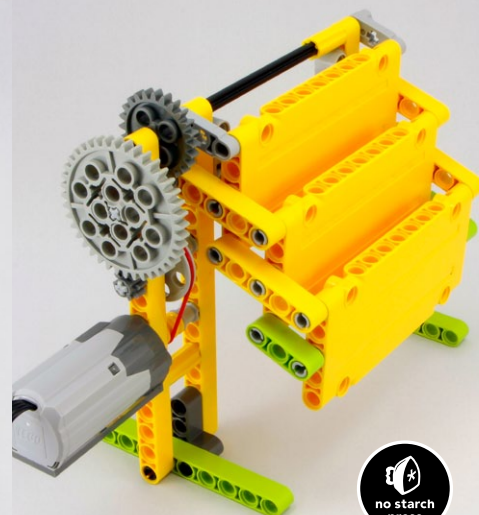
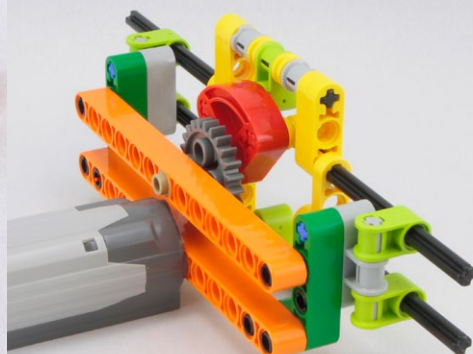
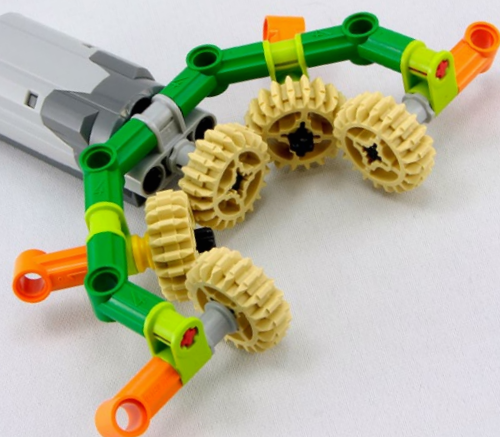


THE LEGO® POWER FUNCTIONS IDEA BOOK

MACHINES AND MECHANISMS

YOSHIHITO ISOGAWA



THE LEGO® POWER FUNCTIONS IDEA BOOK
MACHINES AND MECHANISMS

VOLUME 1

THE LEGO®
POWER
FUNCTIONS
IDEA BOOK

MACHINES AND
MECHANISMS

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



The LEGO® Power Functions Idea Book, Volume 1: Machines and Mechanisms.

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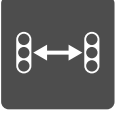




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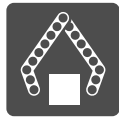
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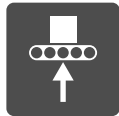
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Introduction

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

Where Are the Words?

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

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

The Use of Color

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

Substituting Parts

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

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

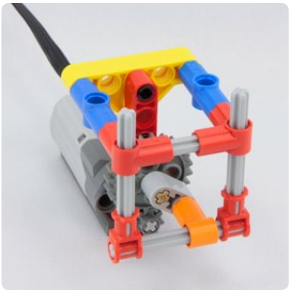
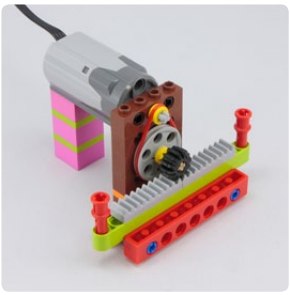
For example, there are many types of LEGO tires. If you don't have the tires shown in a particular project, try using any tires you have that are a similar size. Also, there are several types of Power Functions motors. In this book, the commonly available Medium (M) motors are used most frequently. It's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

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

You Are the Creator

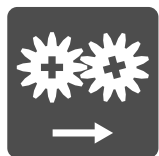
Look at the models you build closely. By thinking about how they move and why they are designed that way, you will greatly improve your building skills.

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

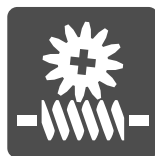


PART 1

Basic Mechanisms



4



52



90



114



154



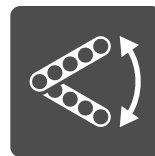
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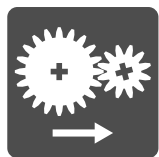
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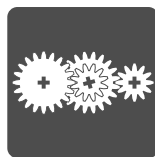
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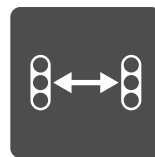
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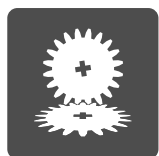
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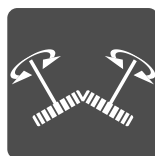
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42



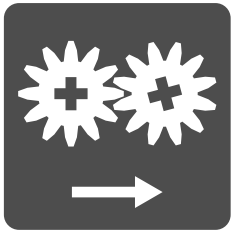
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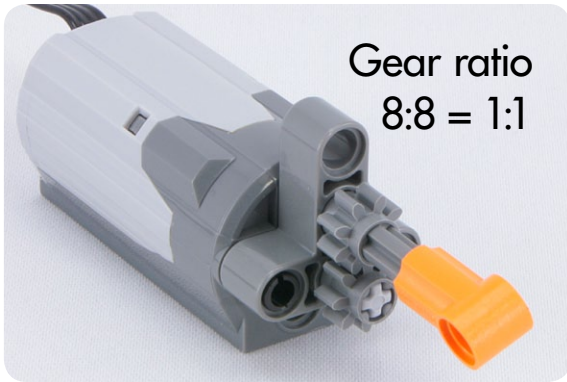
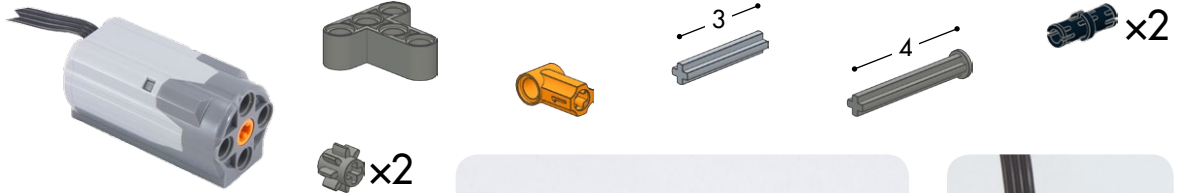


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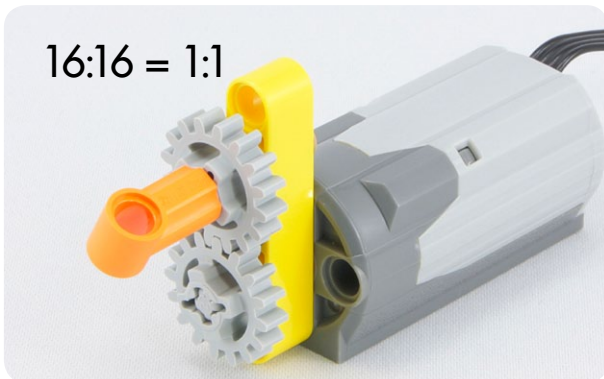
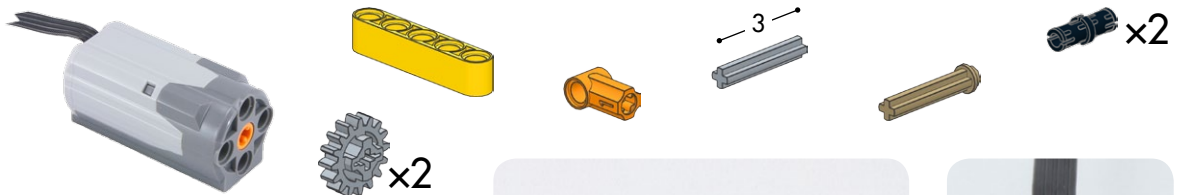


