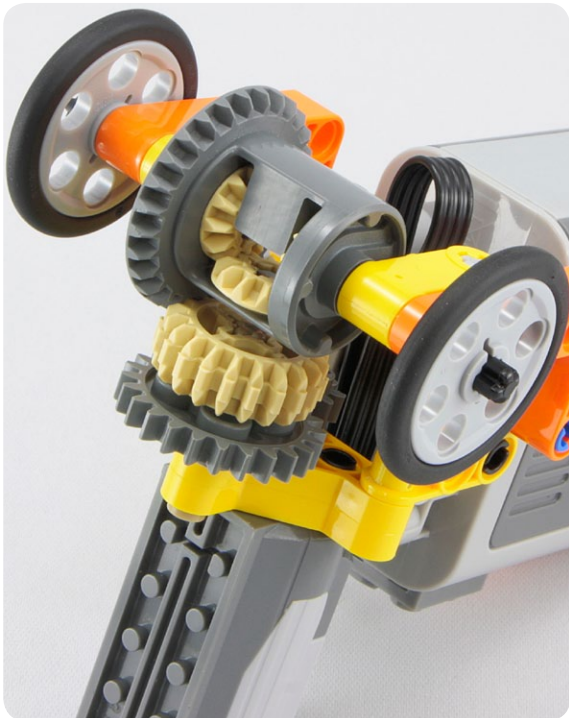
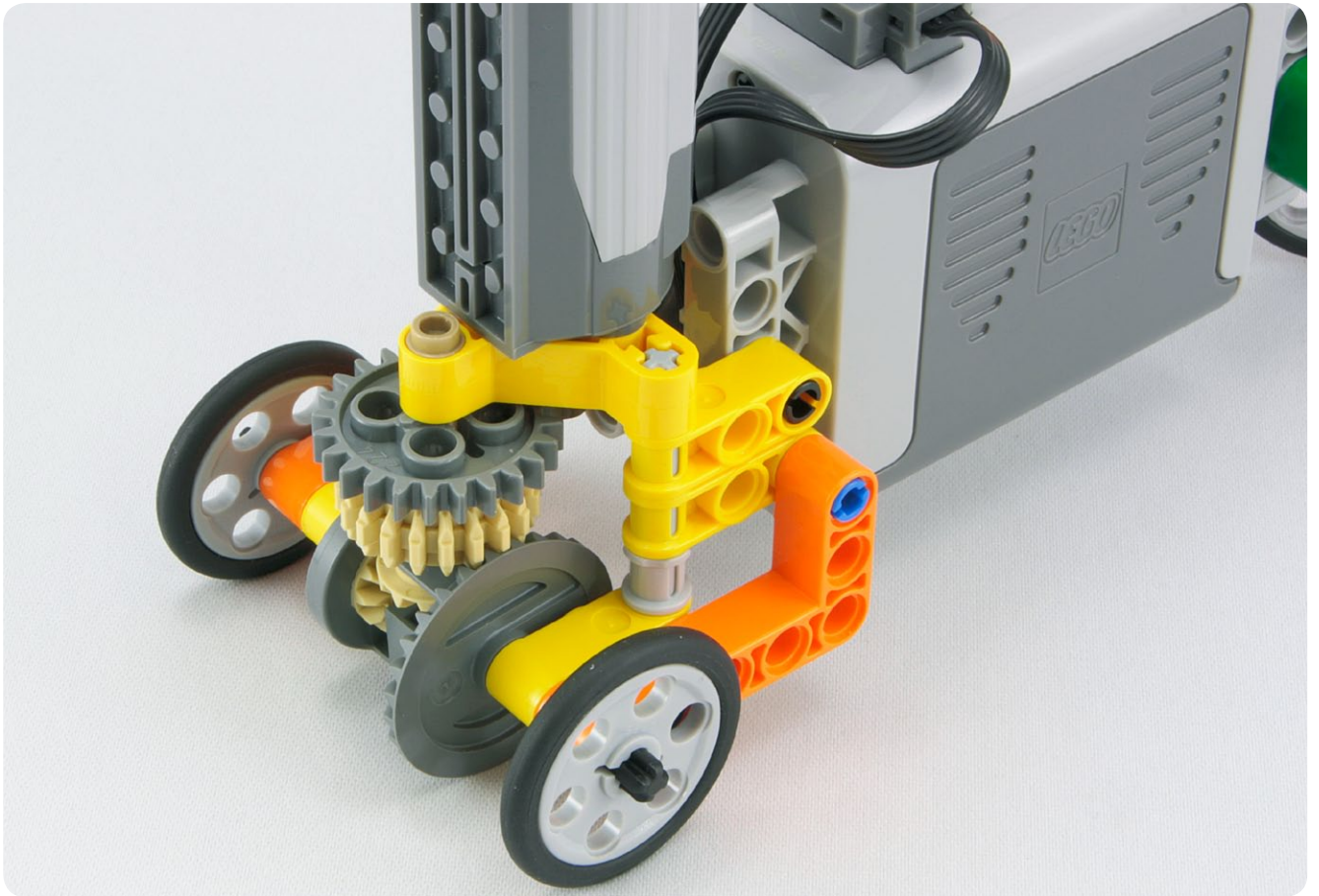
#88

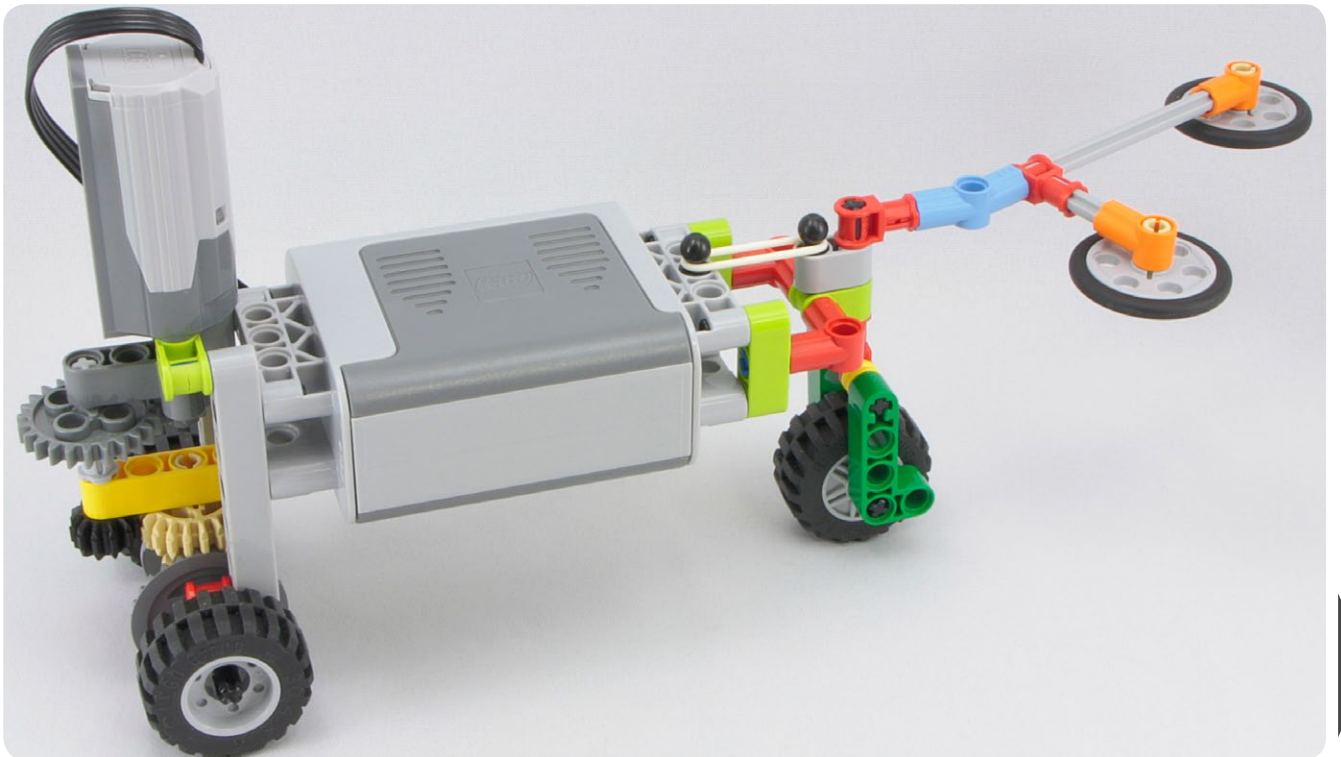
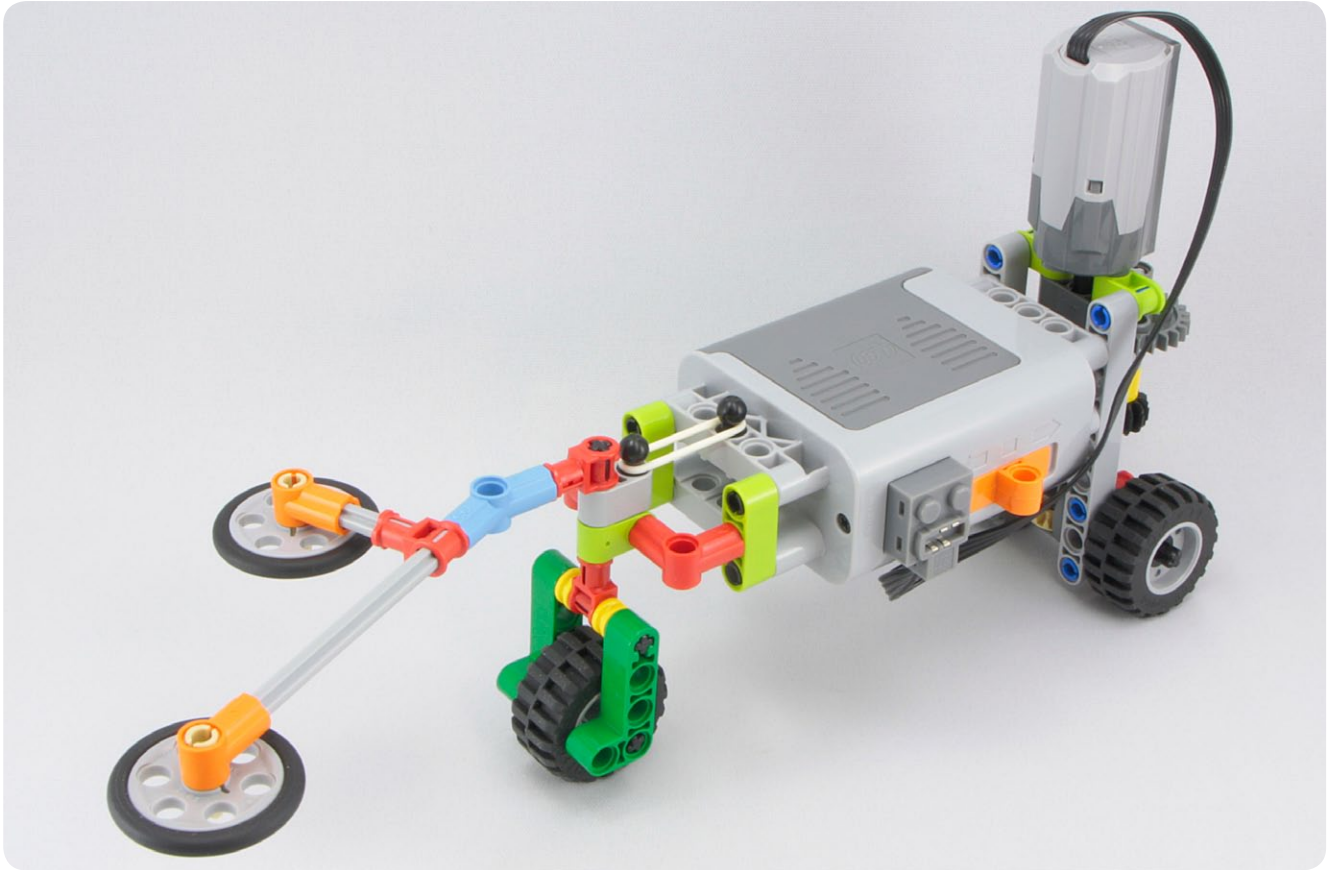


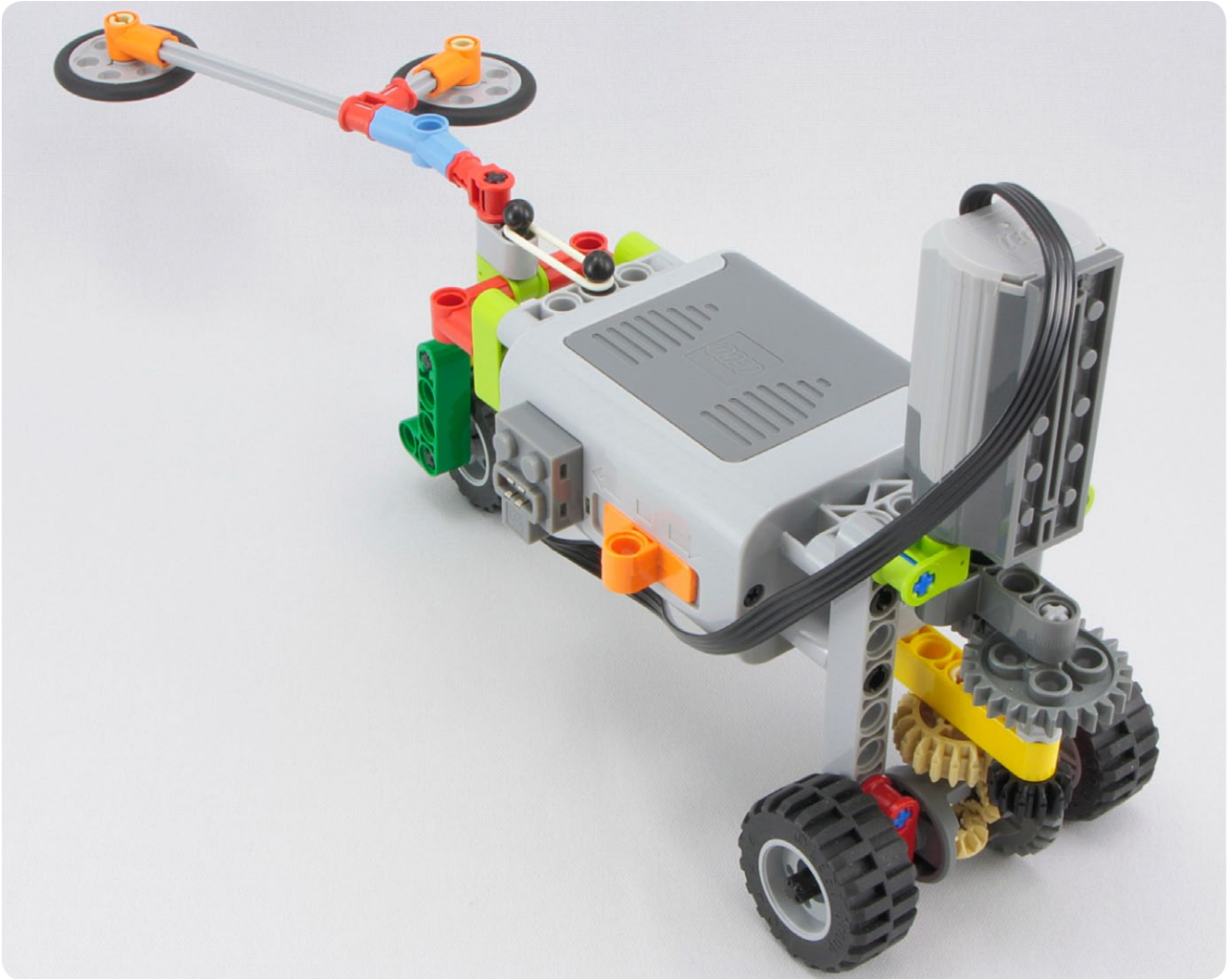


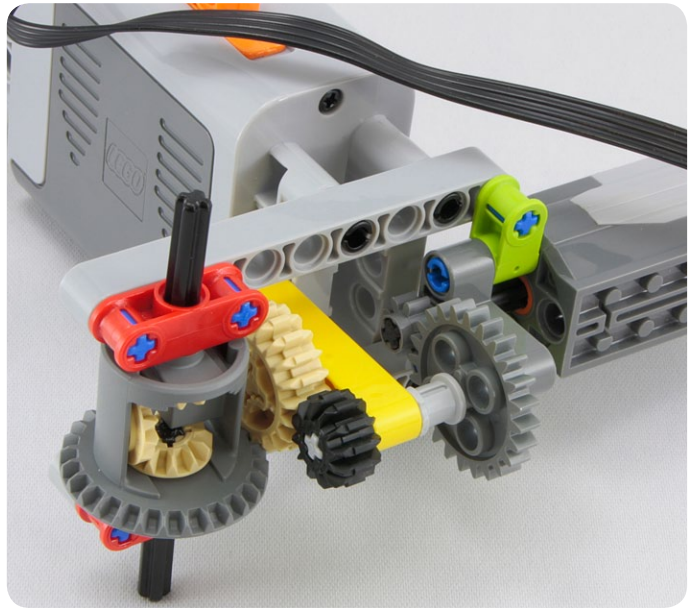
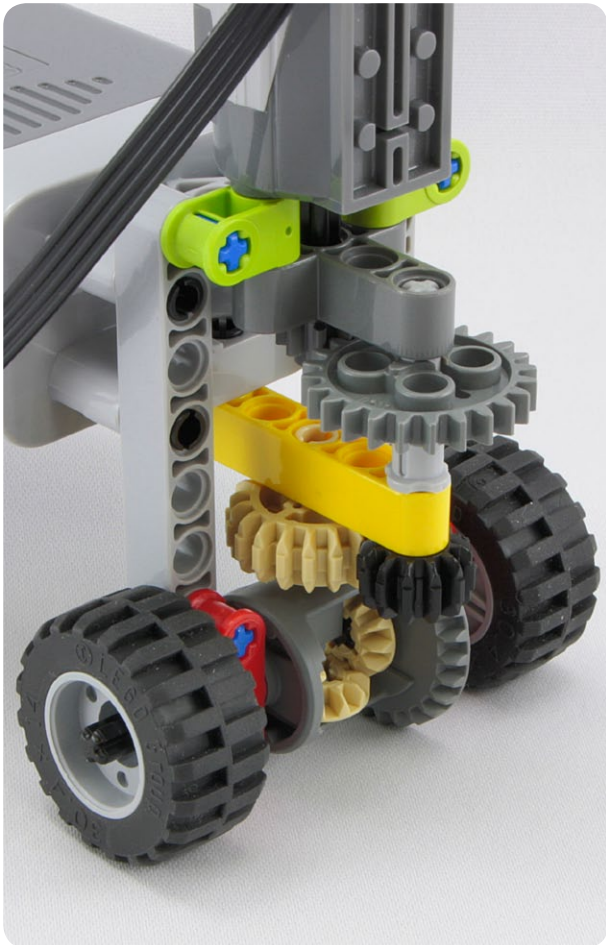
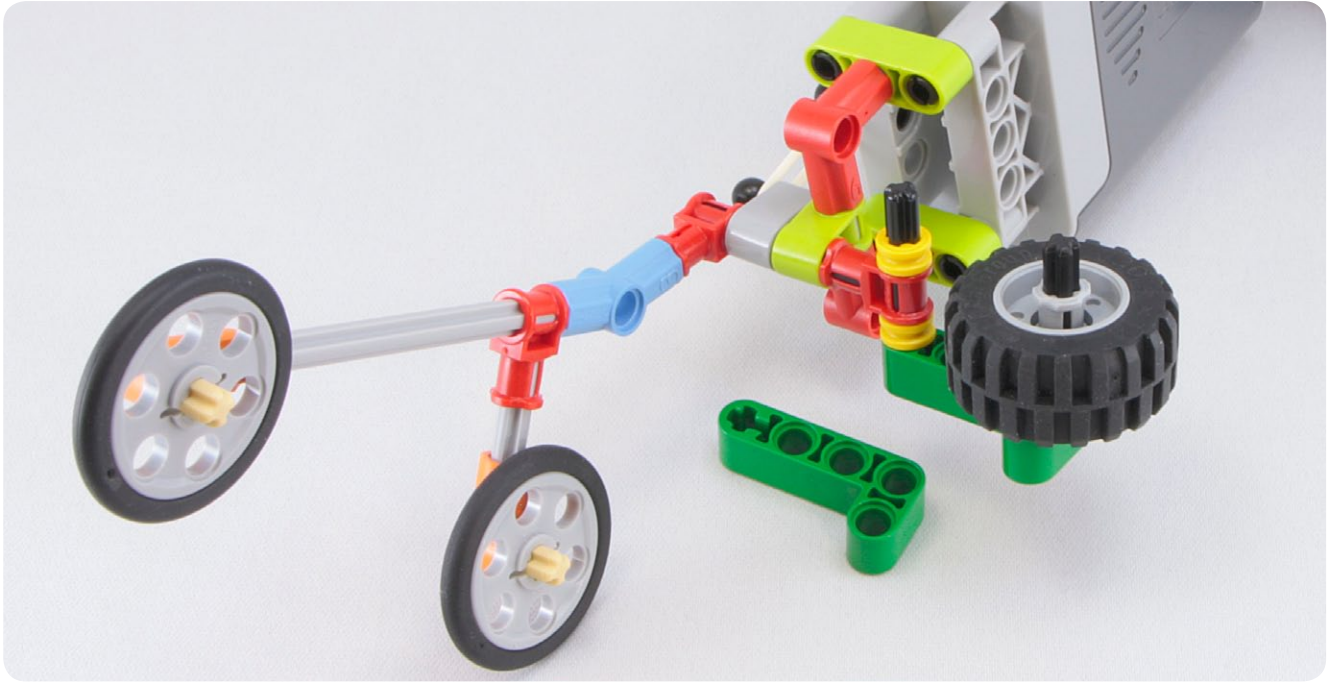




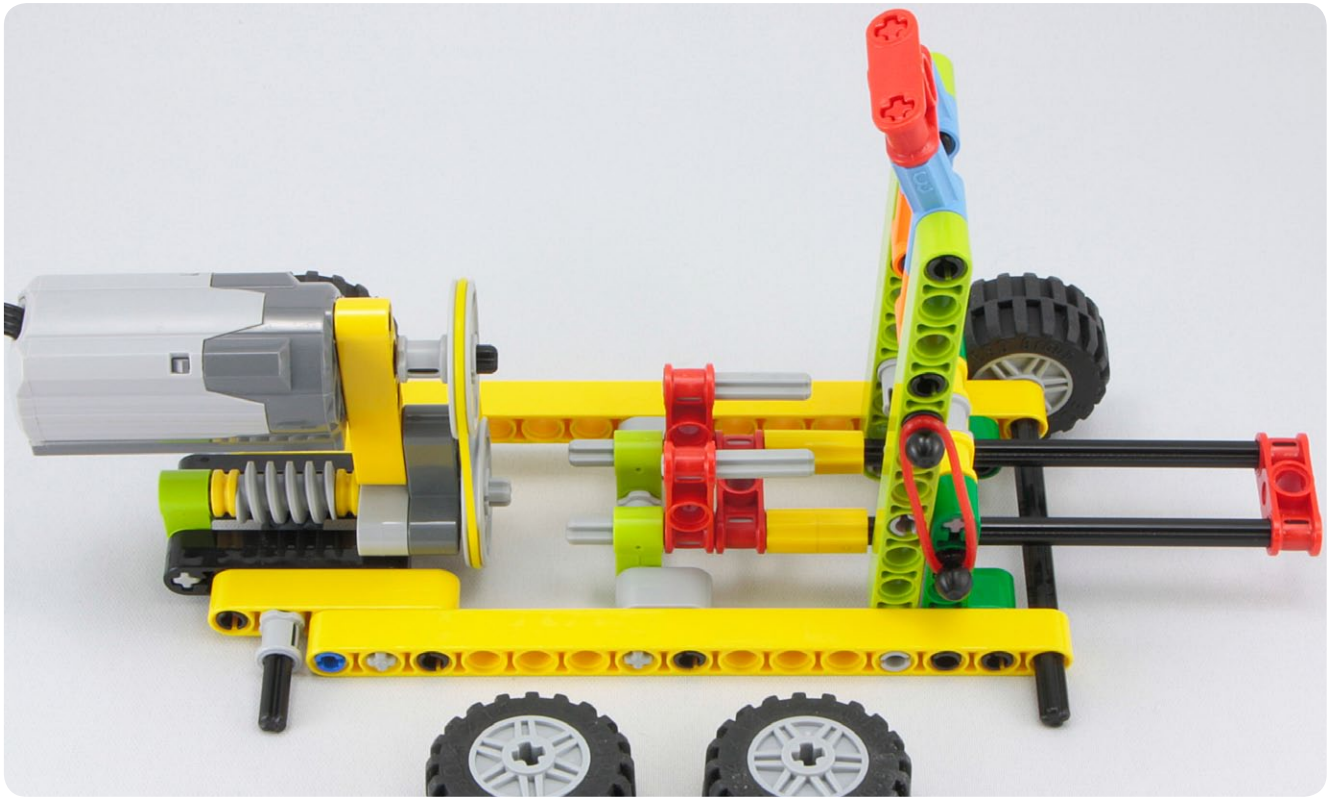


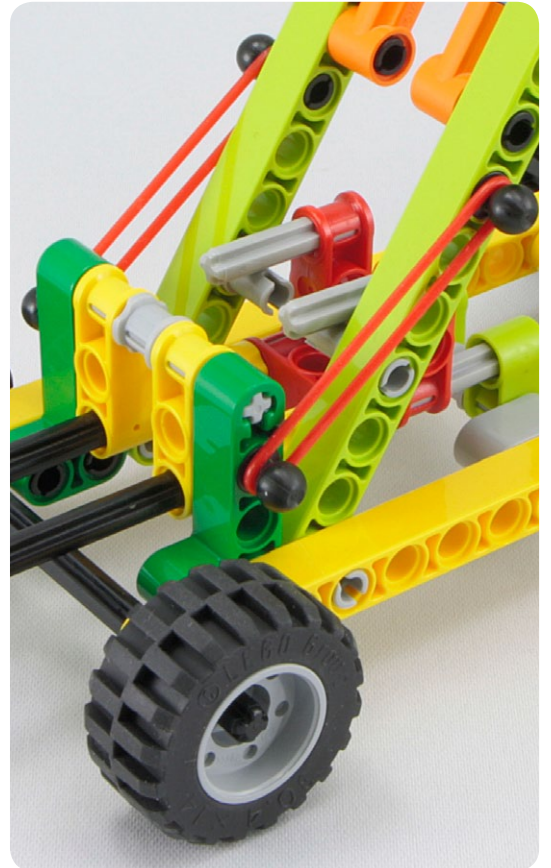
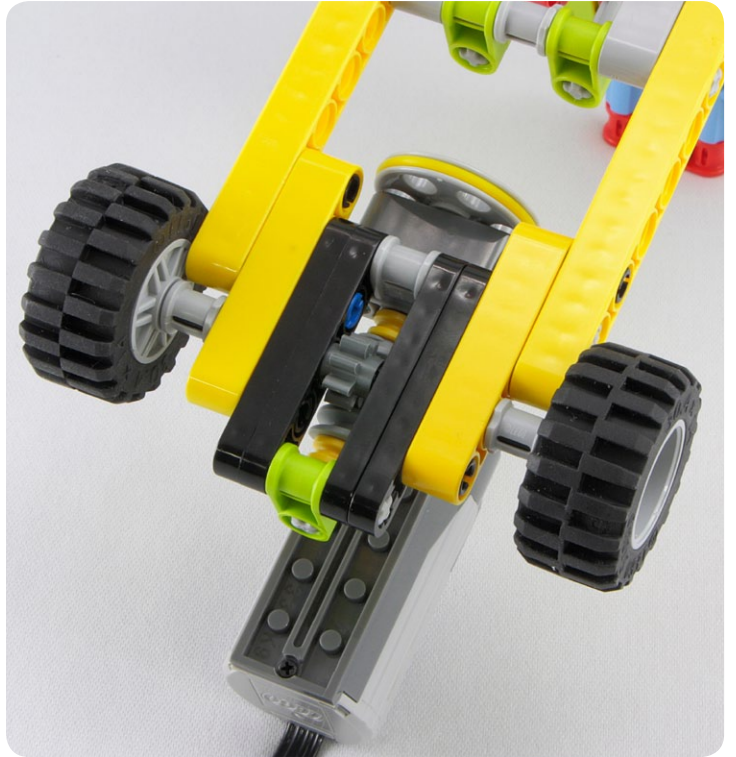
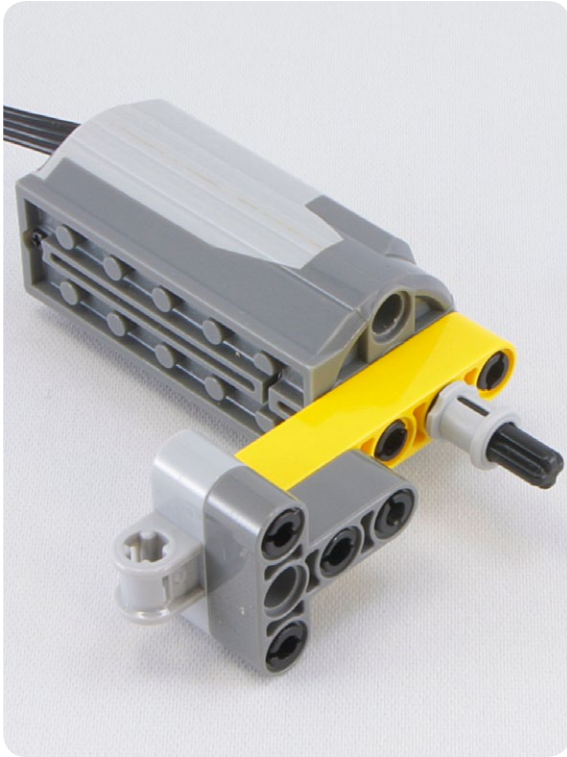




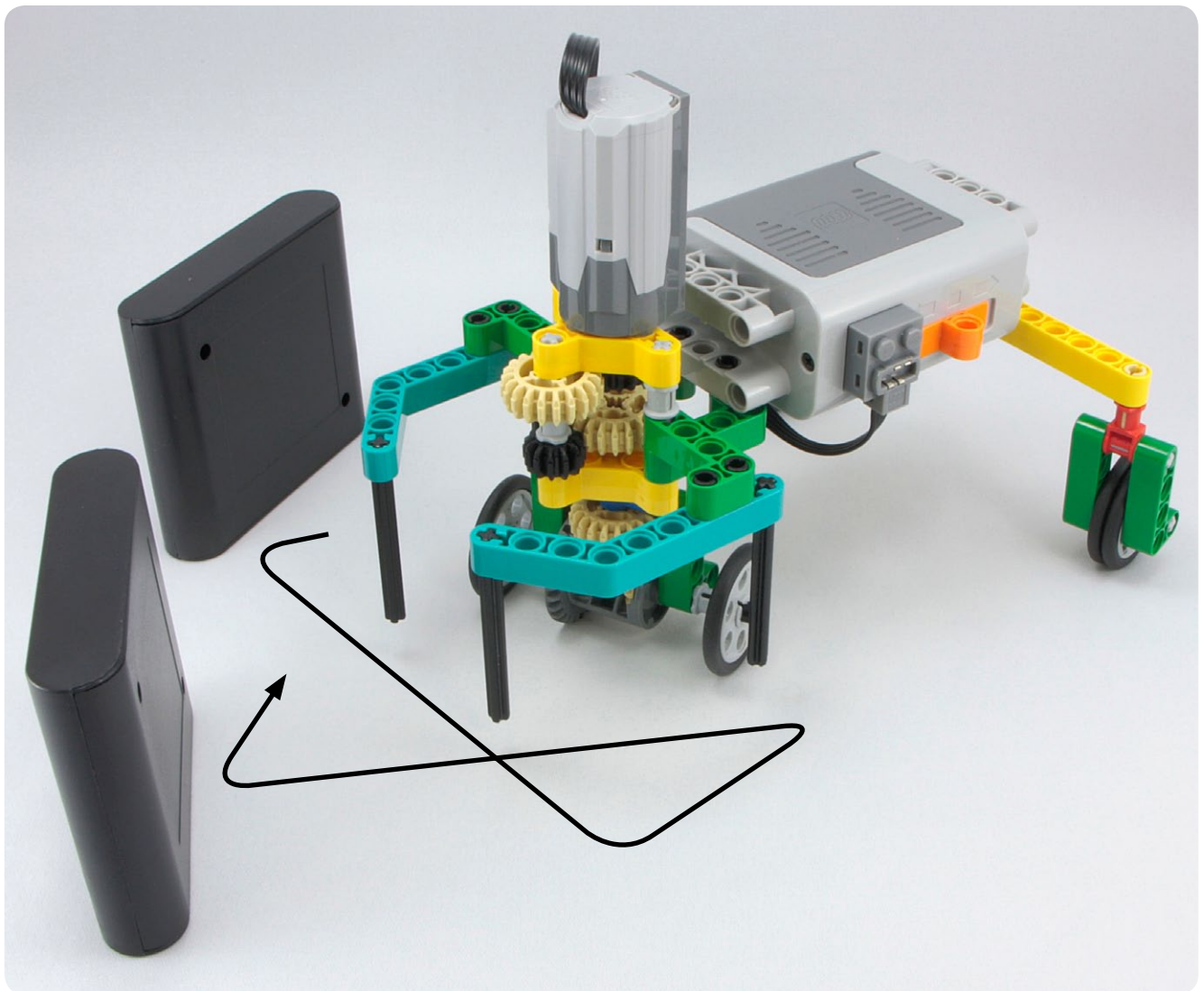
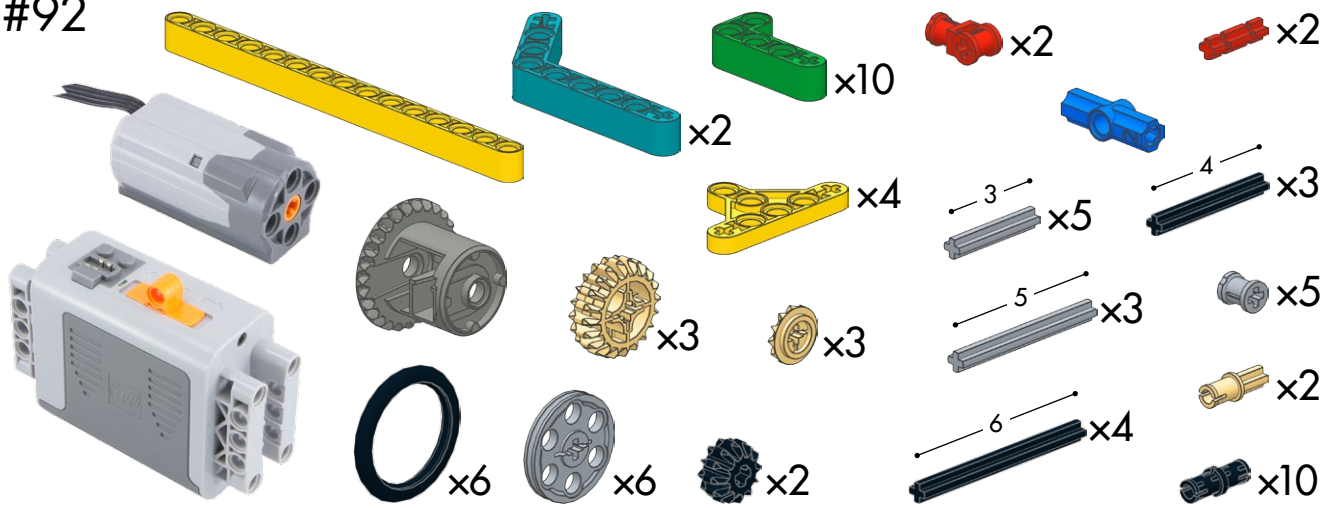


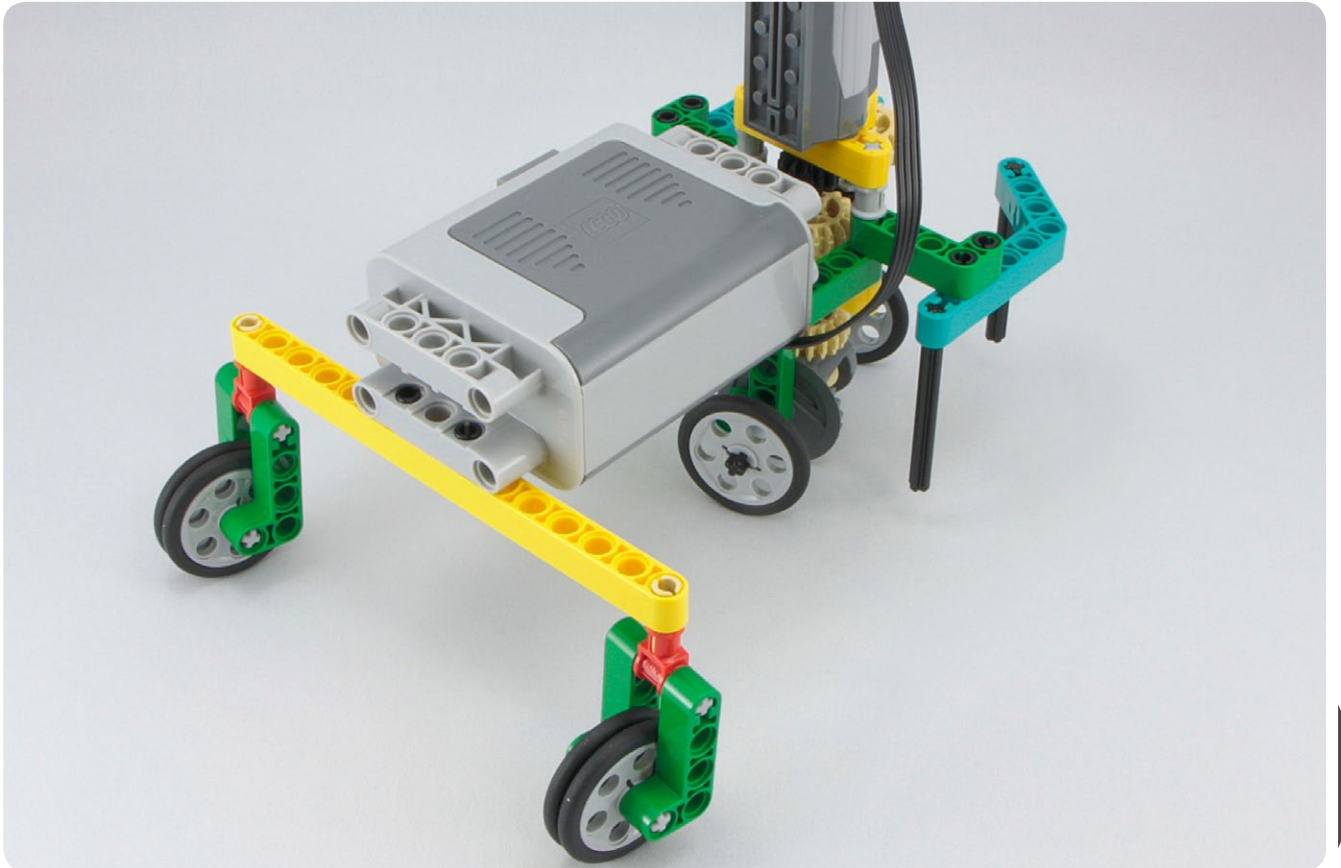
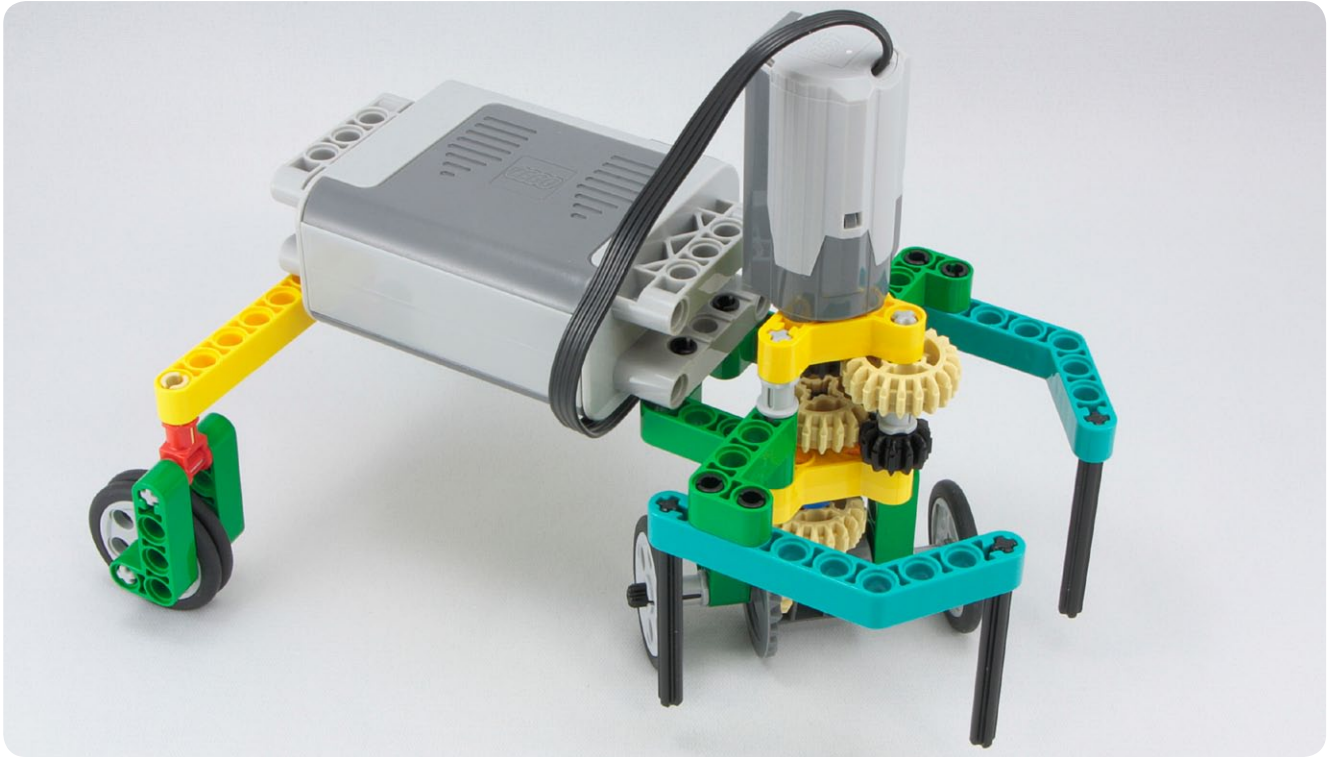


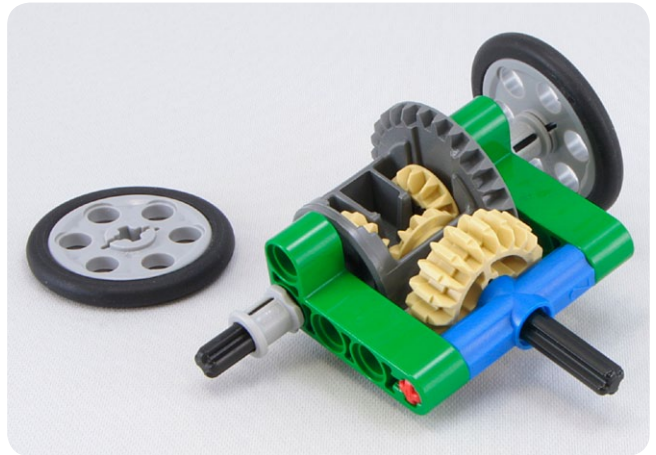
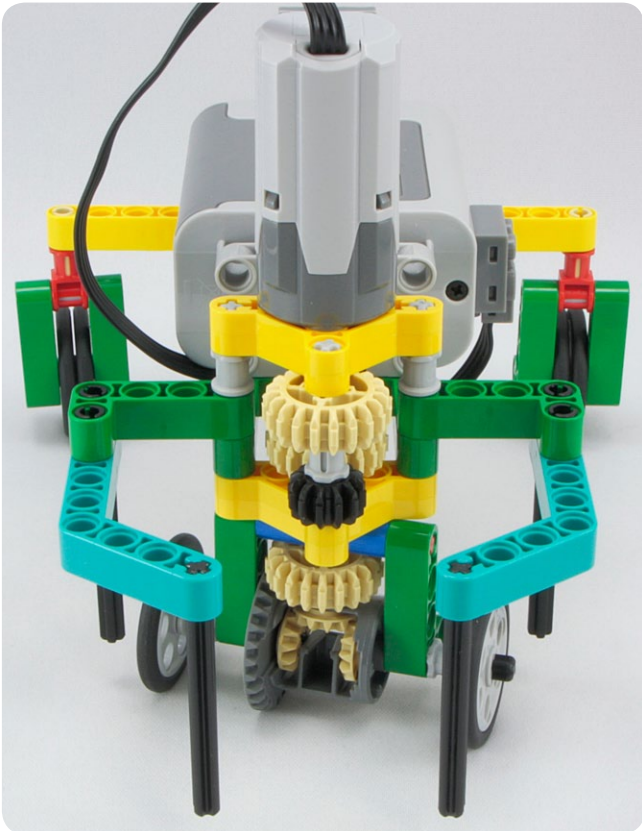
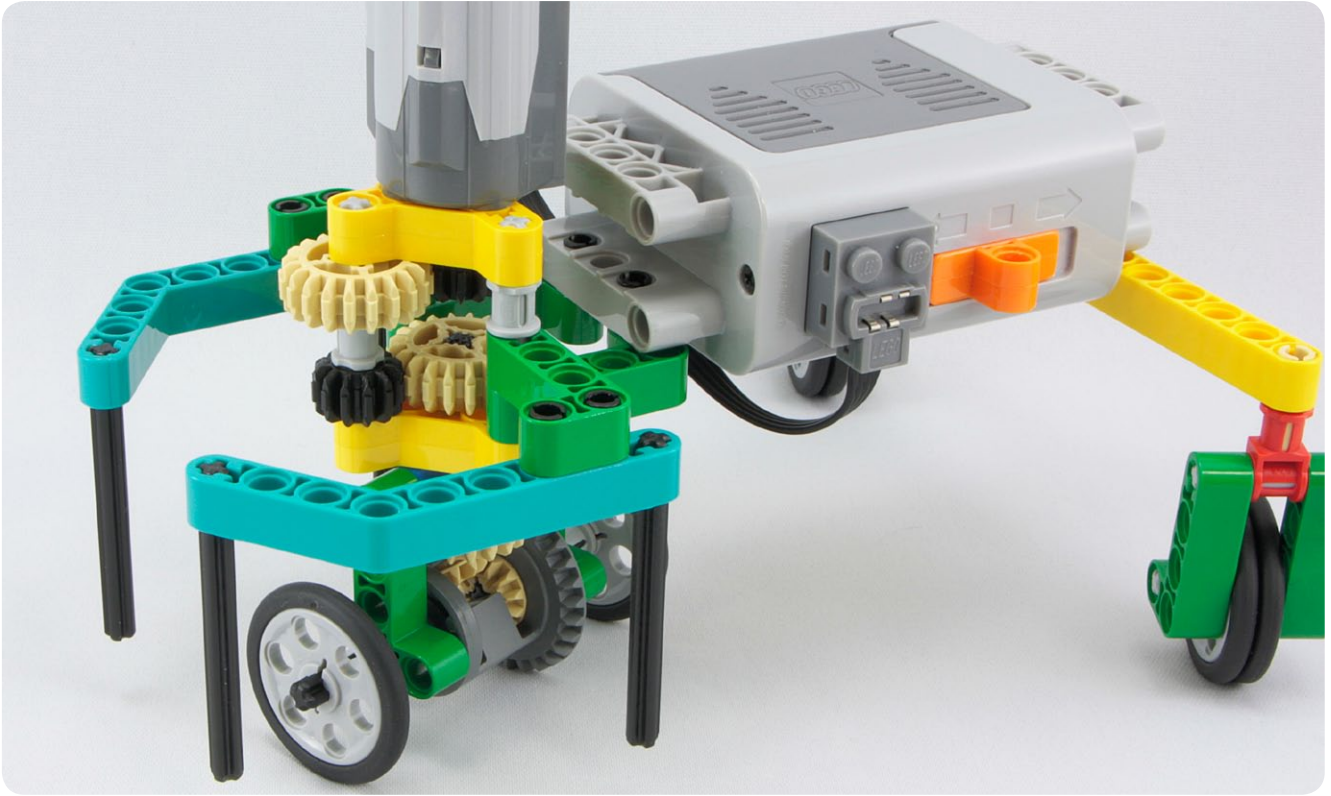


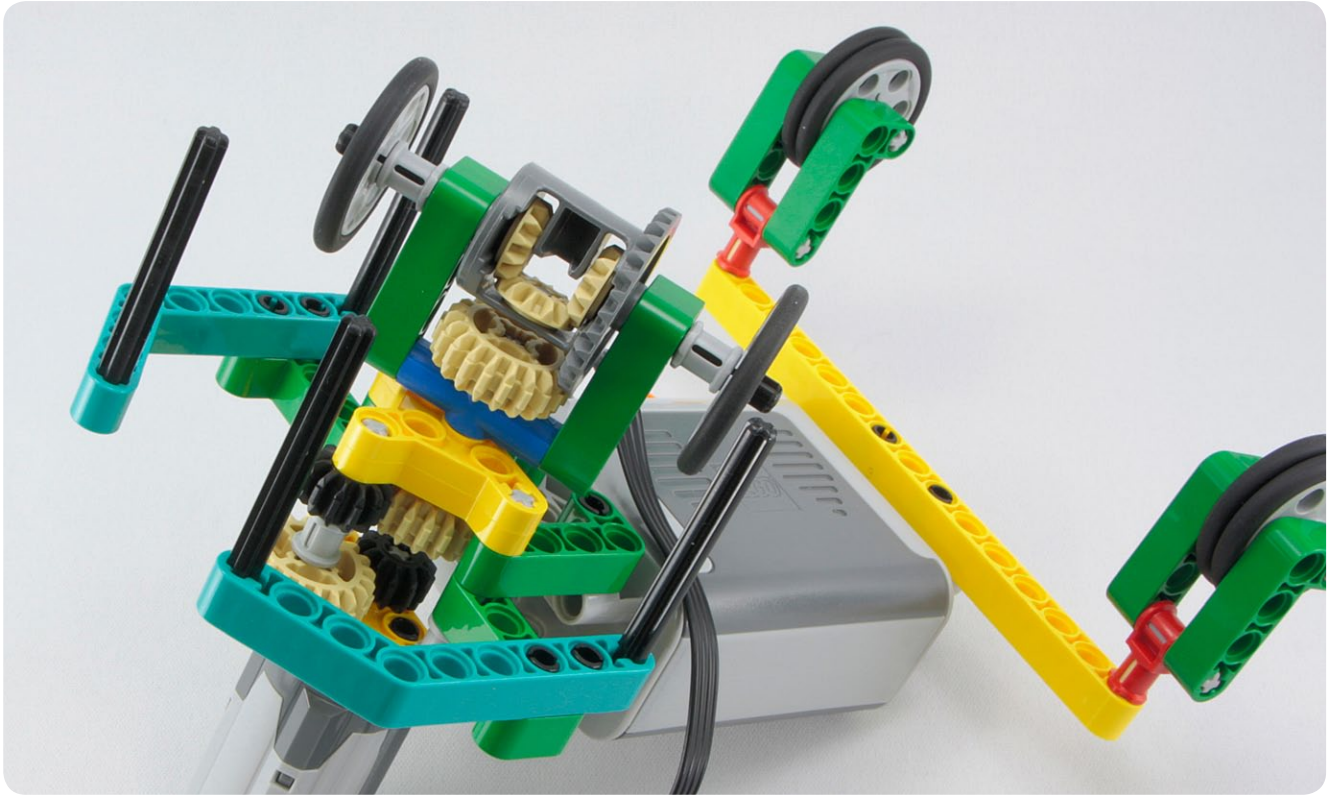


#92





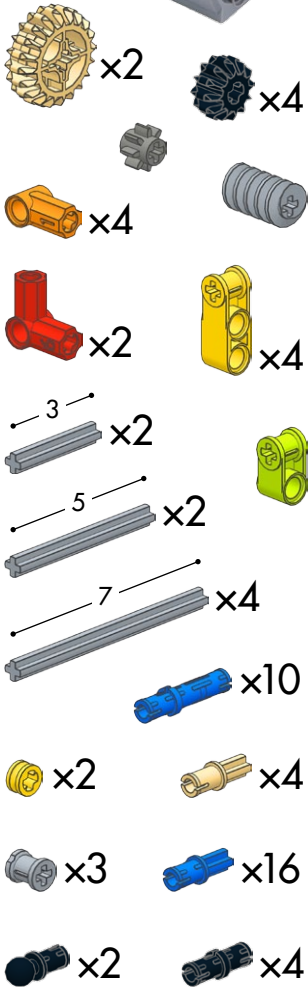
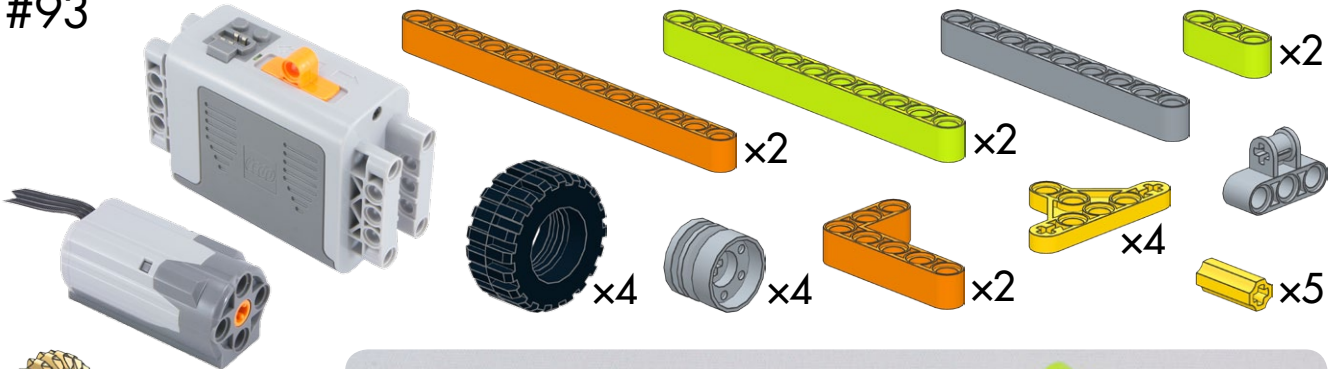


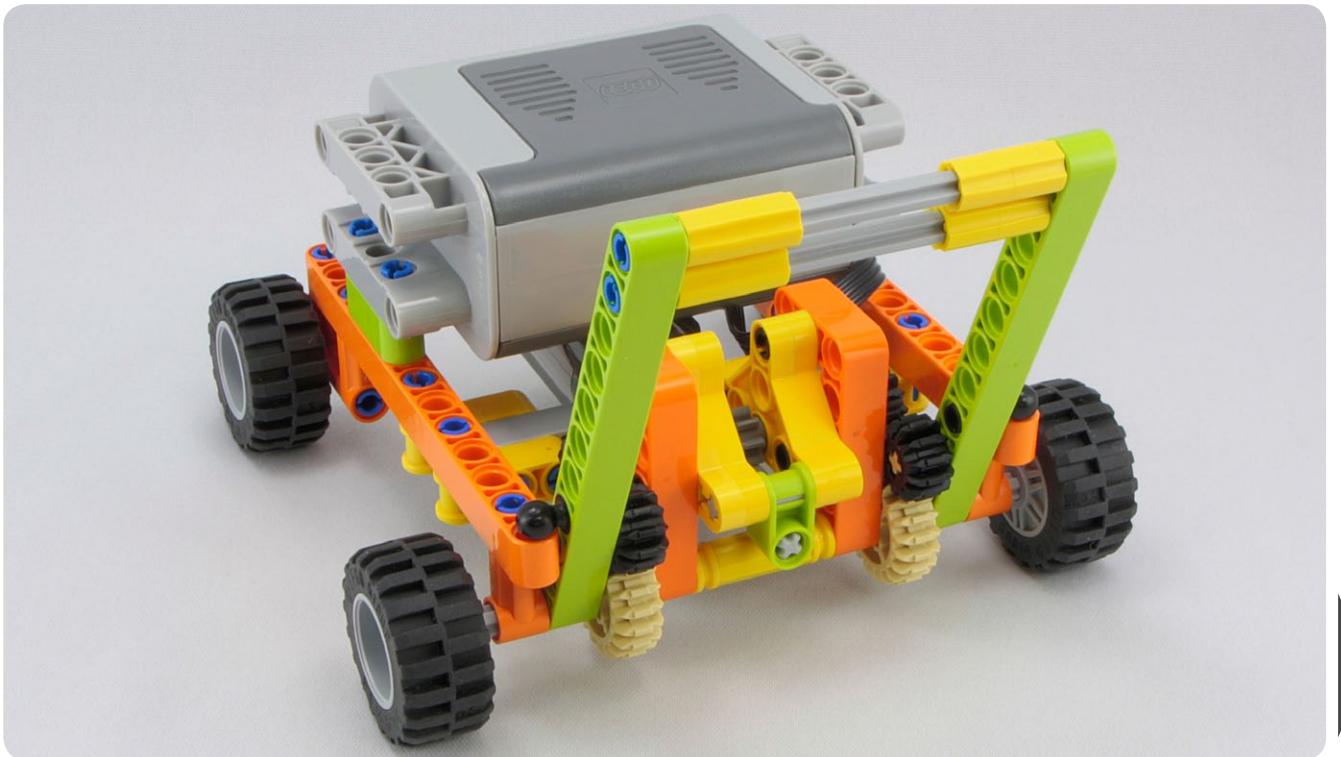


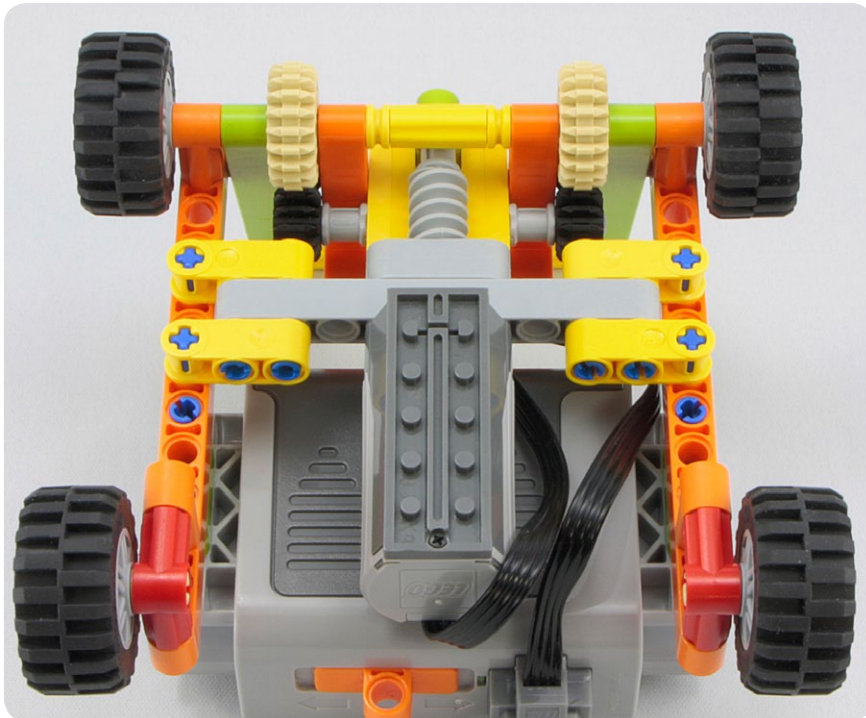
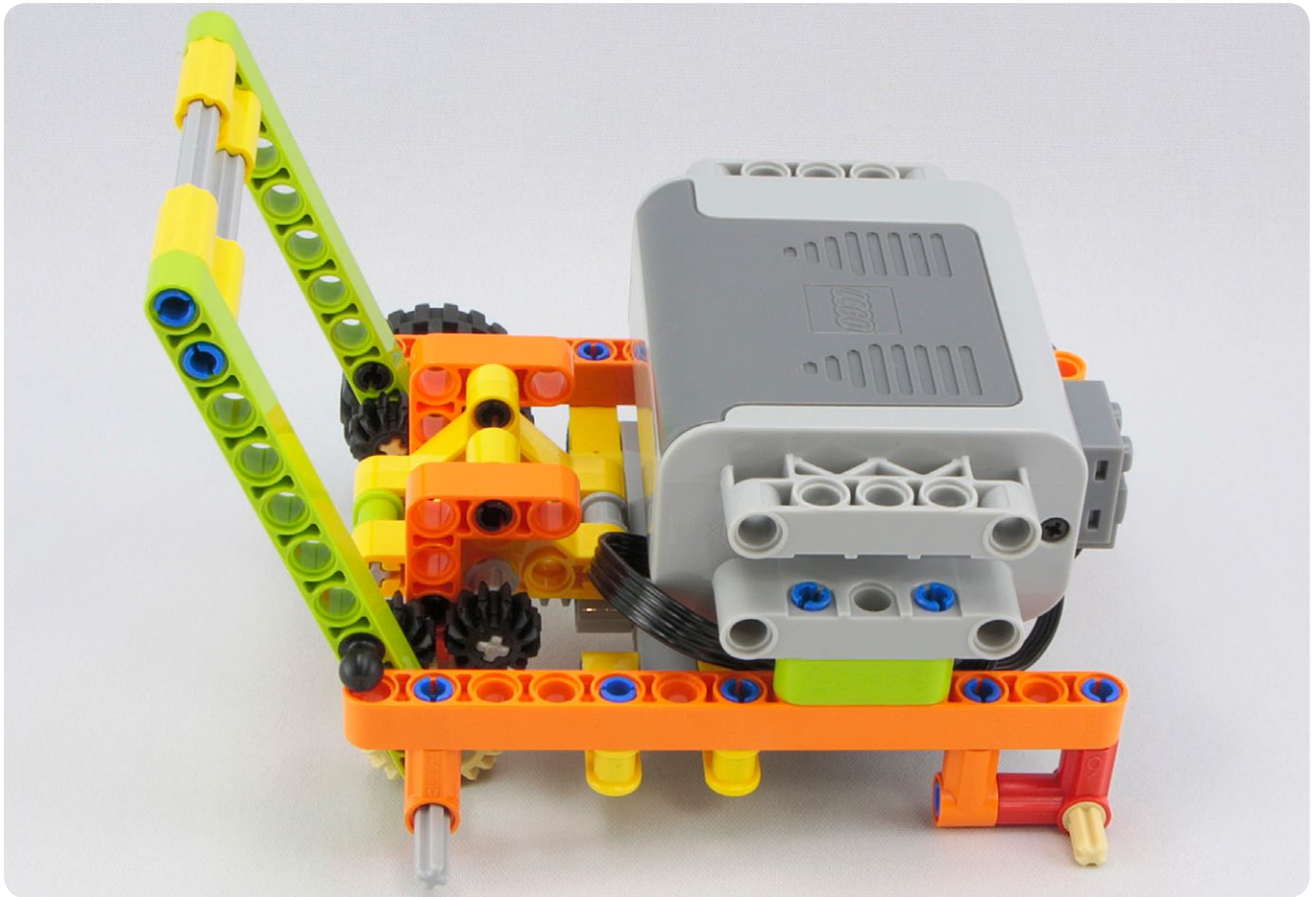


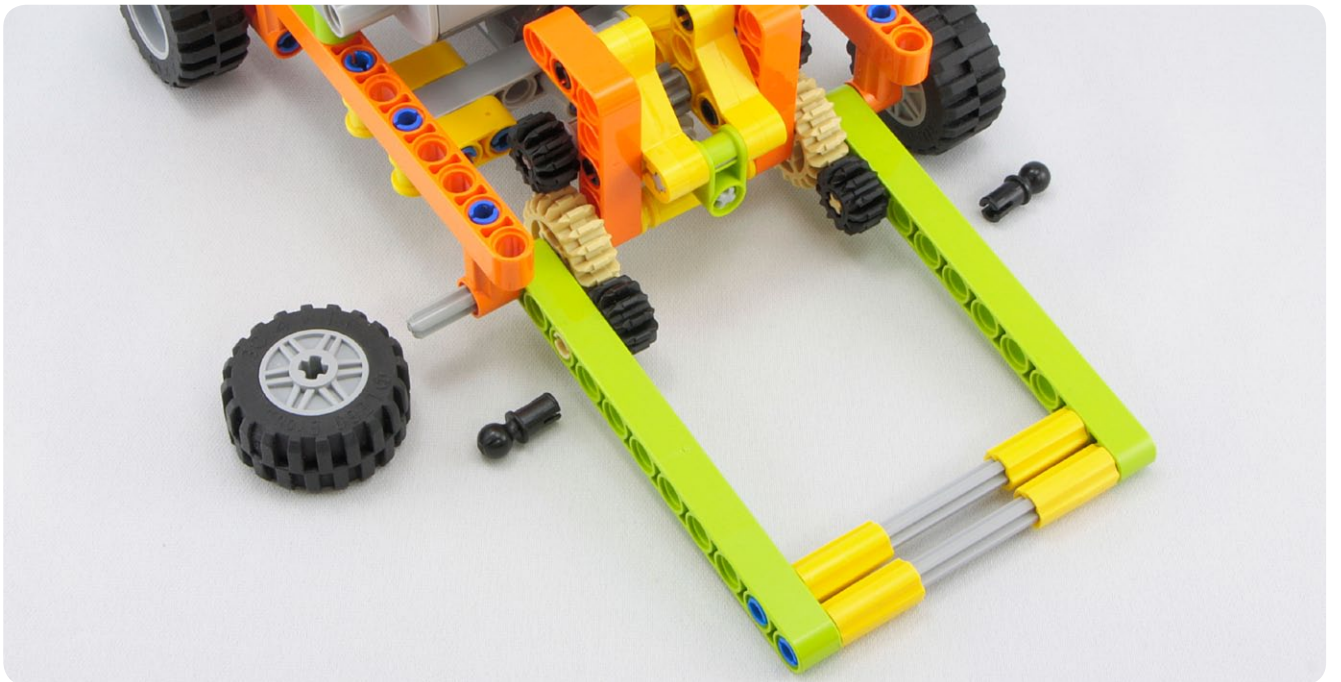
Cool cars

#93

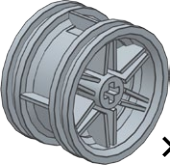





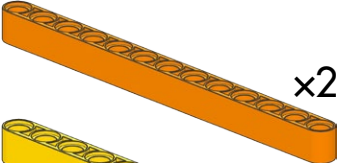
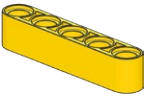
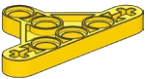



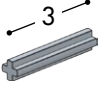
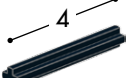

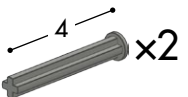




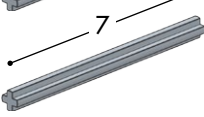



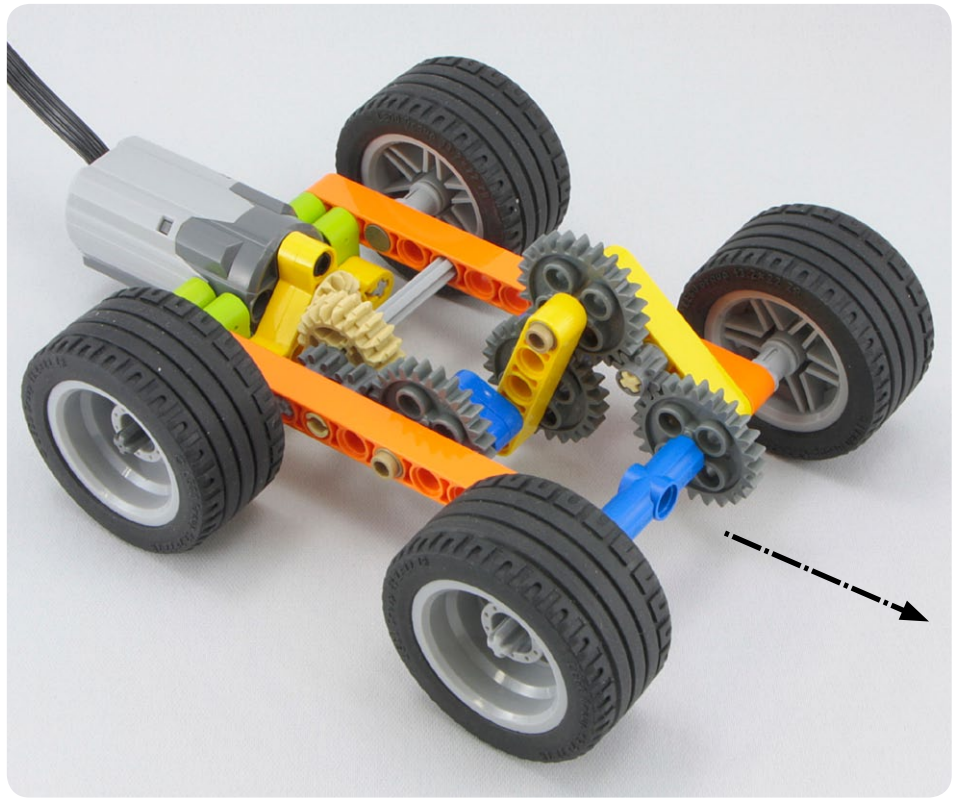


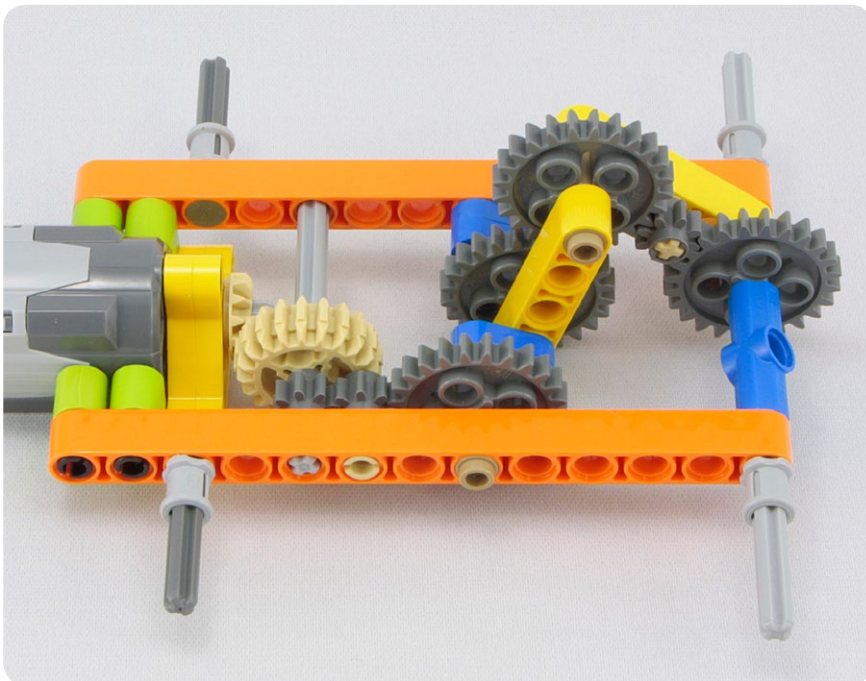
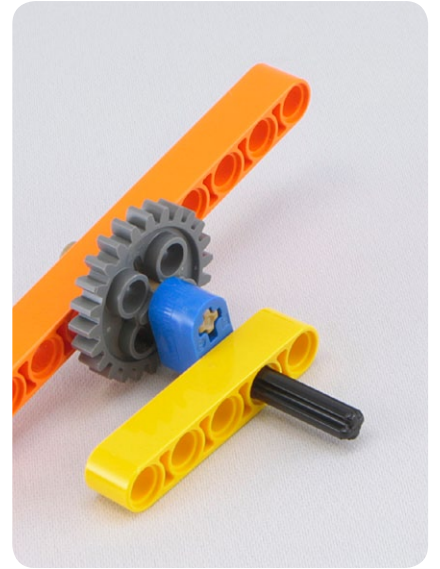
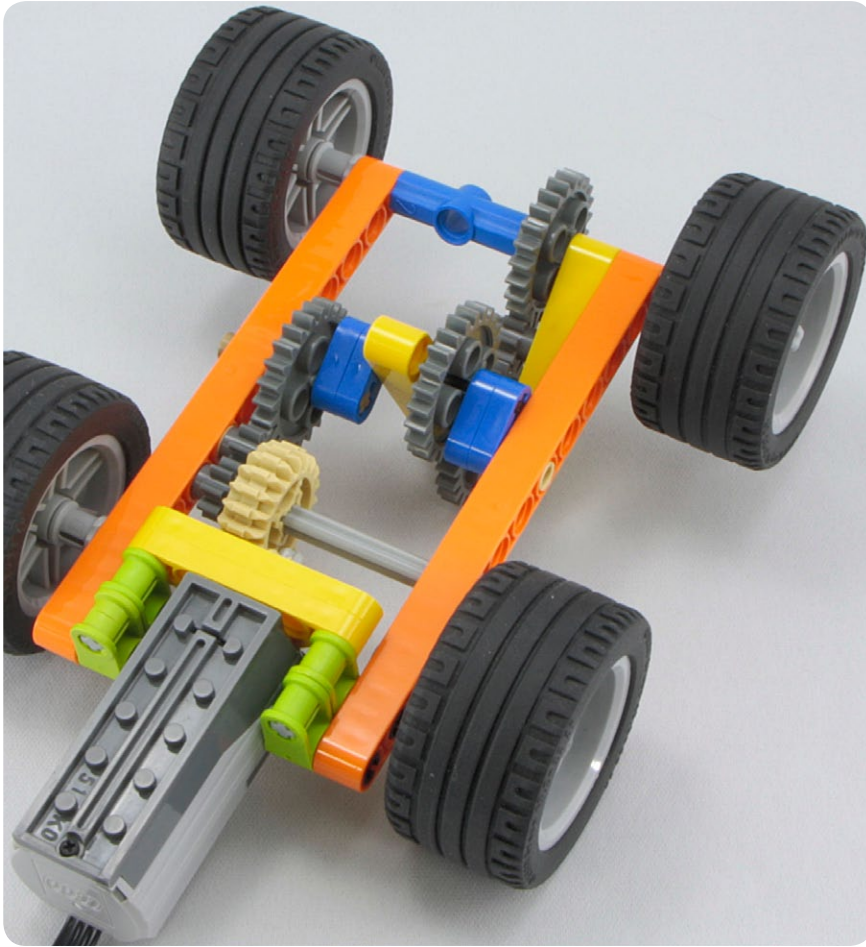













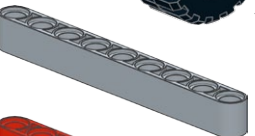
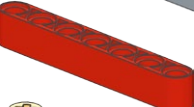
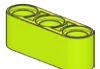
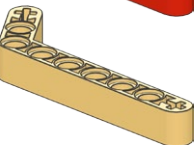
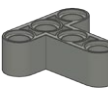
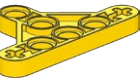

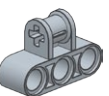





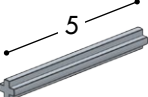

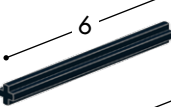
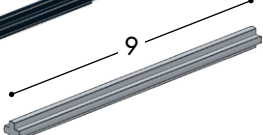
#94

-  x4
-  x4
- 
-  x3
- 
-  x4
-  x2
-  x2
-  x2
- 
-  x4
-  x4
-  x3
-  x4
-  x2
-  x2
-  x4
-  x5
-  x3
-  x7
-  x2
-  x6

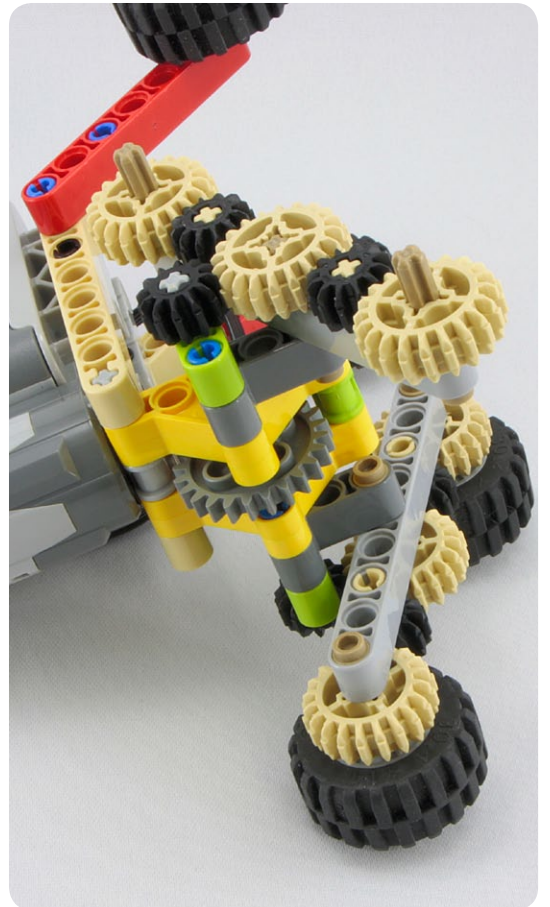
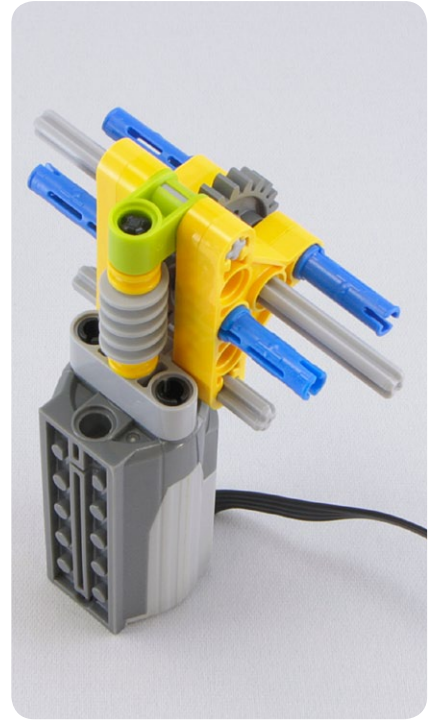
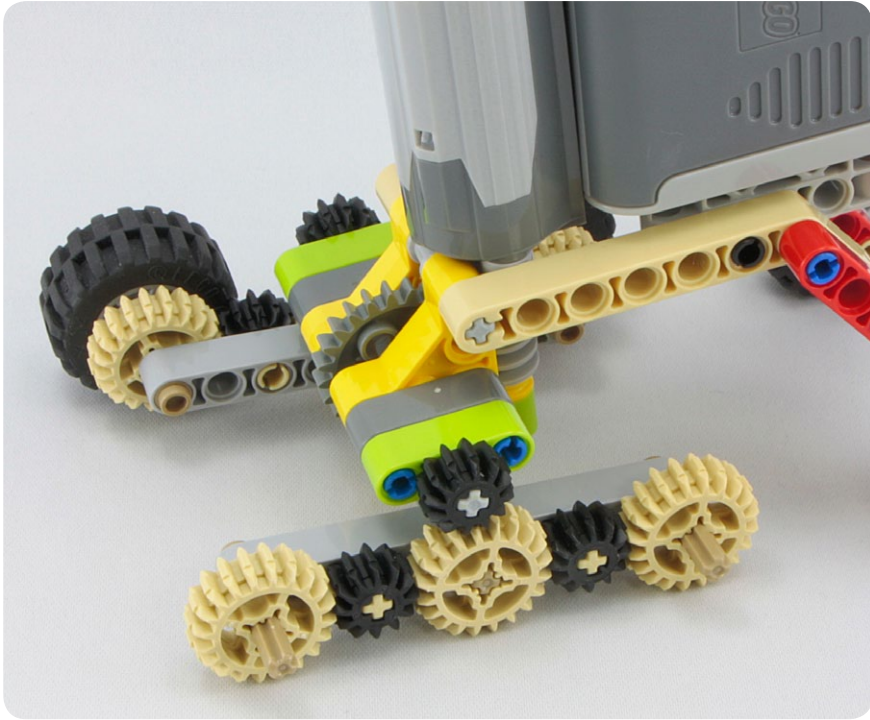


