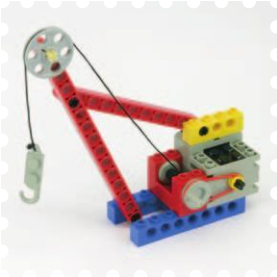
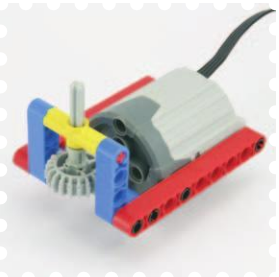
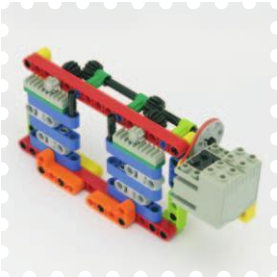


The LEGO® Technic Idea Book
SIMPLE MACHINES

Yoshihito Isogawa





no starch press

$19.95 ($22.95 CDN)
Shelve In: HOBBIES/GAMES

LEGO® Inspiration for All Ages

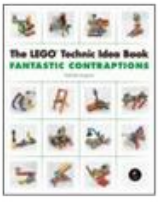
The LEGO Technic Idea Book: Simple Machines is a collection of hundreds of working examples of simple yet fascinating Technic models that you can build based on their pictures alone. Colors distinguish each part, showing you how the models are assembled. Each photo illustrates a different principle, concept, or mechanism that will inspire your own original creations.

The Technic models in *Simple Machines* demonstrate basic configurations of gears, shafts, pulleys, turntables, connectors, and the like. You'll learn how to create small, elegant machines like cranes, operable doors, motorized cars, a rubber band–powered rocket launcher, a hand-cranked drag racer, and even musical instruments.

This visual guide, the first in the three-volume *LEGO Technic Idea Book* series, is the brainchild of master builder Yoshihito Isogawa of Tokyo, Japan. Each title is filled with photos of Isogawa's unique models, all of which are designed to fire the imaginations of LEGO builders young and old.

Imagine. Create. Invent. Now, what will you build?

Visit *http://nostarch.com/technic/* to view videos of many of this book's projects and to join the discussion!



VOLUME 1

The LEGO® Technic Idea Book
SIMPLE MACHINES

Yoshihito Isogawa

no starch press

The LEGO® Technic Idea Book: Simple Machines. Copyright © 2011 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.

Fourth printing

Printed in Canada

15 14 13 12 4 5 6 7 8 9

ISBN-10: 1-59327-277-4
ISBN-13: 978-1-59327-277-7

Publisher: William Pollock
Production Editor: Serena Yang
Cover and Interior Design: Yoshihito Isogawa and Octopod Studios
Technical Reviewer: Sumiko Hirano
Compositor: Octopod Studios

For information on book distributors or translations, please contact No Starch Press, Inc. directly:
No Starch Press, Inc.
38 Ringold Street, San Francisco, CA 94103
phone: 415.863.9900; fax: 415.863.9950; info@nostarch.com; www.nostarch.com

Library of Congress Cataloging-in-Publication Data

Isogawa, Yoshihito.
Simple machines / by Yoshihito Isogawa.
p. cm. -- (The LEGO Technic idea book ; 1)
ISBN-13: 978-1-59327-277-7
ISBN-10: 1-59327-277-4
1. Gearing. 2. LEGO toys. I. Title.
TJ184.I87 2010
621.8'33--dc22

2010024747

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 configuration, 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.

This book is full of little seeds for ideas.
It is you who will cultivate those seeds
so they grow into wonderful masterpieces.

Yoshihito Isogawa

Contents

Introduction ix
Note to Parents x
Where to Find Parts x

Part 1

4

Gears

What is a gear? 4
Counting teeth 5
Different kinds of teeth 5
Even more gears 6
Pulleys are gears without teeth 7

8

Shafts and Connectors

Measuring gears 8
Measuring shafts 8
Pegs and connectors 9
Various shafts and connectors 9

10

Gear Combinations

Going from small to large gears 10
Going from large to small gears 11
Combining gears in different ratios 12

26

Gears in a Turntable

Using gears inside the cogs of a turntable 26

28

Gears in Series

Many gears in series 28
Attaching different gears to the same shaft 29

30

Angled Gears

Using gears to change the angle of rotation · · · · · · · · · · · · 30

40

Worm Drives

Using worm drives · 40

Part 2

48

Chains and Treads

Transmitting rotational power with chains · · · · · · · · · · · · · · 48

Transmitting rotational power with caterpillar treads · · · · · · · 50

52

Rubber Bands

Various rubber bands · 52

Transmitting rotational power with rubber bands · · · · · · · · · 52

56

Rack-and-Pinion Gears

Changing rotational motion into linear motion with rack-and-pinion gears · 56

60

Moving To and Fro

Translating rotational motion into reciprocal motion · · · · · · · 60

66

Moving Freely

Transmitting rotational power in any direction · · · · · · · · · · · 66

72

Going the Distance

Transmitting power over distance using many gears · · · · · · · 72

Using chains · 73

Using rubber bands · 74

Using shafts · 75

Part 3

78

Motors and Gears

Combining motors and gears · 78

90

Building in Any Direction

Combining pieces so you can build in any direction · · · · · · · 90

100

Strong Combinations

Making strong combinations! · 100

102

Two Simple Chassis

What can we make with a simple chassis? · · · · · · · · · · · · · 102
A car with windows · 103
A Formula One racer · 103
A paneled car (with tiles) · 103
A hot rod · 103
What can we make with another chassis? · · · · · · · · · · · · · 104
A car with pipes · 105
A rocket car · 105
A monster car—with claws! · 105
A car with a hood and a trunk · 105

Part 4

108

Doors

Two doors opened by turning a handle · · · · · · · · · · · · · · 108
Swinging doors · 109
A door opened by pushing a plate · · · · · · · · · · · · · · · · · 110
An automatic sliding door with a motor and rack gears · · · 112
A little garage door · 114
A vault door · 116
A door that closes itself · 117
A door with a key · 118

A door that catches like a "real" door 120
Little car doors 122
Gull-wing car doors 124

126

Pulley Systems

Lifting a load with thread 126
Various winches 128
Making your own winches 128
Simple cranes 130
The mysterious crane 132
A crane using chains 133
The mysterious crane using chains 134

136

Rubber Band Power

Launching a rocket with a rubber band 136
A windup car 138
A hand-cranked drag racer 140

142

More Uses for Gears

Changing the speed between two parallel shafts 142
Increasing power between two perpendicular shafts 144
Increasing power between two parallel shafts 145
Using two crank shafts to move pistons 146
Always rotating in the same direction 147
Something like a bug foot 148
Something like a bird feather 149
Linear motion with worm gears 150
Growing and shrinking with worm gears 152

154

Making Music

A xylophone 154
A little guitar 155
A music box 156

INTRODUCTION

LEGO® Technic is designed to allow builders to create advanced models with moving parts, like those built with LEGO MINDSTORMS®. The *LEGO Technic Idea Book* series is a collection of unofficial LEGO building guides that offer hundreds of ideas and examples for building mechanisms with Technic. This volume focuses on gears and power transmission.

Building with LEGO

LEGO bricks aren't designed to fit in just one specific place, one particular way. Your imagination is your guide when building with LEGO, and you can put bricks and other LEGO pieces together in many ways to build an almost infinite number of creations. After building a model according to the instructions included with your set, try taking the model apart and using its pieces to create a variation of the model—or build a new one altogether. That's where the real world of LEGO begins.

My hope is that this book will give you some ideas to help you build your own original creations.

You Are the Creator

The LEGO Technic Idea Book: Simple Machines is full of photographs of mini-projects designed to show you various ways to build with LEGO gears and bricks. Combine these projects, add decorations, and change them to create your own unique masterpieces.

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 brick shapes. Judicious use of color can add real beauty to your models, and I've tried, wherever possible, to use colors in an artistic way. You don't need to use the colors I've chosen in your models; use whichever colors you want to use to make your projects your own.

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 photos of increasingly complex models that are designed to demonstrate building techniques. This is an idea book; it's about imagination. Rather than tell you what to see or think when you look at each photograph, I encourage you to interpret each one in your own way. If I were to tell you what to see, you would see things through my eyes. My hope is that you will see my models through your own eyes and that your interpretations will lead you to invent your own LEGO creations.

Join the Discussion!

View videos of many of this book's models, ask questions, and share your own designs at ***http://nostarch.com/technic/***.

NOTE TO PARENTS

Praise Your Child

When your child shows you their creations, take the time to really look at them together. Ask your child what they were focused on when building their model or what they wanted to accomplish. Offer your child sincere praise about their work and address aspects of the model that impress or surprise you. Talent is fostered by praise. Encourage and praise your child, and watch their talent shine through.

Express Your Feelings

Talk to your child about their creations. Ask them to show you how things move and how the parts fit together. Have them explain how they came up with their design. Your words can serve as hints or advice for your child, planting the seeds for new ideas.

Play with Your Child

Make things with your child. Offer ideas and build together. For a challenge, compete against each other to build different versions of a model. It can be inspiring for your child to see what an adult can do. When competing with your child, always encourage them and explain your creations so that they can learn from your experience.

WHERE TO FIND PARTS

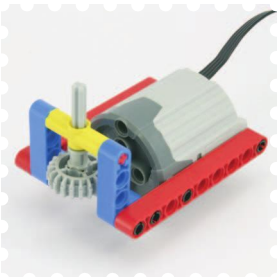
There are hundreds of models in The Lego Technic Idea Books, and you may not have all of the parts you need in order to build a particular model. If you are having trouble finding a specific piece, please visit ***http://nostarch.com/technic/*** for a list of parts and answers to questions that you may have (the information on this page is dynamic so check back for changes).

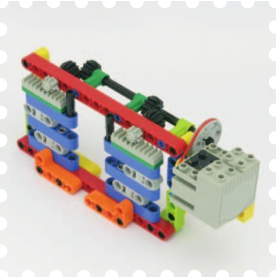
The parts list includes various Technic pieces used in this series, from basic gears and pins to harder-to-find treads, springs, and electric motors. Each part is accompanied by a picture and a link to the BrickLink website, where you can easily browse for and order any part you desire. For the more unique parts, I have also included some purchasing tips as well as specific page references to where each part is used in each book.

If you prefer to purchase a LEGO Technic set, please visit ***http://nostarch.com/technic/*** for a recommended list on the parts list page. This list will change as the LEGO Group frequently replaces their Technic sets, so check back for updates.

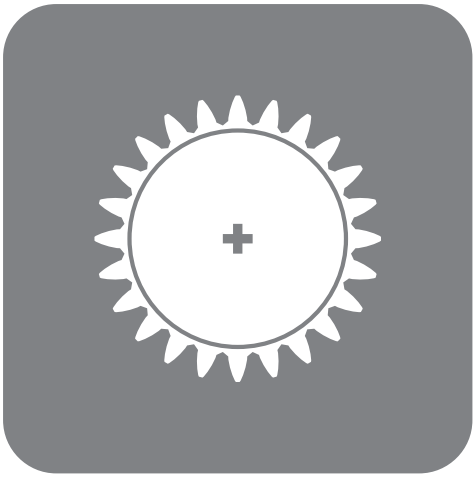
If you still cannot find a particular piece used in one of my models, try substituting your own parts. The models in this series are meant to inspire, and there is no one right way to build. I encourage you to explore and have fun.