Transmitting rotation

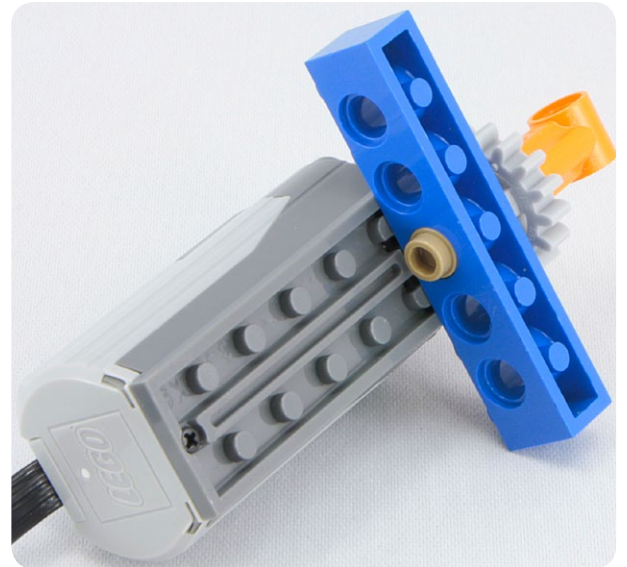
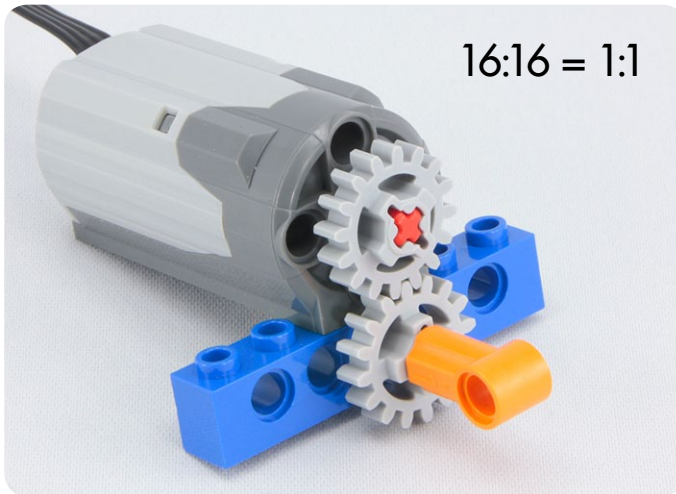
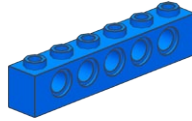
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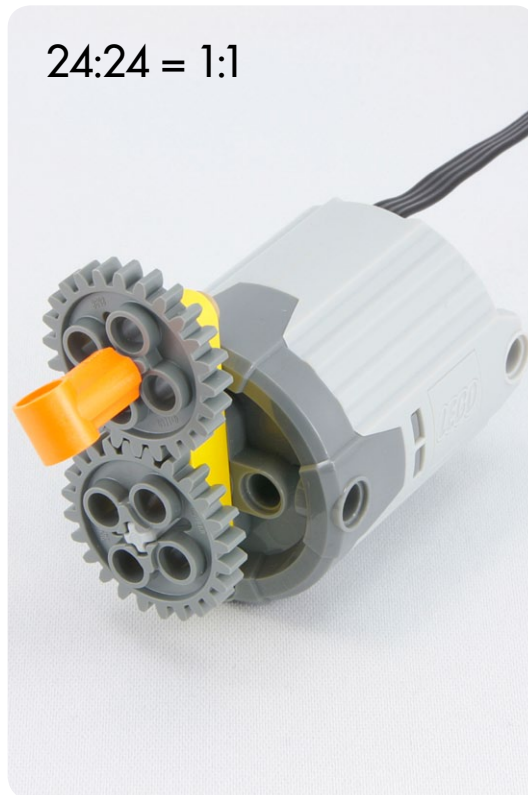
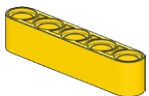
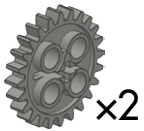


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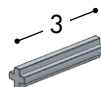
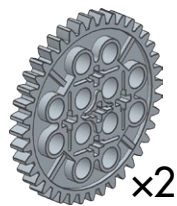


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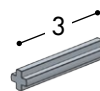
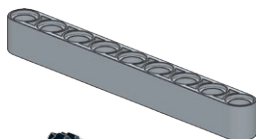
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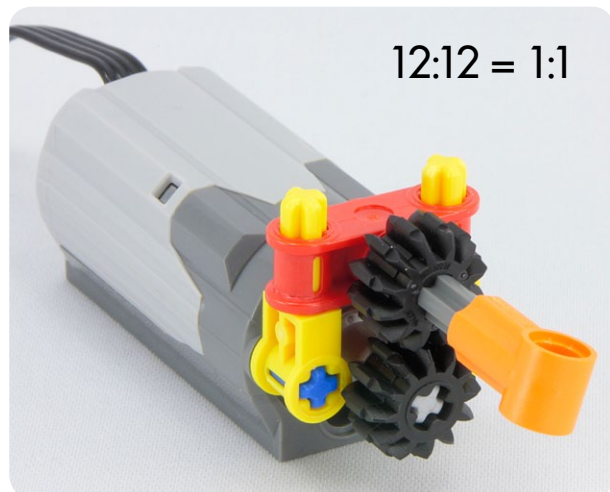
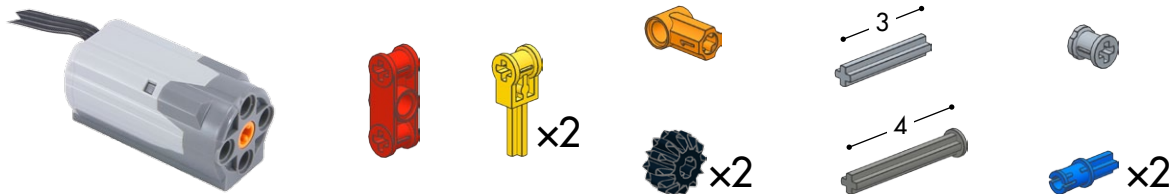
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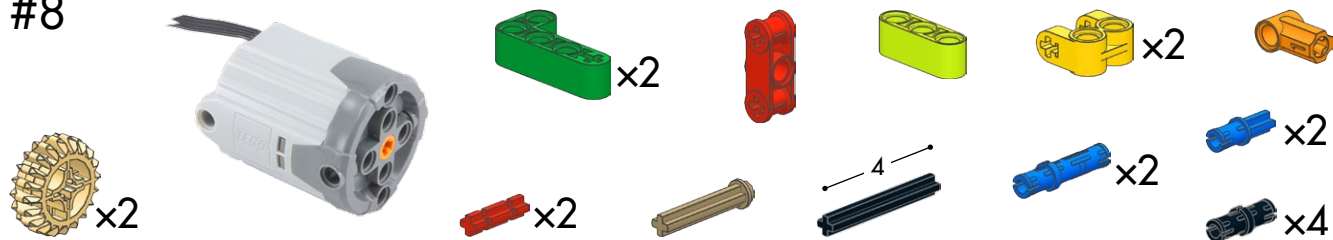
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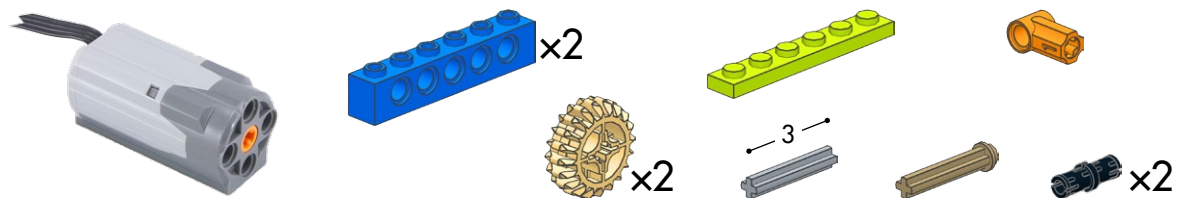
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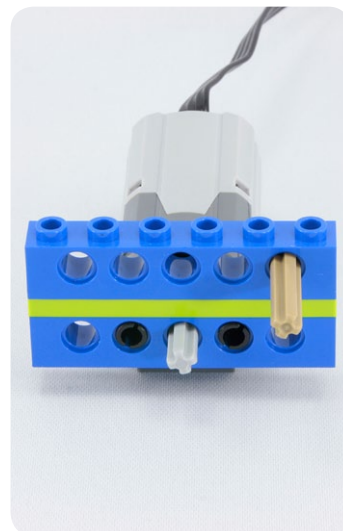
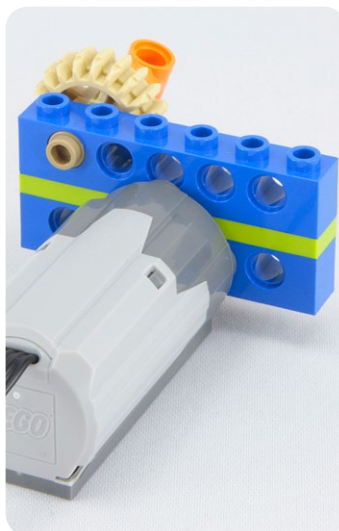
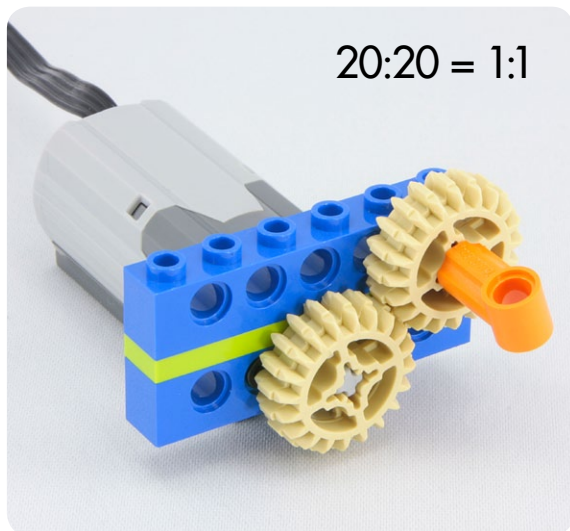
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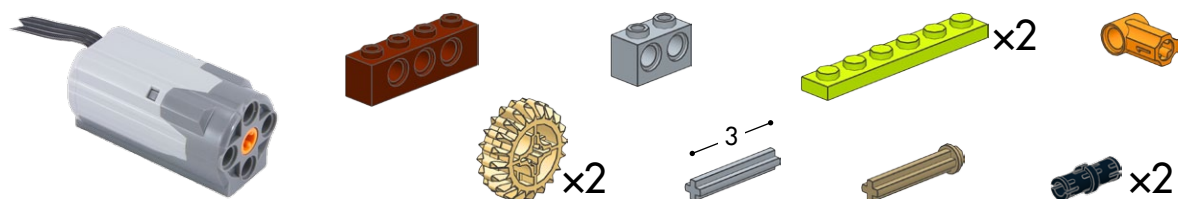
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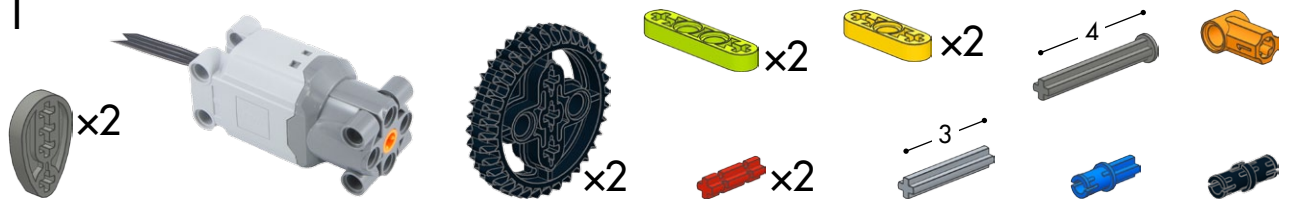
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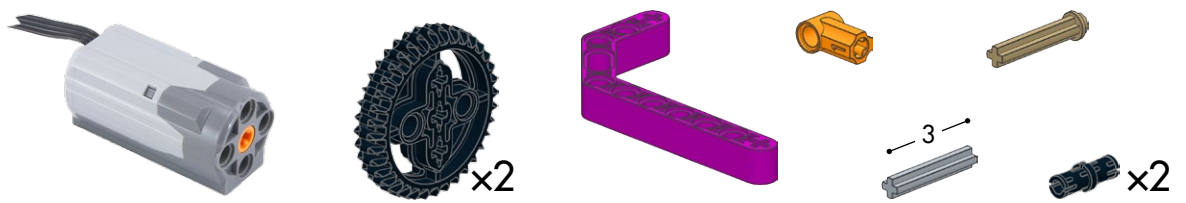
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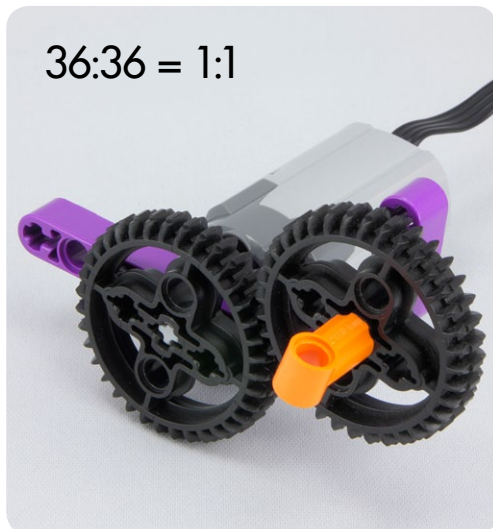
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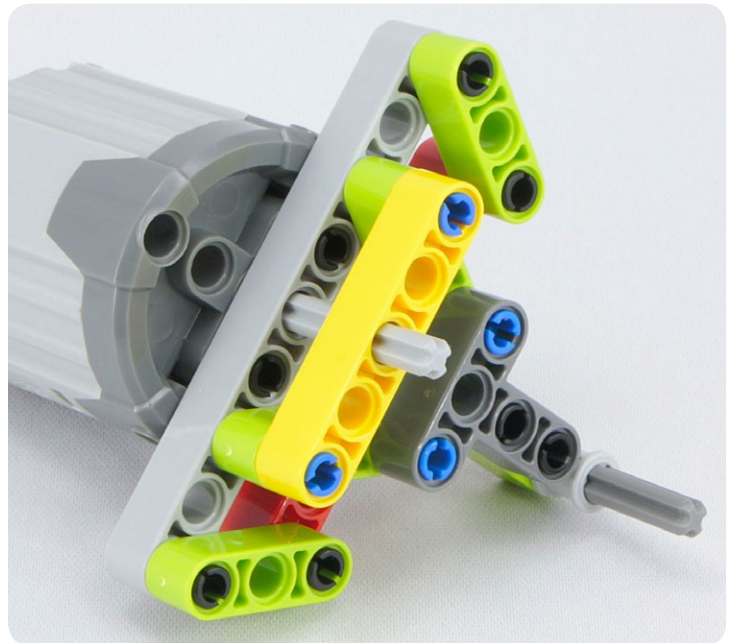
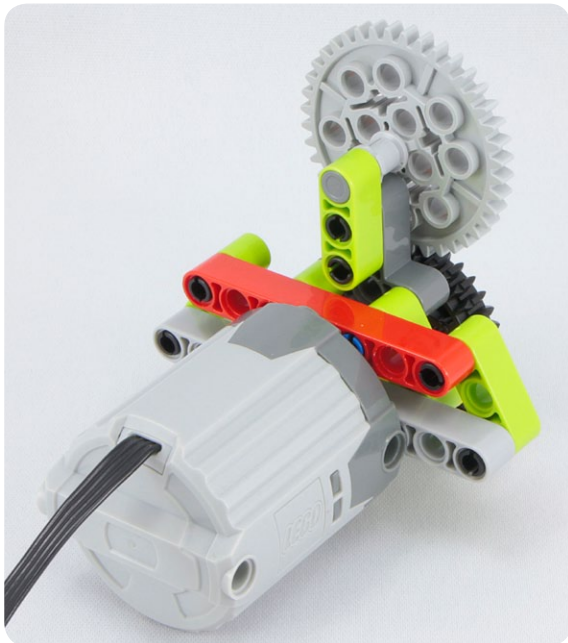