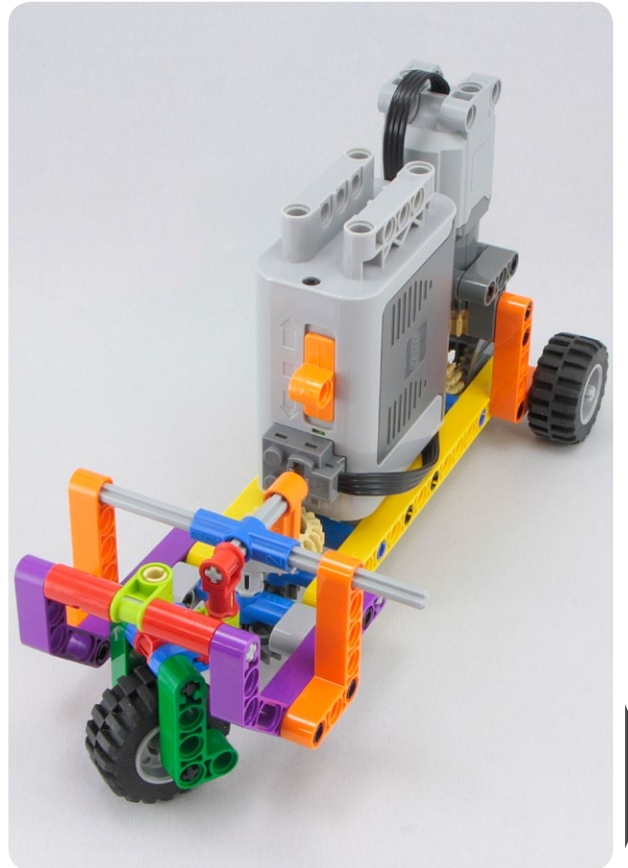


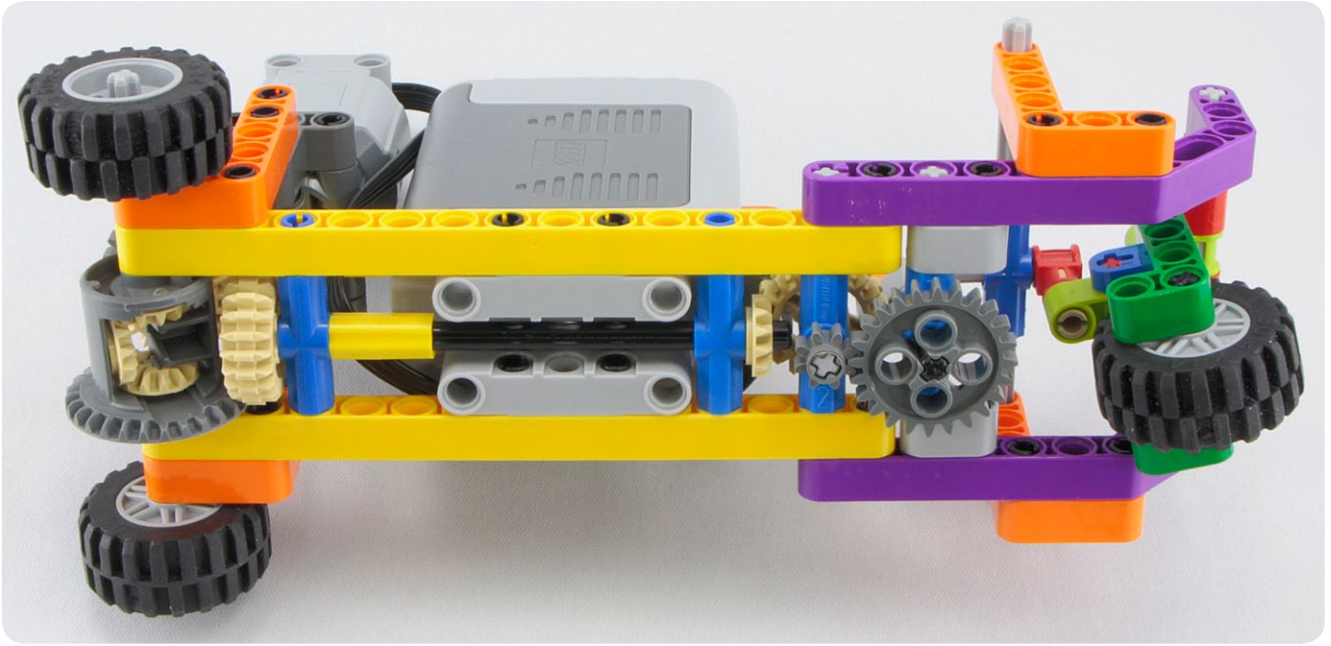
#95

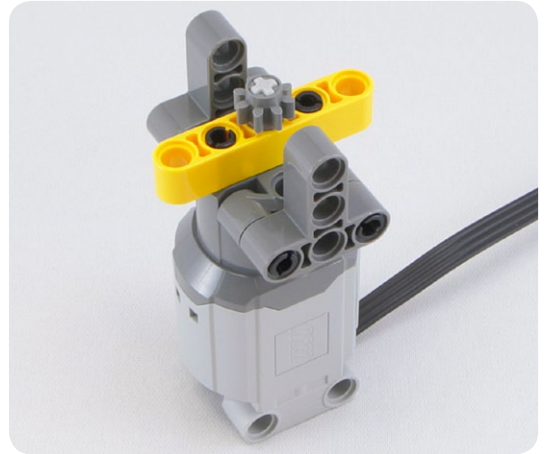
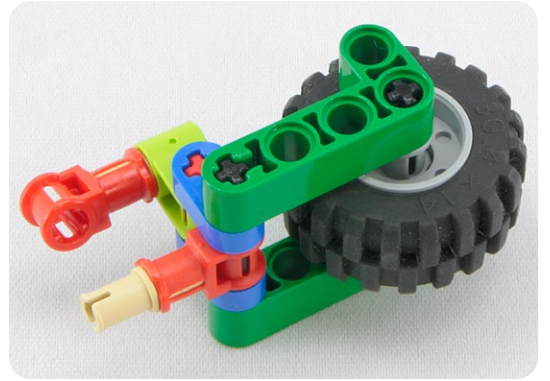
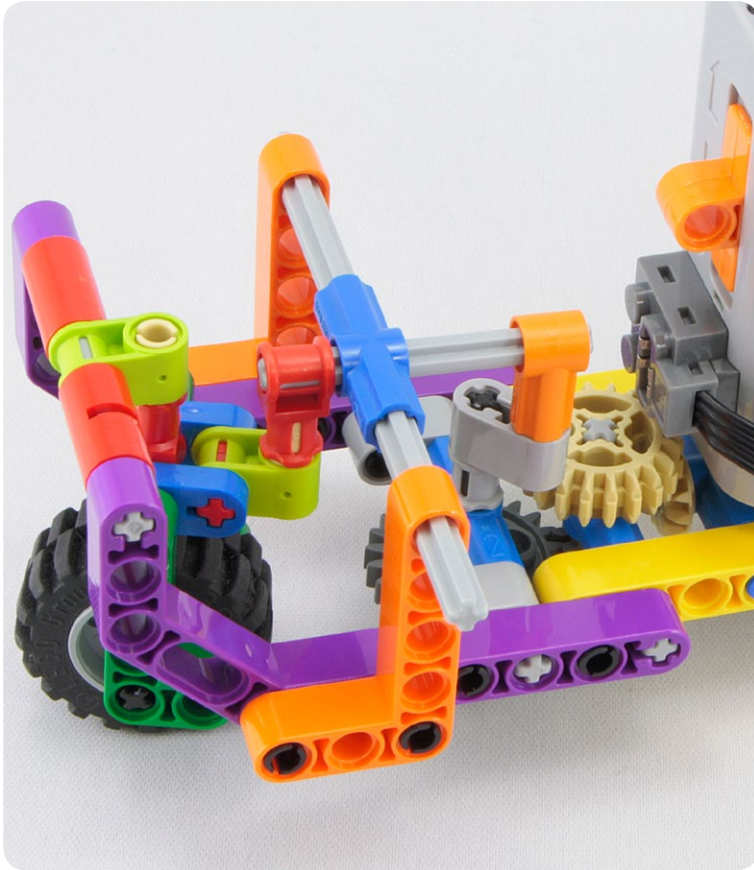
-  x6
- 
- 
-  x6
- 
- 
- 
-  x6
-  x6
-  x2
-  x2
-  x2
-  x2
-  x2
-  x4
-  x2
- 
-  x6
-  x6
-  x6
-  3
-  x2
-  5
-  x4
-  6
-  9



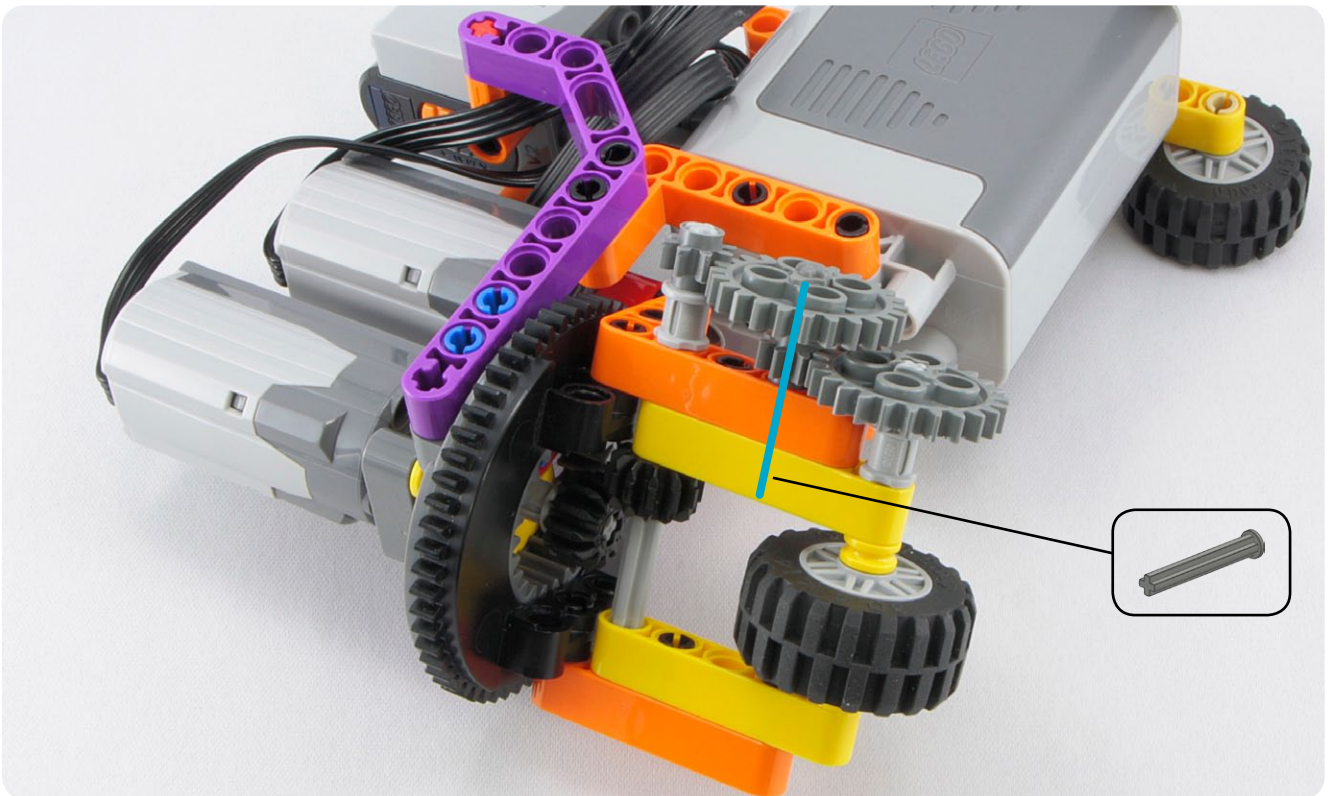
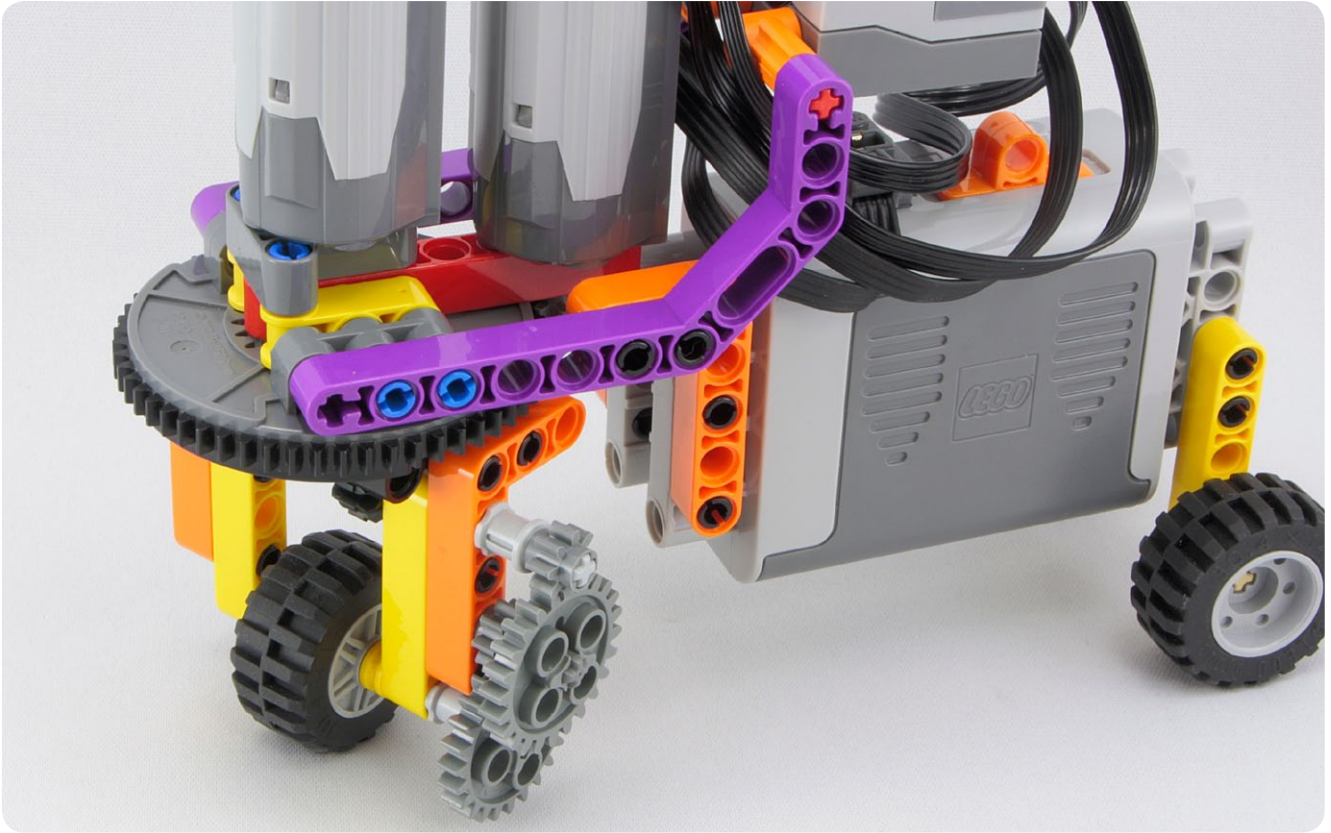


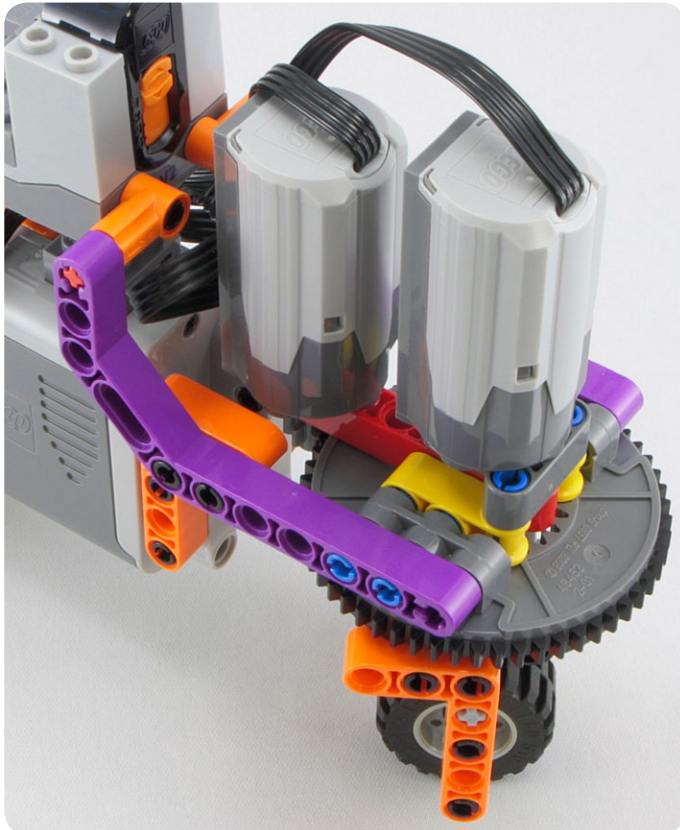
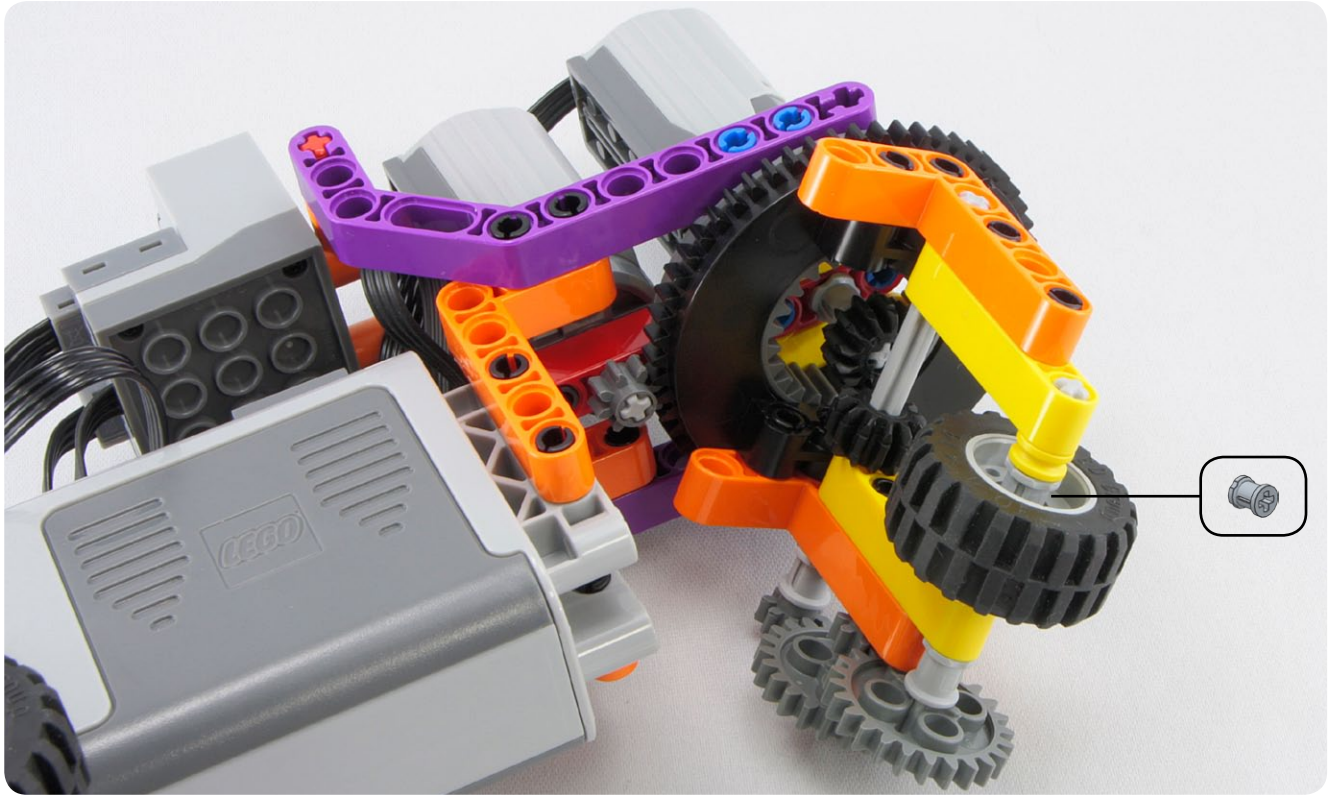




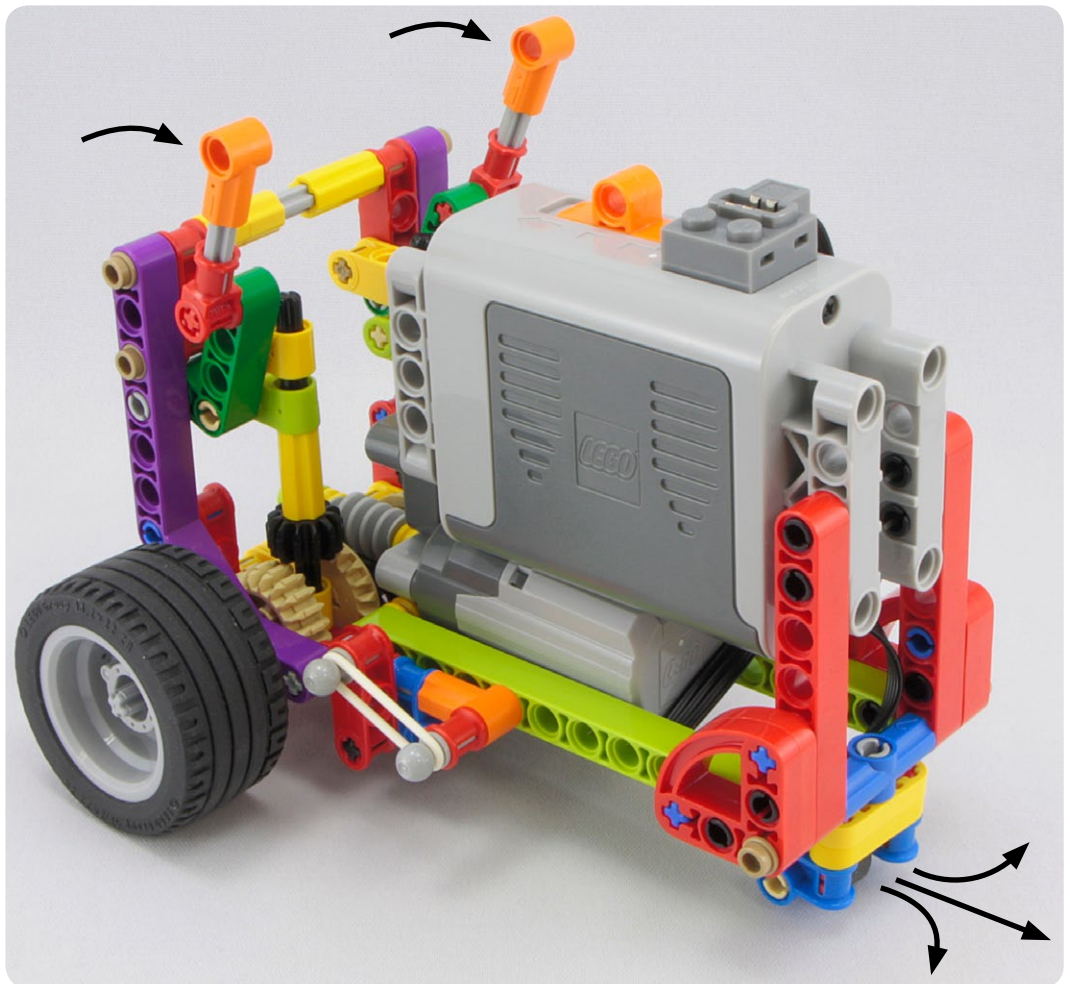
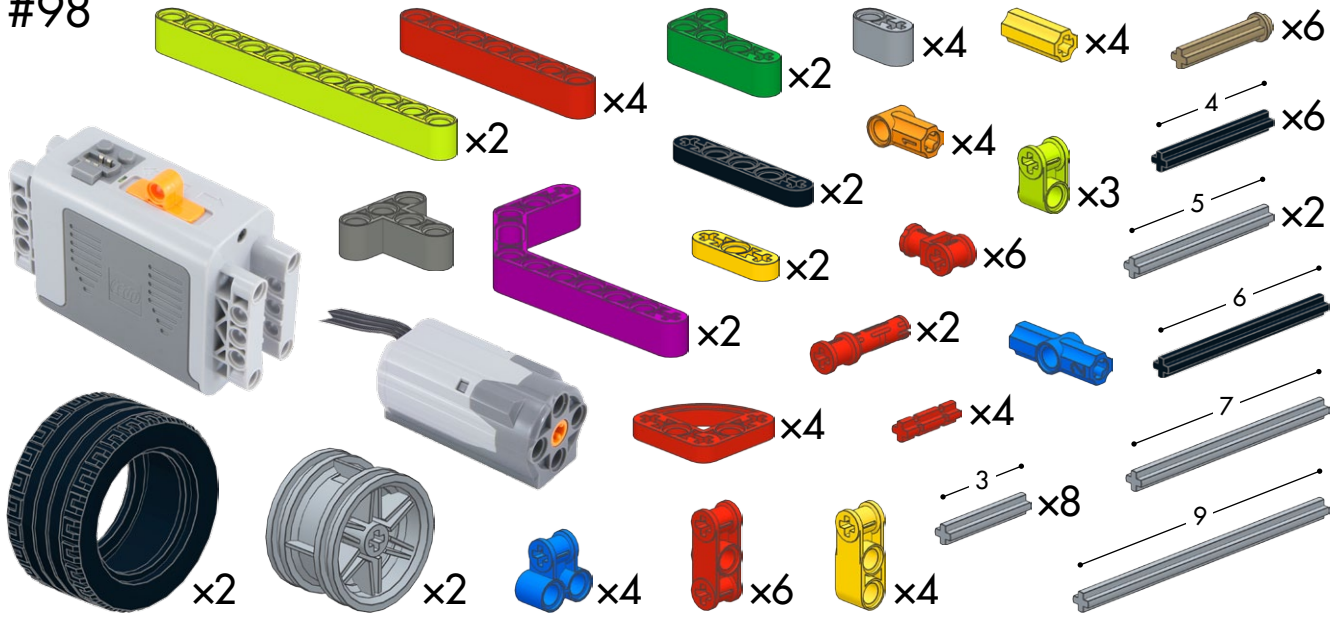


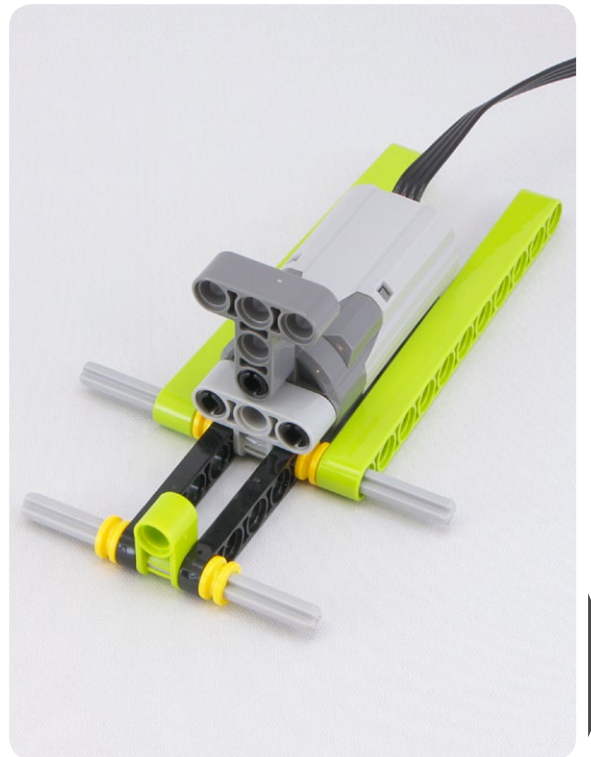


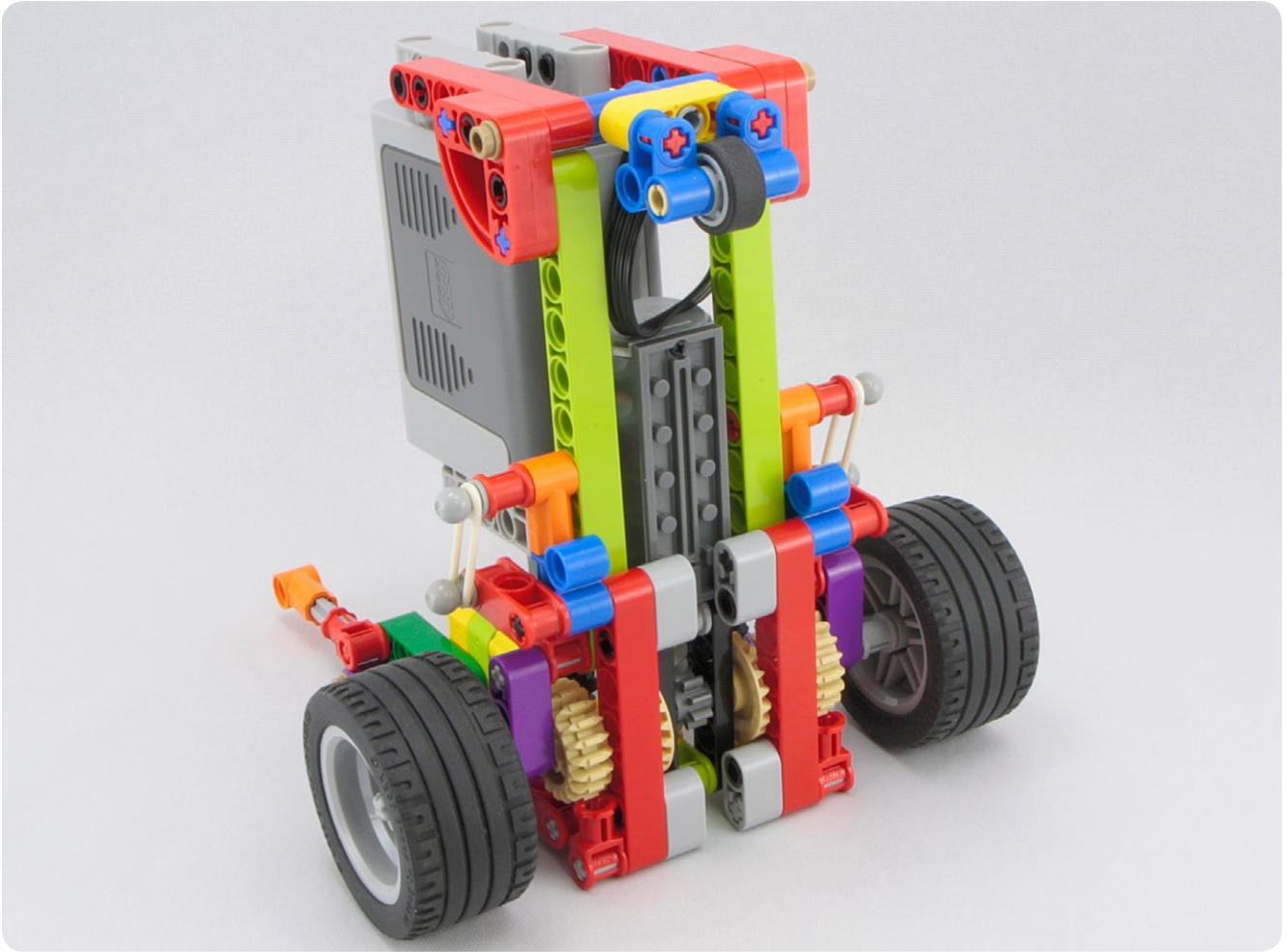


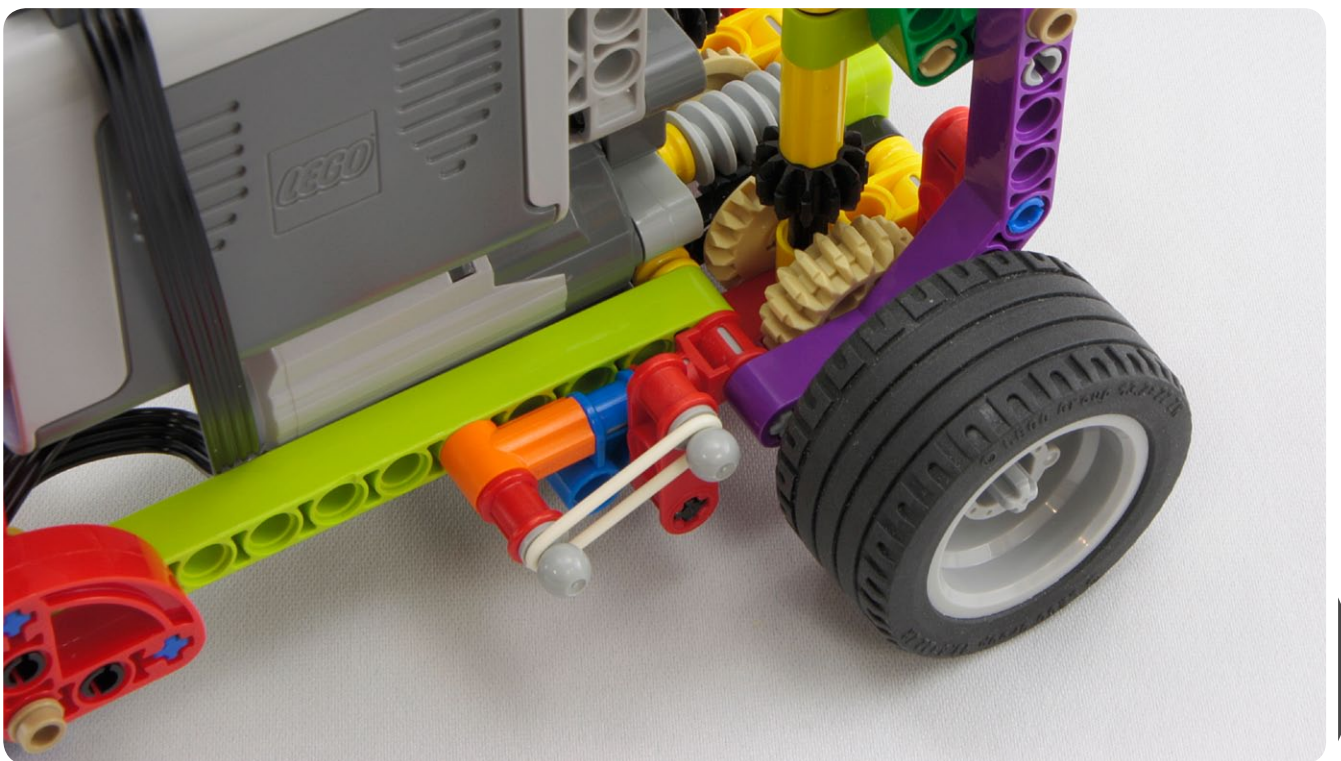
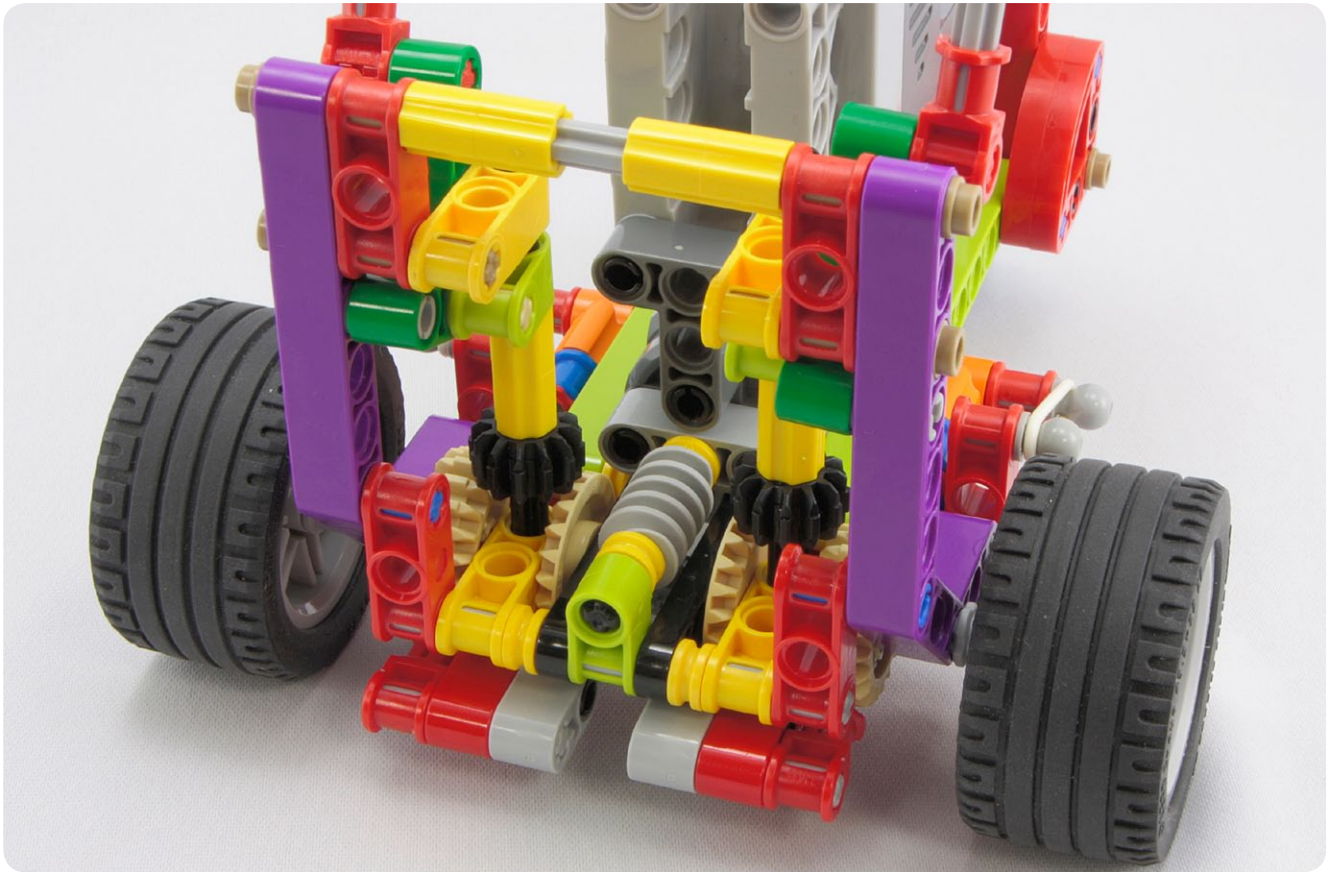


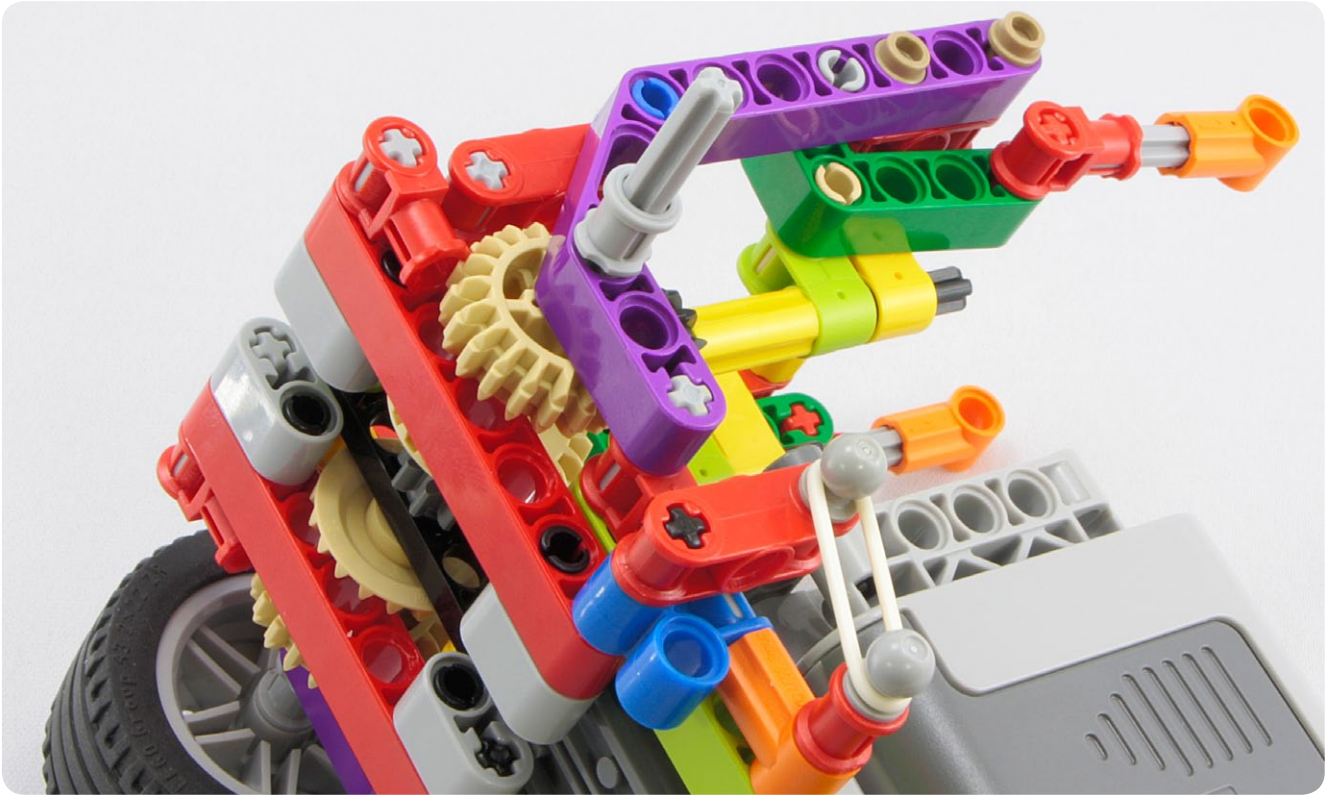
#98

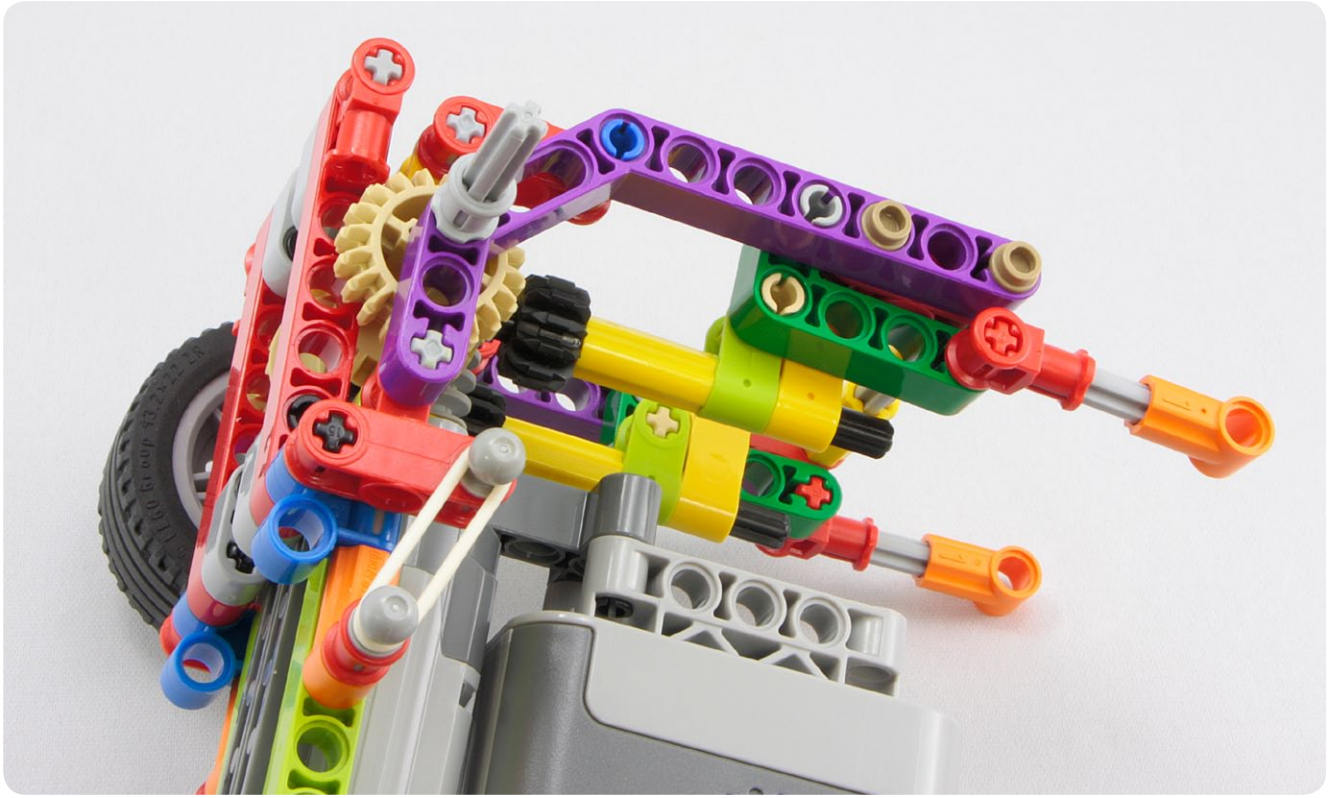


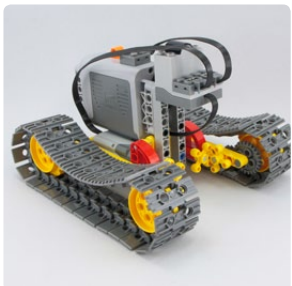












PART 2

Moving Without Tires



196



220



234



244



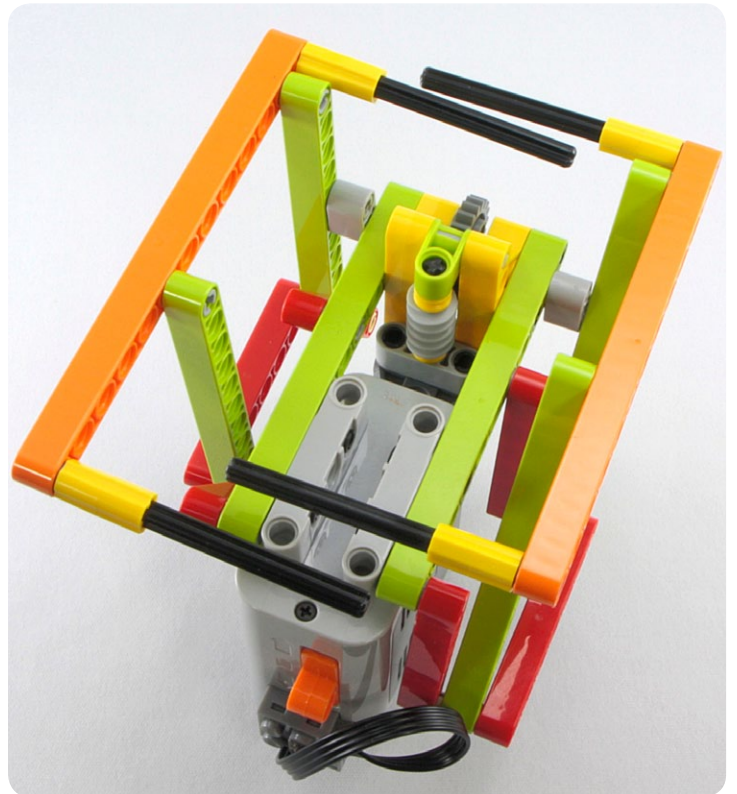
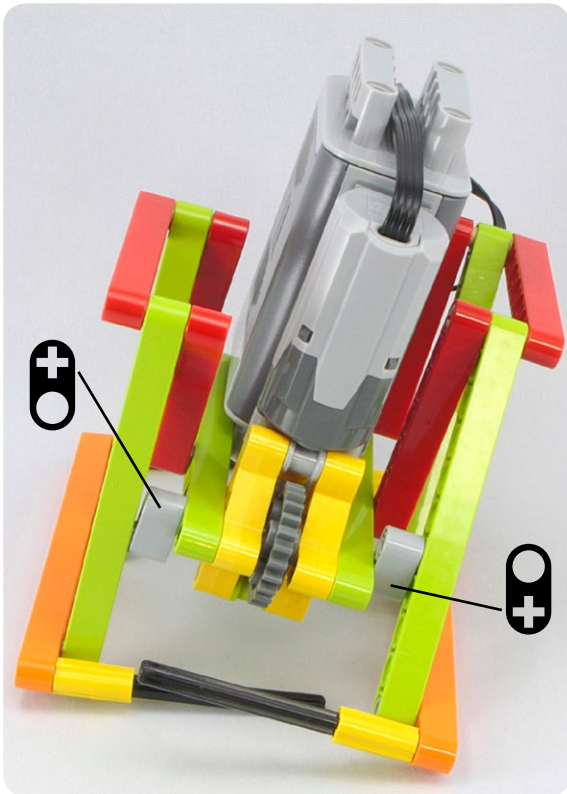
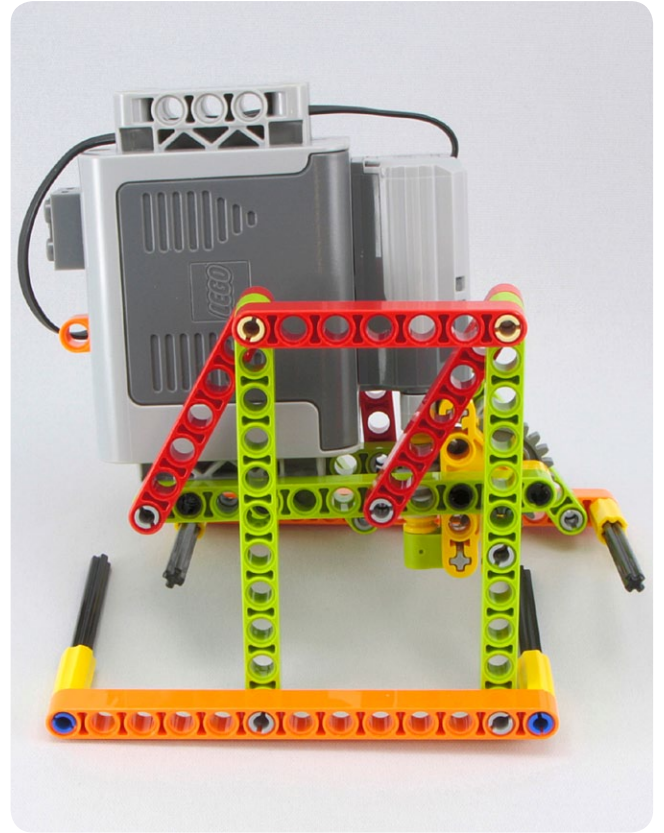
208



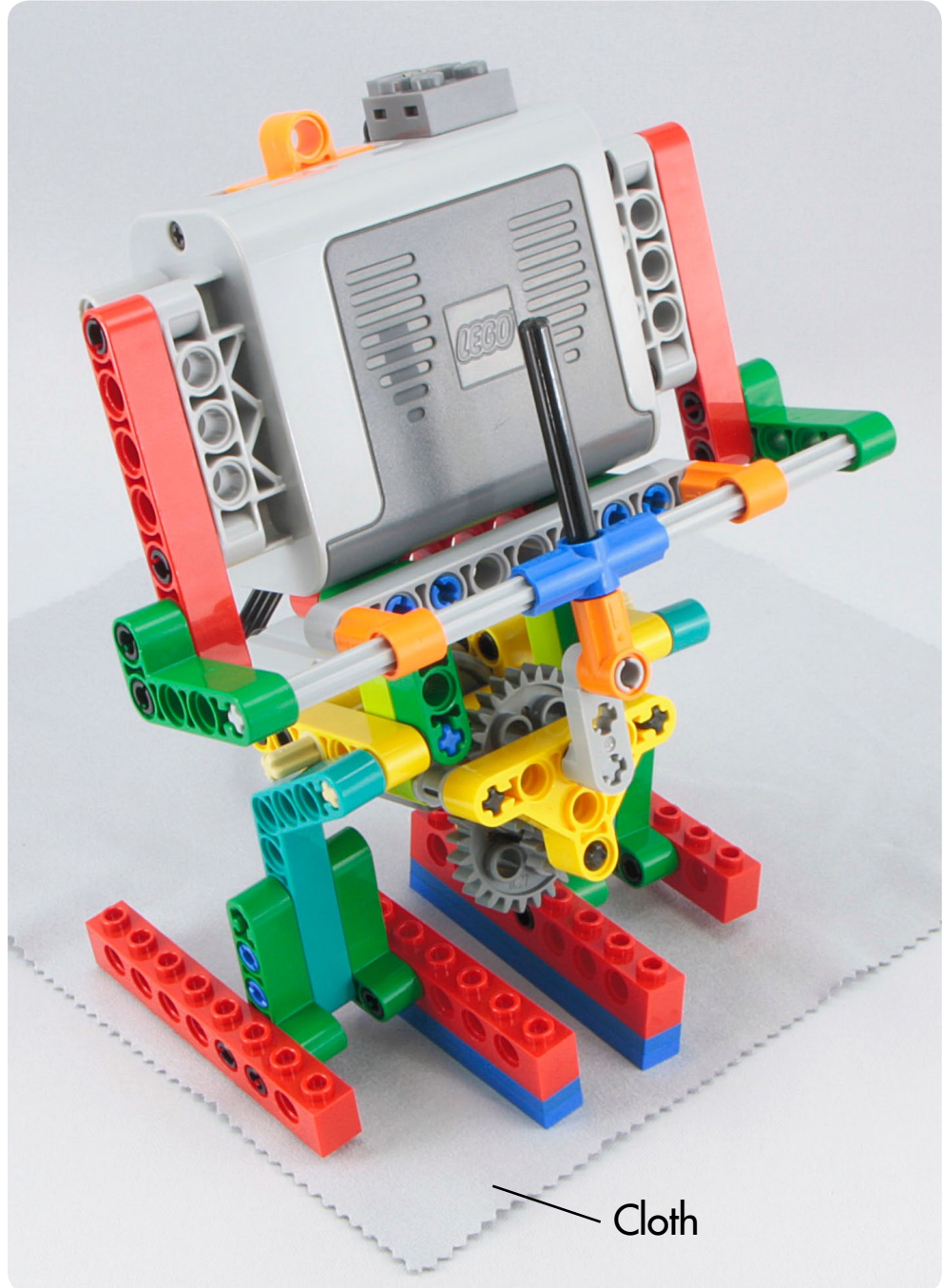
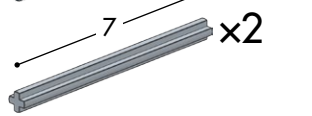
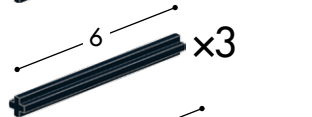
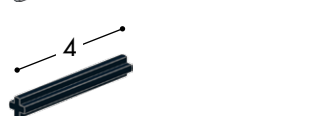
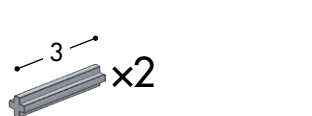
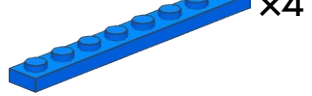
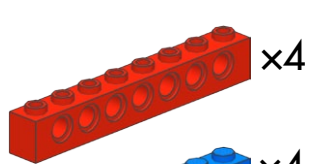
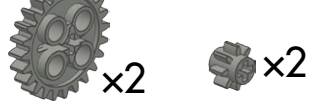
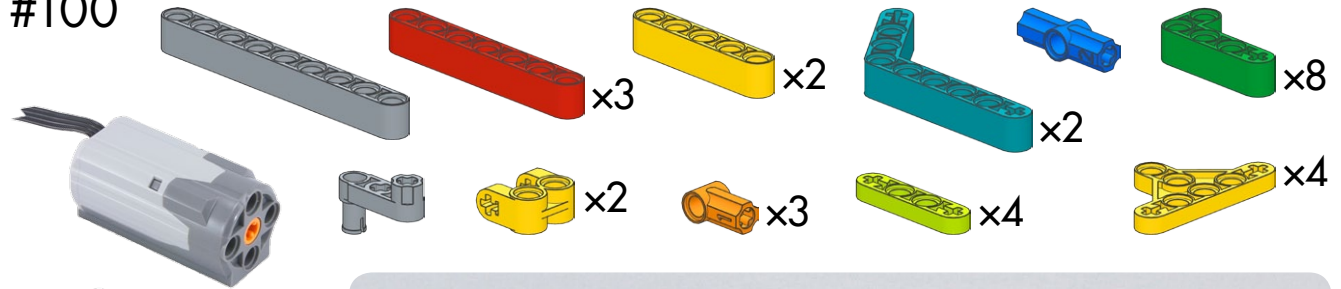
224

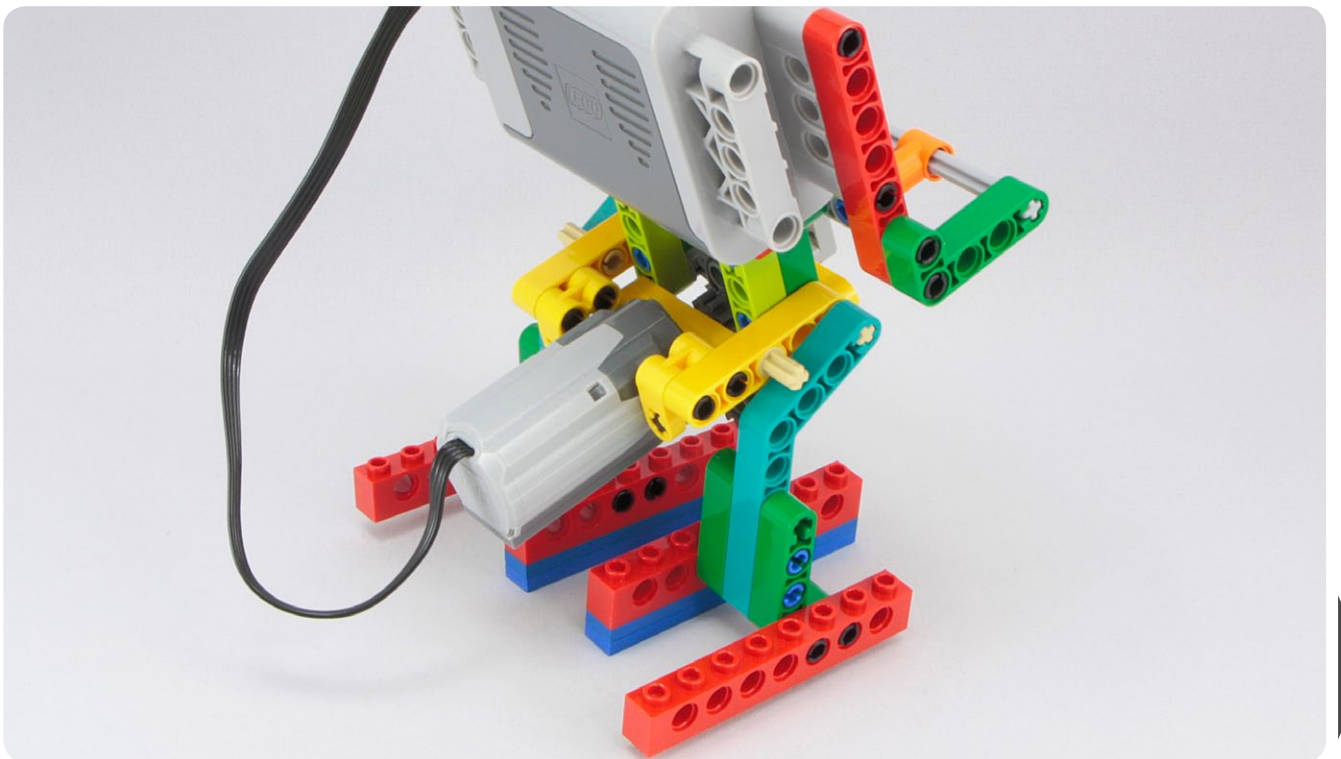
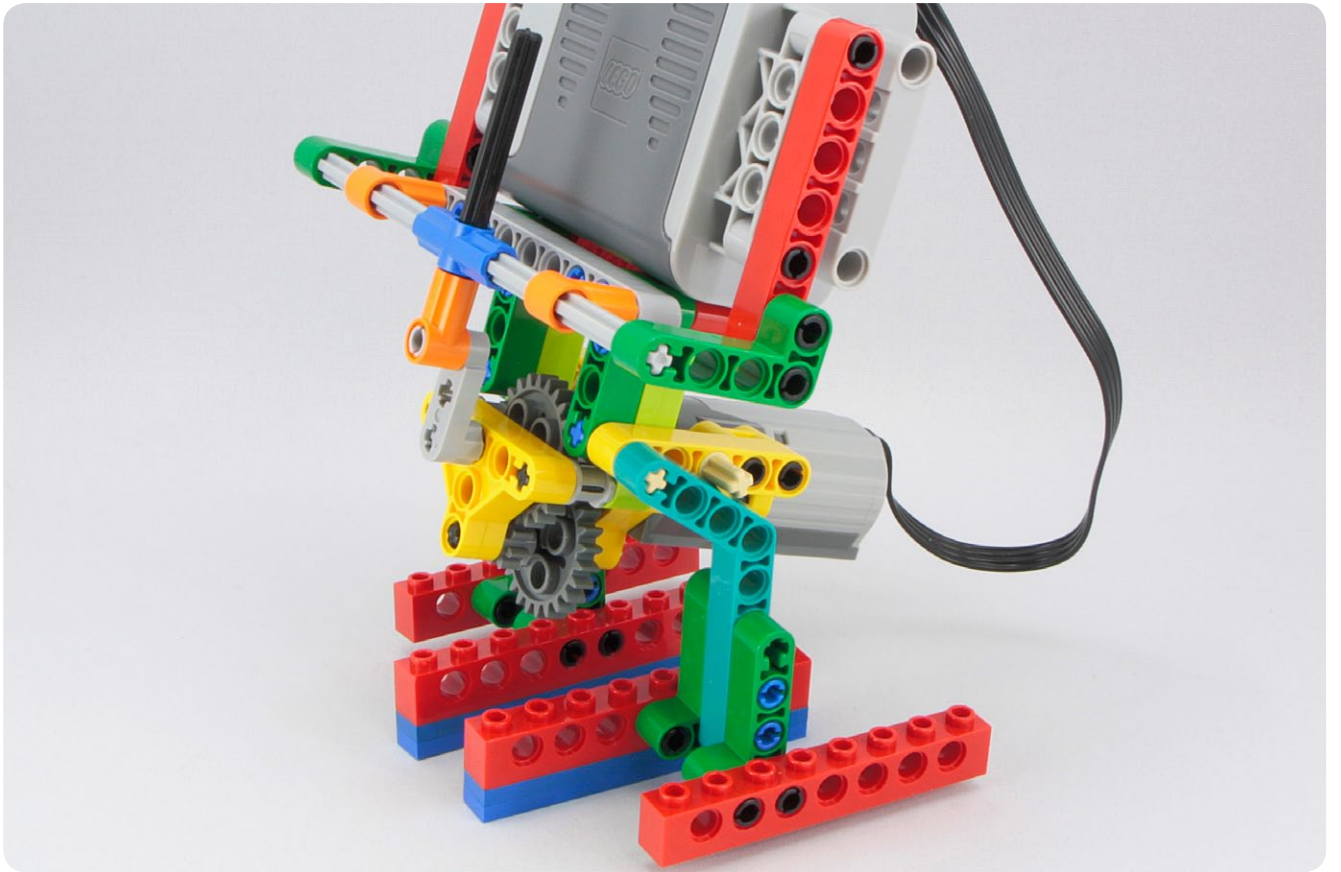


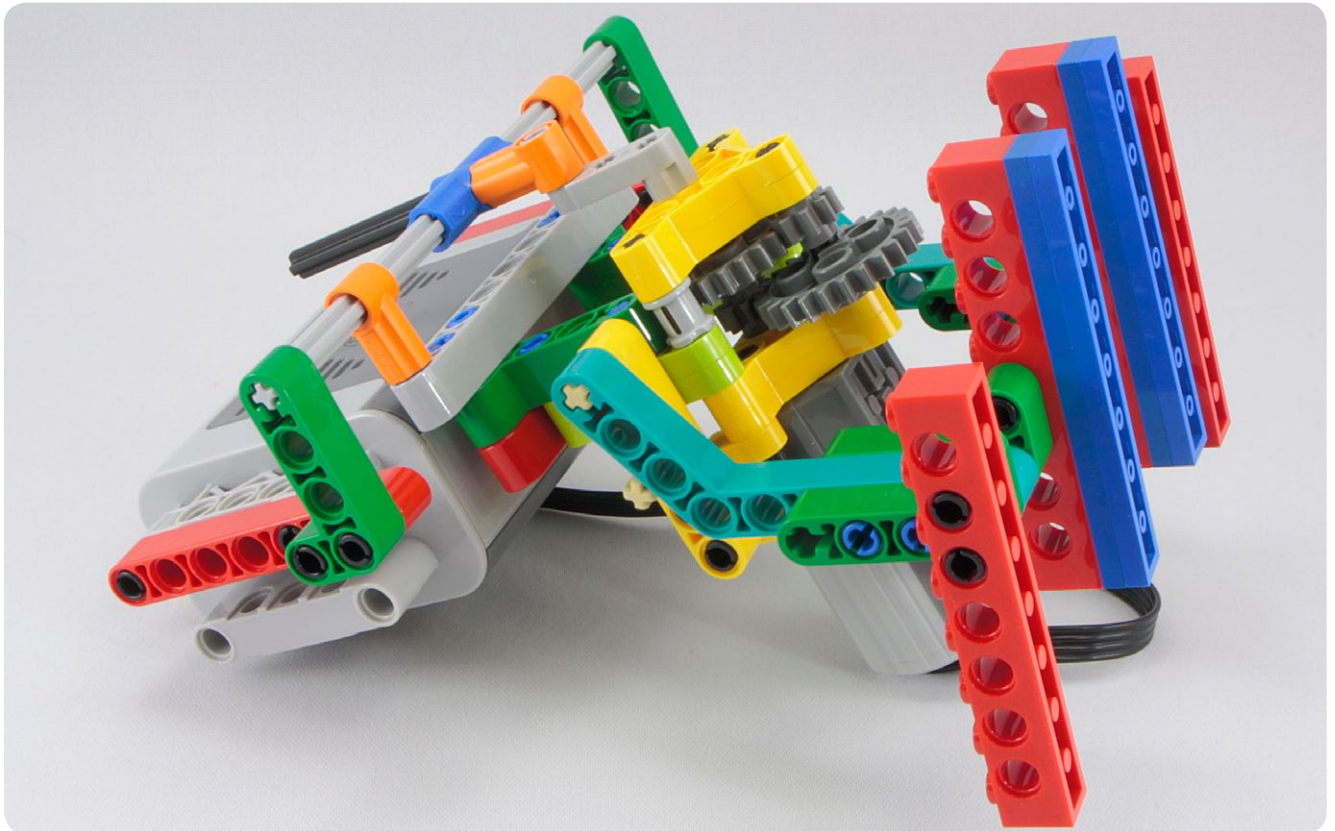
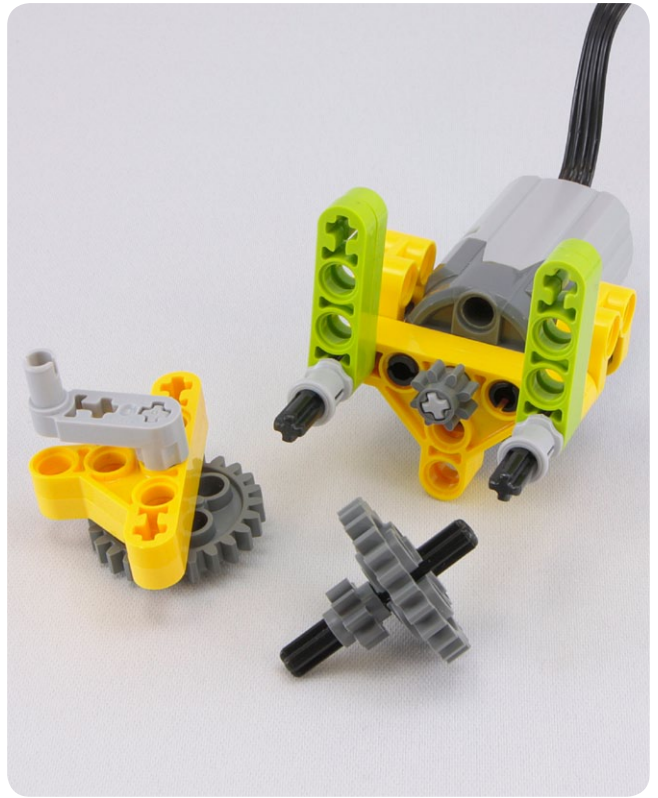
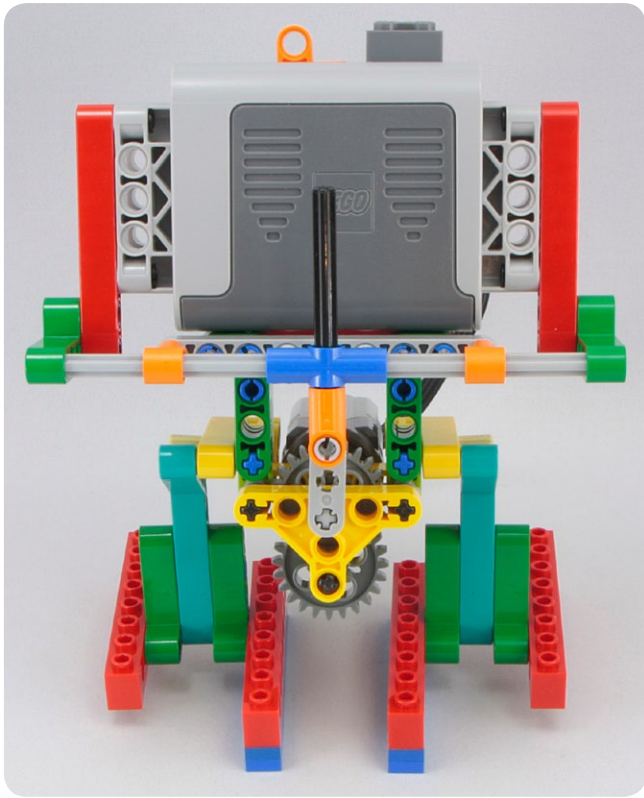
240

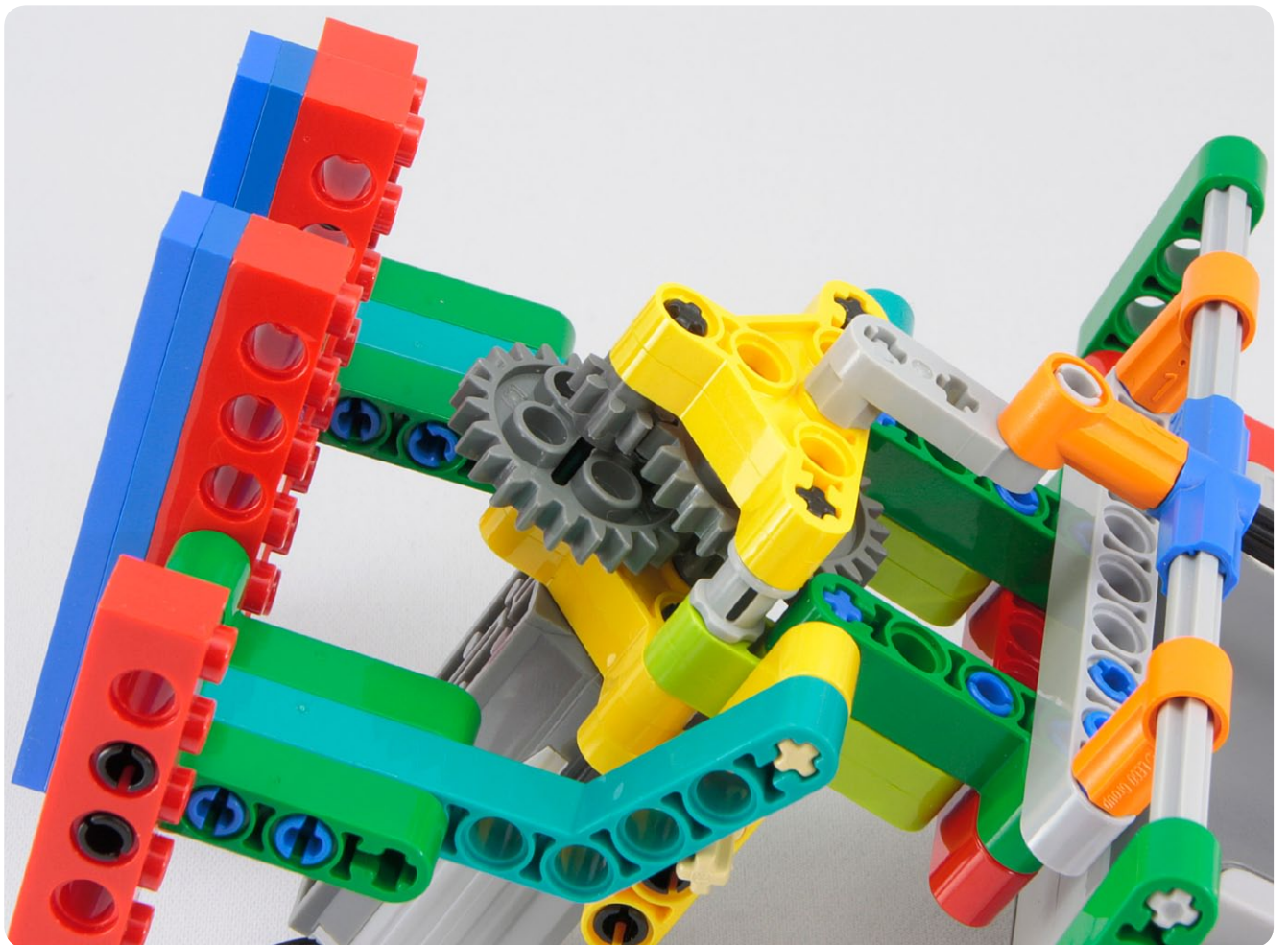
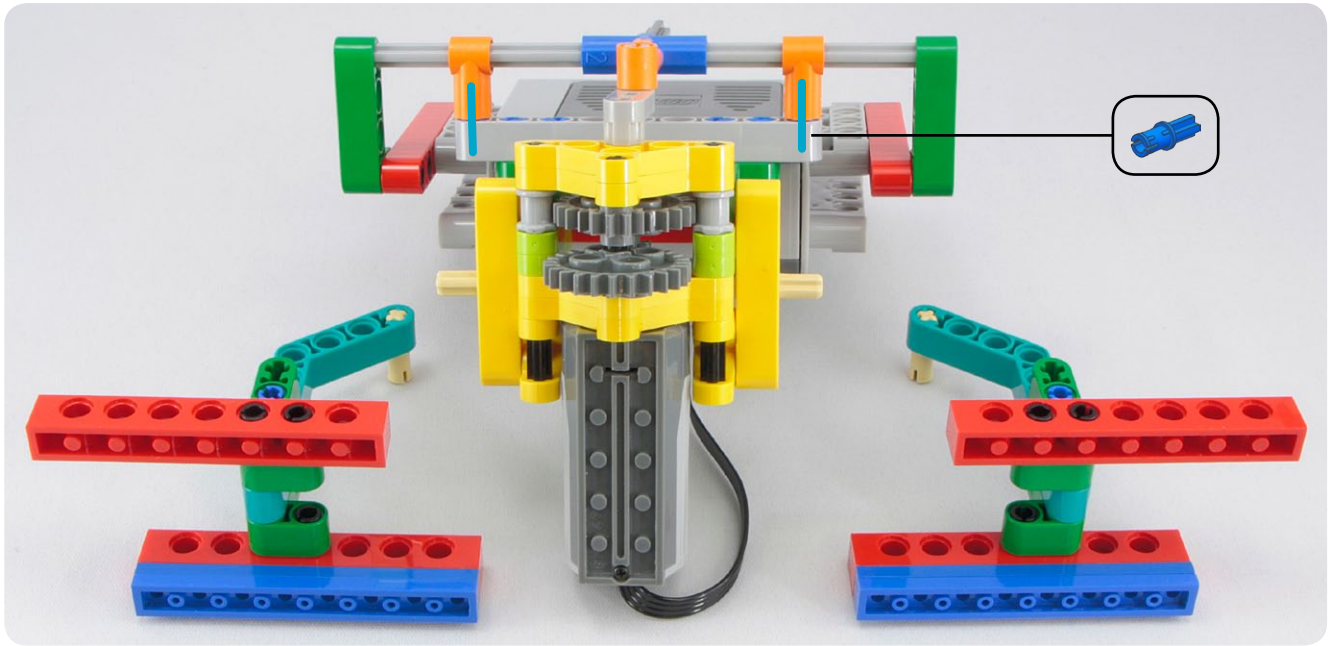