PART 1



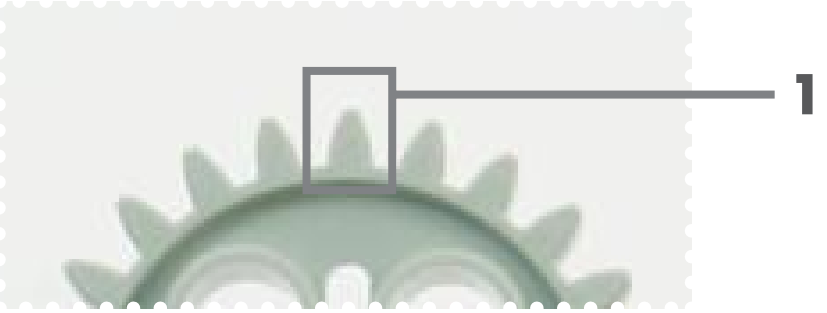


4
8
10
26
28
30
40



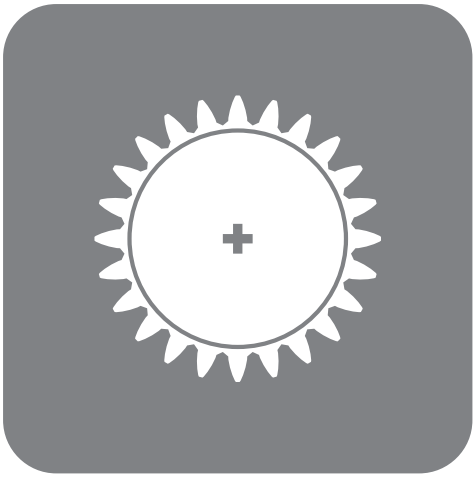
8 12 16 20 24

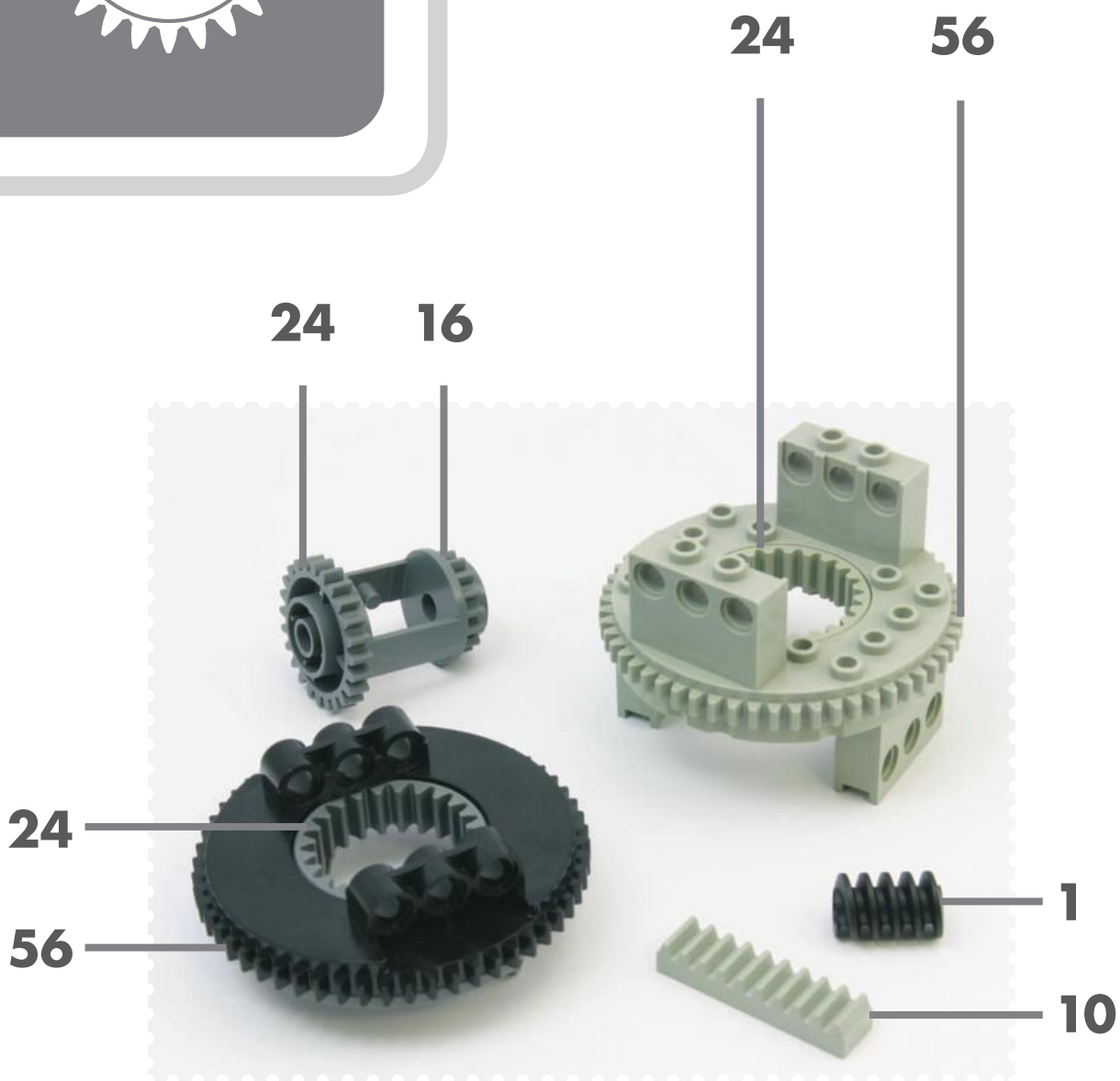
36 40

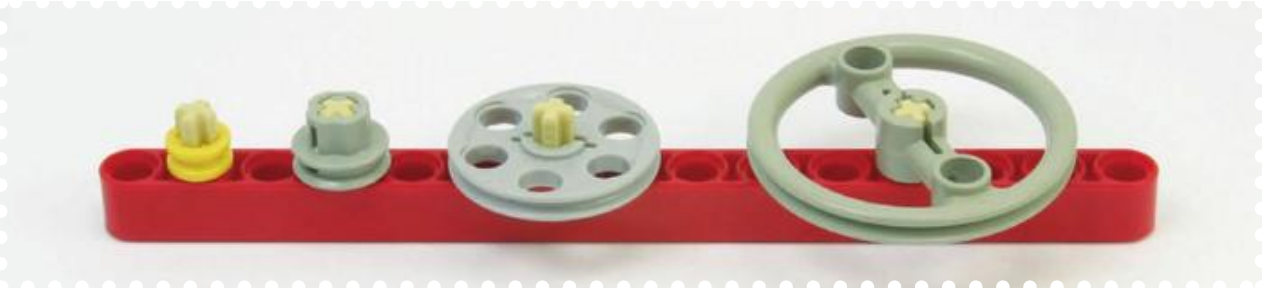


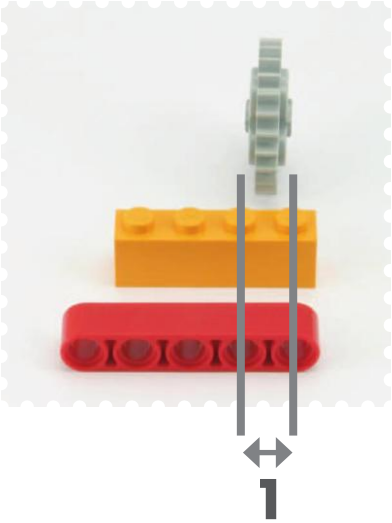
12 14 20 24

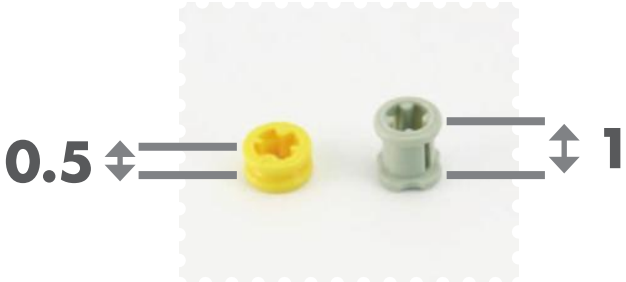
16 24 4

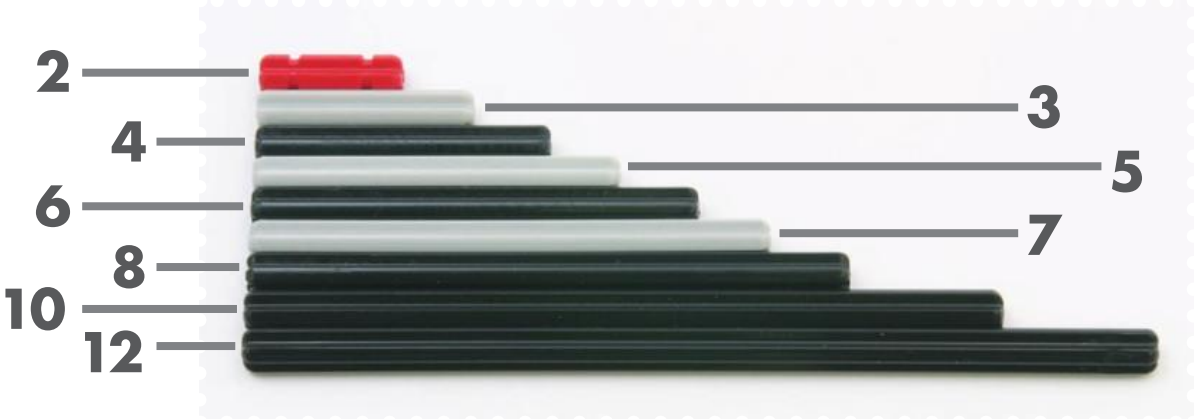


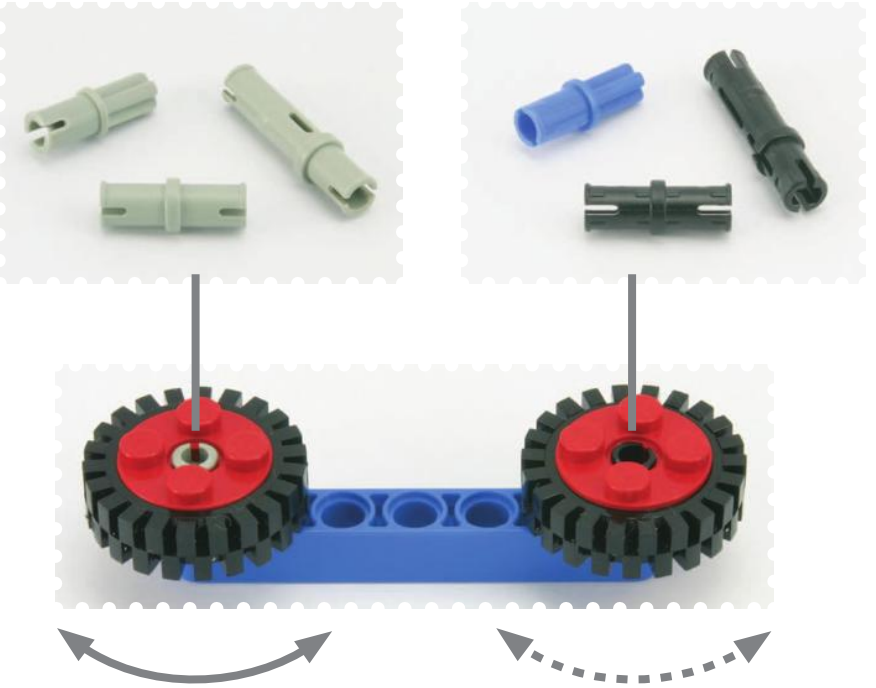

24
56
24
16
24
56
1
10

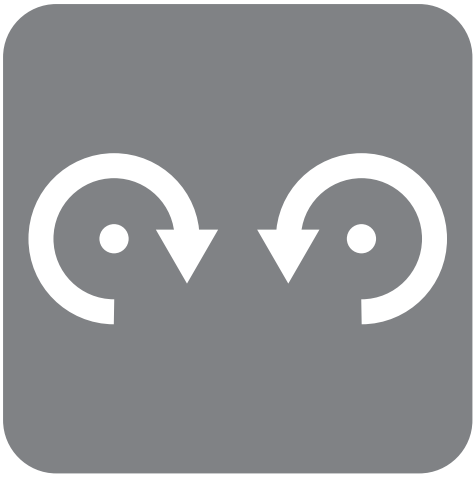


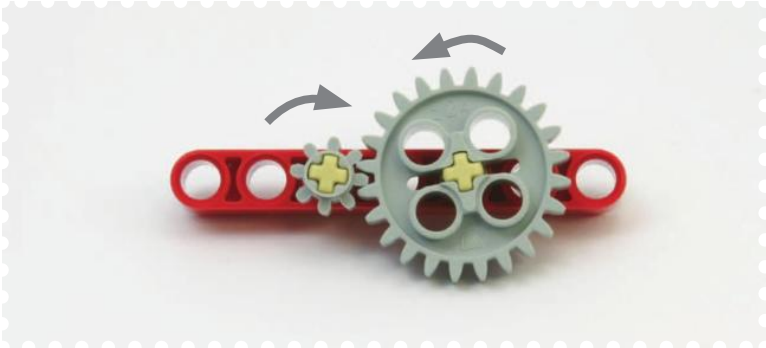

1

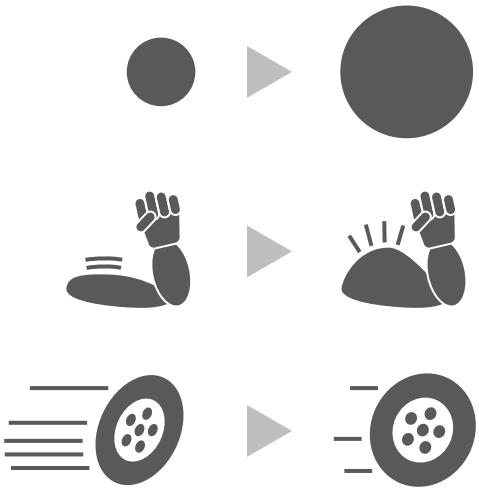

0.5
1


2
4
6
8
10
12
3
5
7

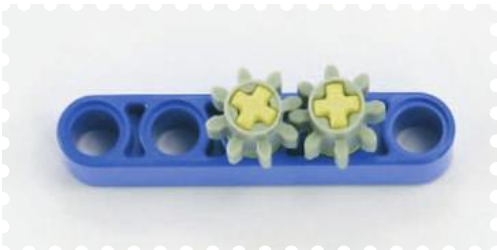


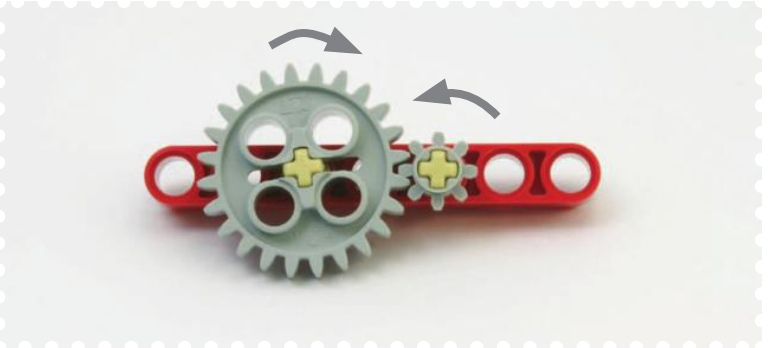


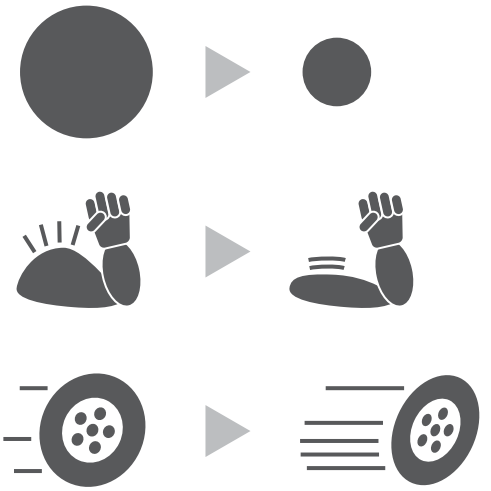




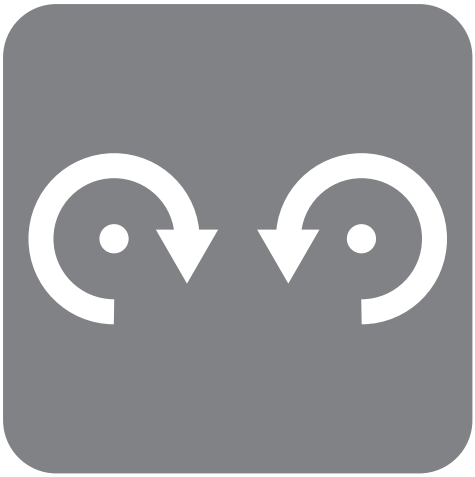
1 : 1



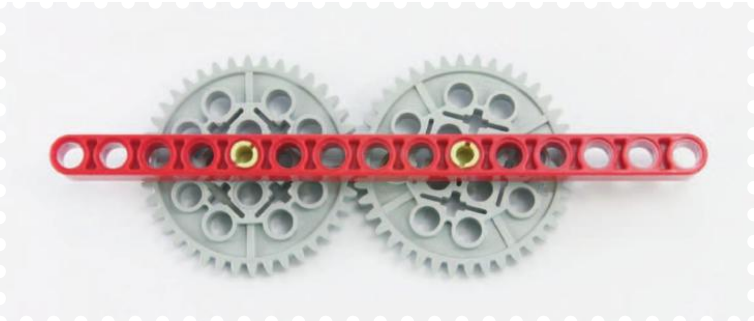




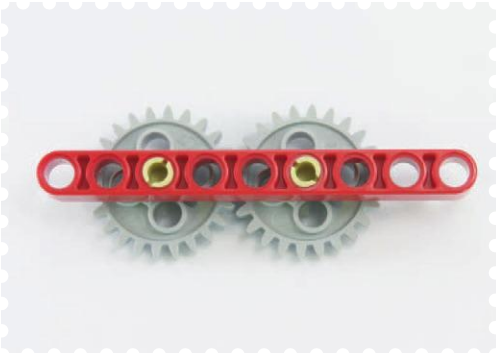
1 : 1



1 : 1



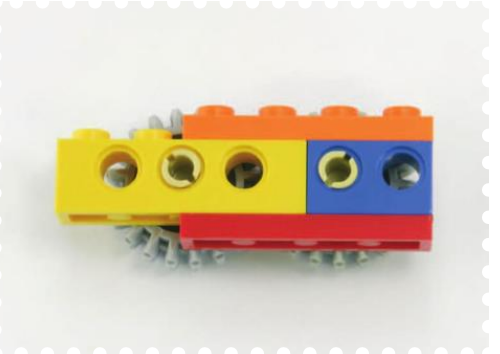
1 : 1



1 : 1

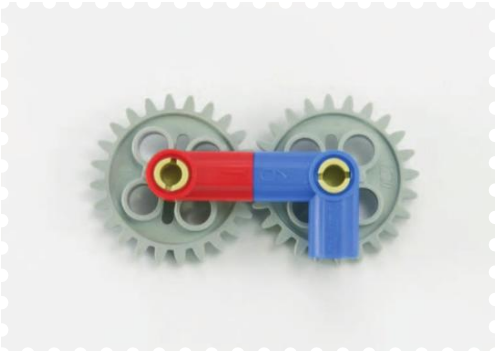
1 : 1

1 : 1

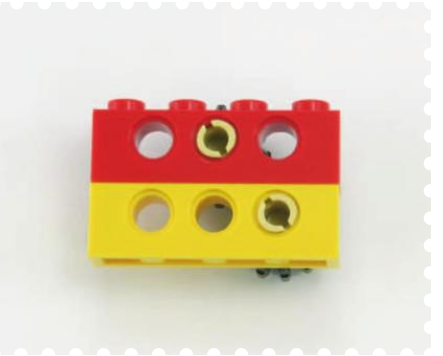


1 : 1

1 : 1



1 : 1



1 : 1

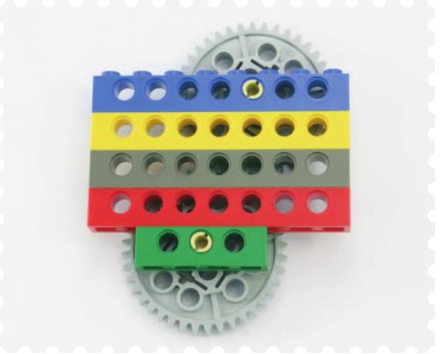
1 : 1

1 : 1

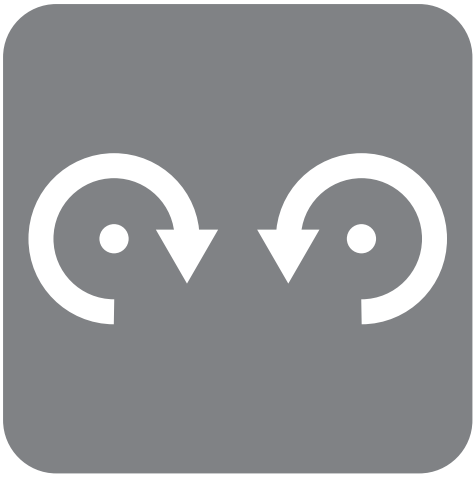
1 : 1

1 : 2

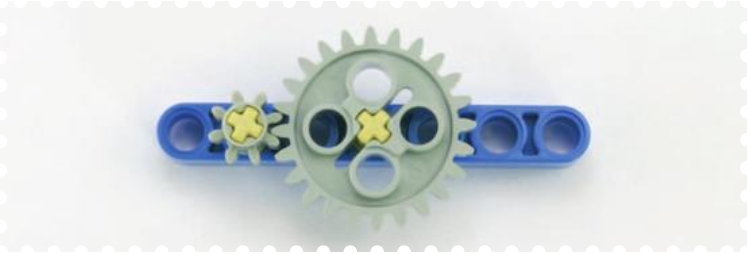
1 : 1

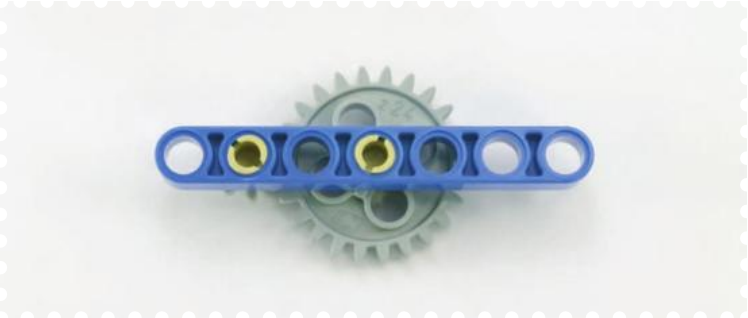


1 : 2



1 : 3

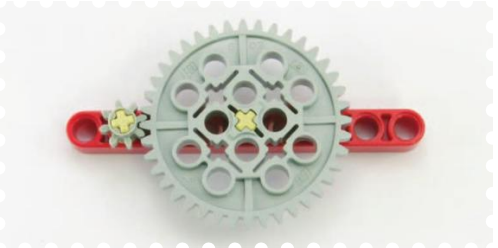


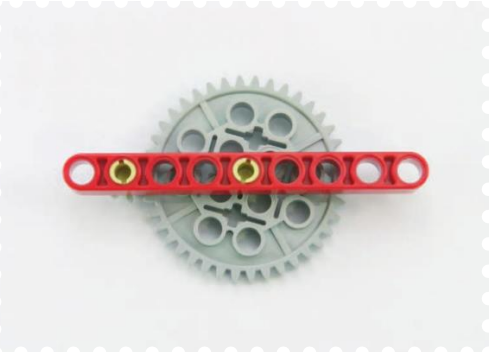


1 : 3

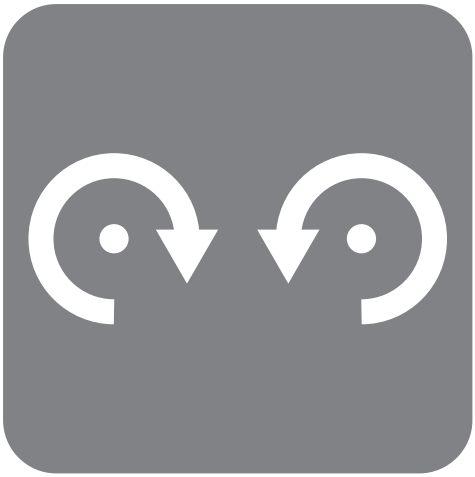
3 : 5

1 : 5





3 : 5



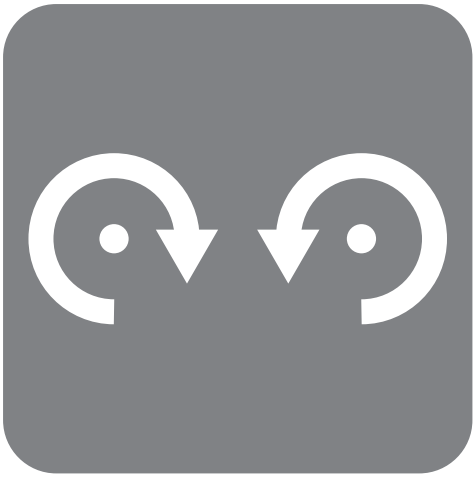
1 : 3

2 : 3

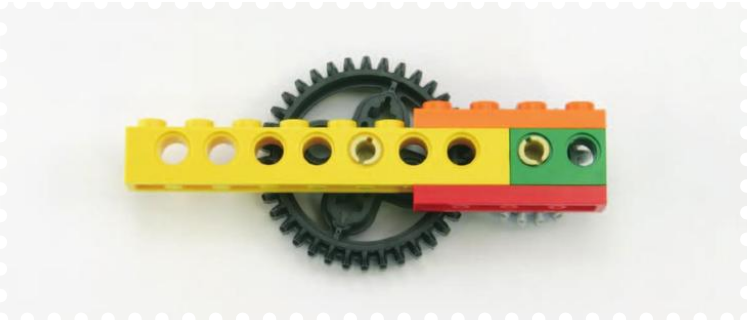
3 : 5

2 : 3

2 : 3



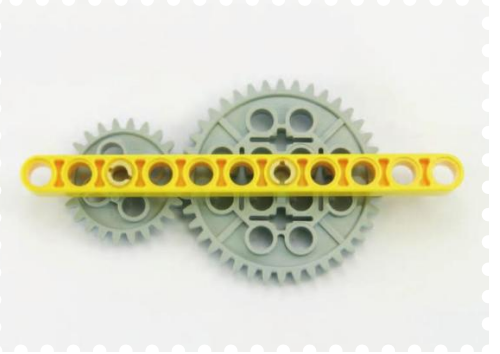
5 : 9



5 : 9

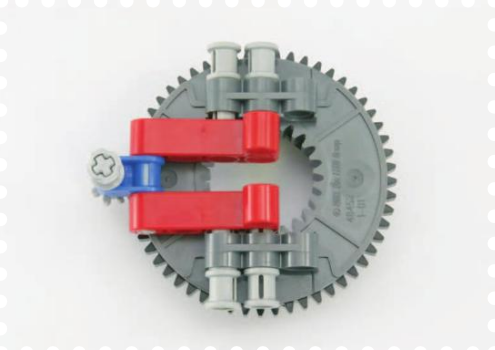
5 : 9

3 : 5

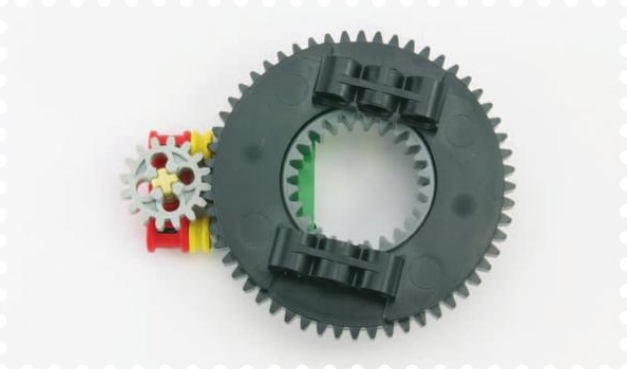


3 : 5

1 : 7

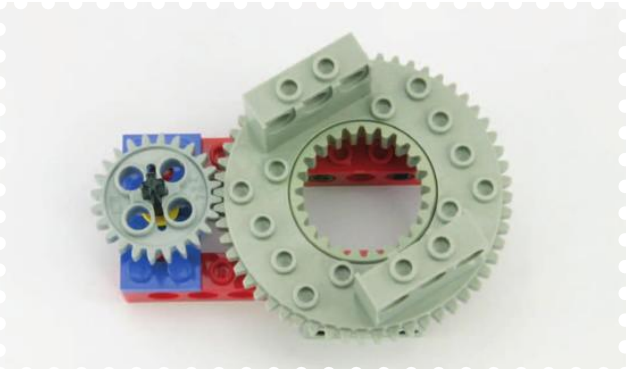


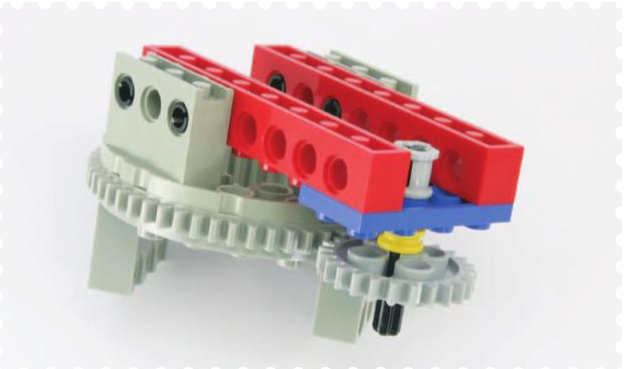
2 : 7



3 : 7

3 : 7