#14



Parts list for step 14:

- 1x Motor
- 1x Gear (Large, Grey)
- 1x Gear (Small, Black)
- 1x Beam (Grey, 11 holes)
- 1x Beam (Red, 5 holes)
- 1x Beam (Yellow, 5 holes)
- 1x Beam (Green, 3 holes) x5
- 1x Connector (Orange)
- 1x Connector (Grey)
- 1x Connector (Blue) x4
- 1x Pin (Grey, 4) x1
- 1x Pin (Grey, 5) x1
- 1x Pin (Black) x8

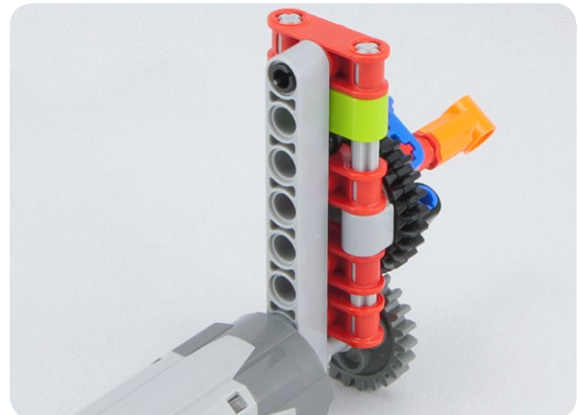


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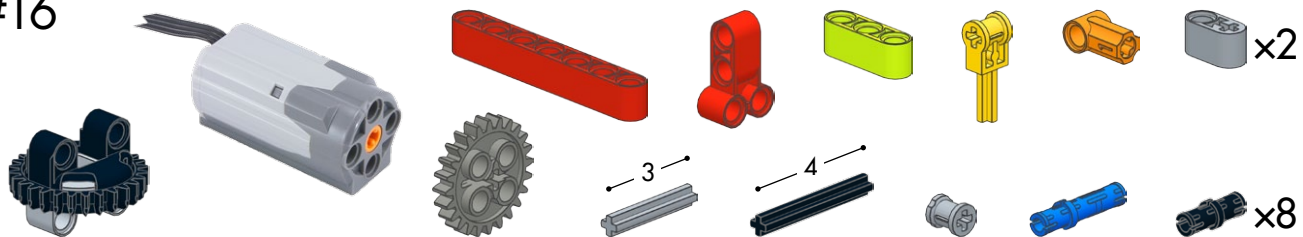
24:28 = 6:7 ▶ 0.86



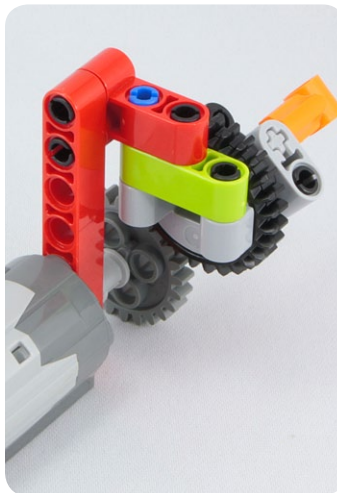
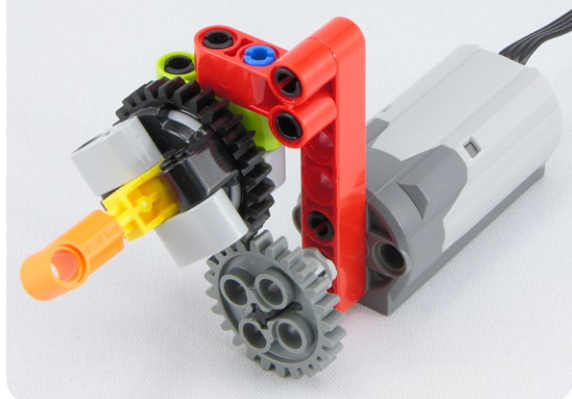
A photograph of a LEGO Technic assembly. On the left is a grey motor with a black cable. A grey vertical beam is attached to the motor. On this beam, there is a red Technic connector, a yellow Technic plate, and a black gear with 24 teeth. A blue Technic connector is attached to the side of the 24-tooth gear. A red Technic connector is attached to the bottom of the 24-tooth gear. A black gear with 28 teeth is attached to the red connector. A blue Technic connector is attached to the side of the 28-tooth gear. An orange Technic connector is attached to the bottom of the 28-tooth gear.