#100

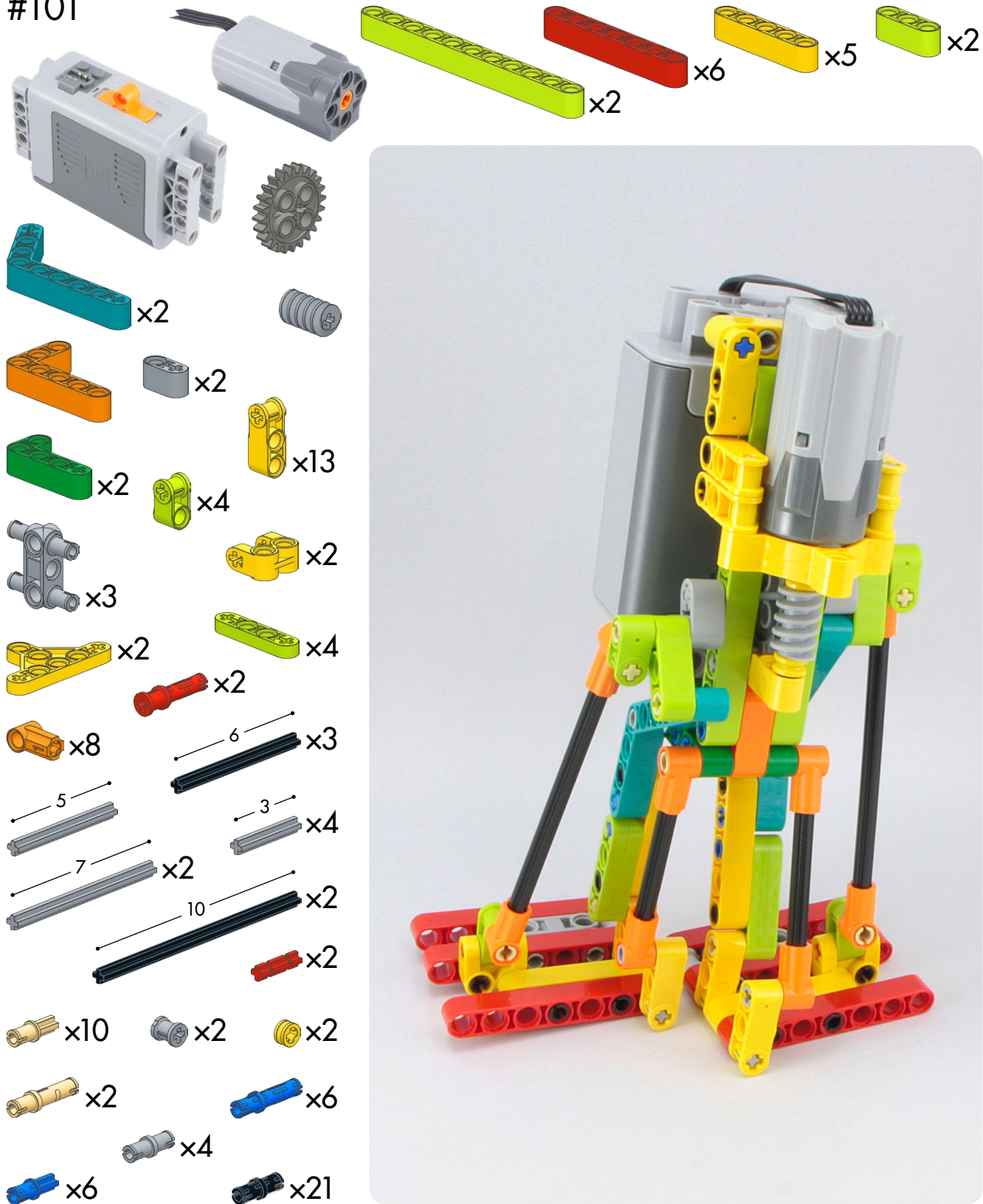


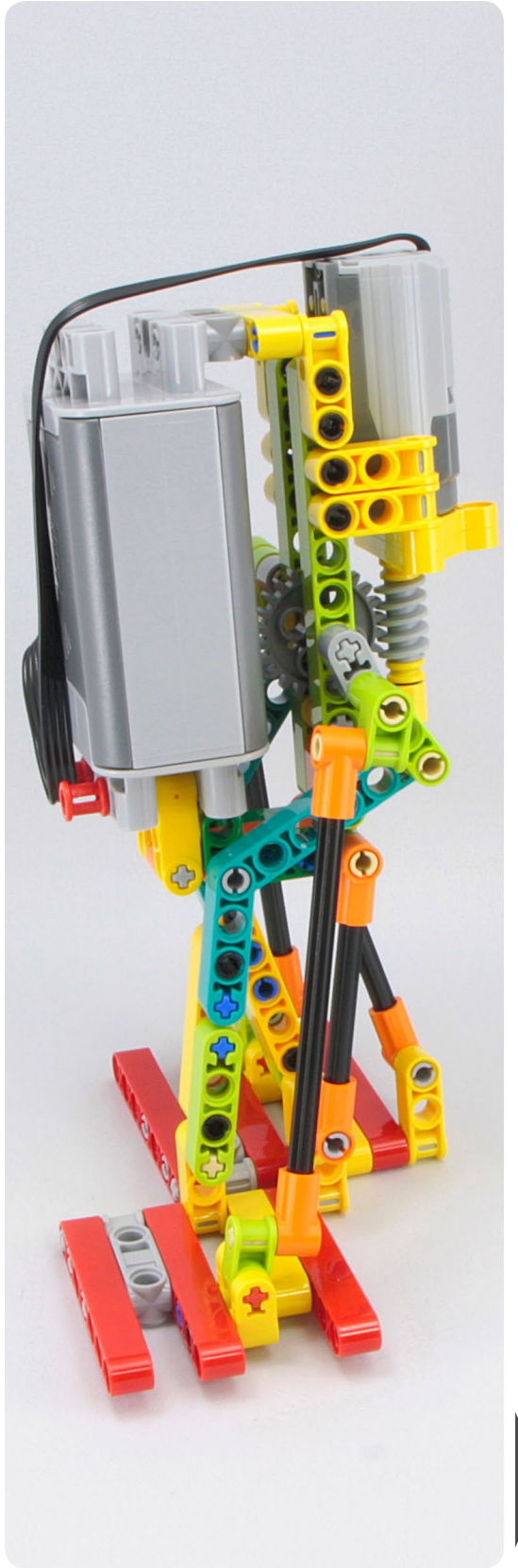
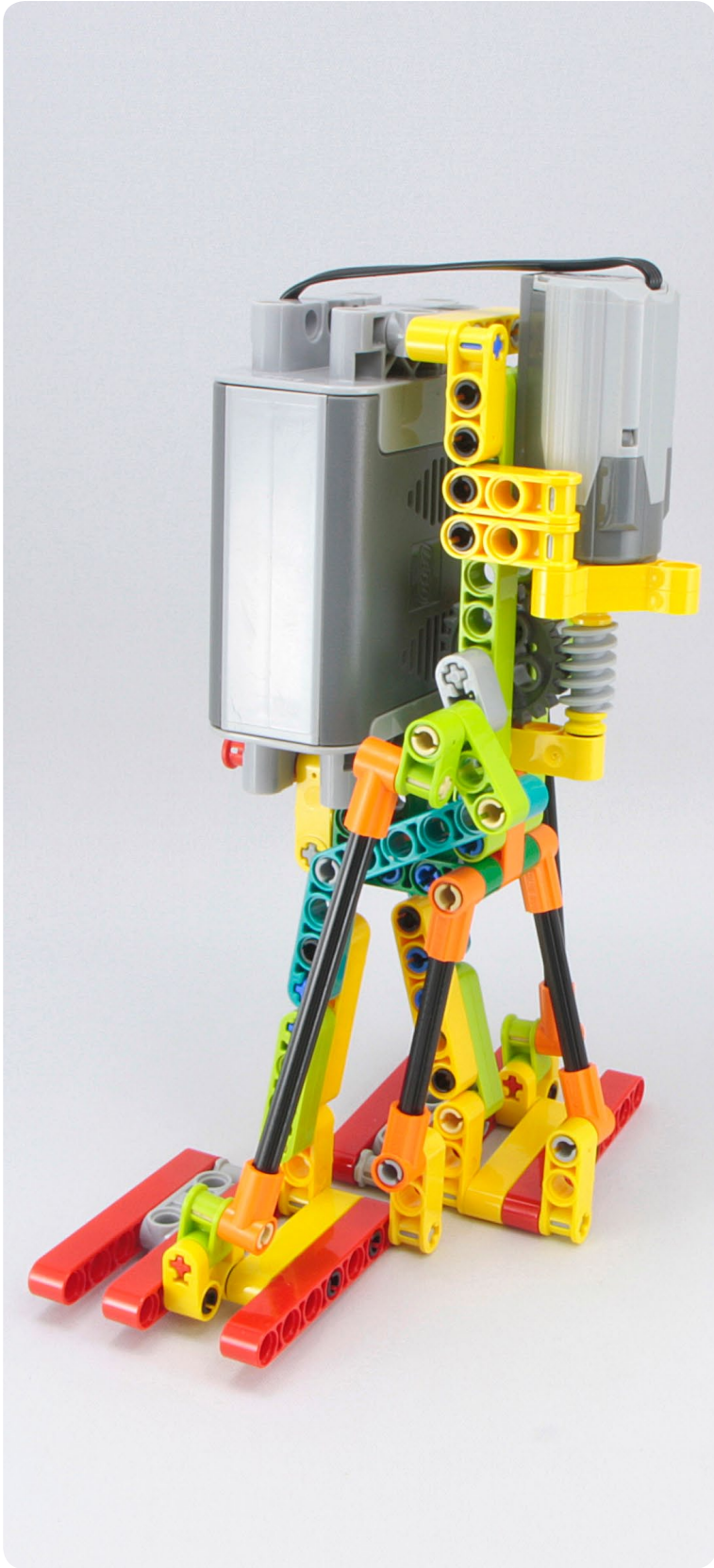


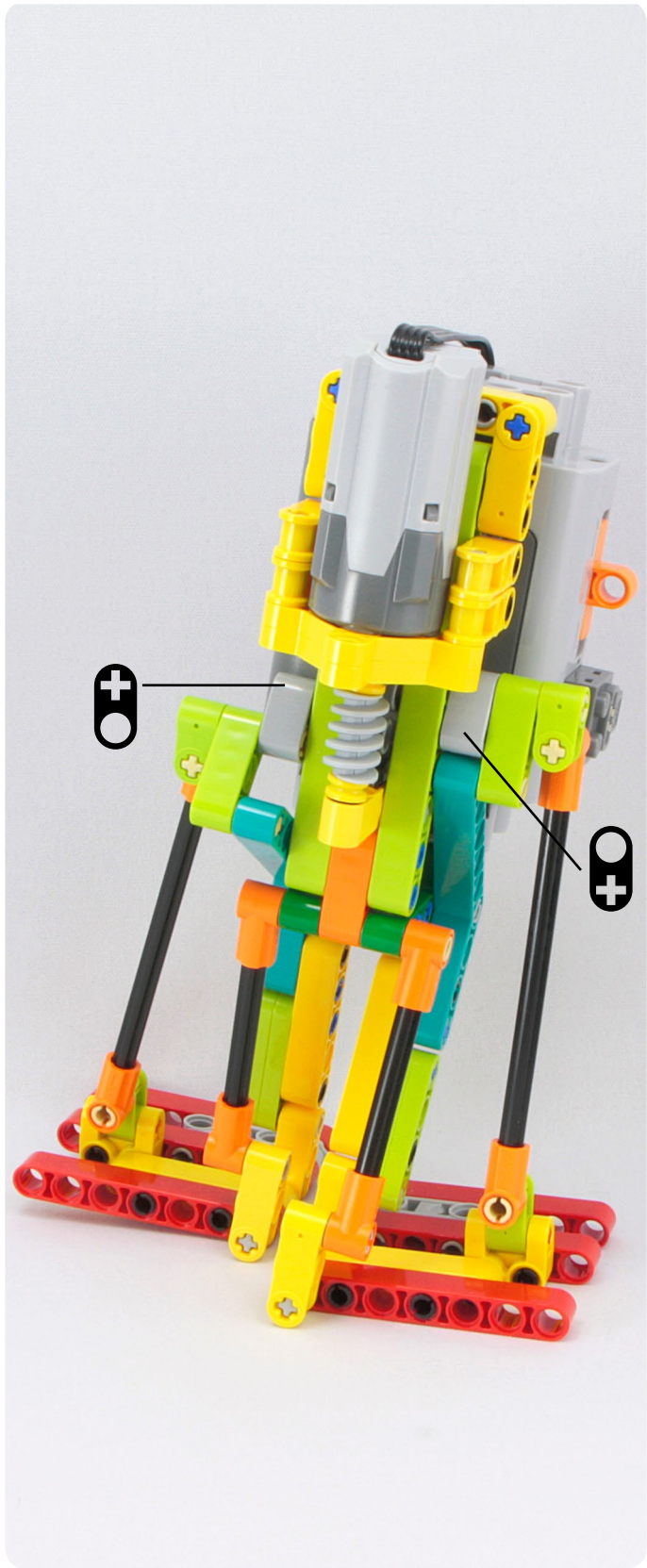


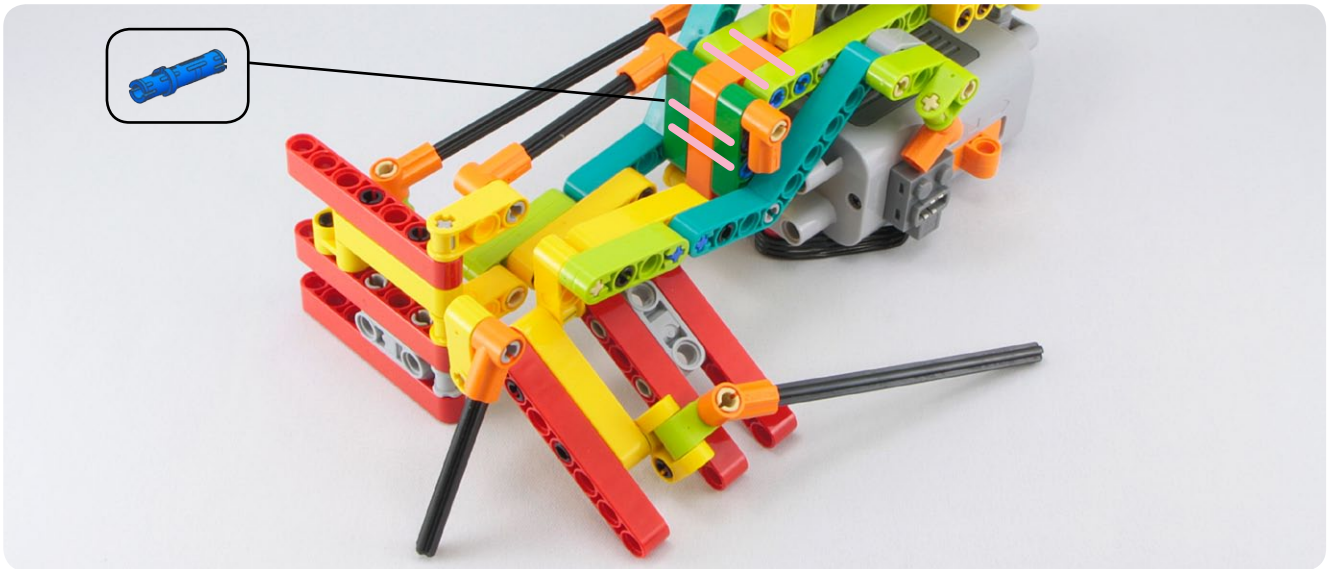
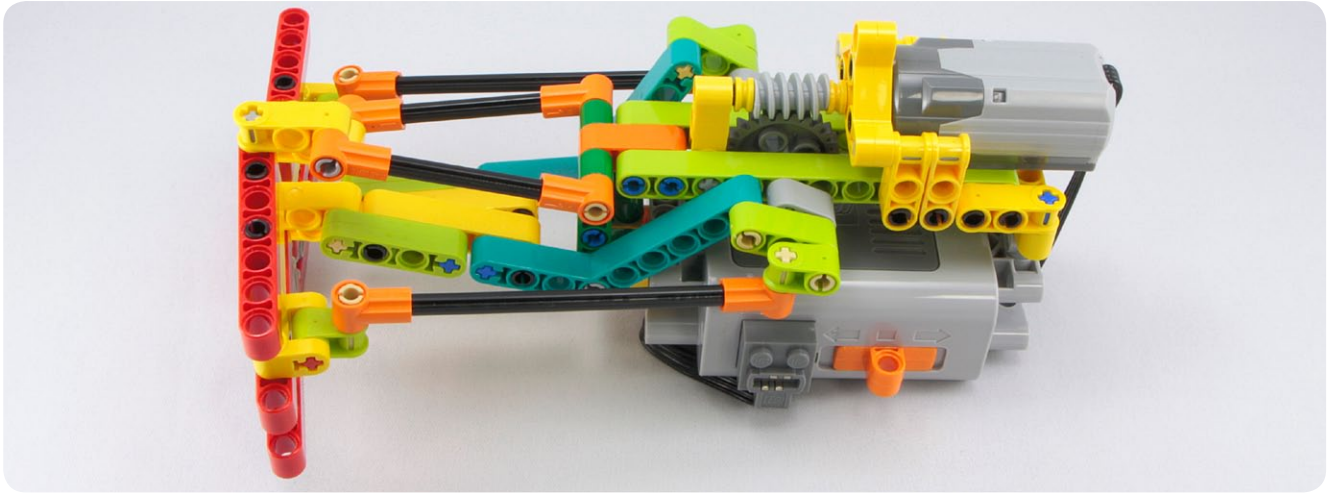


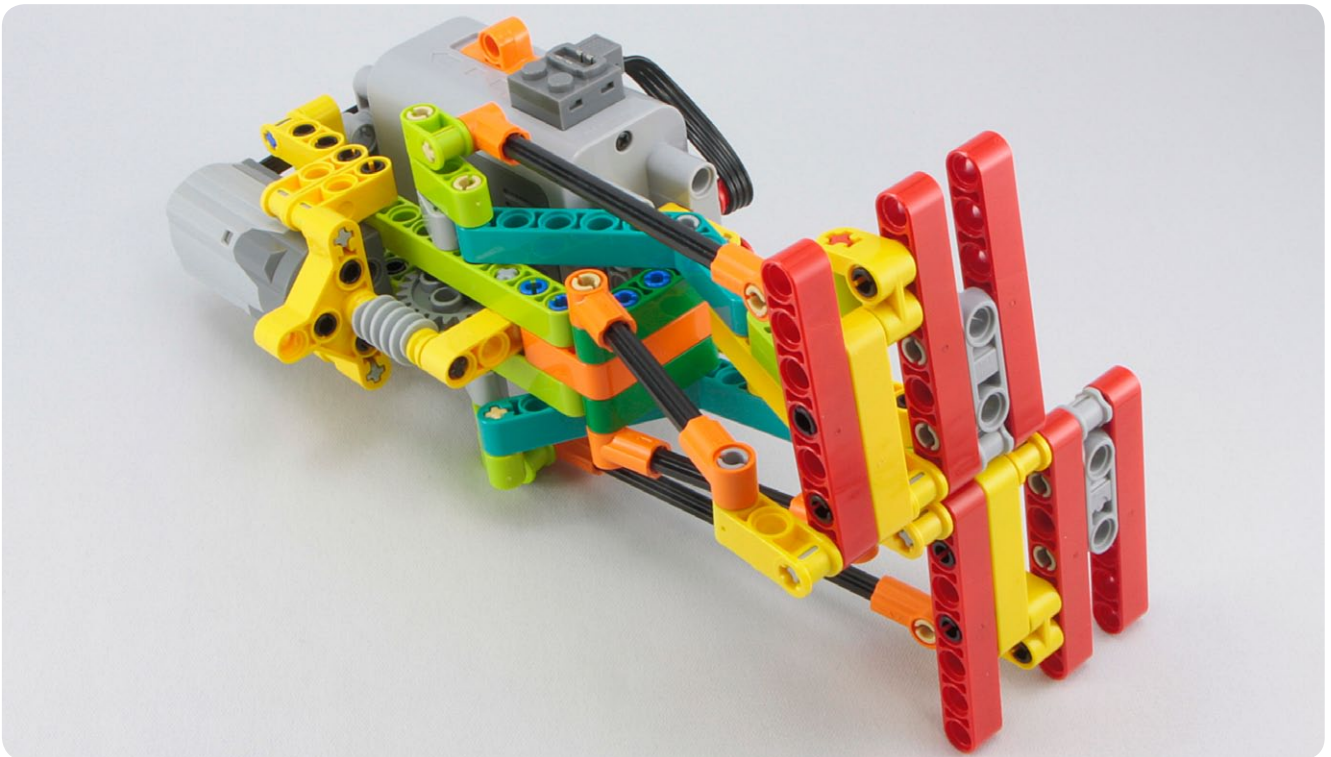
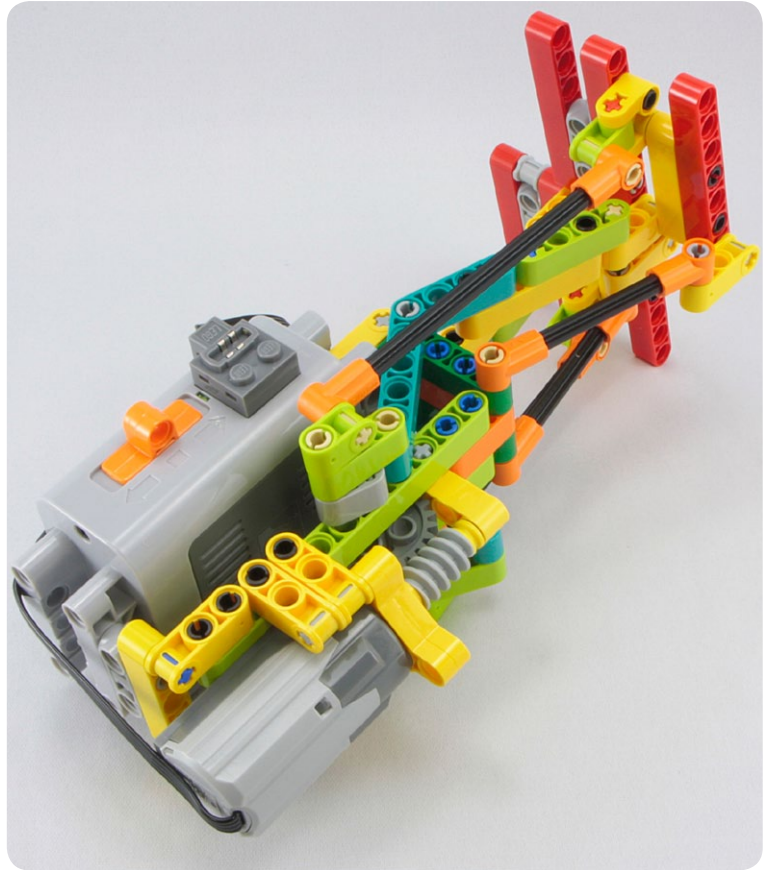
#101

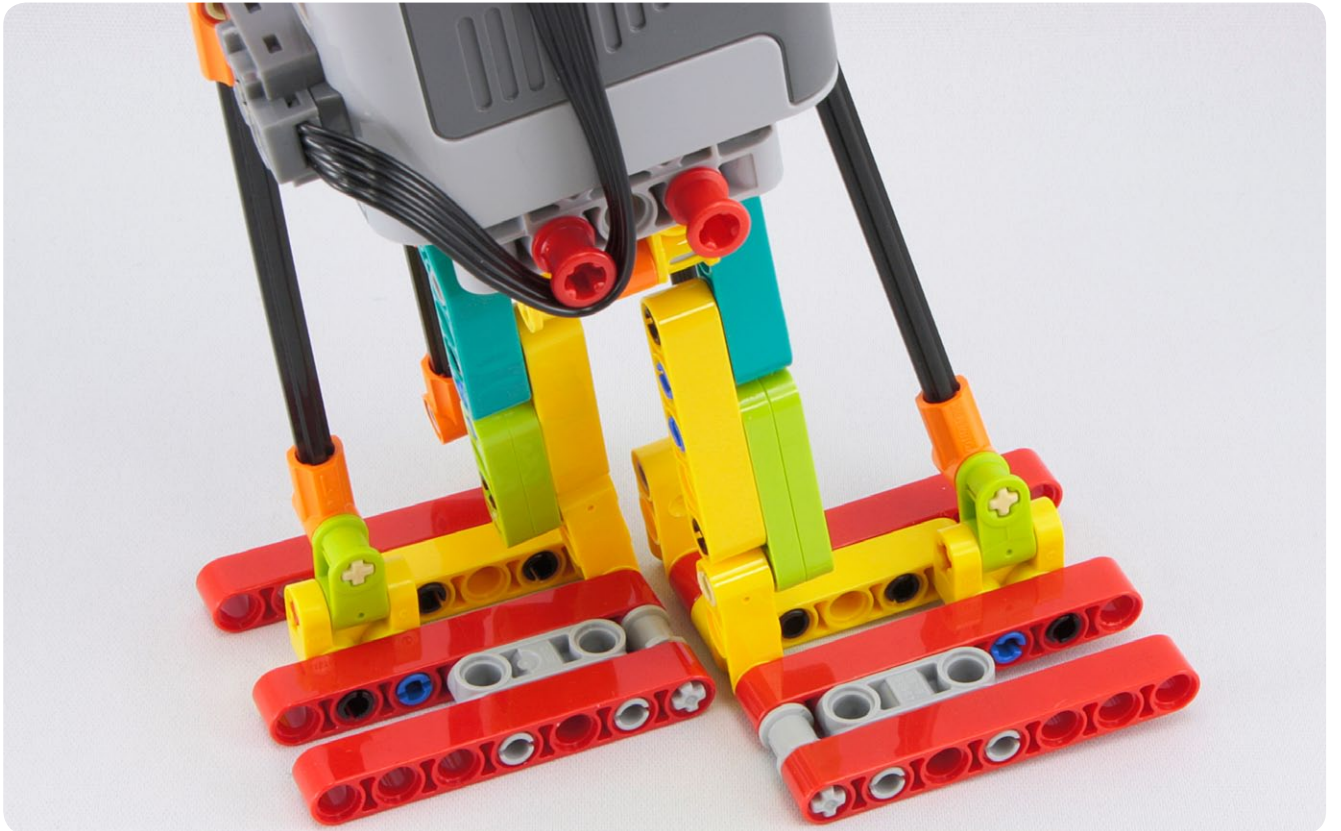


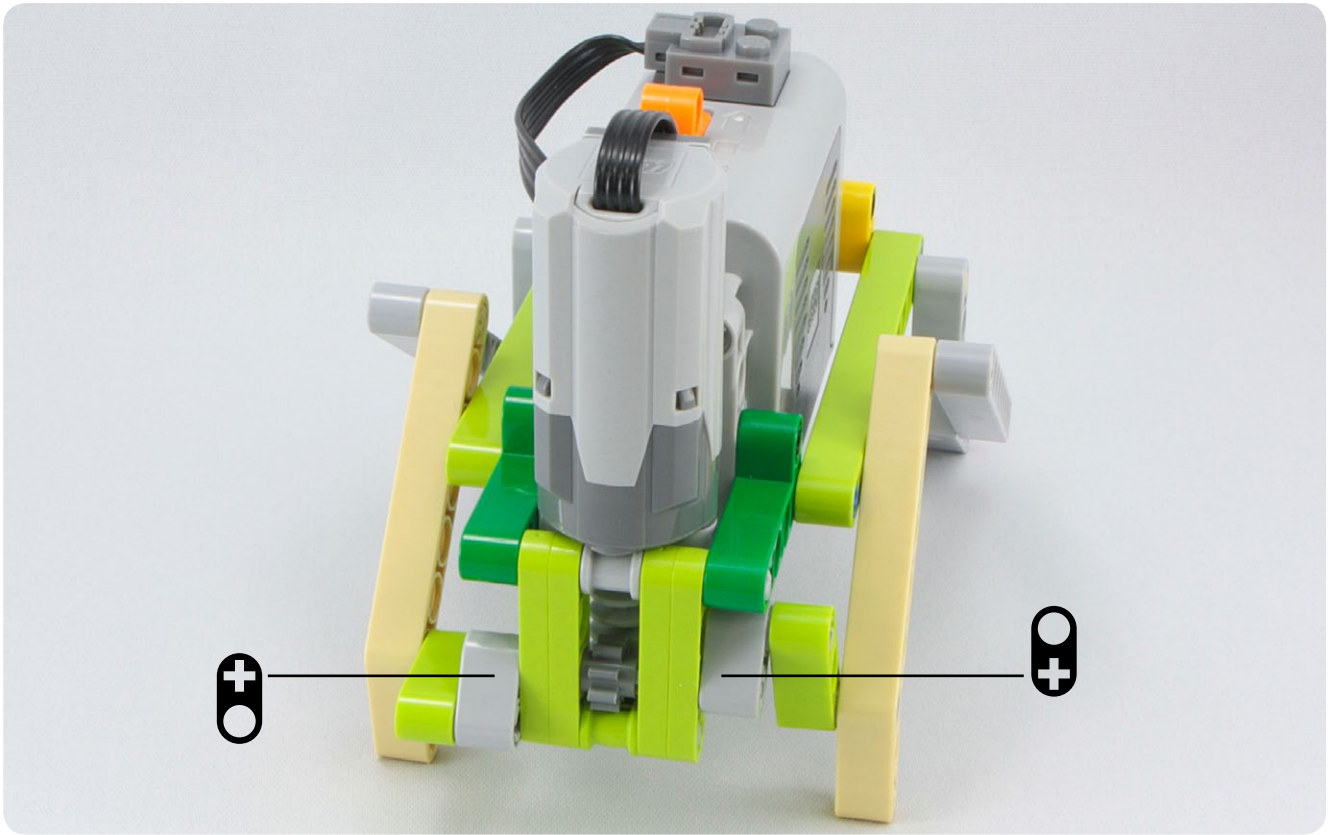








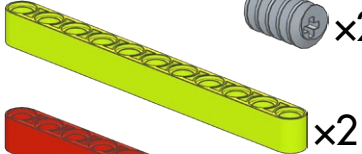
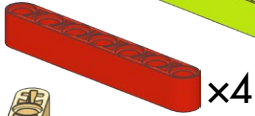
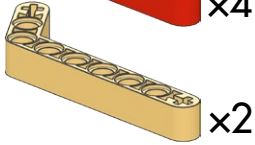

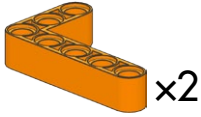
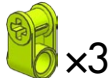
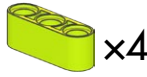
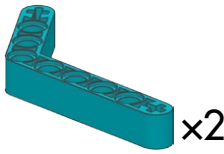
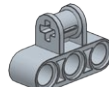

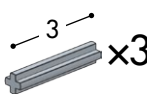
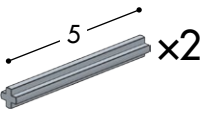
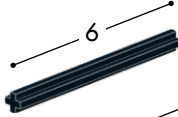
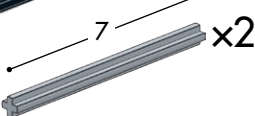






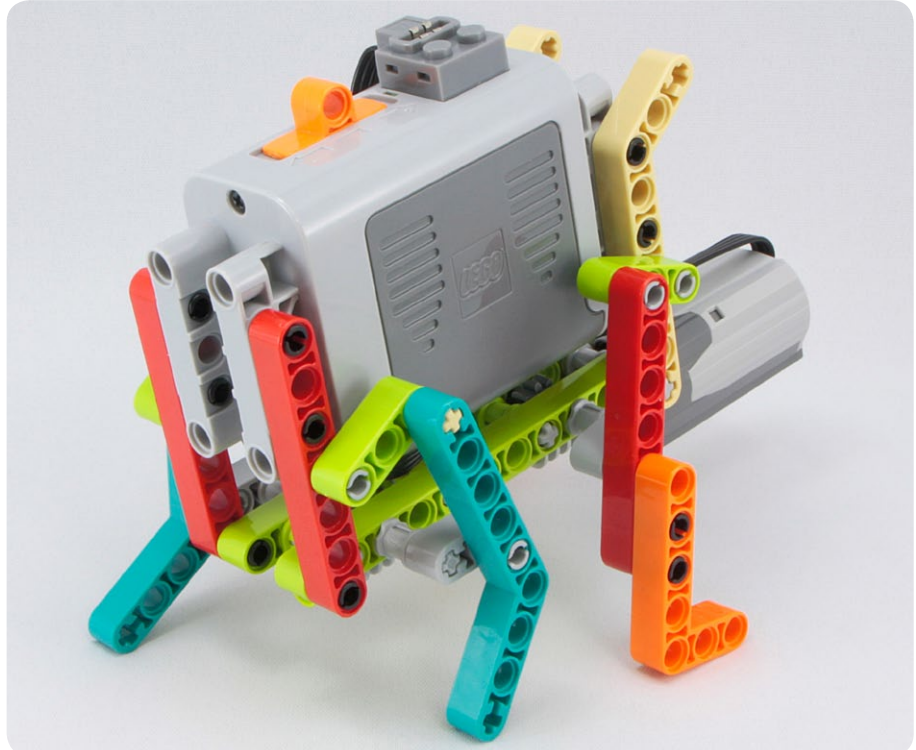
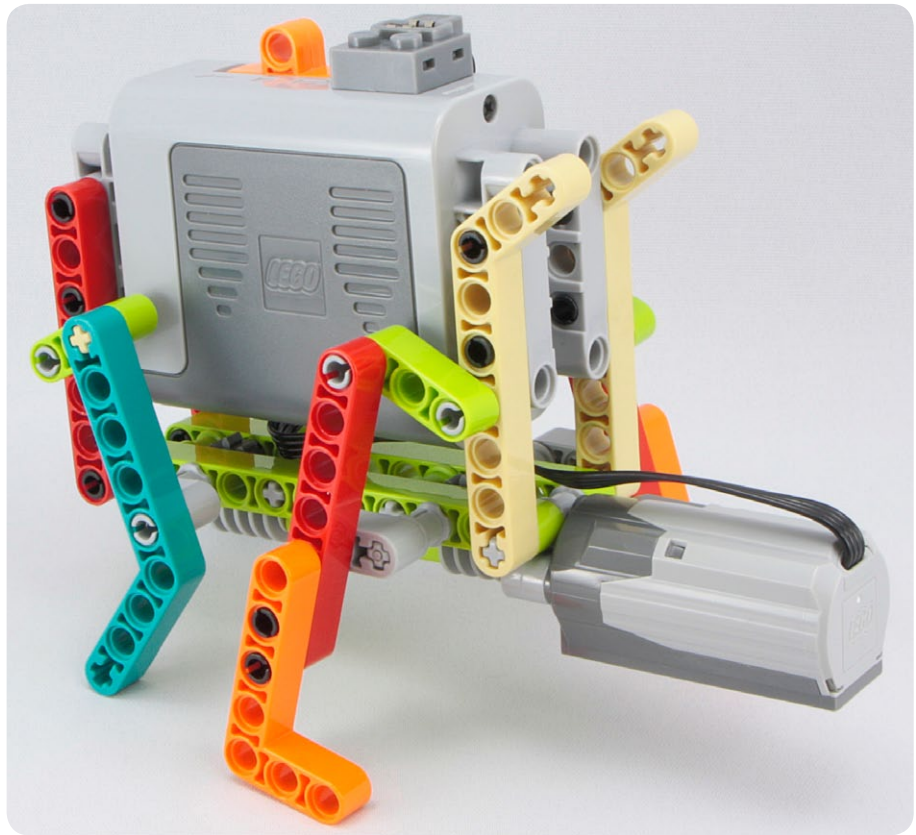


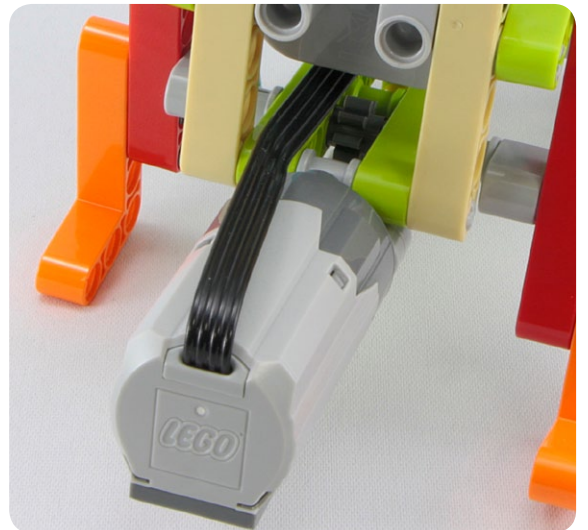
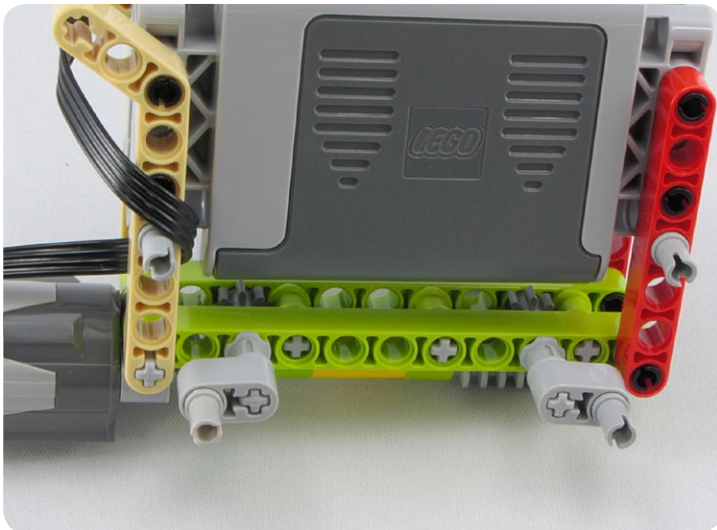
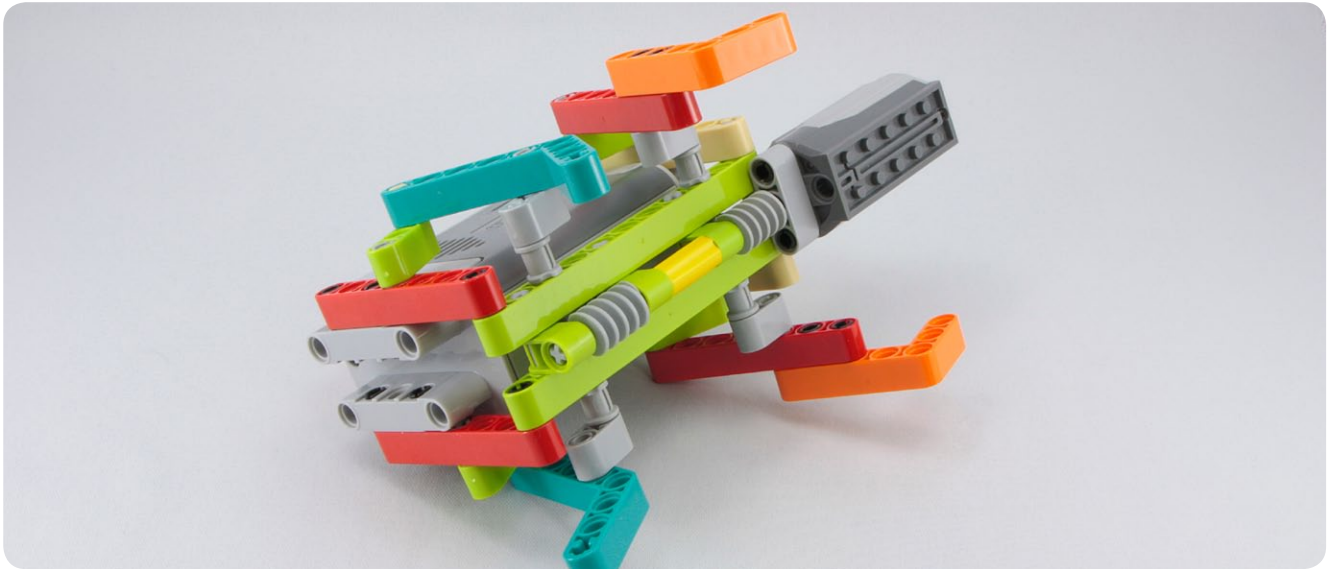
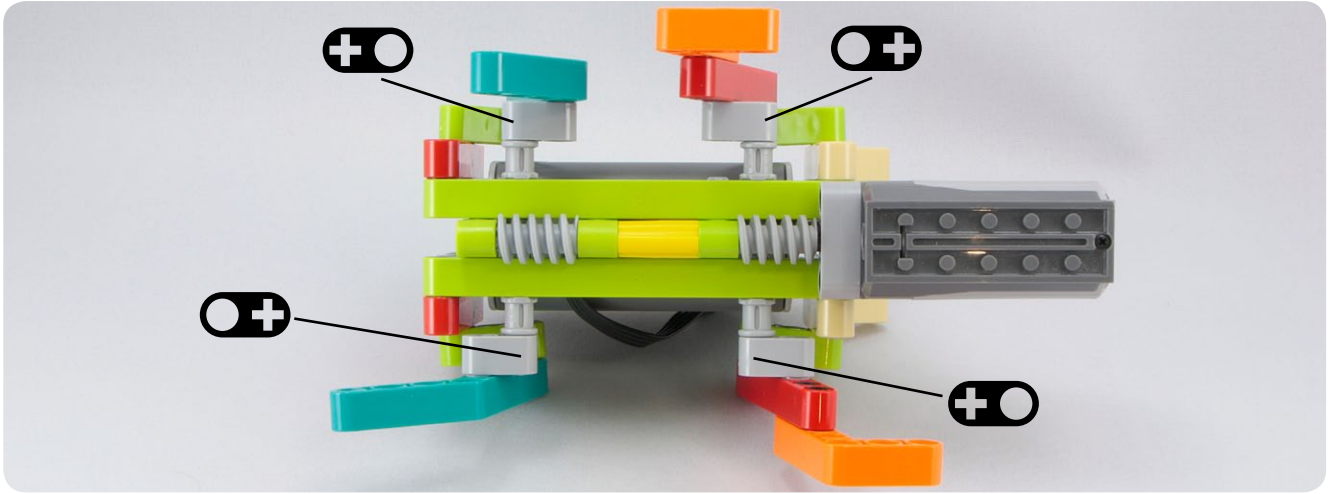




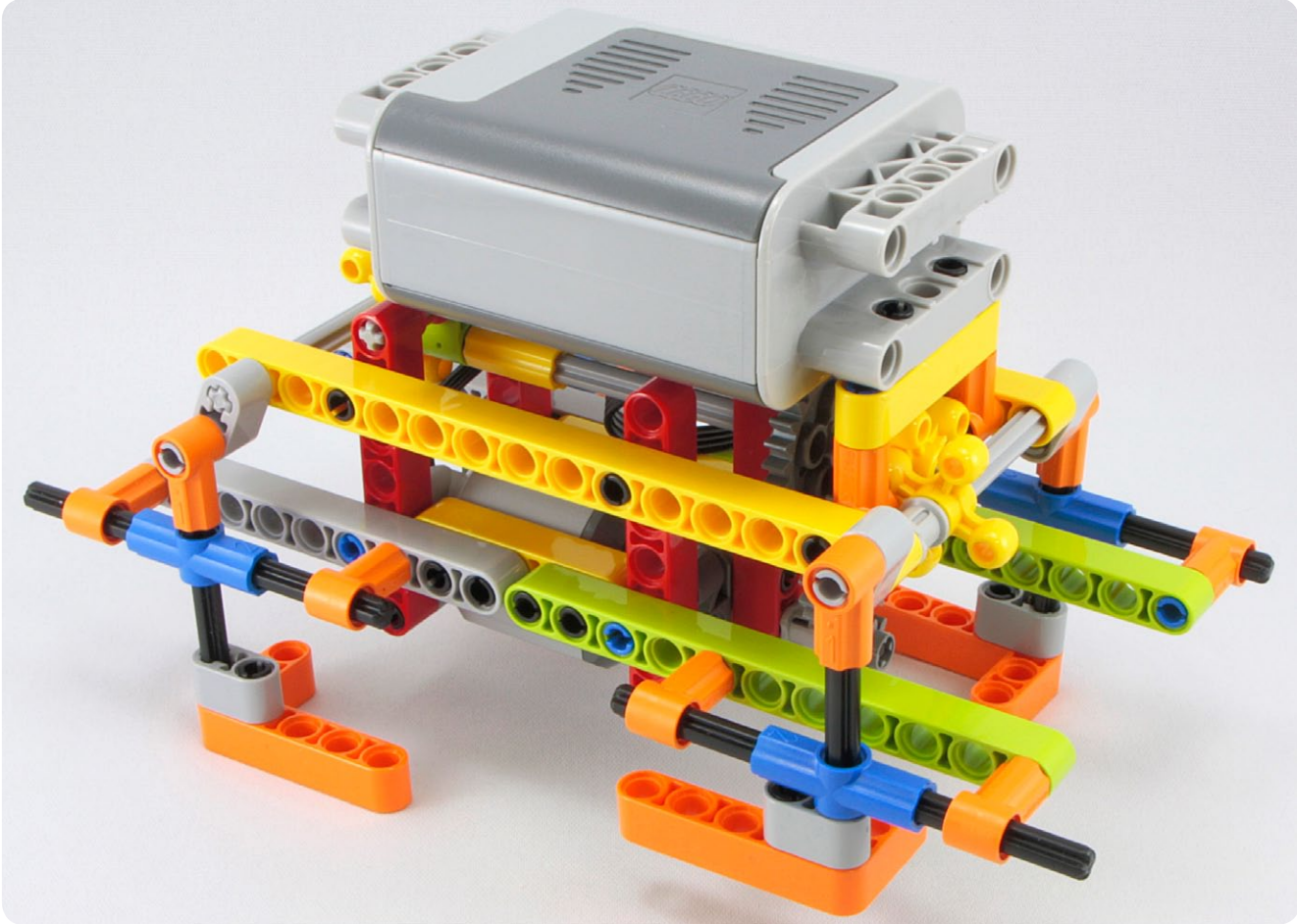
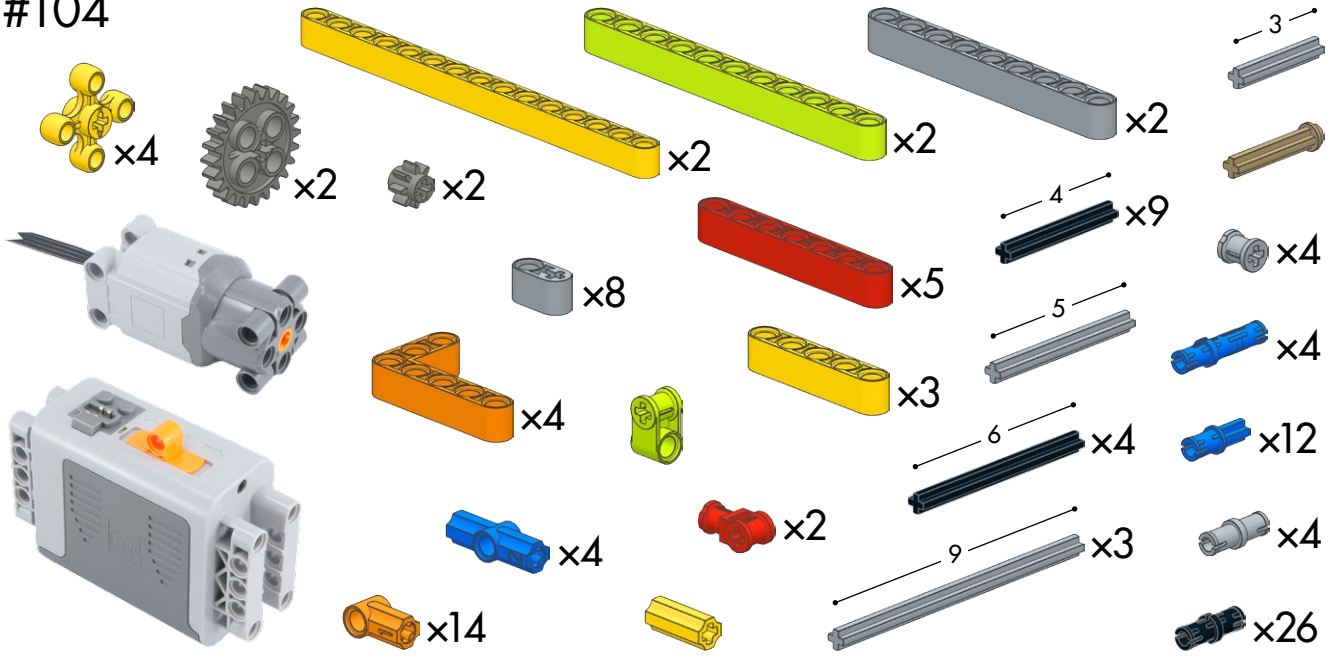
#103

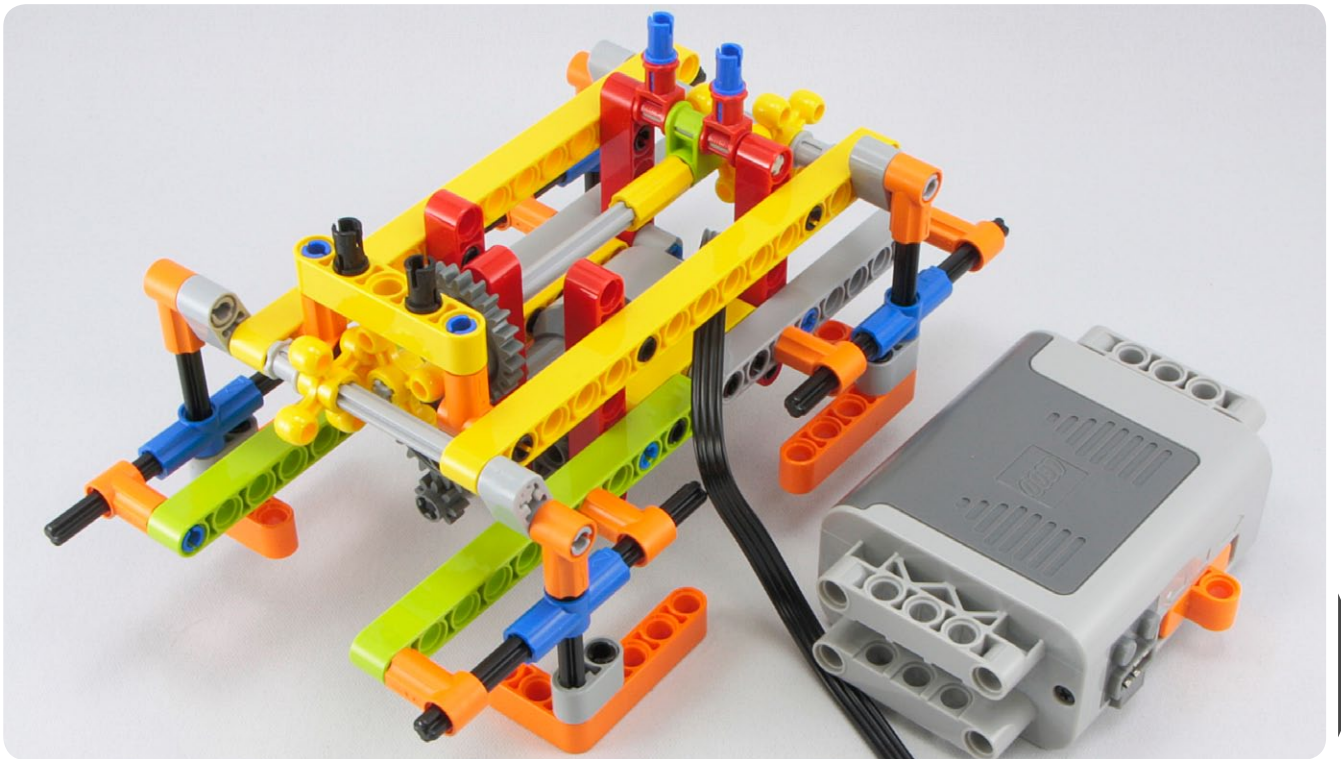
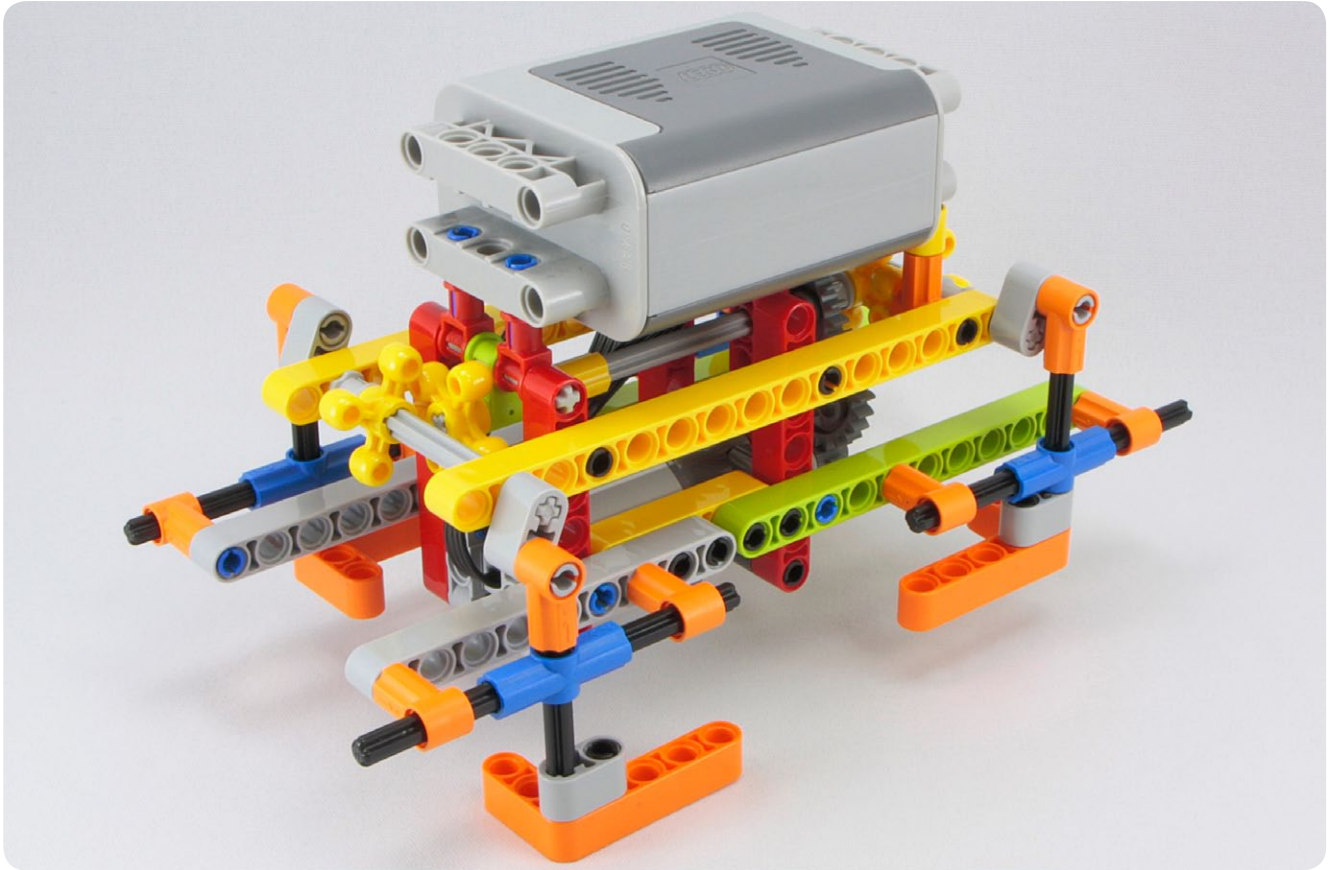
- 
- 
-  x2
-  x2
-  x2
-  x4
-  x2
-  x4
-  x2
-  x3
-  x4
-  x2
-  x2
- 
-  x3
-  x2
-  x2
-  x2
-  x4
-  x2
-  x10
-  x16

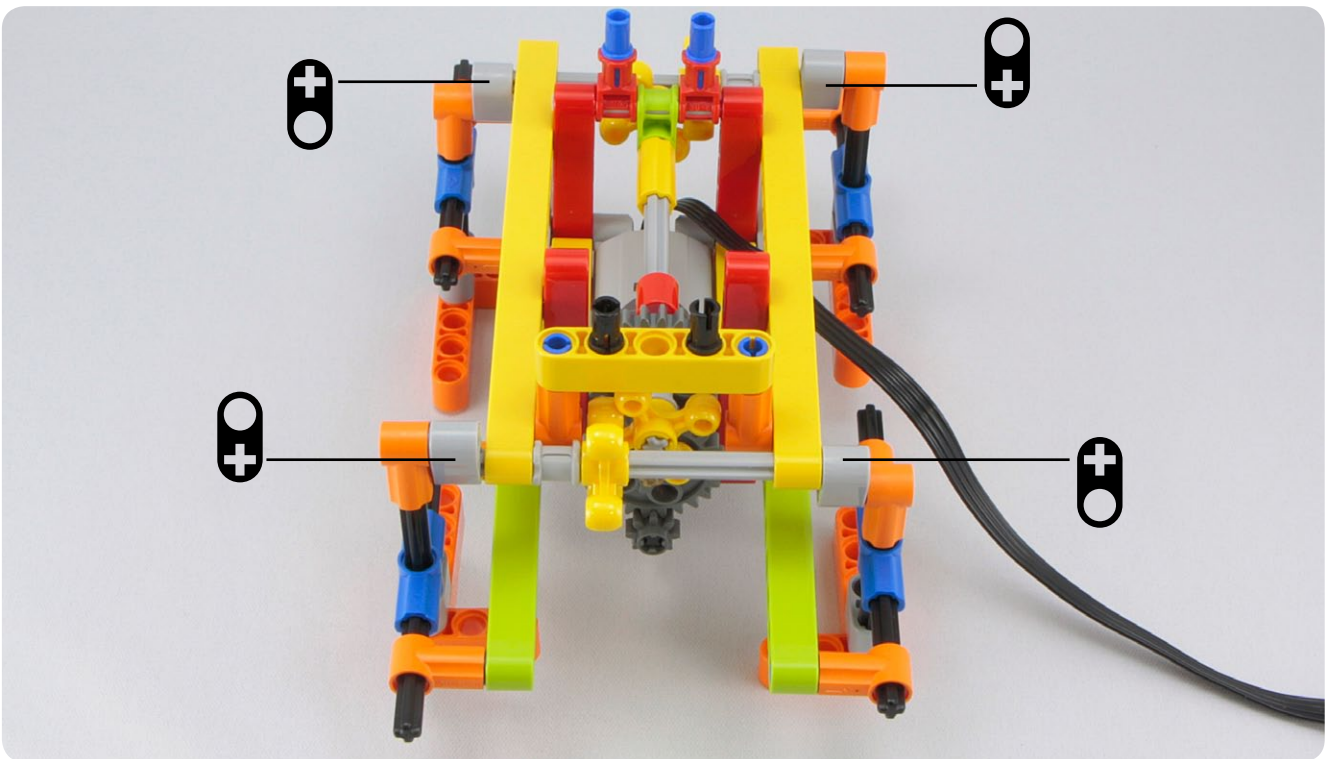
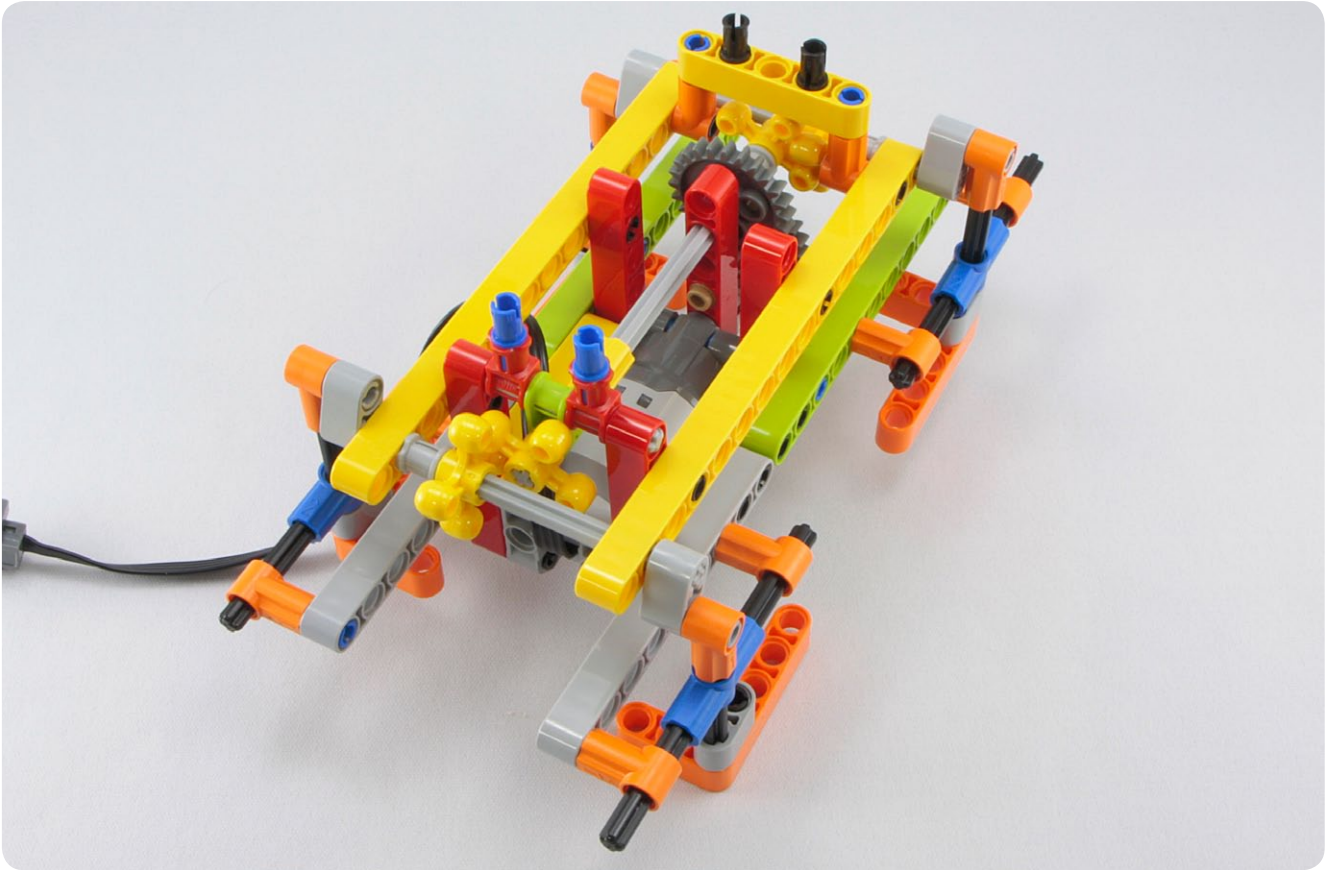


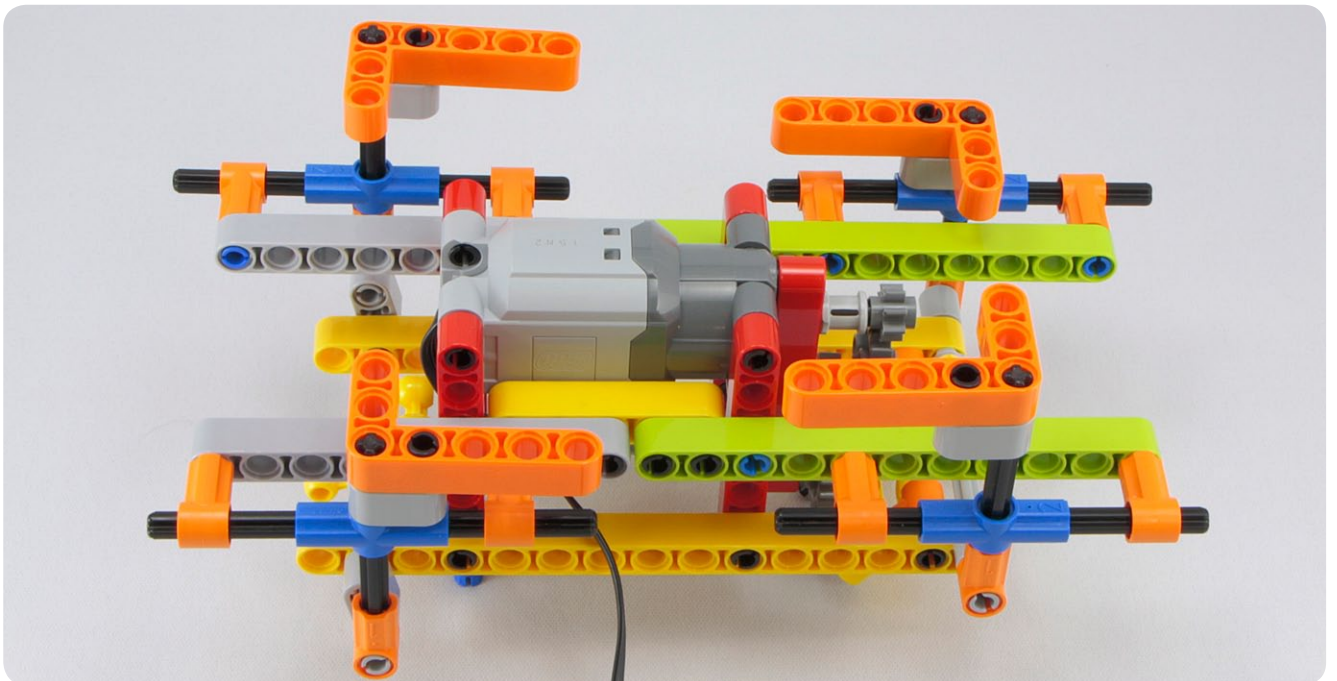
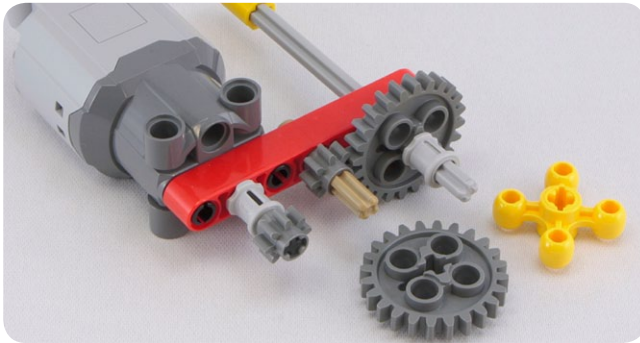
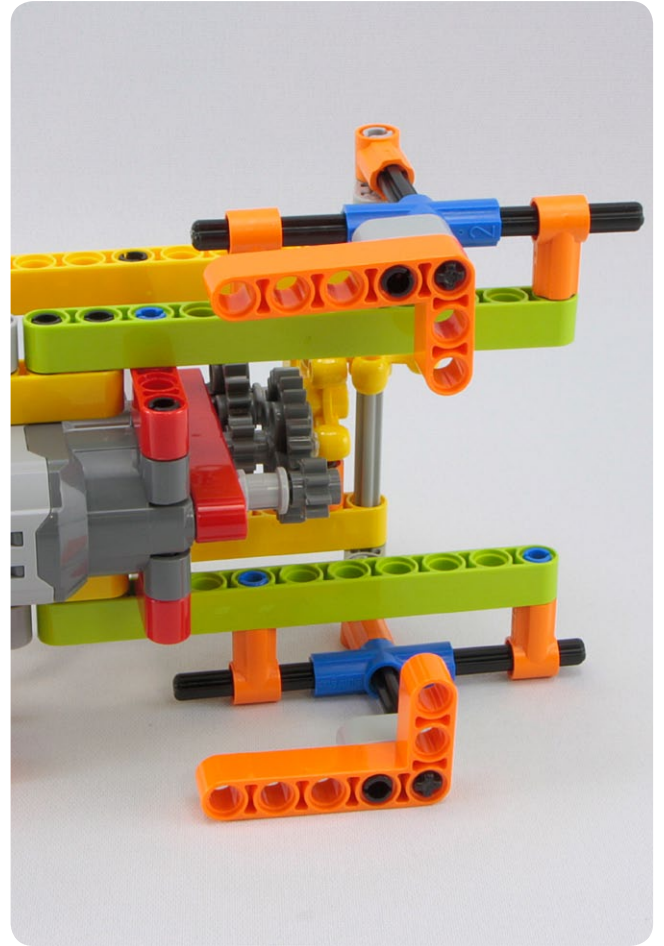


#104

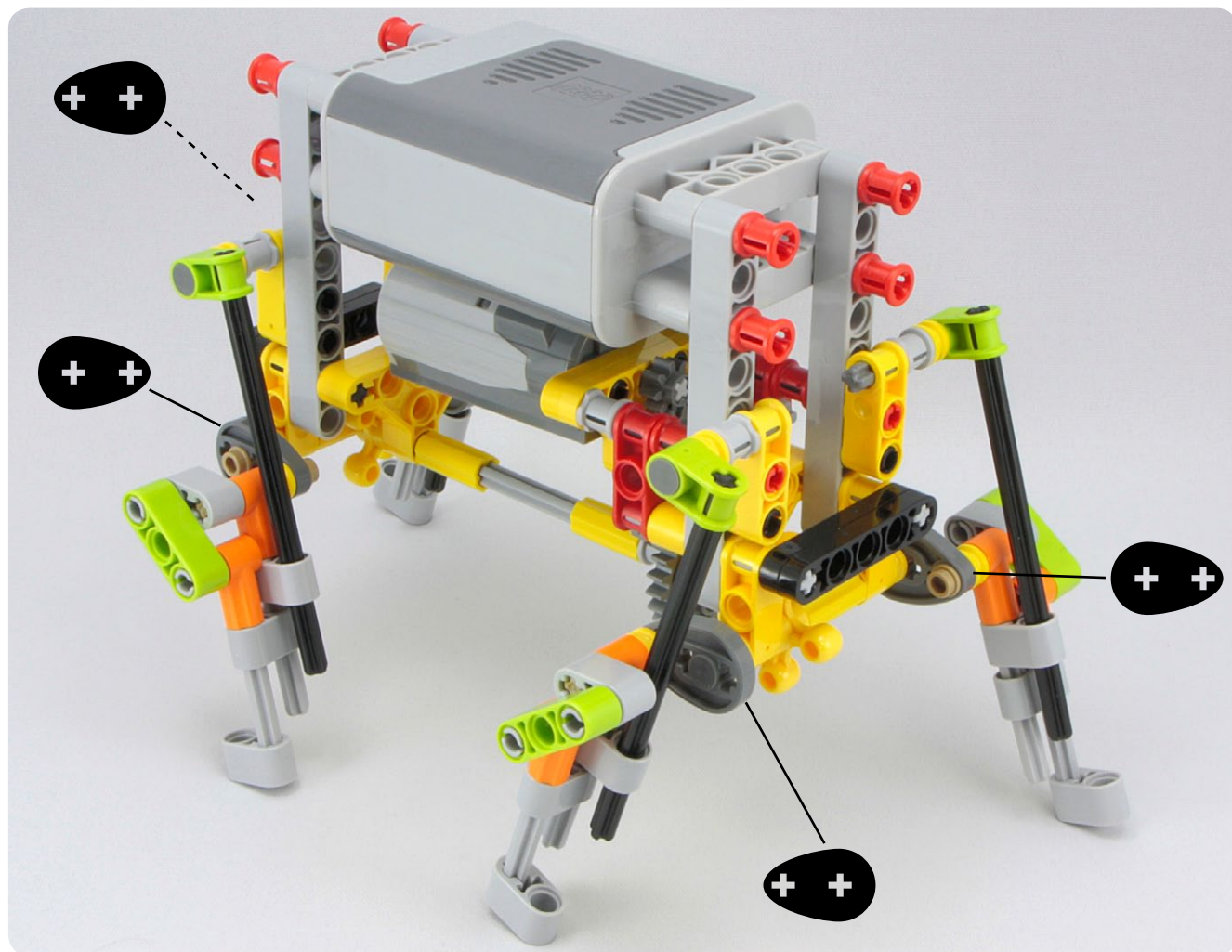
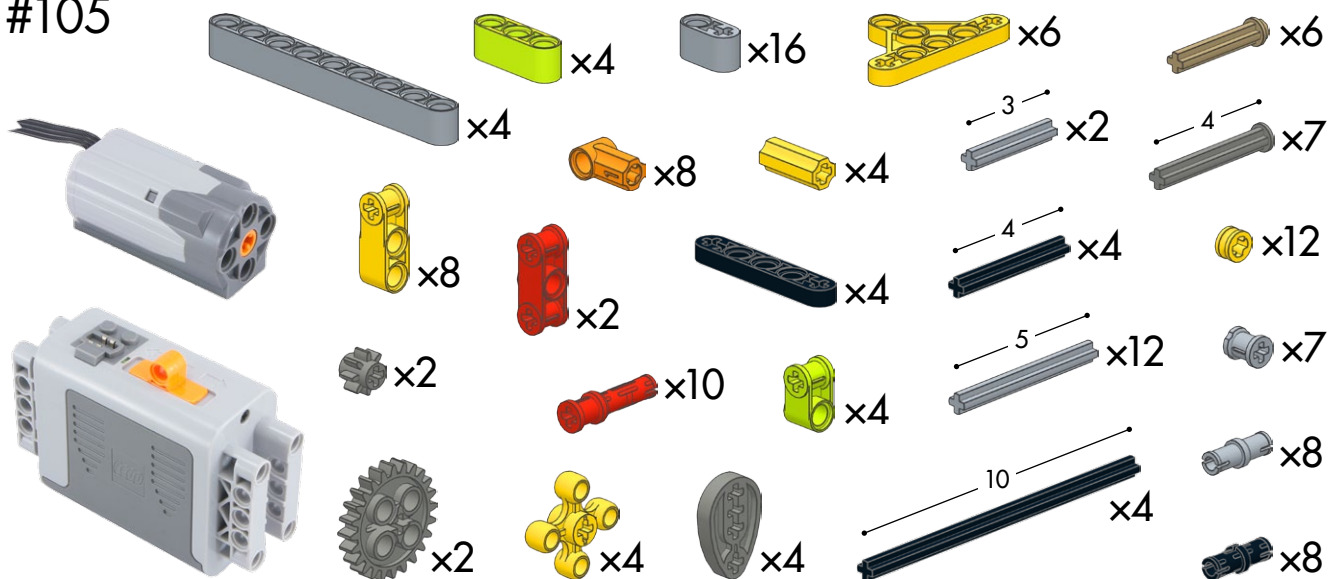


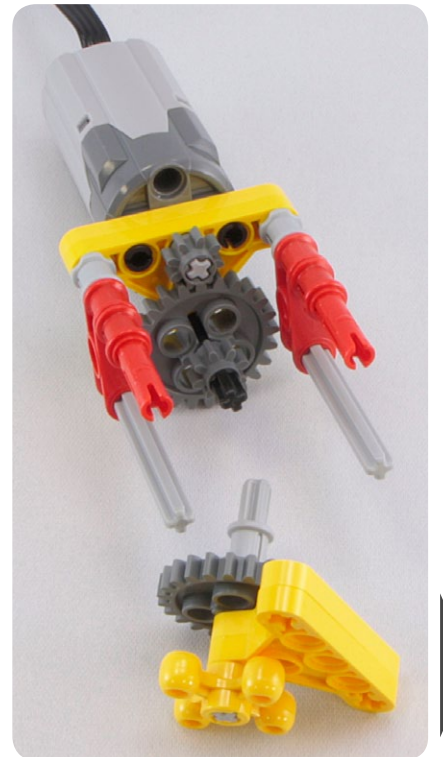
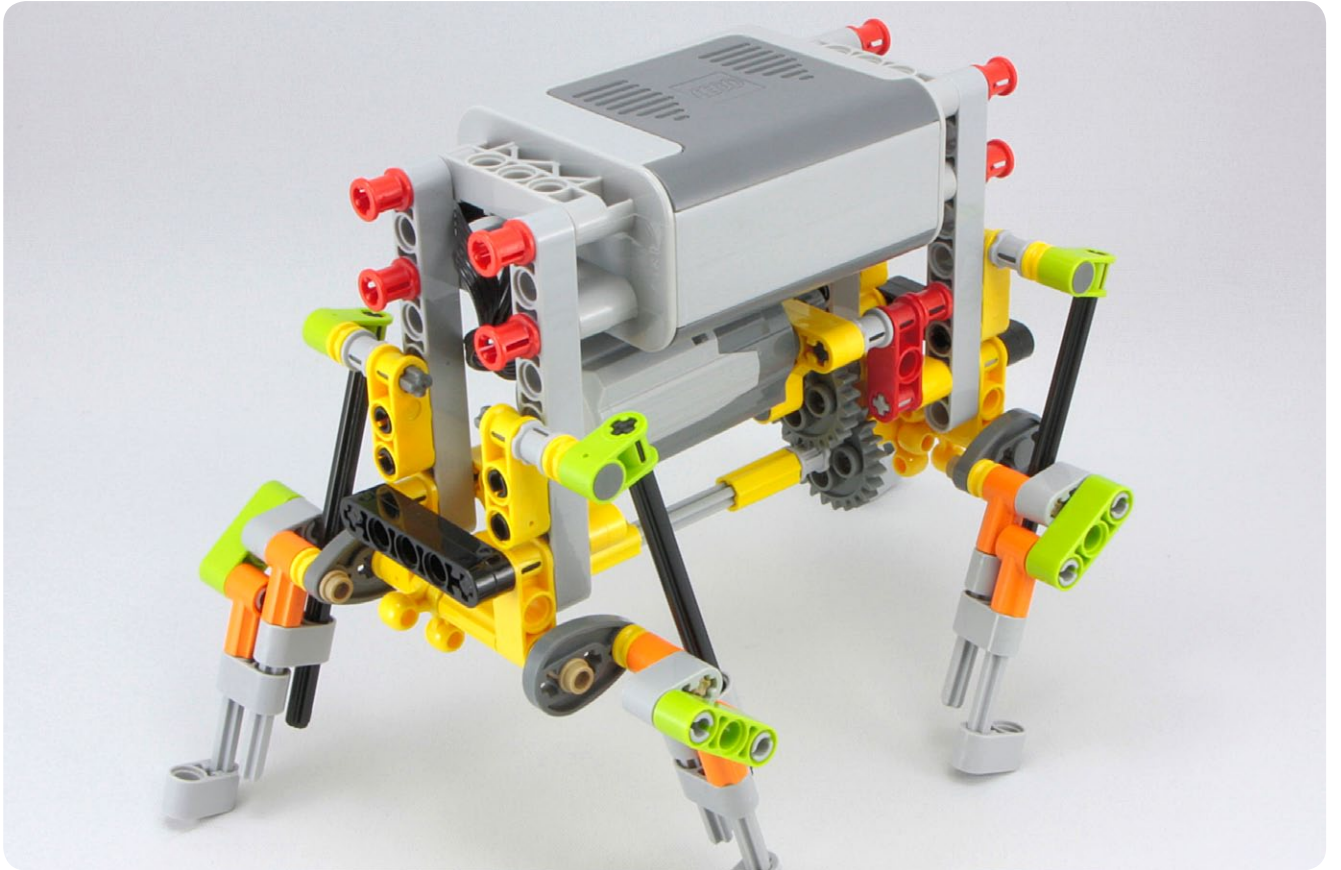


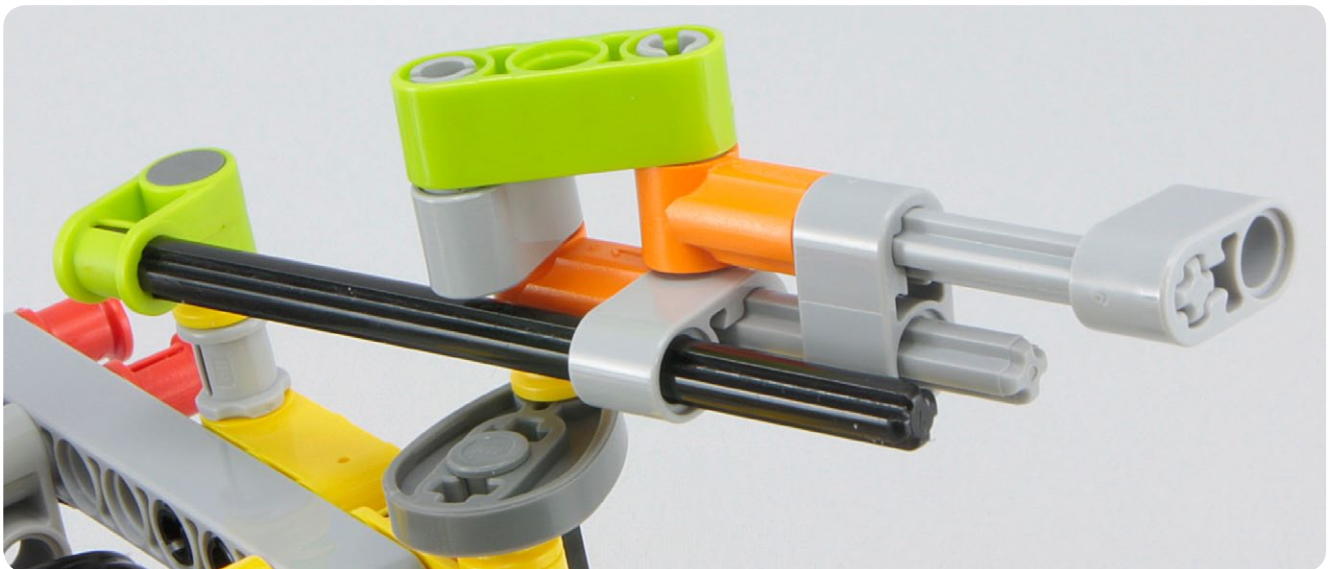
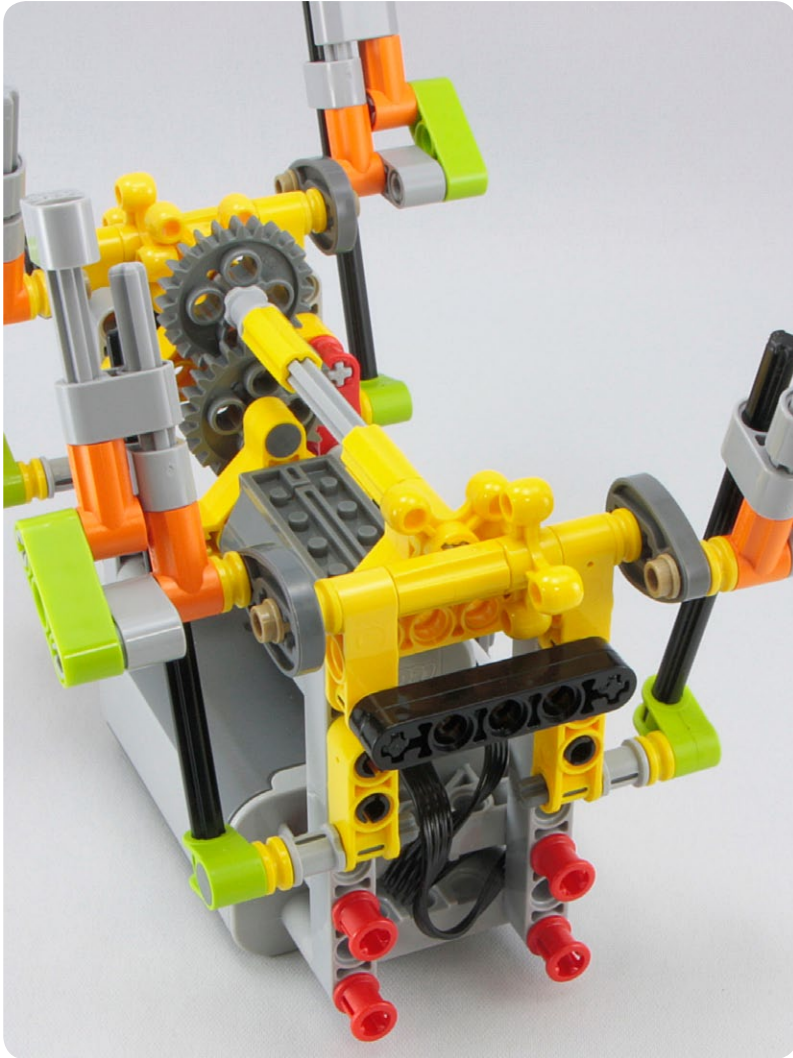