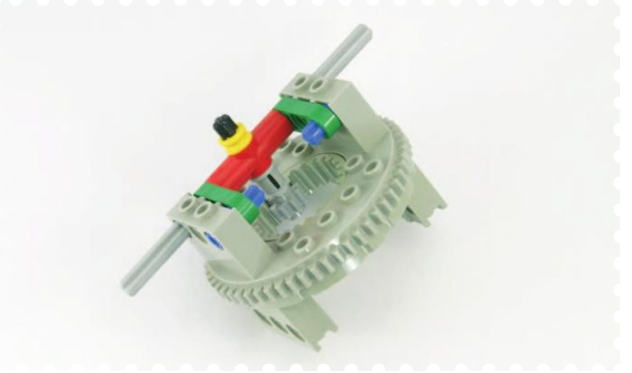


1 : 3

1 : 3

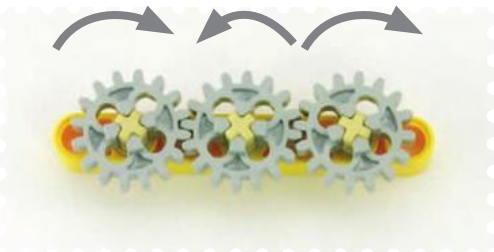
2 : 3

1 : 3

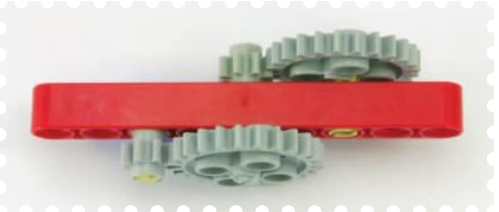


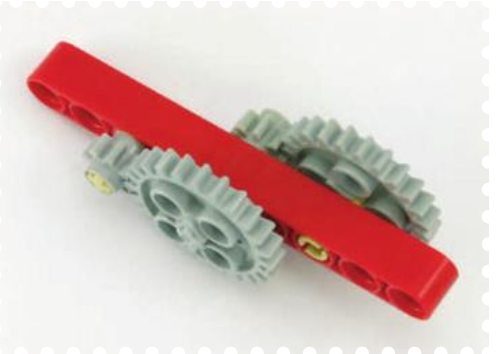
3 : 9 : 3 : 5 : 3

1 : 1 : 1



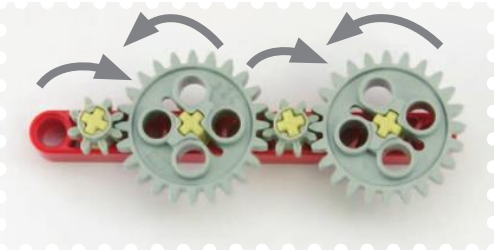
3 : 9





1 : 3

1 : 3 : 1 : 3



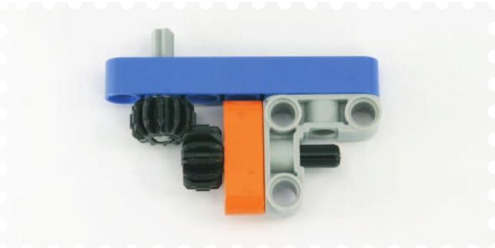
5 : 15

3 : 5

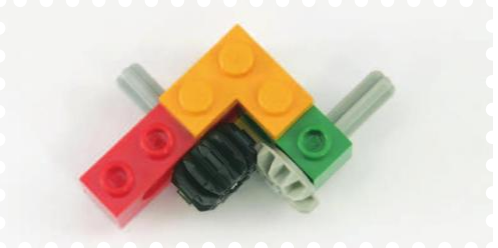
1 : 1

1 : 1

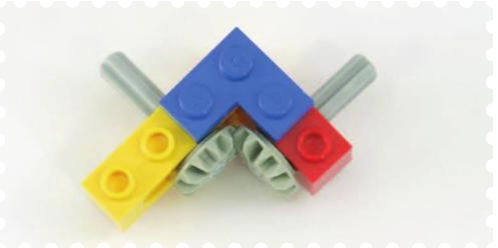
1 : 1



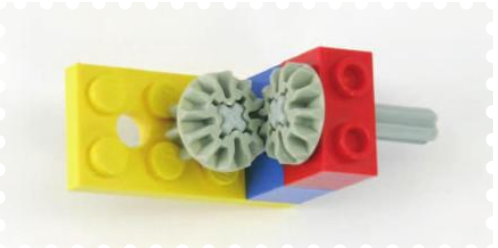
1 : 1

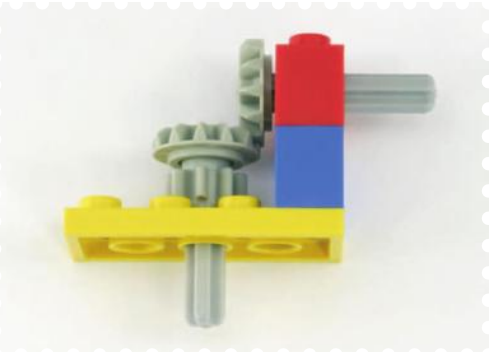


1 : 1



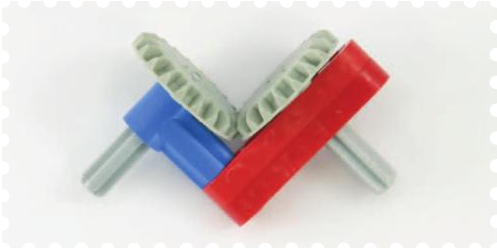
1 : 1



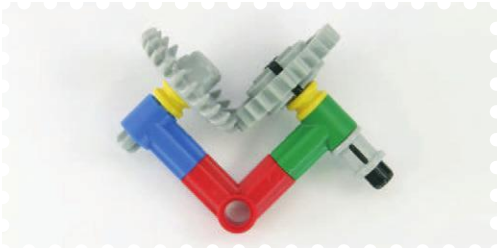


1 : 1

1 : 1

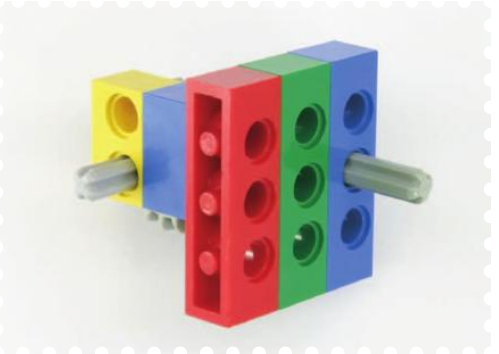


1 : 1

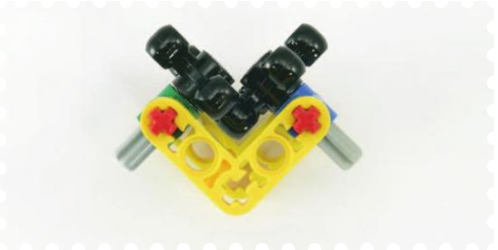


1 : 1

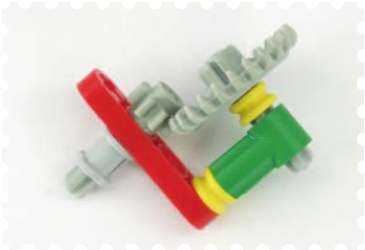
1 : 1



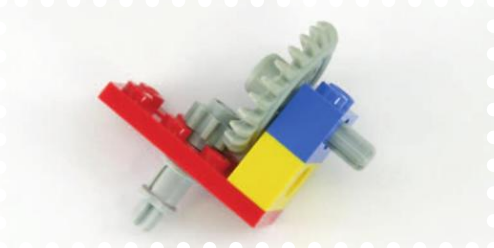
1 : 1



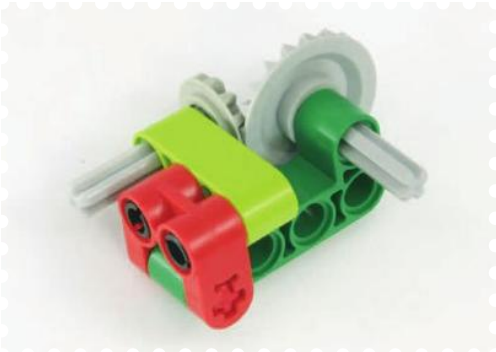
1 : 3



1 : 3

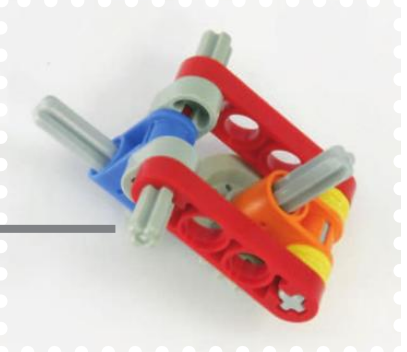


3 : 5



1 : 3

3 : 5



3 : 5

3 : 5

3 : 5

2 : 3

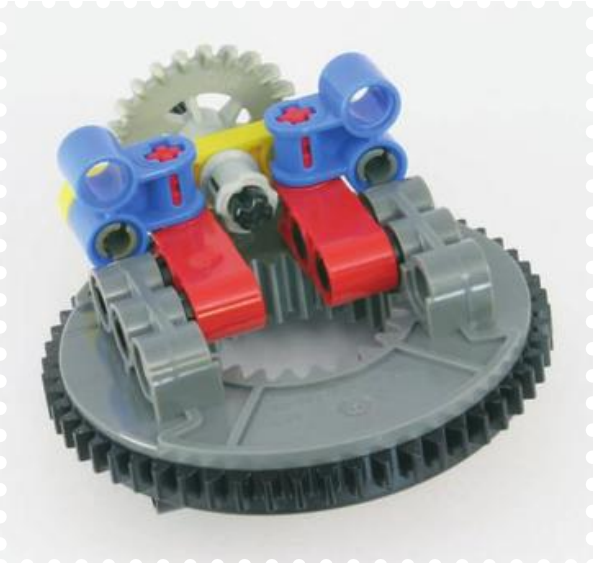
3 : 5

2 : 3

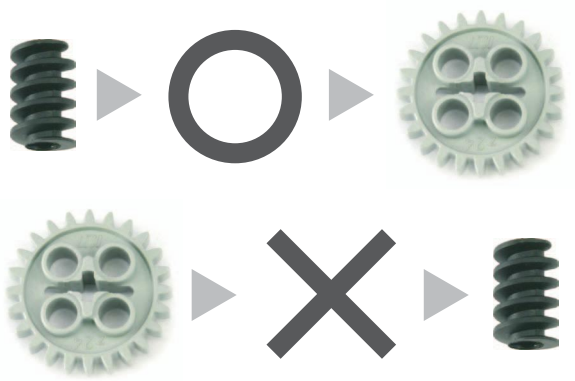
2 : 3

1 : 3

3 : 7



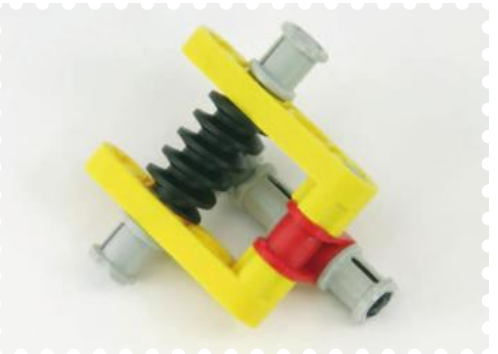
3 : 7



1 : 8

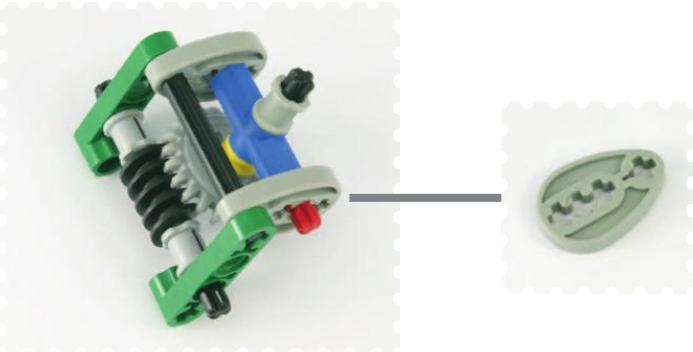
1 : 8

1 : 8



1 : 24

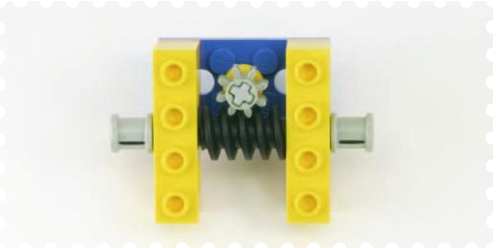
1 : 24



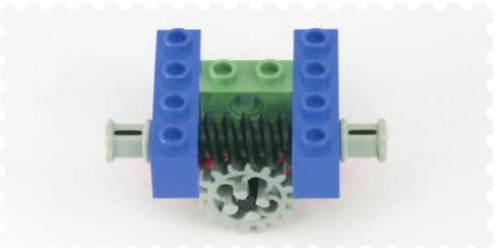
1 : 24

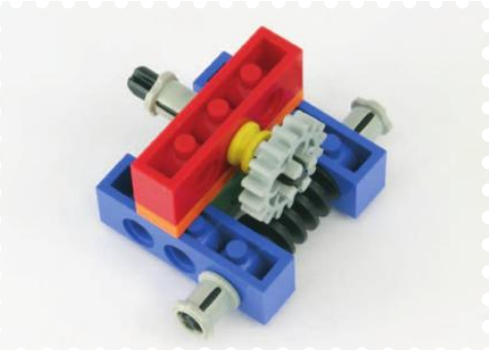
1 : 12

1 : 8



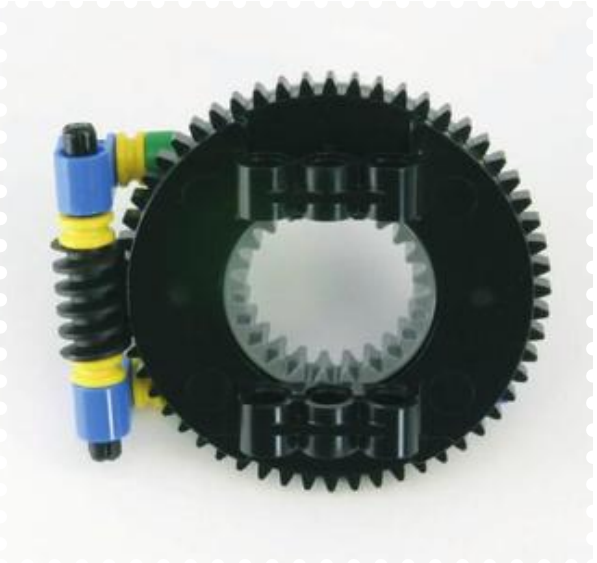
1 : 16





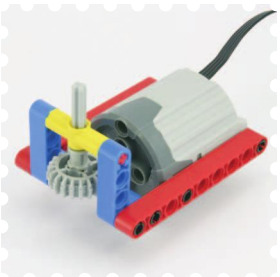
1 : 56

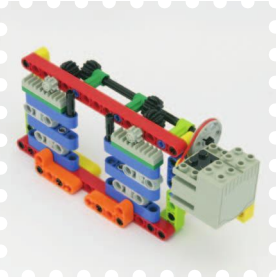
1 : 24



1 : 56

PART 2





48

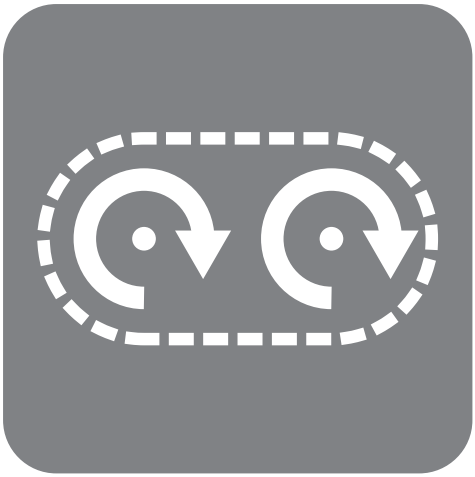
52

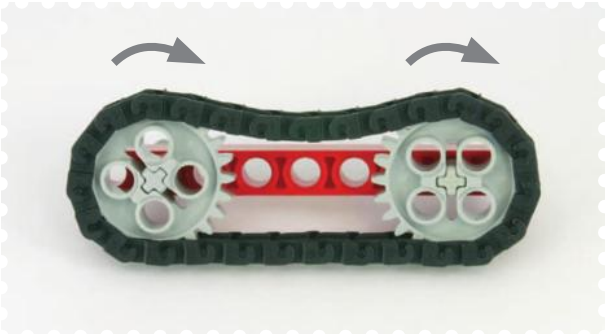
56

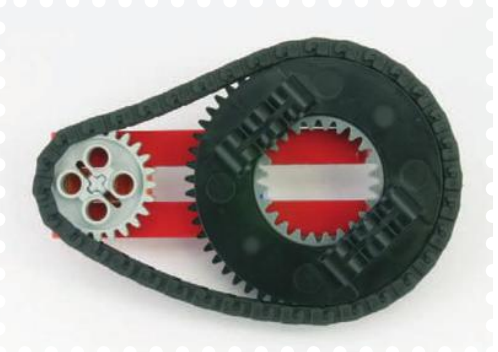
60

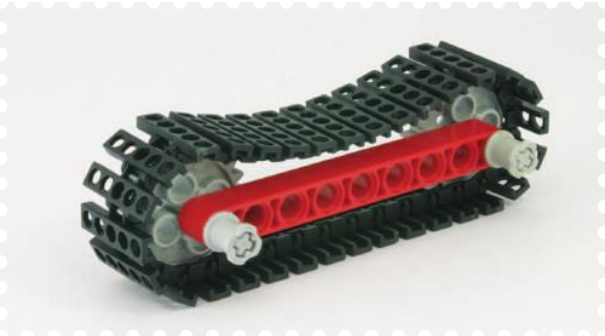
66

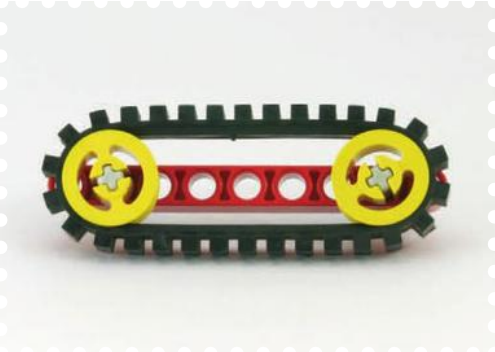
72

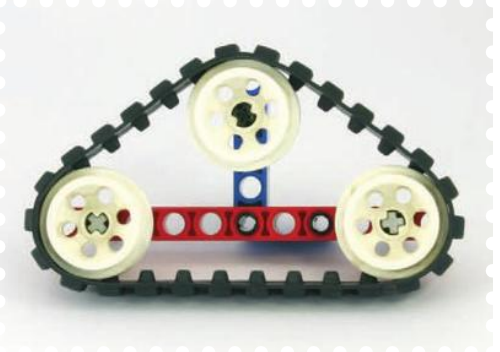