#16



$$24:28 = 6:7 \triangleright 0.86$$



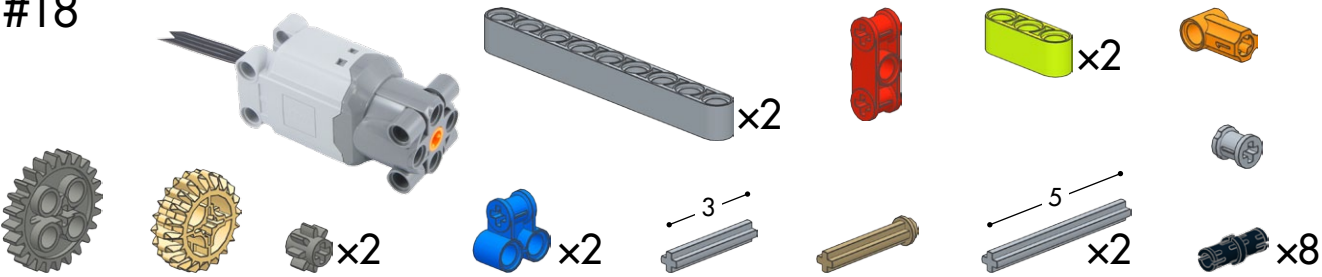
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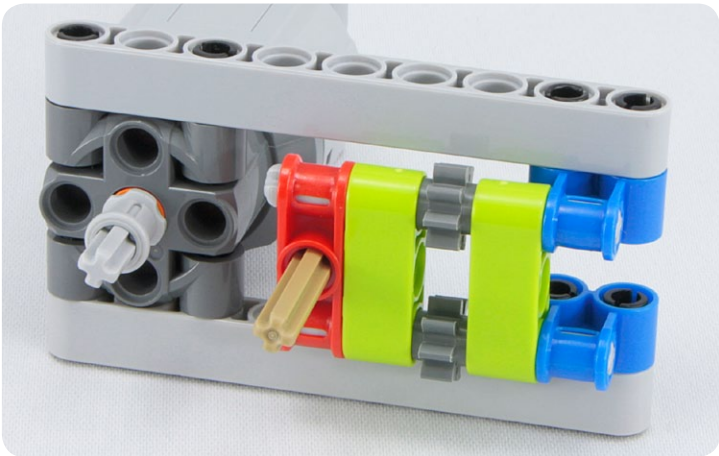
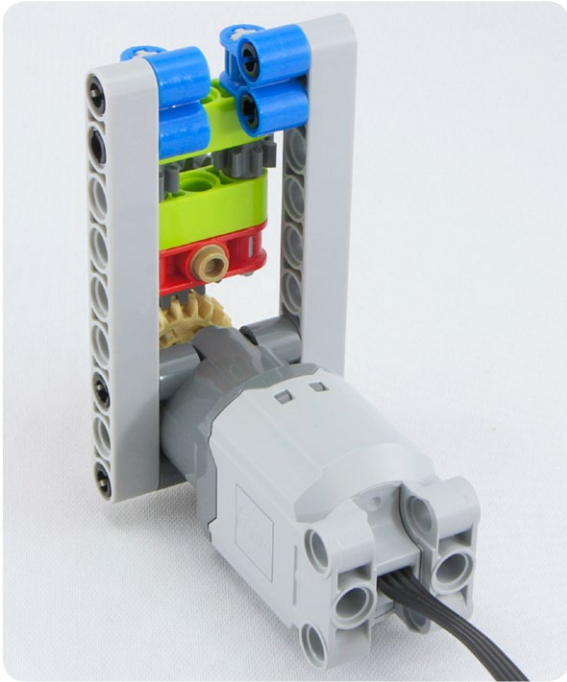
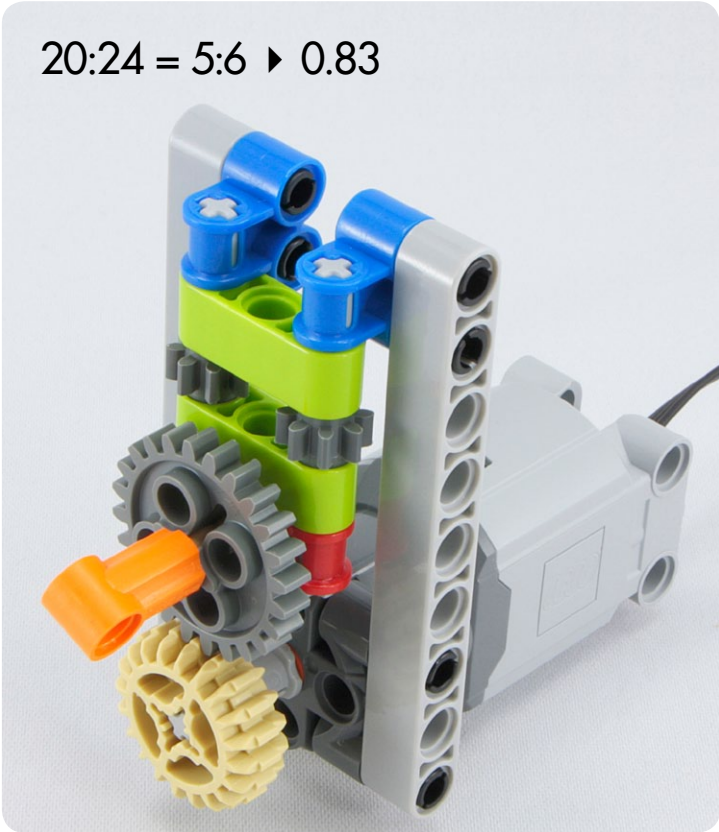
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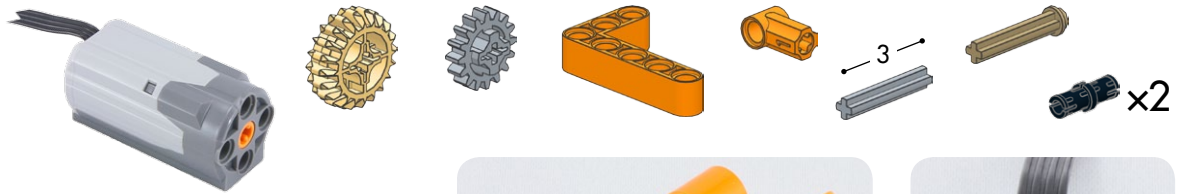
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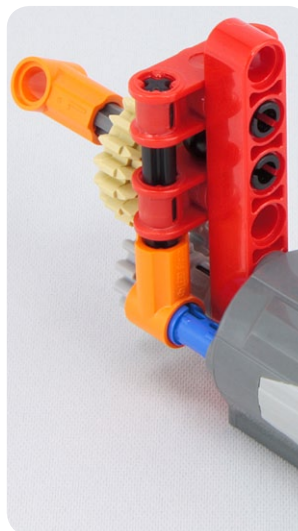
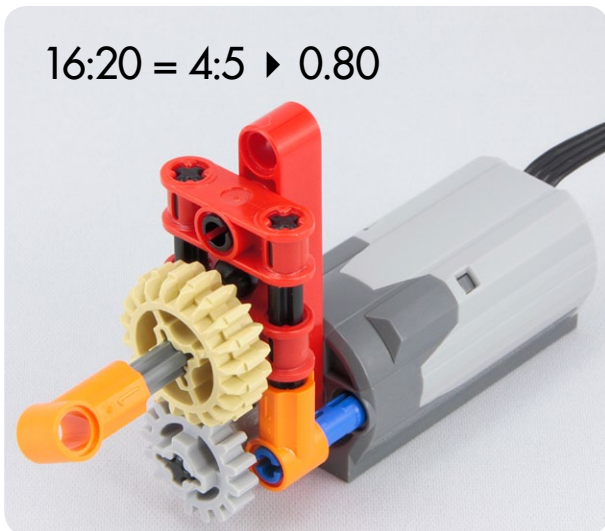
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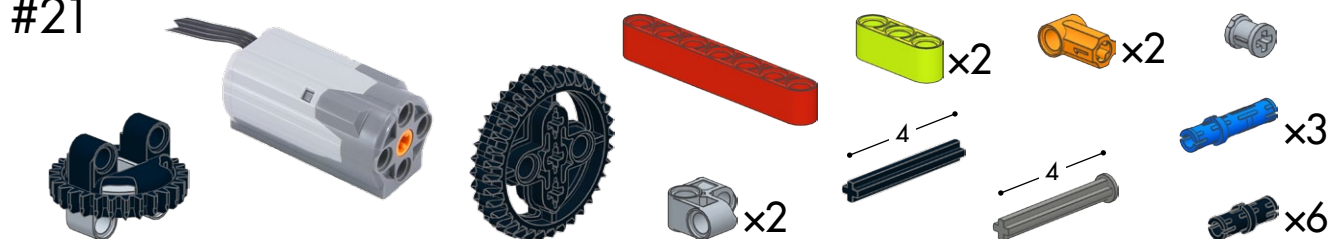
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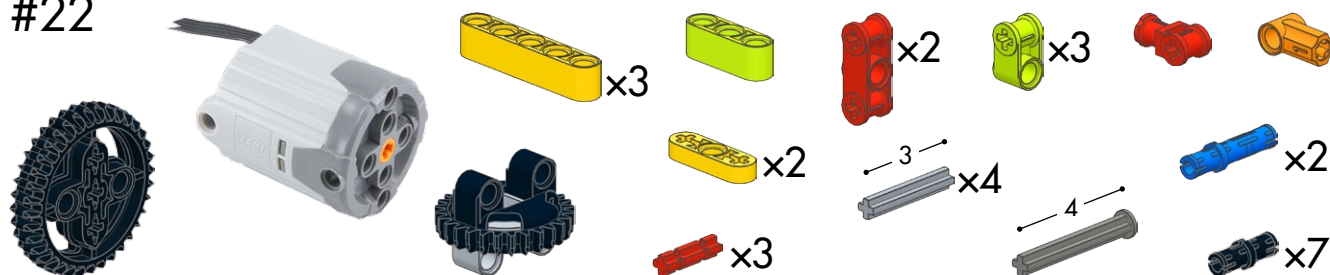
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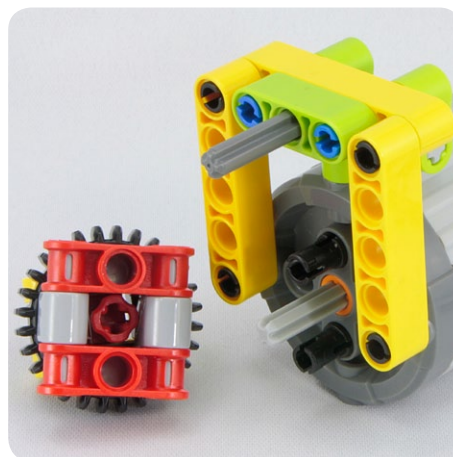
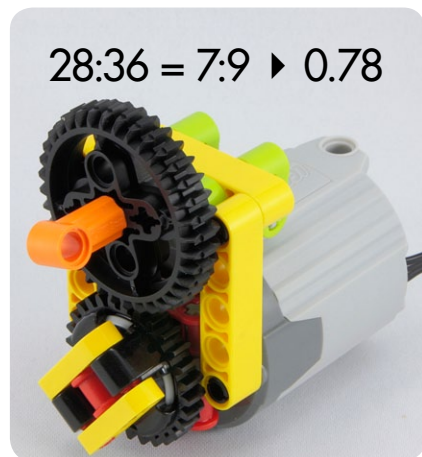
$28:36 = 7:9 \triangleright 0.78$