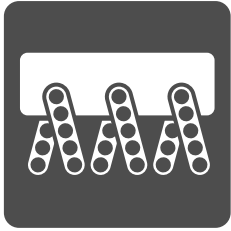


#105



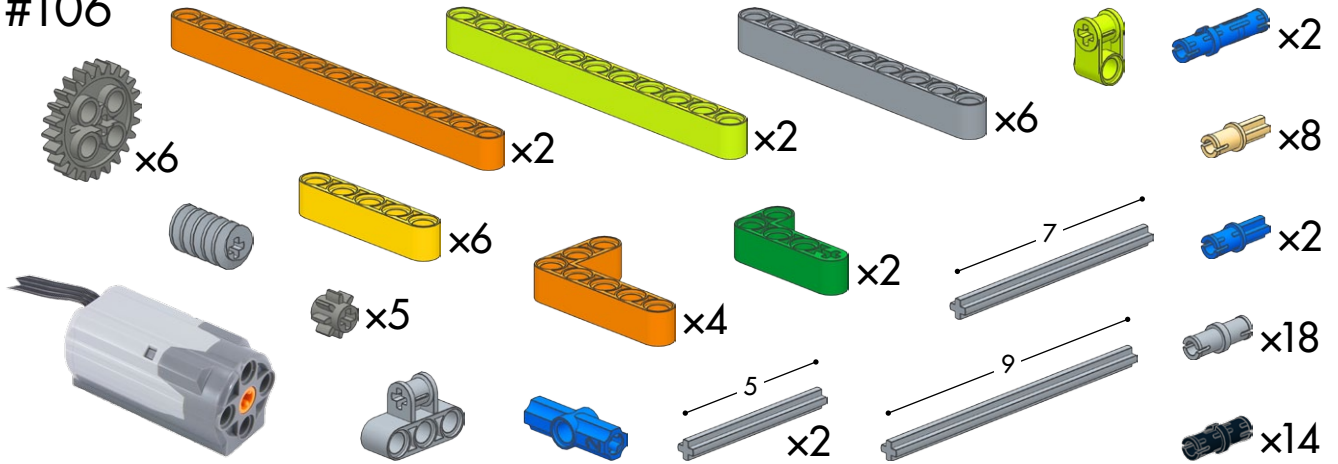


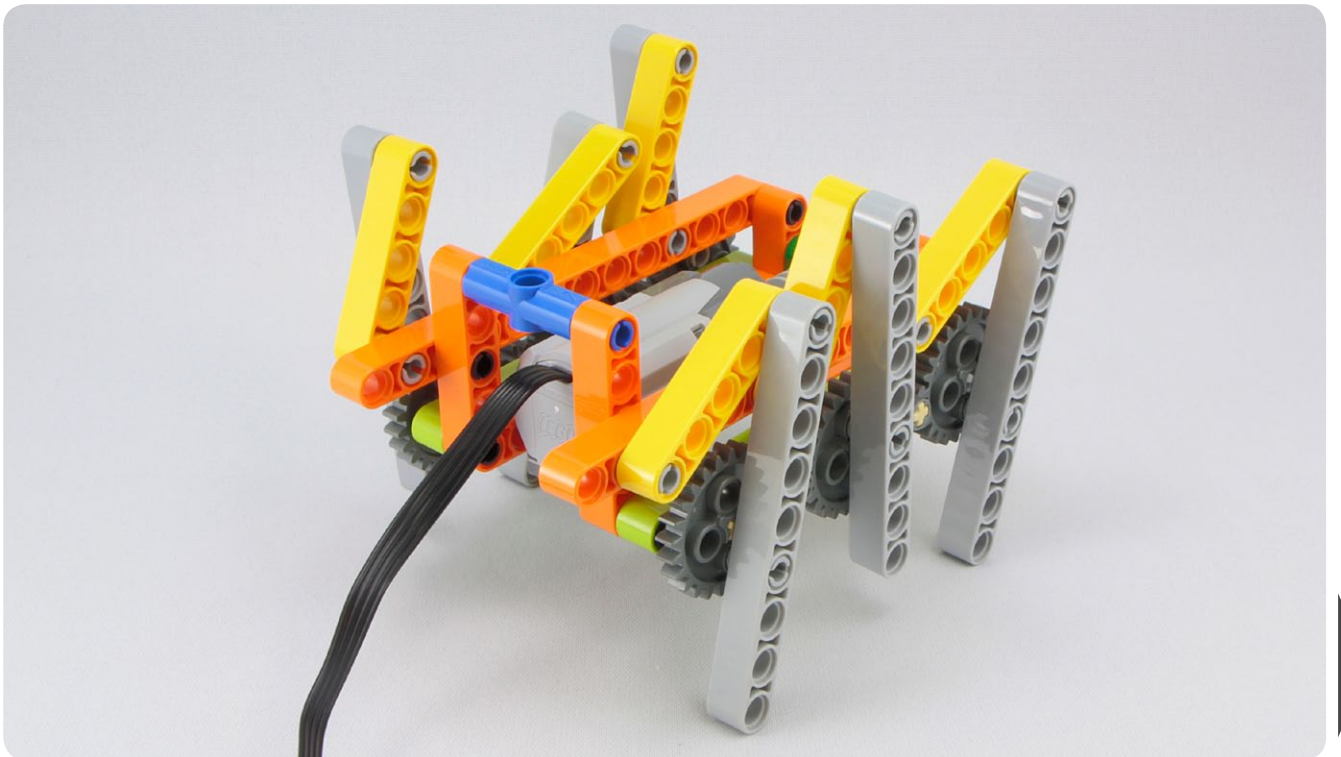
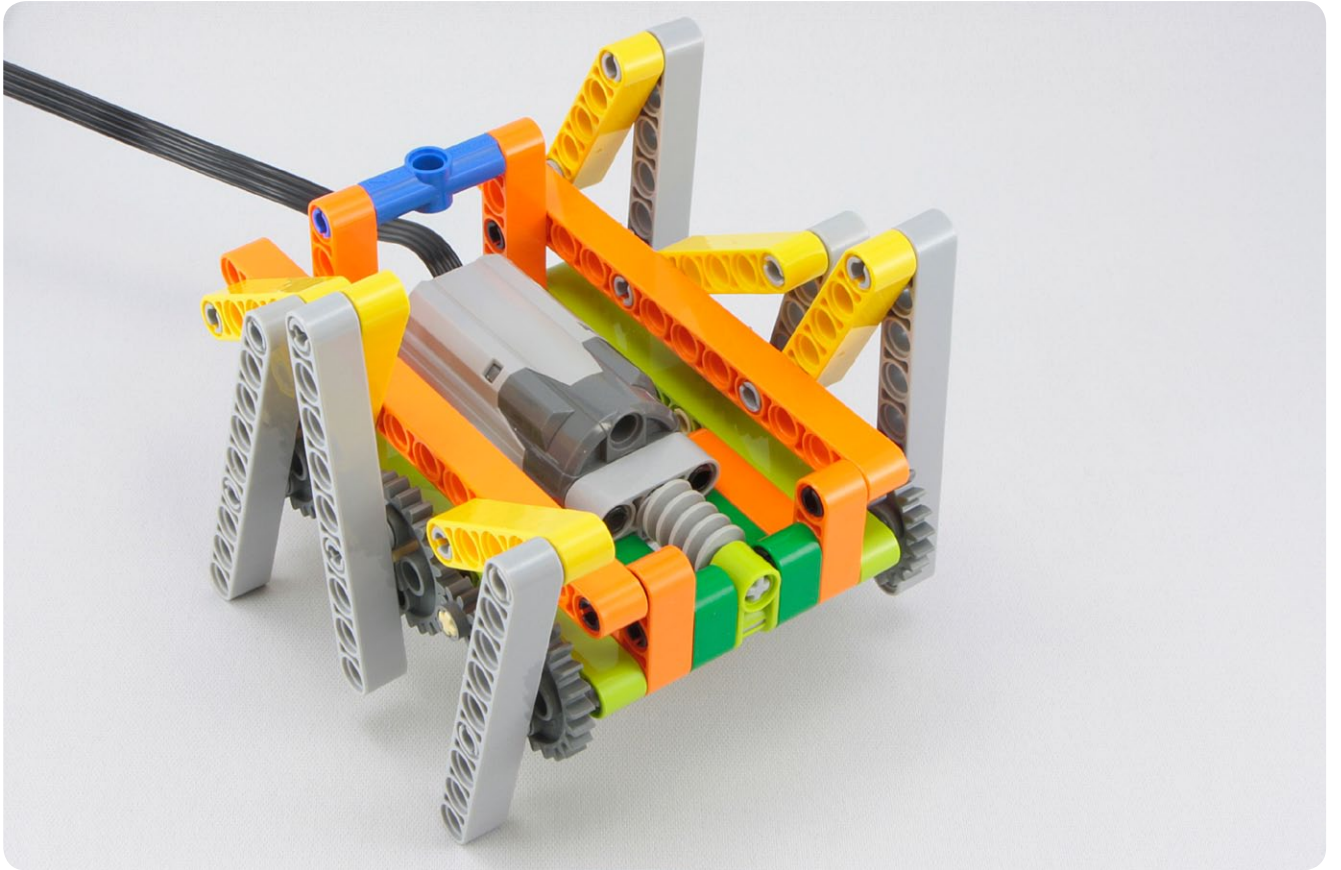


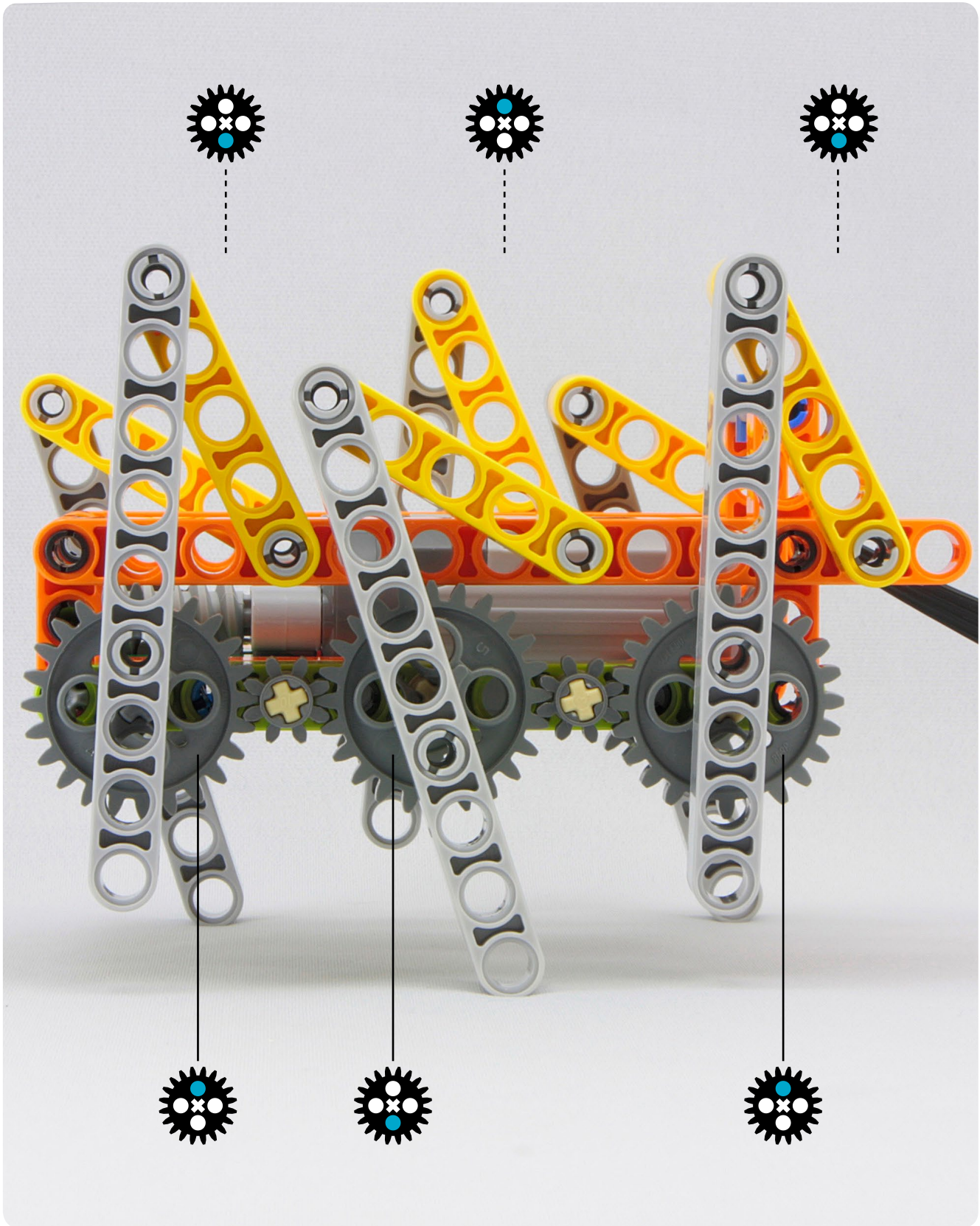


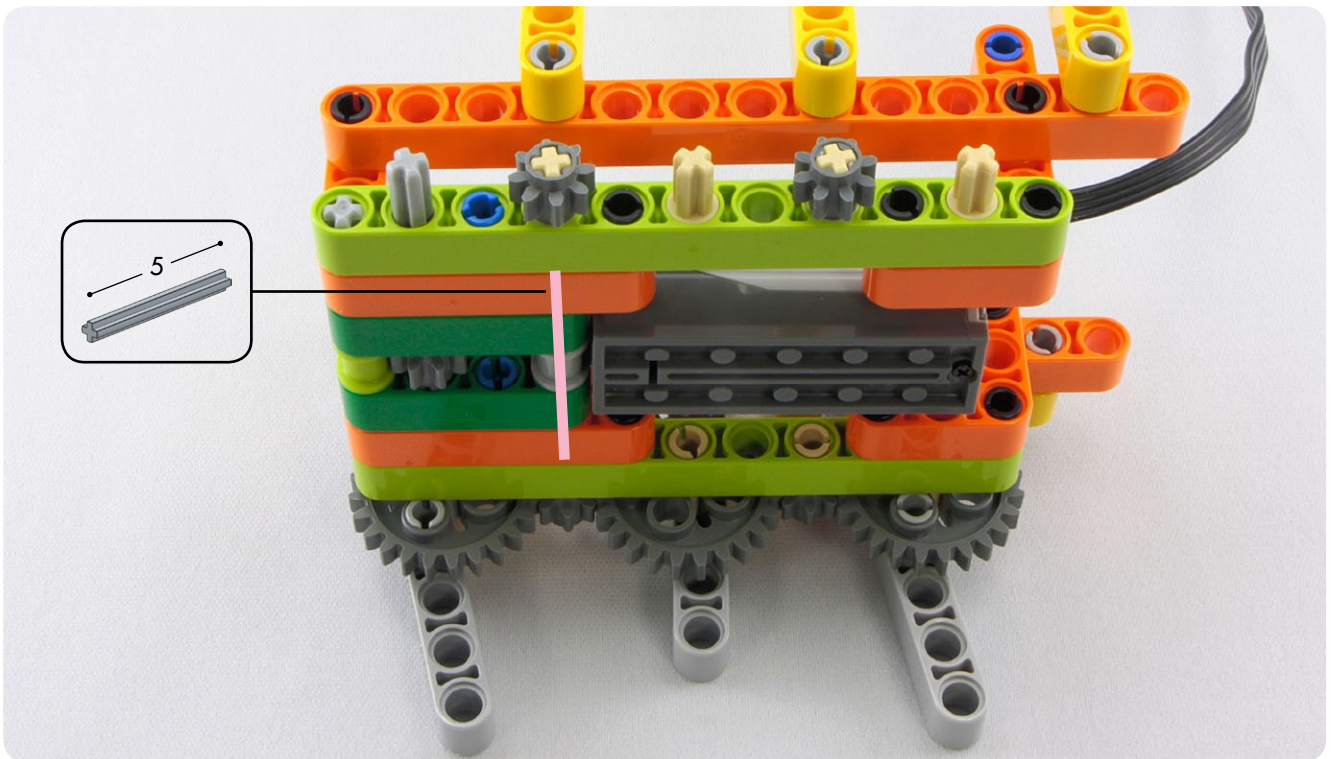
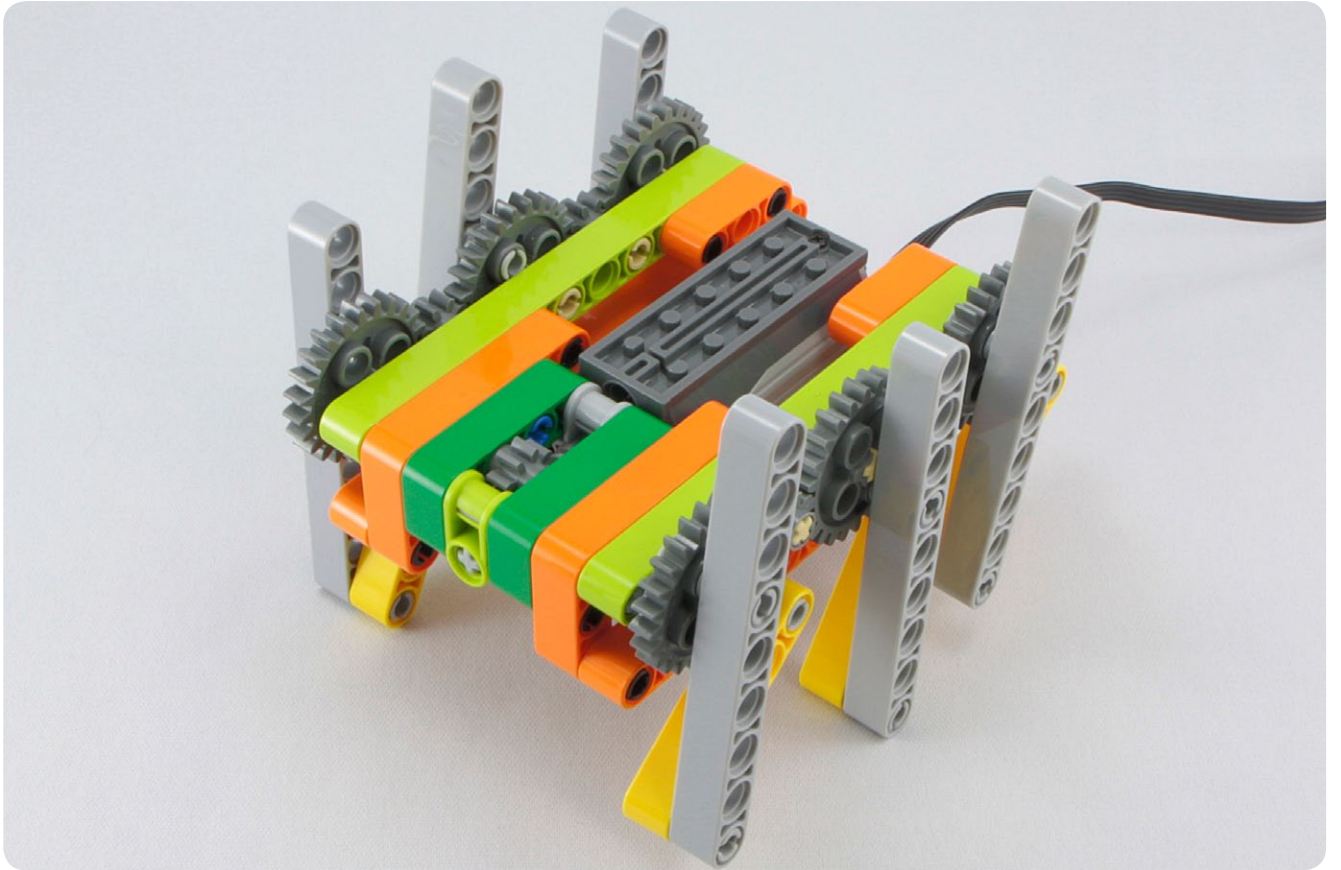
Six-legged walkers

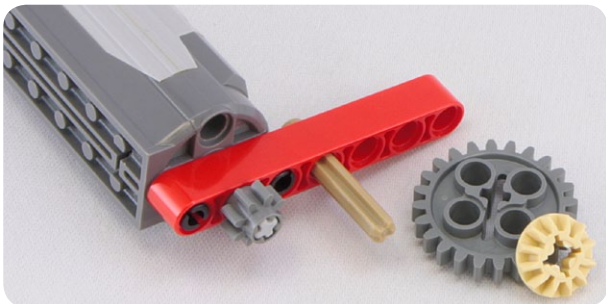
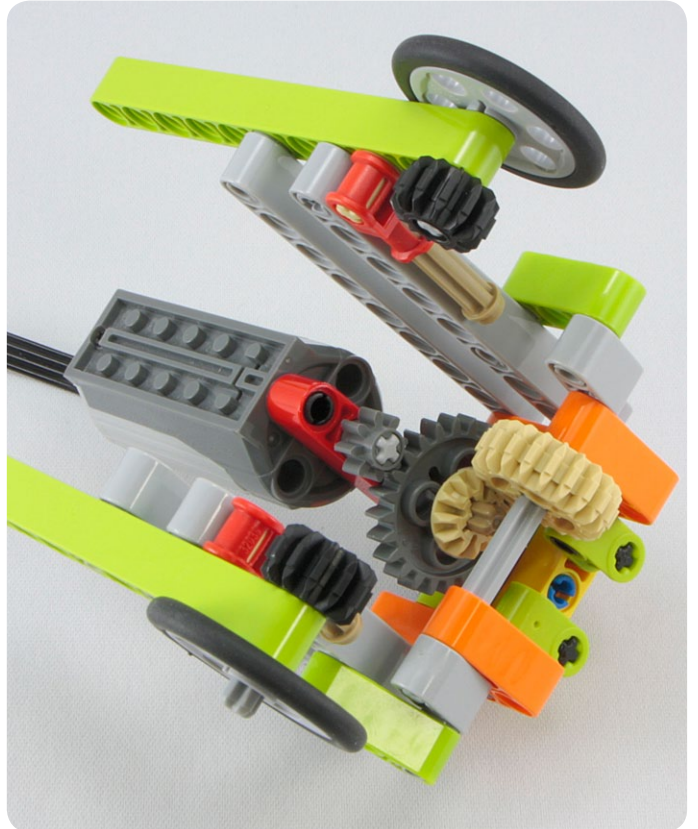
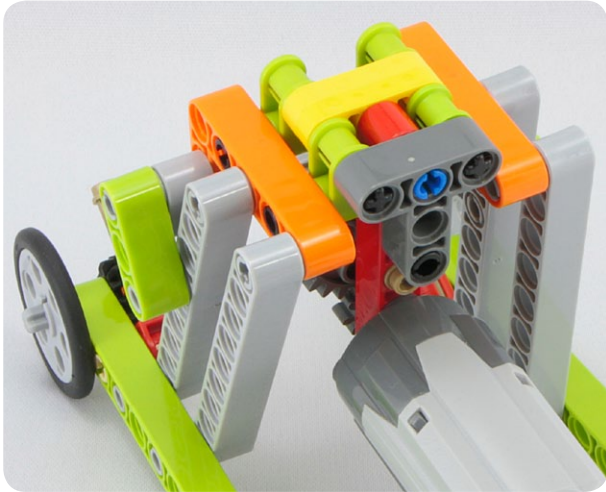
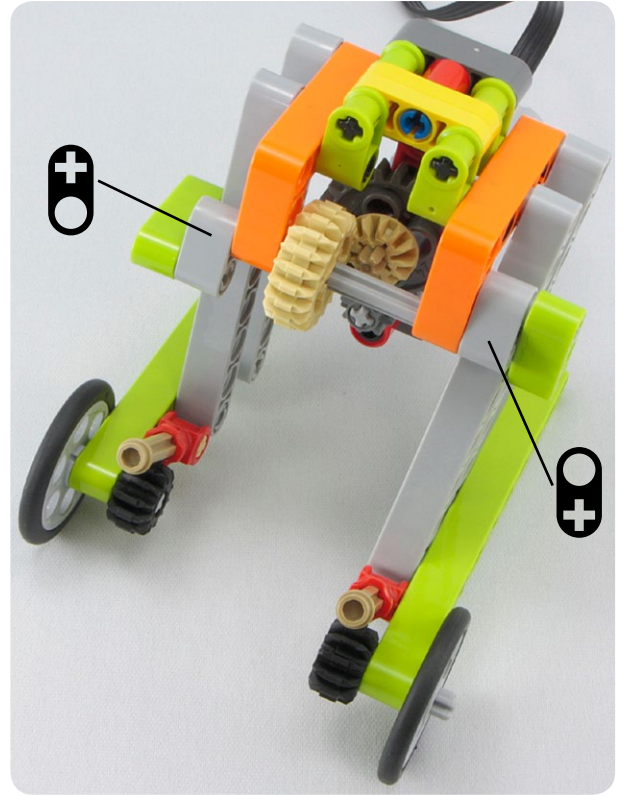
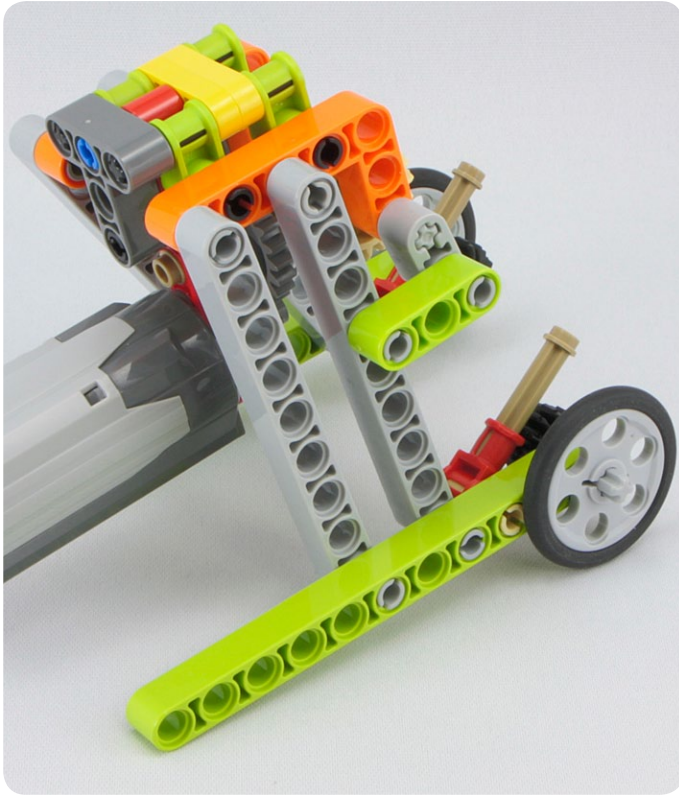
#106

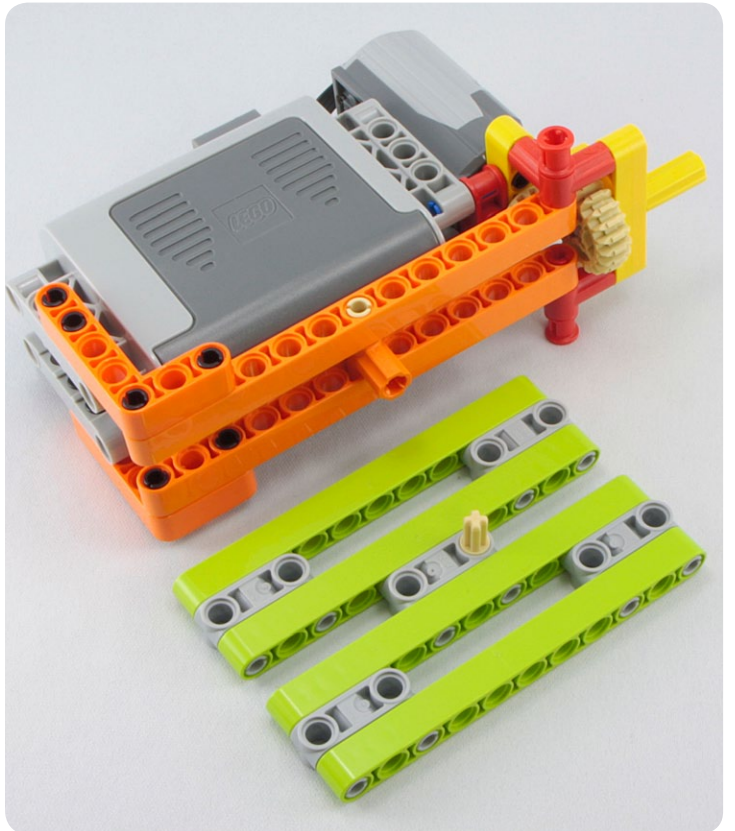
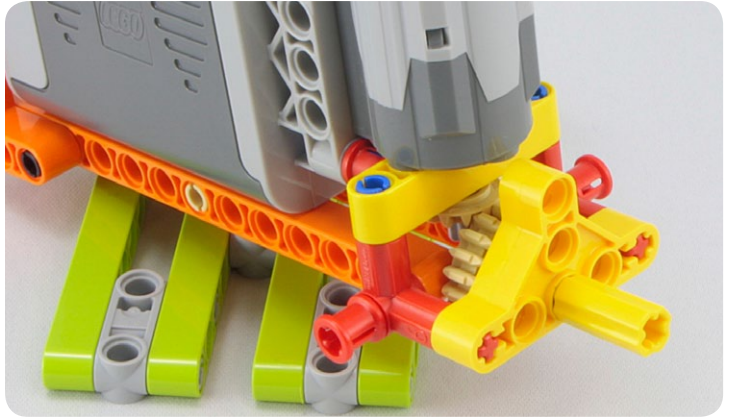
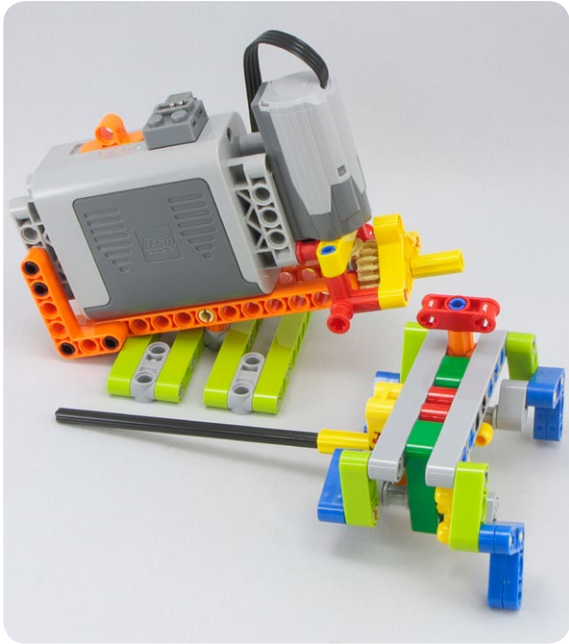


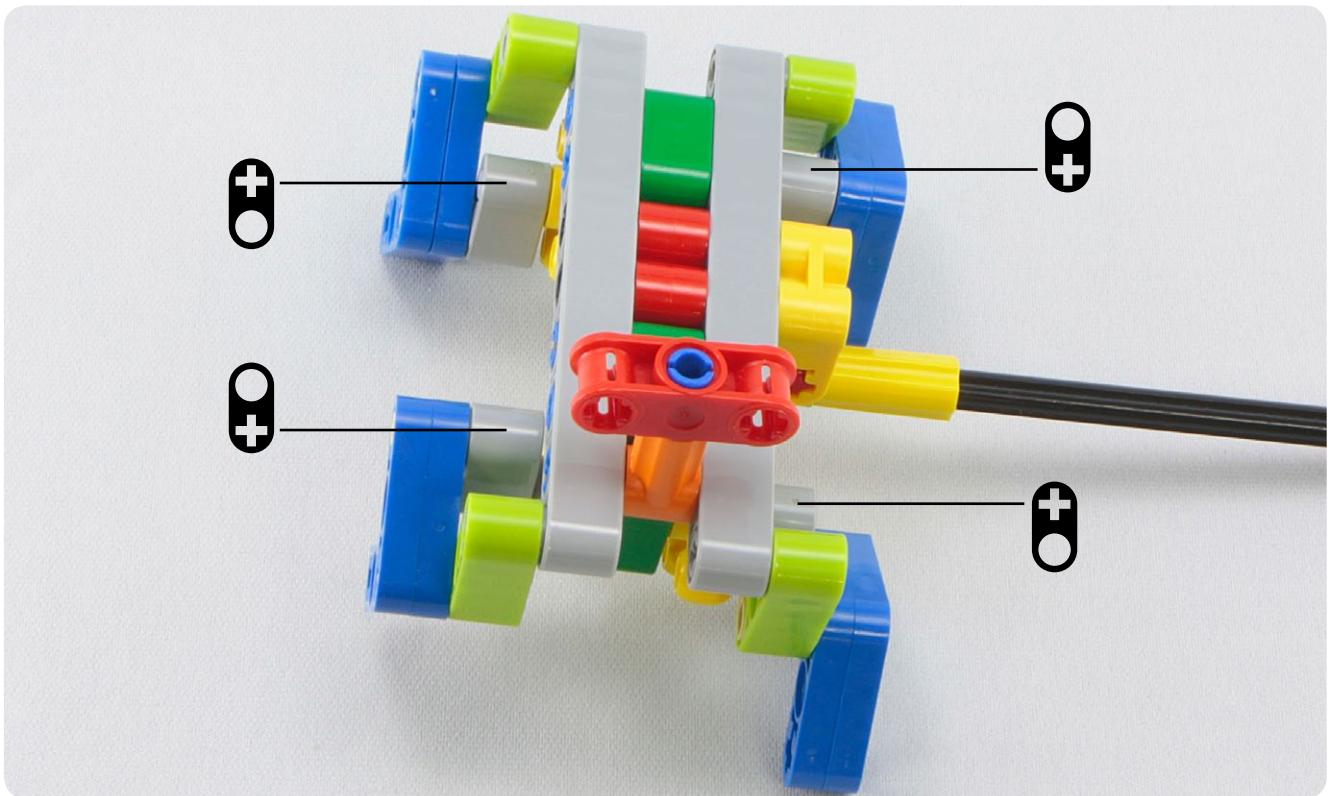
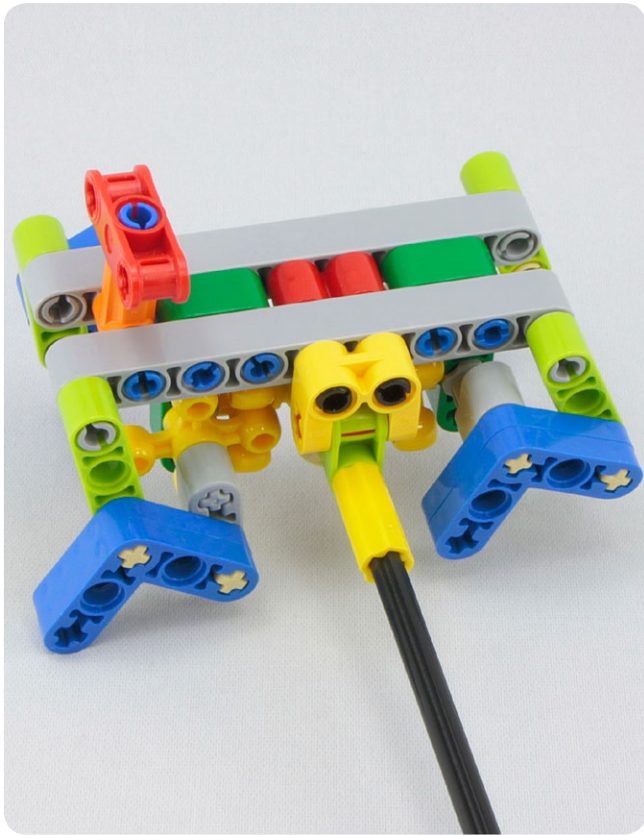


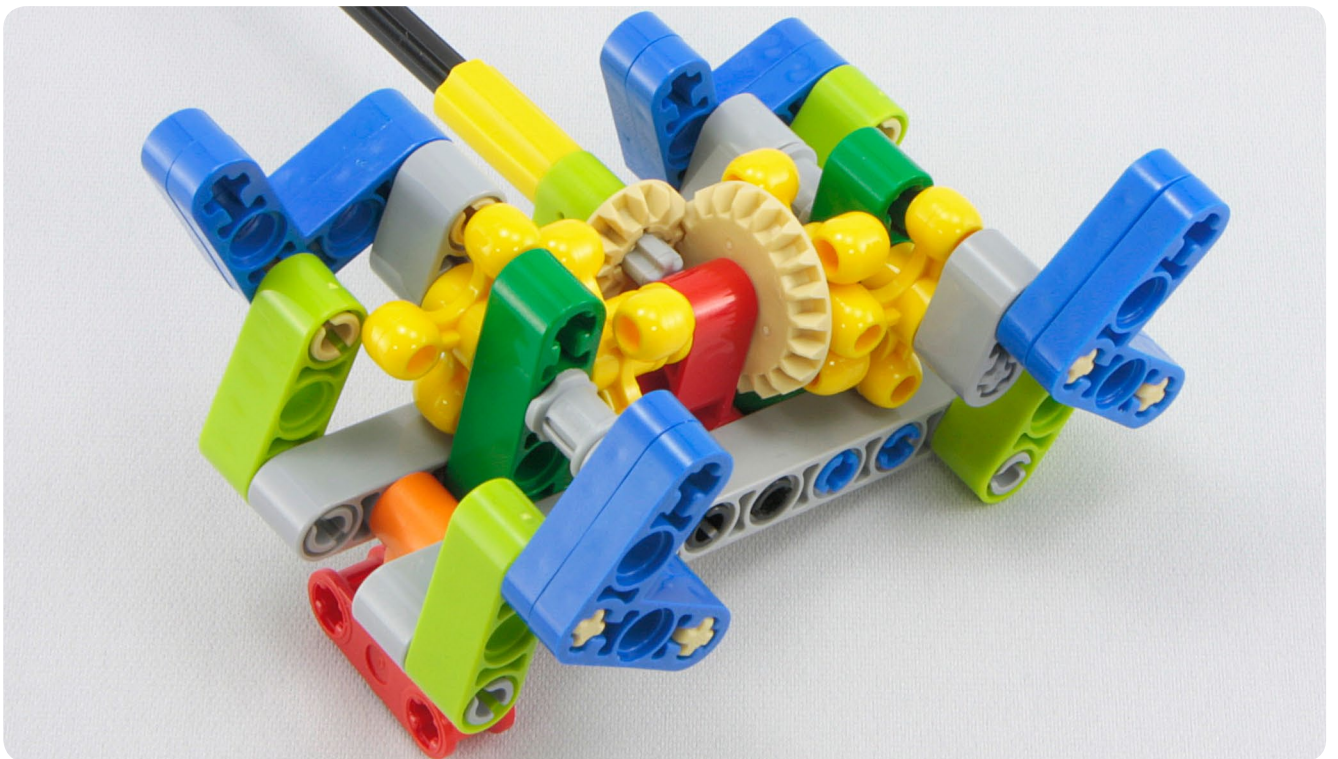
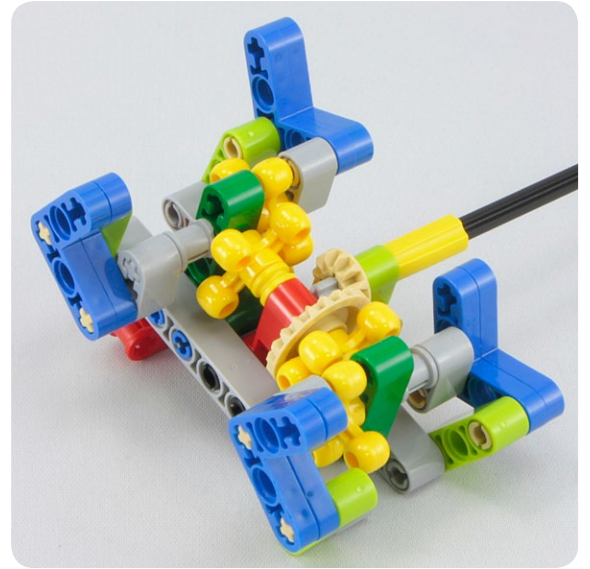
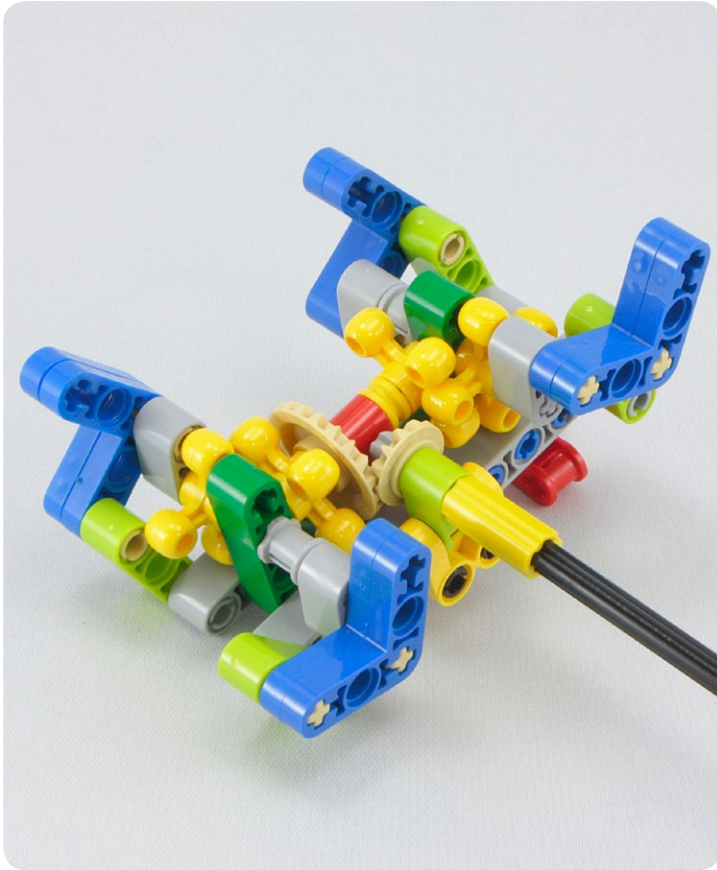




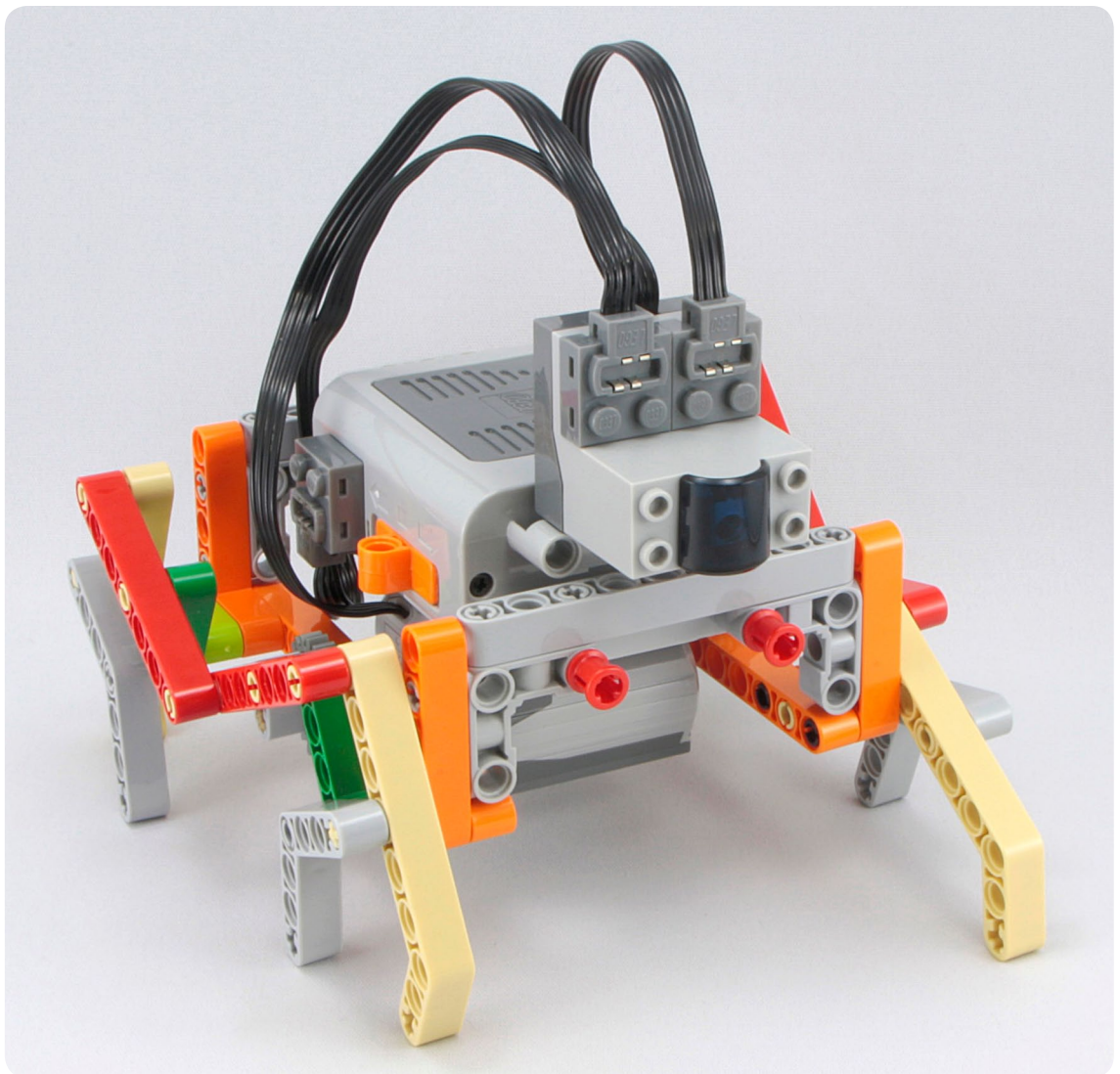
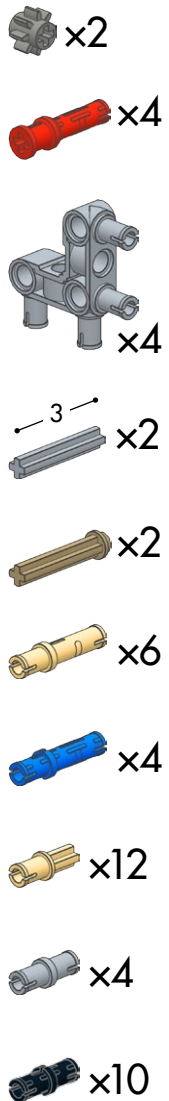


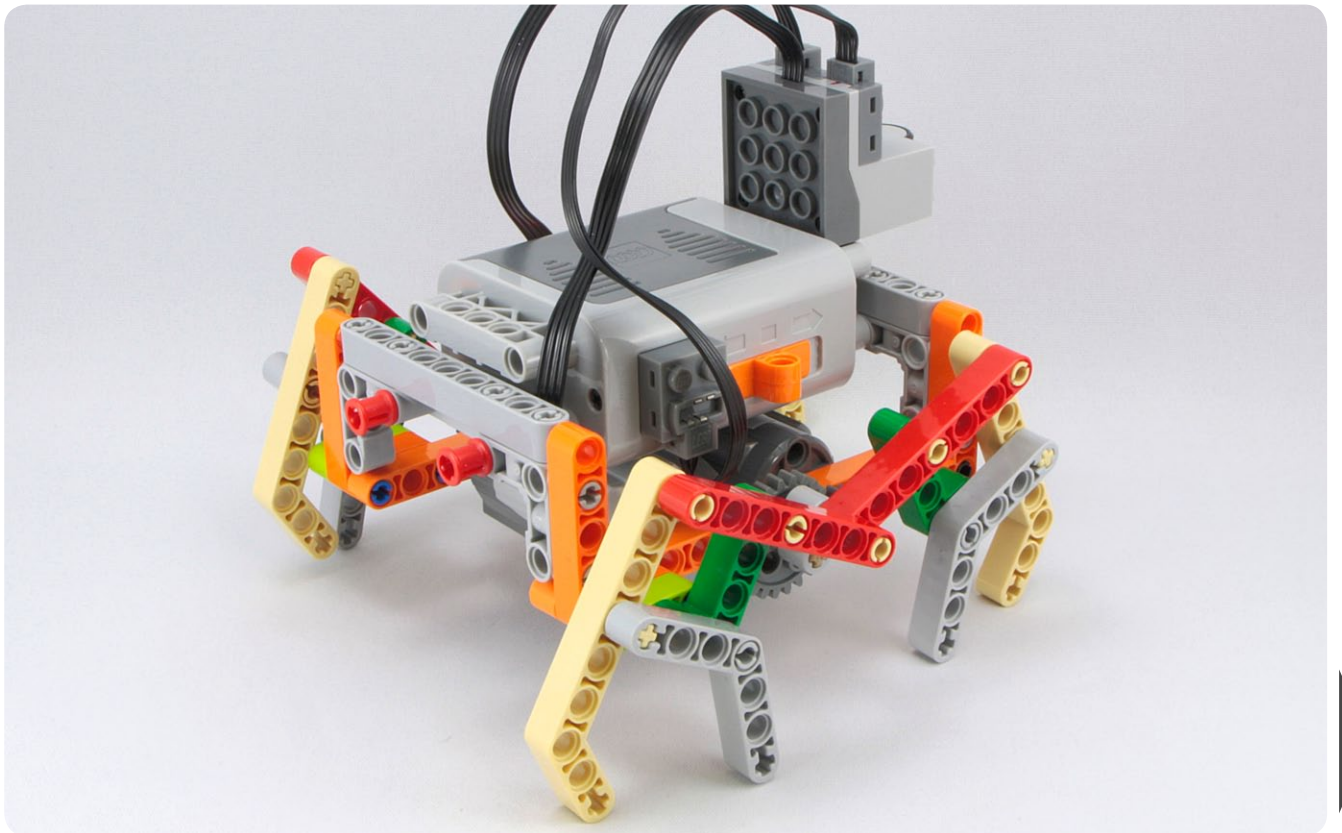
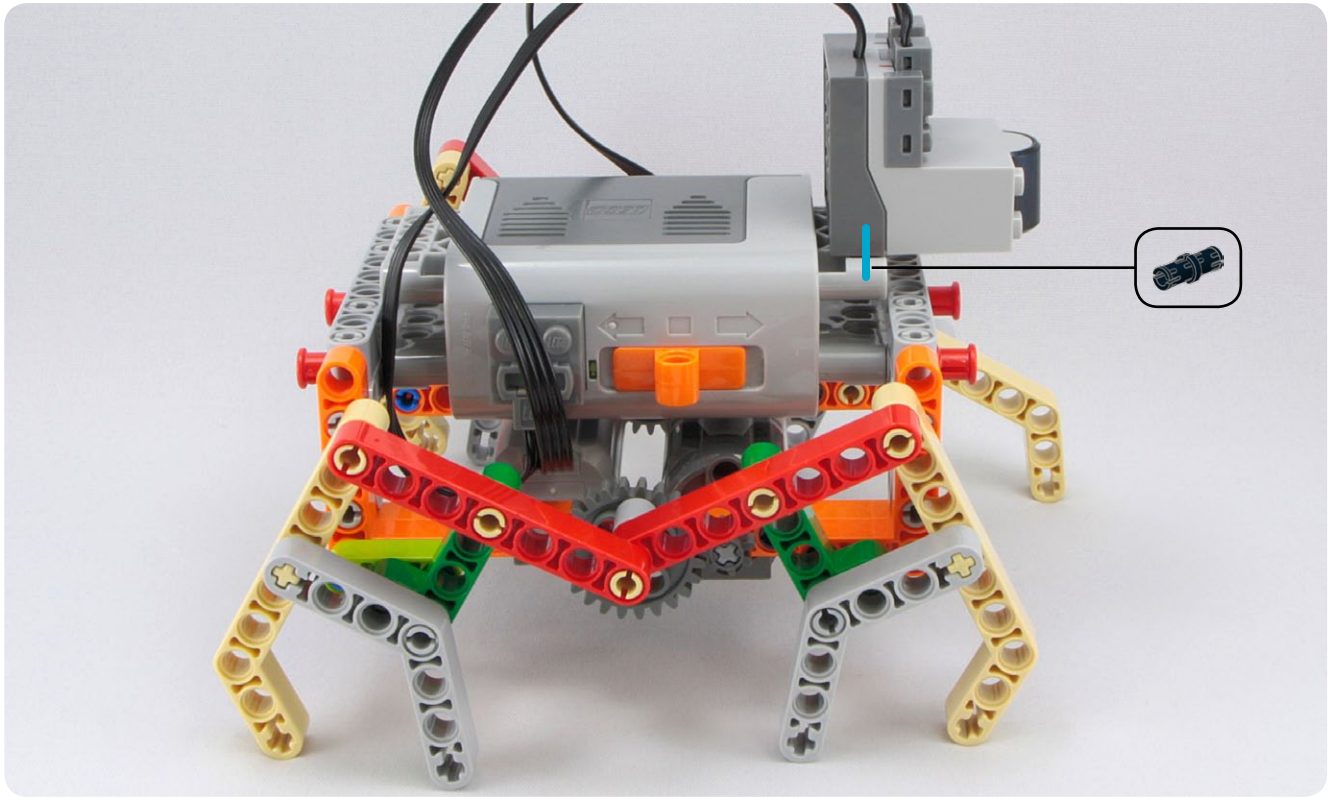


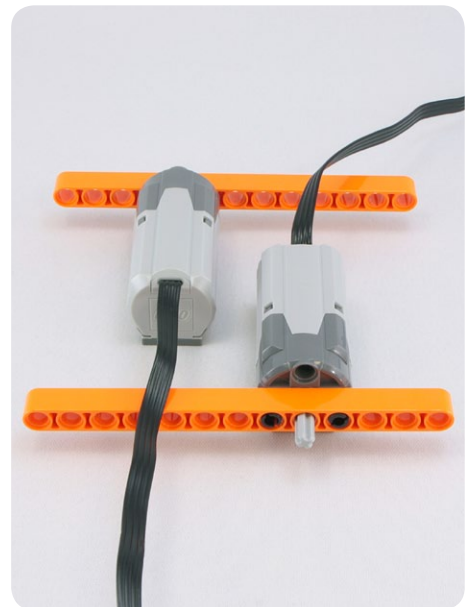
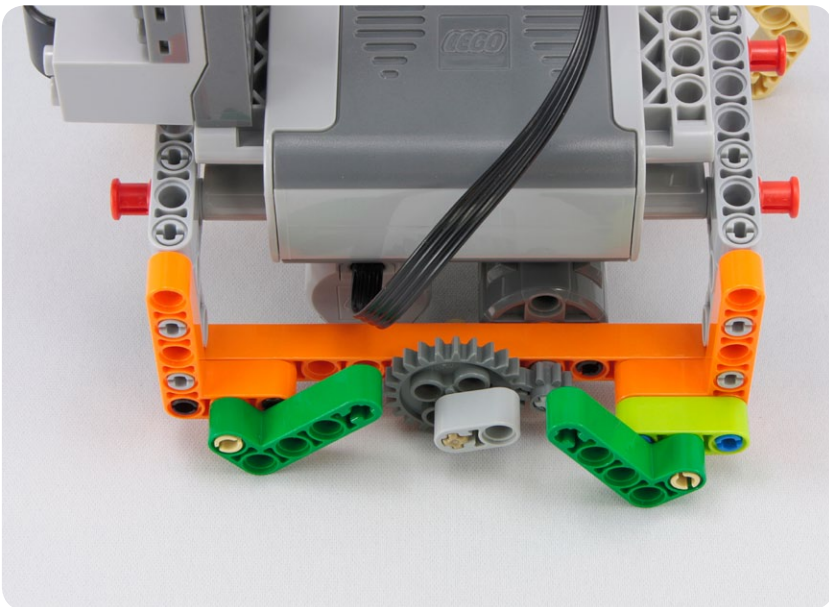
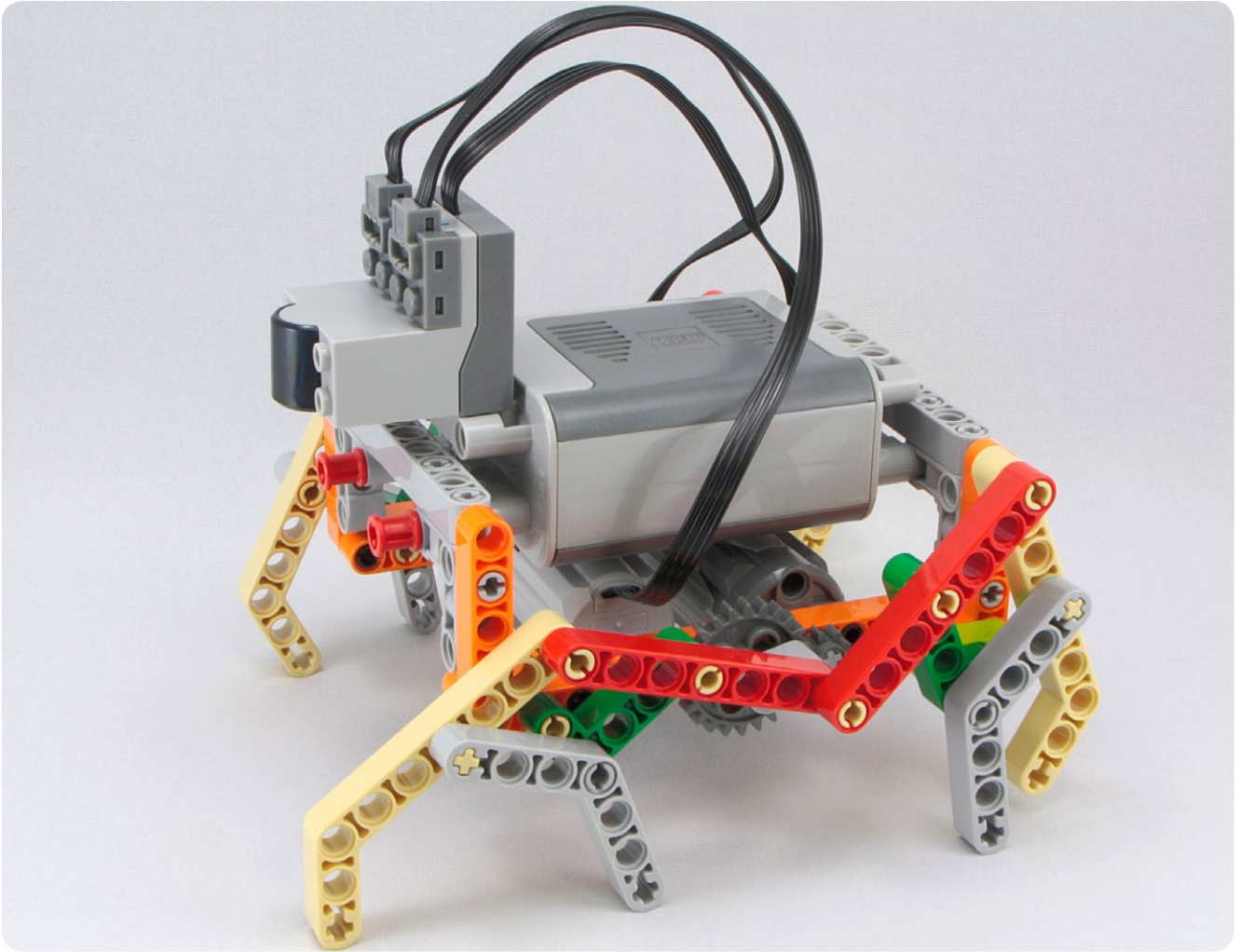


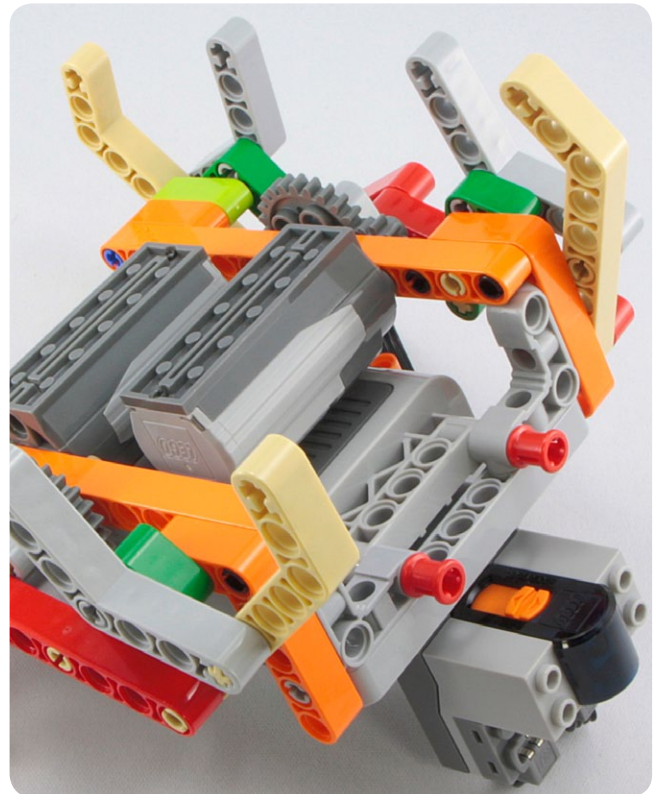
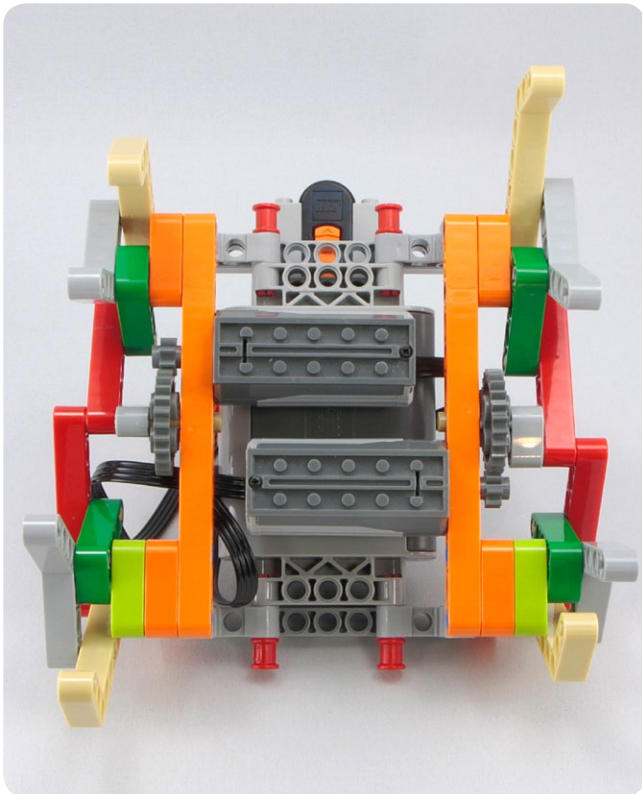
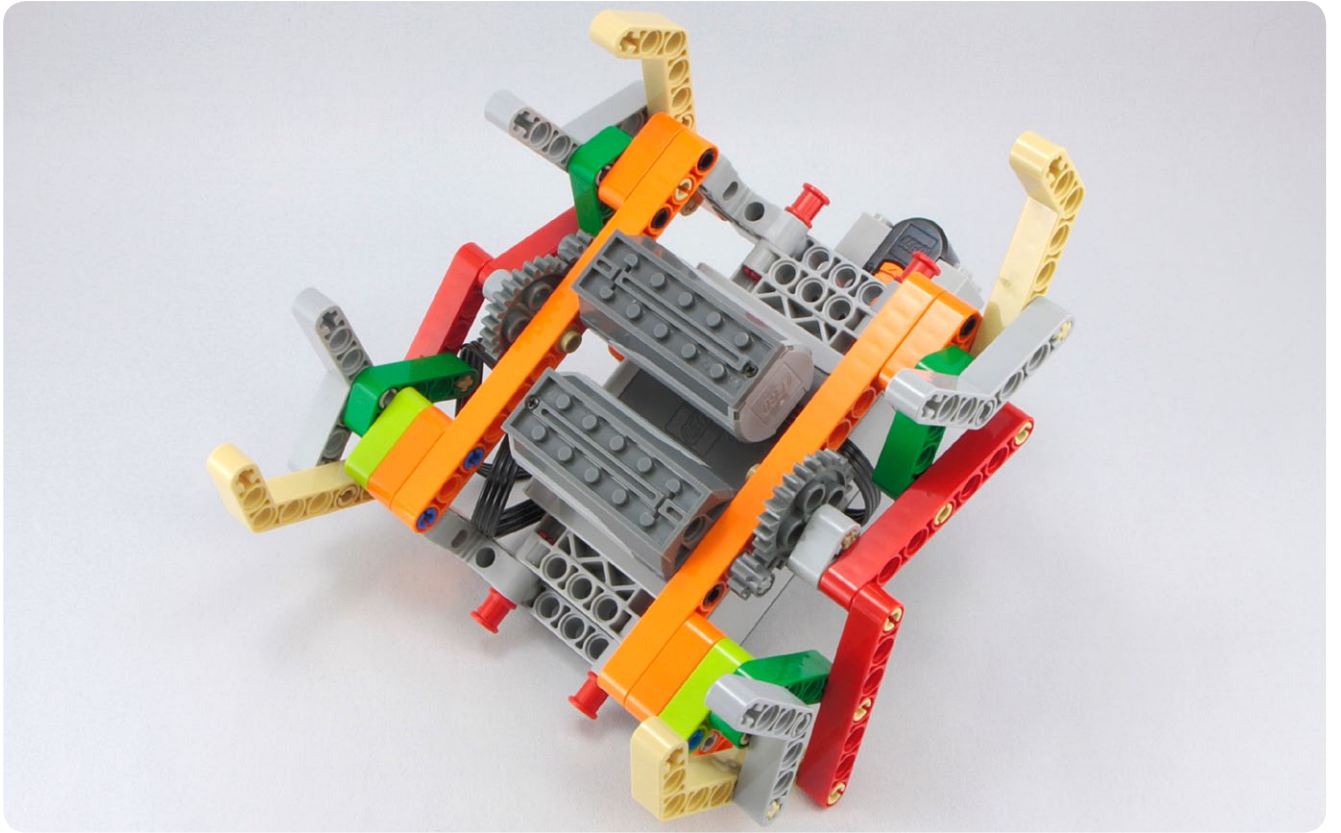


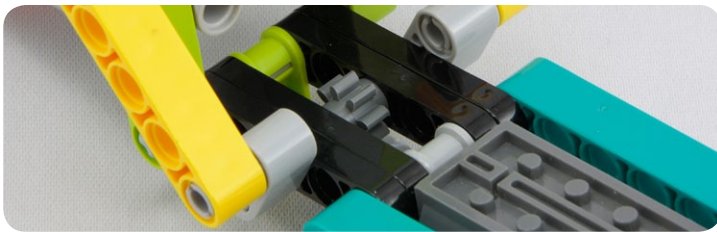
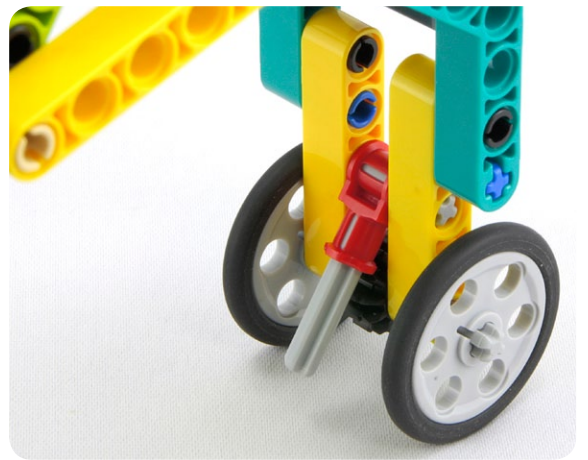
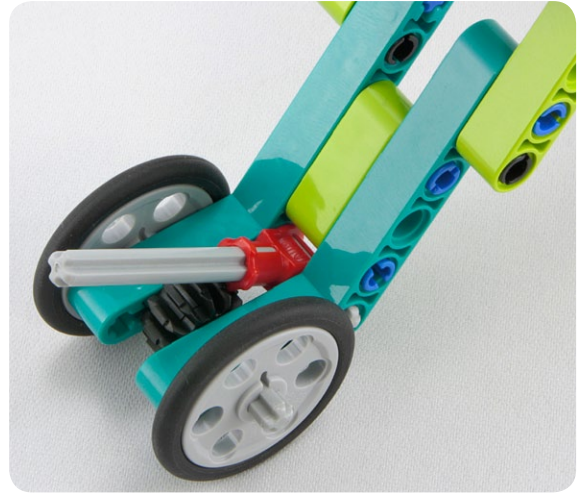
#109

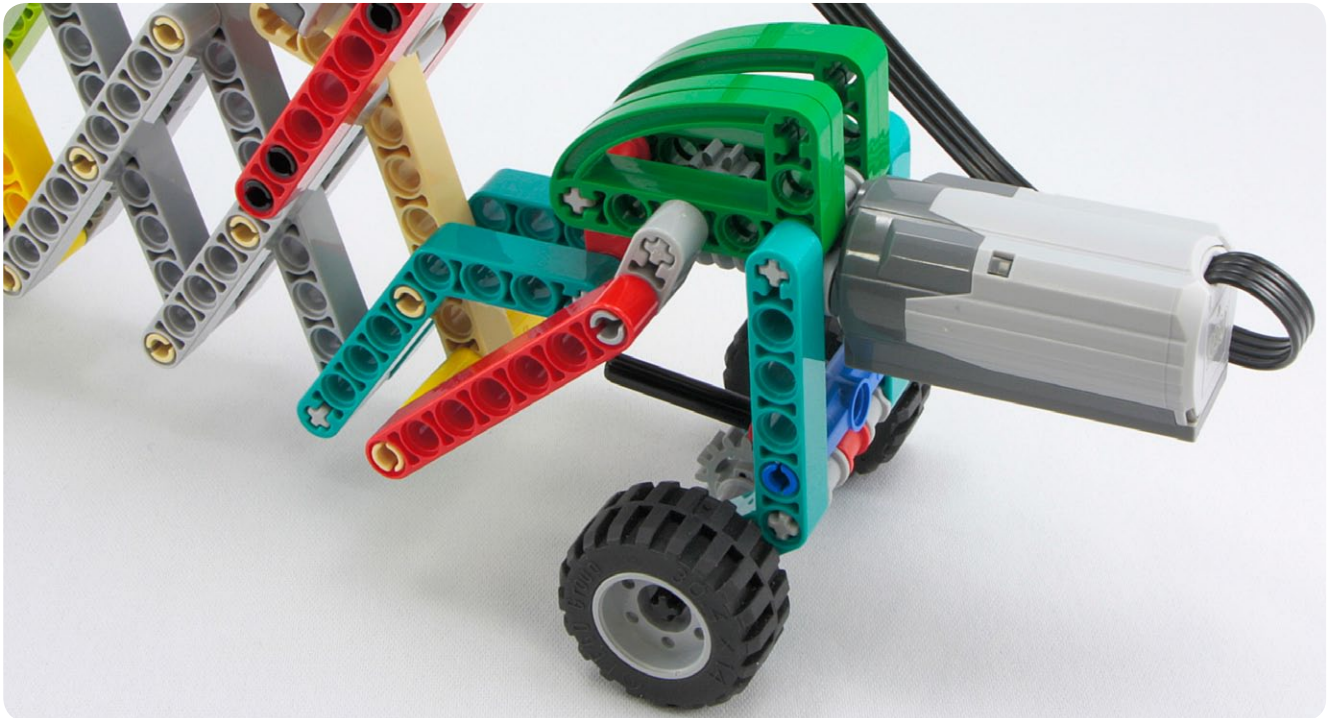
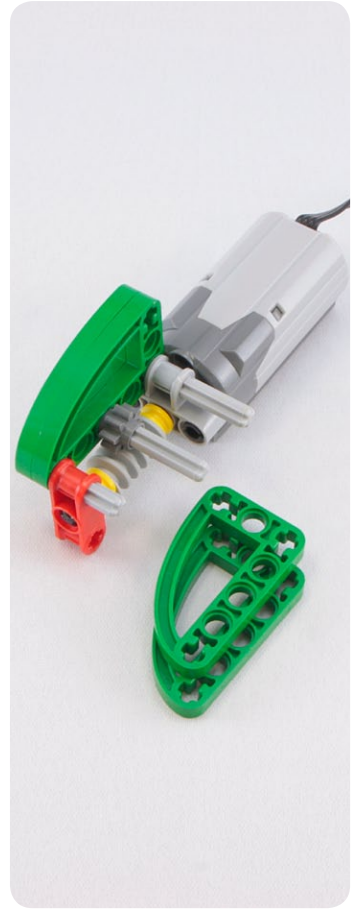


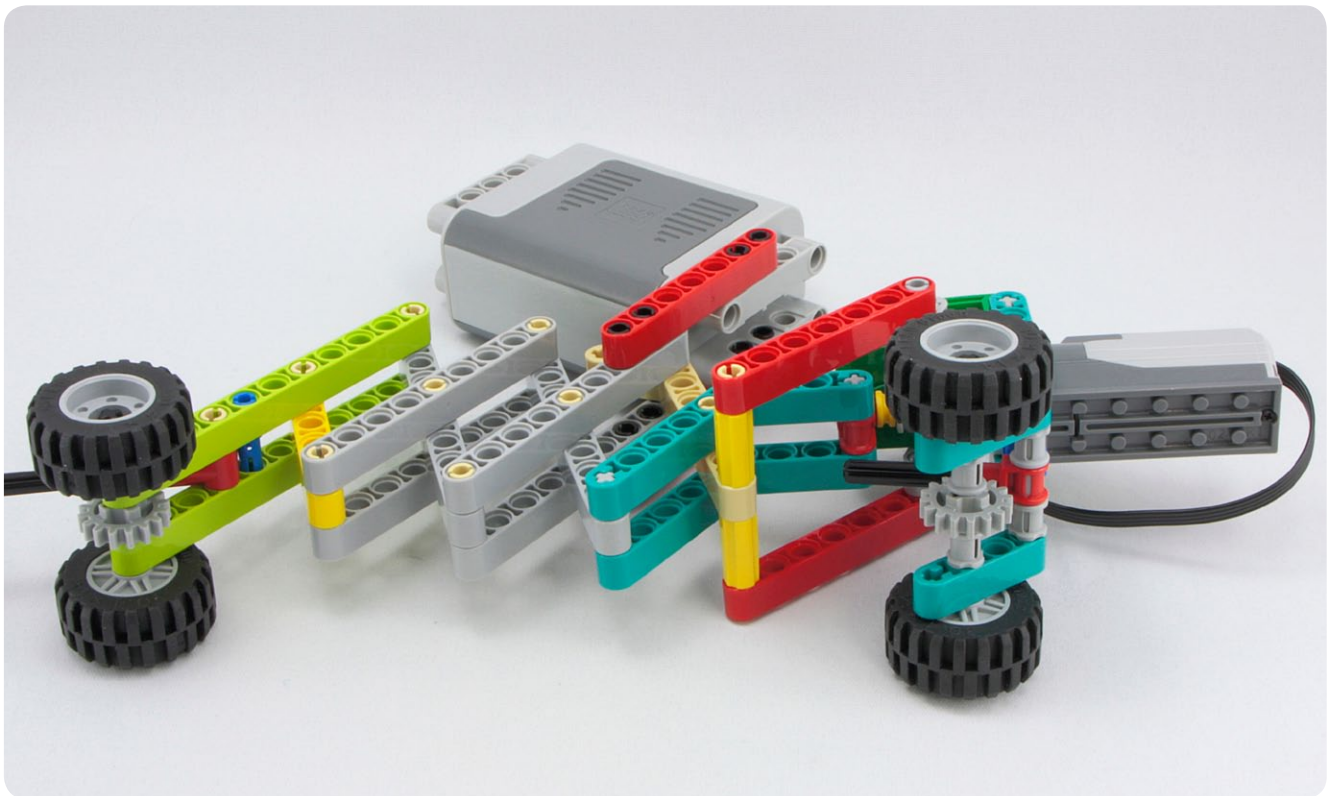
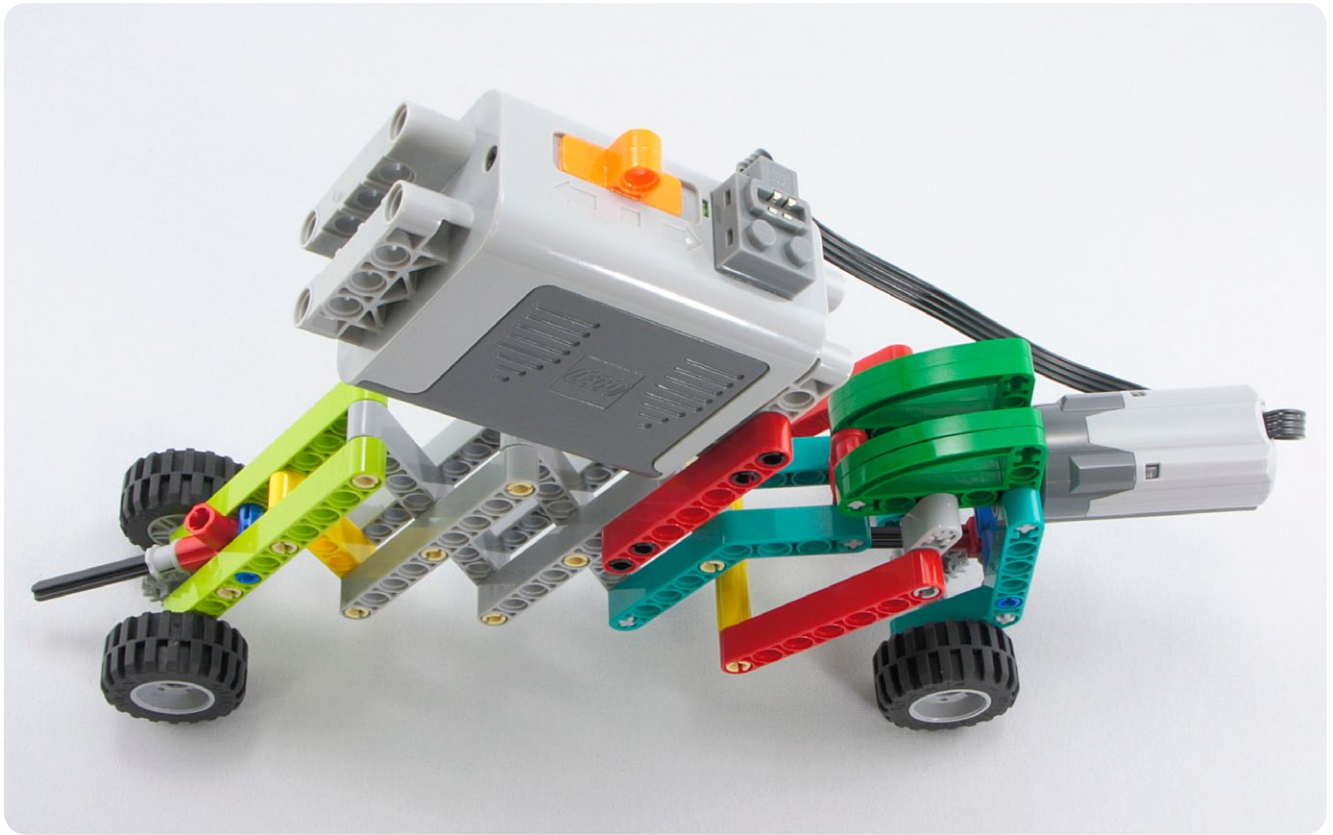