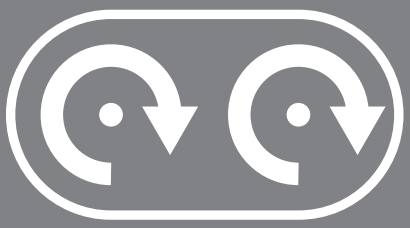


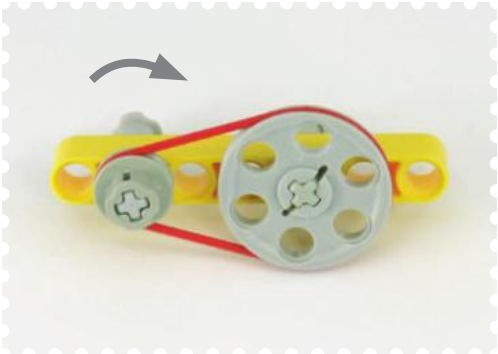


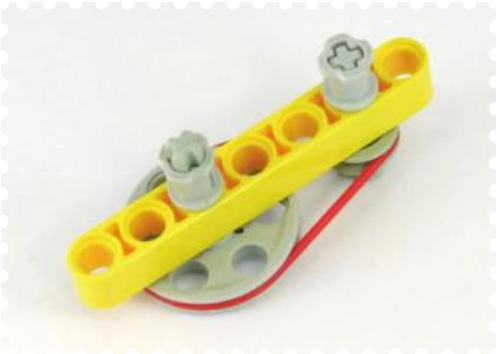


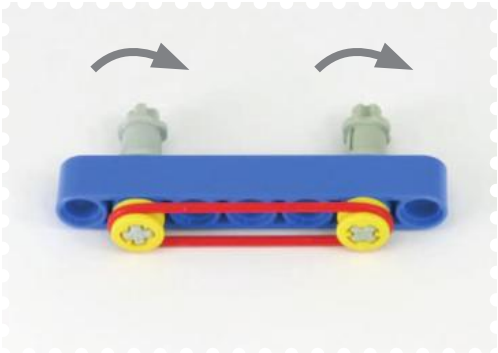


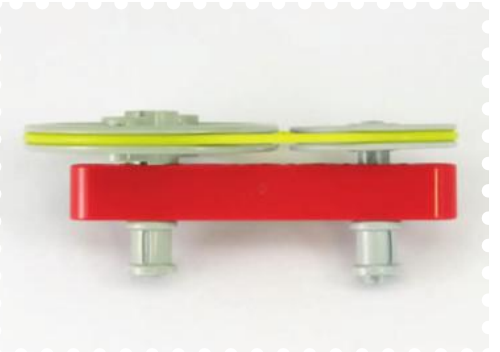


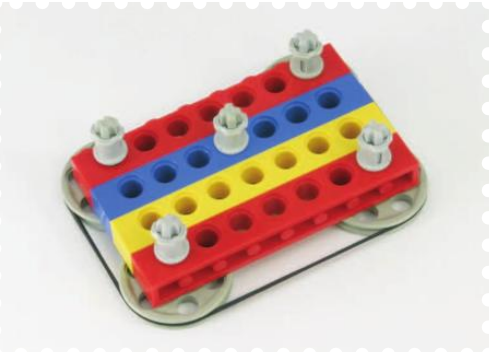


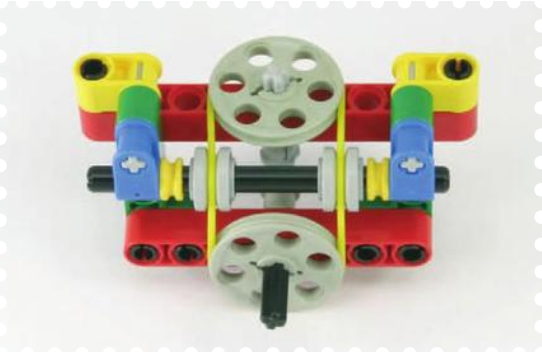


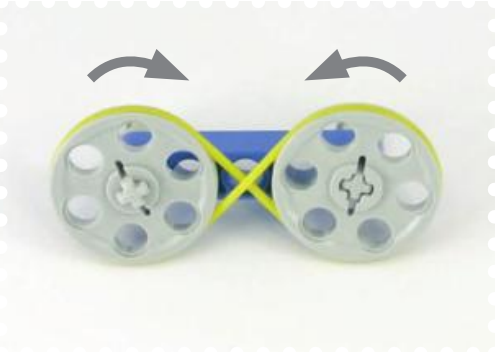


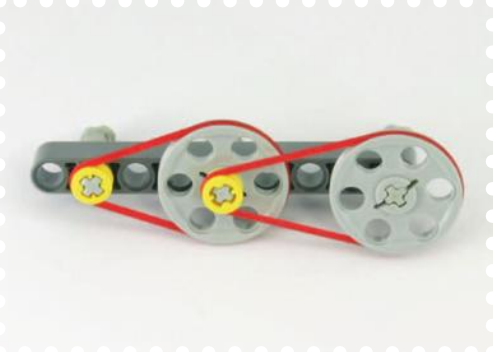


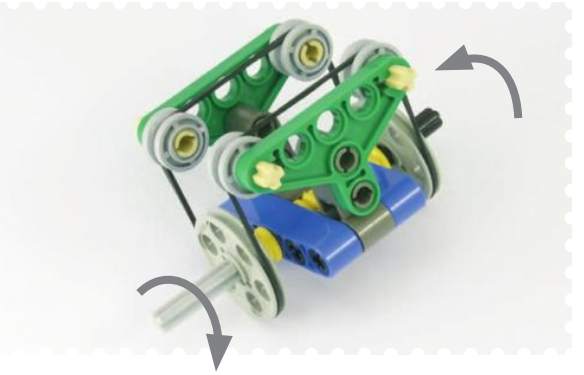


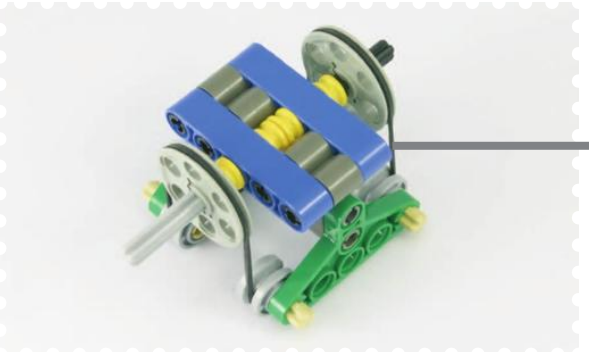


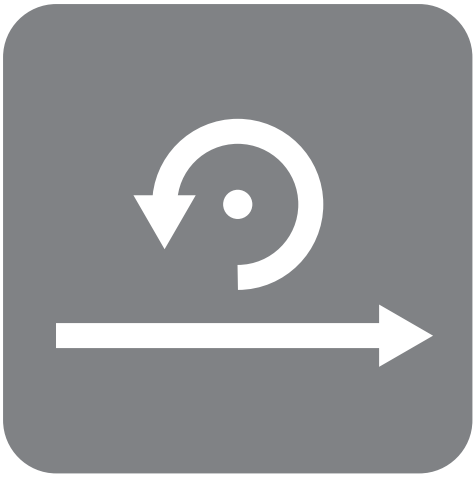


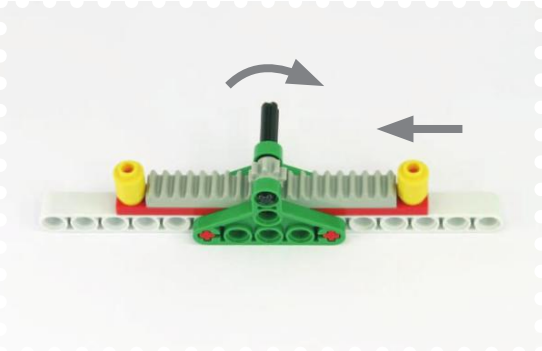


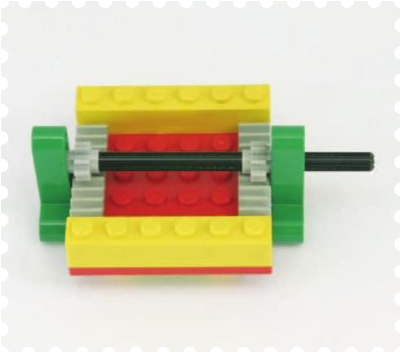


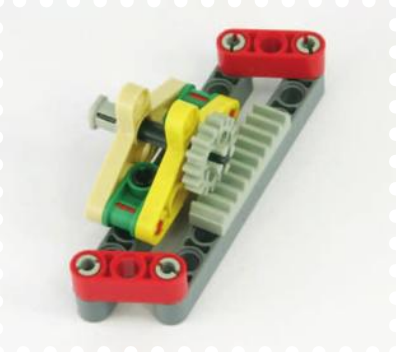


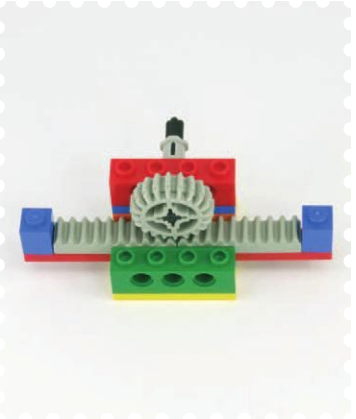


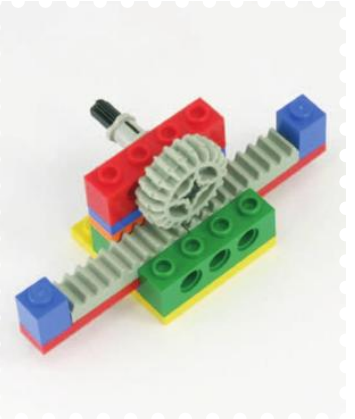


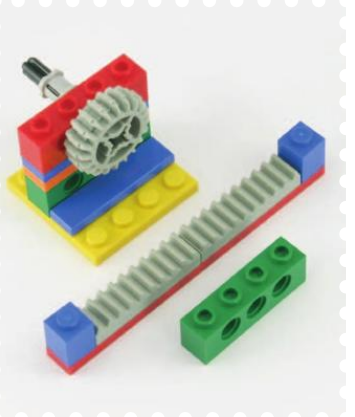


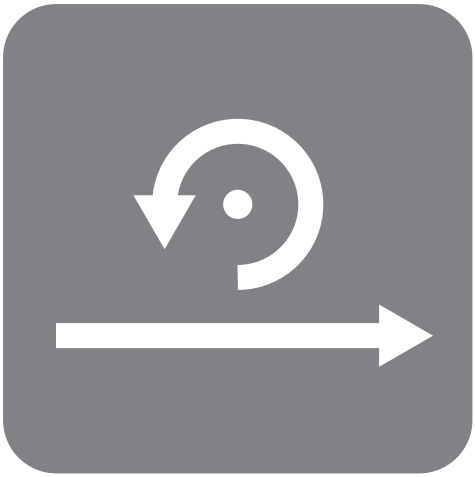


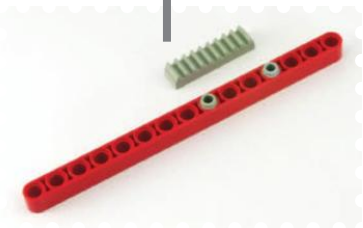


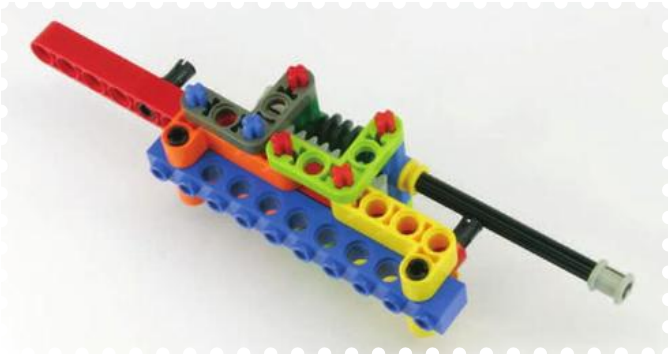


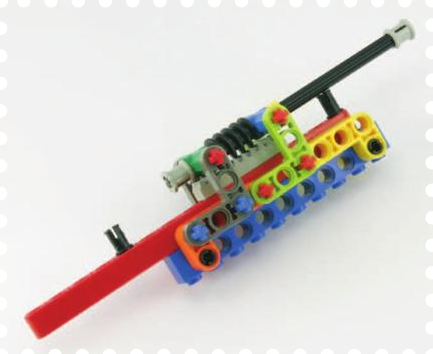


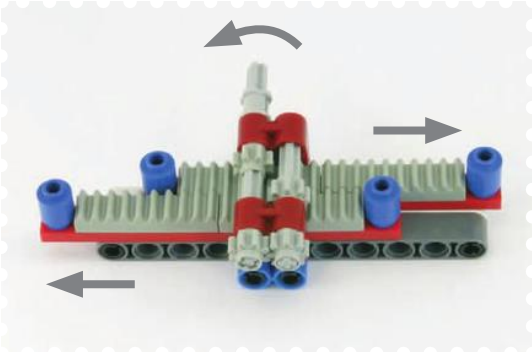


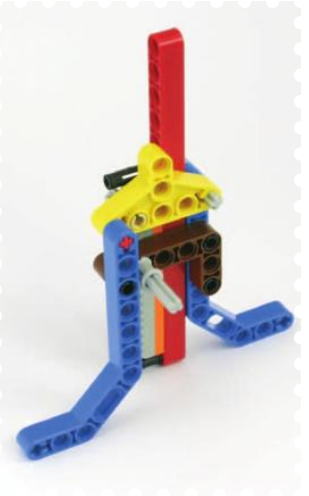


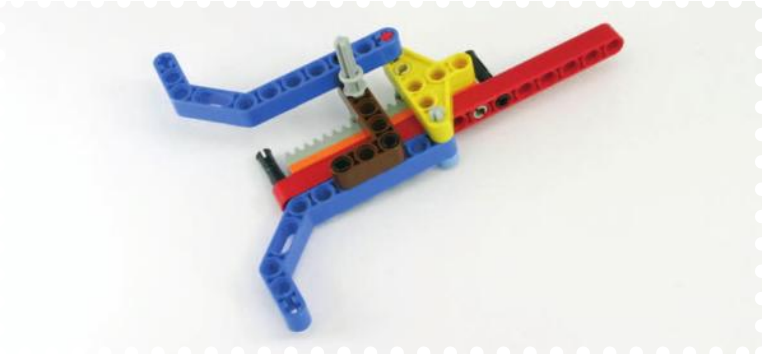


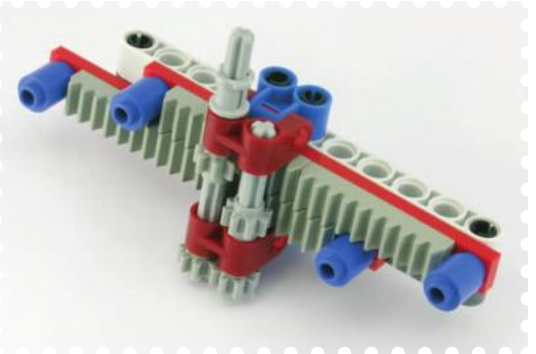


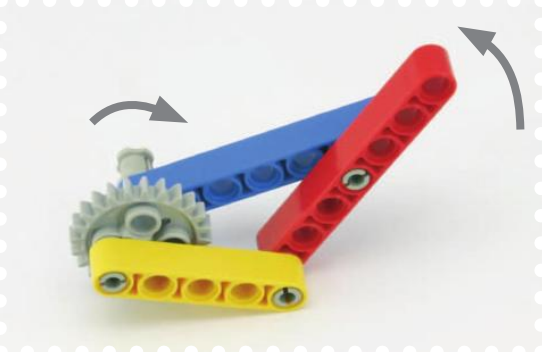


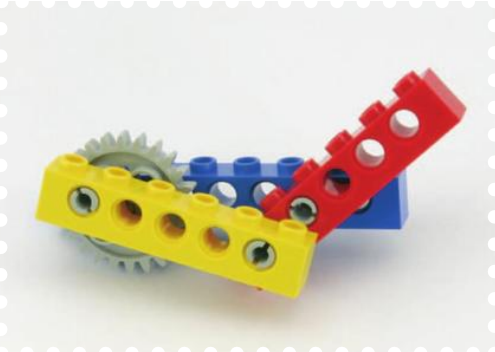


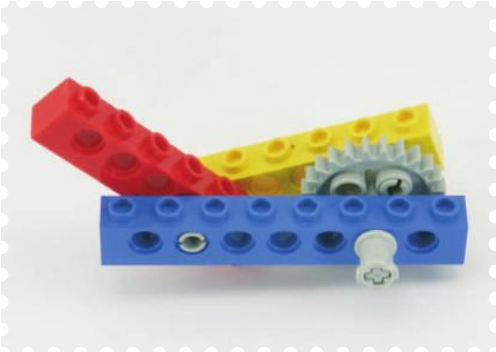


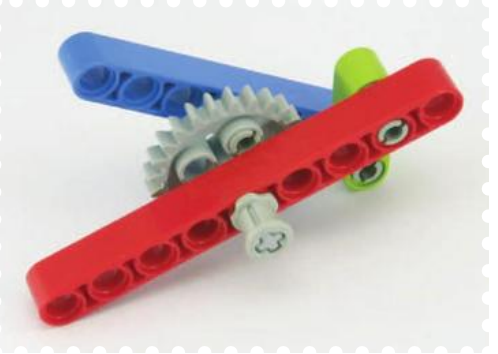


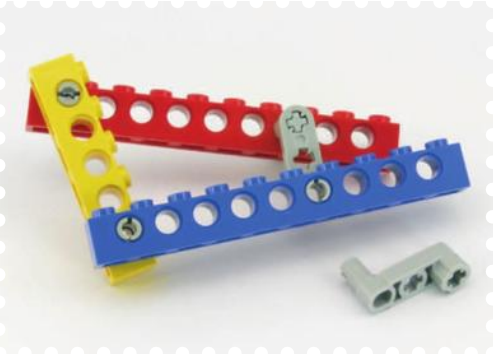


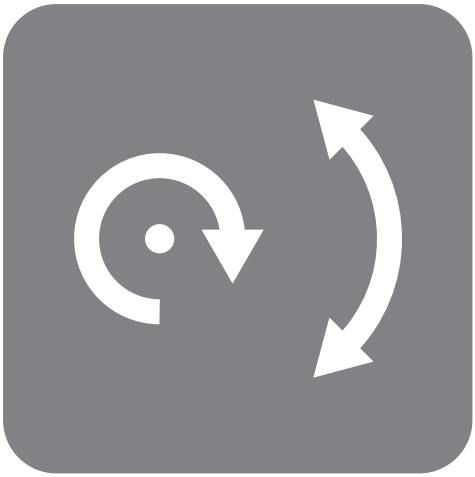


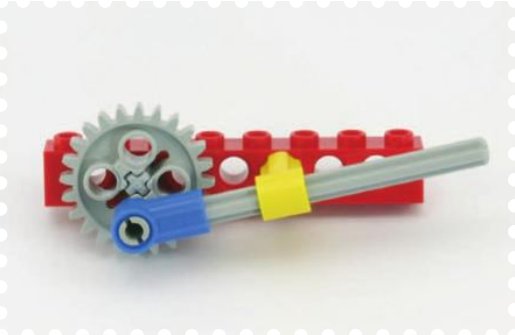


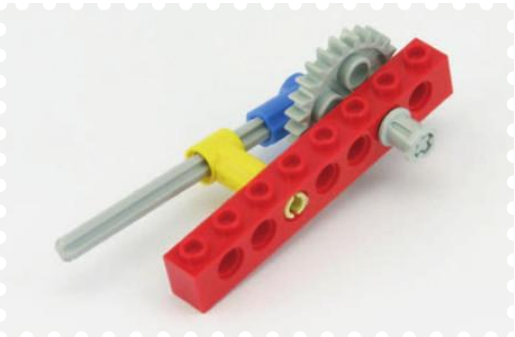


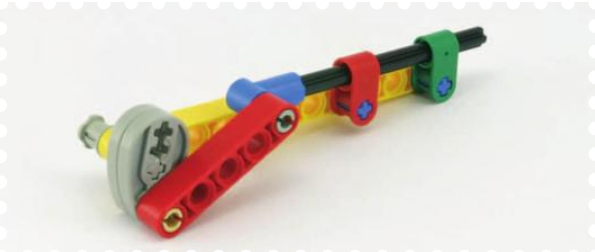


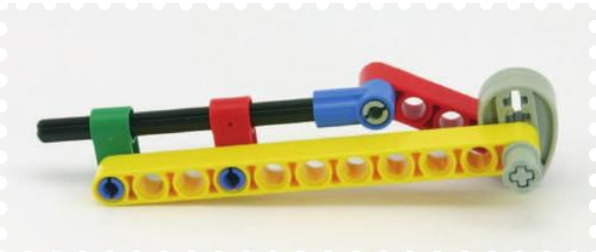


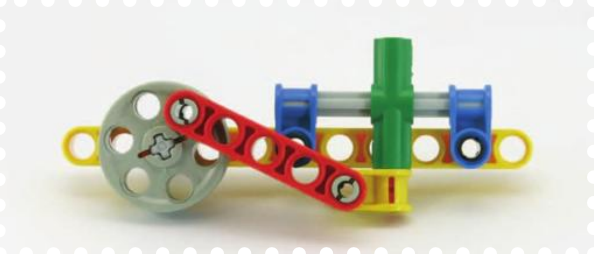


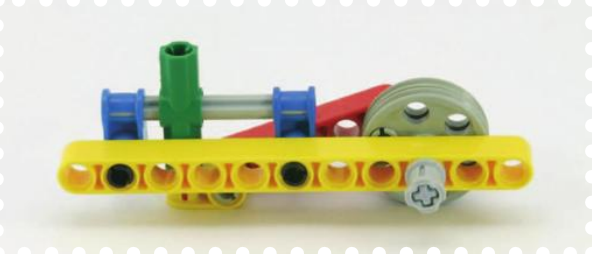


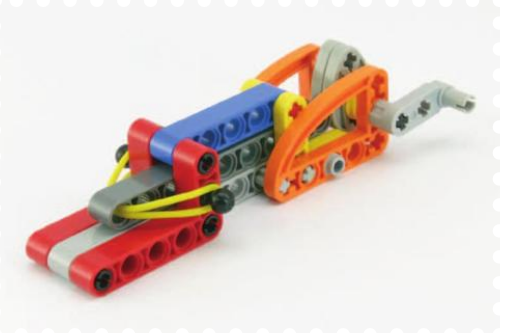


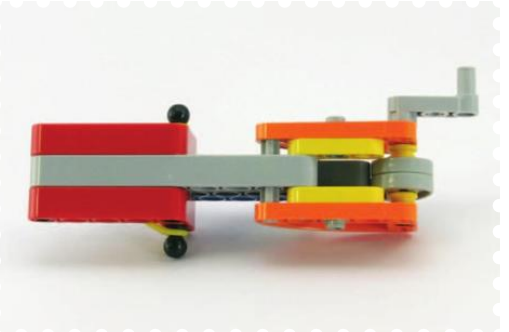


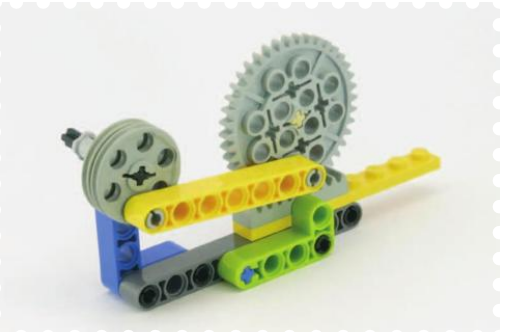
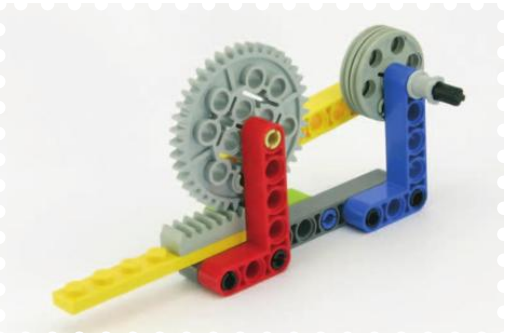
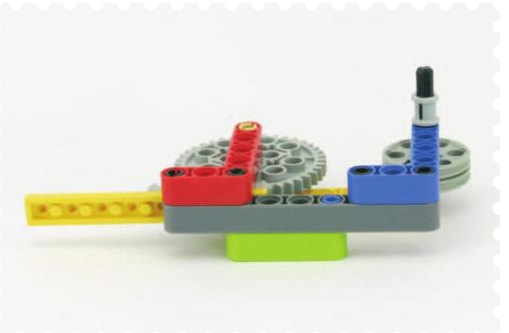