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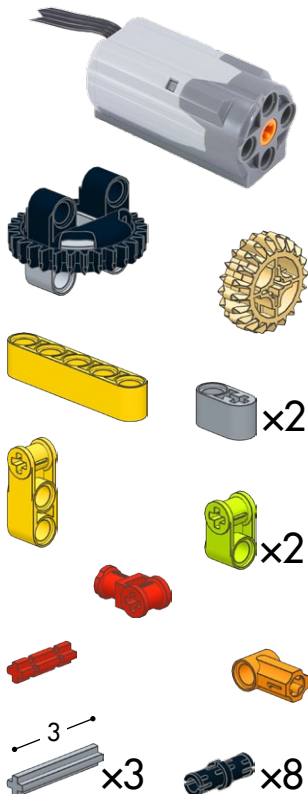
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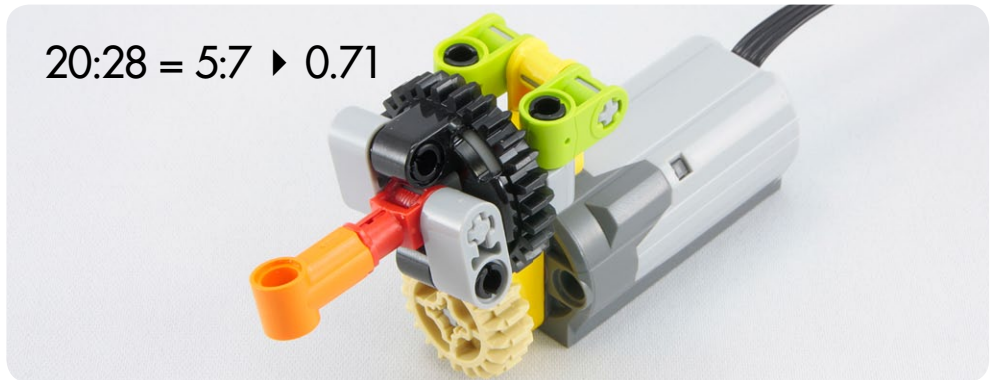
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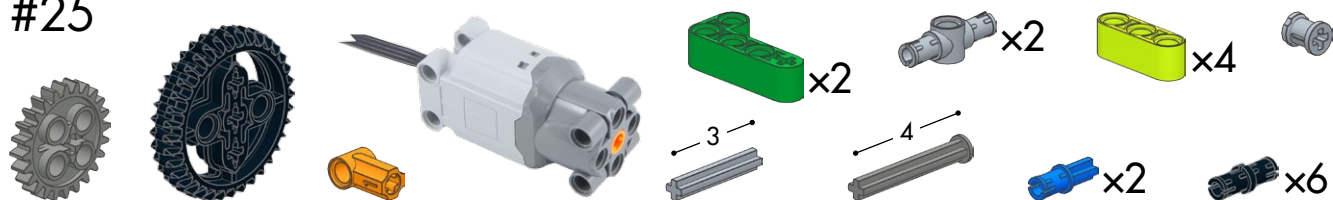
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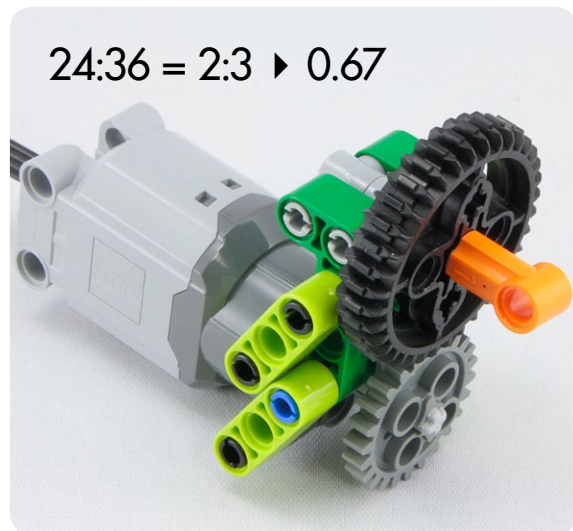
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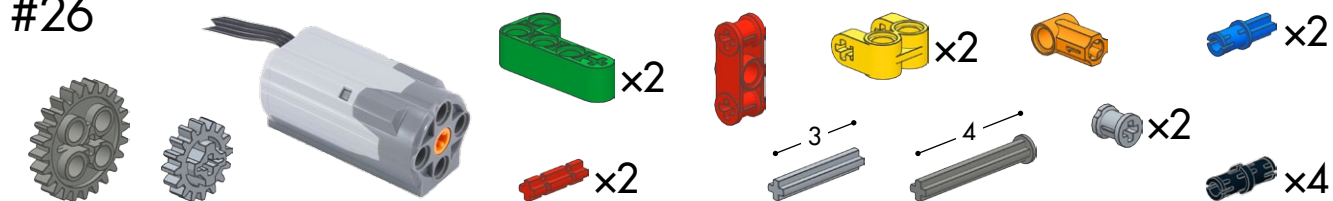
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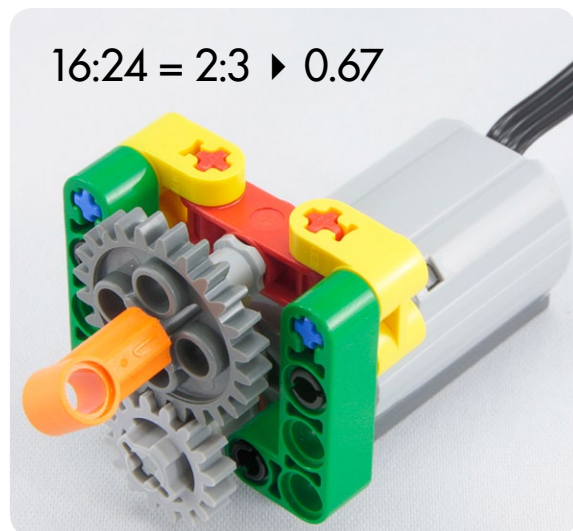
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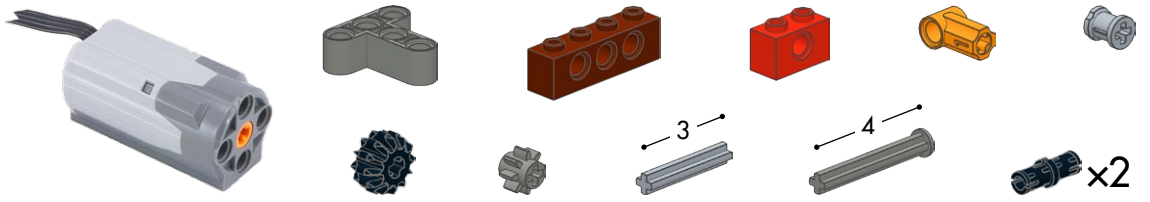
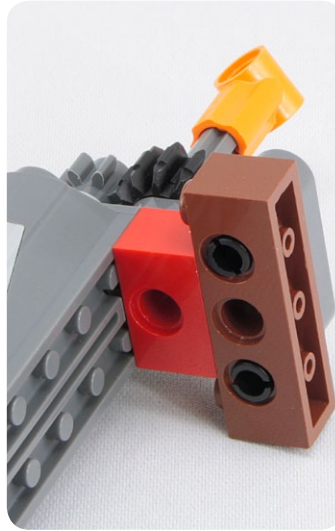
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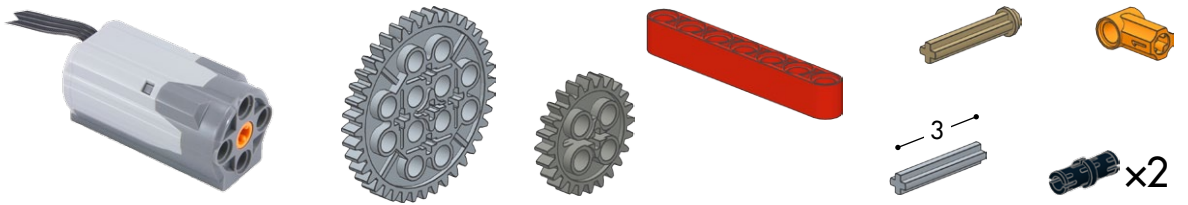
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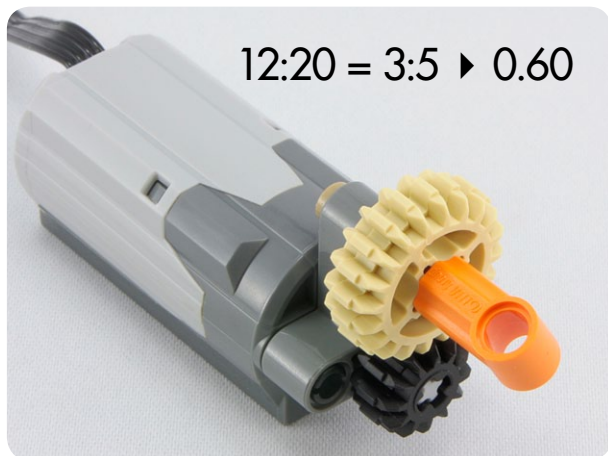
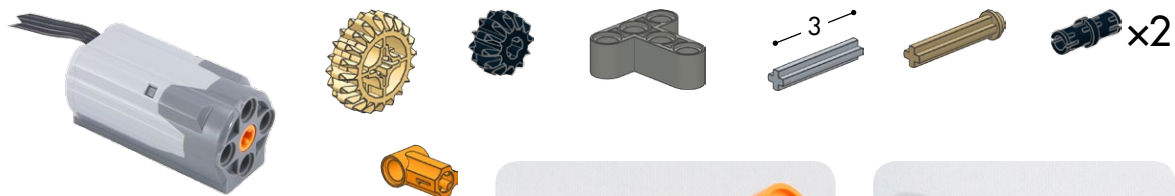
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$$8:12 = 2:3 \blacktriangleright 0.67$$