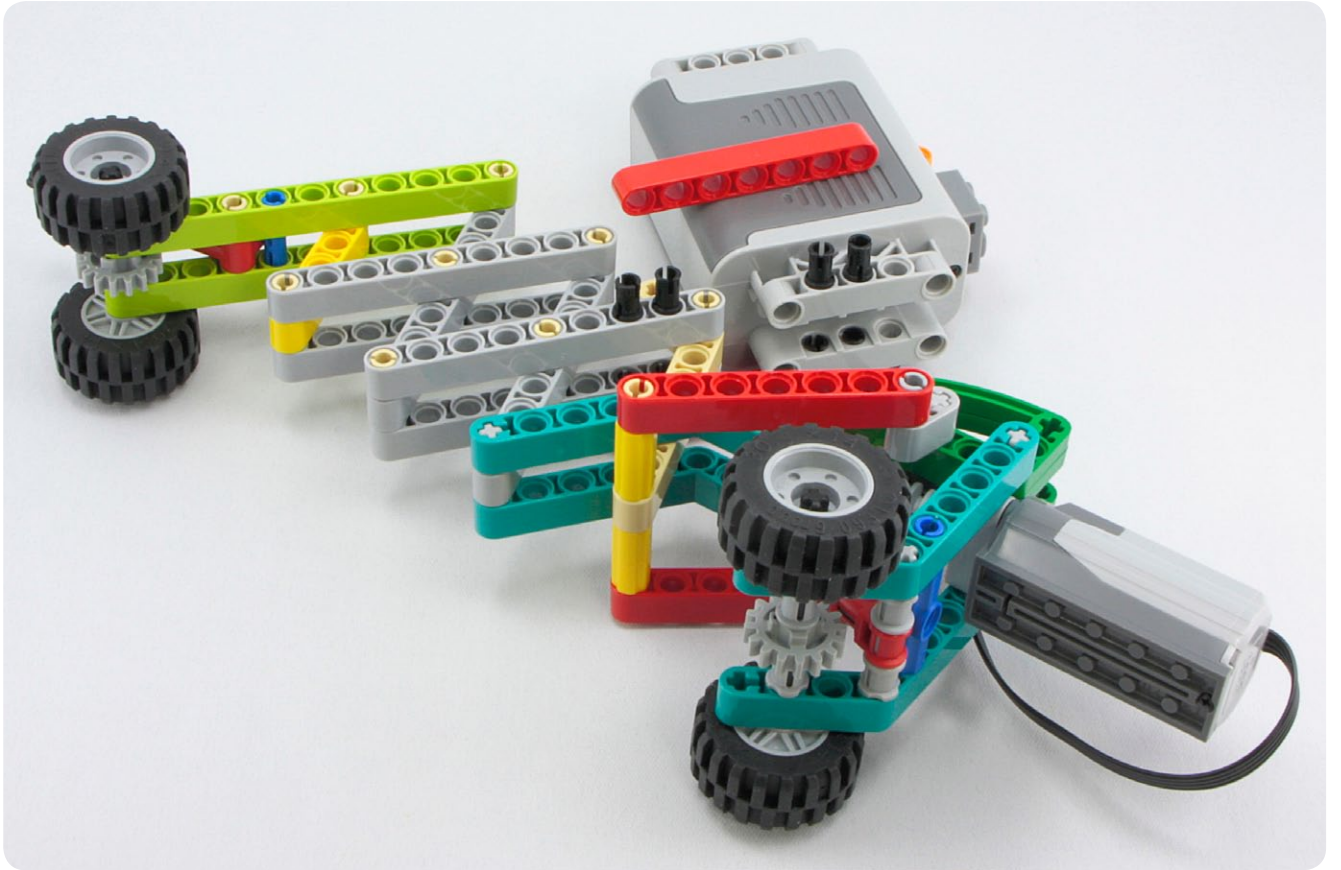


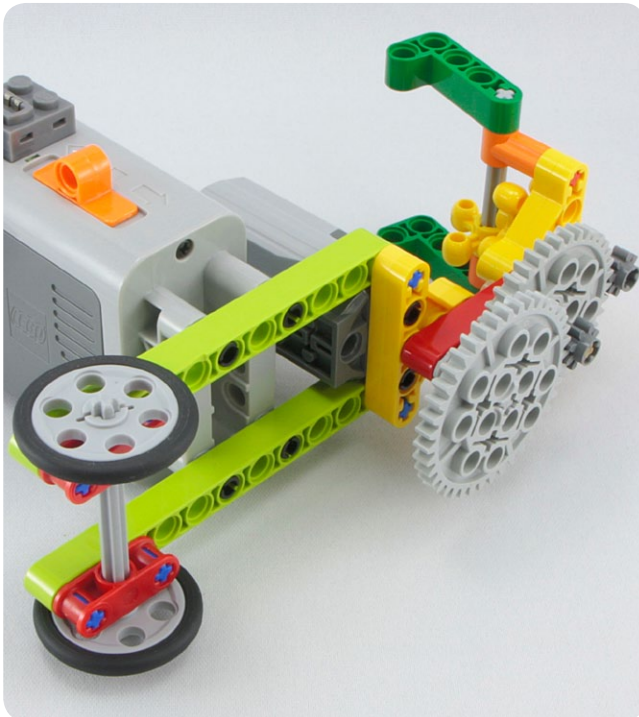
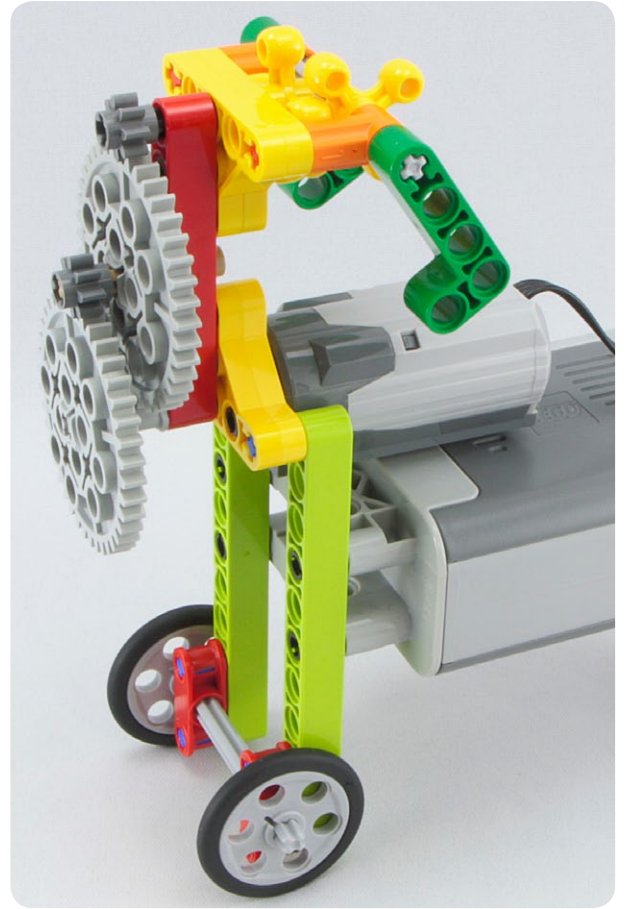




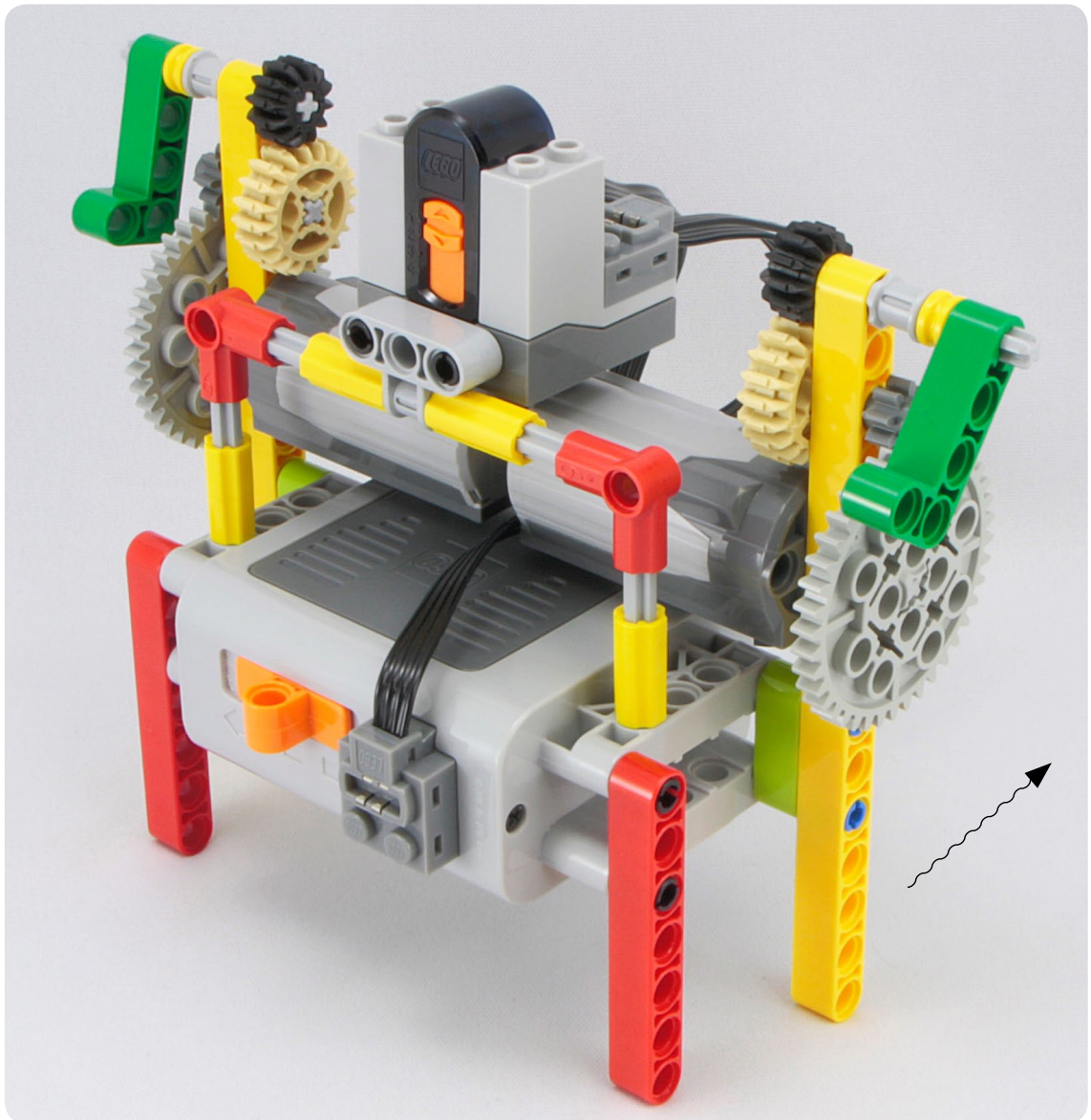
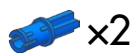
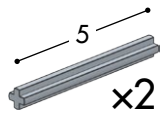
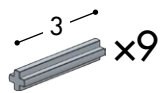
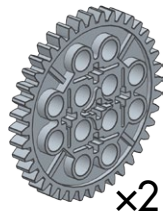
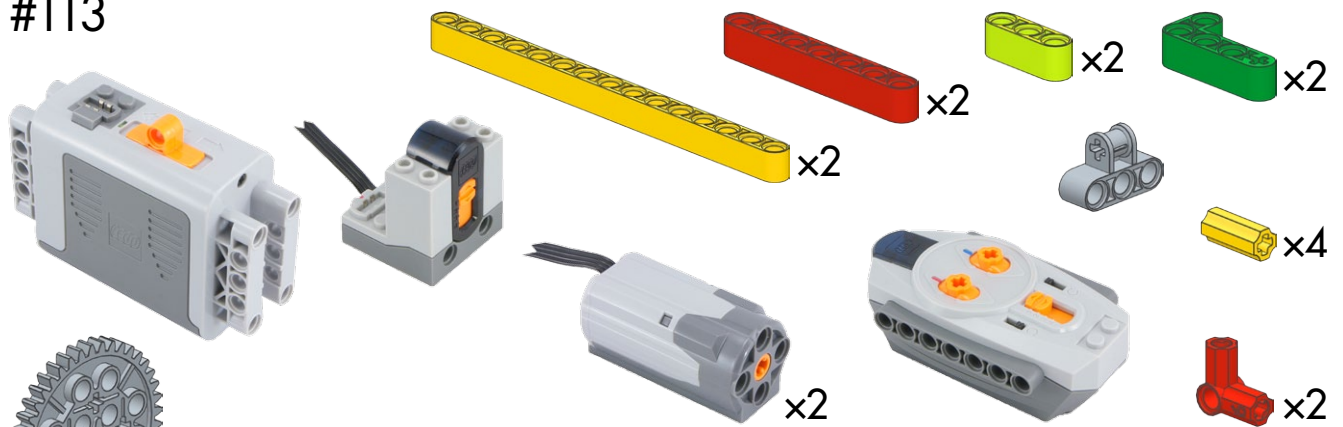


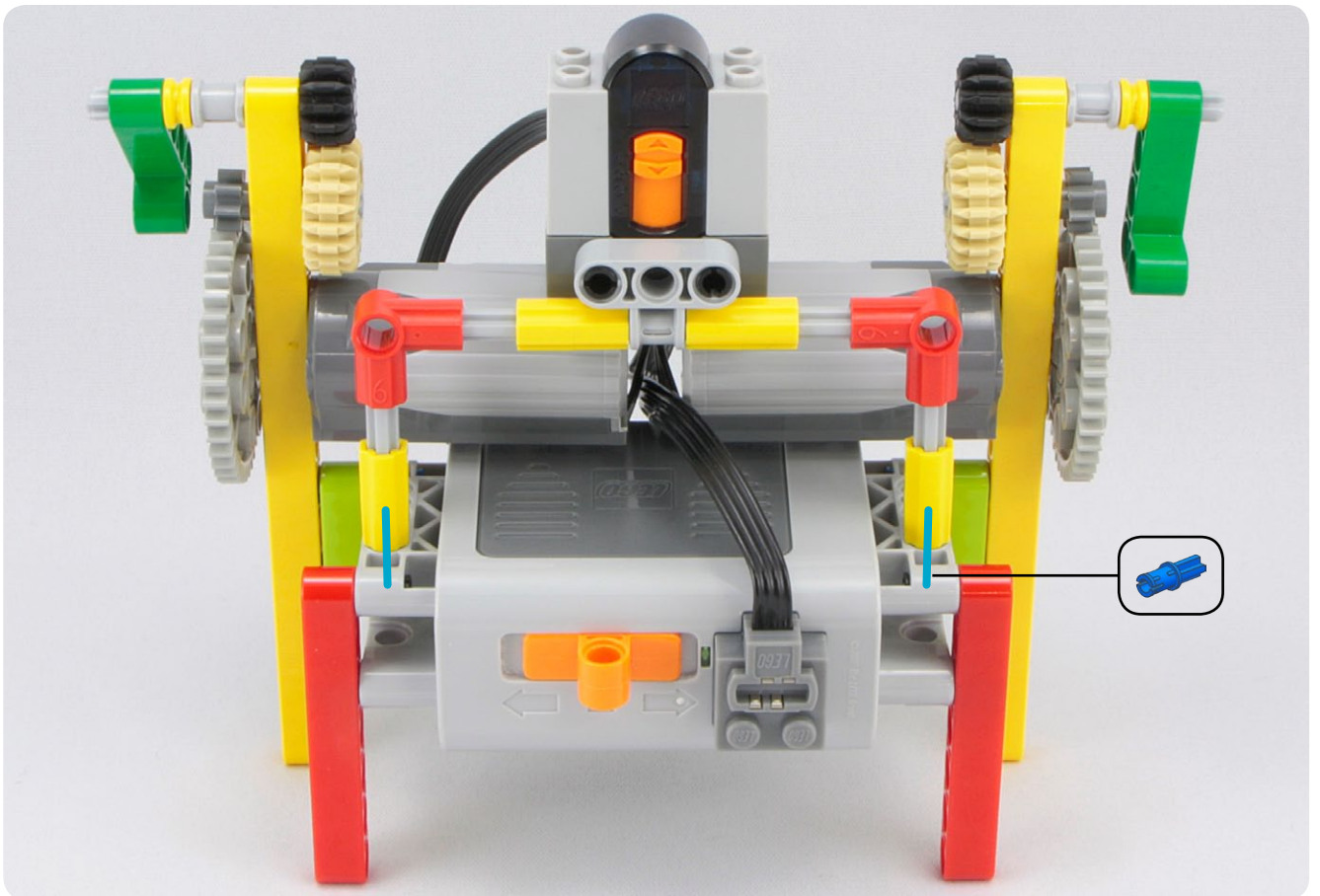
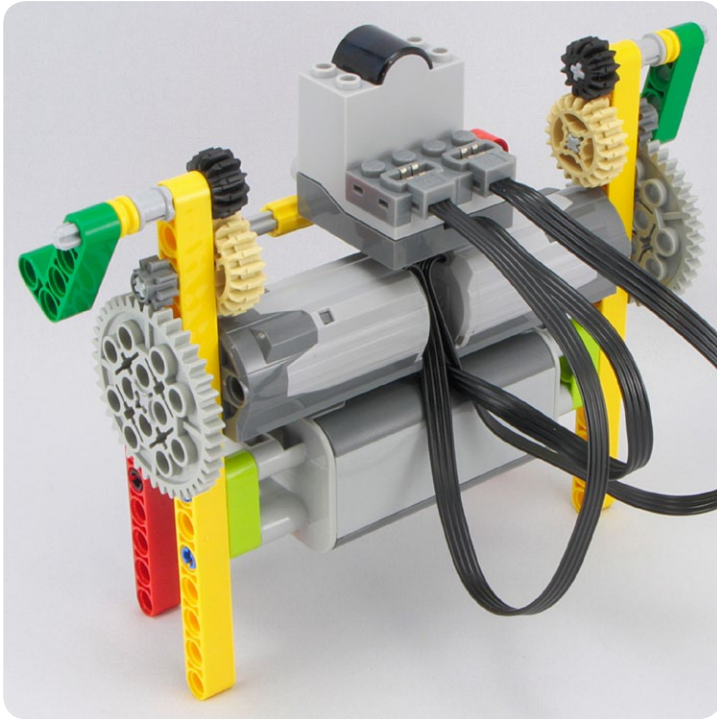


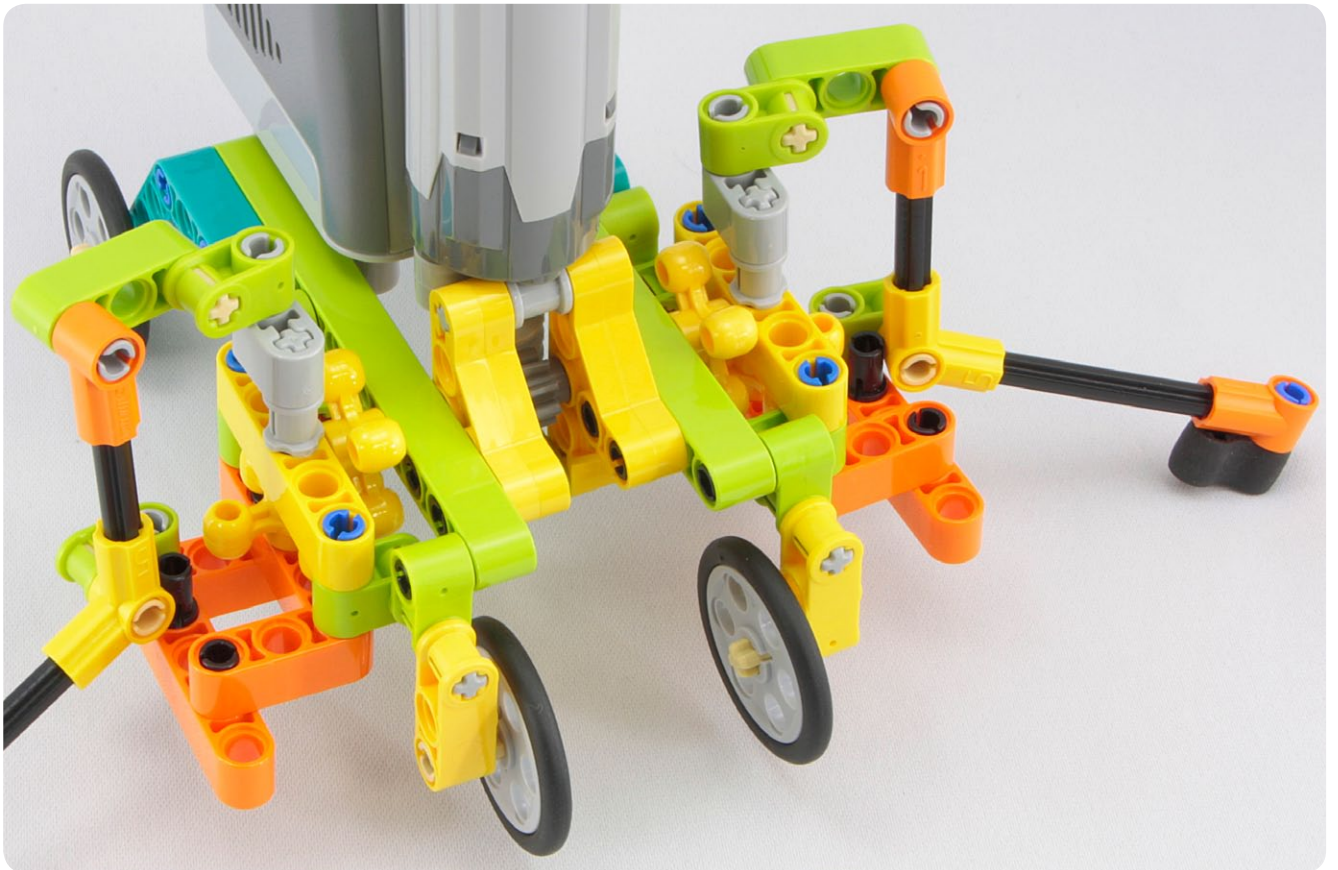


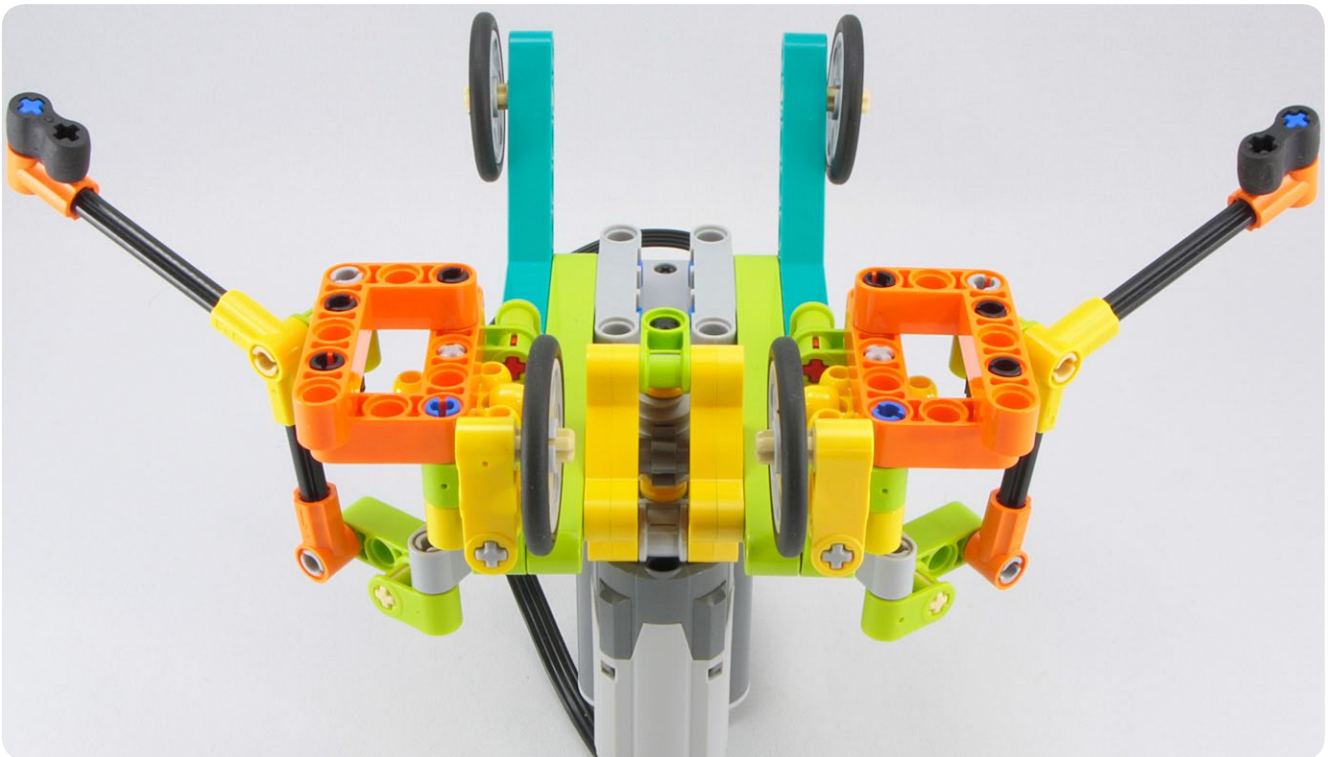
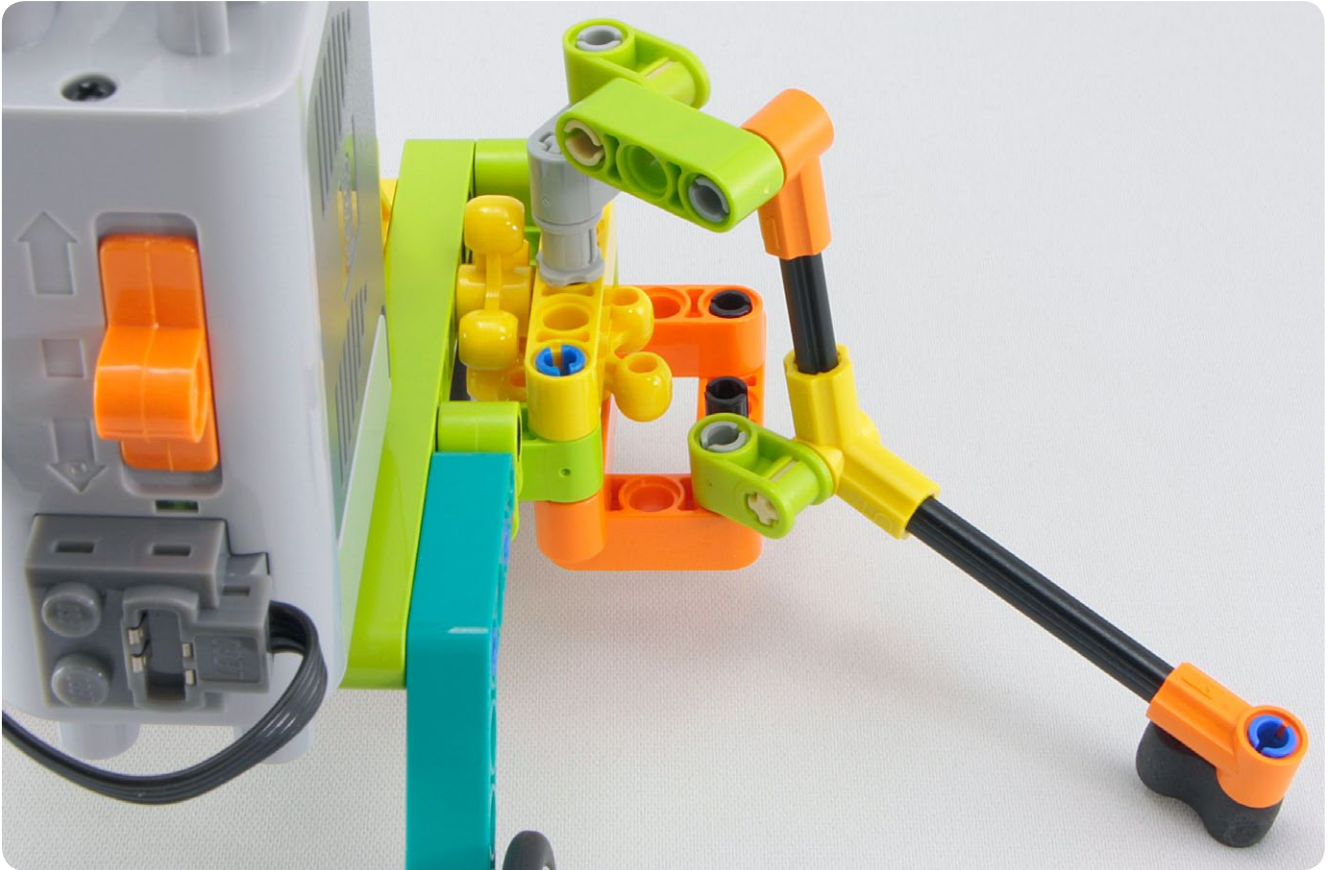


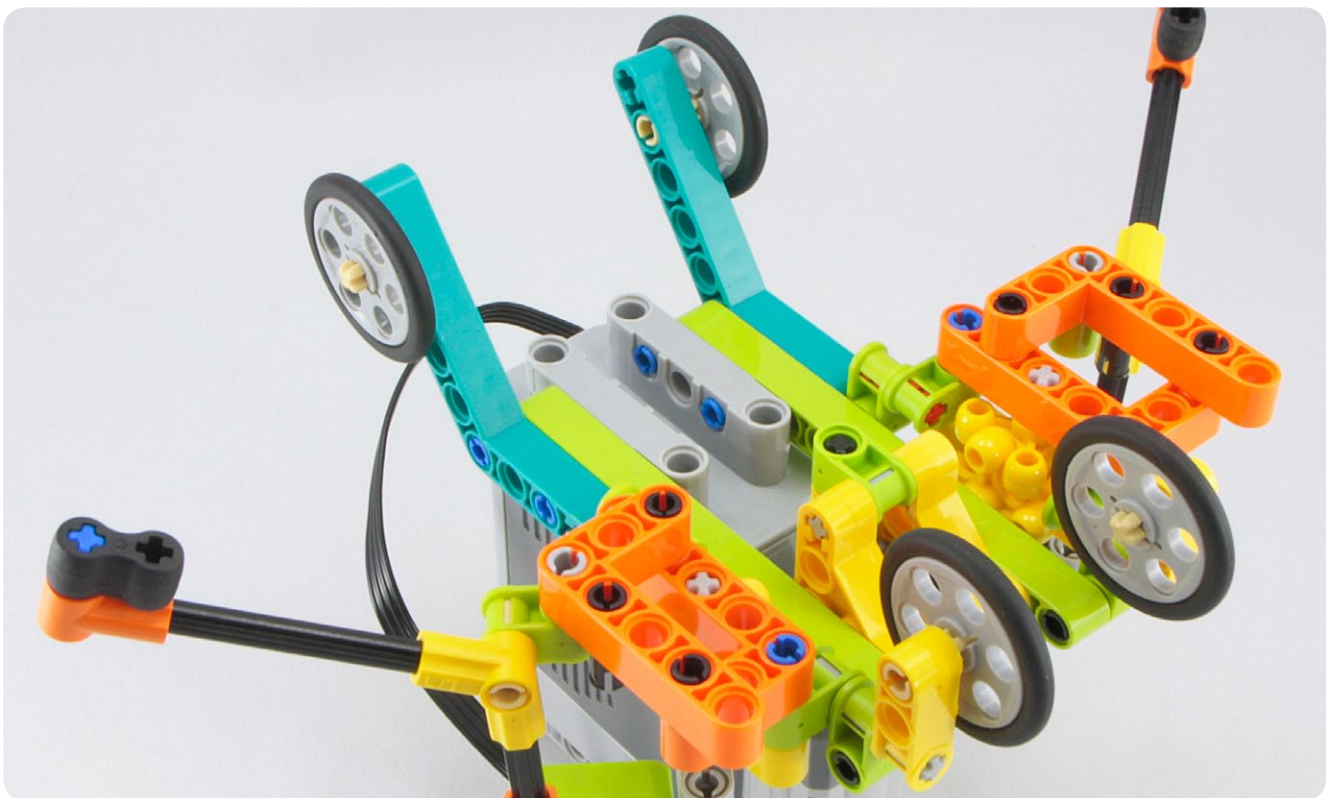
#113













PART 3

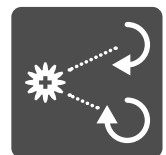
Special Mechanisms



250



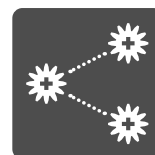
264



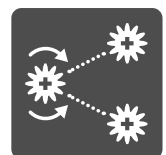
288



256



272

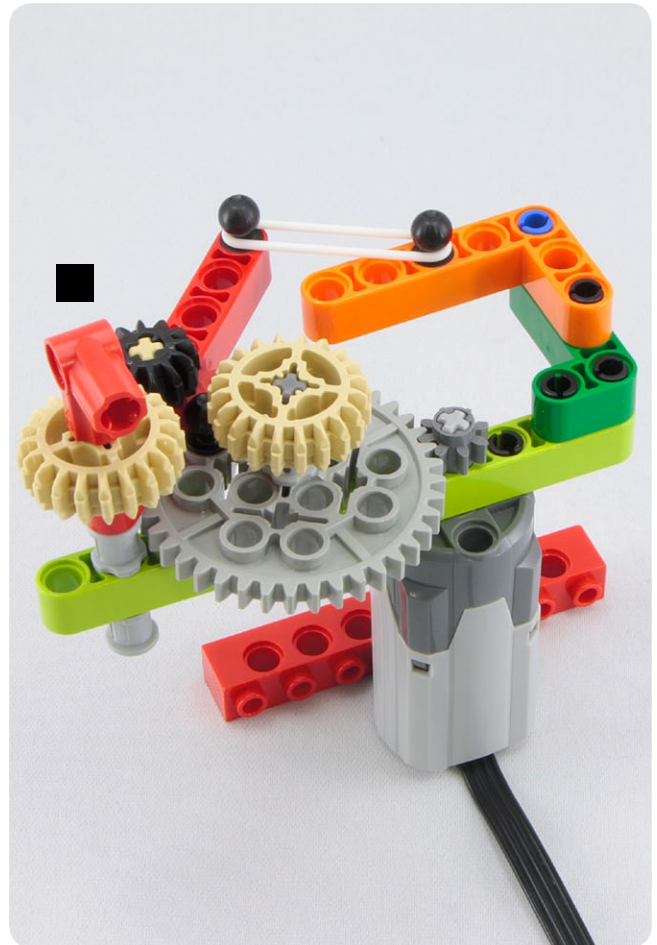
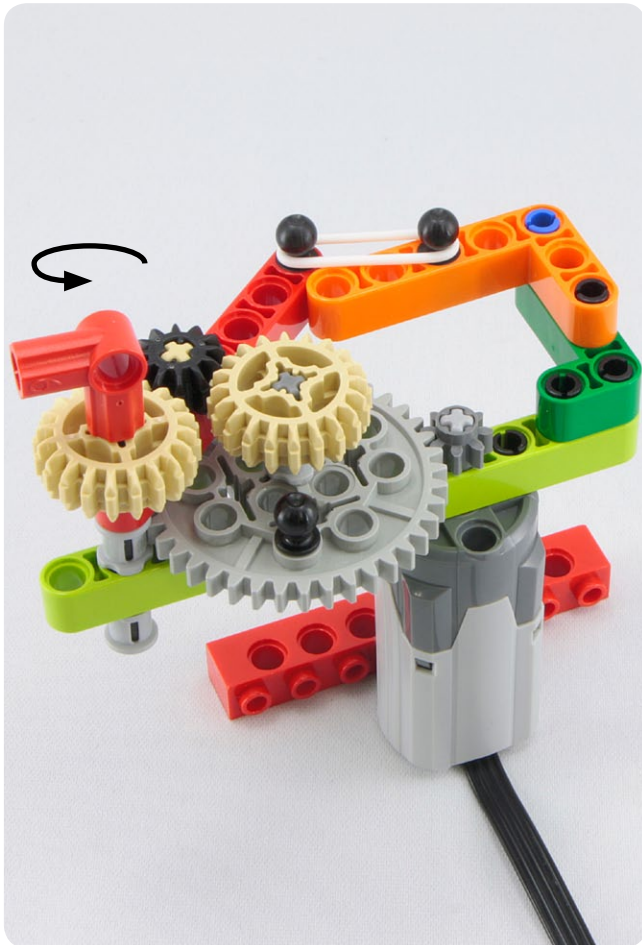
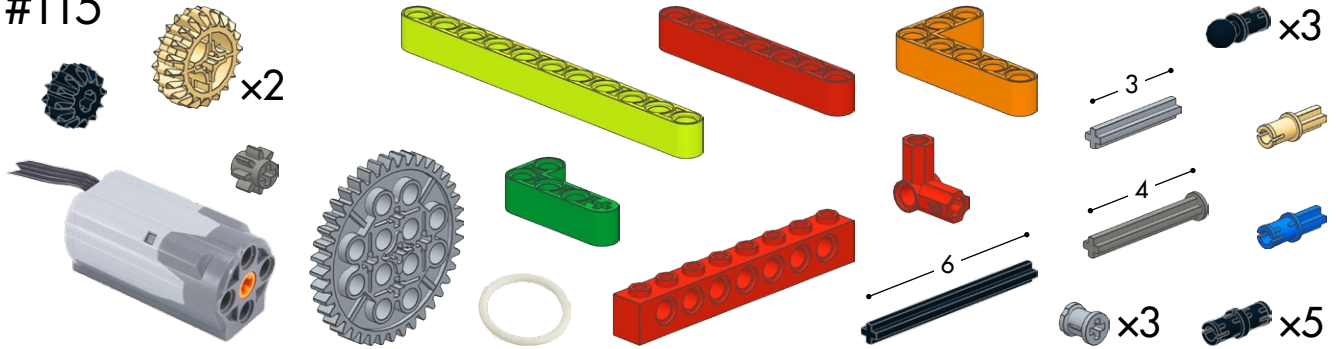


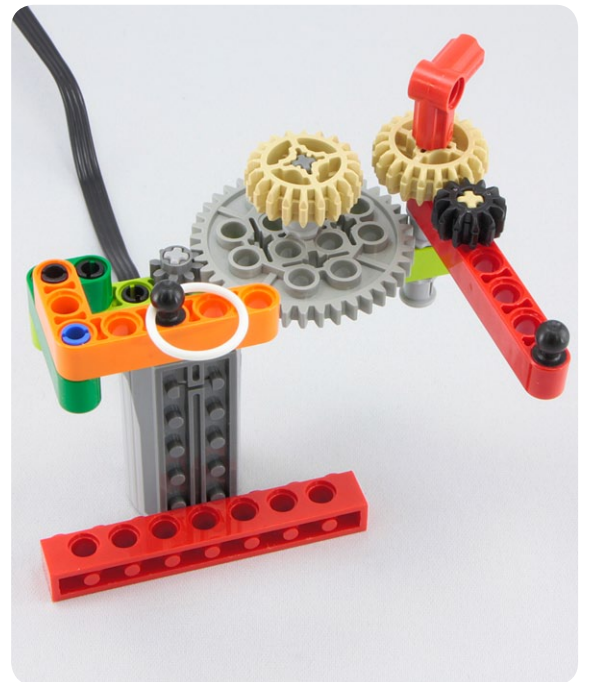
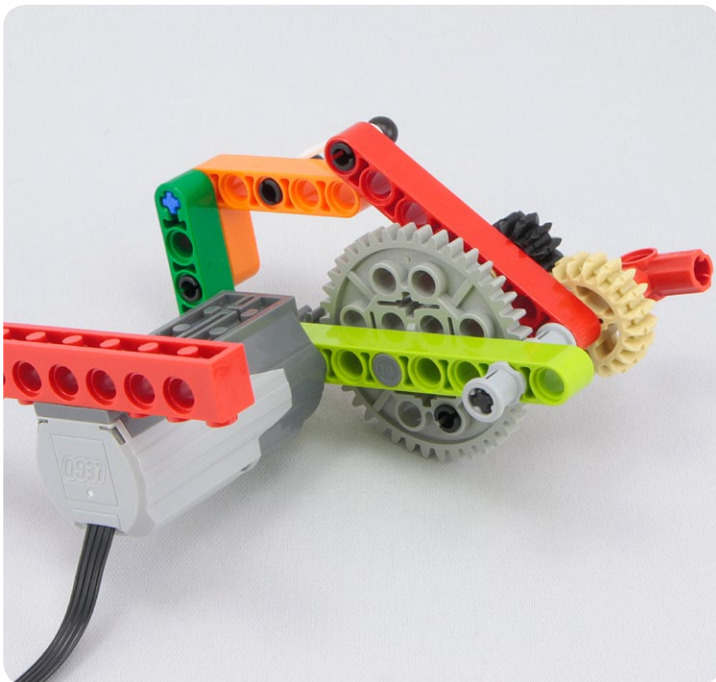
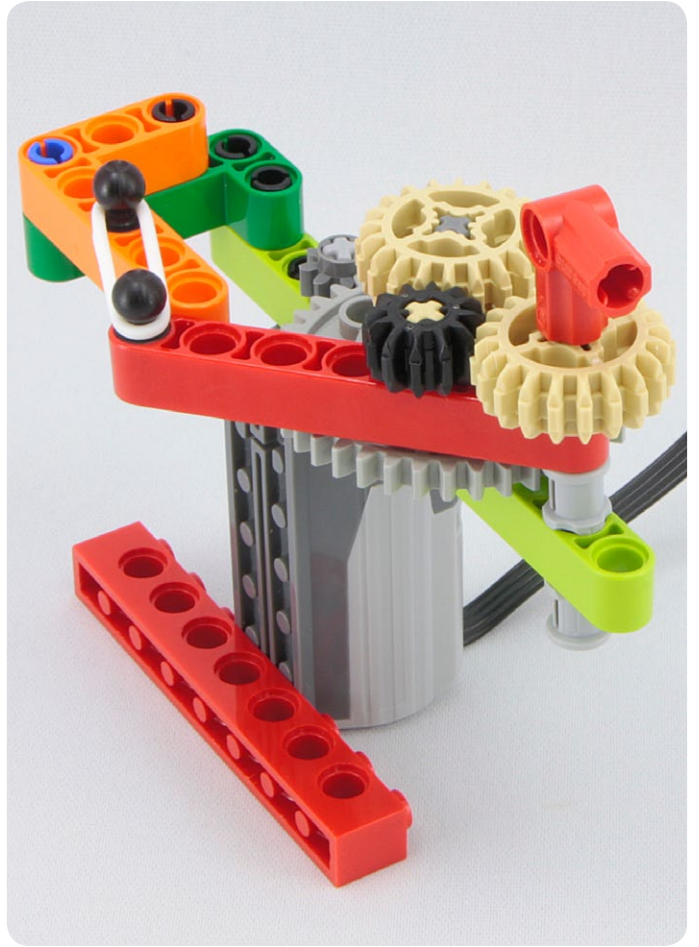
308

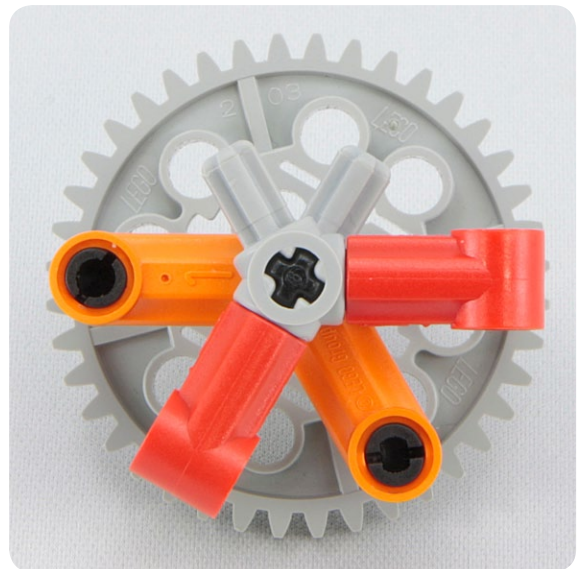
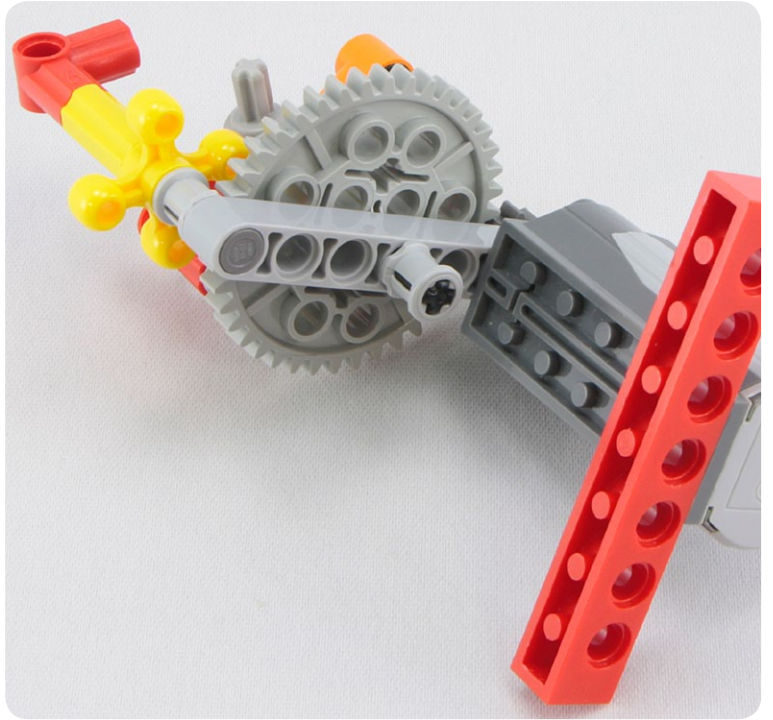


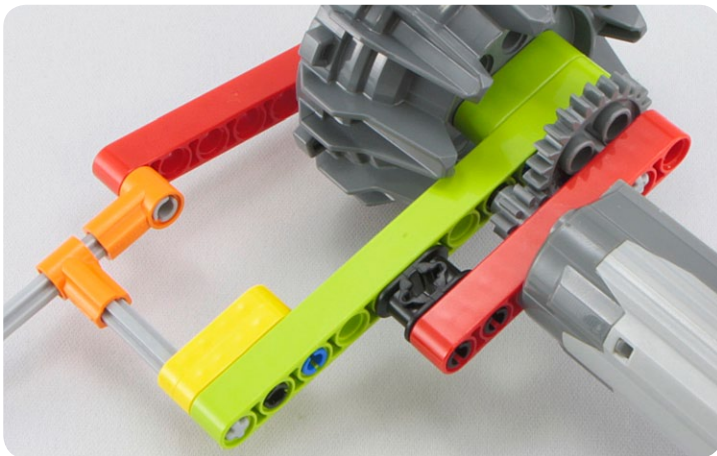
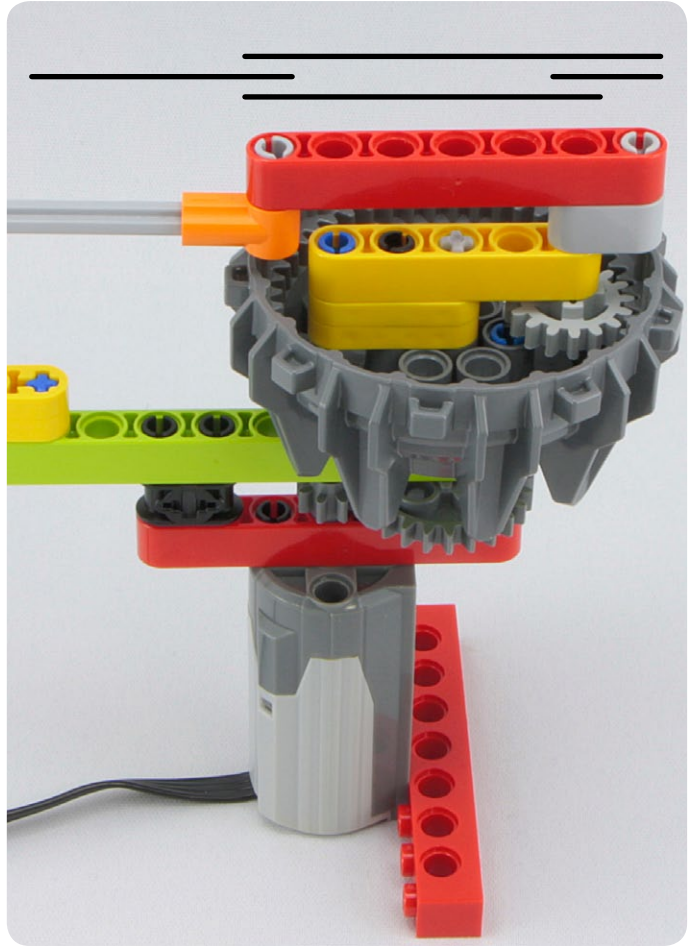
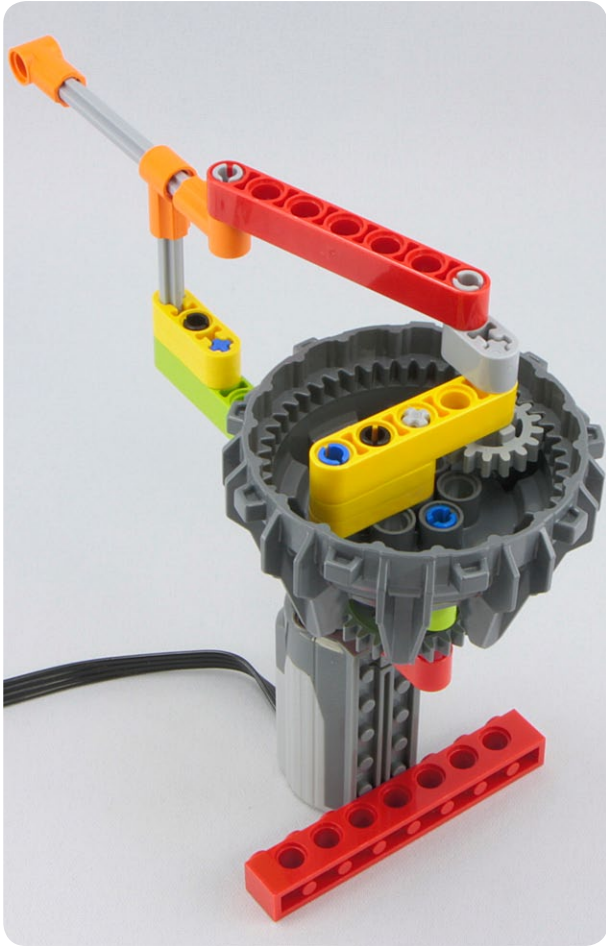
Intermittent motion

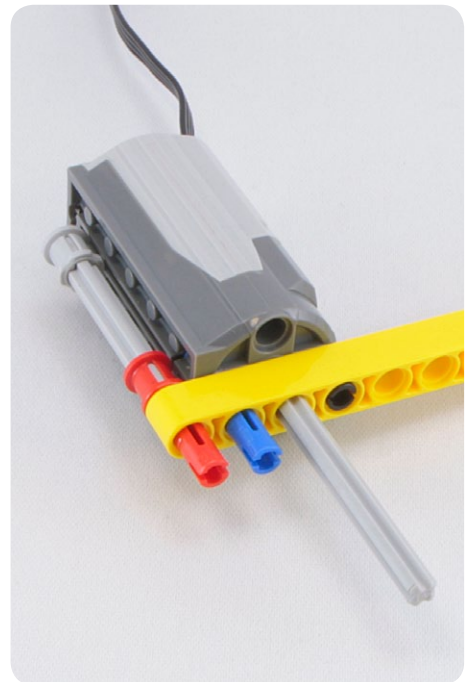
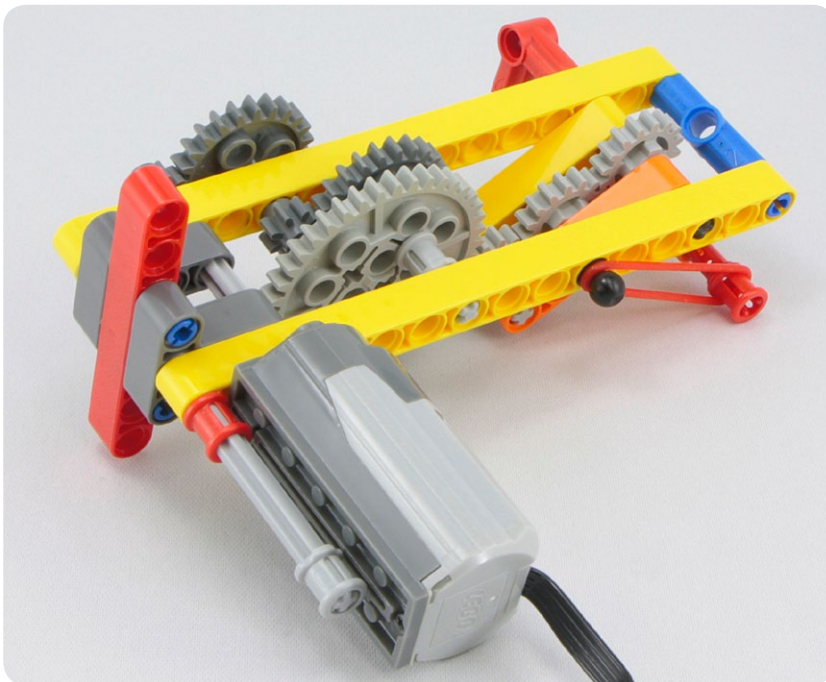
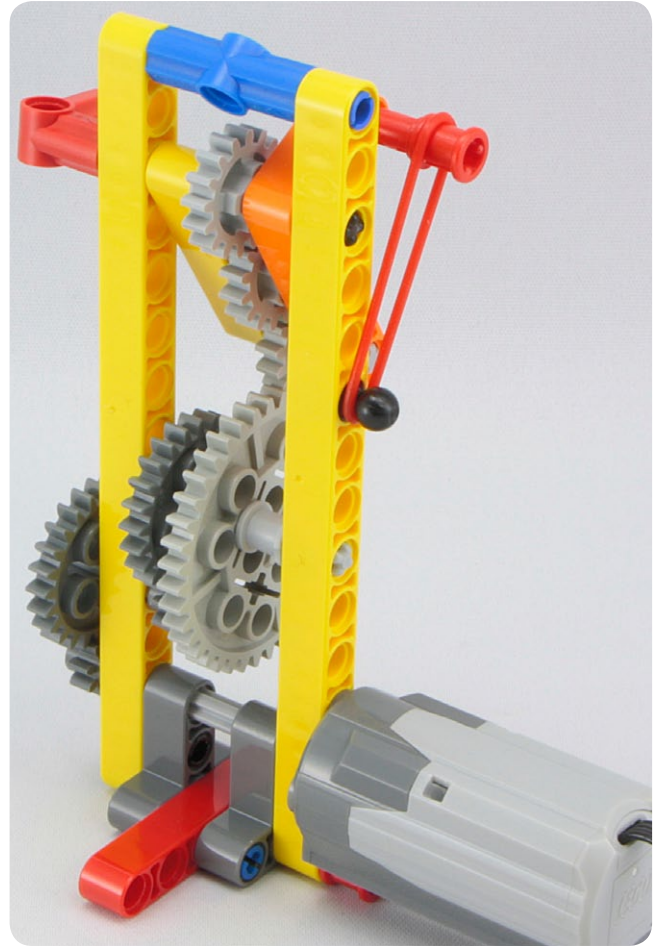
#115

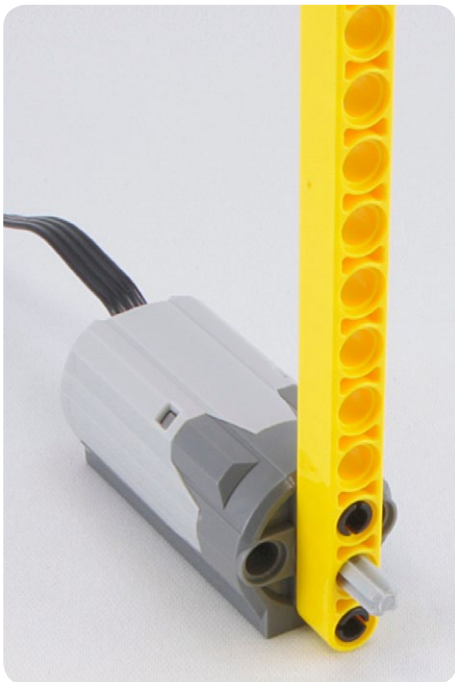
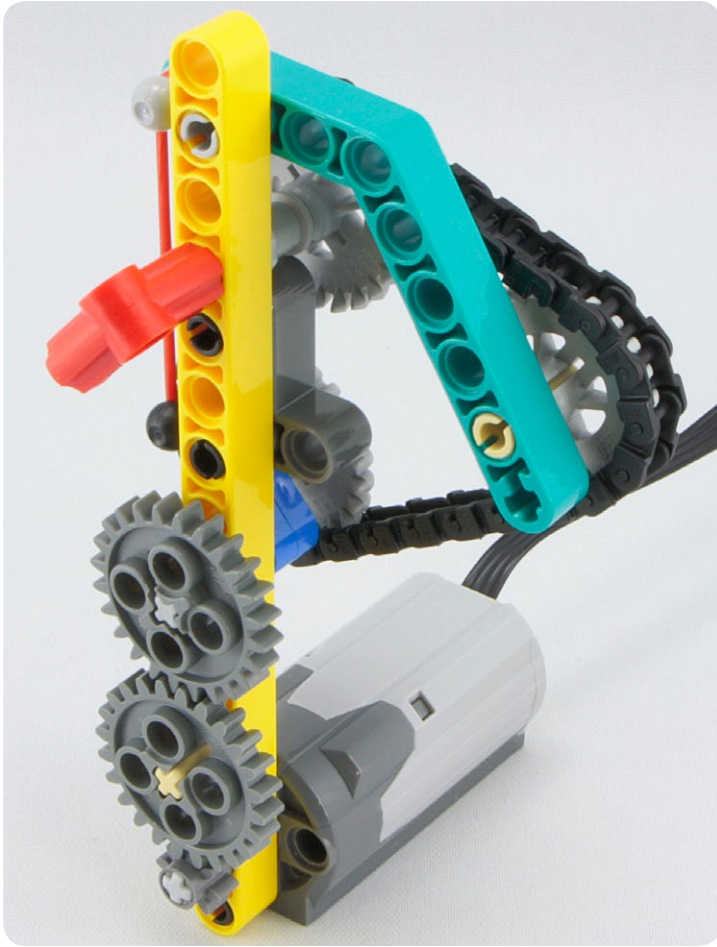






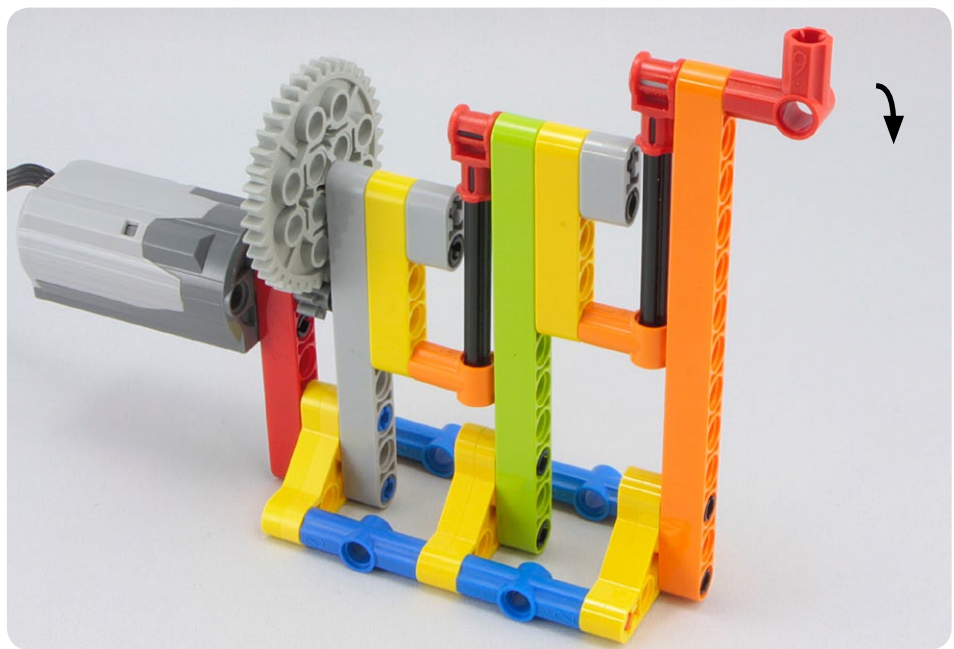
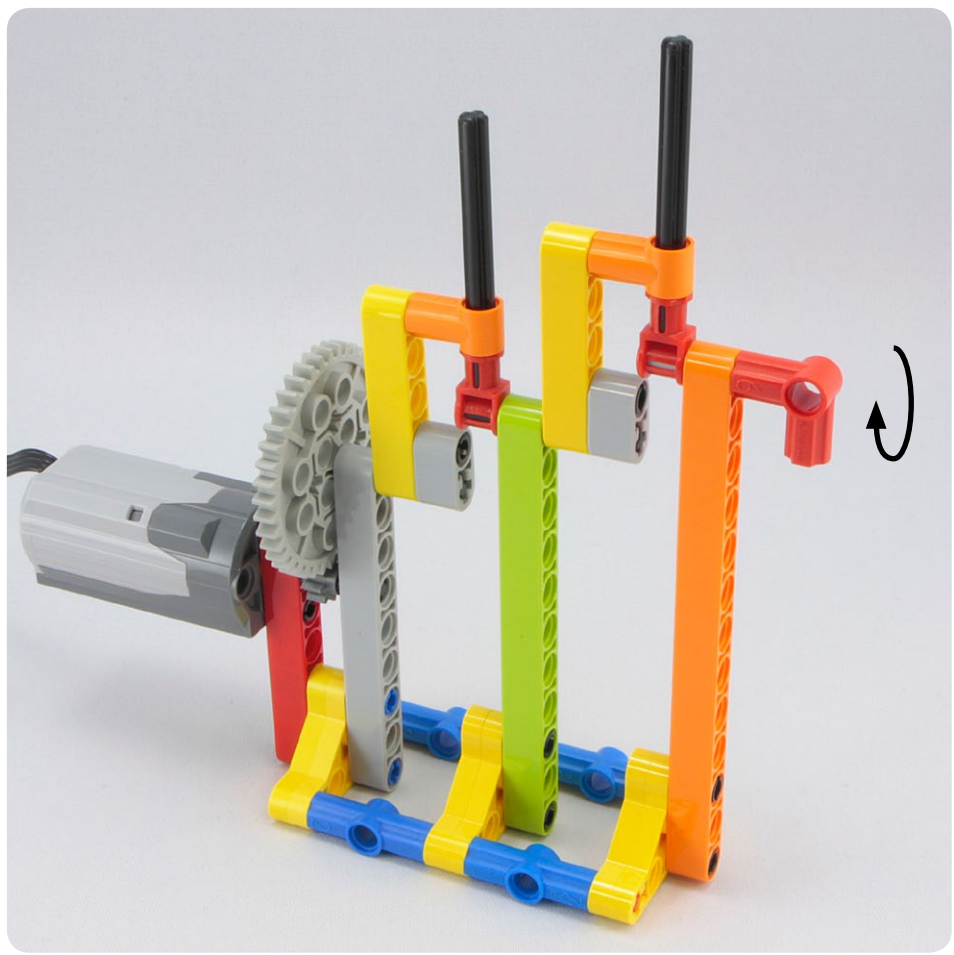


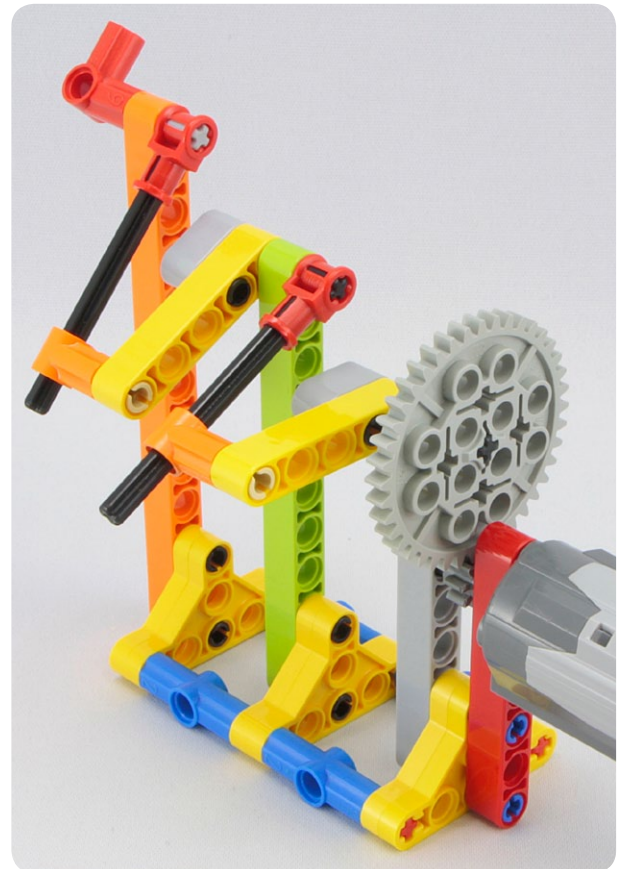
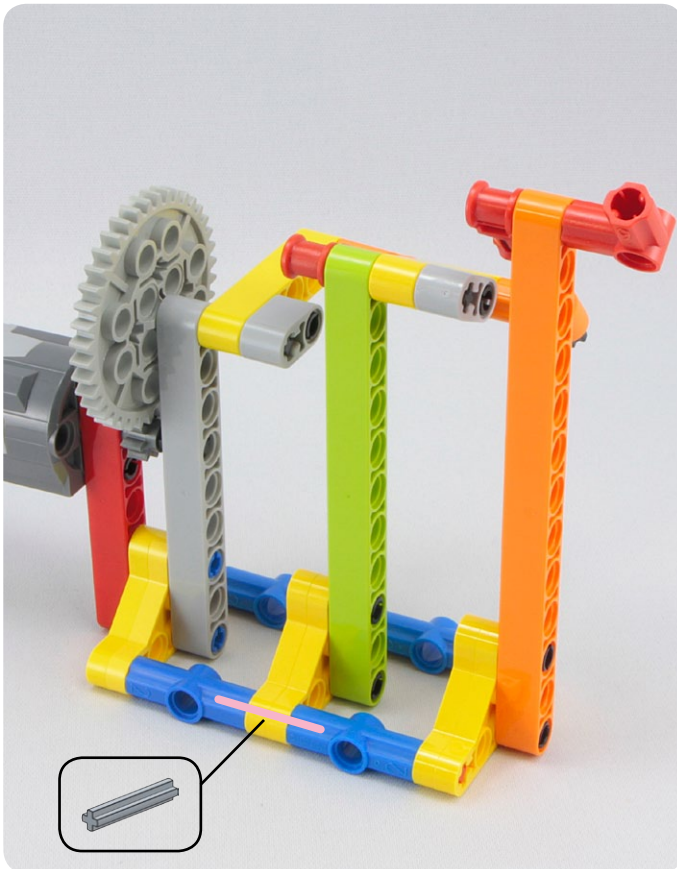
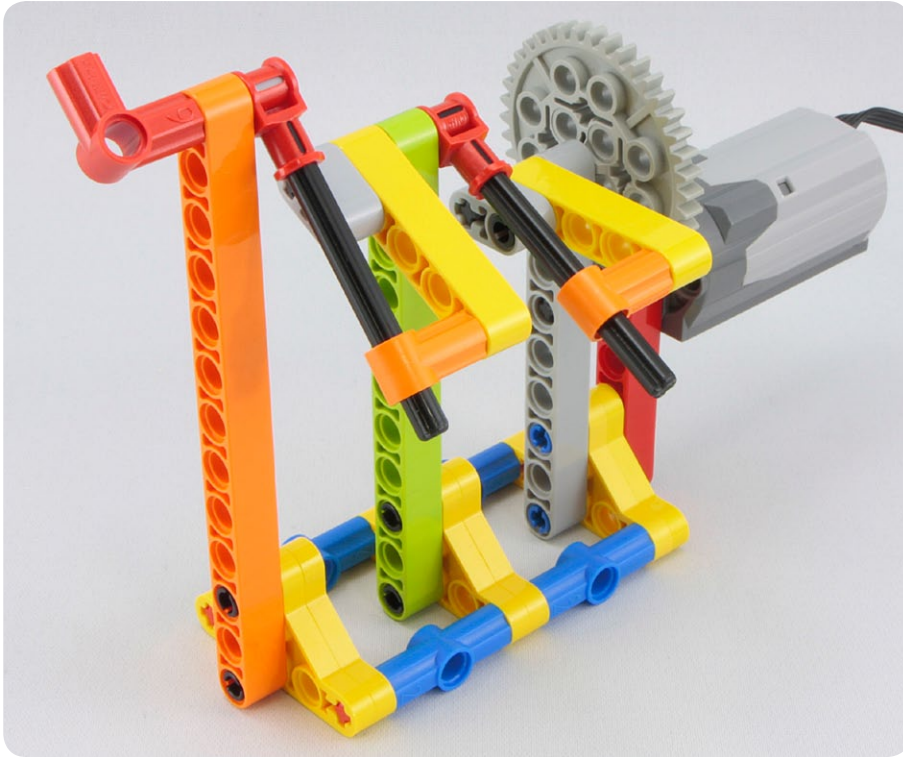


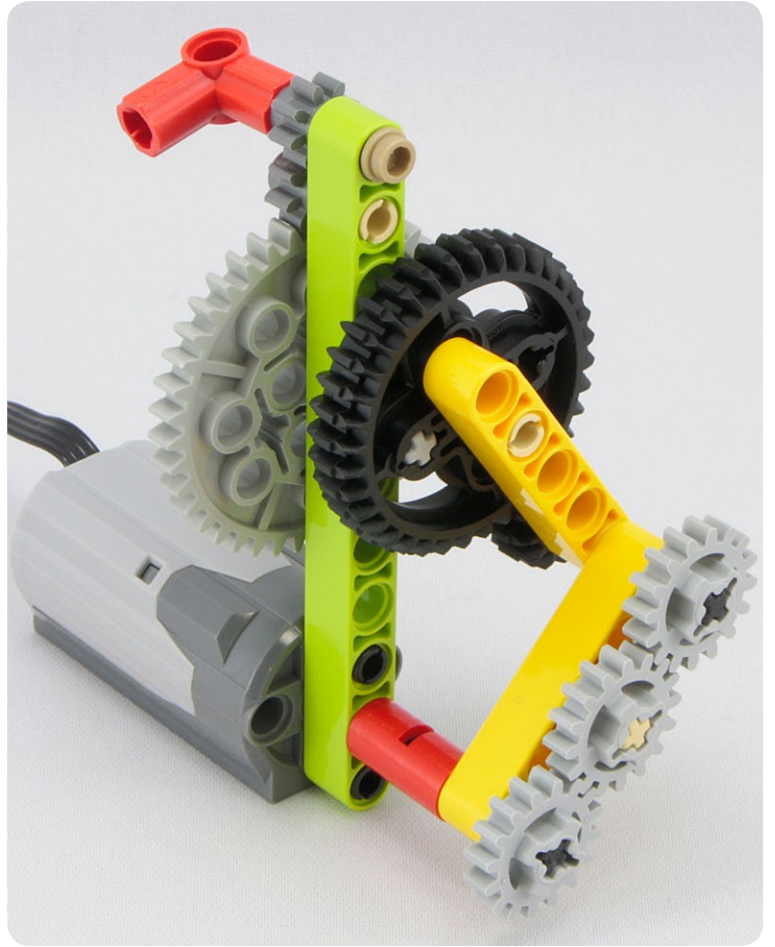


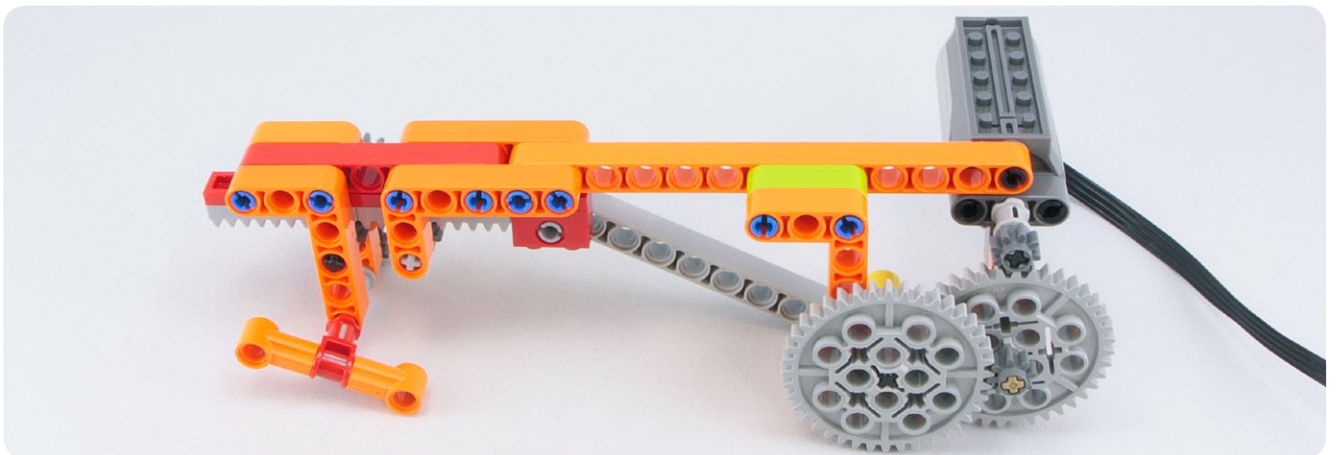
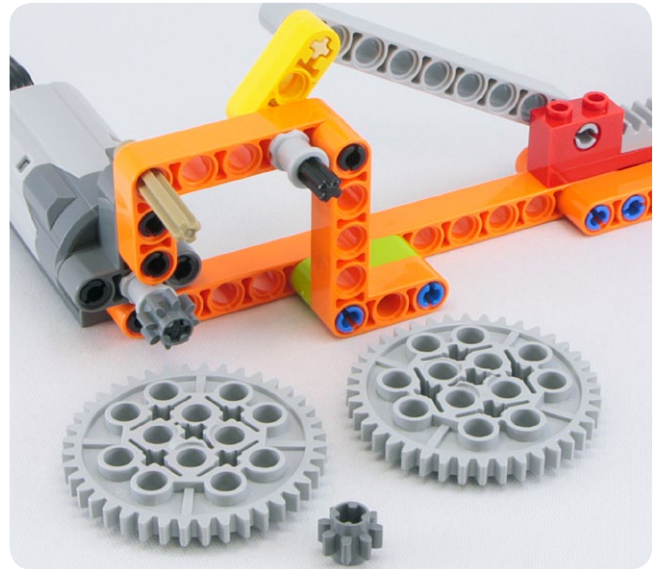
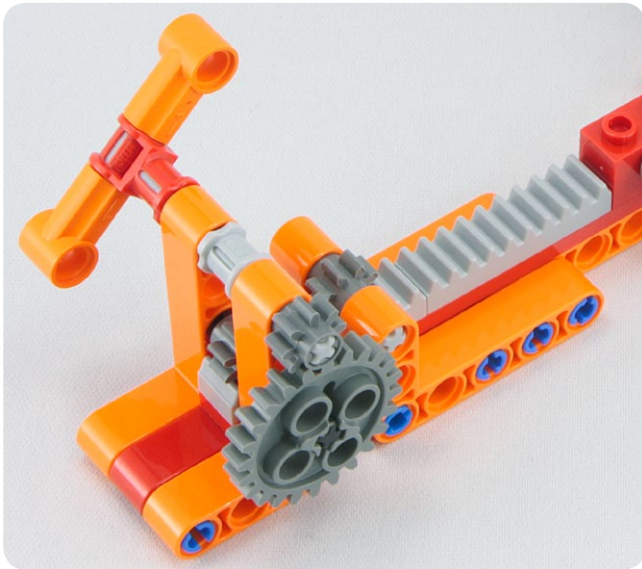
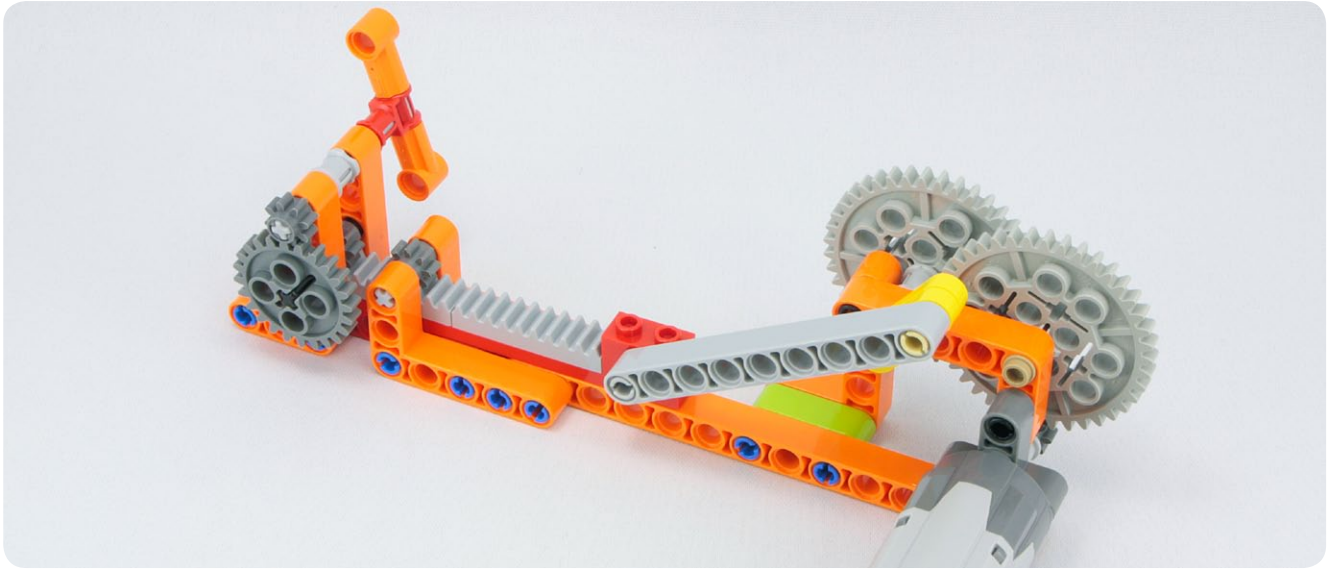
#120