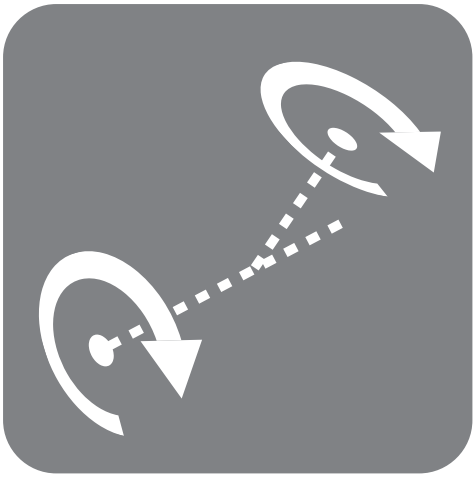


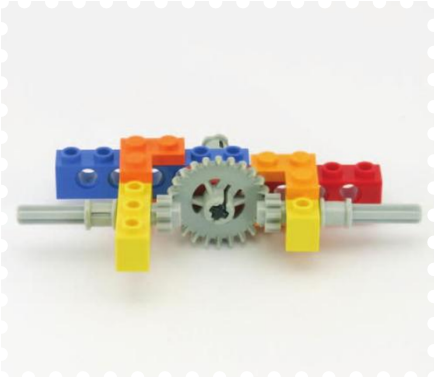


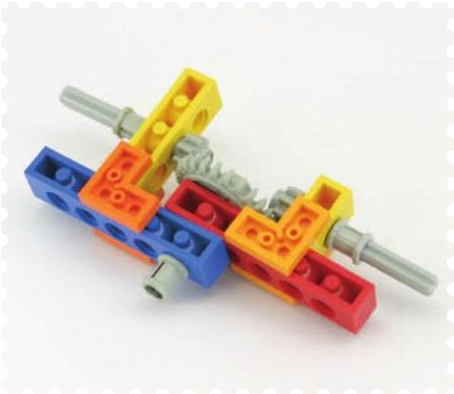


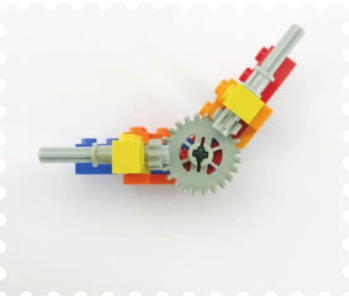


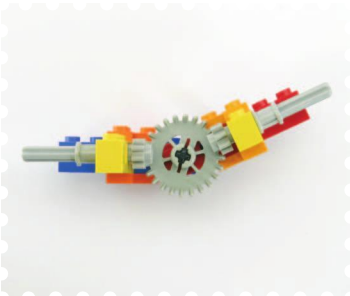




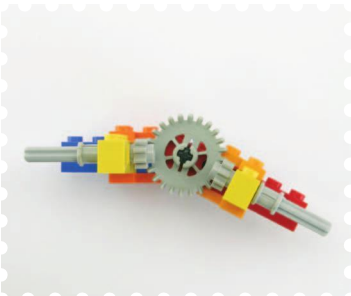


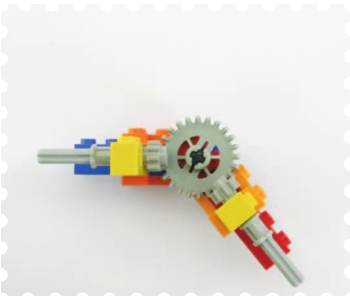


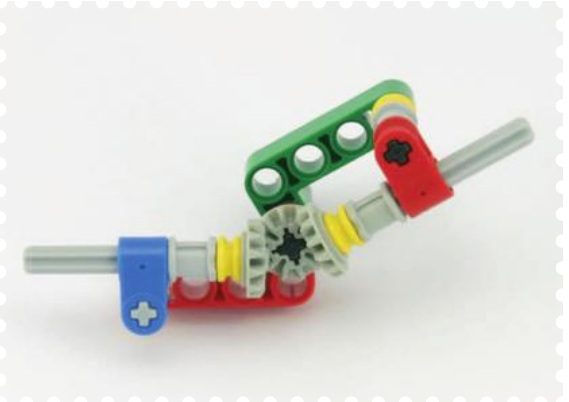


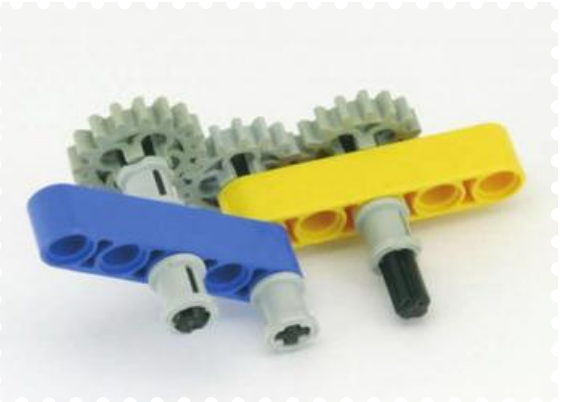


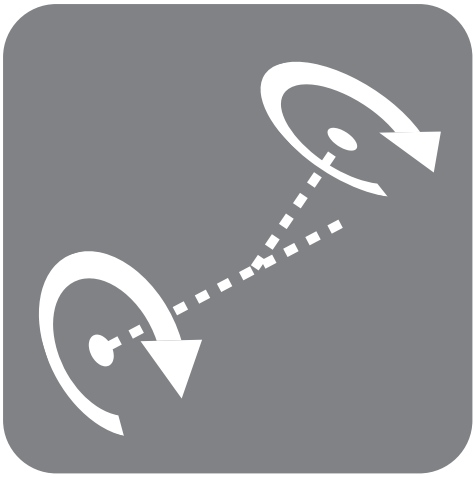


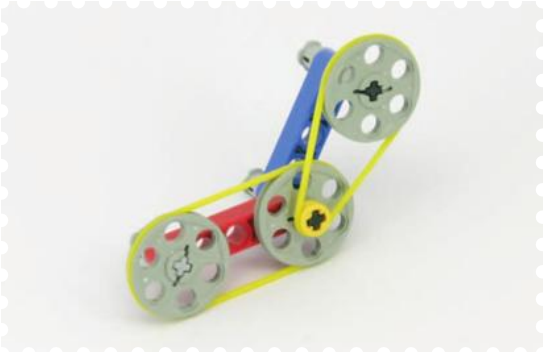


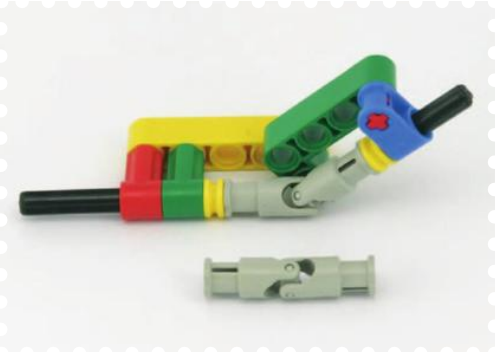


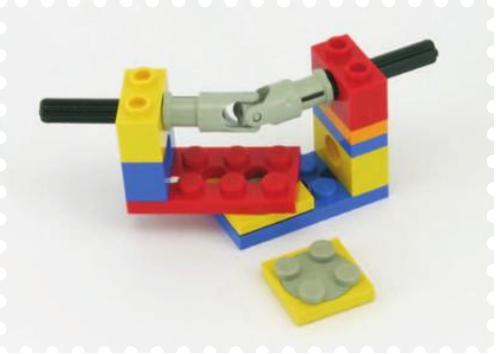


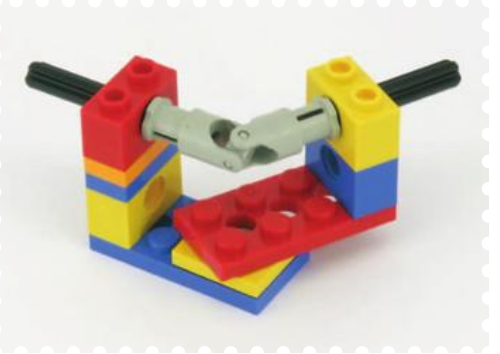


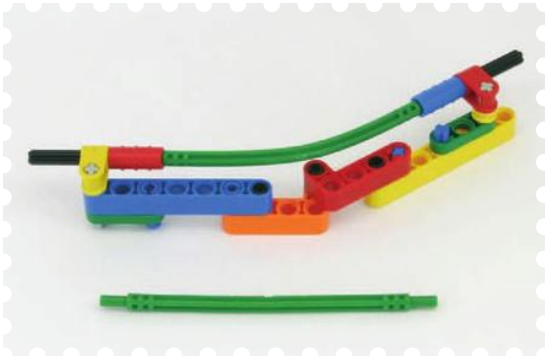


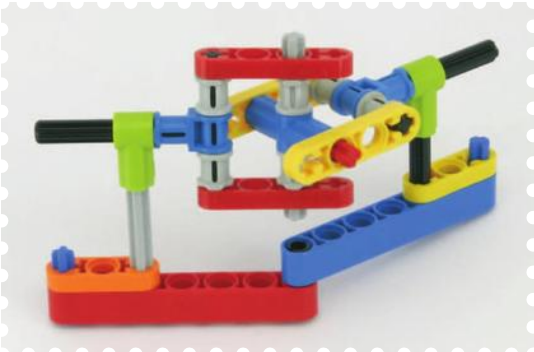


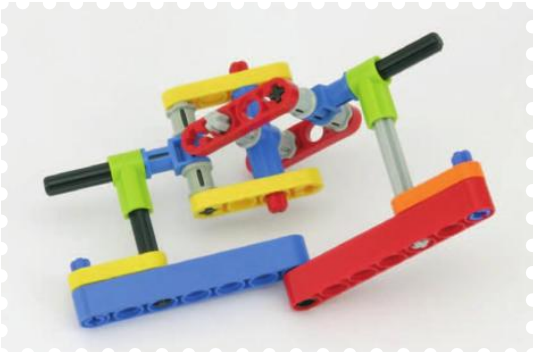


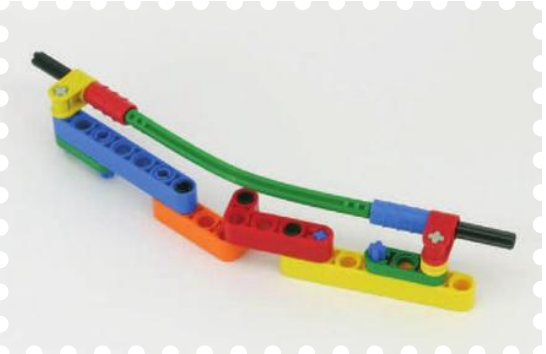


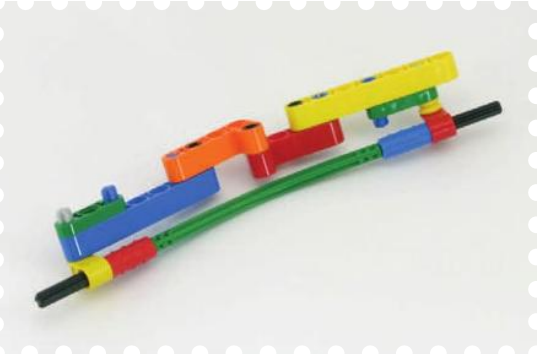


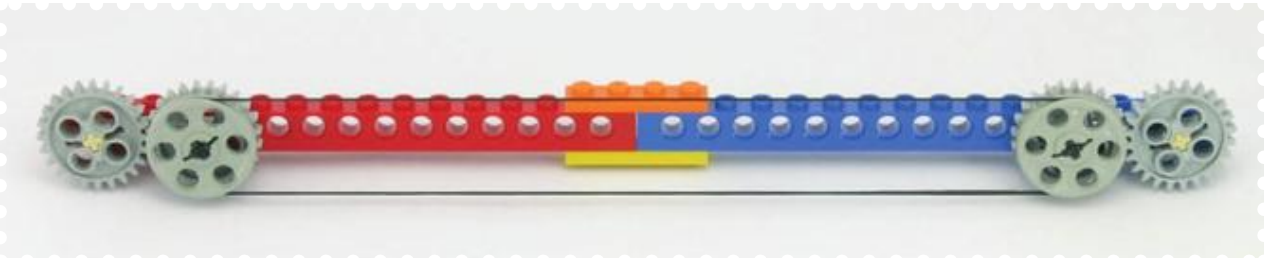


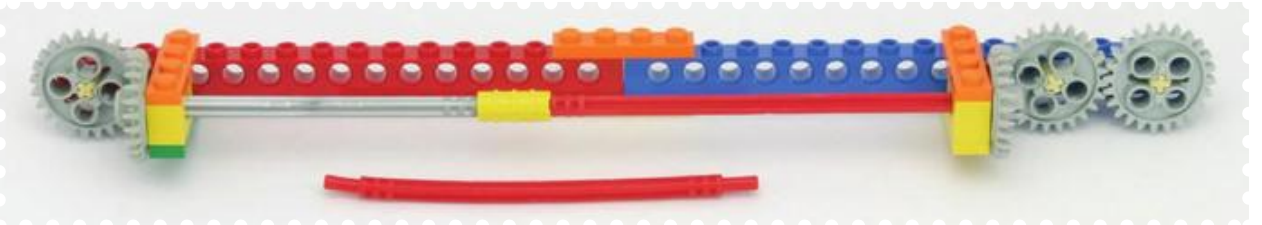


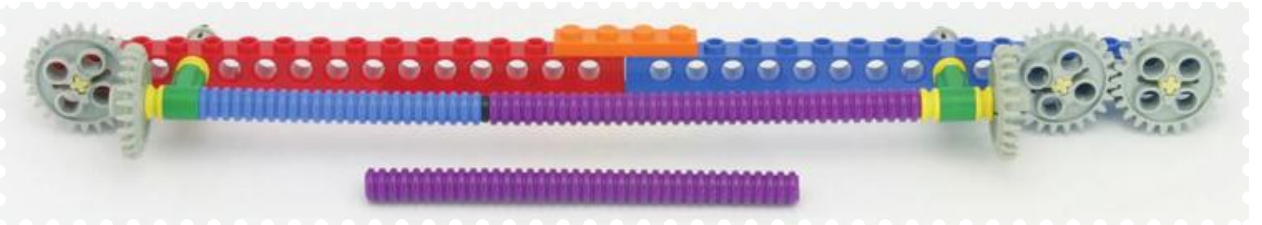




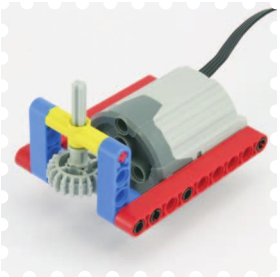


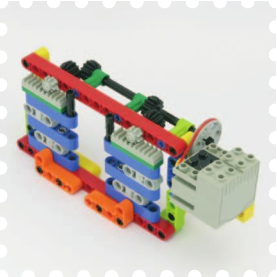






PART 3



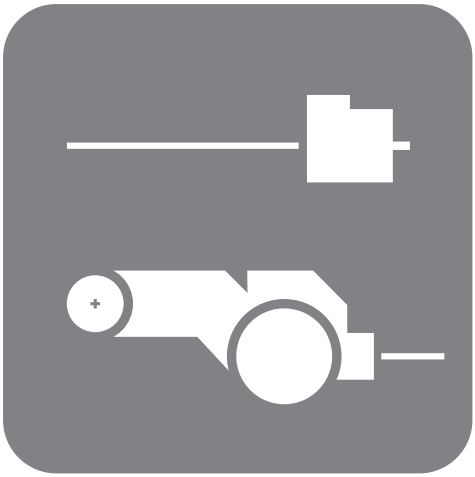


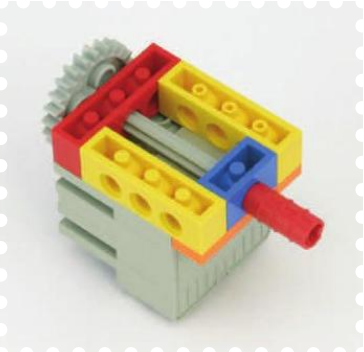
78

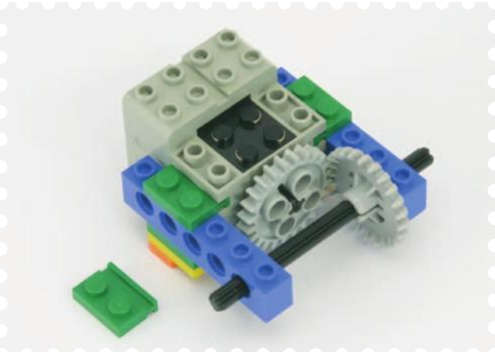
90

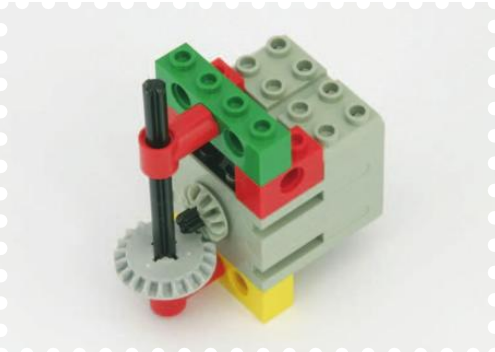
100

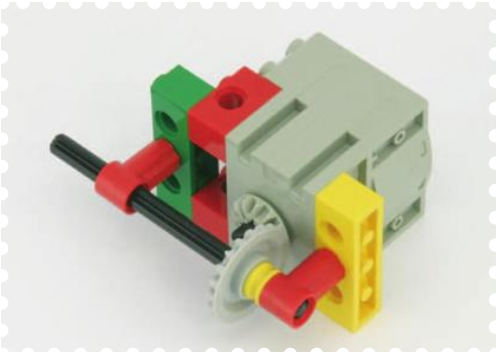
102

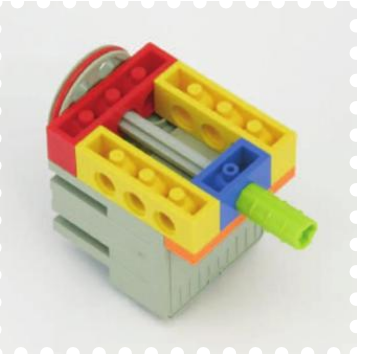


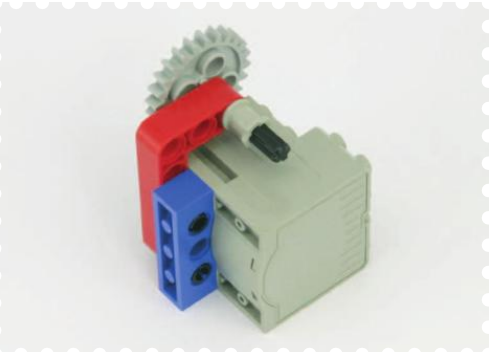


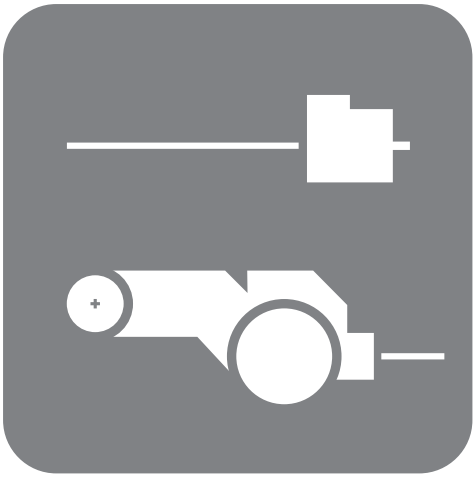


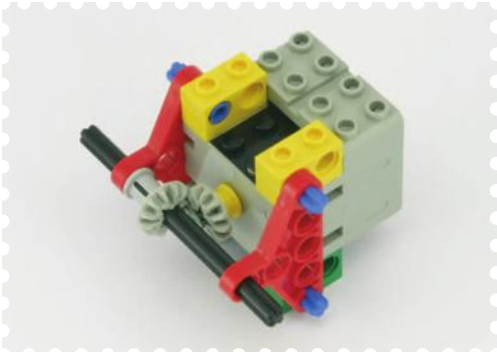


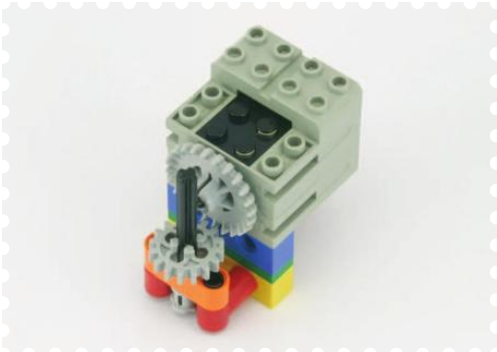


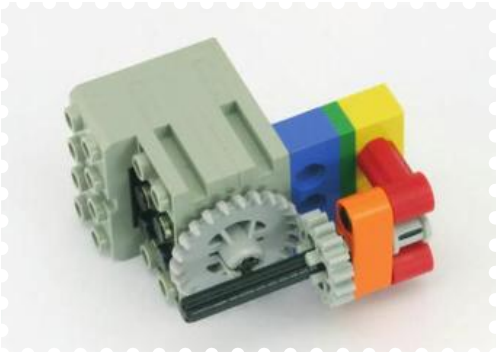


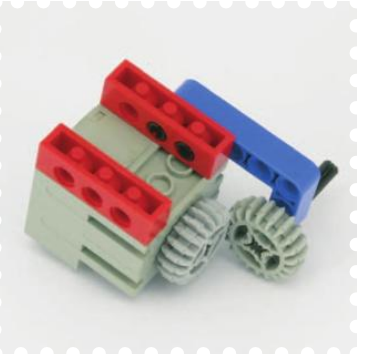


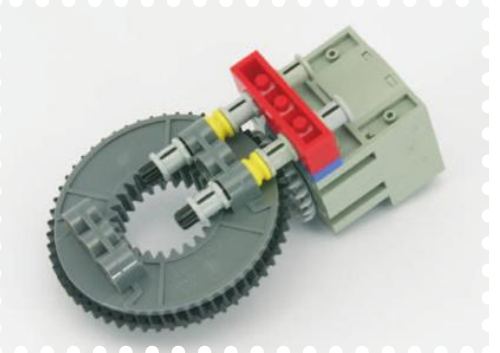


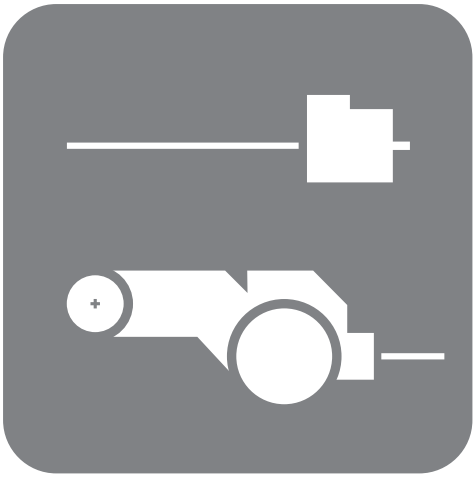