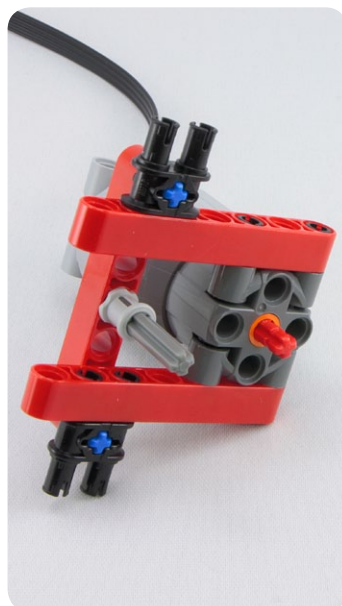
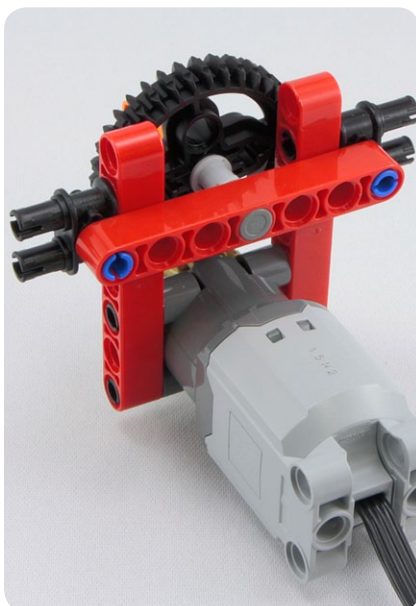
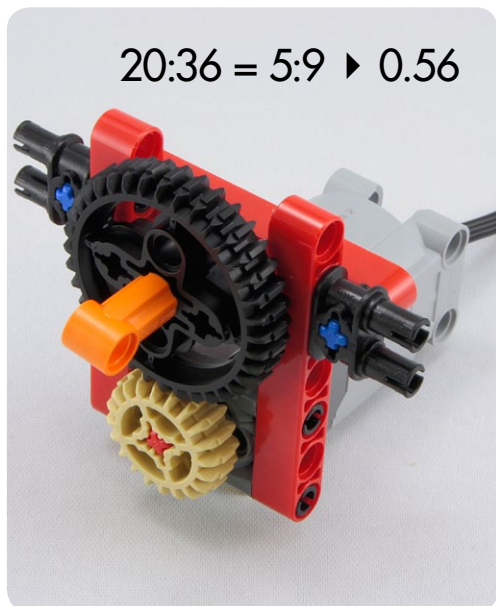
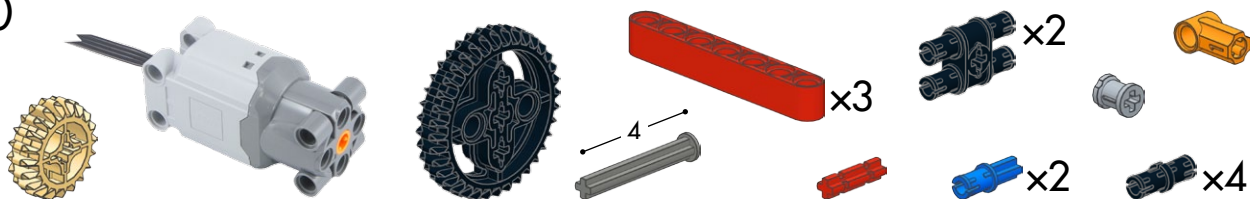
#28