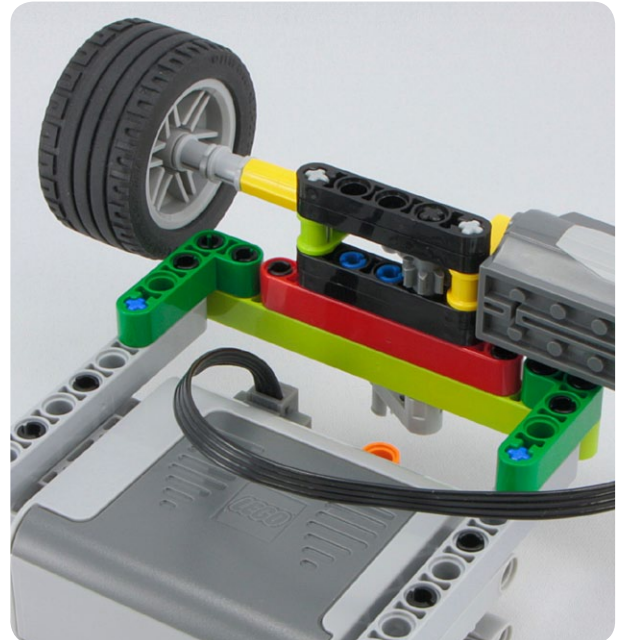
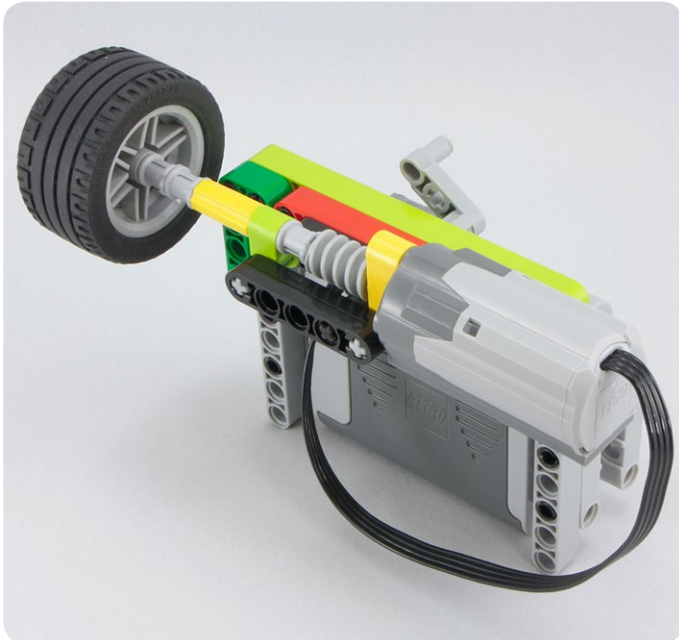
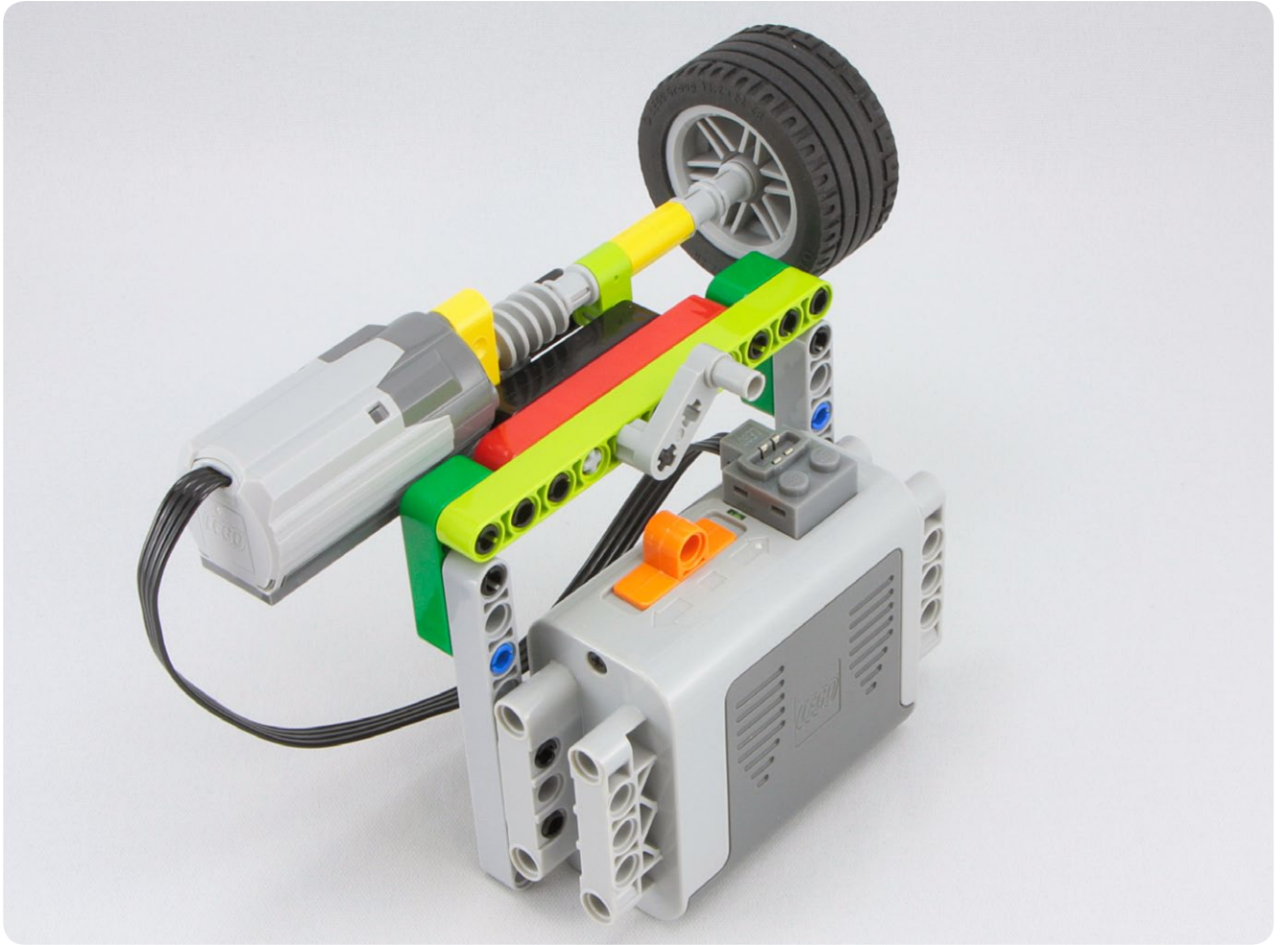
-
-
-
- x6
-
-
-
-
- x2
- x2
- x2
- x4
- x2
-
- x3
-
- x3
- x4
- x2
- x2
- x2
- x8




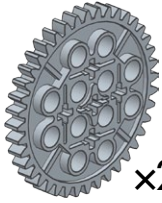




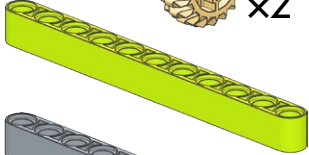

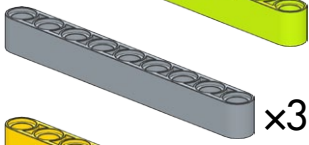
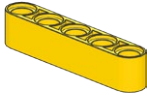
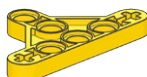
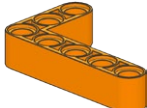
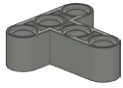
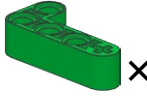






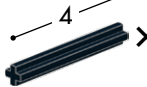

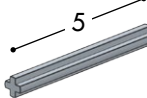
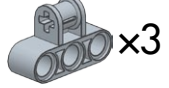
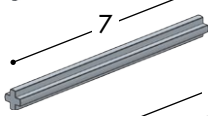
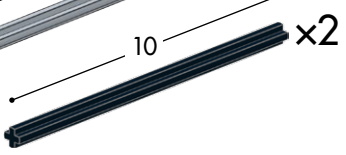







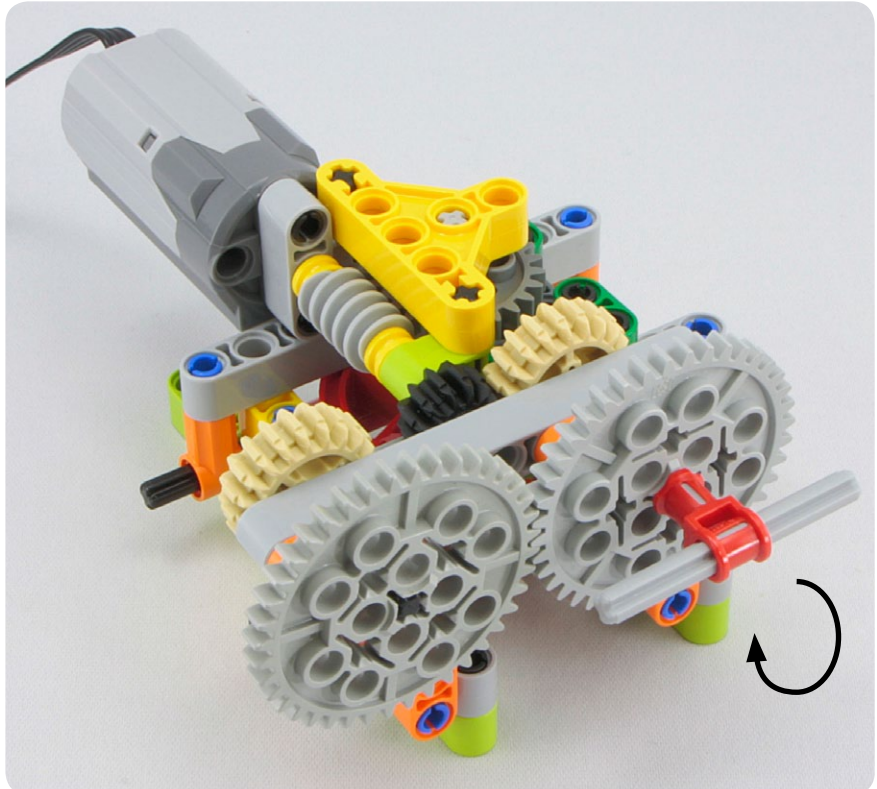
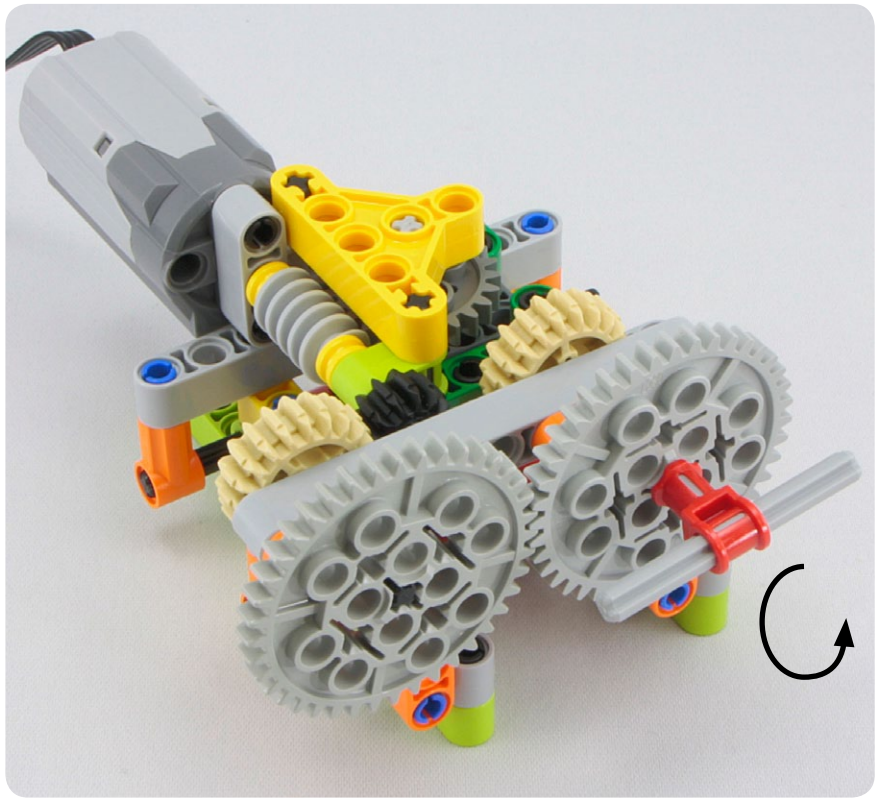


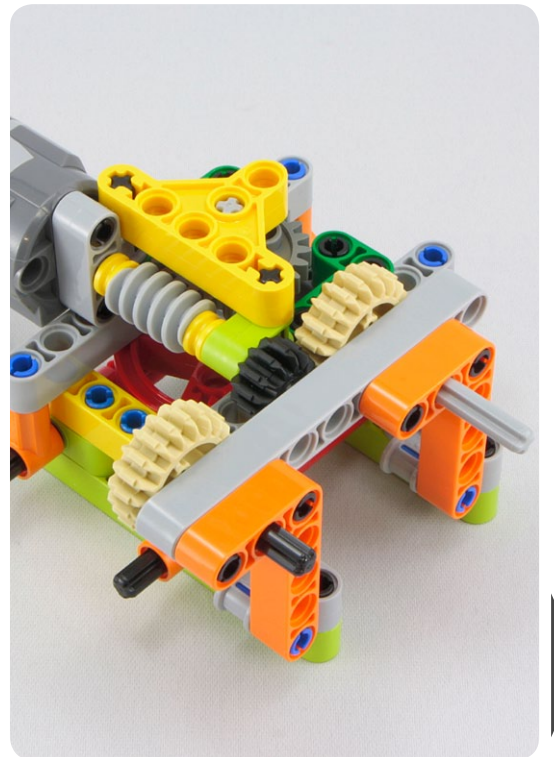
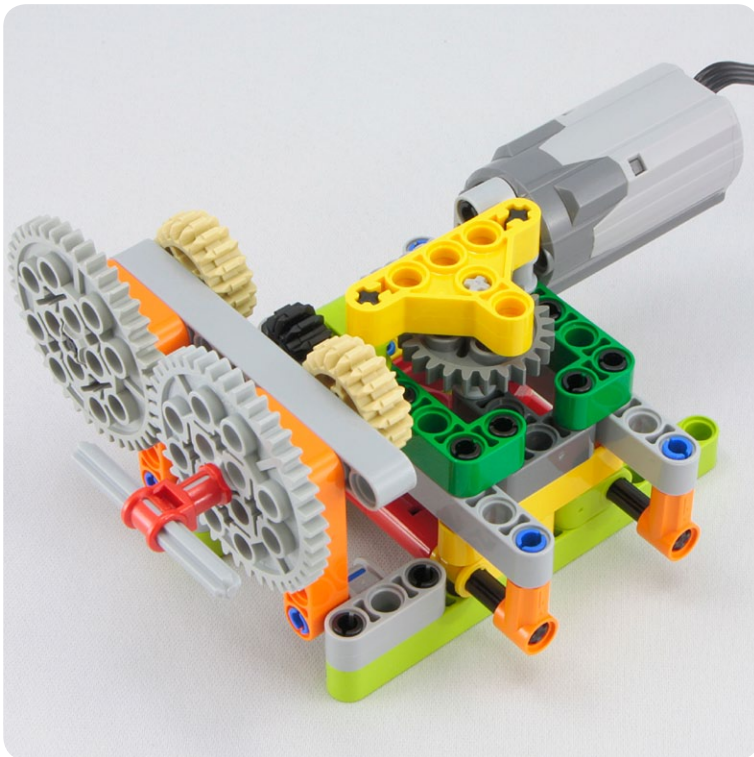
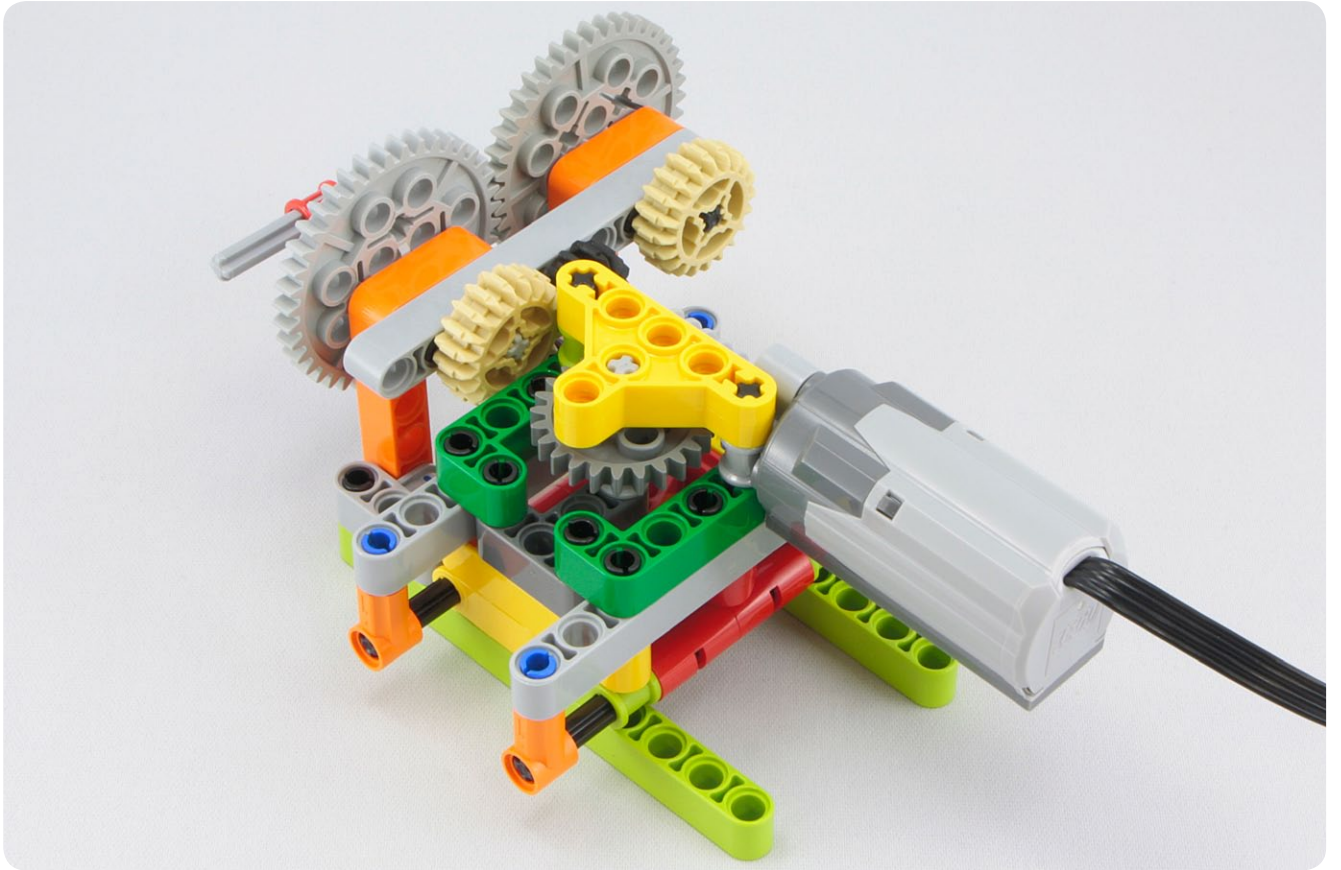


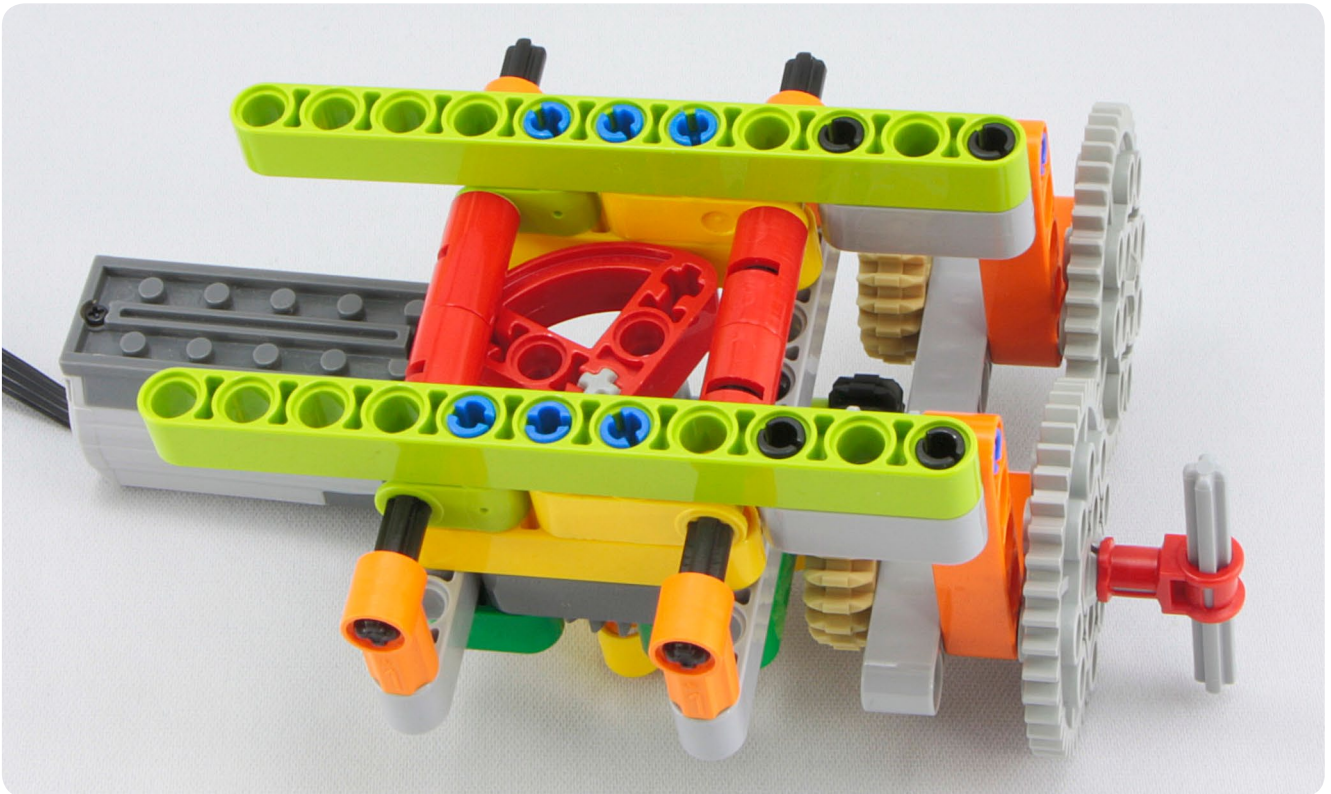
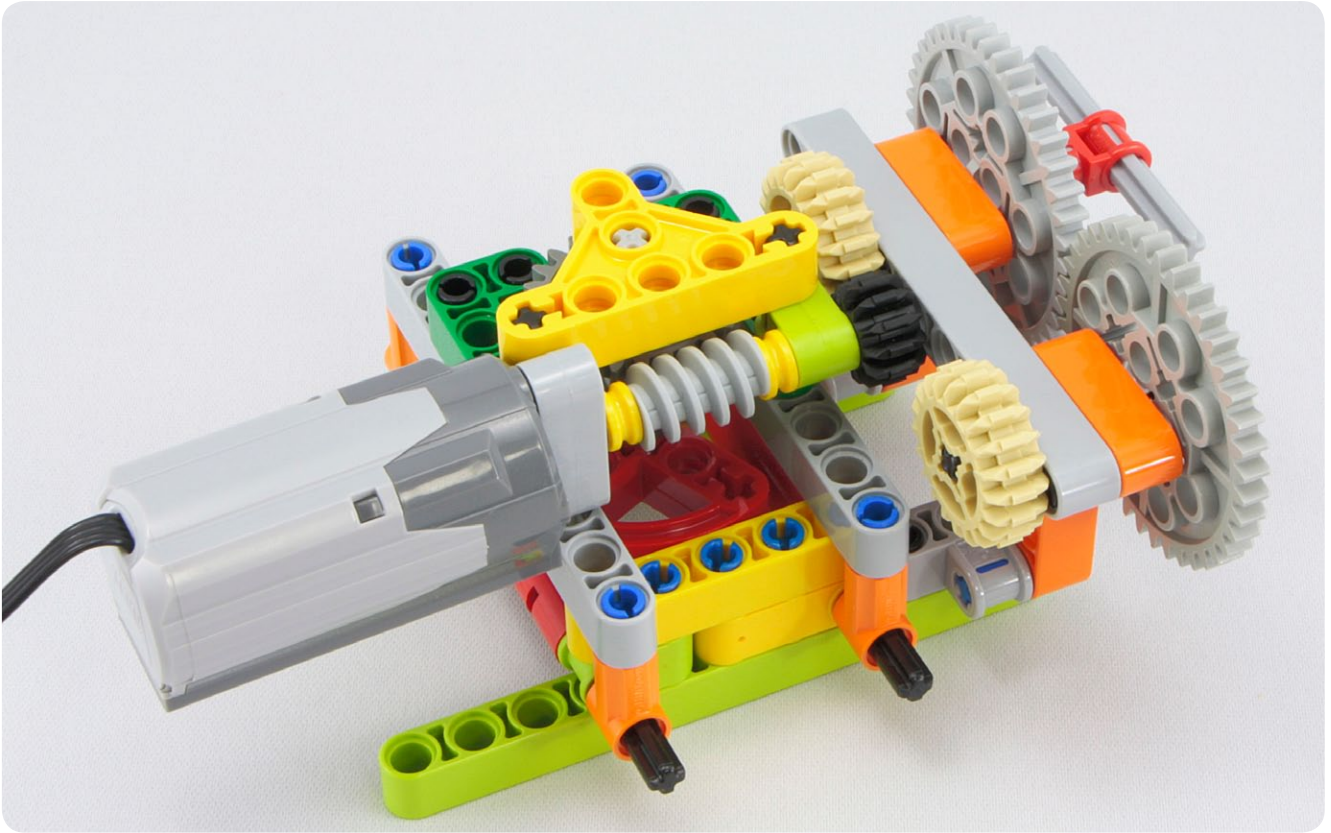


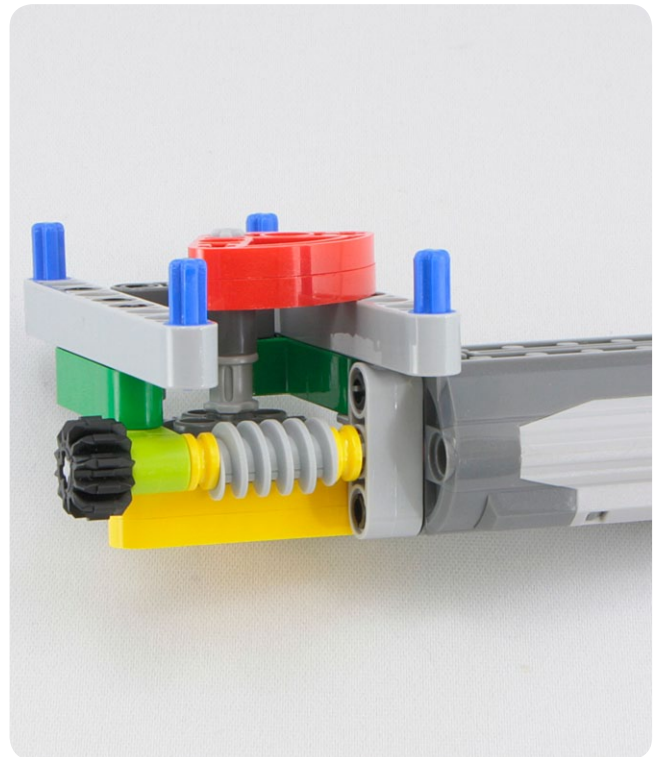
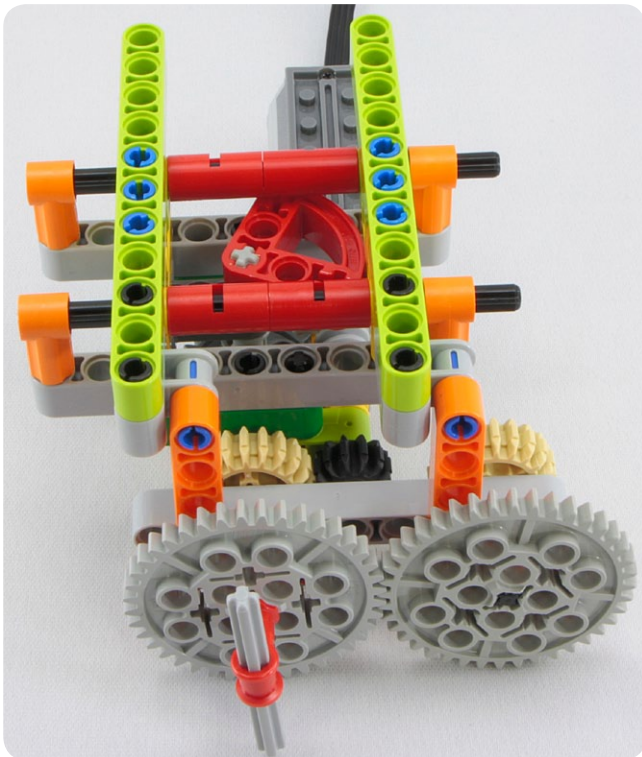
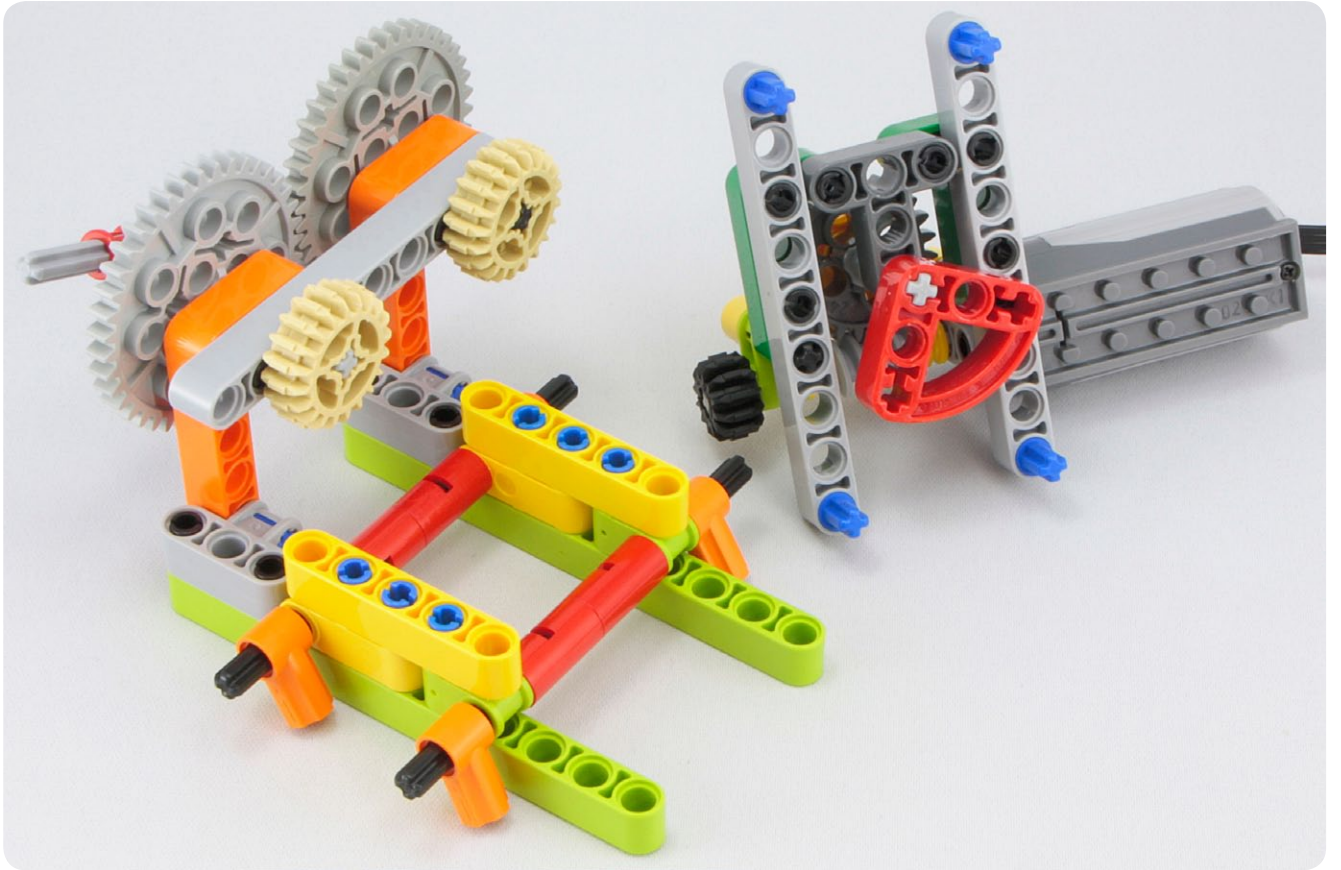
#124

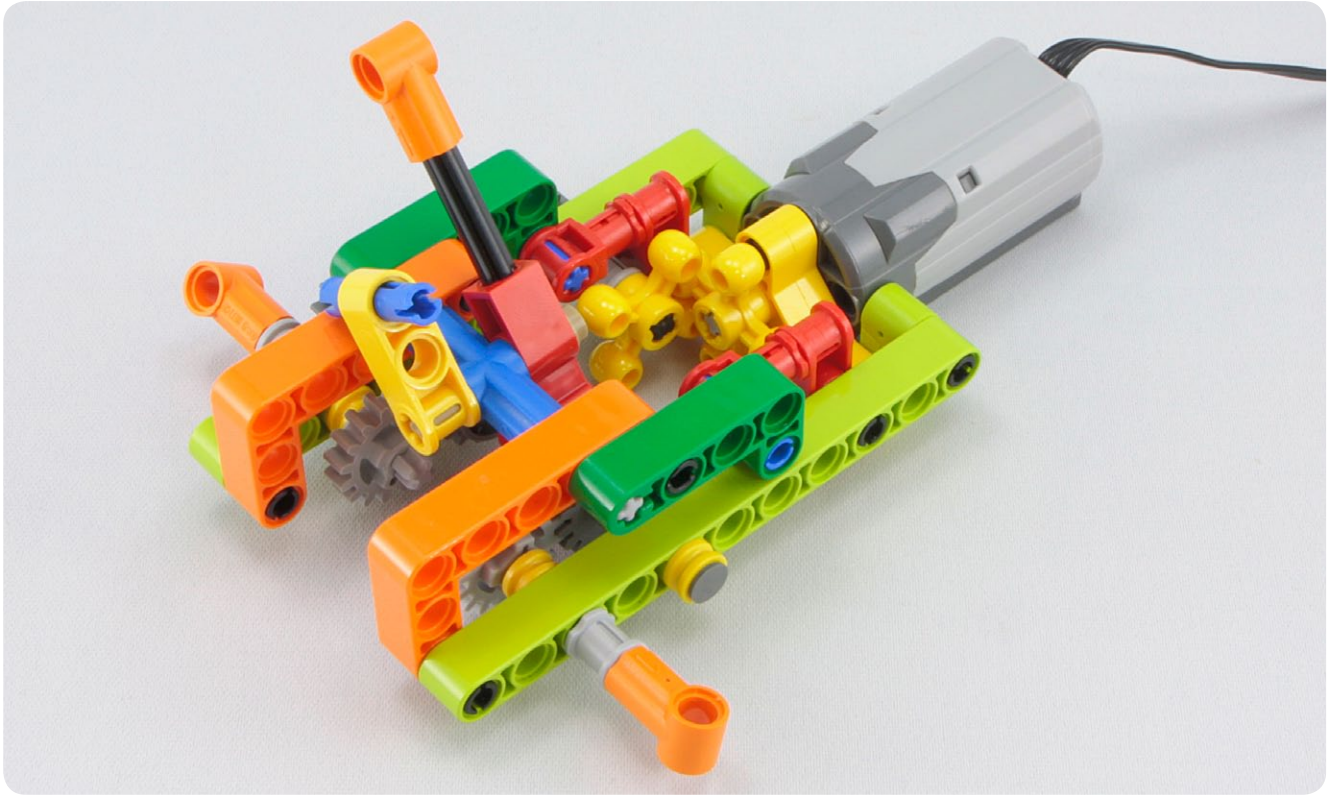
-   x2 
-   x2 
-  x2 
-  x3
-  x2  x2
-  x2 
-  x2  x2
-  x2  x3  x4
-   x4
-  x3  x4
-  x3  x3
-  x2  x2
-  x2  x6
-   x6  x16

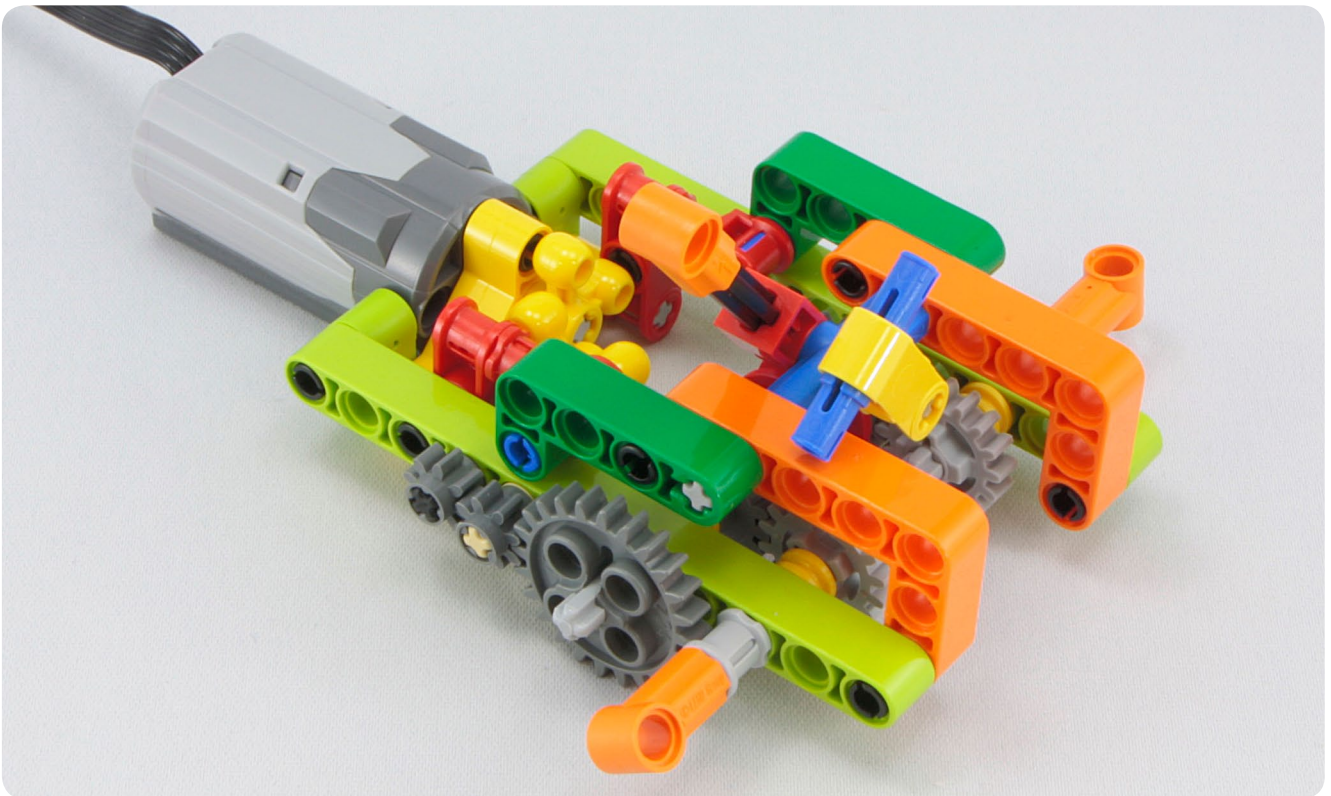
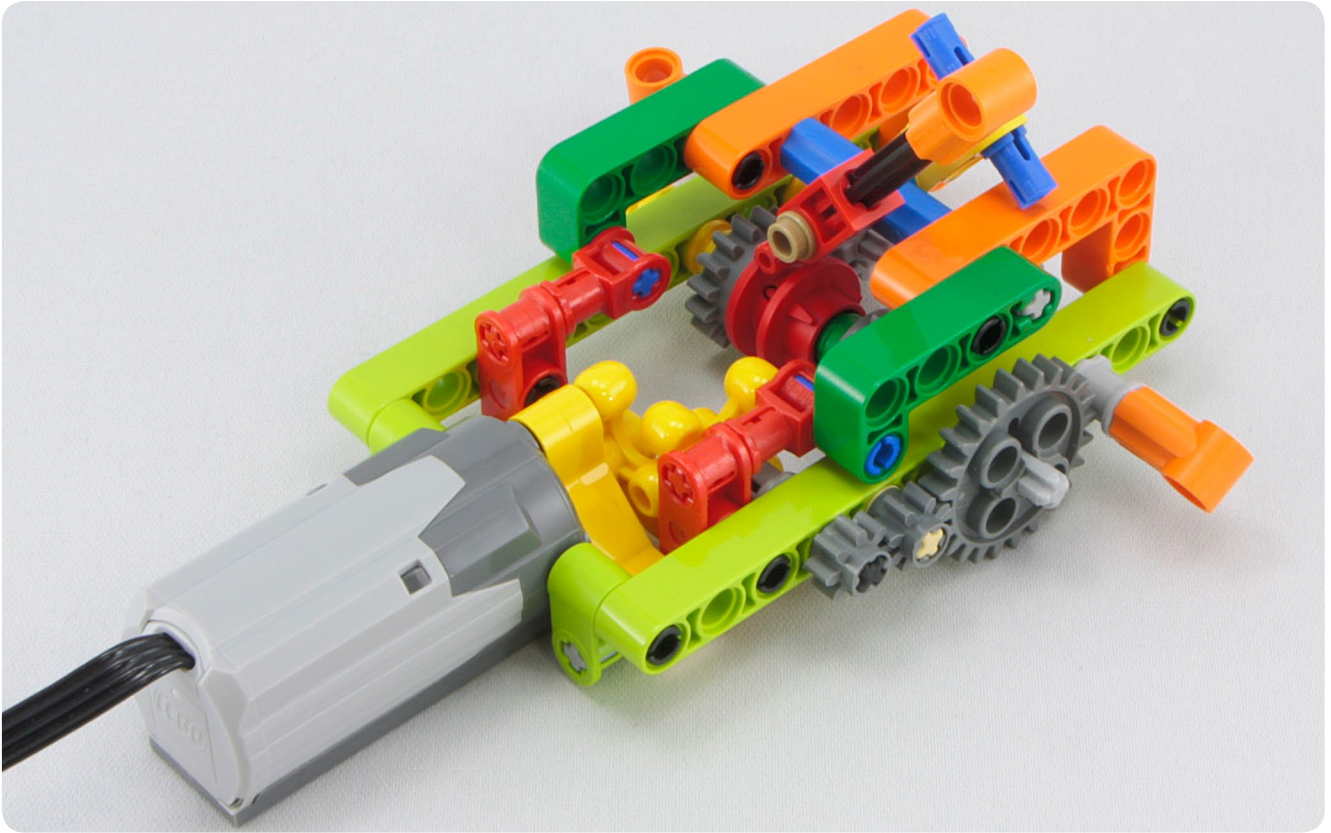


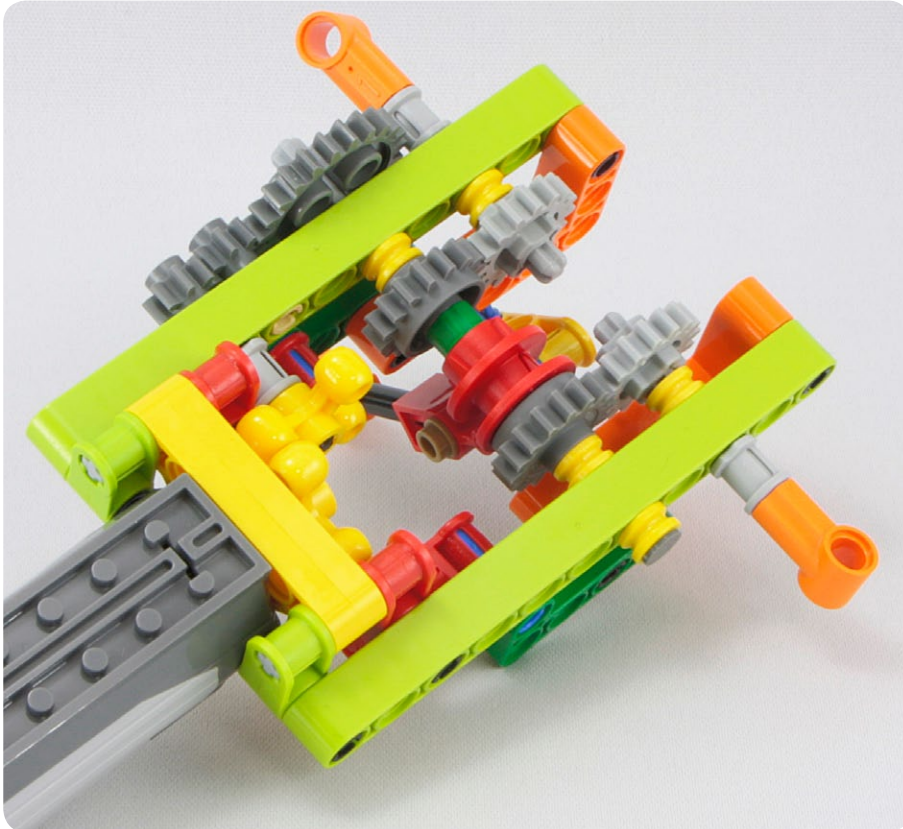
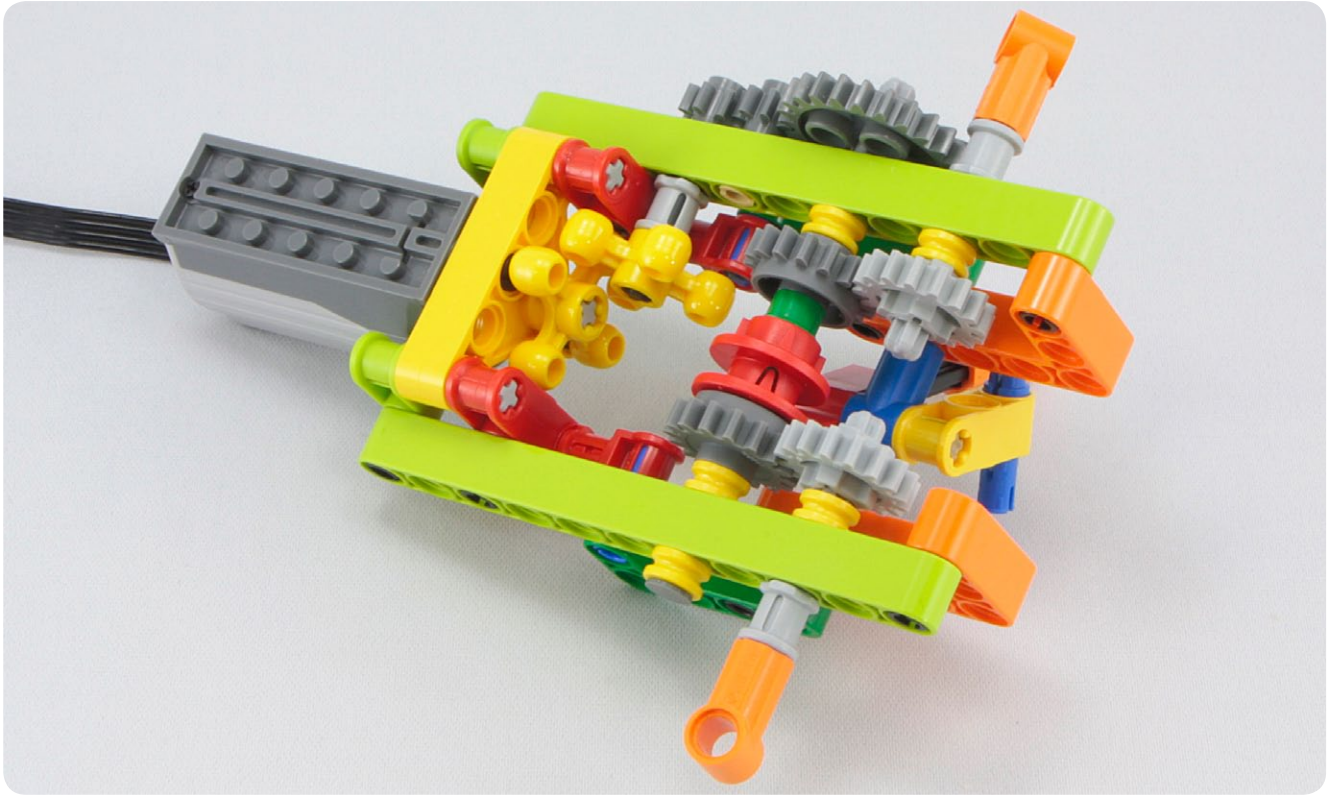




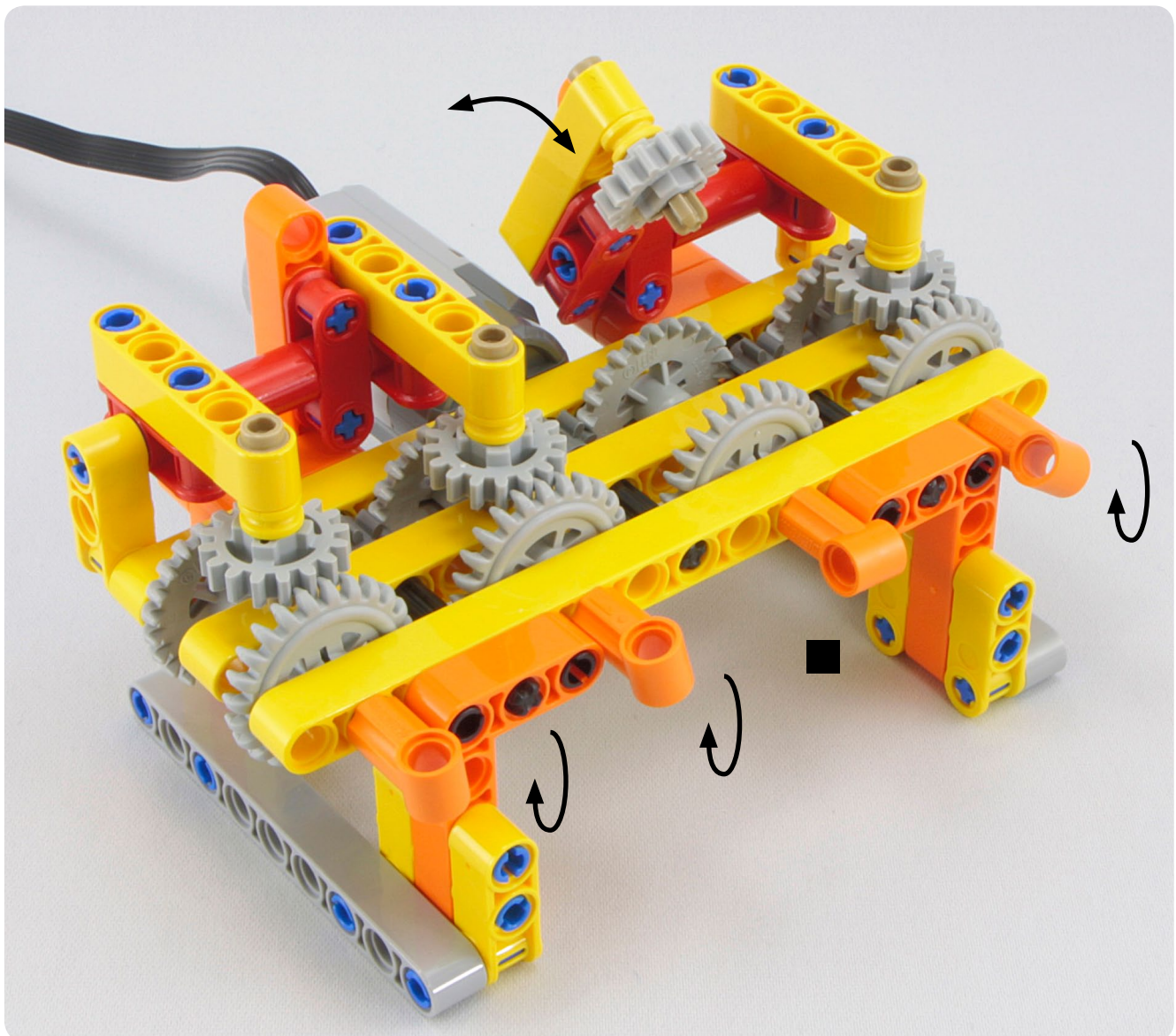
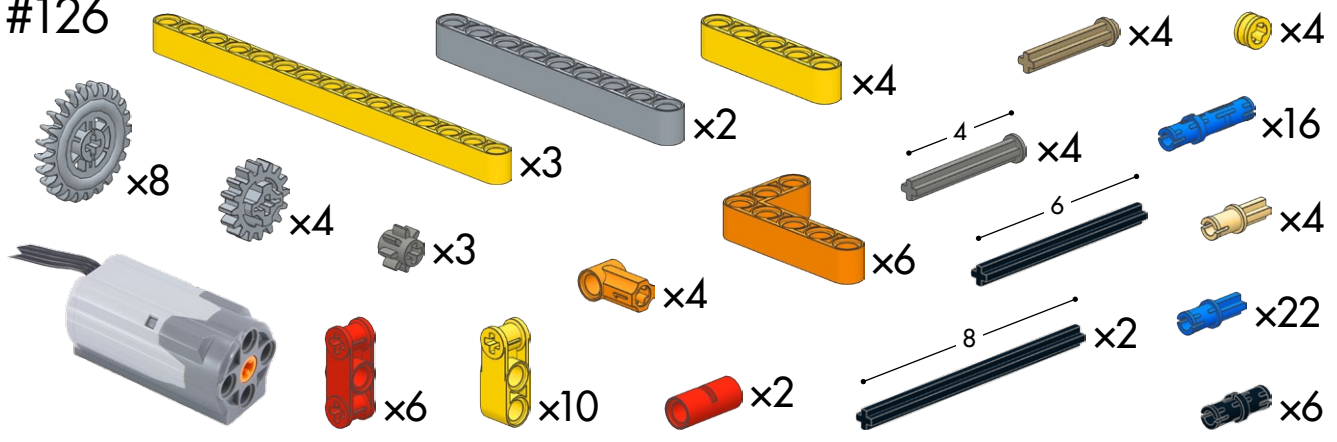


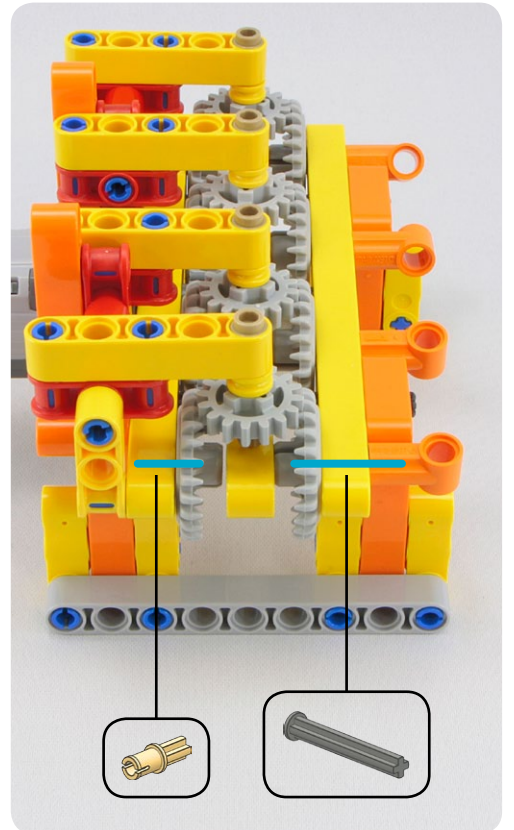
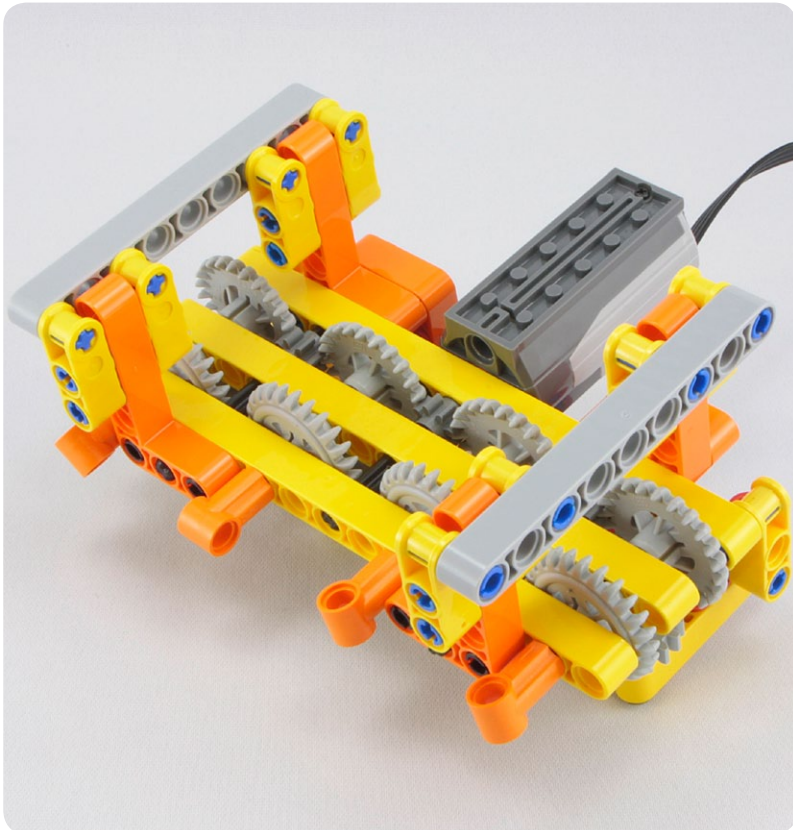
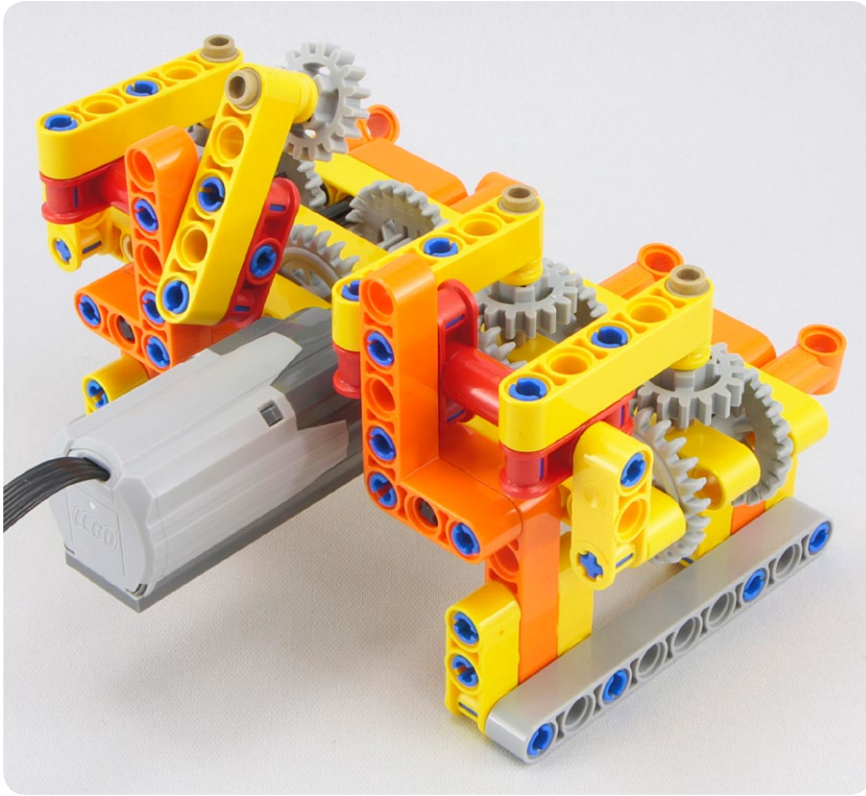








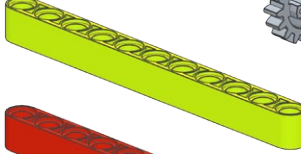

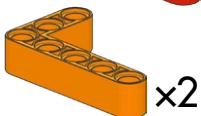
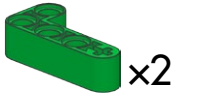

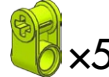



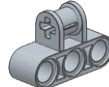




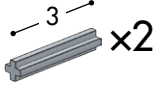



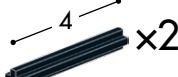








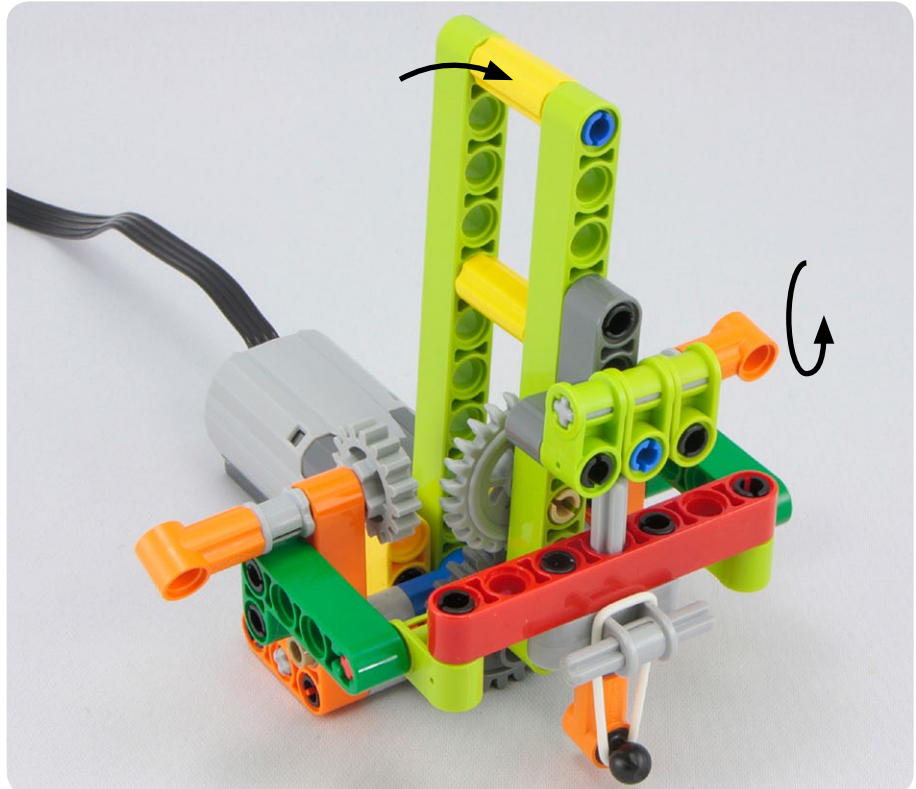
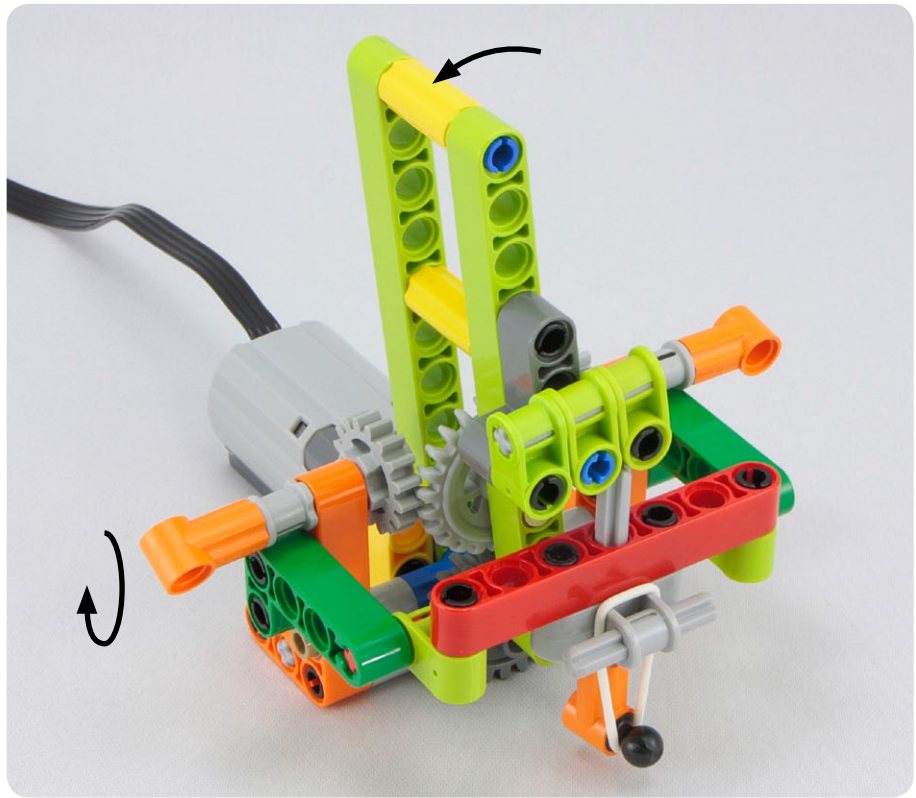
#126

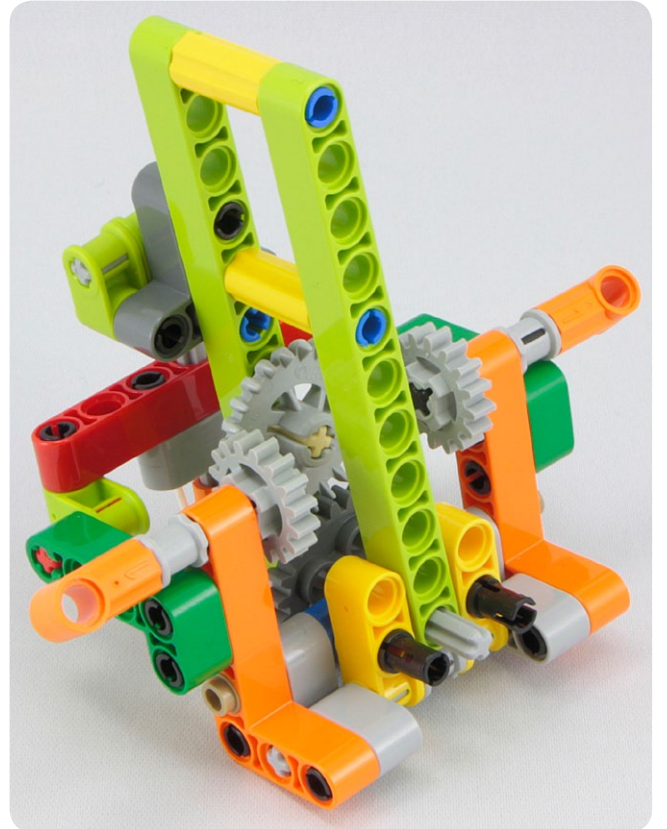
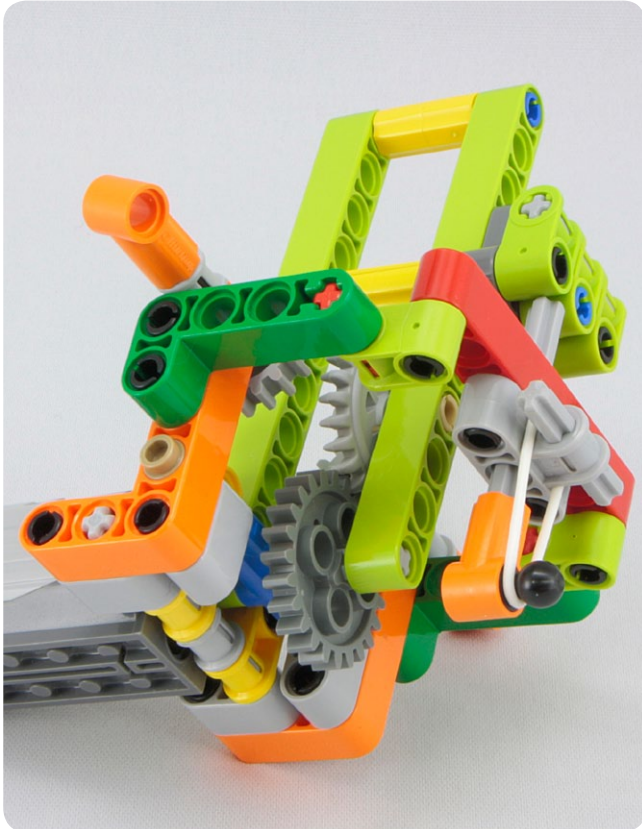
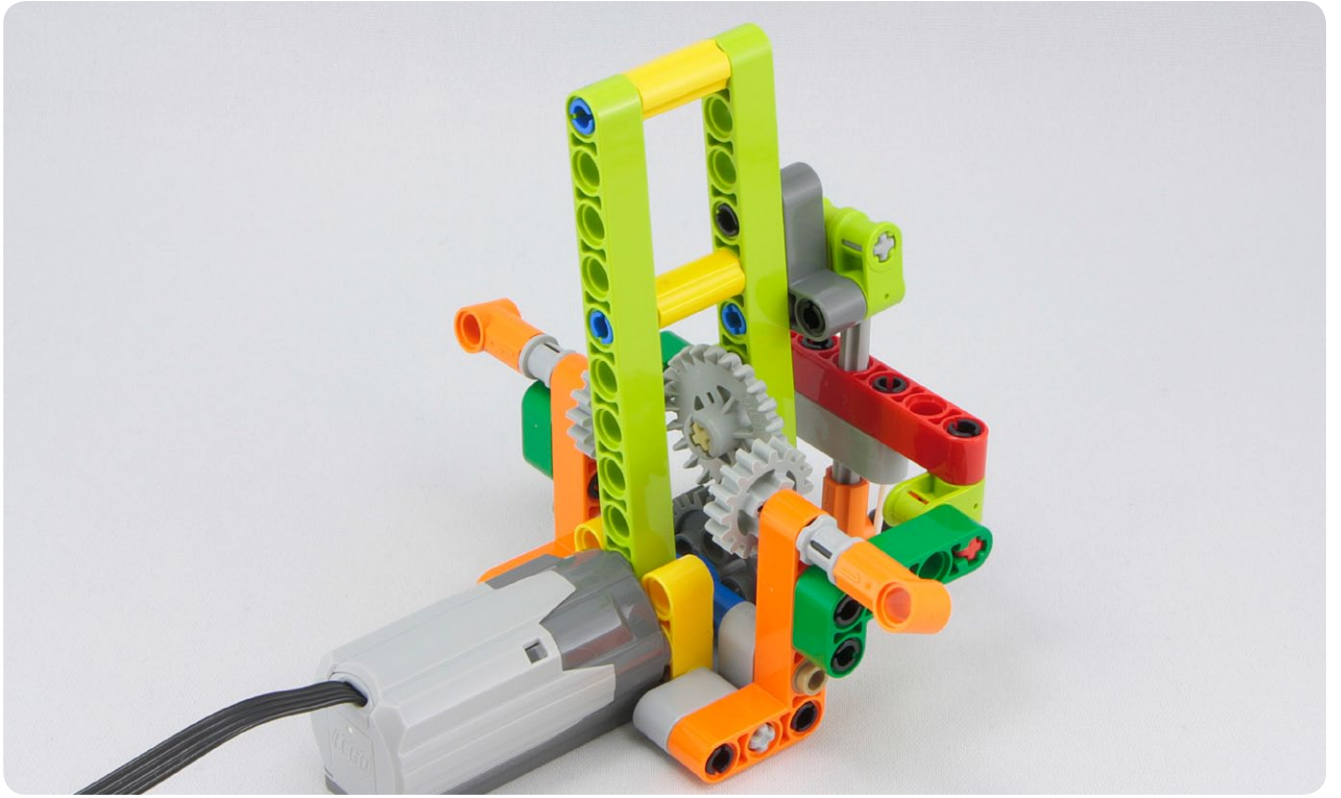


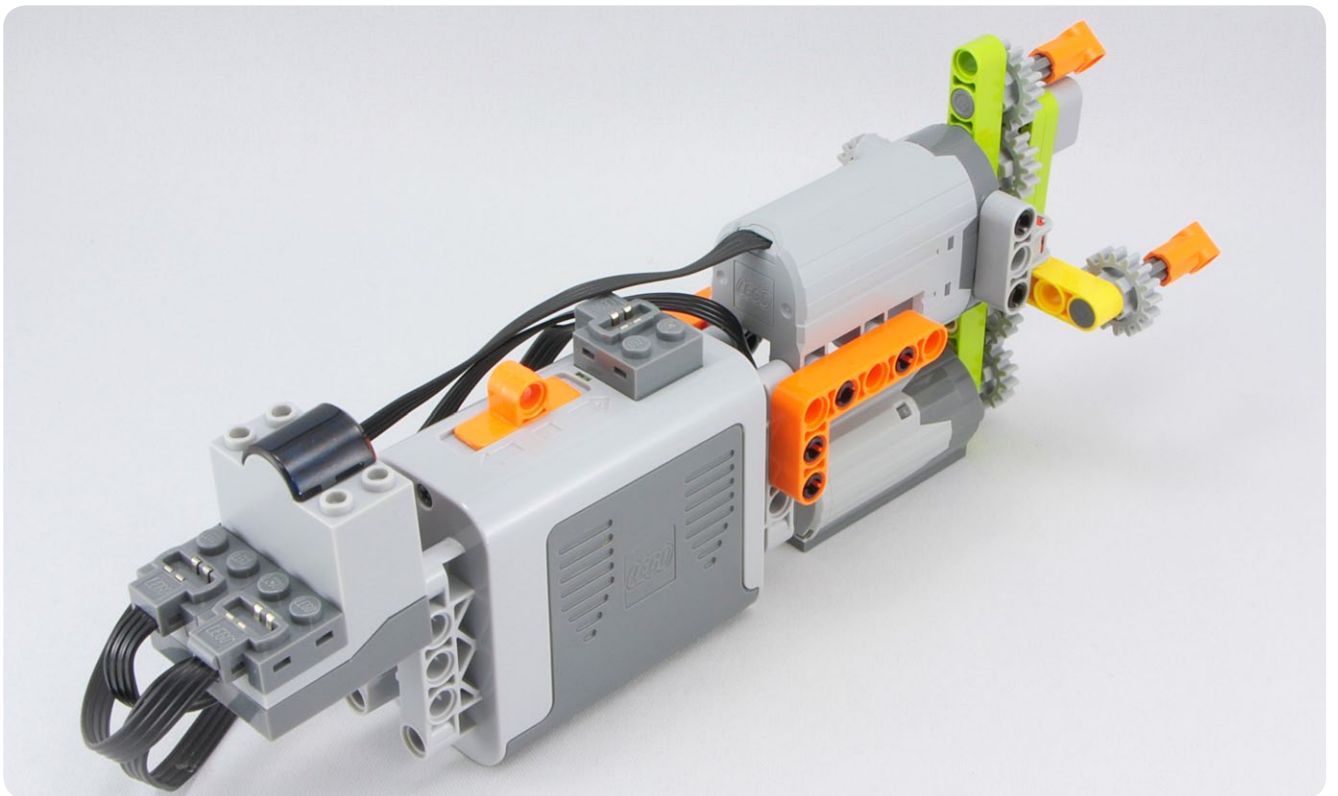
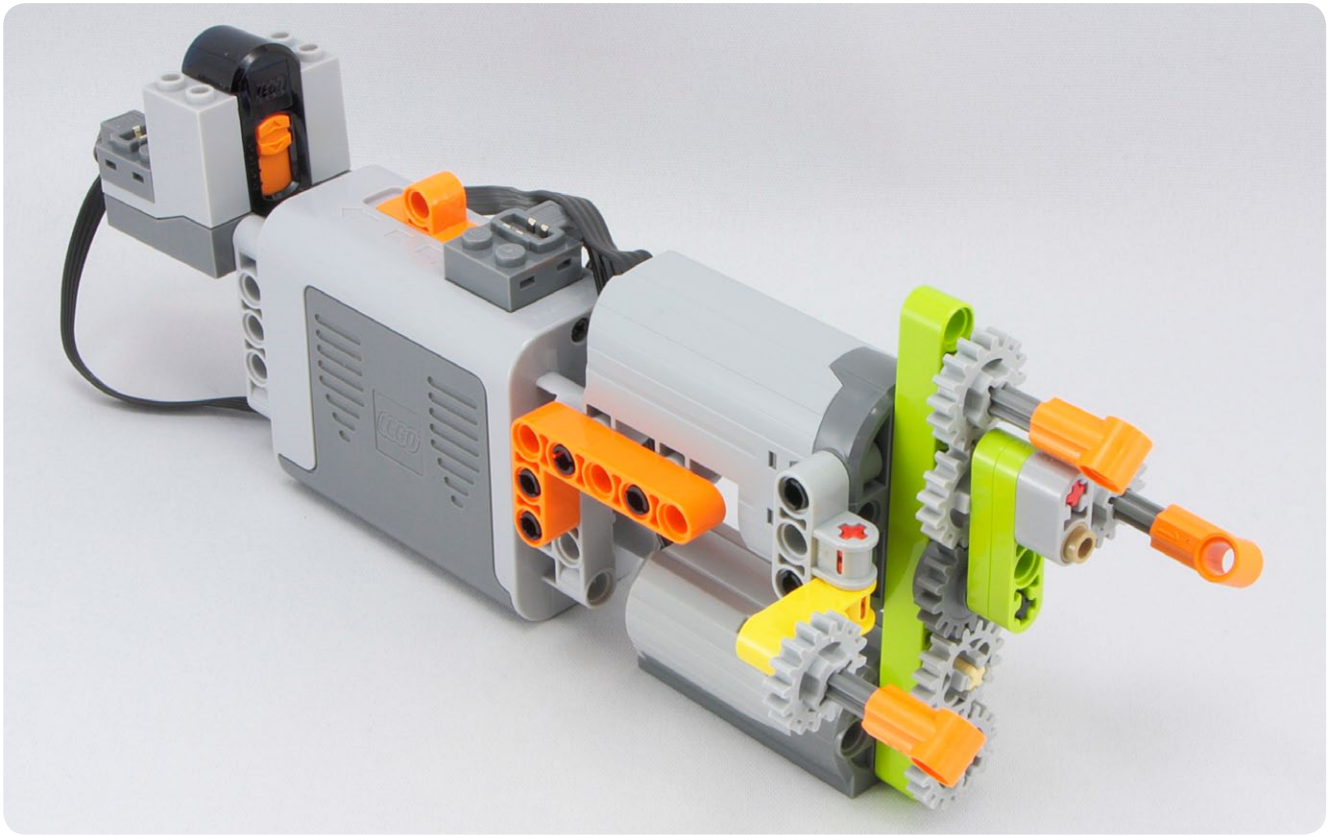