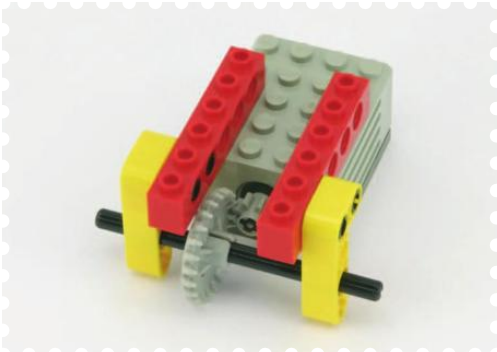


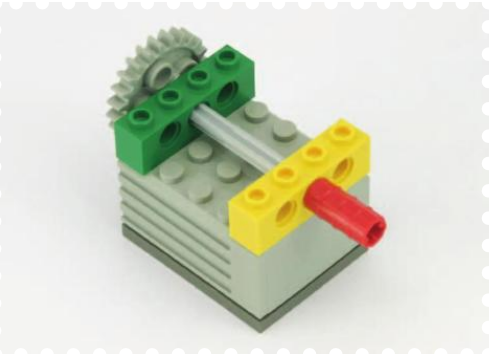


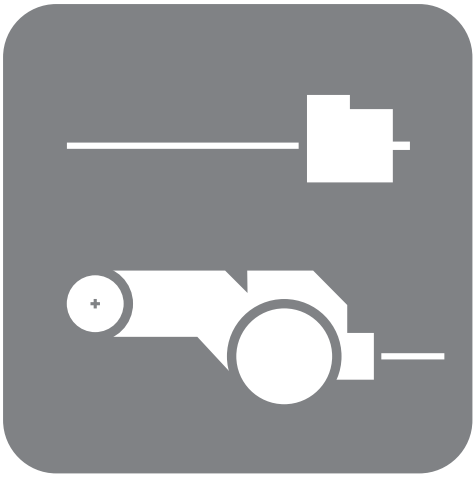


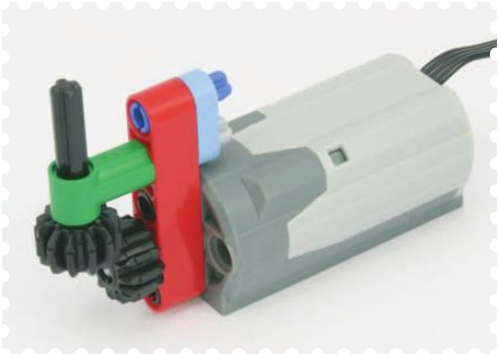


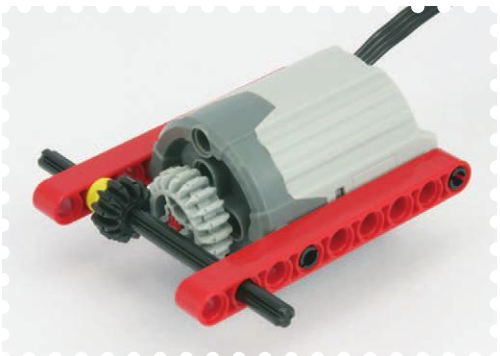


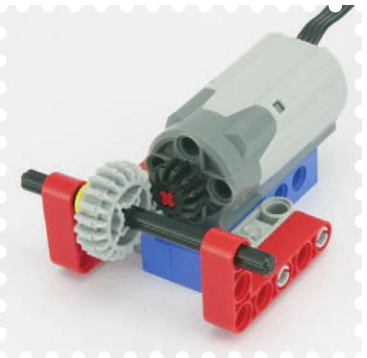


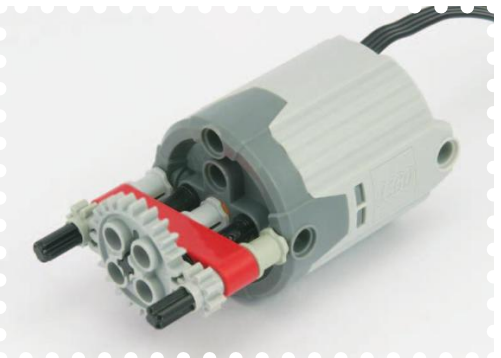


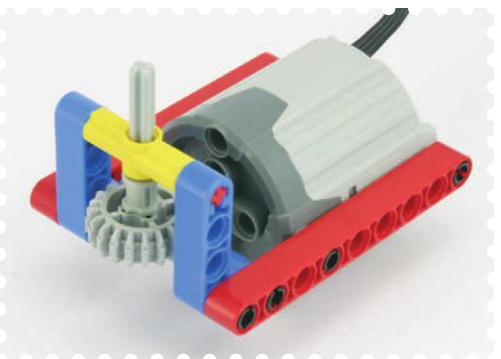


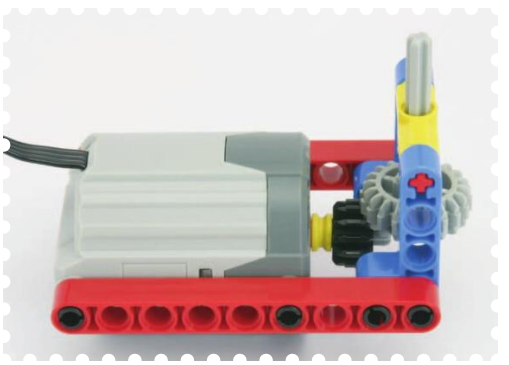


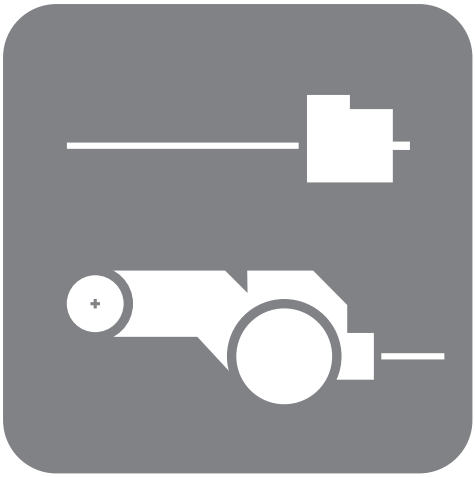






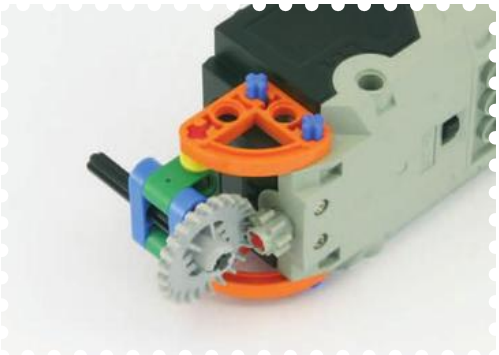




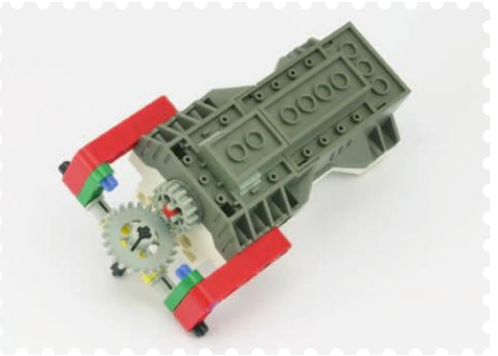


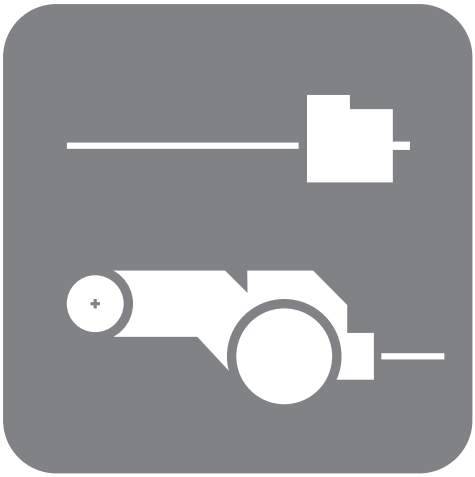
SELECT
RUN

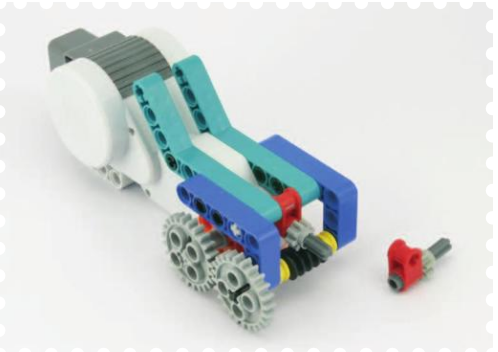
SELE
ON-OFF
RUN

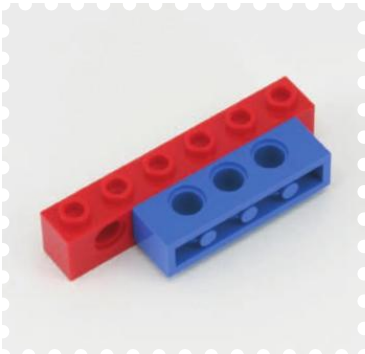


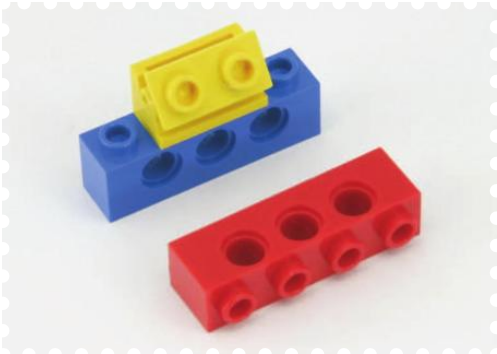
SELECT
RUN

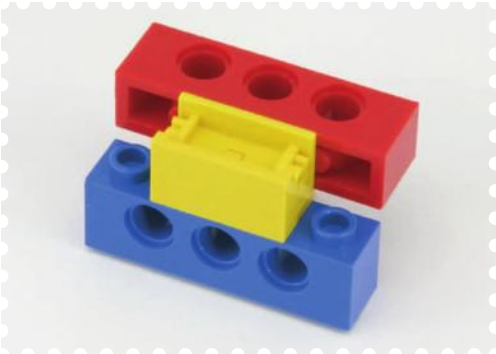


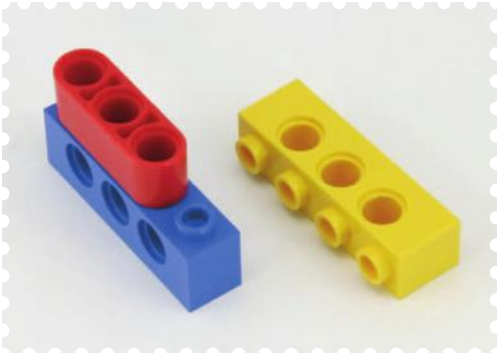


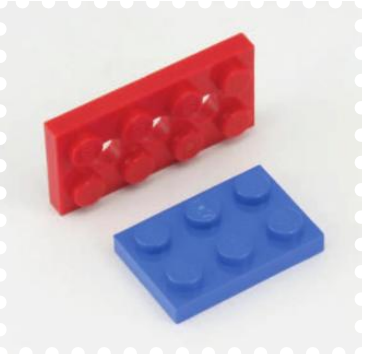


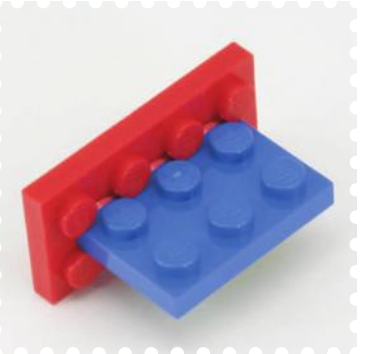


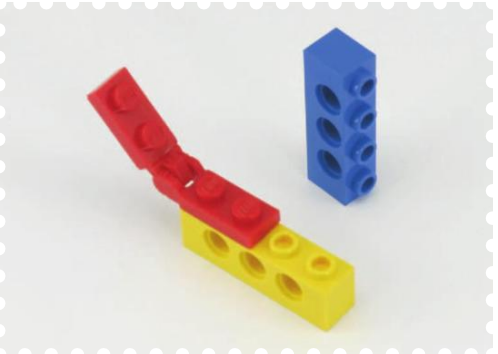


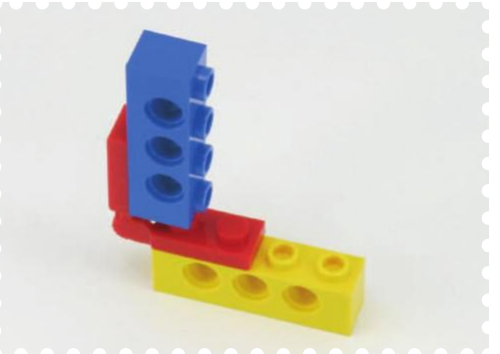


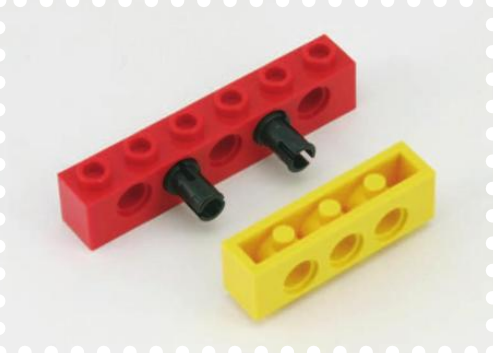


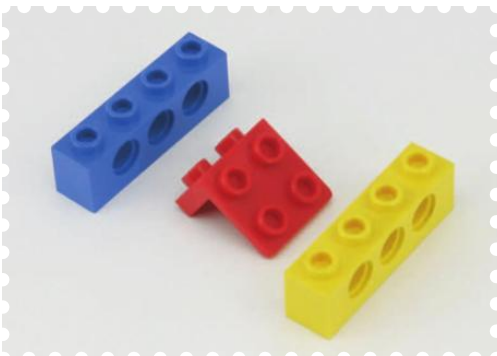


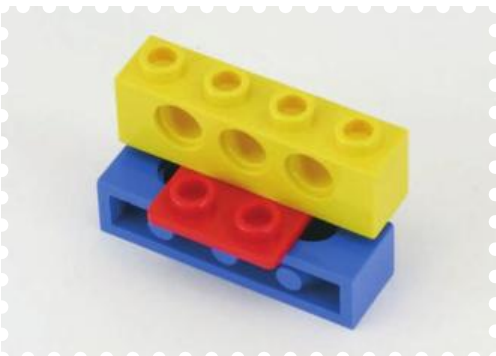


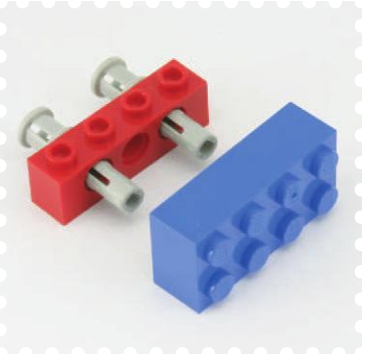


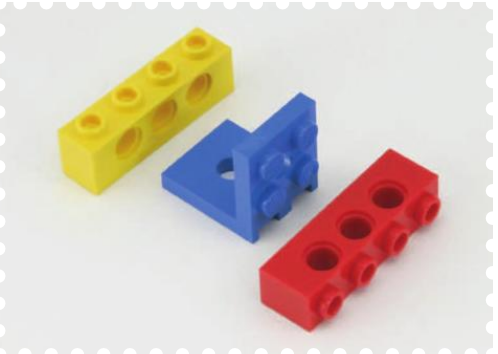


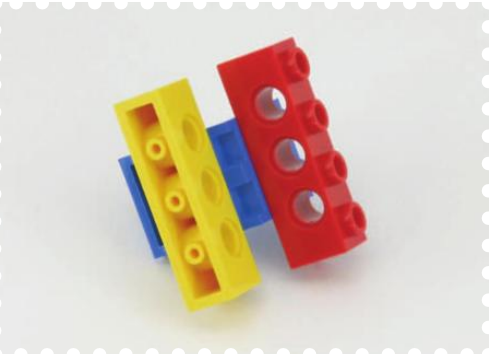


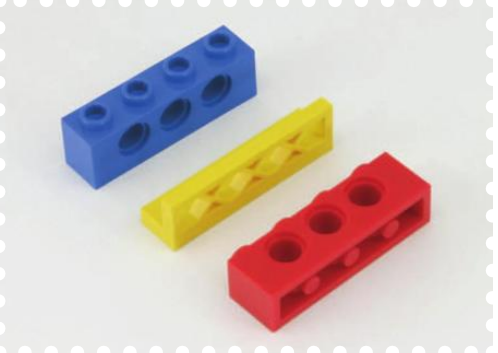


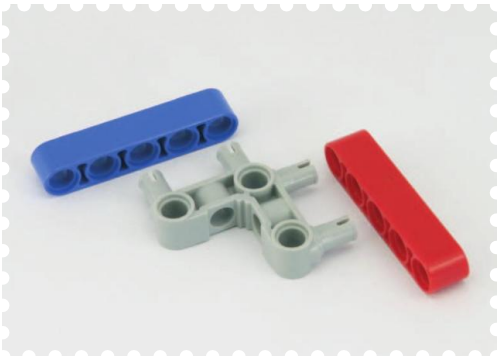


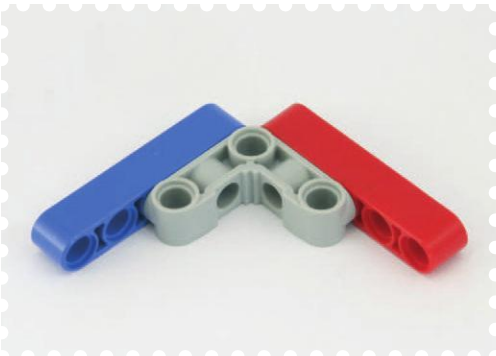


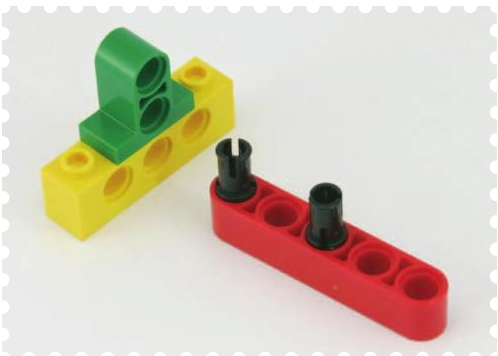


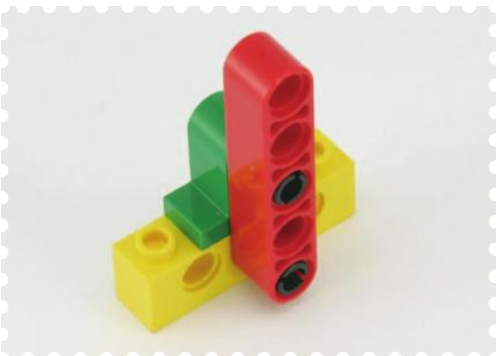


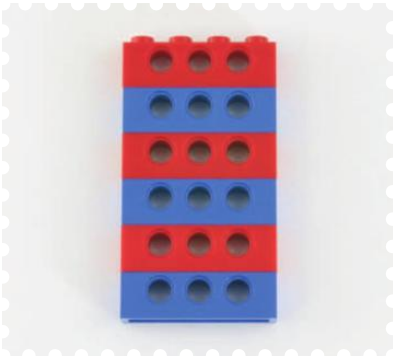


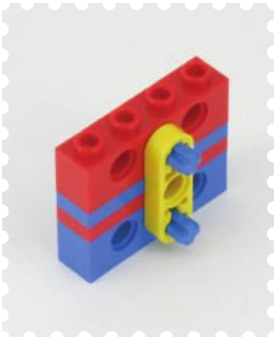


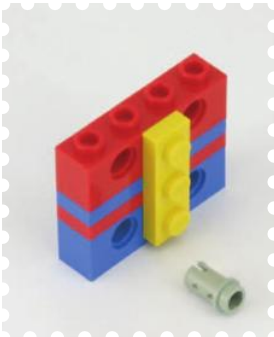


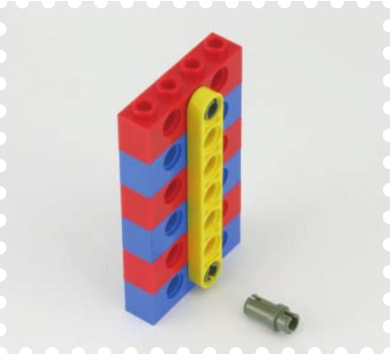
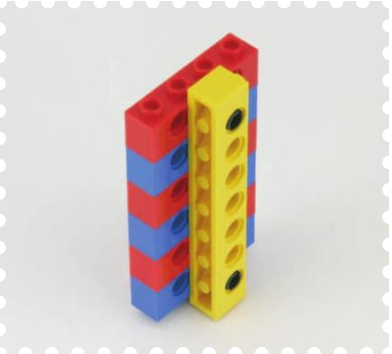