$$24:40 = 3:5 \triangleright 0.60$$

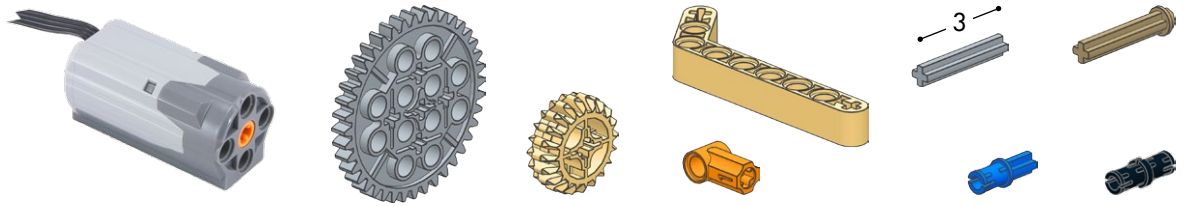

#29



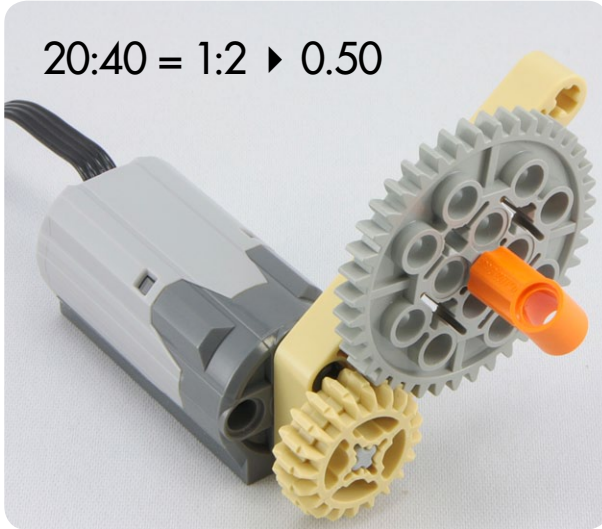
#30



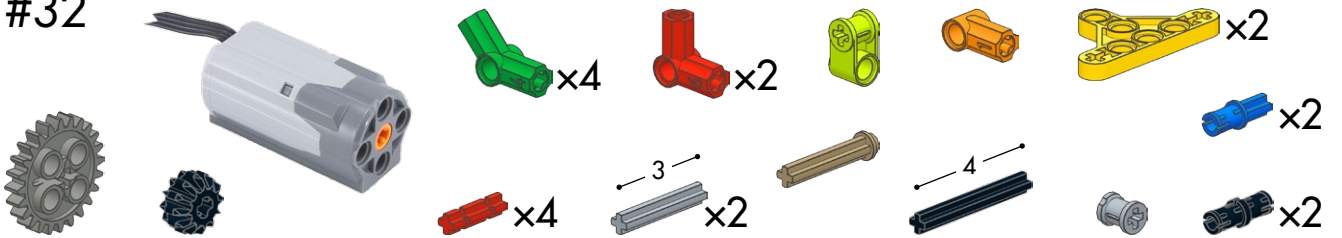
#31



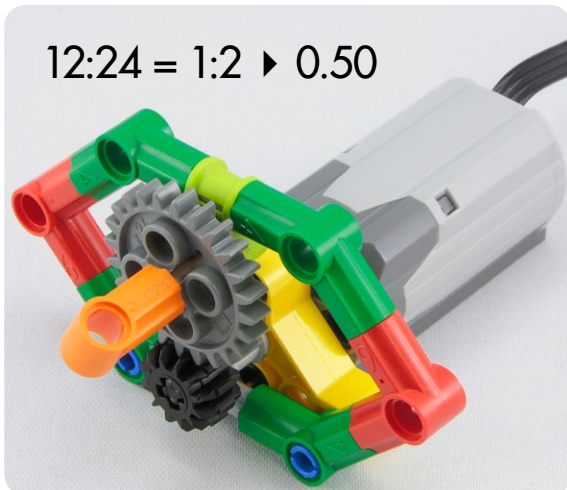
$20:40 = 1:2 \rightarrow 0.50$



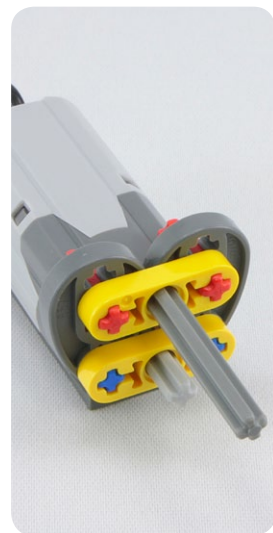
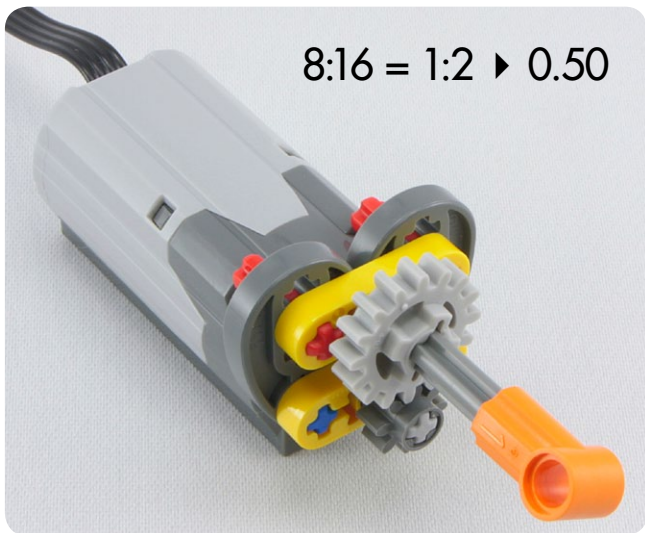
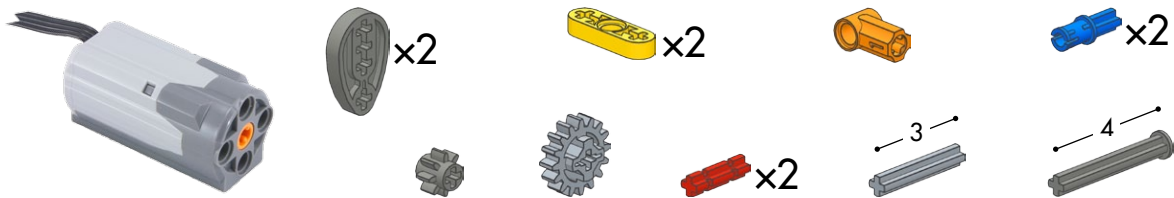
#32



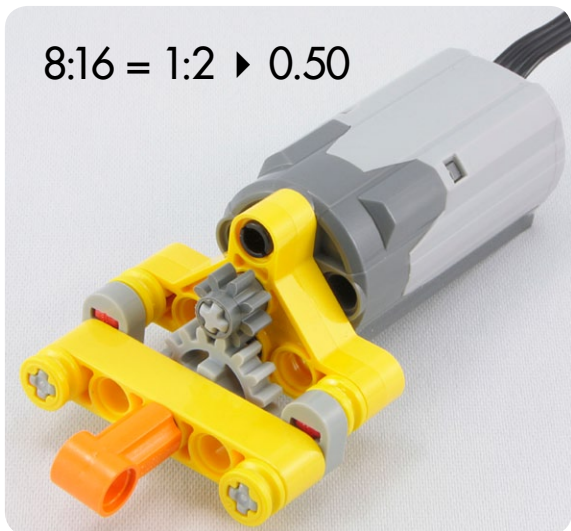
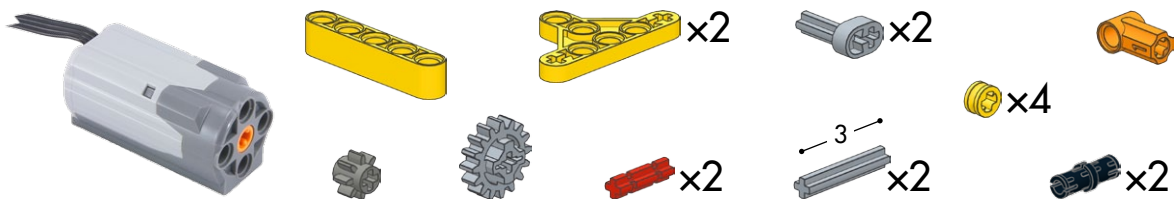
$12:24 = 1:2 \rightarrow 0.50$



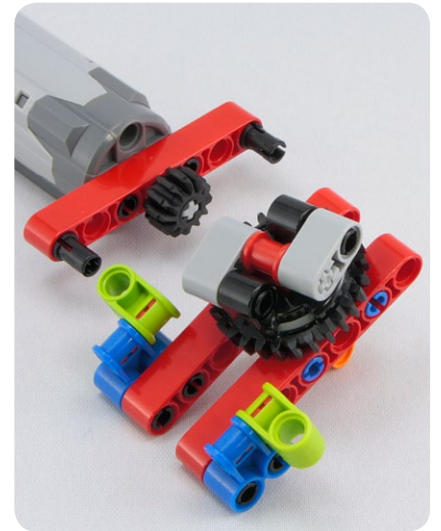
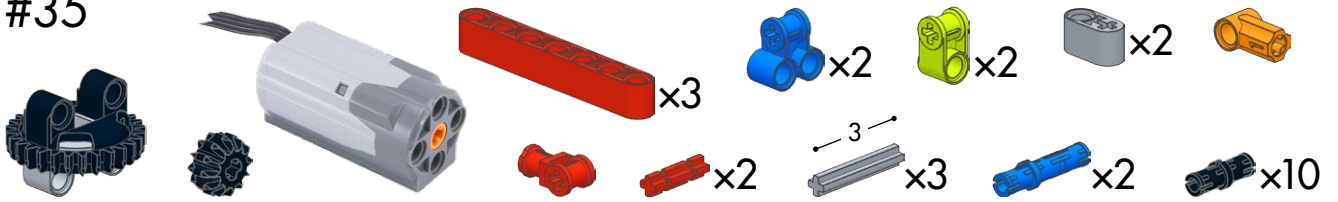
#33