#127

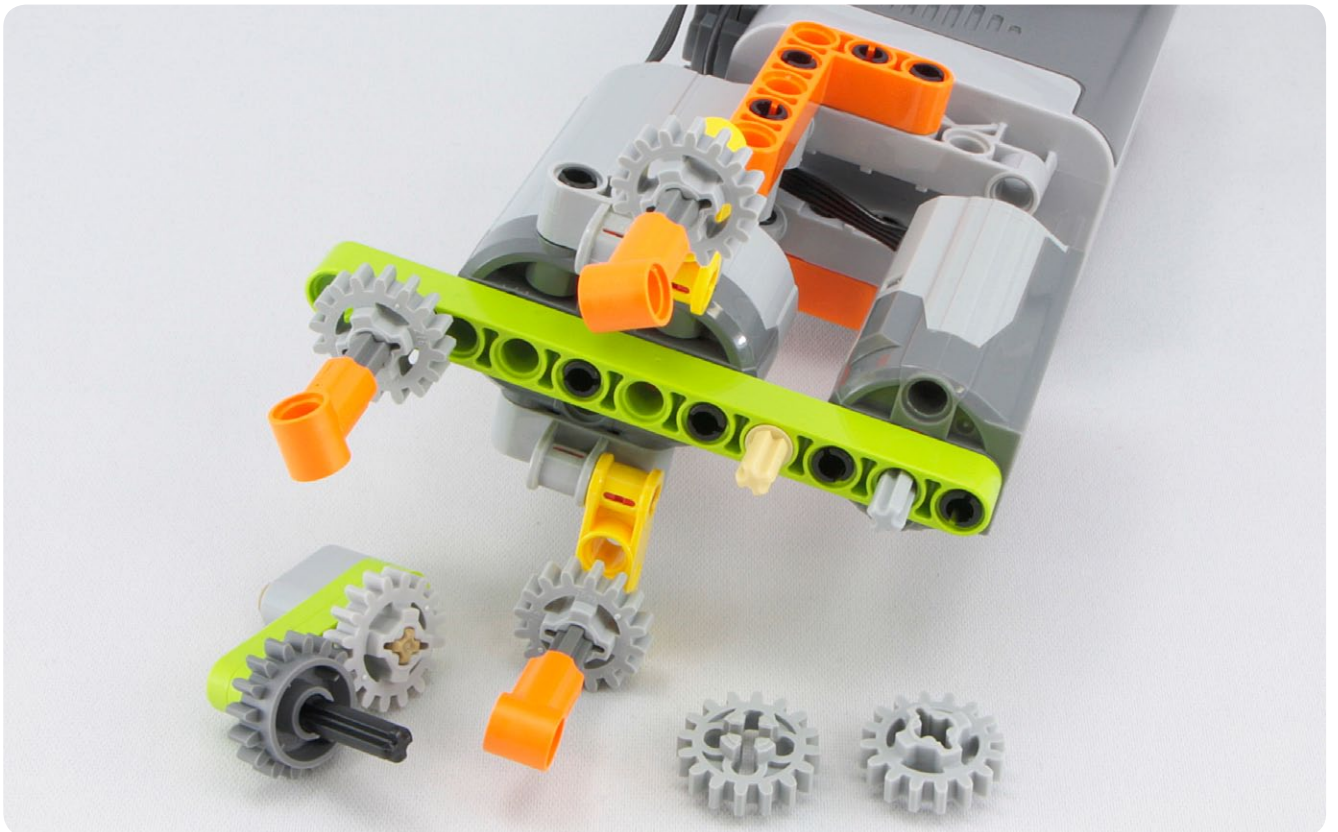
-  Motor
-  Gear 48
-  Gear 24
-  Gear 12 x2
-  Beam 1x12 yellow-green x2
-  Beam 1x6 red x2
-  Beam 1x3 orange x2
-  Beam 1x3 green x2
-  Beam 1x2 yellow x2
-  Beam 1x2 green x5
-  Bracket x4
-  Ring
-  Bracket
-  Bracket
-  Pin yellow x2
-  Pin orange x3
-  Pin red x2
-  Pin blue
-  Pin grey x2
-  Pin grey x3
-  Pin tan x2
-  Pin black
-  Pin black x2
-  Pin blue
-  Pin tan
-  Pin grey x2
-  Pin blue x4
-  Pin grey x2
-  Pin black x17

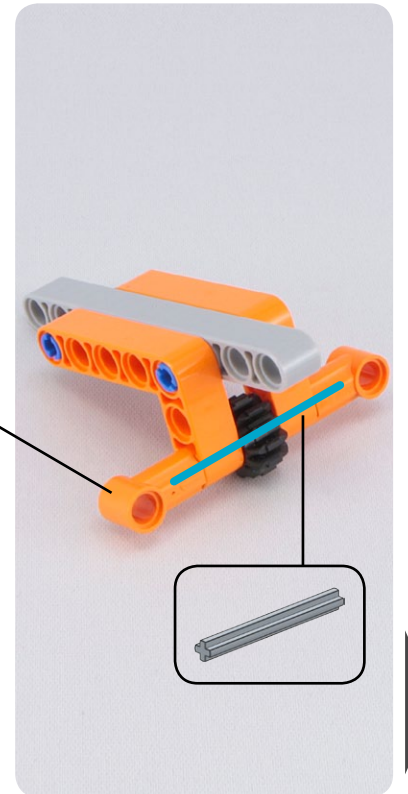
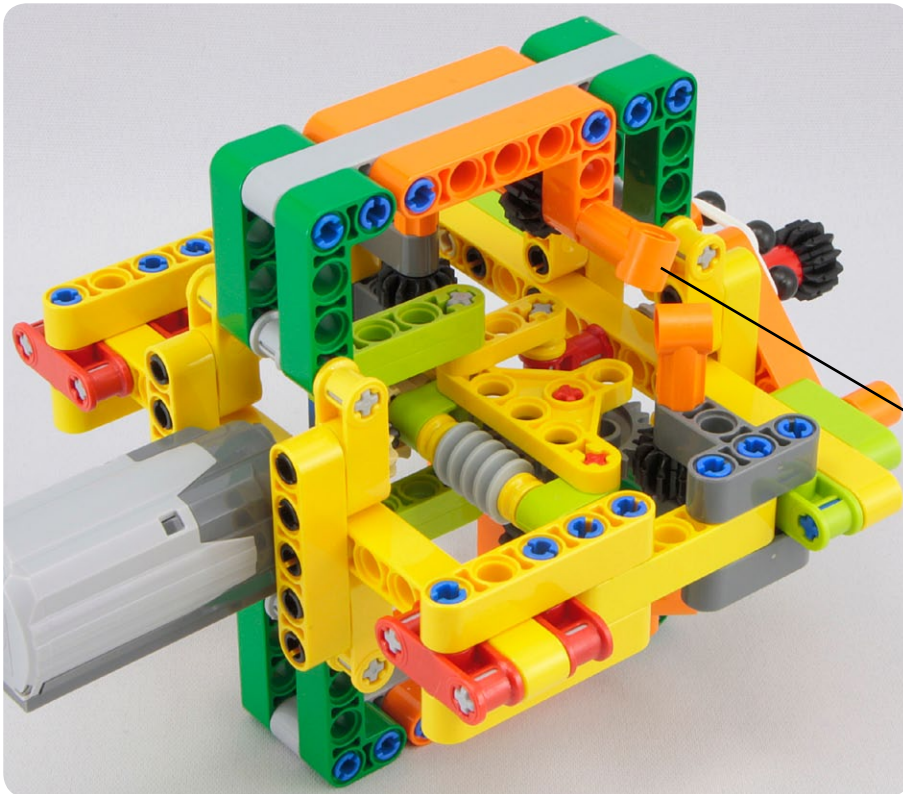
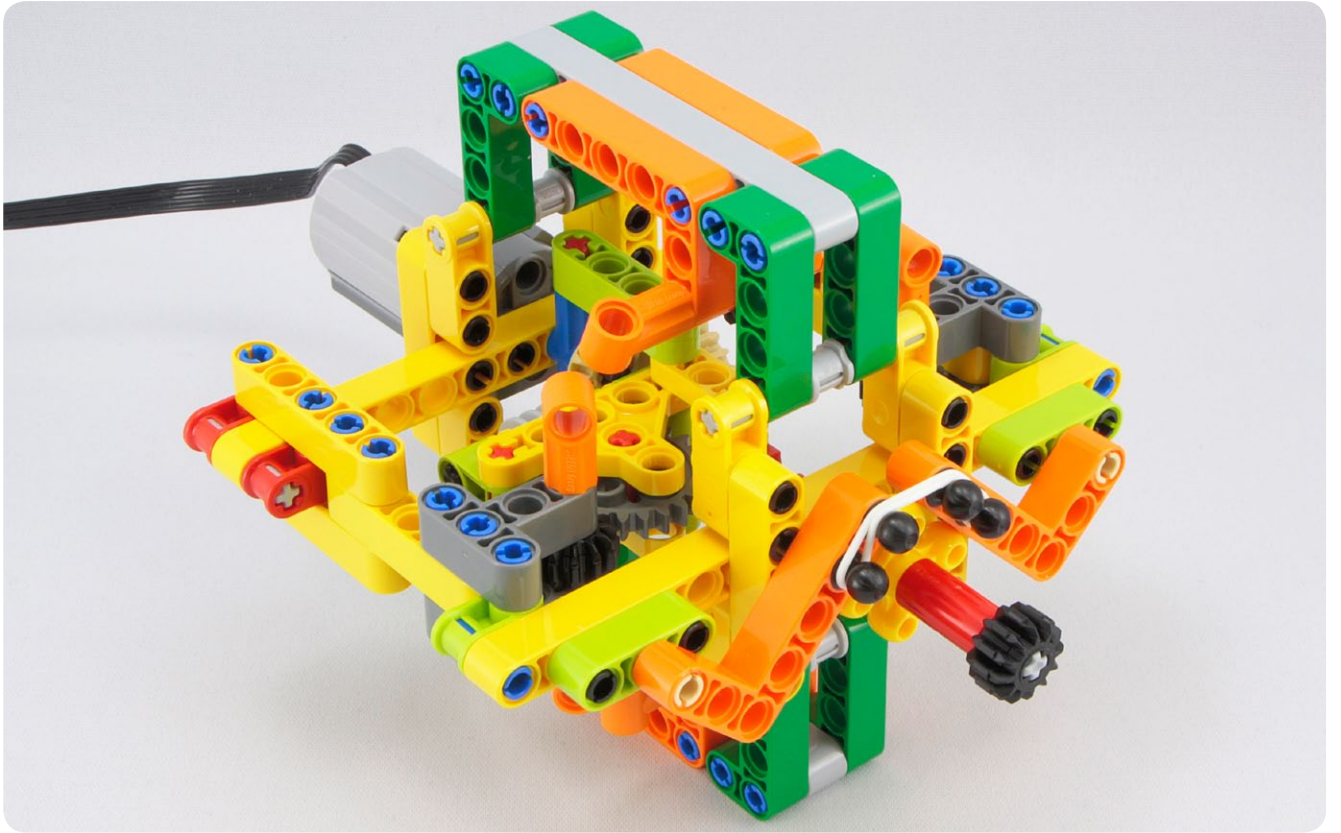


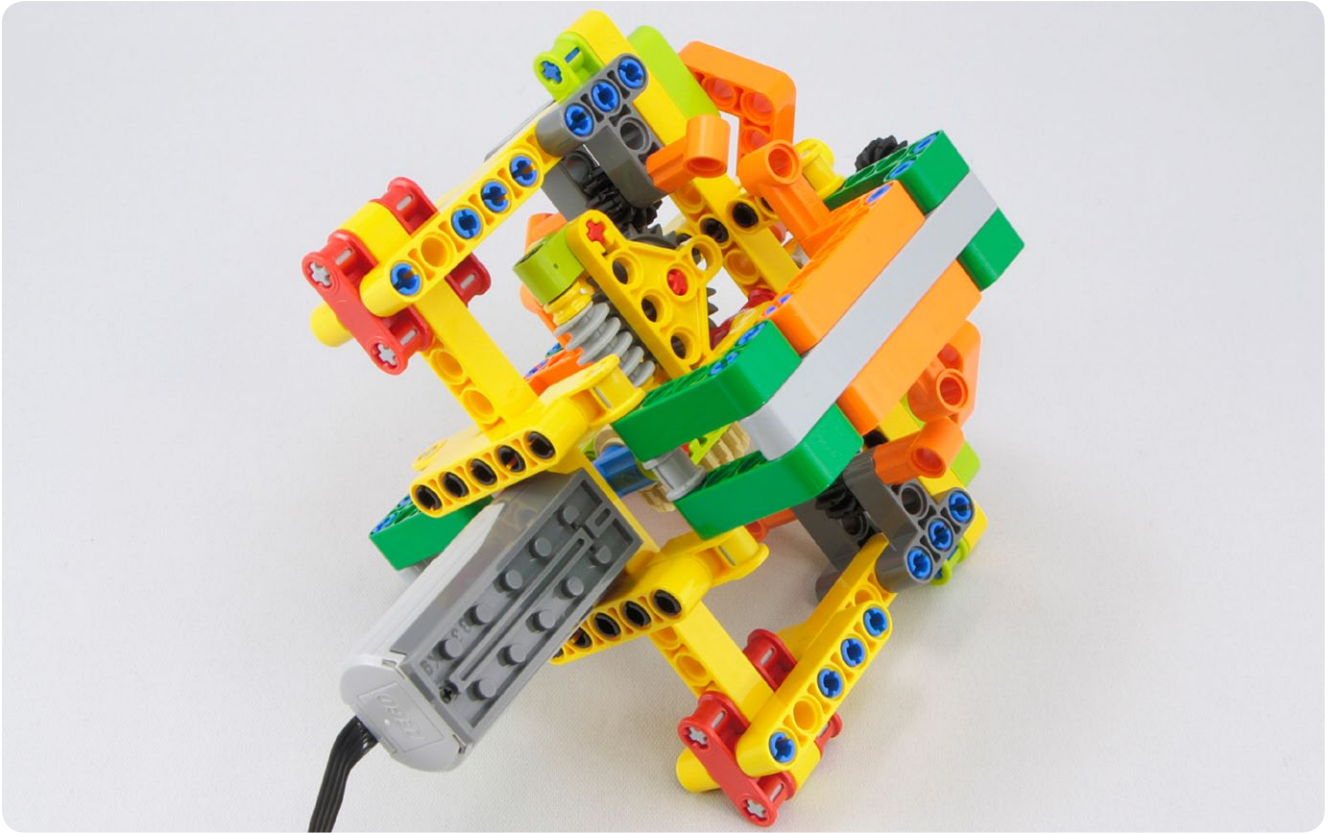


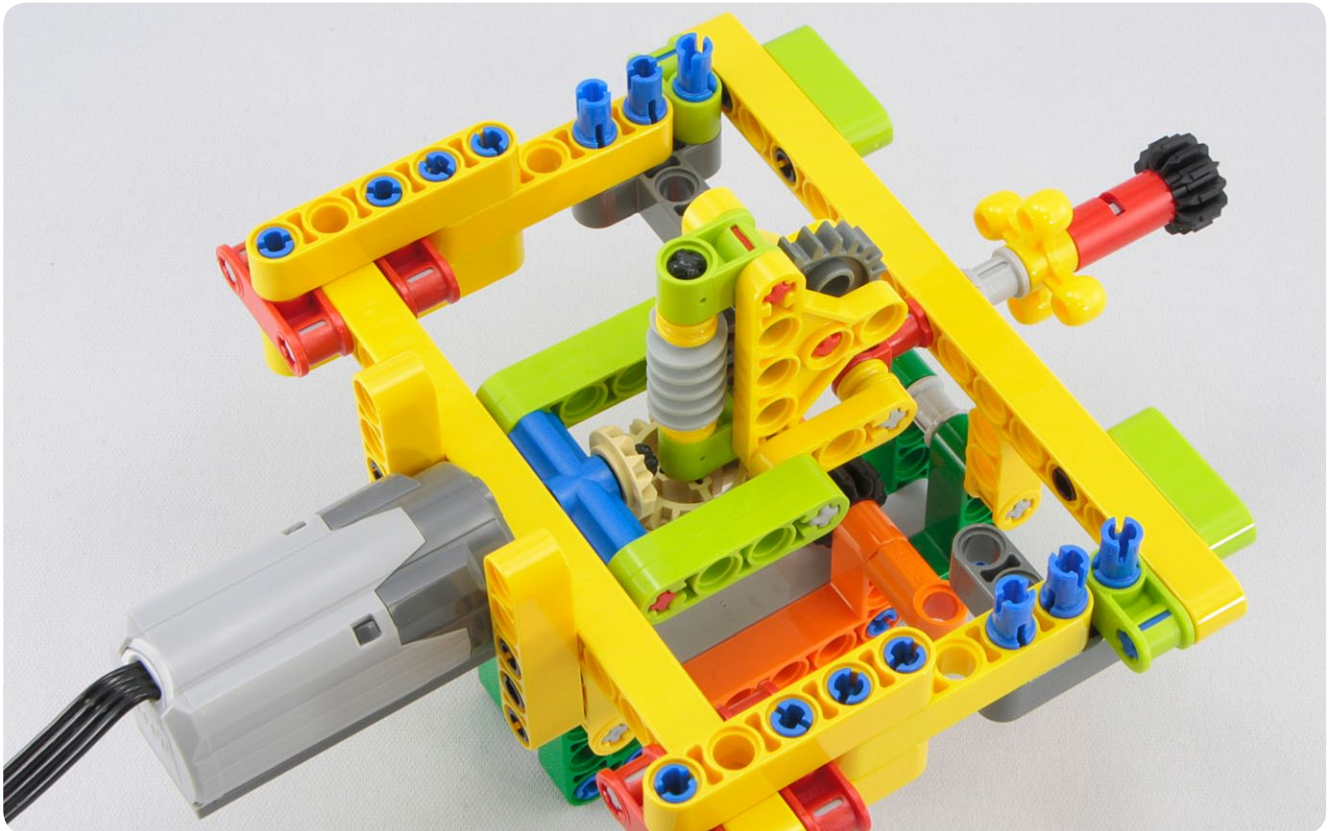
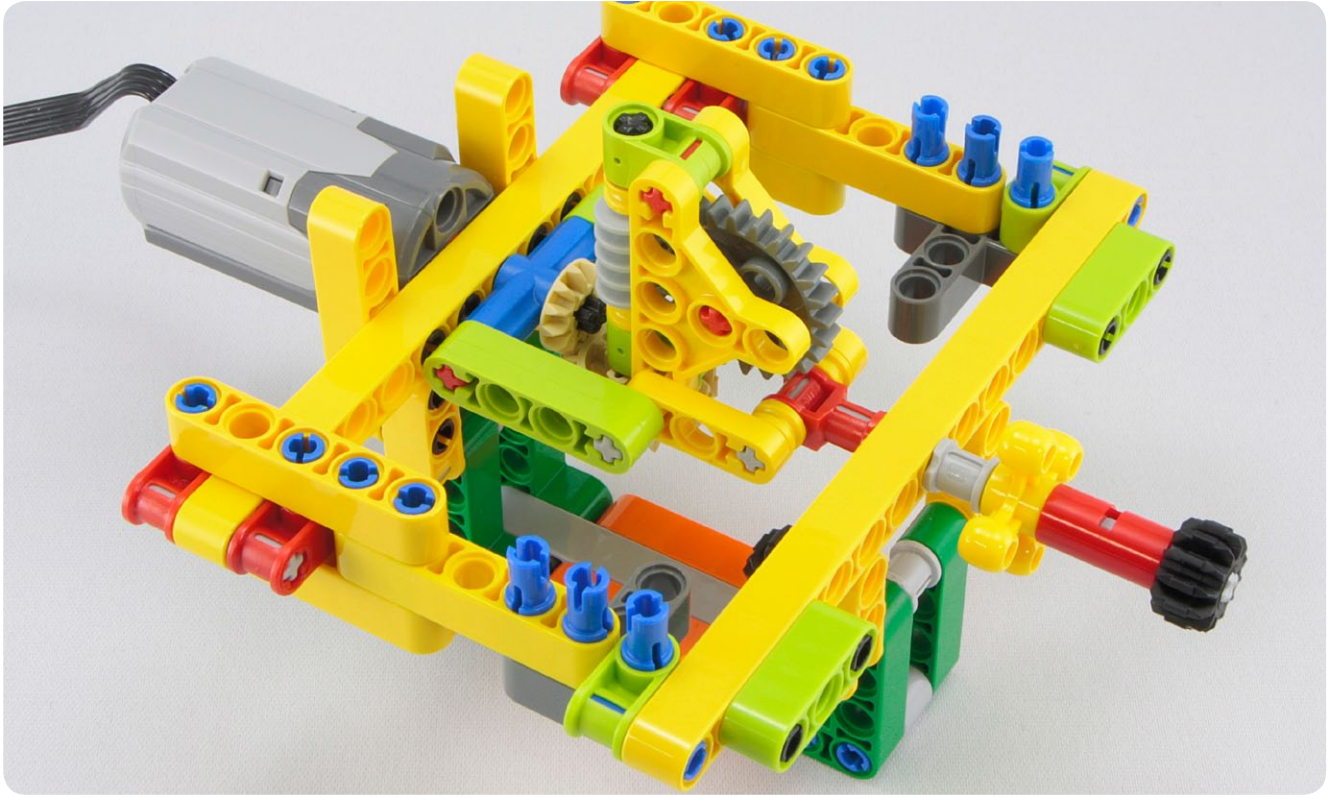


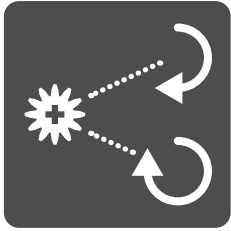






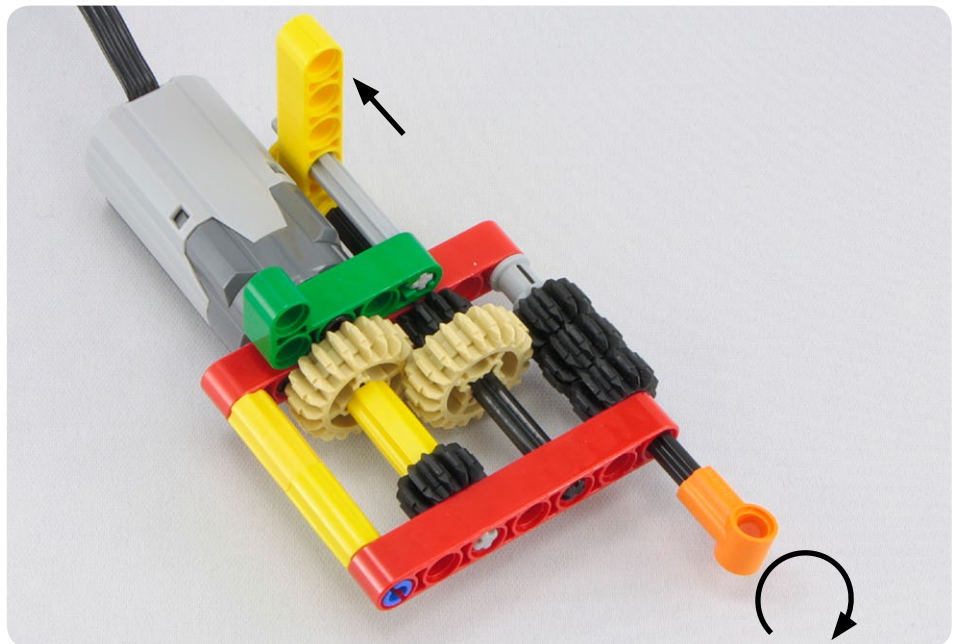
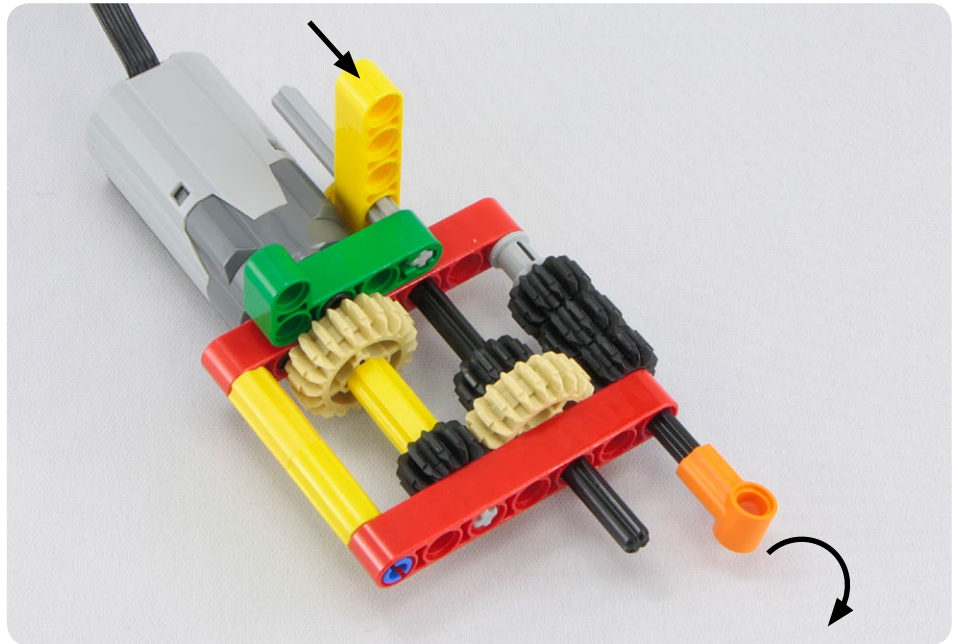
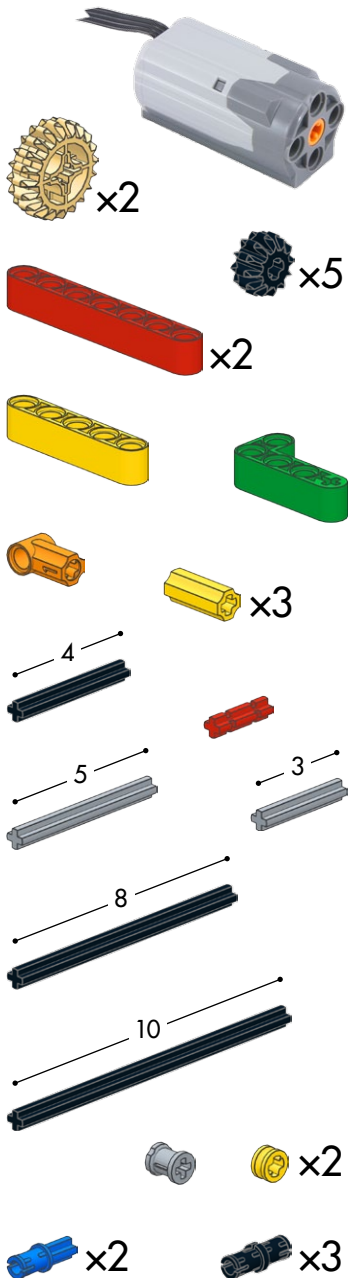


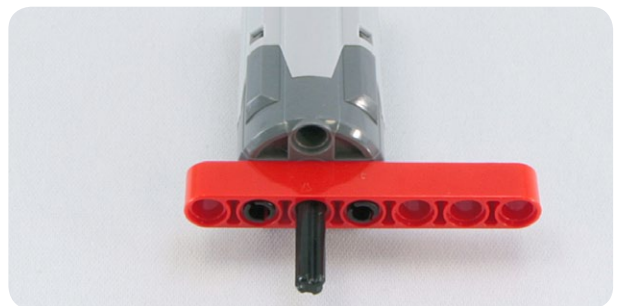
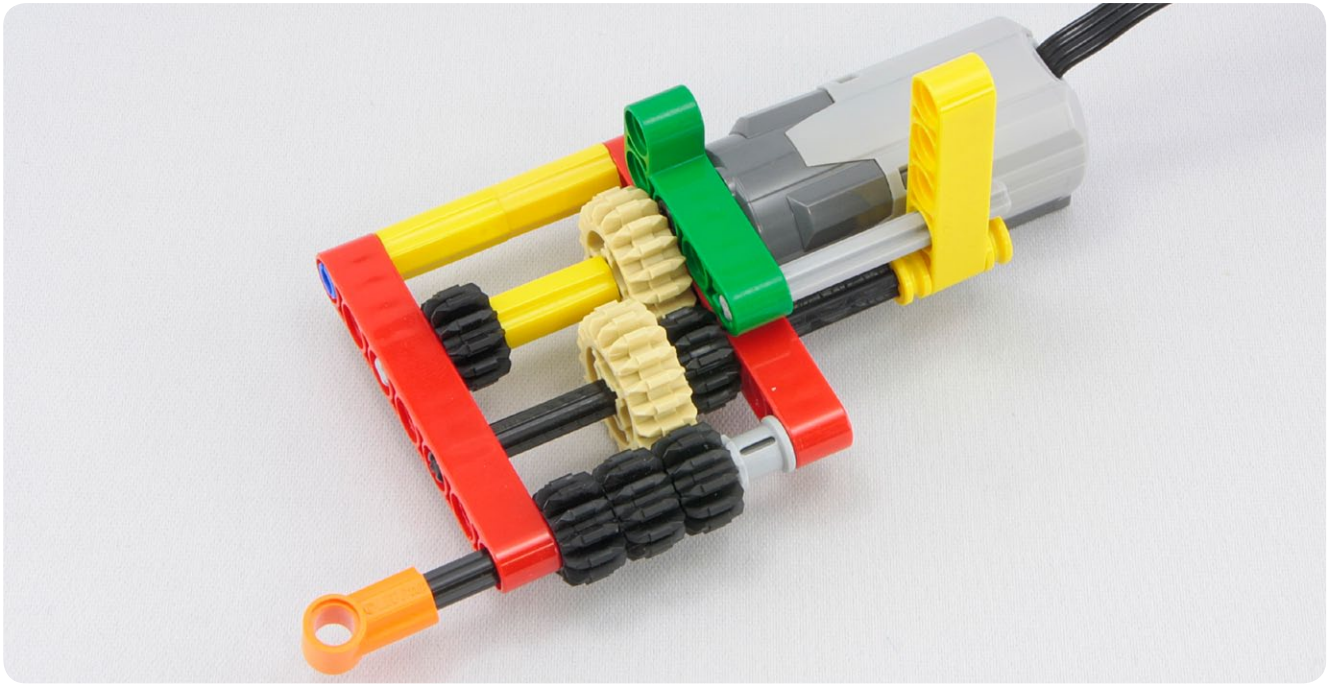


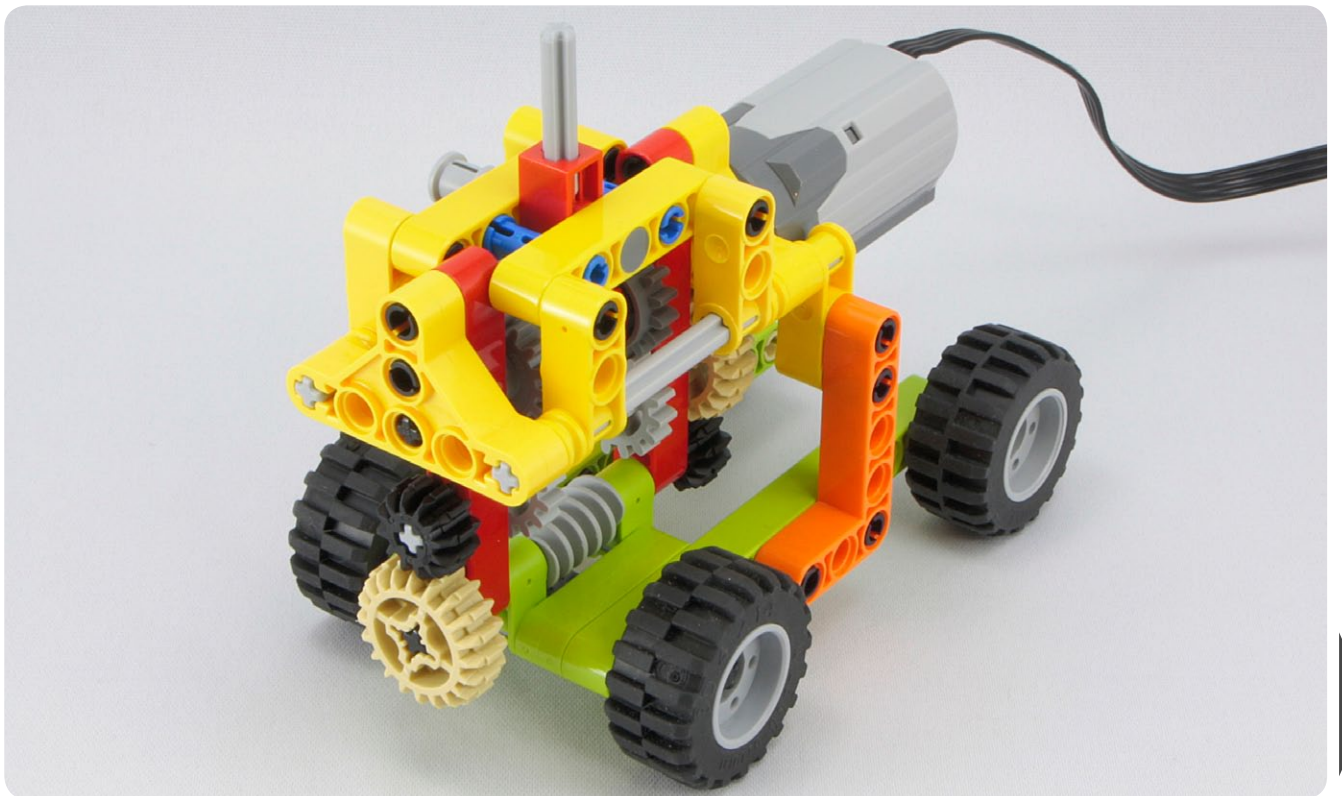


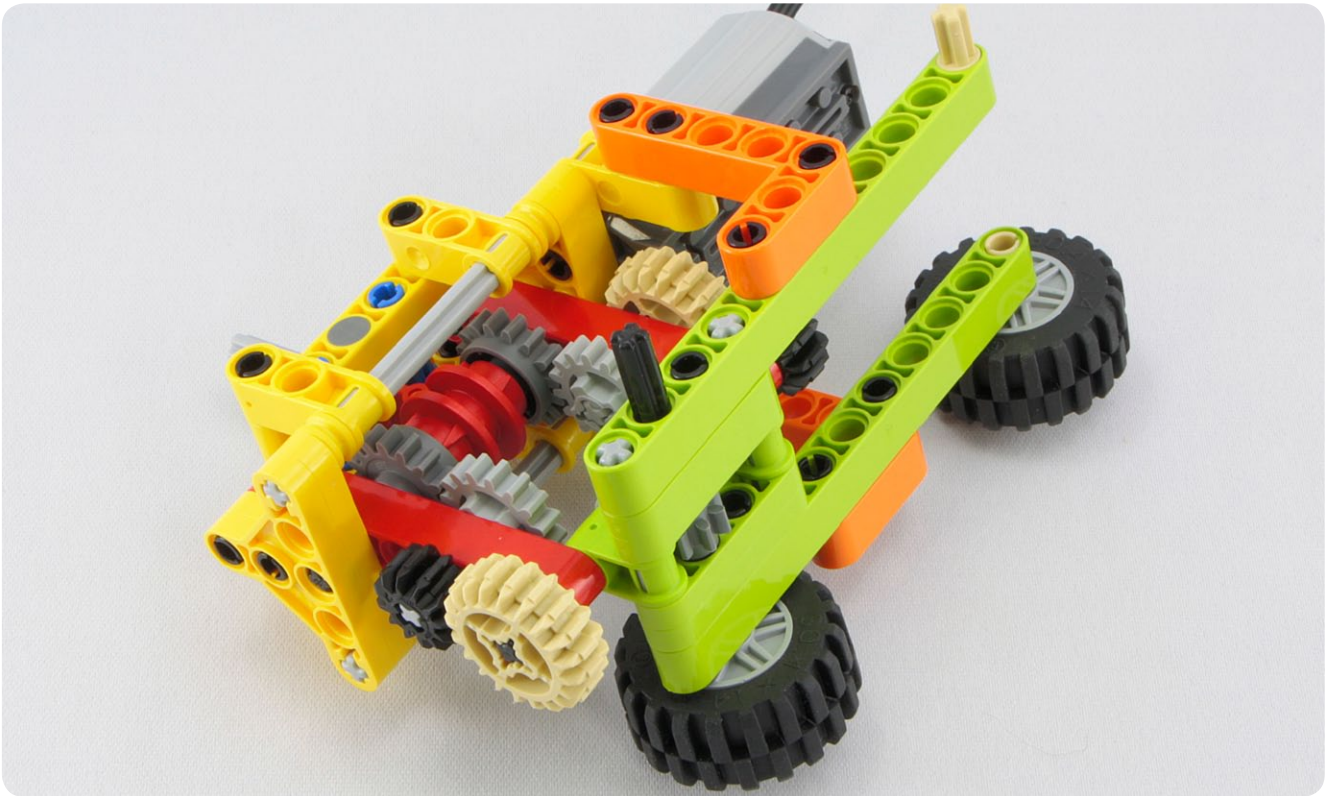
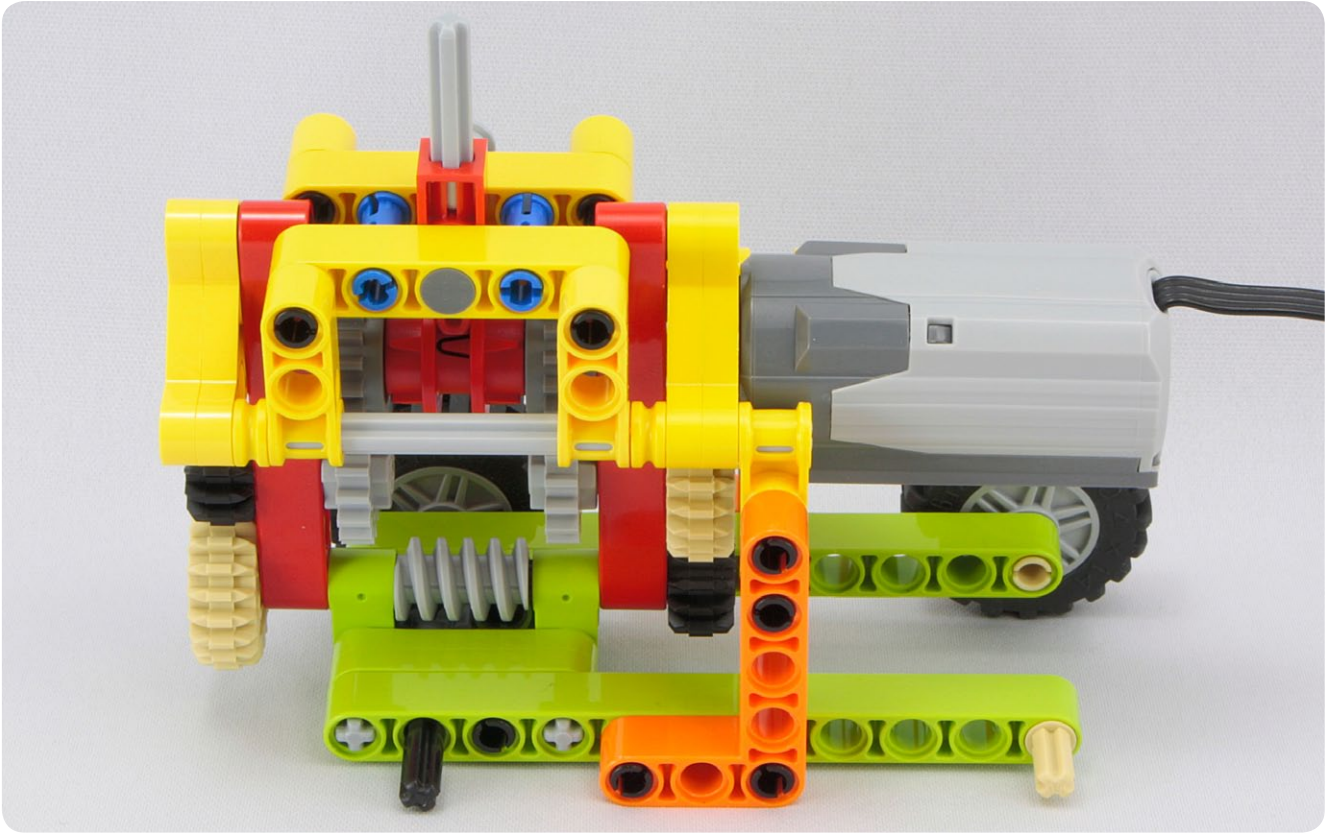
Transmissions

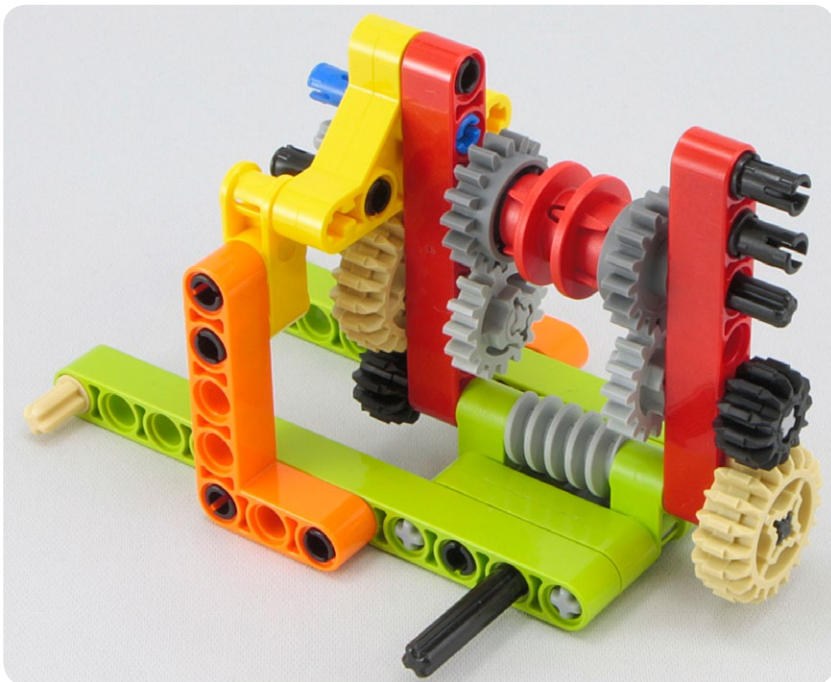
#130

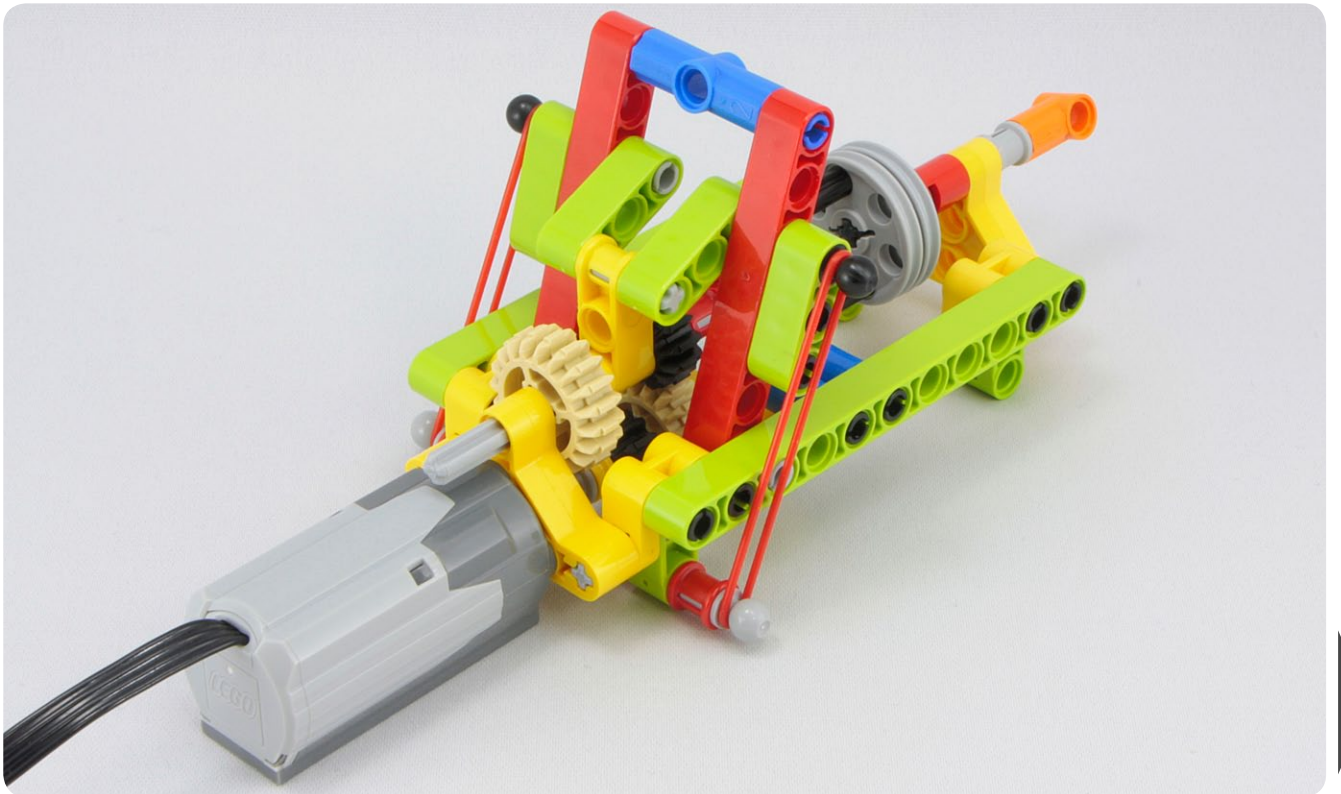
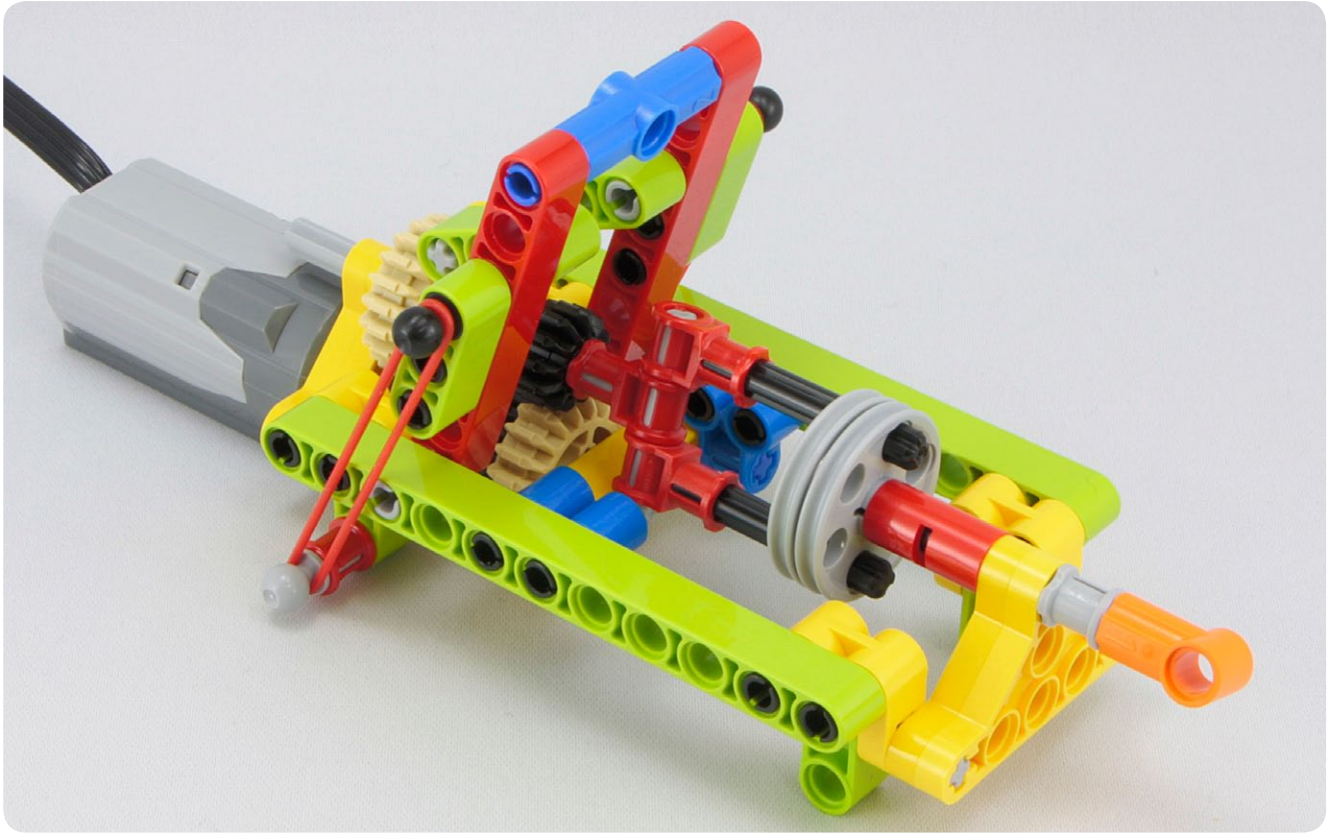


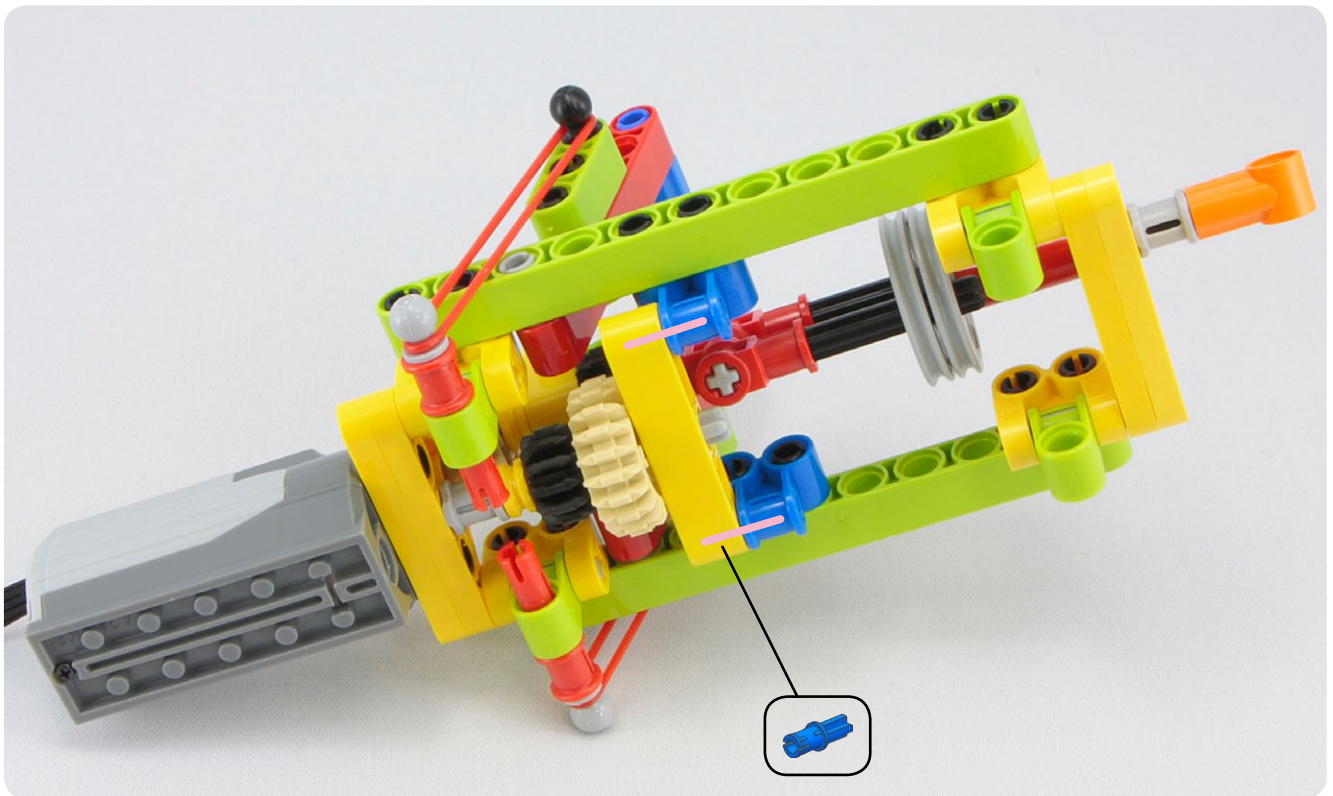
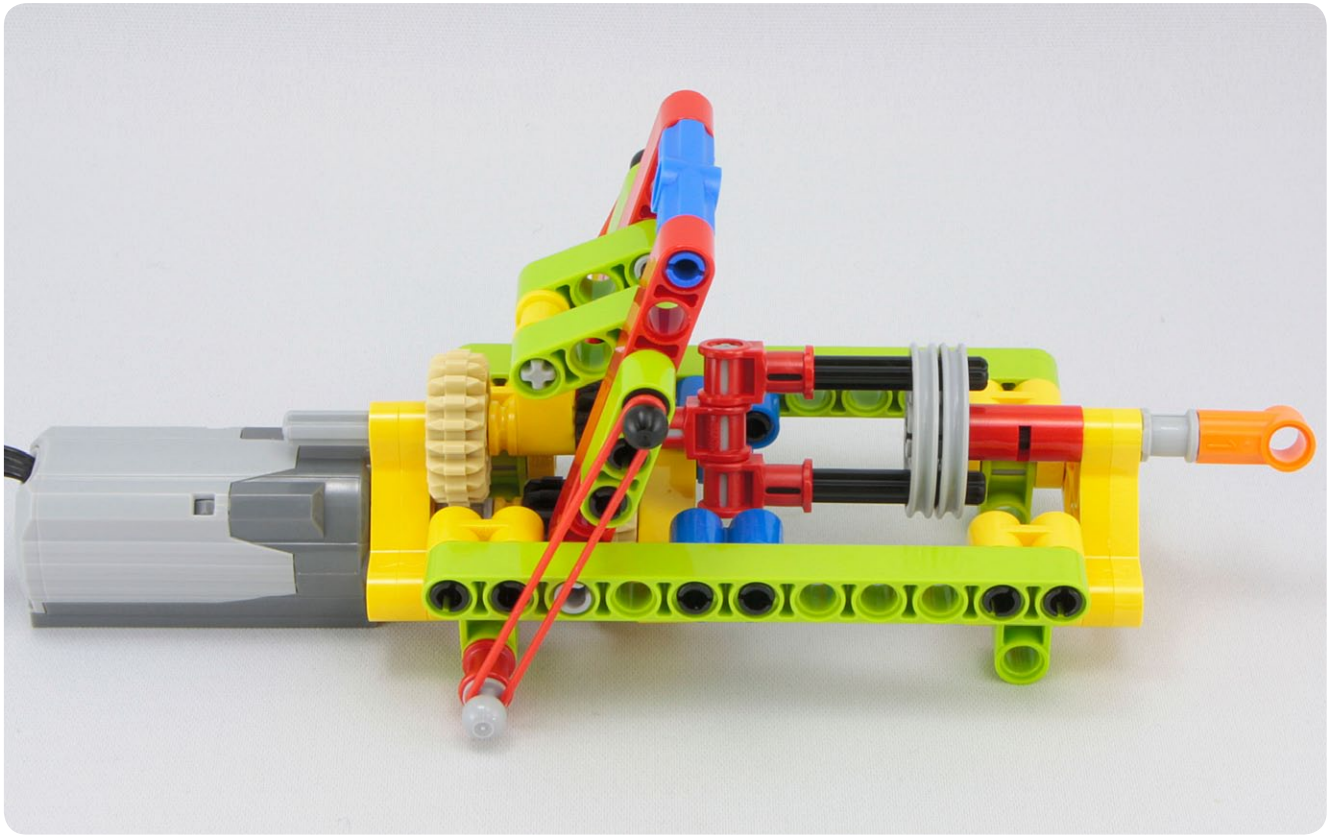


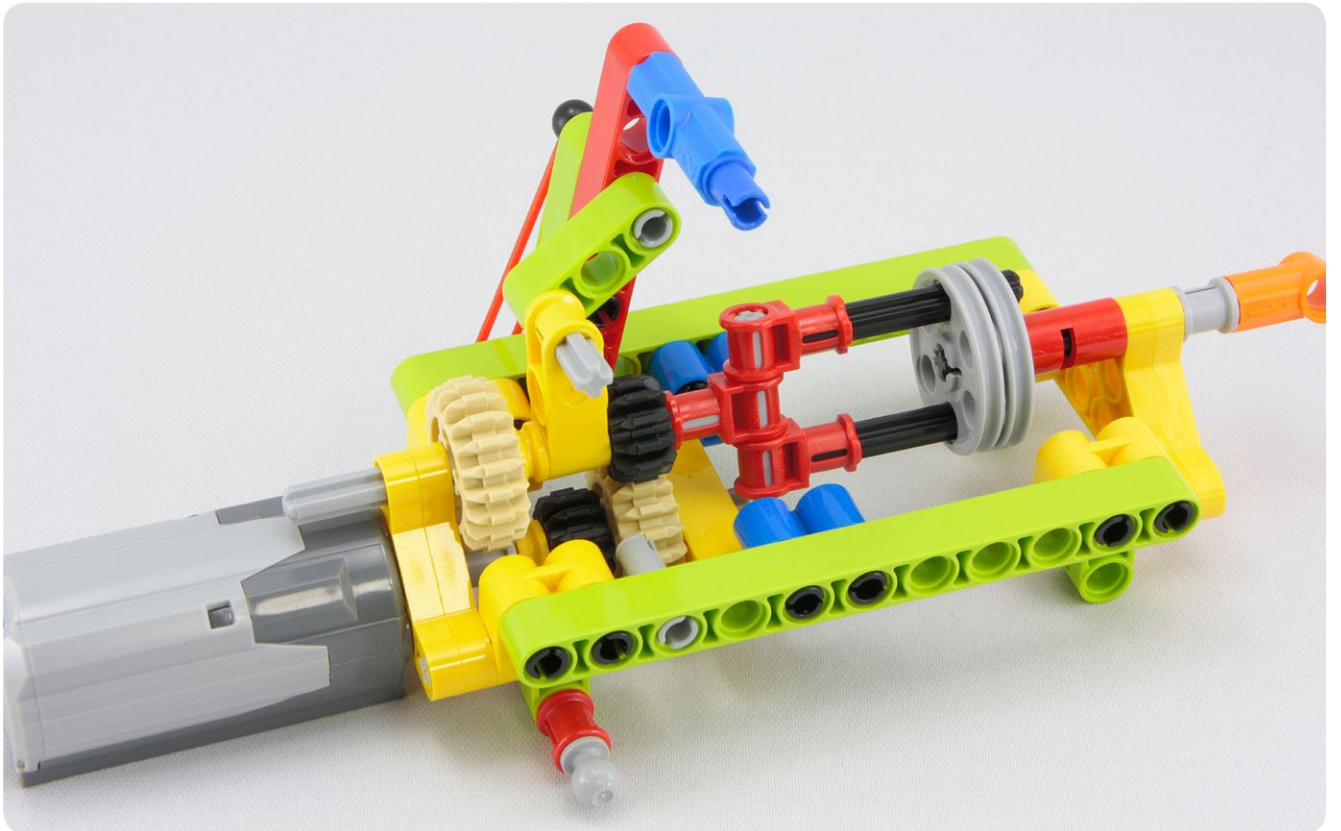
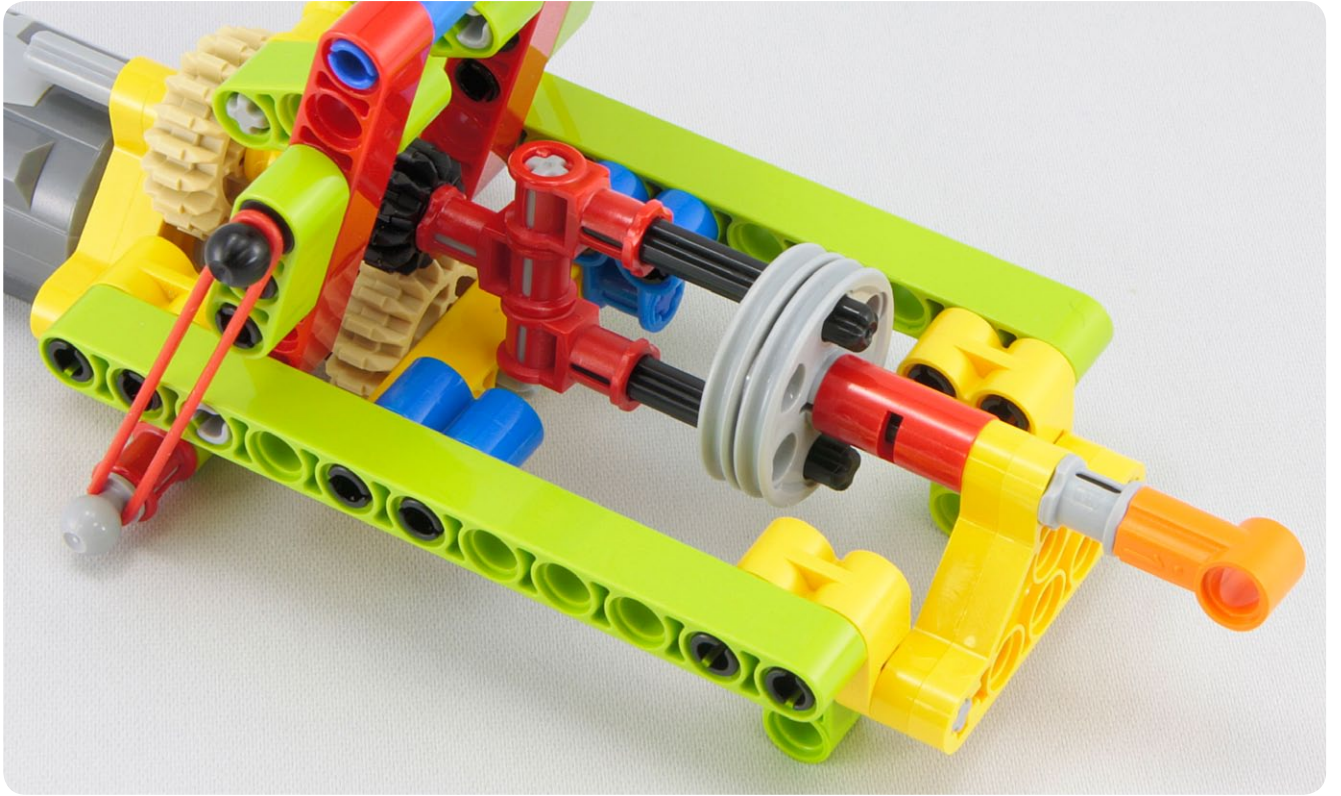







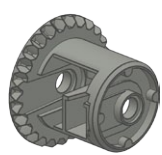



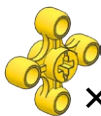

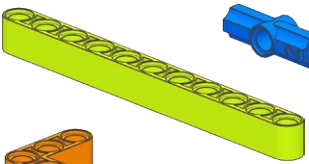

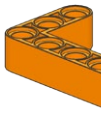

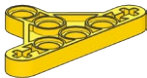
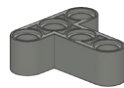

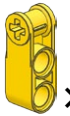

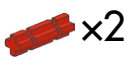


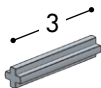
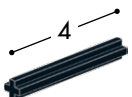

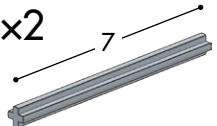
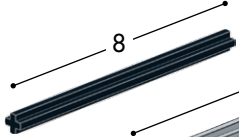
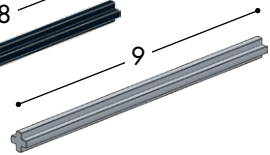


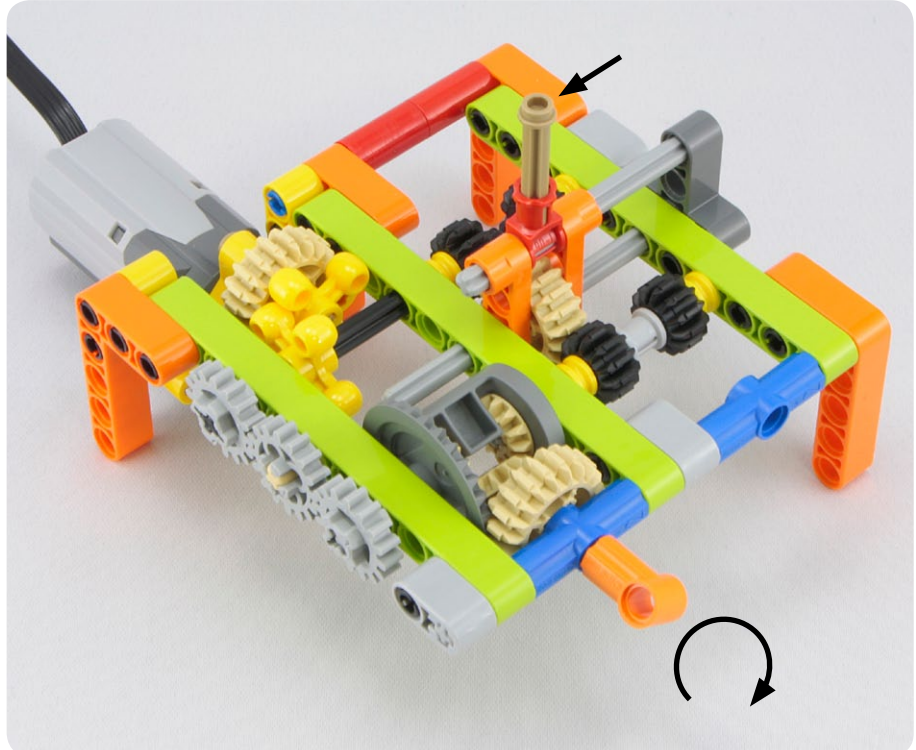
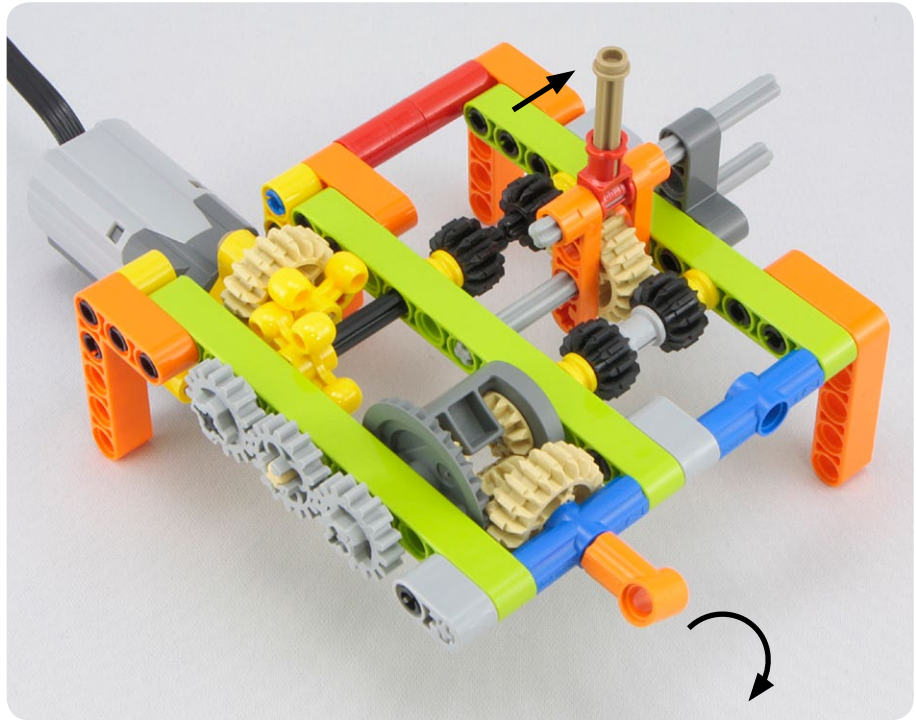


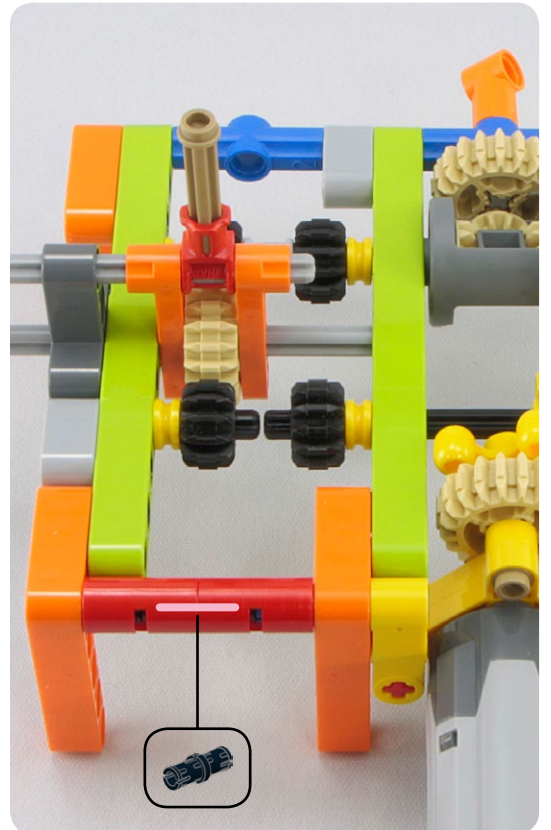
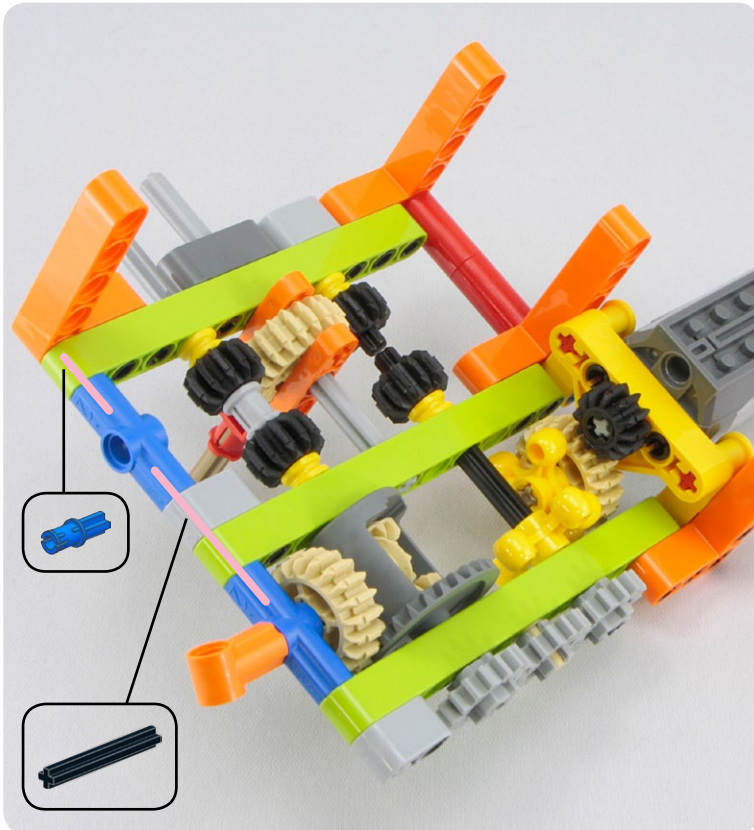
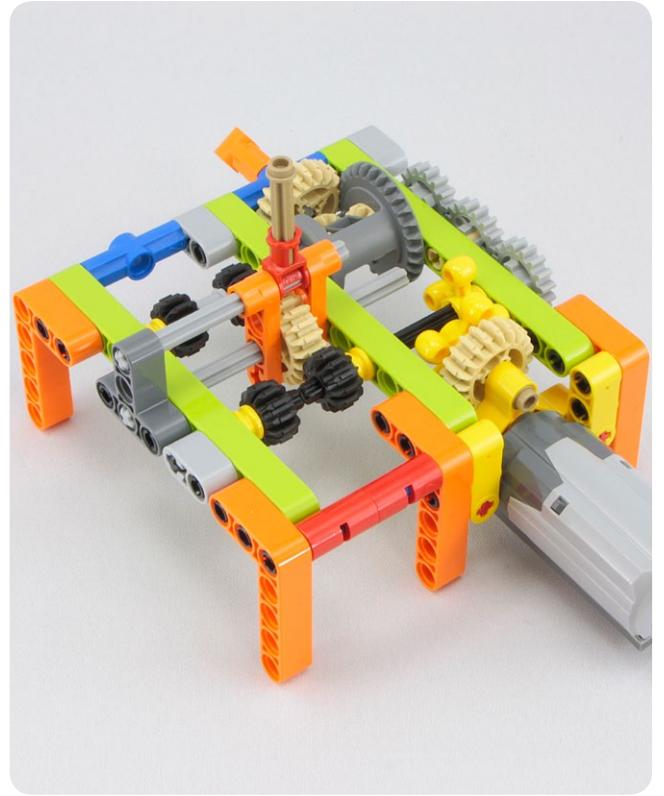
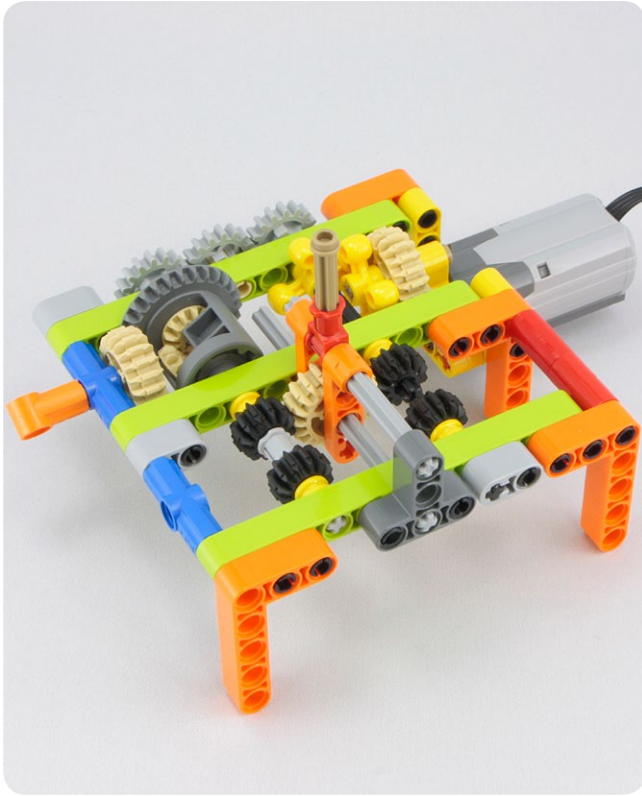


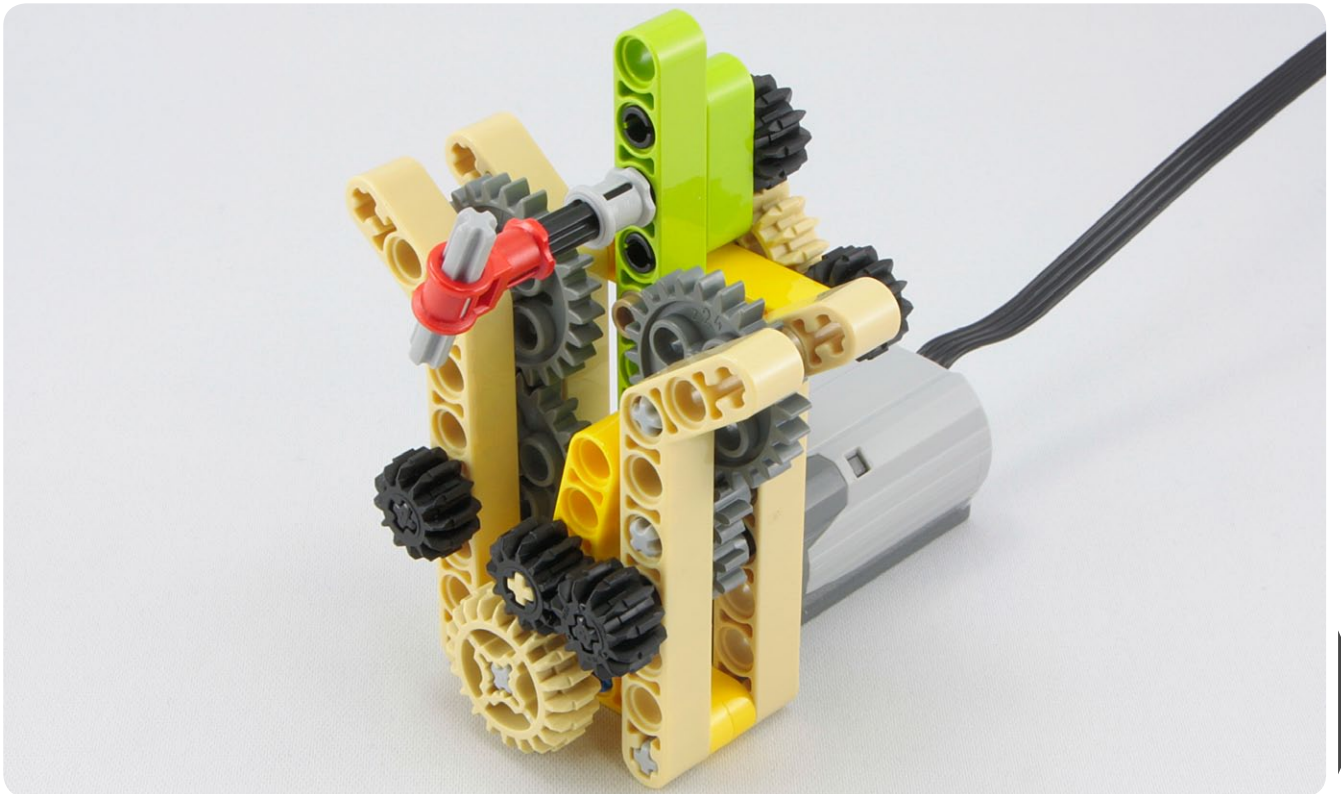
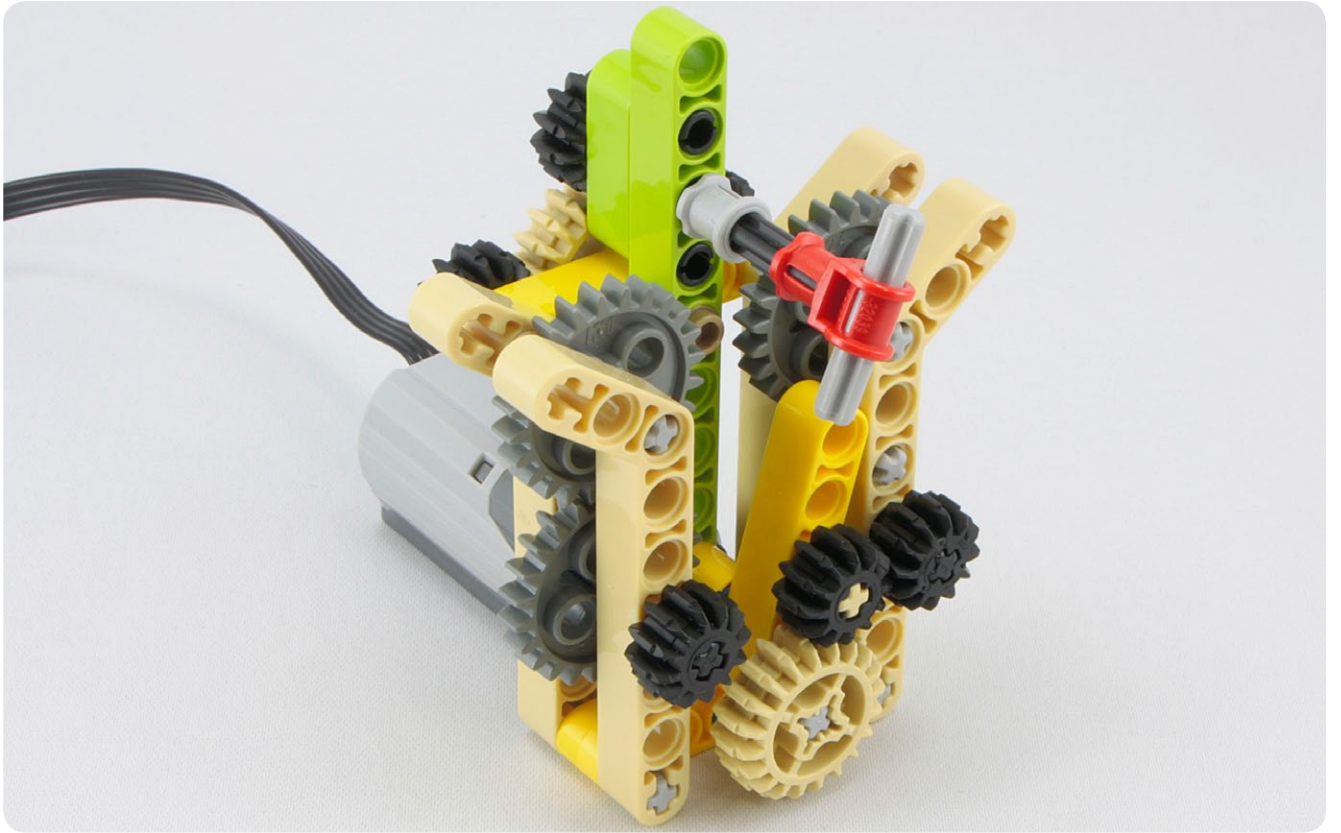
#133