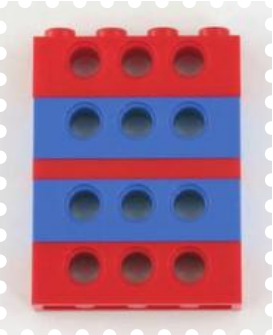


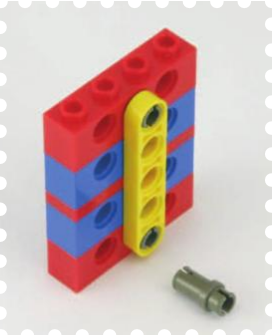


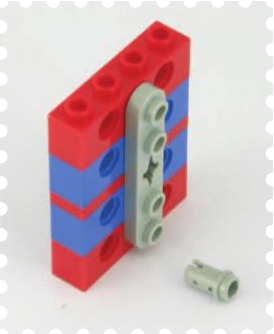


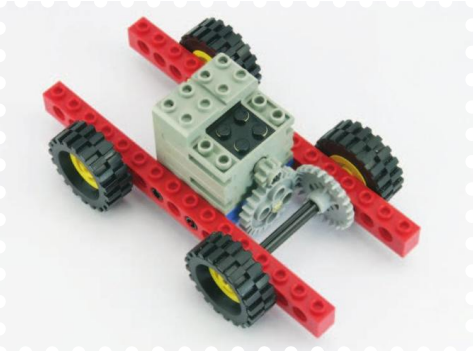


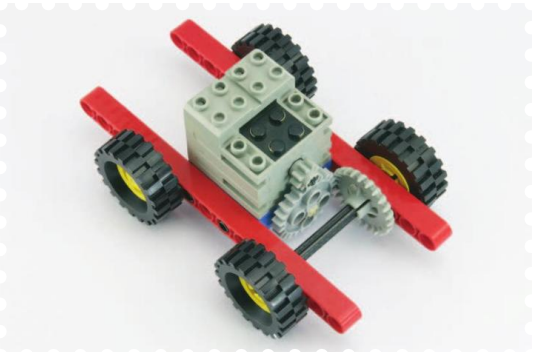





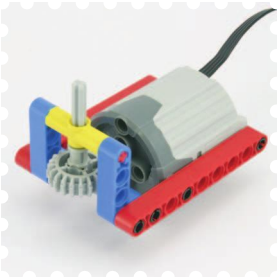


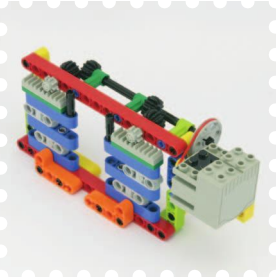






PART 4





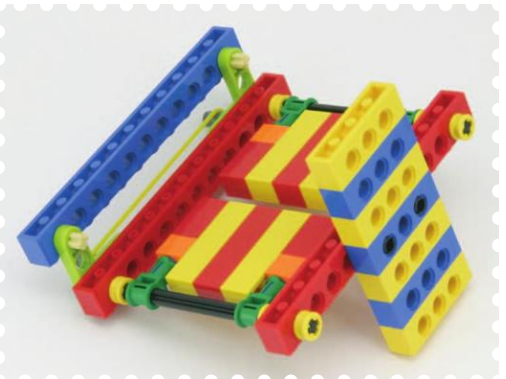
108

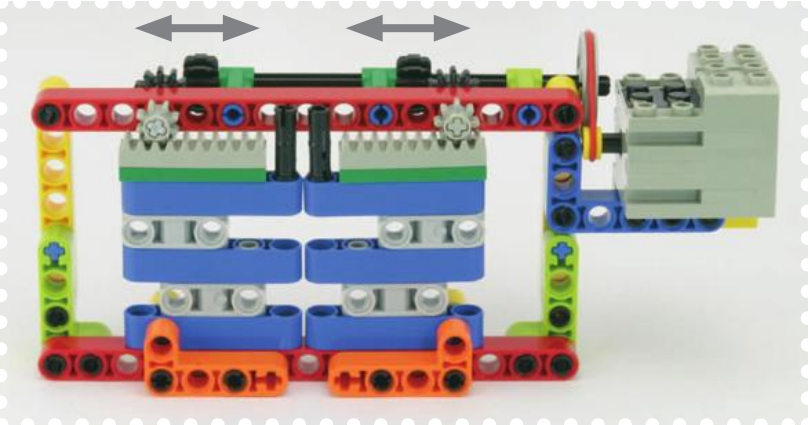
126

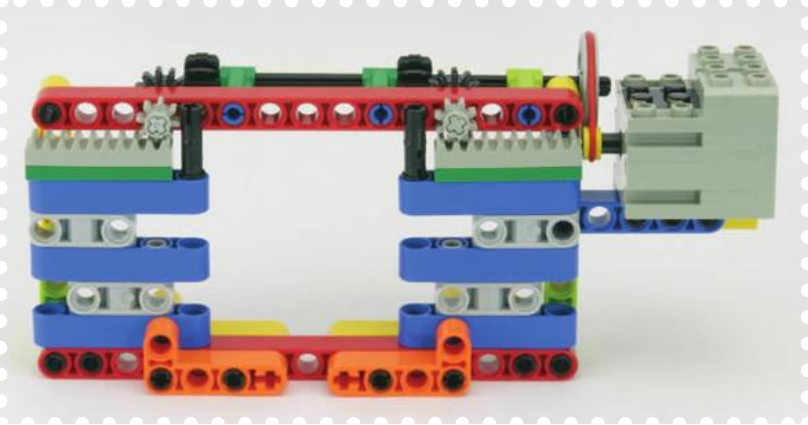
136

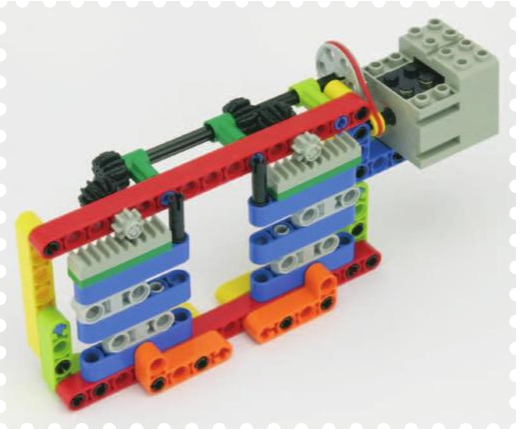
142

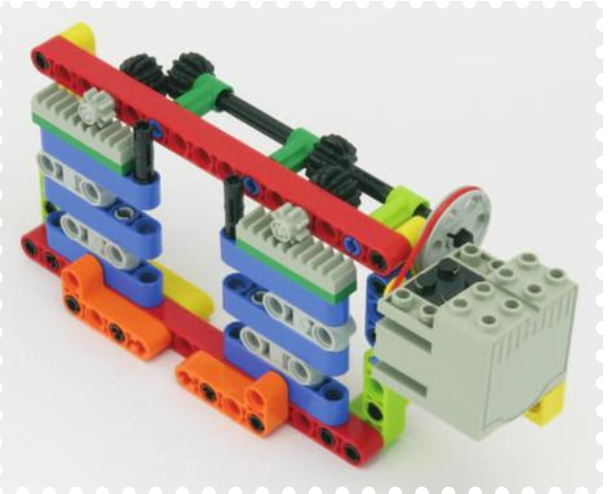
154

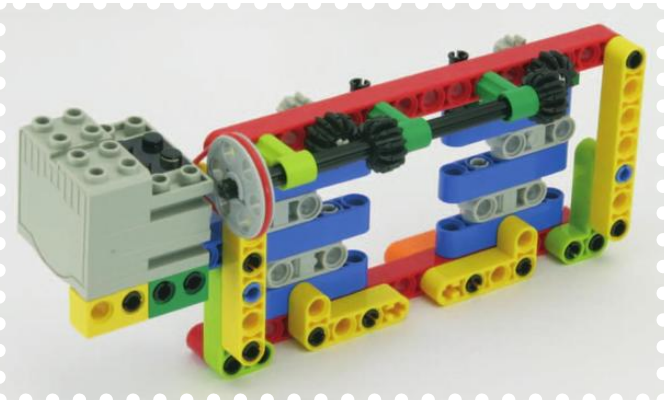


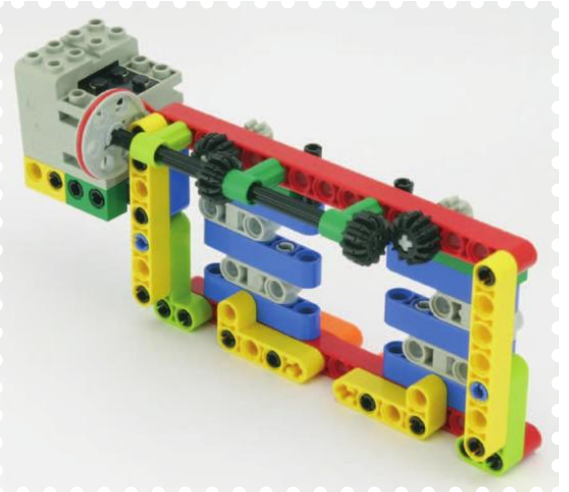


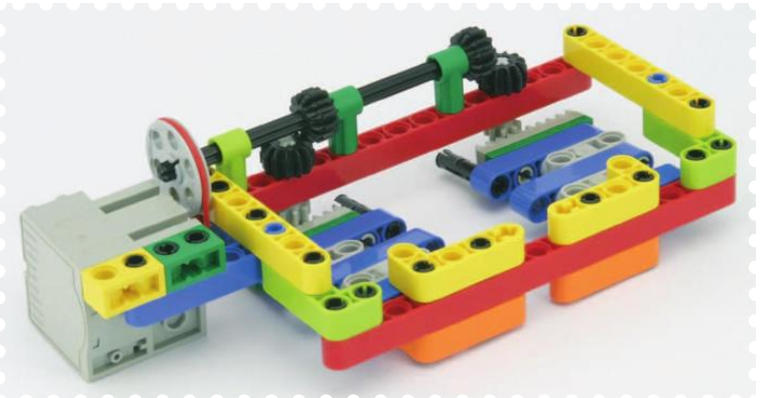


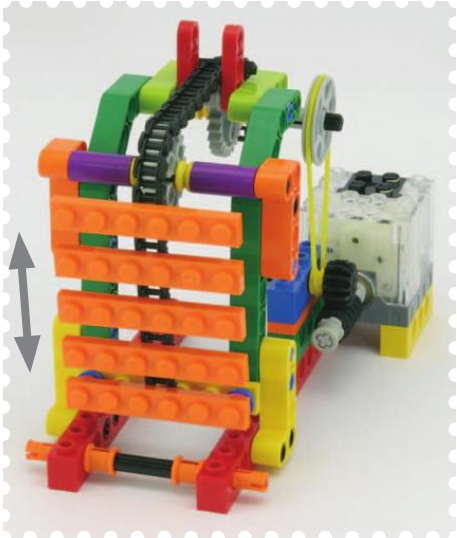


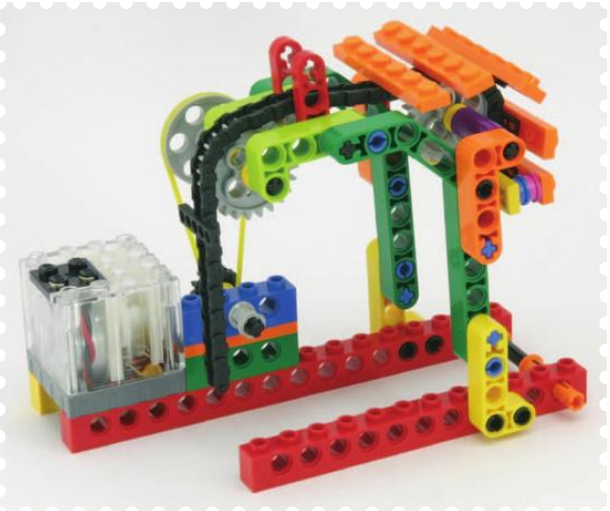


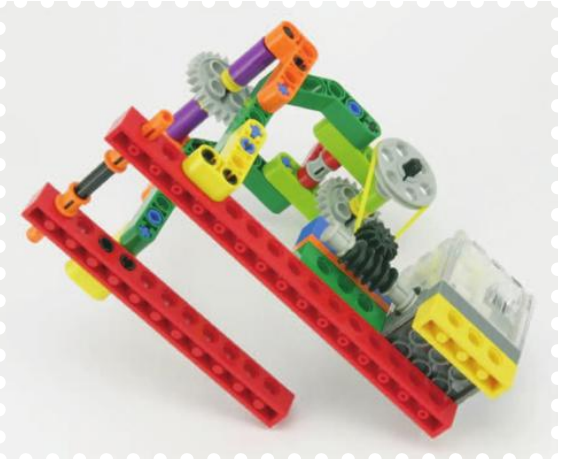


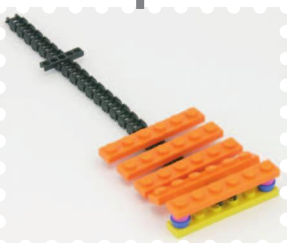


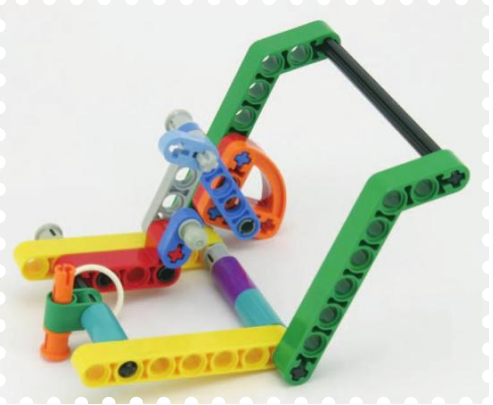


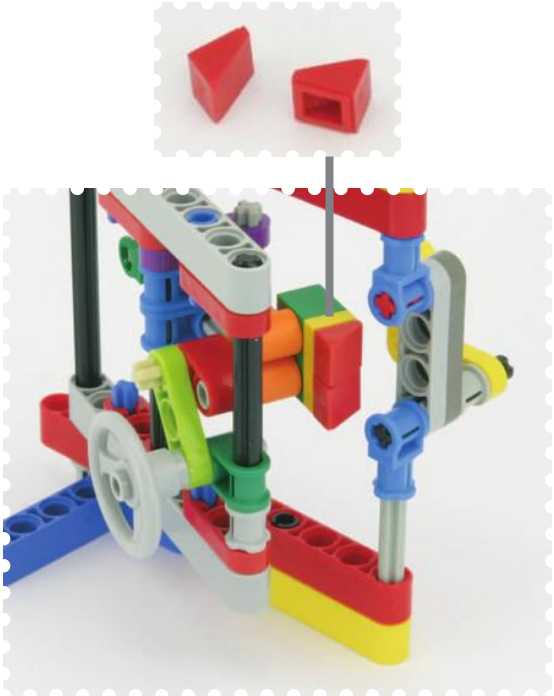


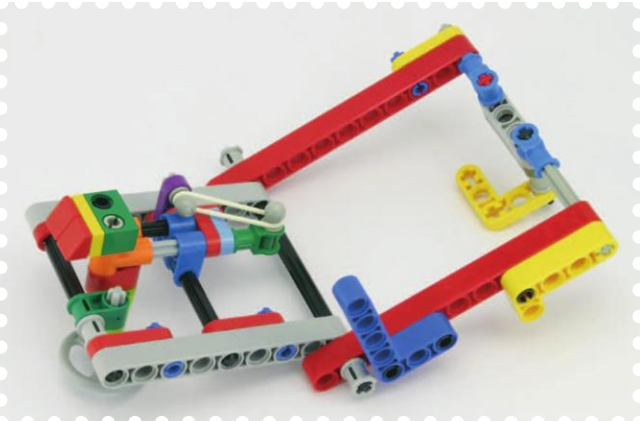


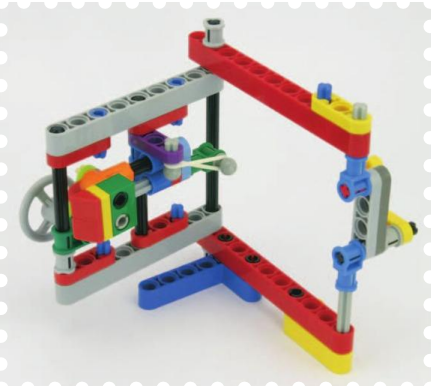


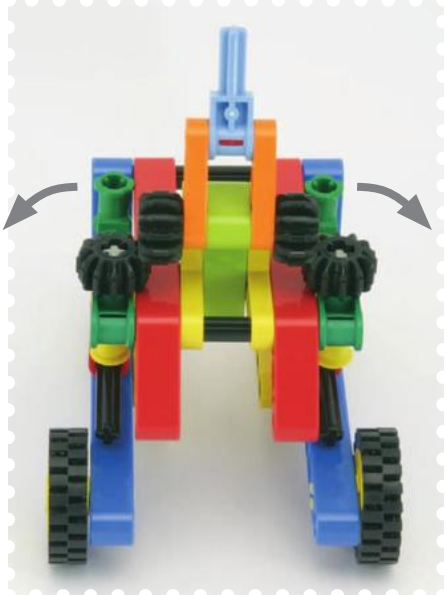


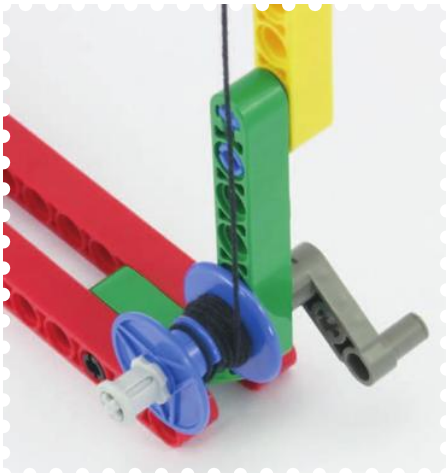


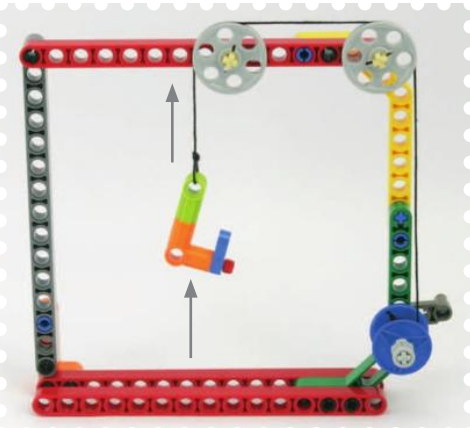


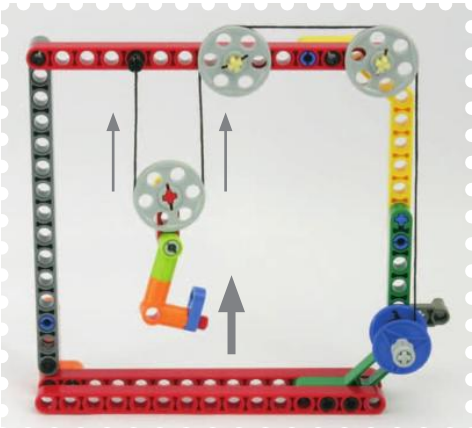


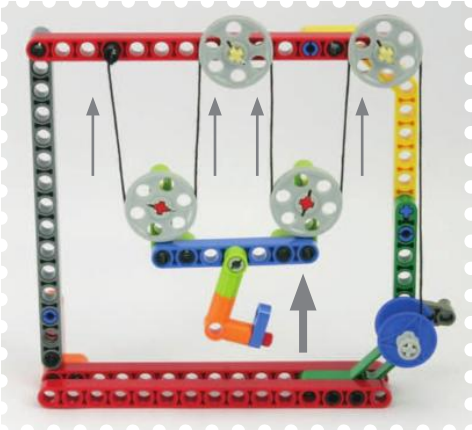


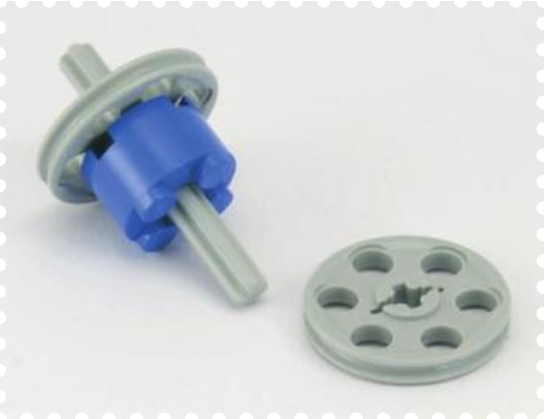


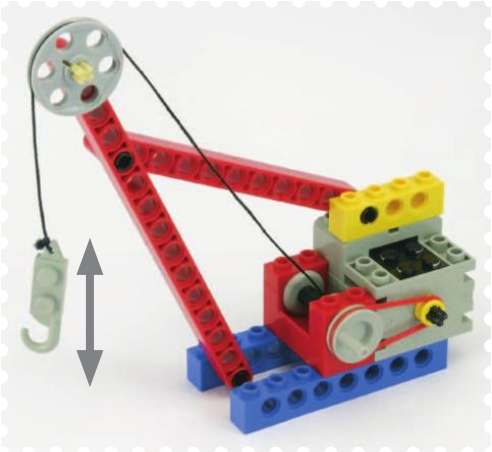


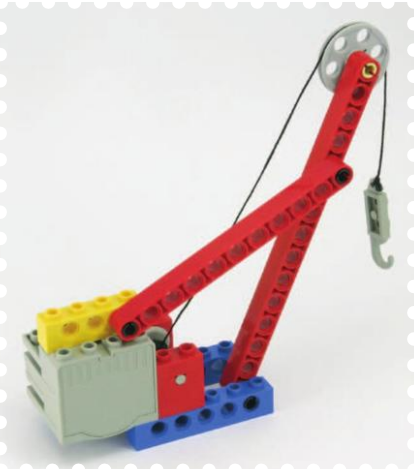


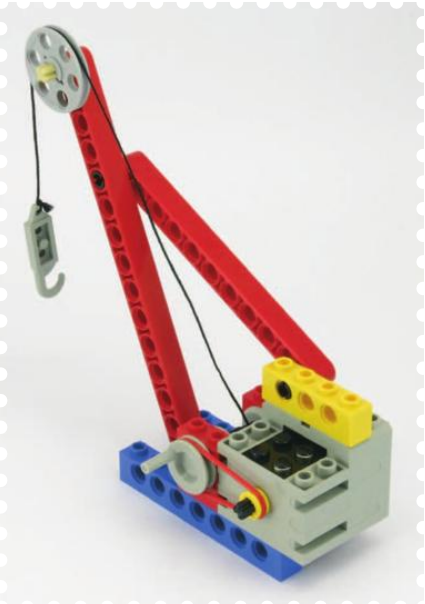


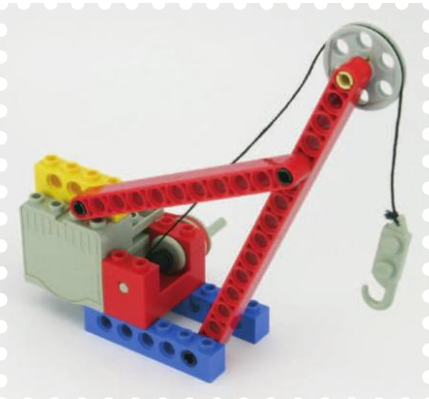


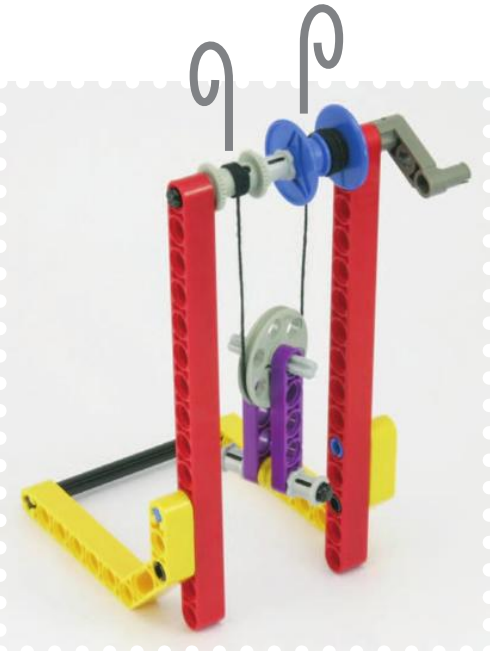


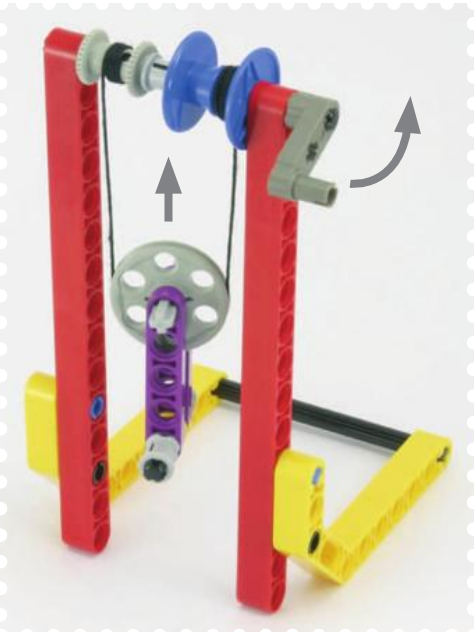


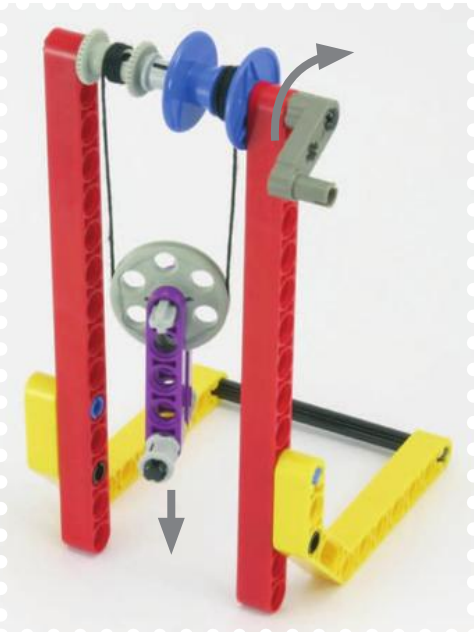


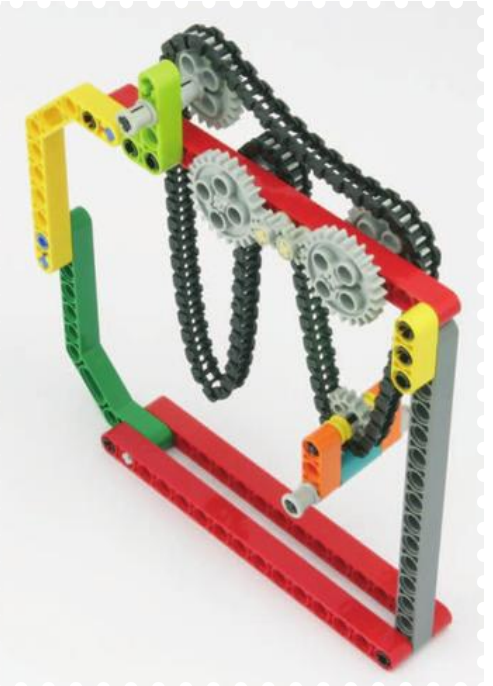


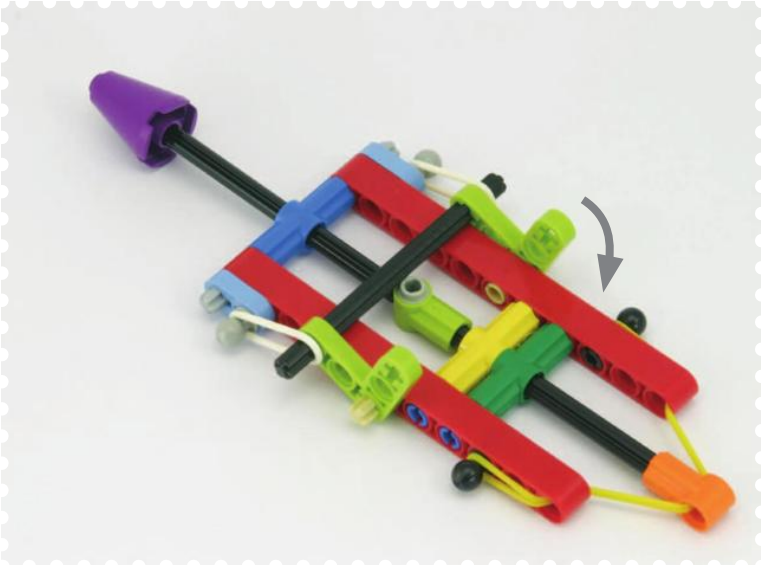


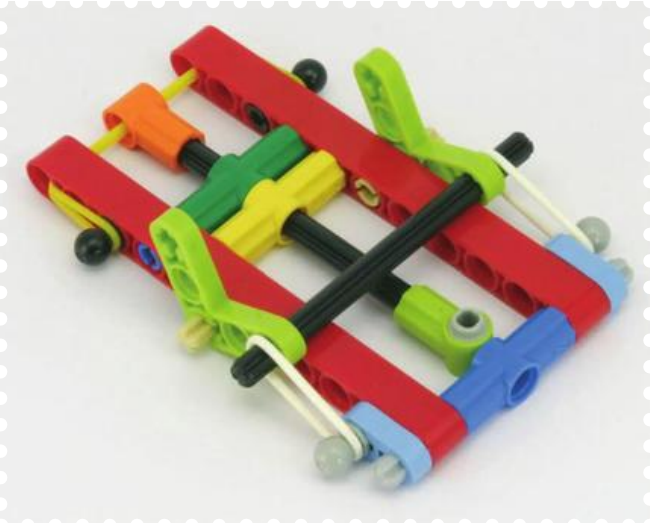


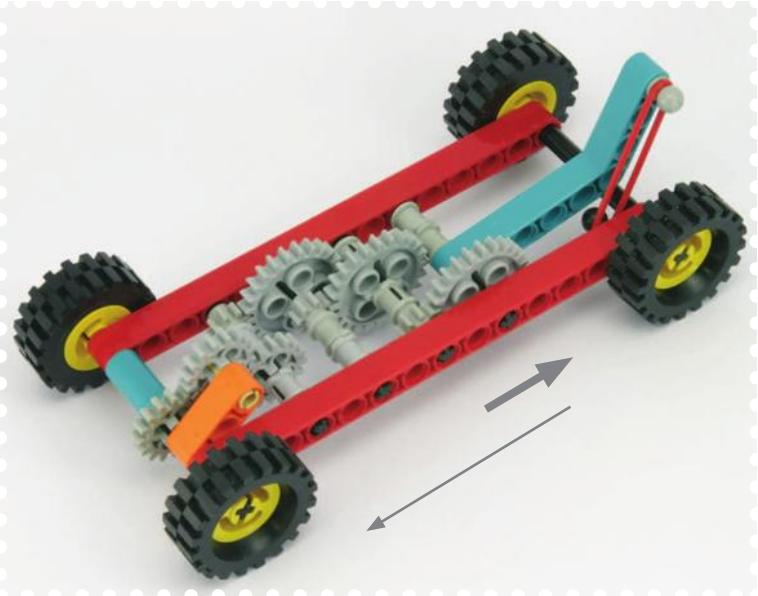


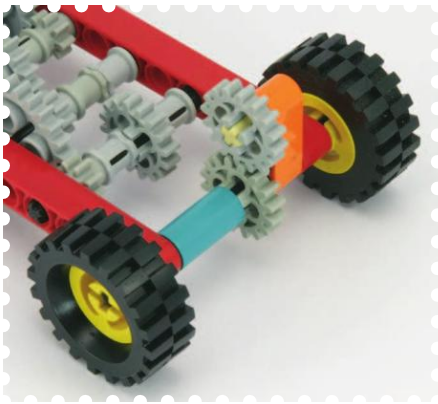


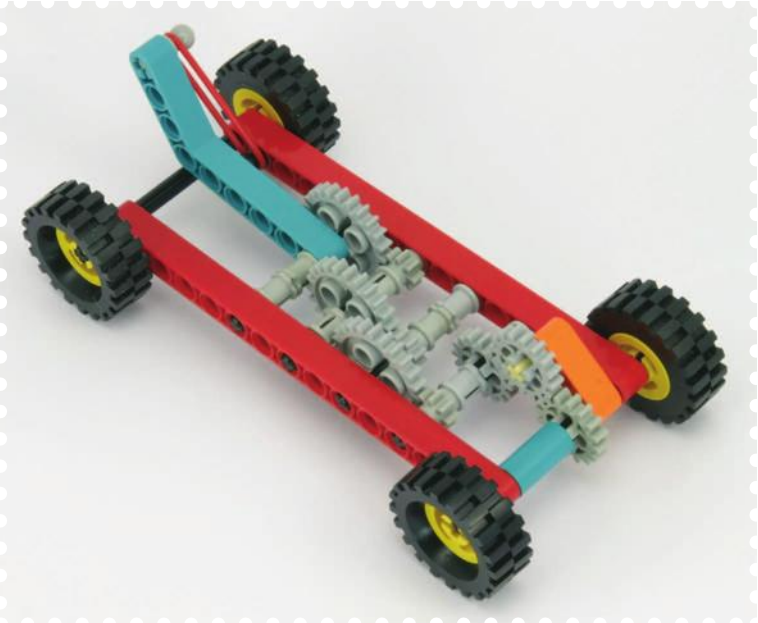


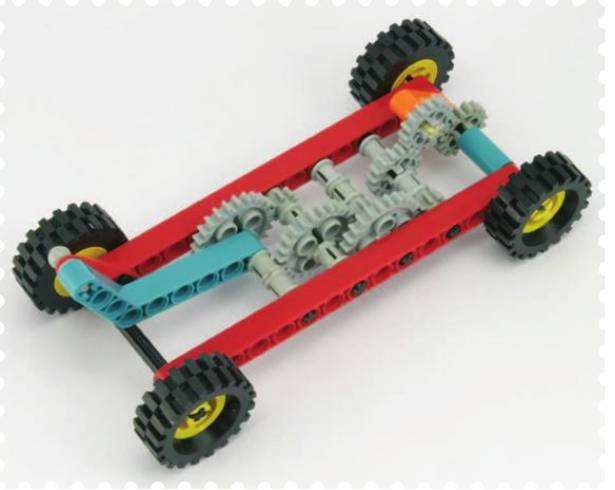


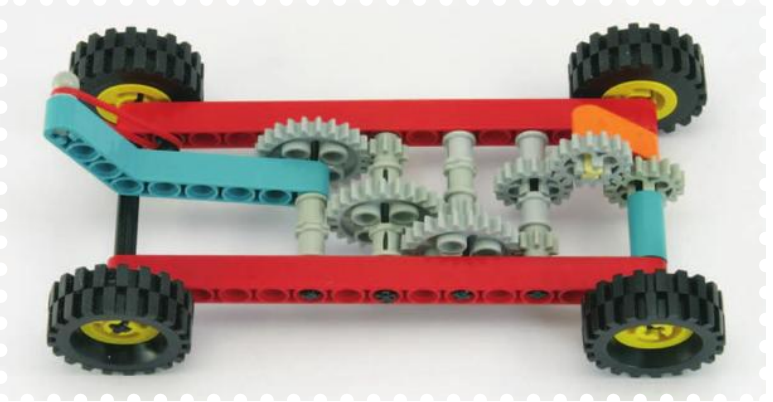


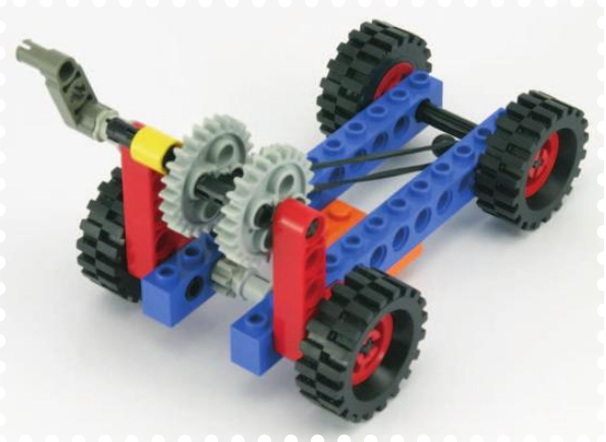


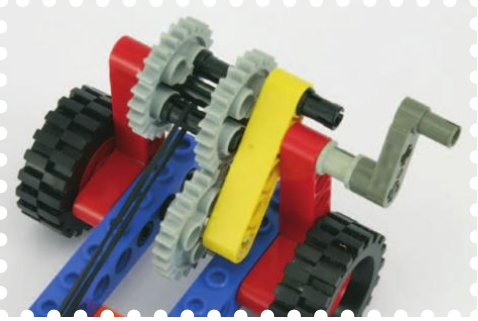


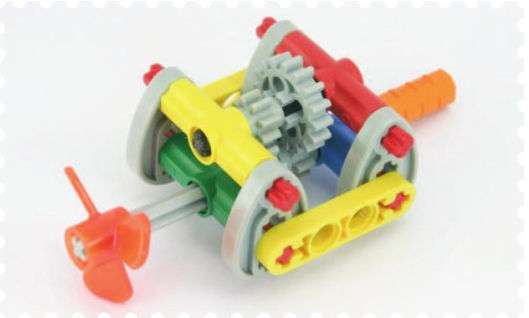
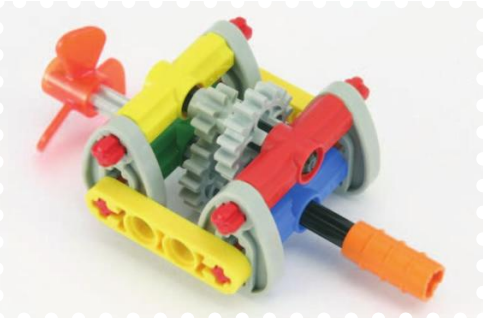
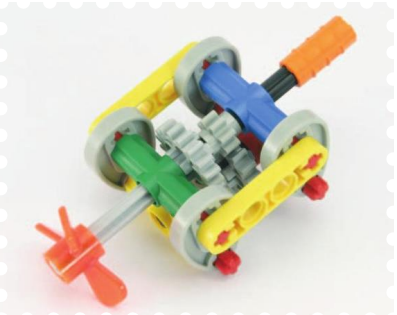


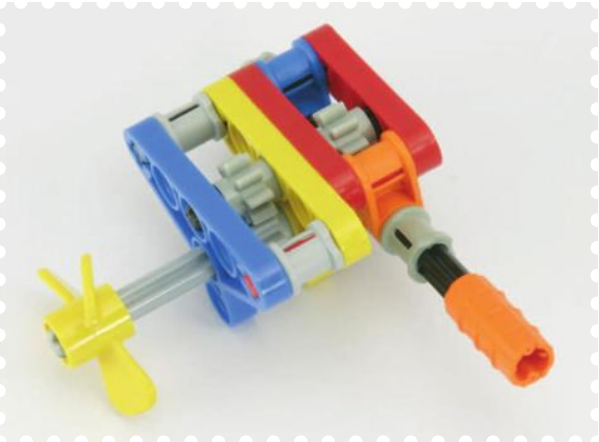


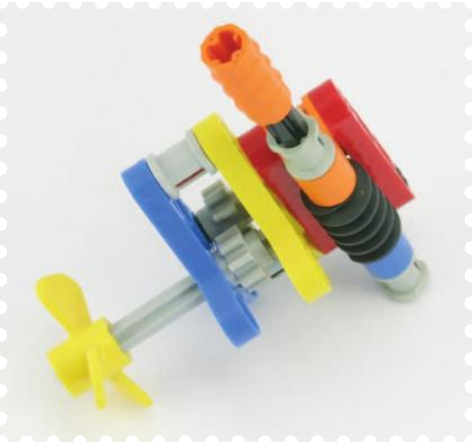


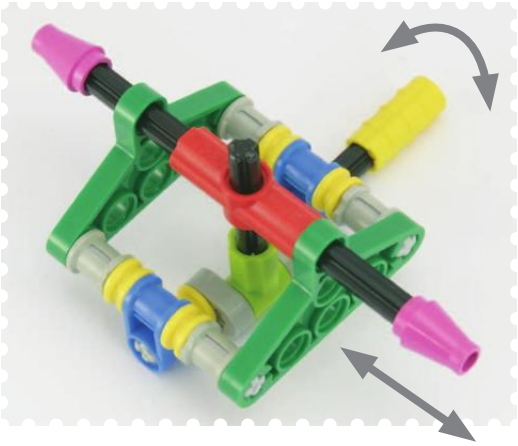


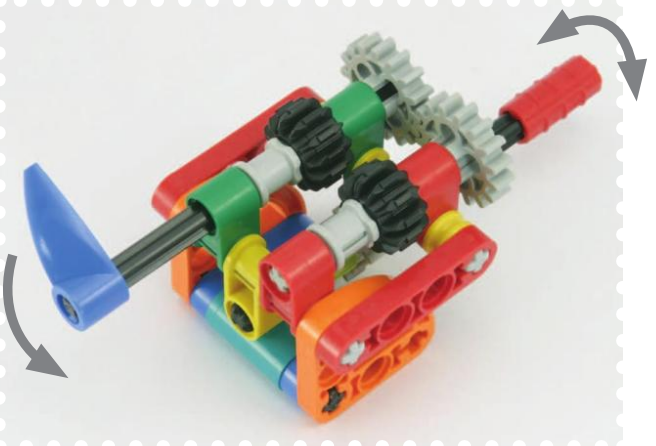


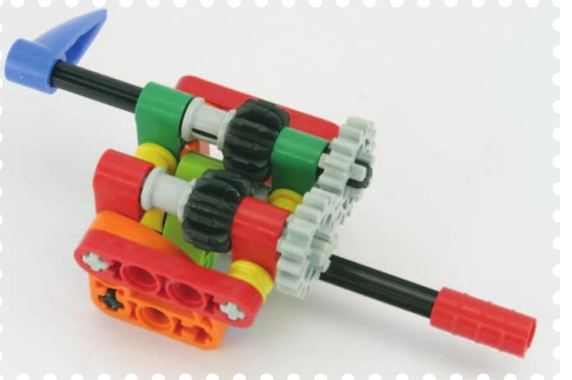




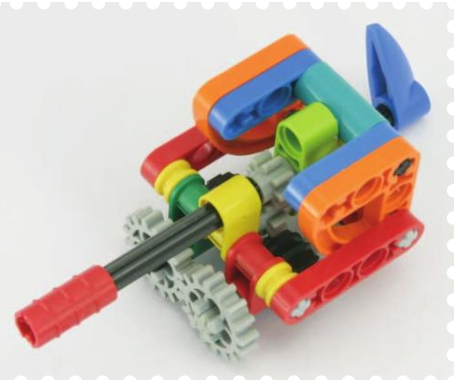


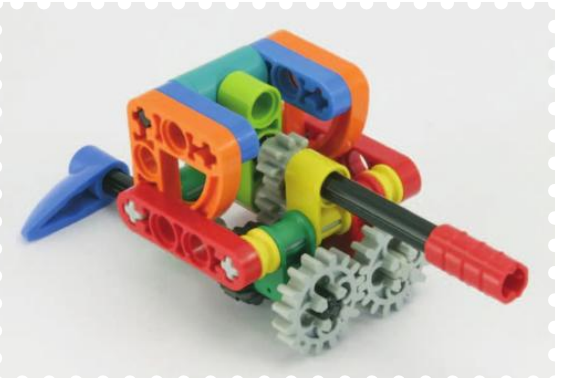


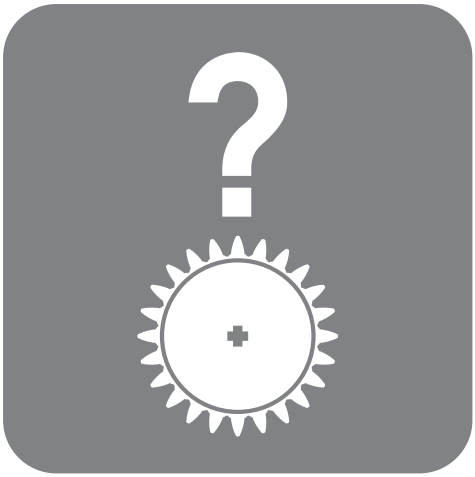


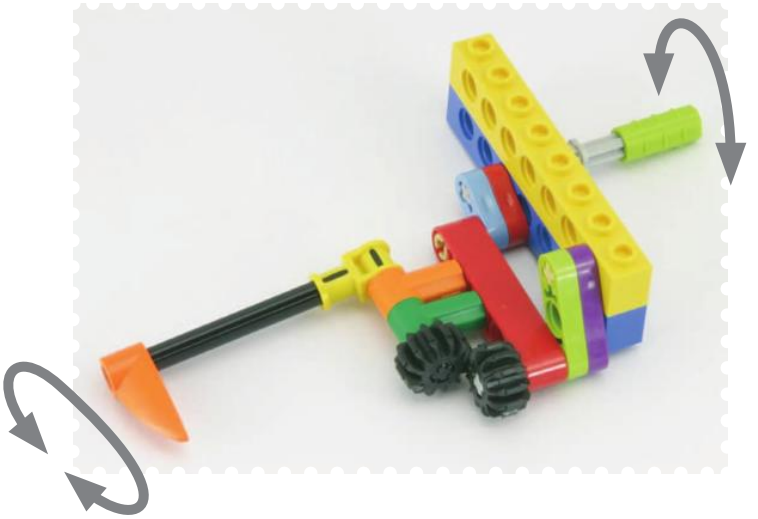


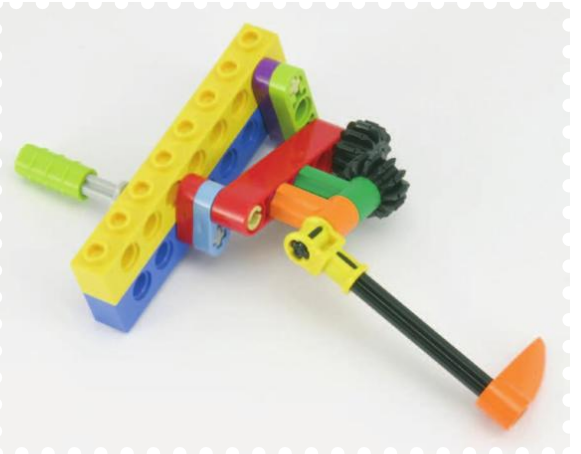


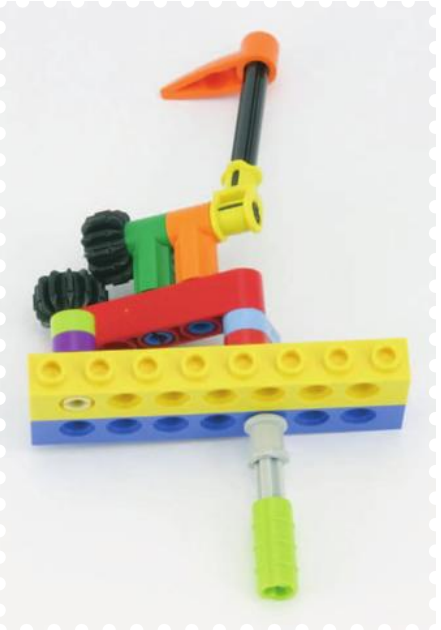


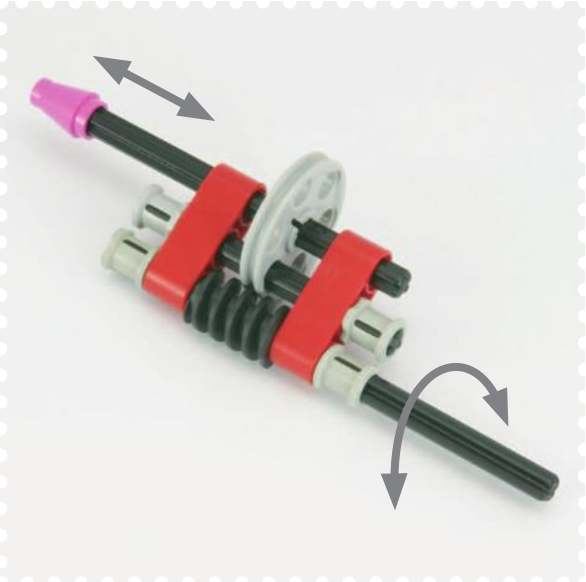


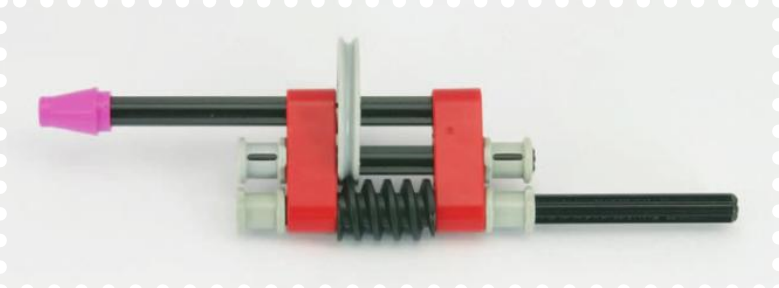


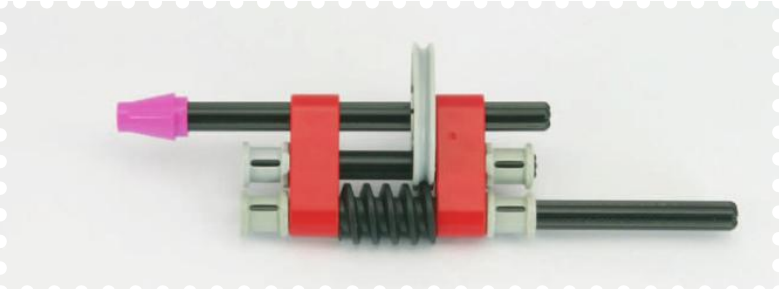


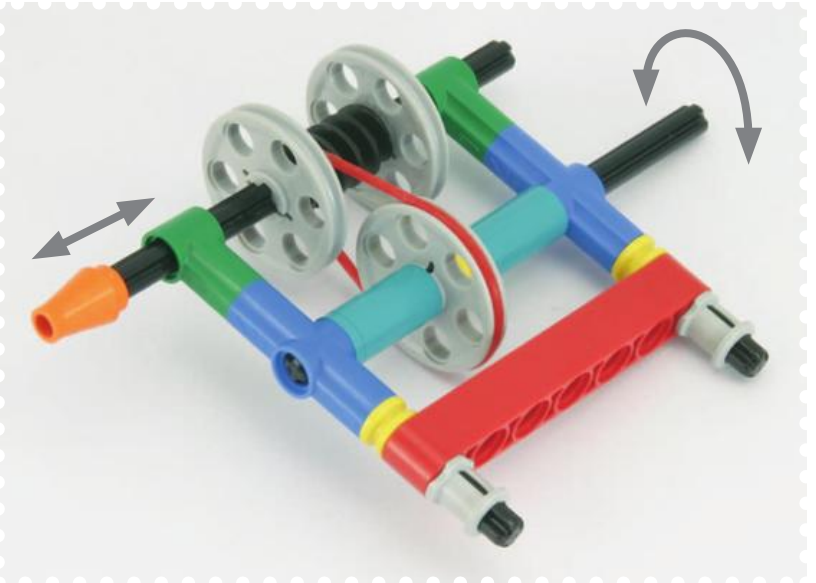


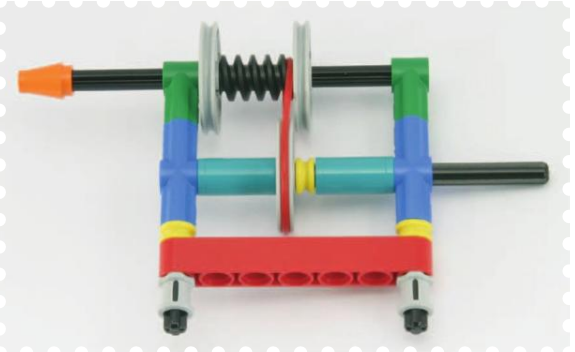


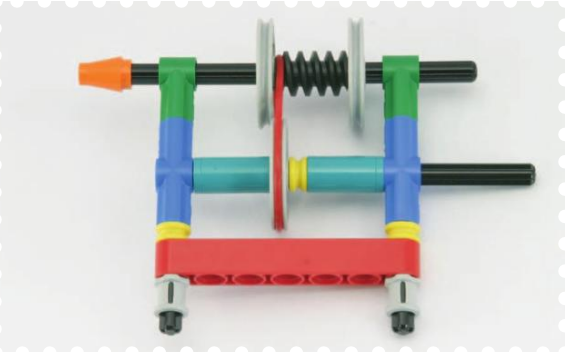


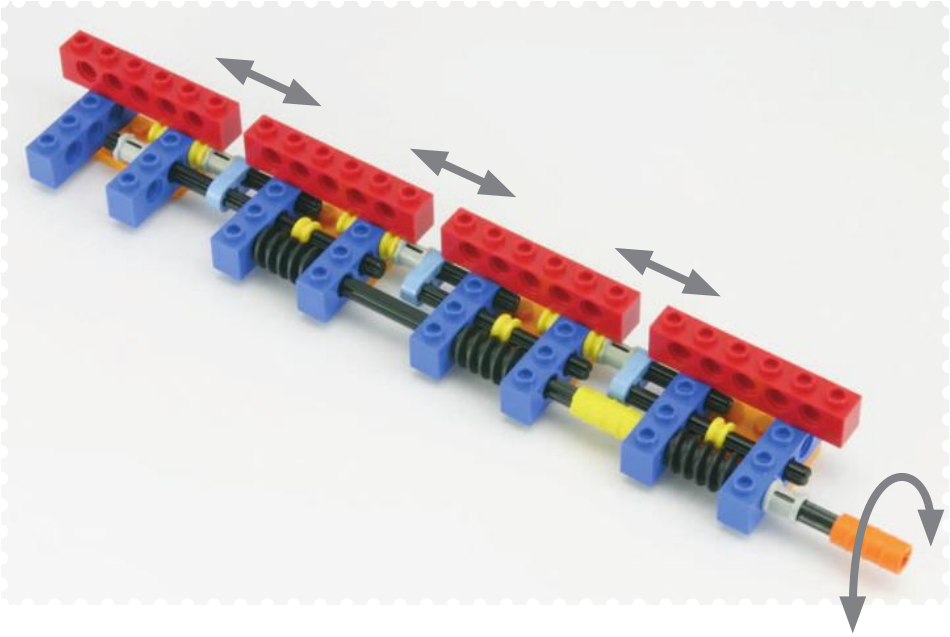


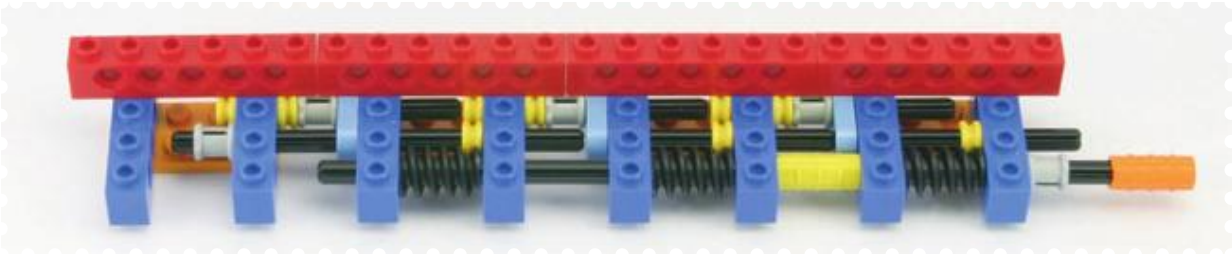


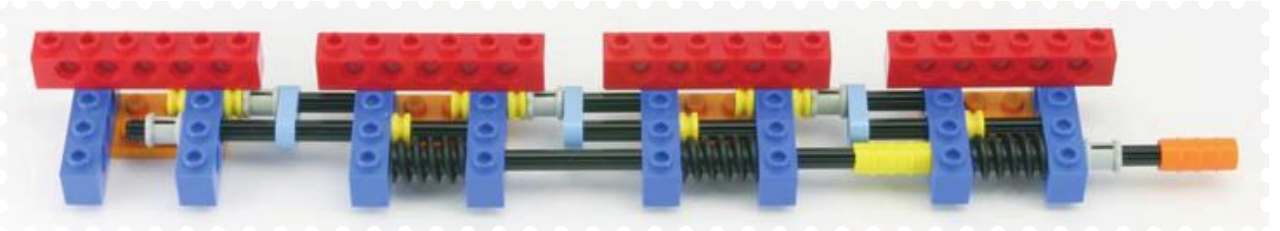


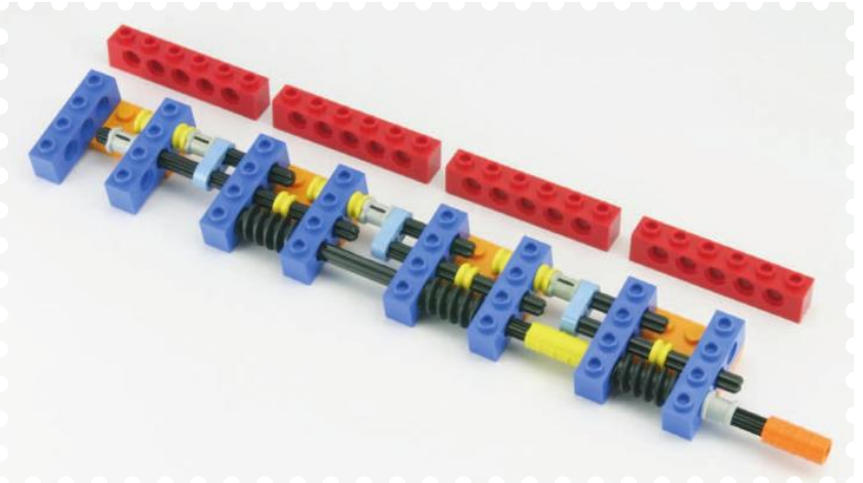


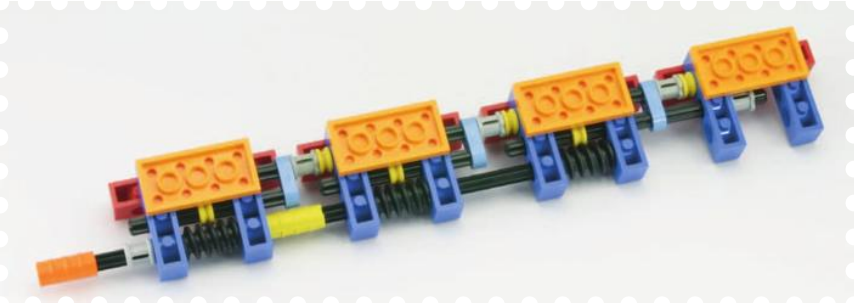


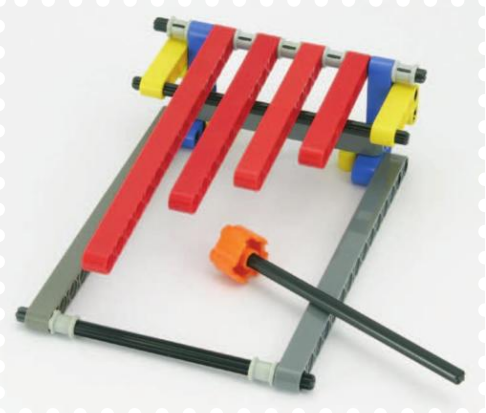


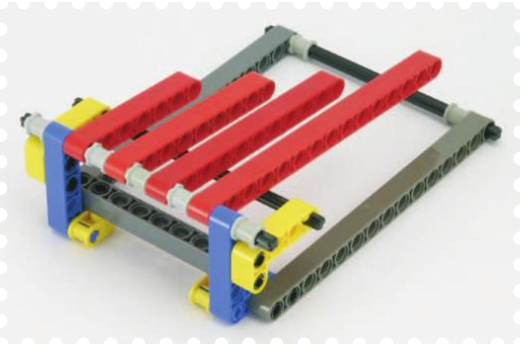


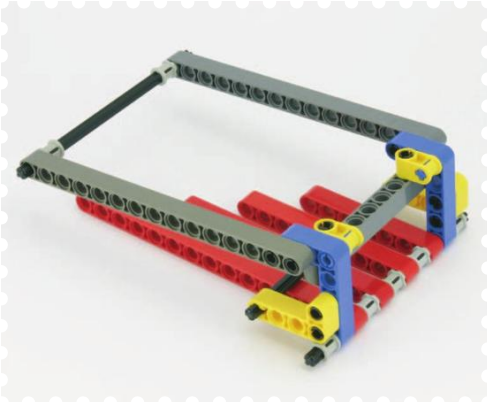


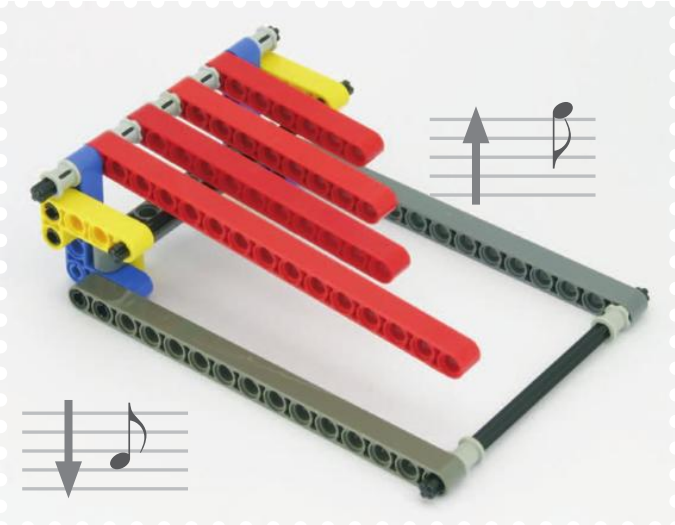


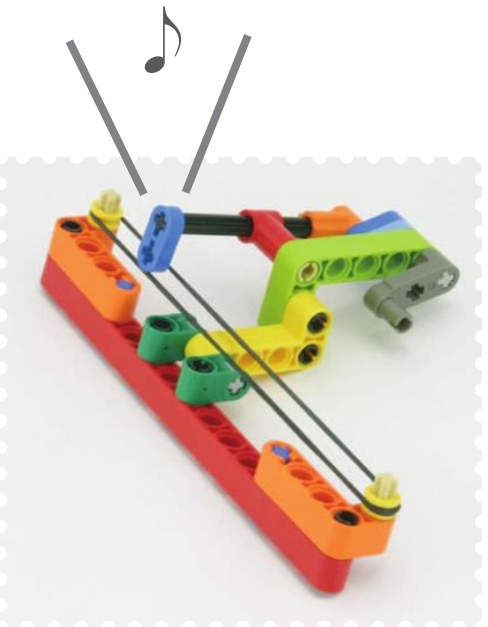


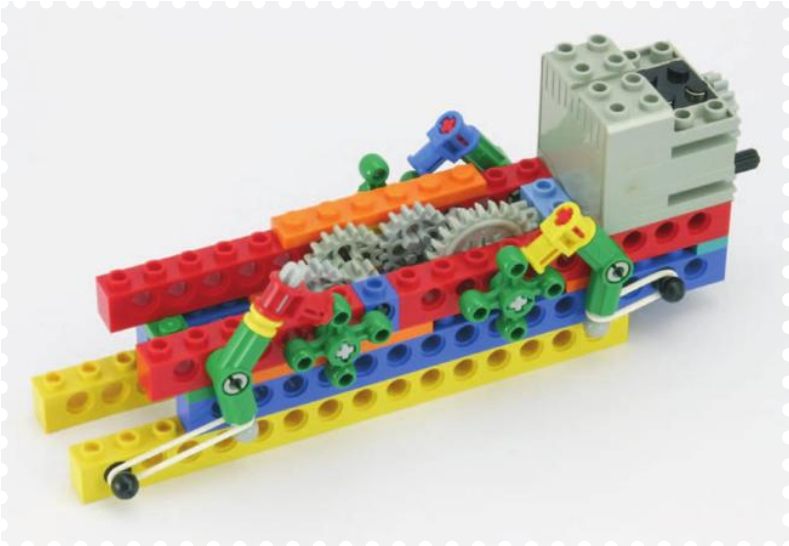


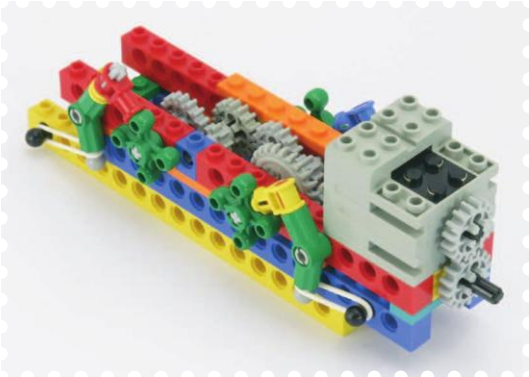


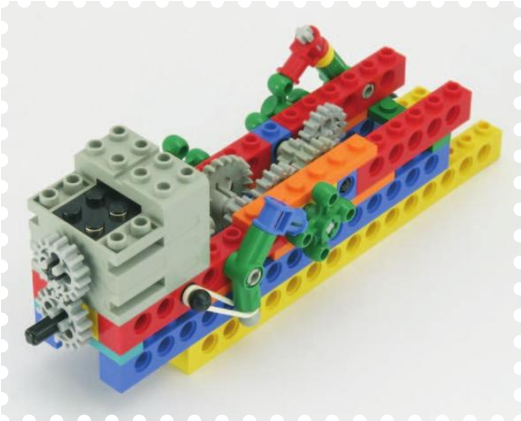


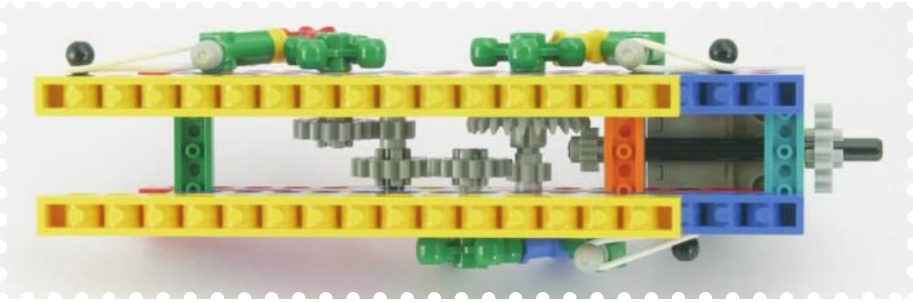


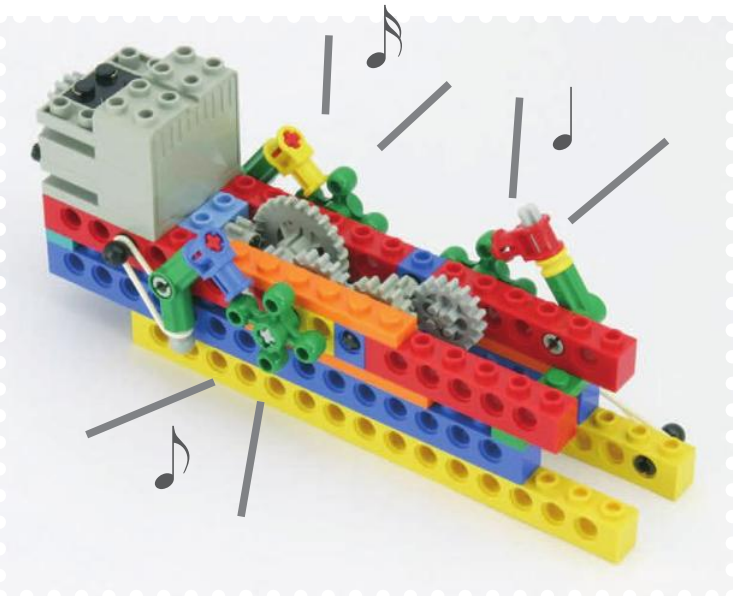


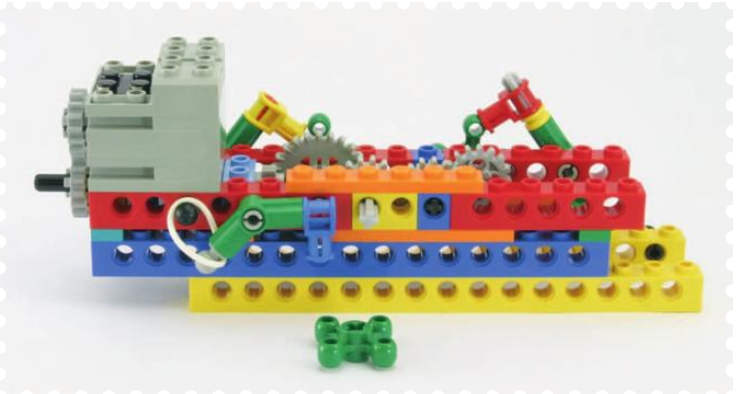








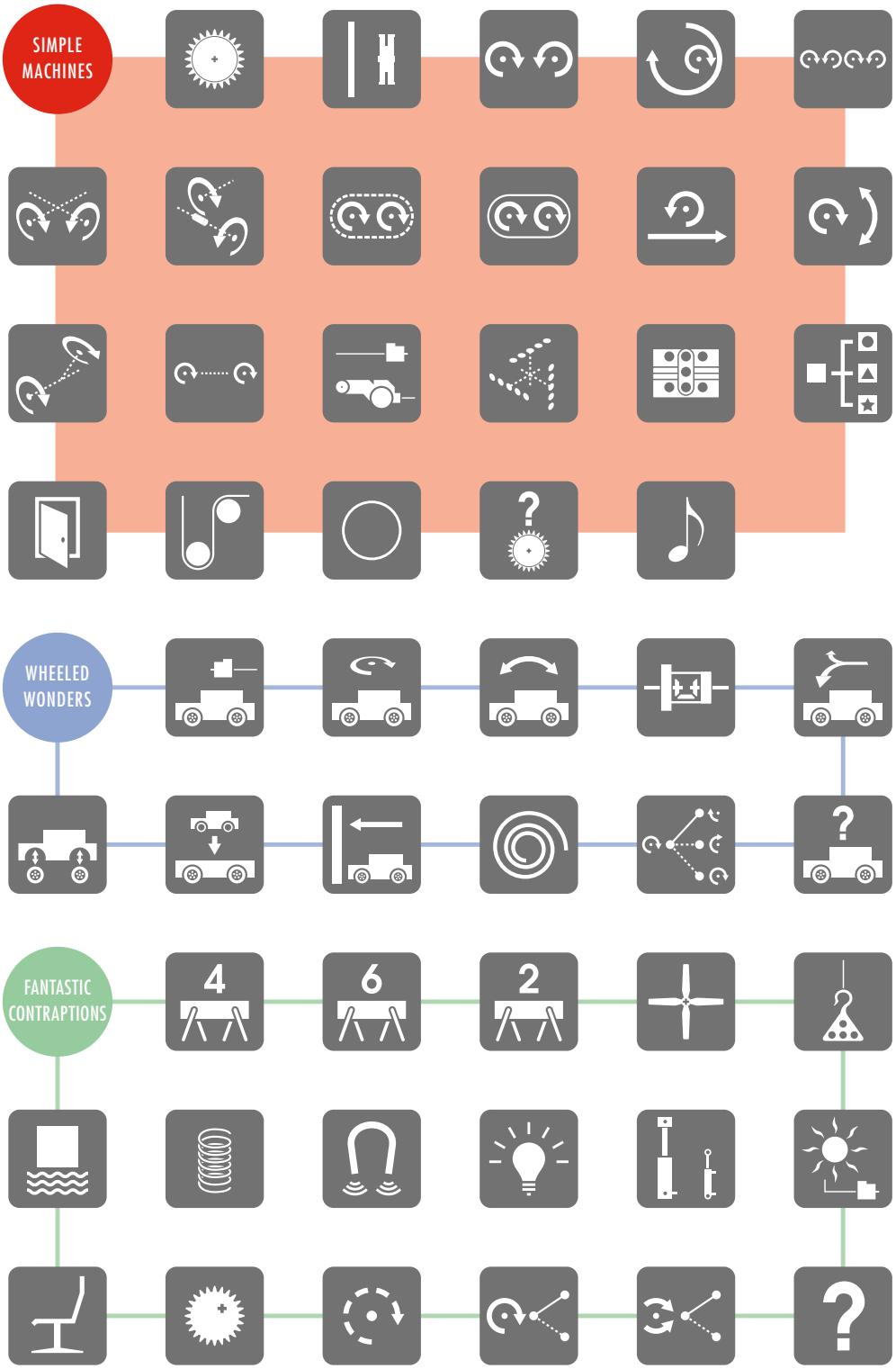




Yoshihito Isogawa of Tokyo, Japan, is a technical writer and LEGO® luminary. In addition to running Isogawa Studio, Inc., he regularly holds LEGO workshops, lectures at schools and science museums, and creates LEGO models for events and exhibitions. He is the author of the *LEGO MINDSTORMS NXT Orange Book*, *Making Machines with Bricks*, and several other Japanese-language LEGO titles. He is a graduate of the Faculty of Engineering at the Tokyo University of Science.

These unofficial books are not endorsed or authorized by the LEGO Group.

LEGO® INSPIRATION FOR ALL AGES



ISBN: 978-1-59327-277-7

no starch press
THE FINEST IN GEEK ENTERTAINMENT™
www.nostarch.com