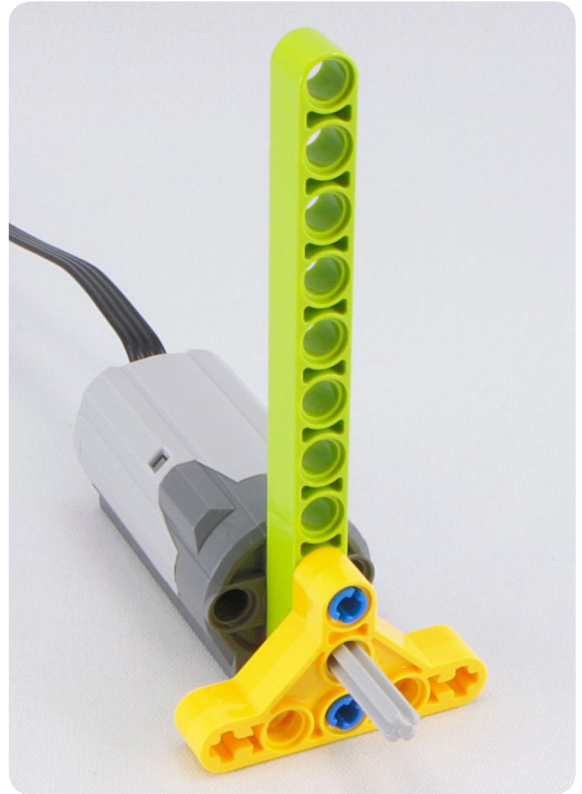
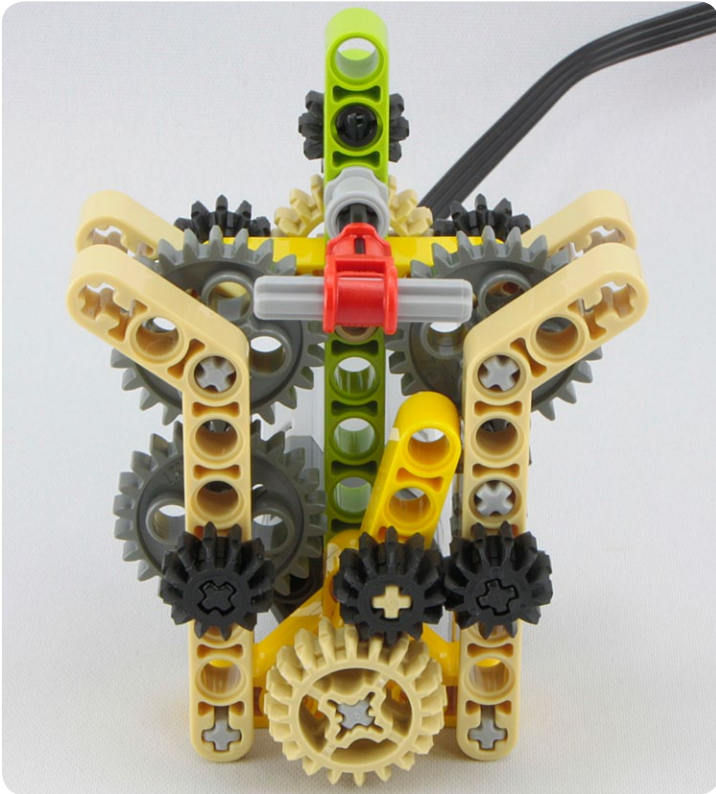
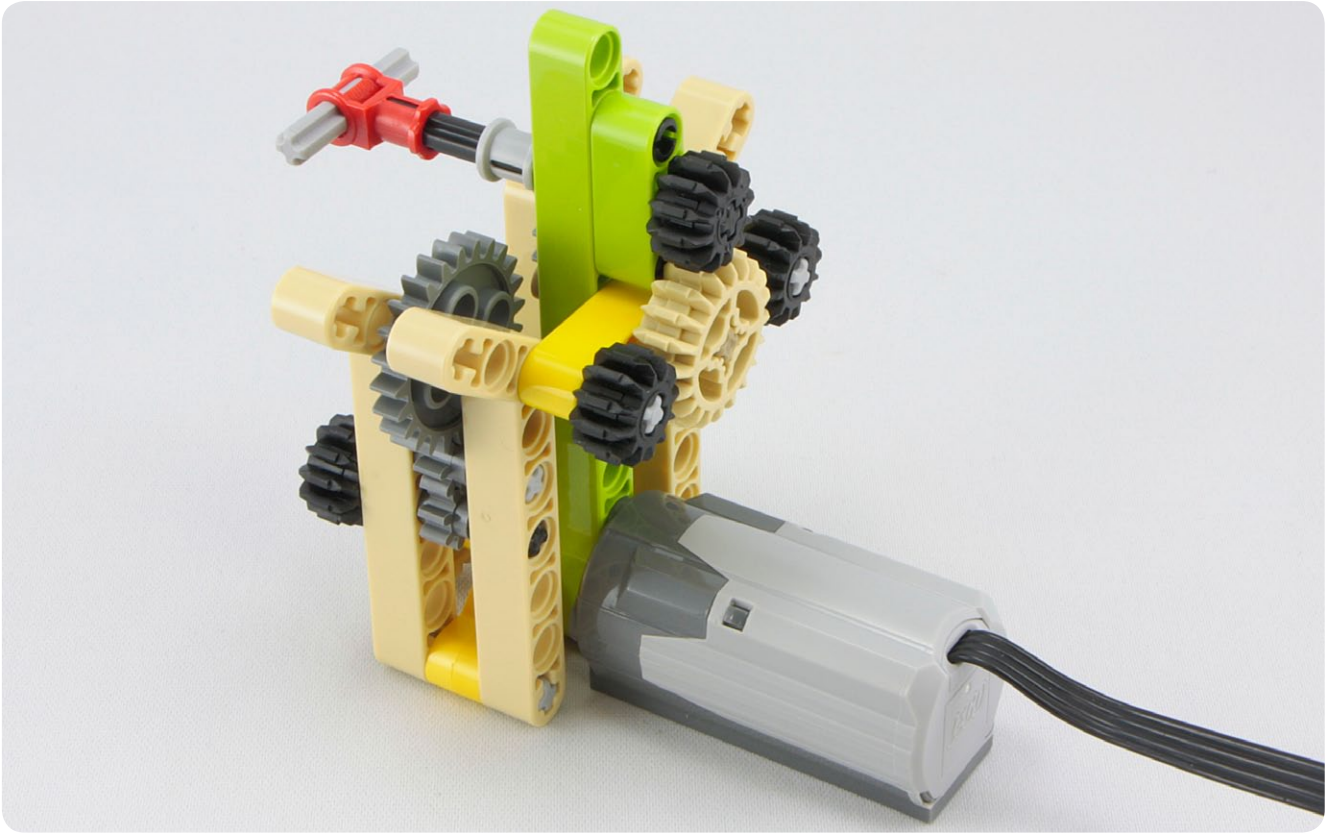
-  x4
- 
- 
- 
- 
-  x20

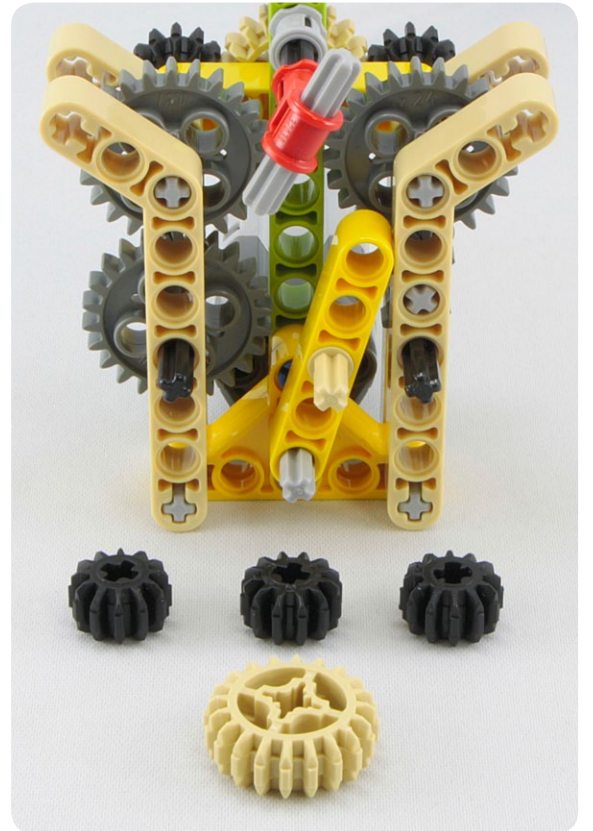
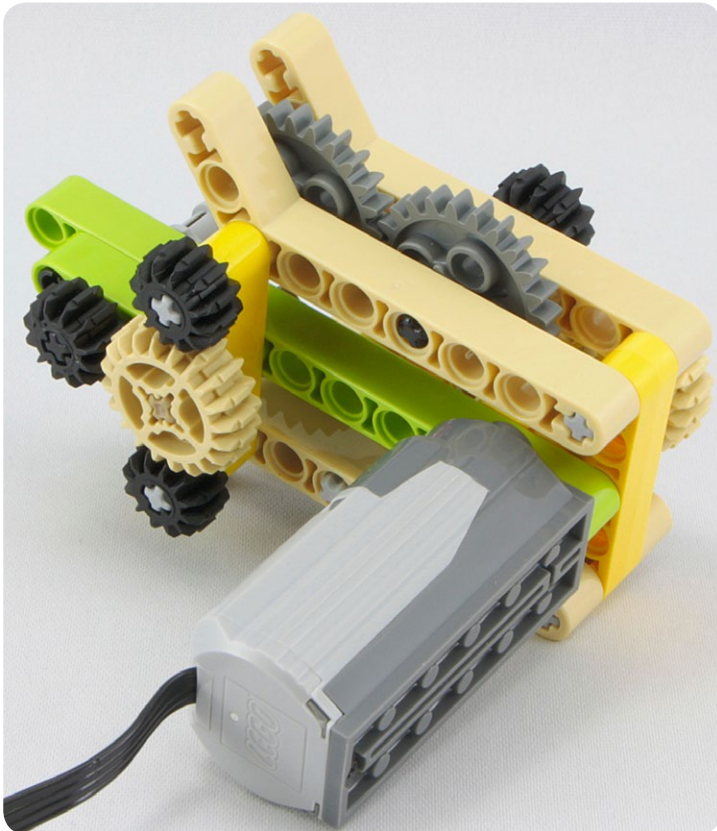
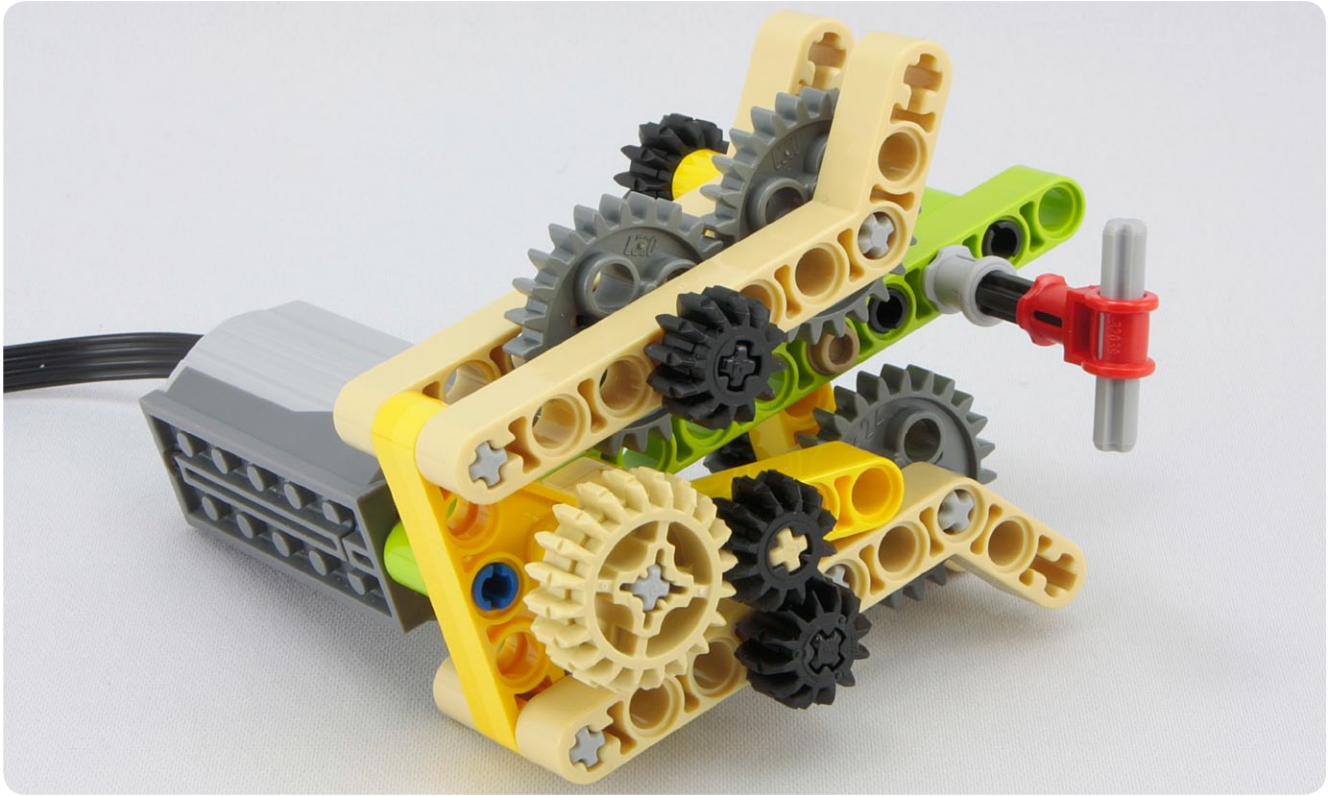
- 
- 
-  x3
-  x5
-  x3
-  x2
-  x3
-  x3
-  x2
-  x4
-  x3
-  x2
- 
-  x2
-  x2
-  x2
-  x2
- 
- 
-  x4
-  x2
-  x2
-  x2
-  x2
- 

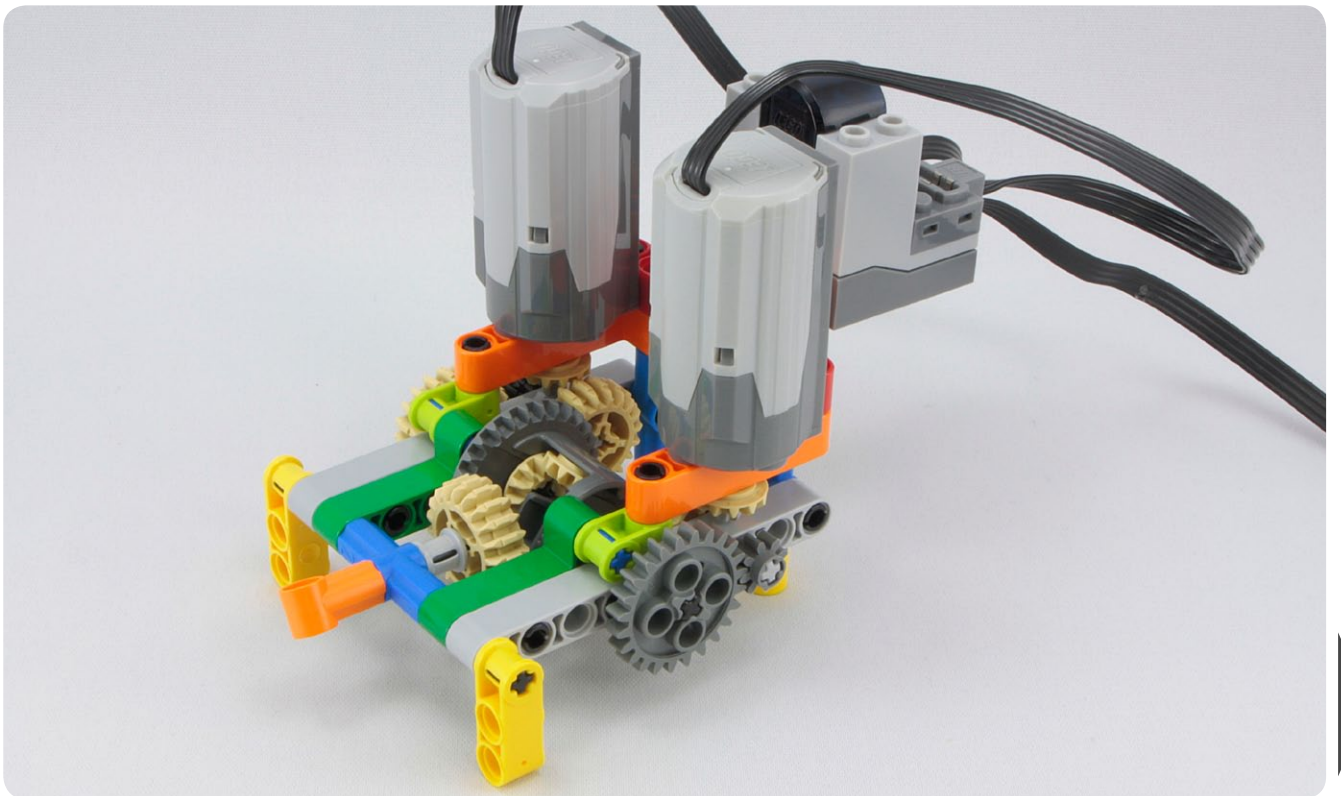
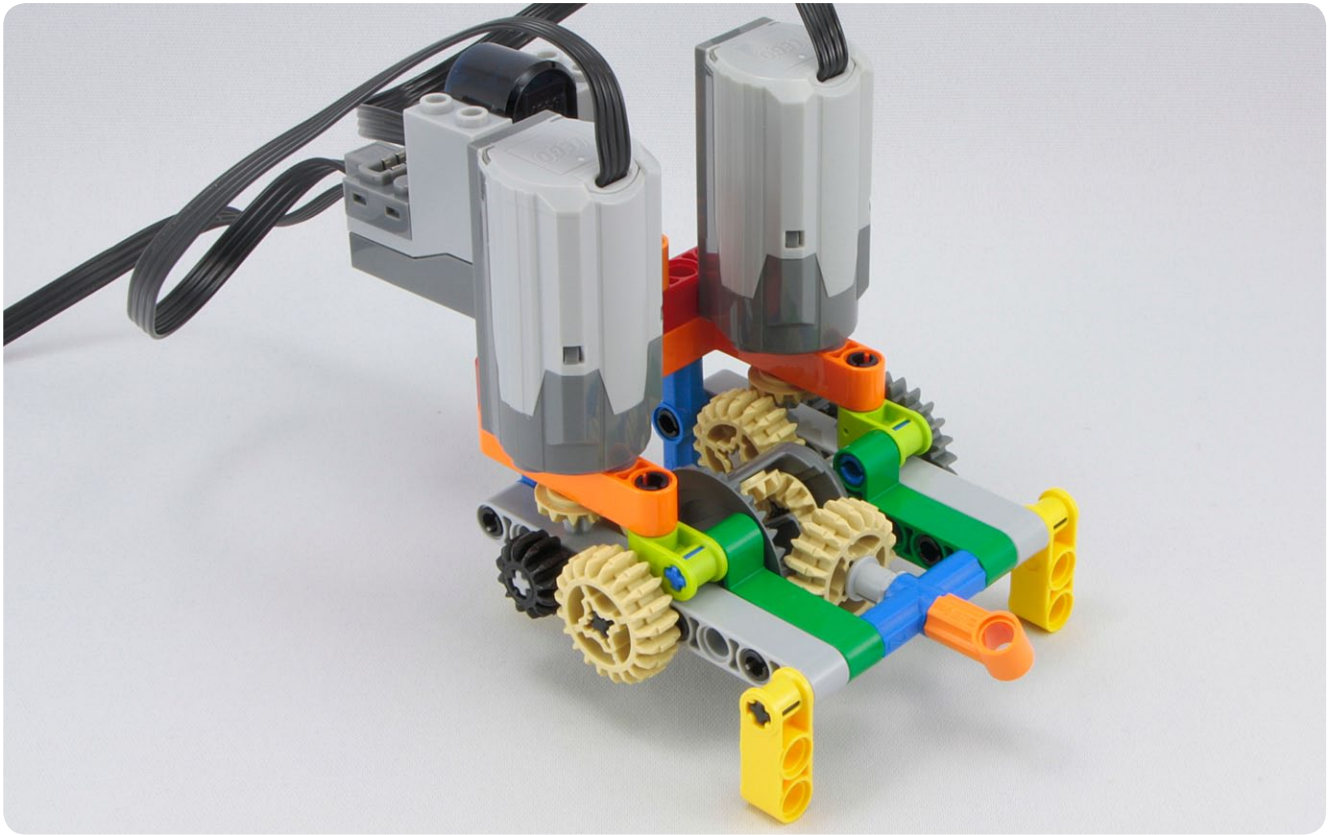


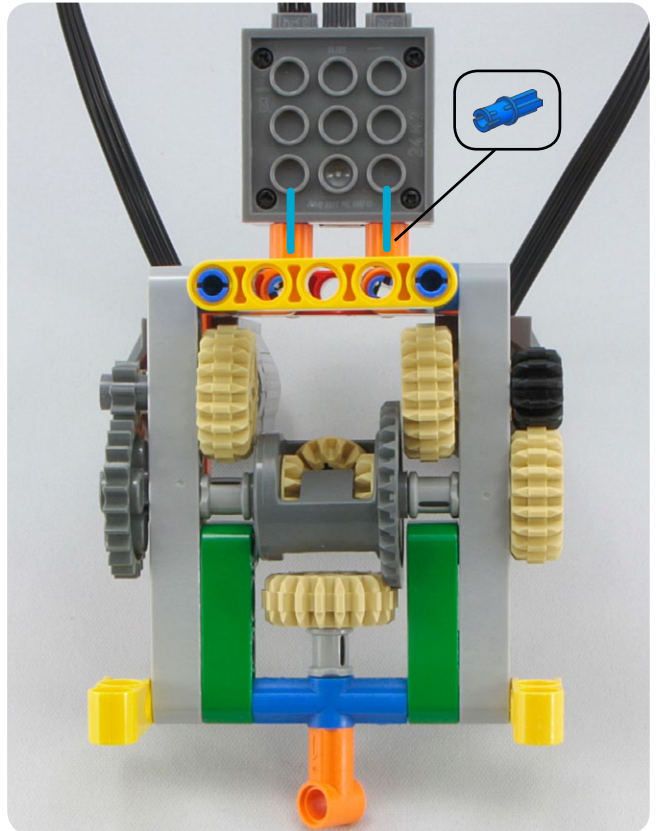
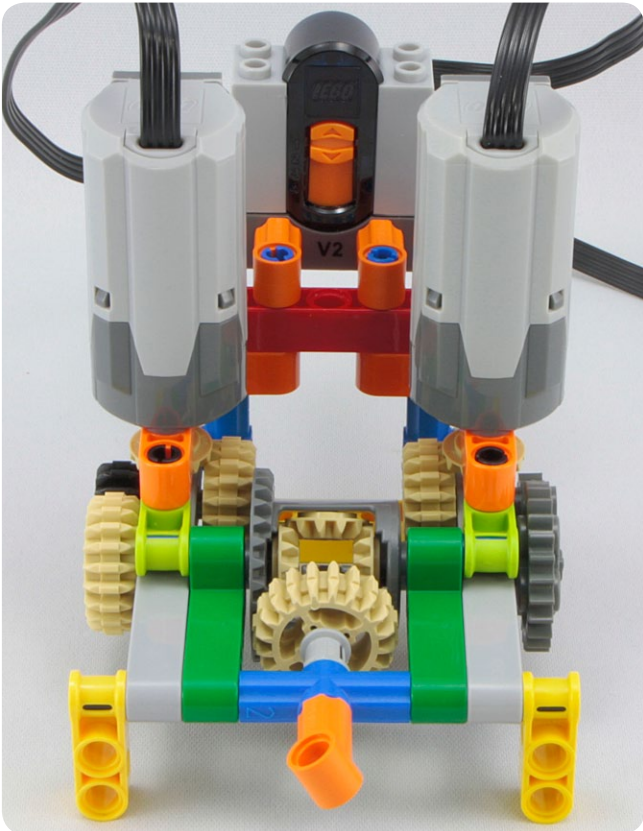
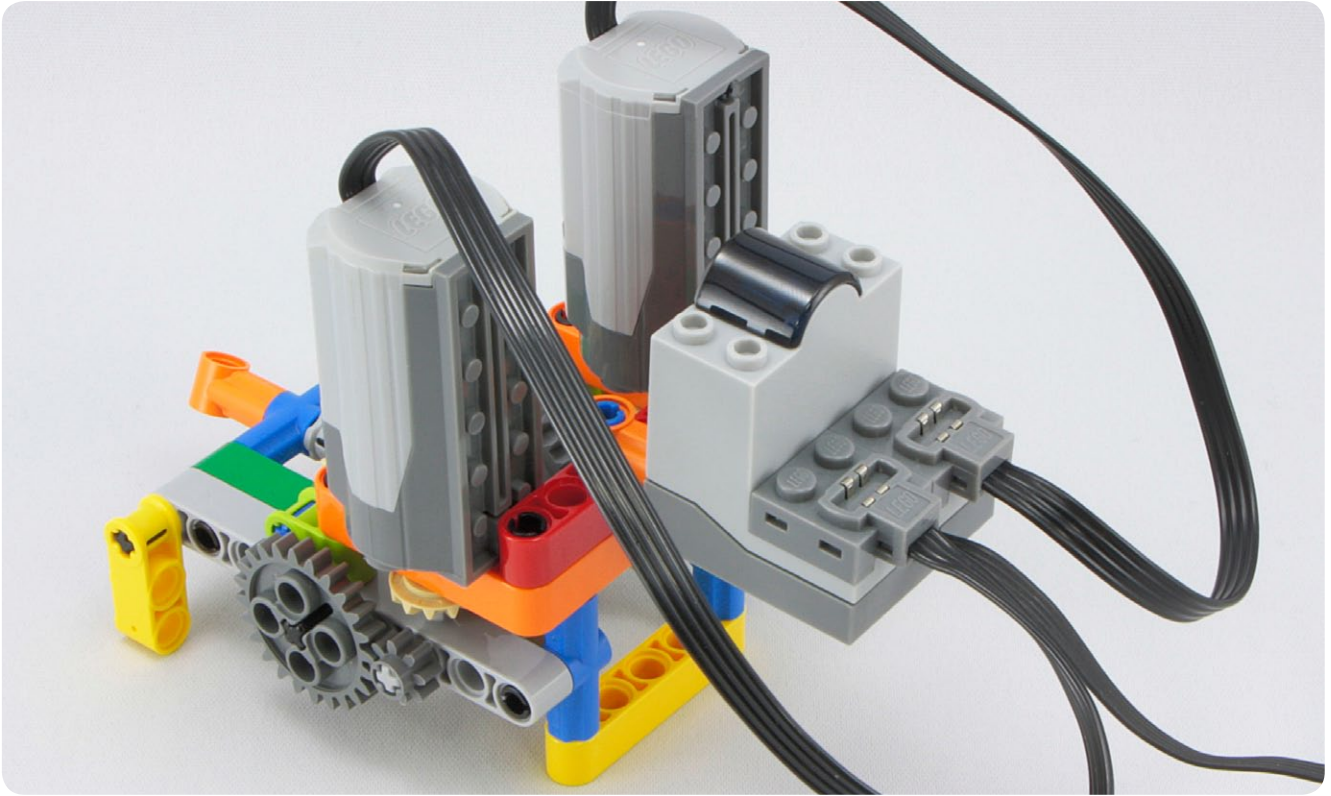


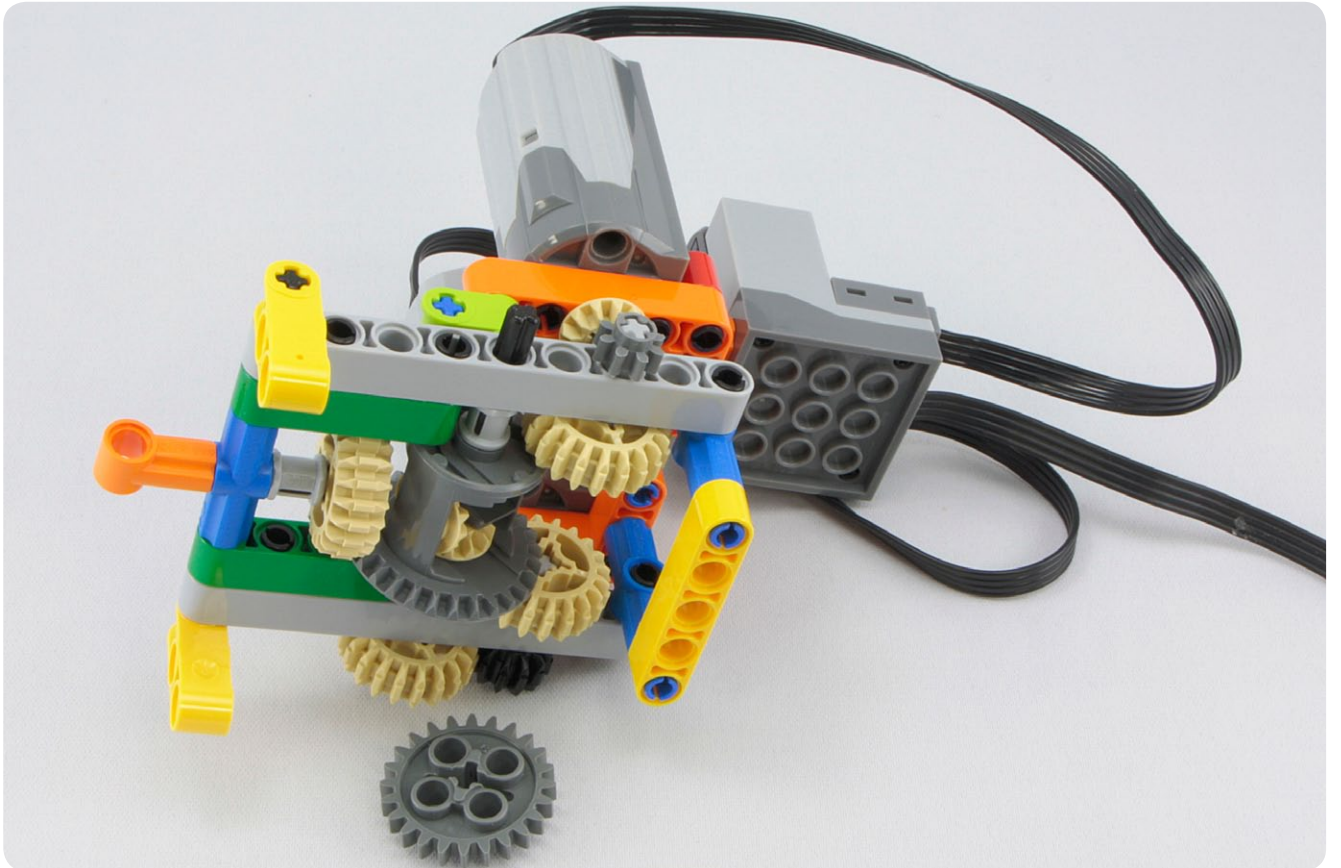
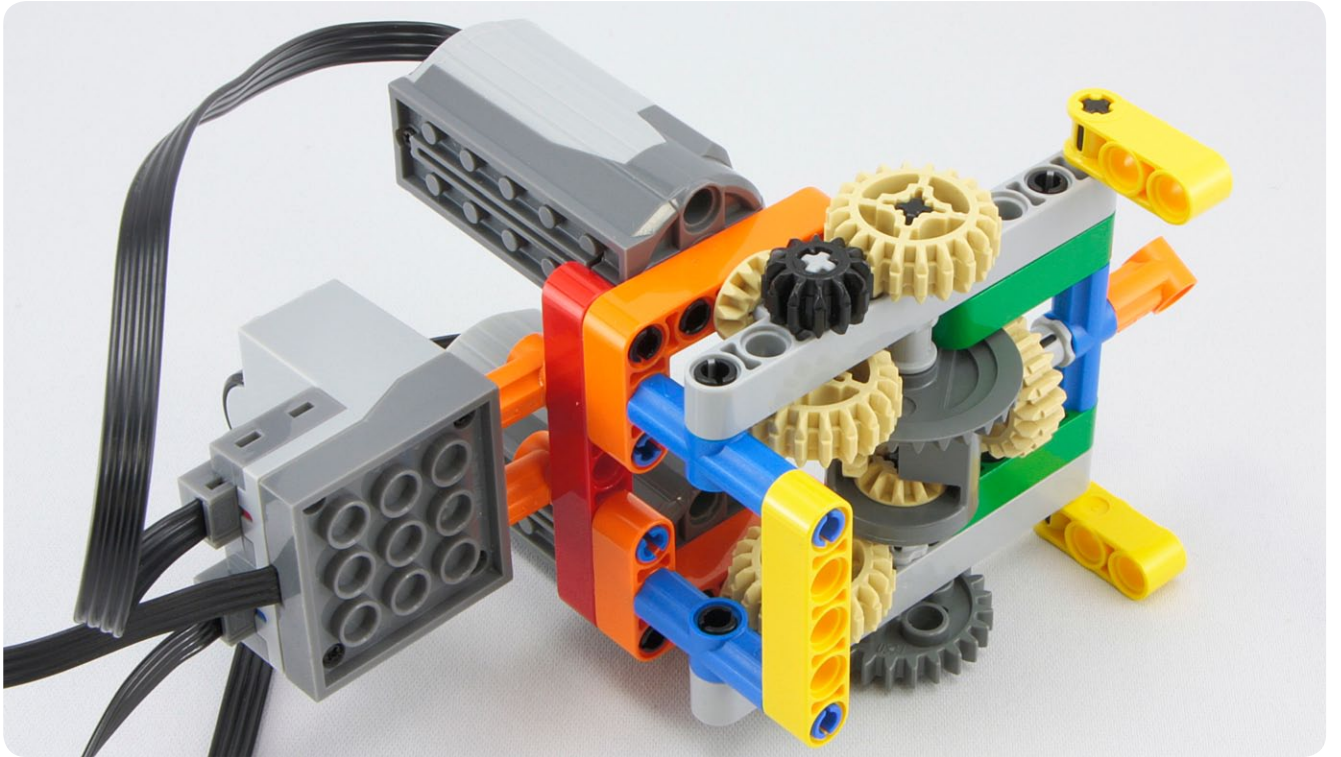


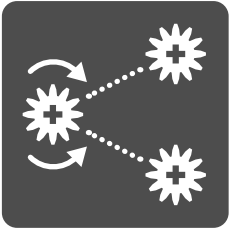











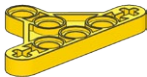

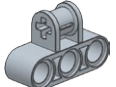

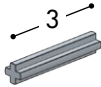

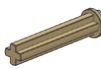
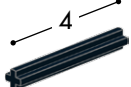
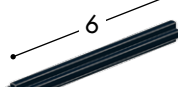



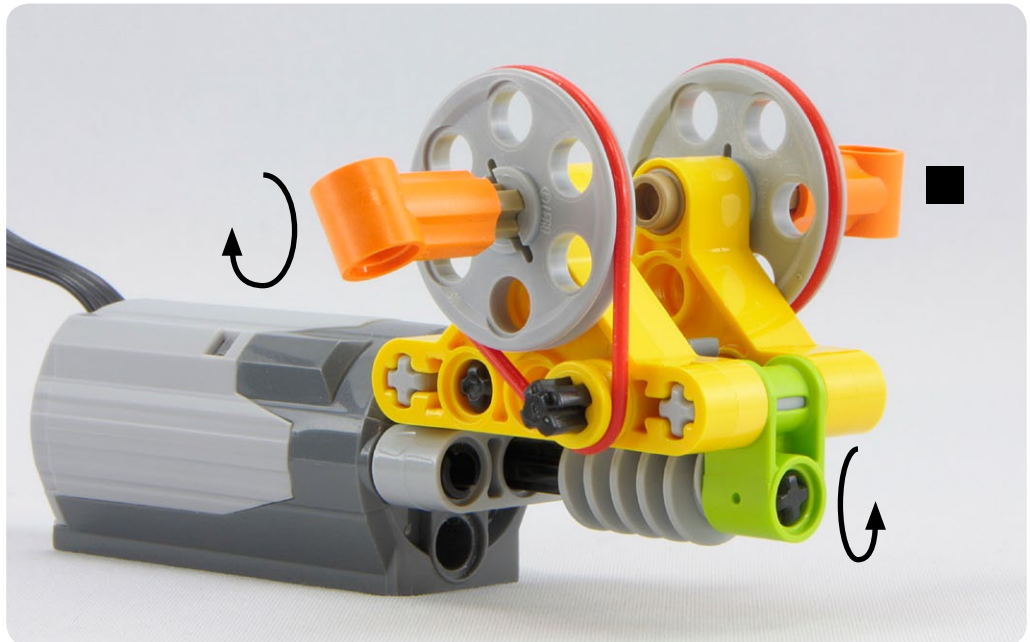
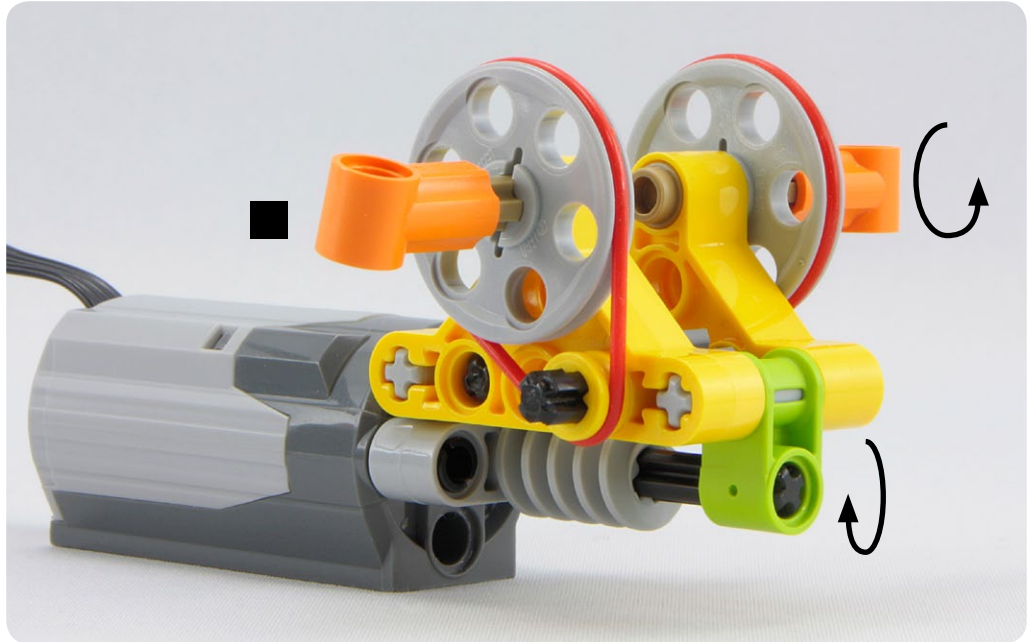


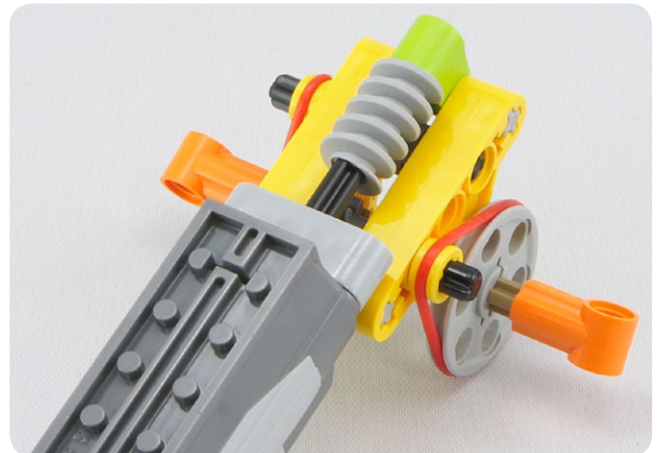
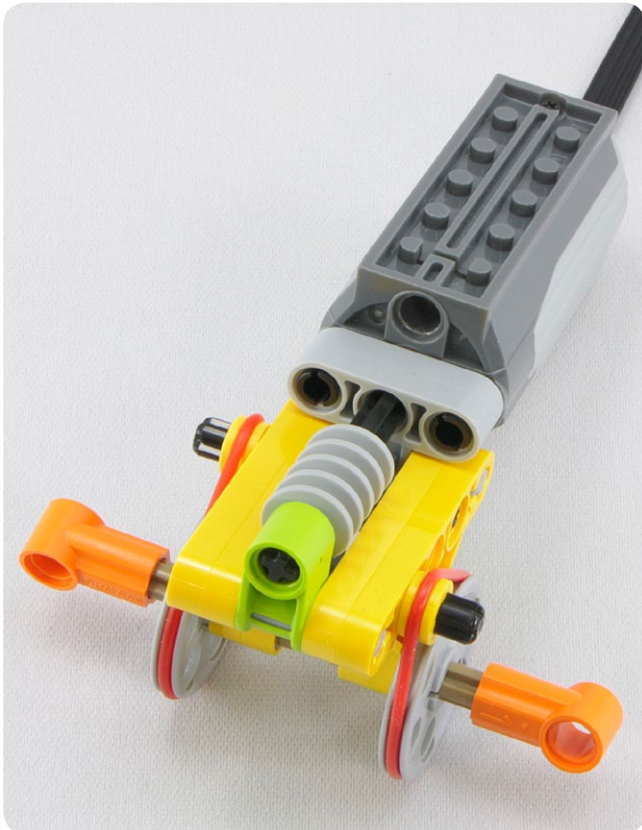
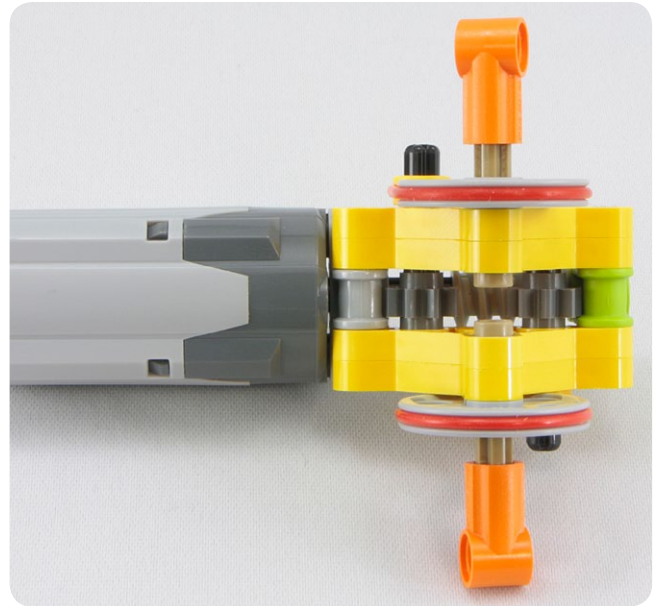
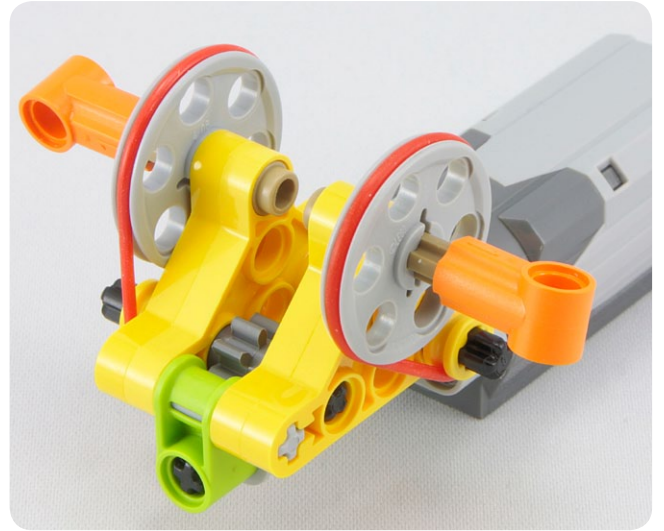


Changeover mechanisms using rotational direction

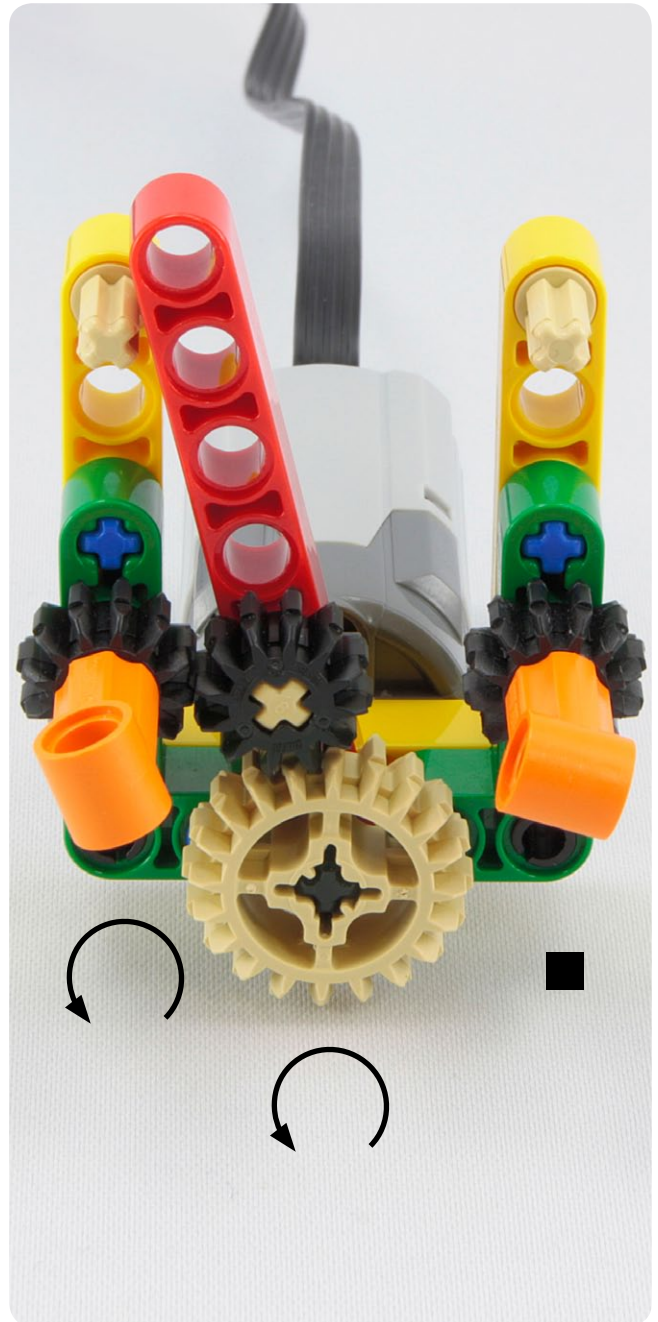
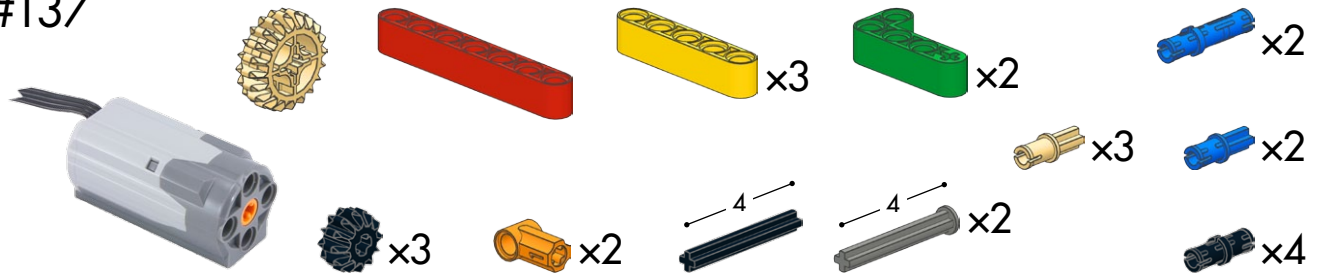
#136

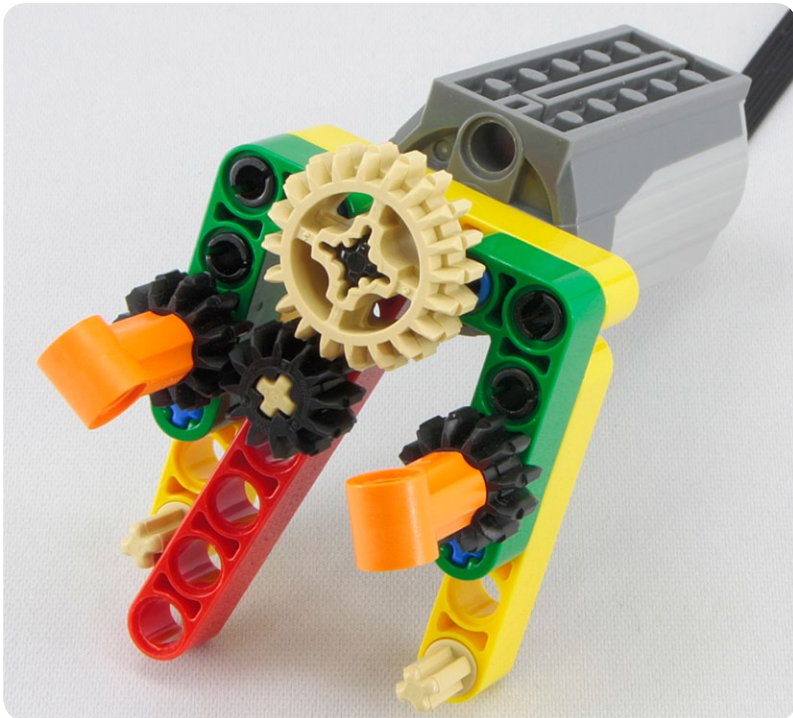
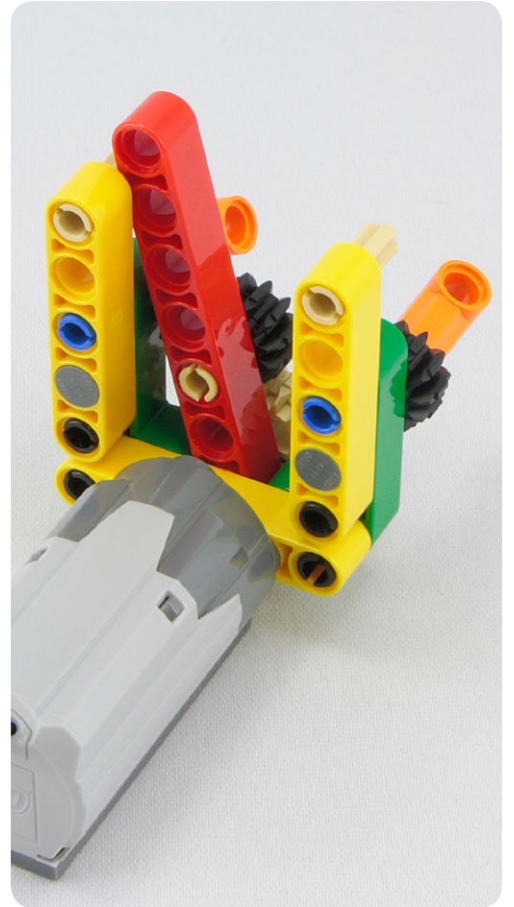
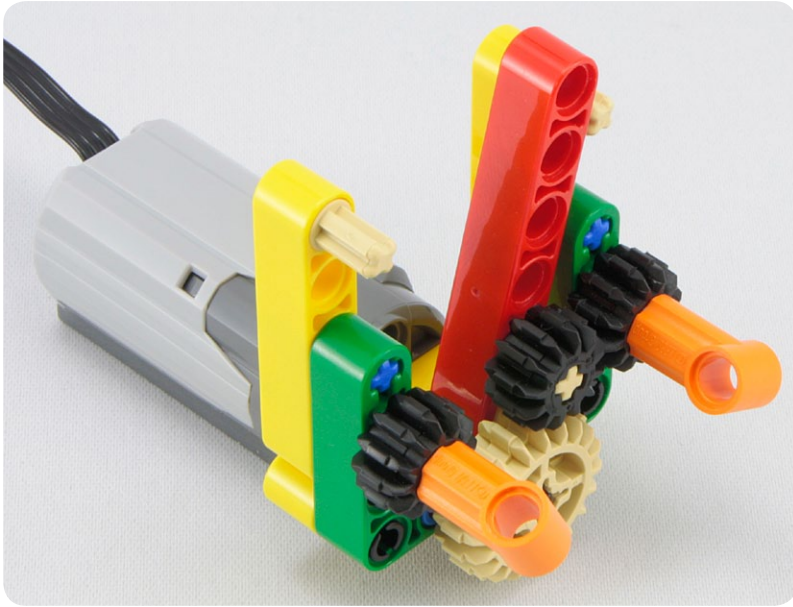
-  x2
- 
-  x2
-  x2
- 
-  x4
-  x2
- 
- 
-  x2
-  x2
-  x2
-  x2
-  x2
-  x2



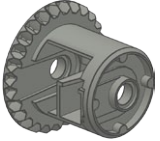





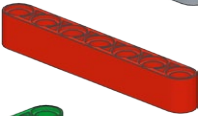
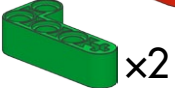




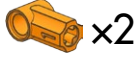


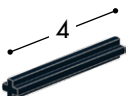
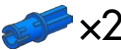




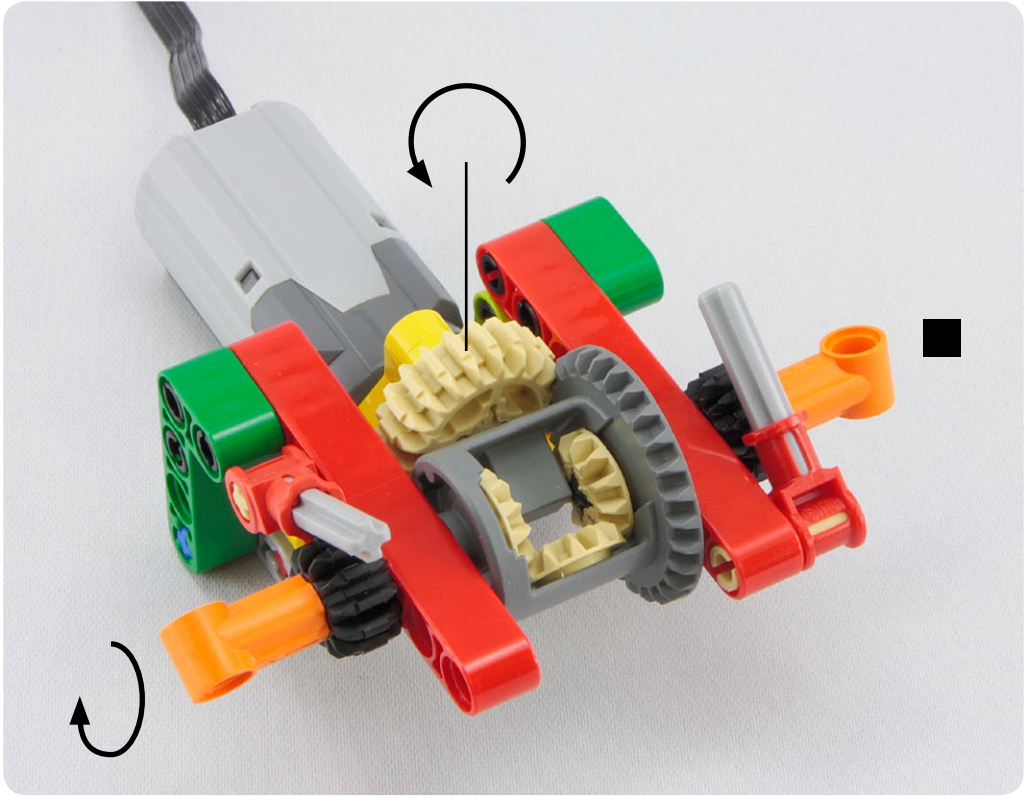
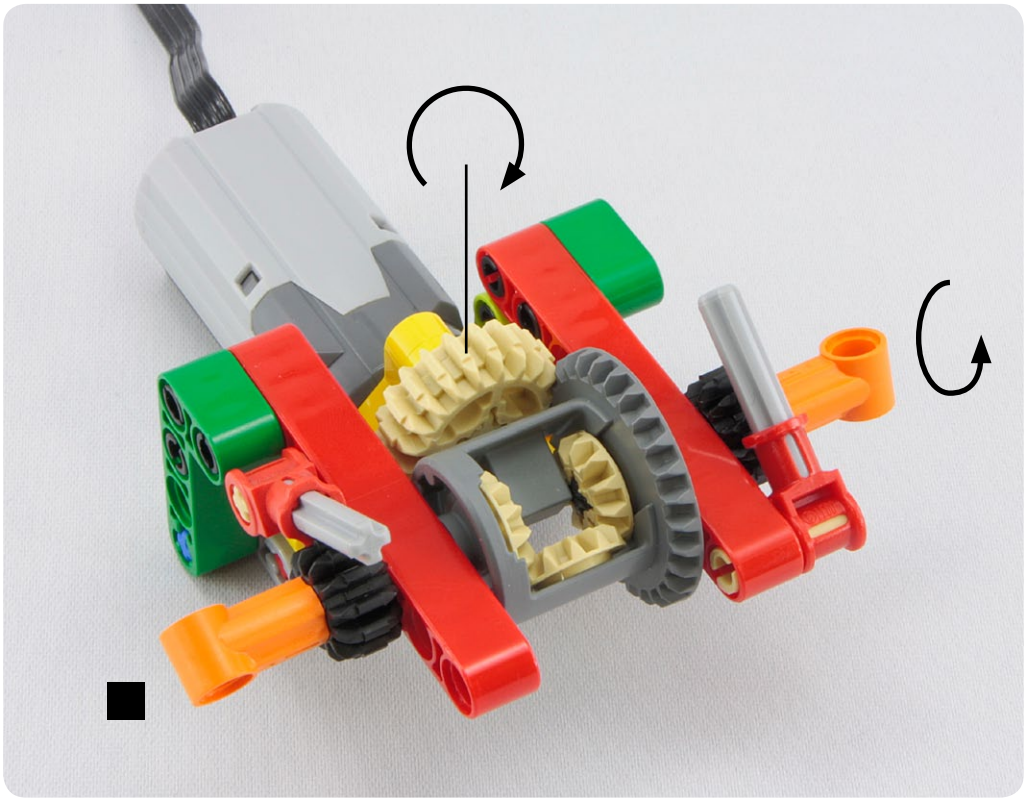
#137

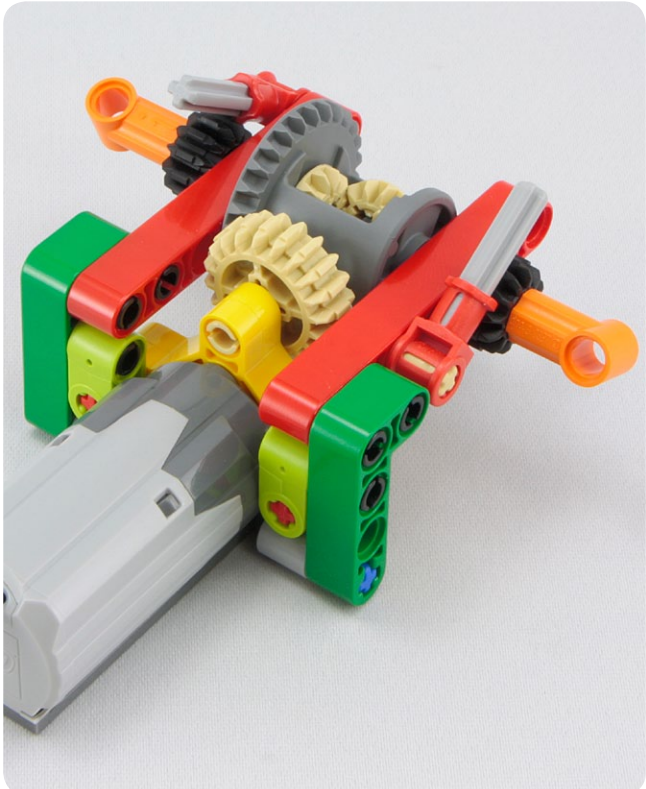
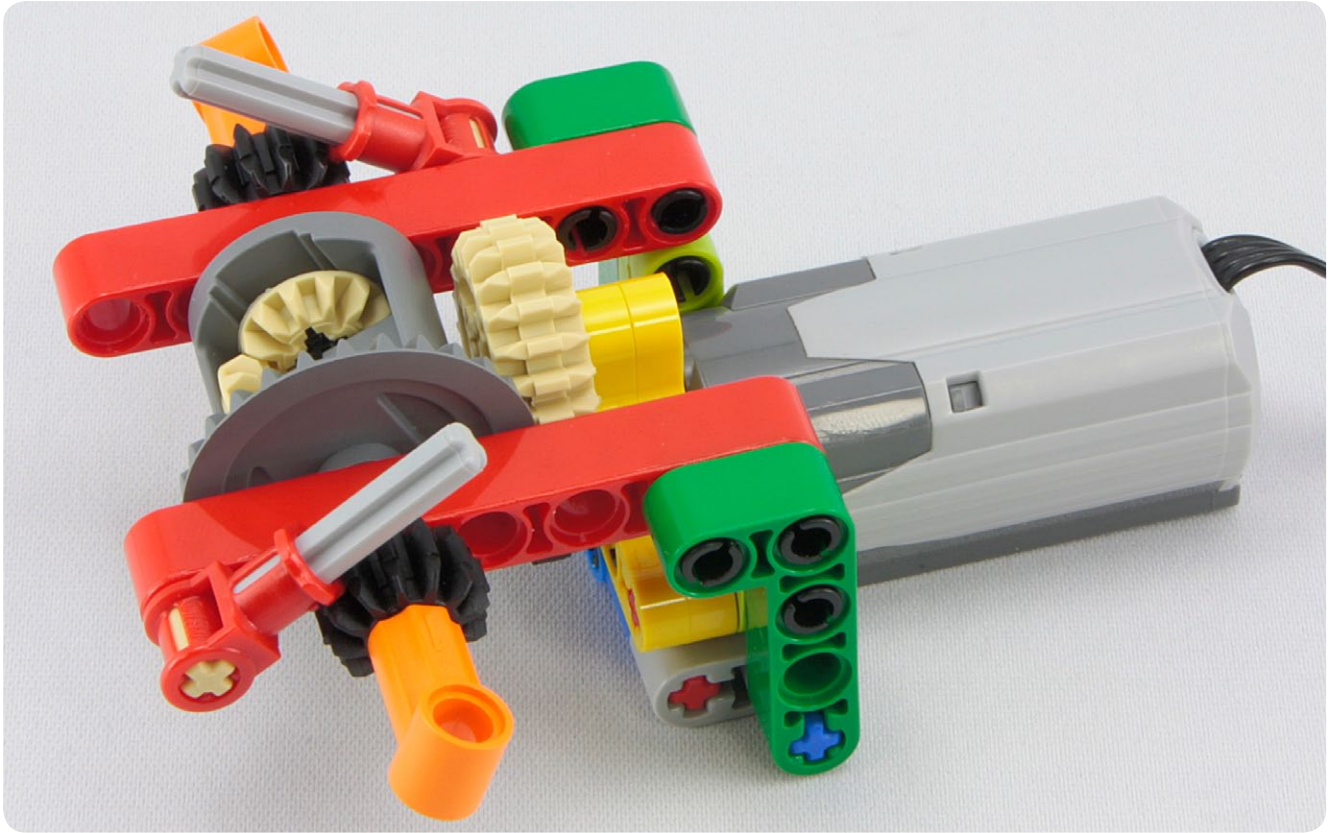




#138

- 
- 
-  x3
-  x3
- 
-  x2
-  x2
-  x2
-  x2
-  x2
- 
-  x2
-  x2
-  x4
-  x3
-  x2
-  x2
-  x3
-  x9

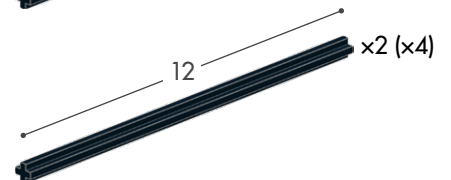
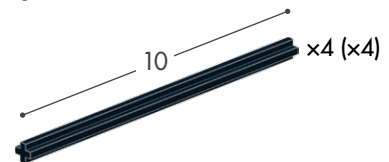
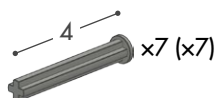
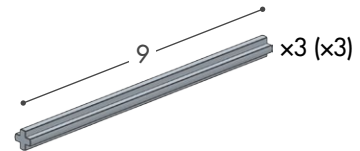
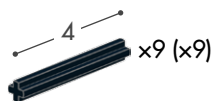
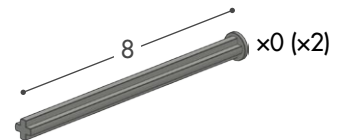
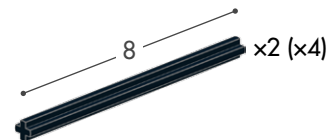
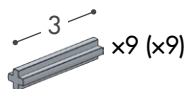
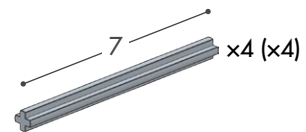
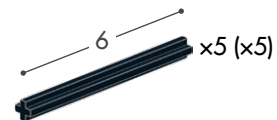
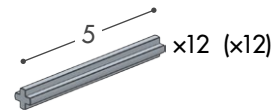
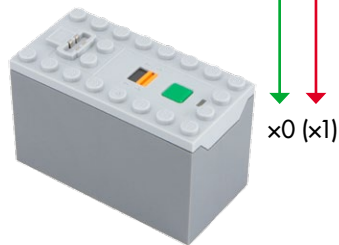


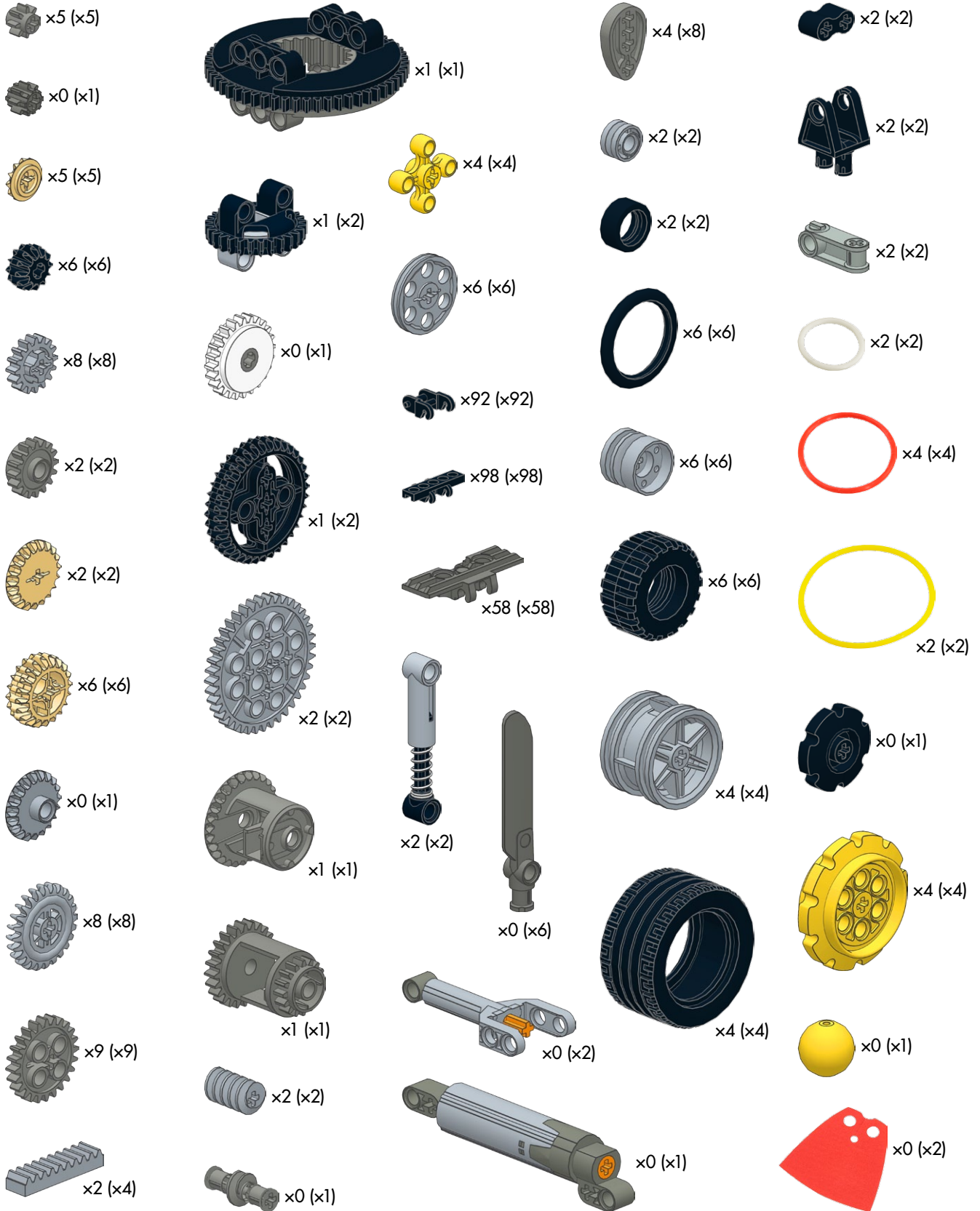


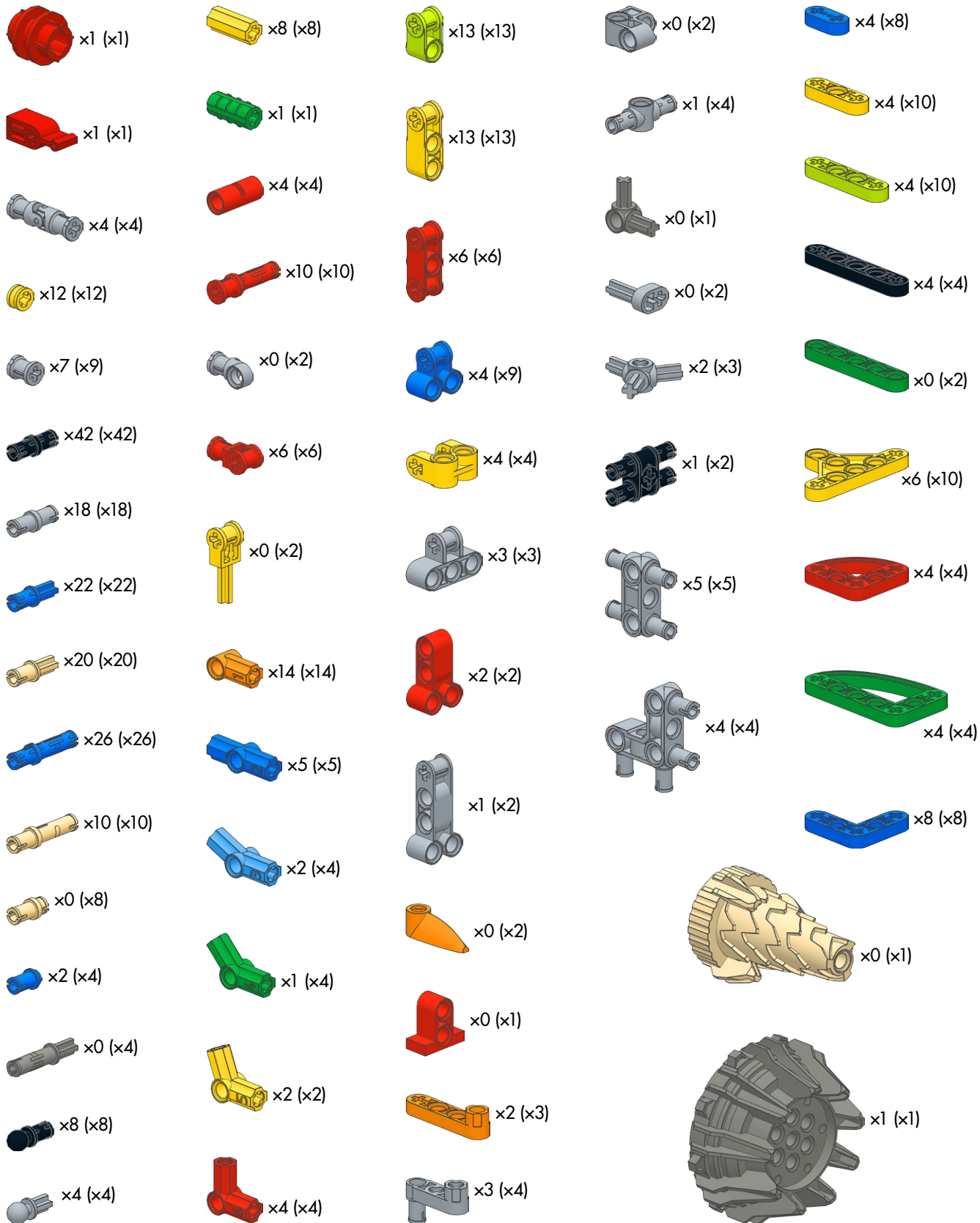
Parts list

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*).

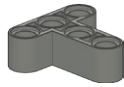








x16 (x16)



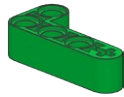
x4 (x4)



x2 (x2)



x2 (x2)



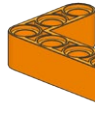
x10 (x10)



x2 (x2)



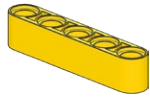
x4 (x6)



x6 (x8)



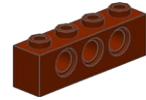
x0 (x2)



x10 (x10)



x4 (x4)



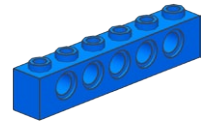
x2 (x5)



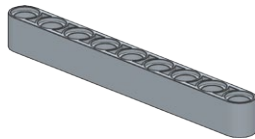
x6 (x7)



x4 (x4)



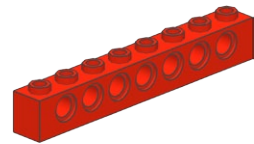
x0 (x4)



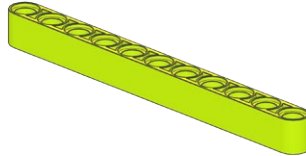
x6 (x6)



x4 (x4)



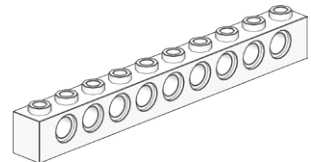
x4 (x4)



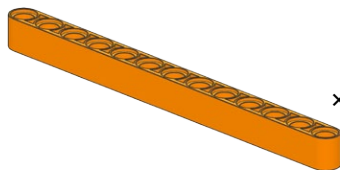
x6 (x6)



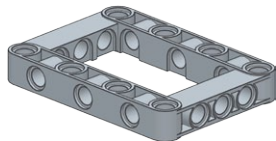
x2 (x2)



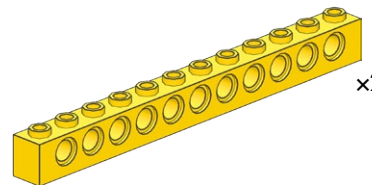
x2 (x2)



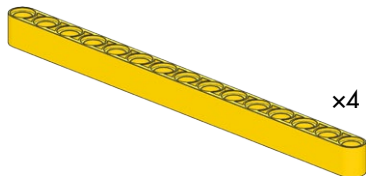
x2 (x2)



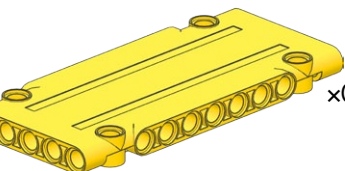
x0 (x1)



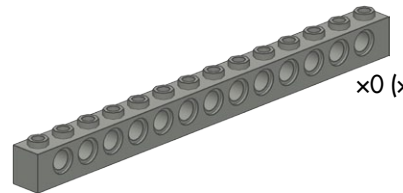
x2 (x2)



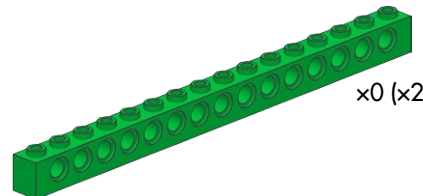
x4 (x4)



x0 (x3)



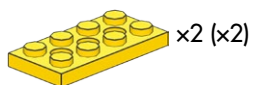
x0 (x2)



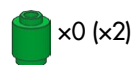
x0 (x2)



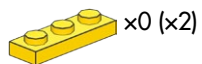
x2 (x2)



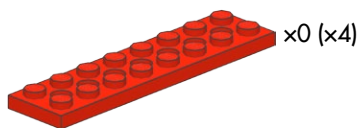
x2 (x2)



x0 (x2)



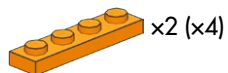
x0 (x2)



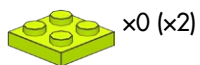
x0 (x4)



x1 (x1)



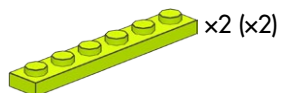
x2 (x4)



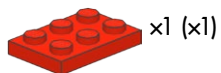
x0 (x2)



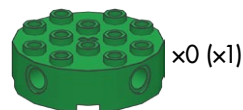
x1 (x1)



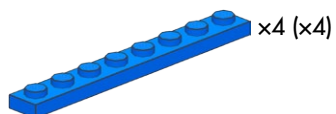
x2 (x2)



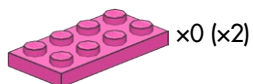
x1 (x1)



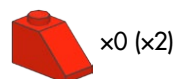
x0 (x1)



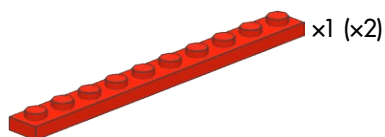
x4 (x4)



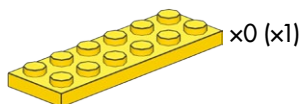
x0 (x2)



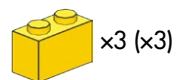
x0 (x2)



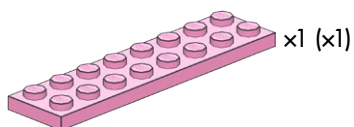
x1 (x2)



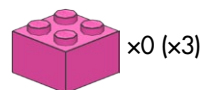
x0 (x1)



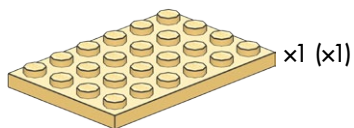
x3 (x3)



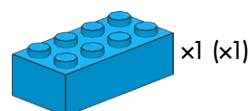
x1 (x1)



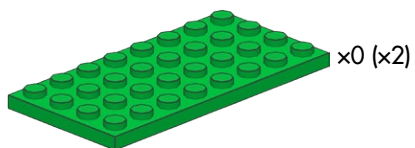
x0 (x3)



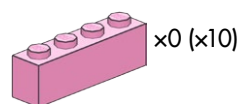
x1 (x1)



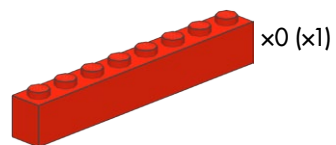
x1 (x1)



x0 (x2)



x0 (x10)



x0 (x1)

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

This second volume of *The LEGO® Power Functions Idea Book, Cars and Contraptions*, 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 four-wheel drive cars, adorable walking 'bots, steerable tanks, robotic inchworms, and cars that can follow the edge of a table!

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 gear systems, power translation, differentials, suspensions, 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.



THE FINEST IN GEEK ENTERTAINMENT™
www.nostarch.com

This book is not authorized or endorsed by the LEGO Group.

SHELVE IN: HOBBIES/LEGO

\$24.95 (\$28.95 CDN)

ISBN: 978-1-59327-689-8



9 781593 276898



5 2 4 9 5



6 89145 76893 0