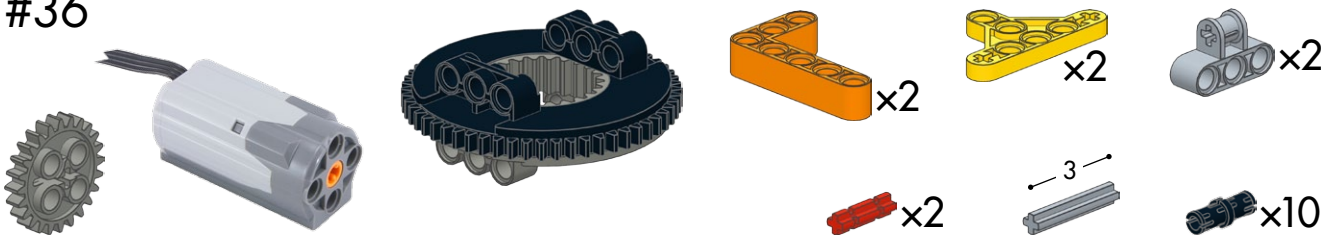
#34



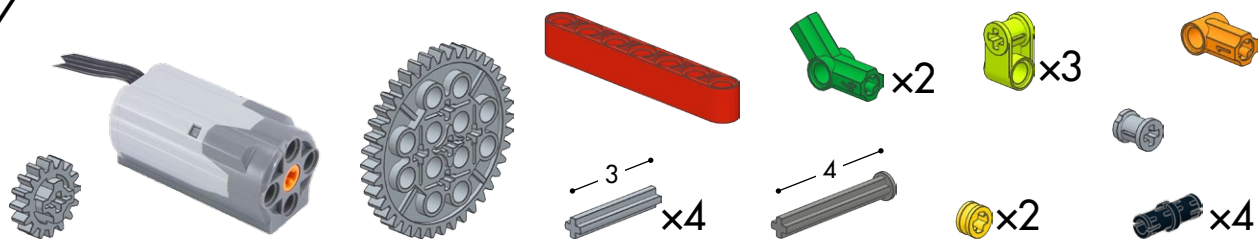
#35



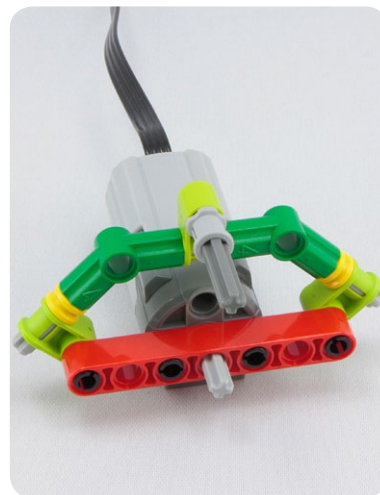
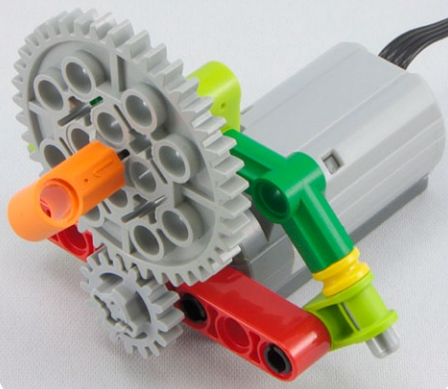
#36



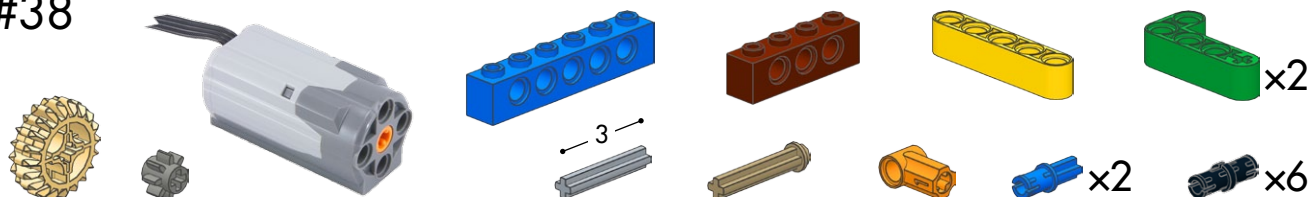
#37



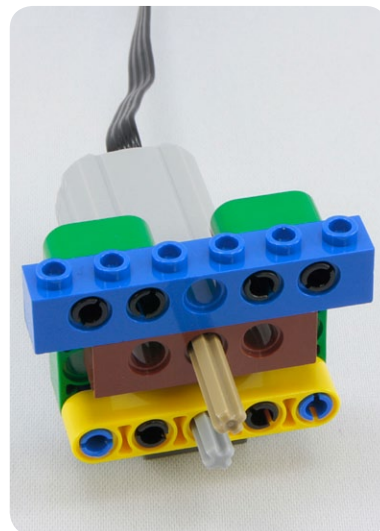
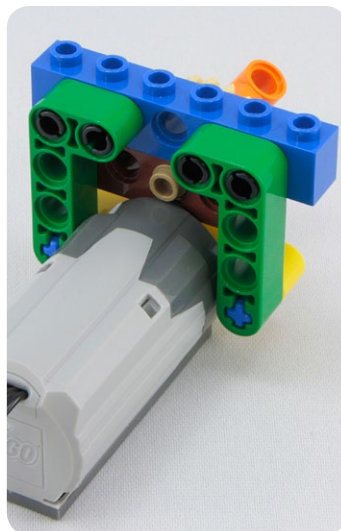
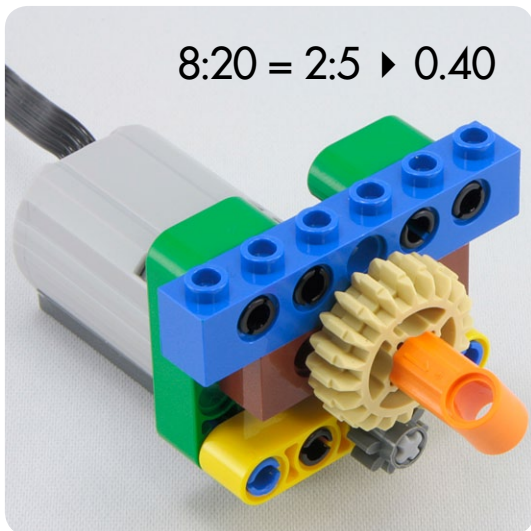
16:40 = 2:5 ▶ 0.40



#38



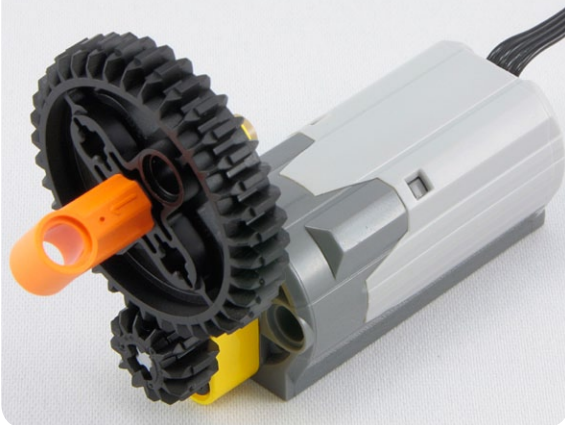
8:20 = 2:5 ▶ 0.40



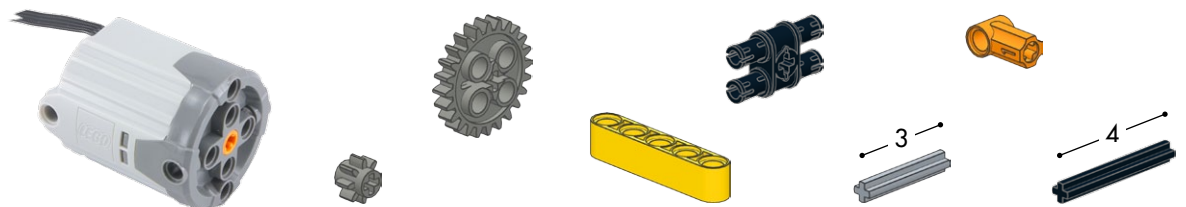
#39



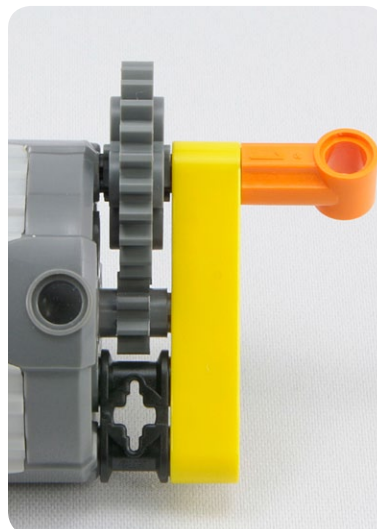
$12:36 = 1:3 \triangleright 0.33$



#40

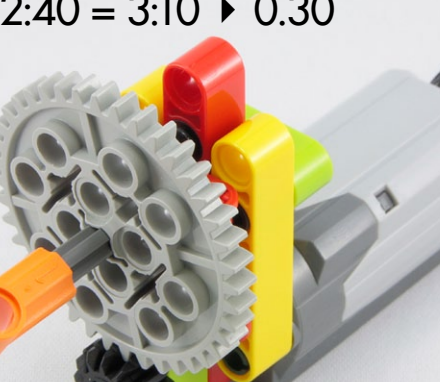
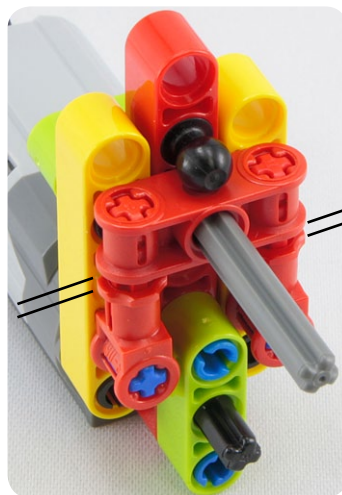
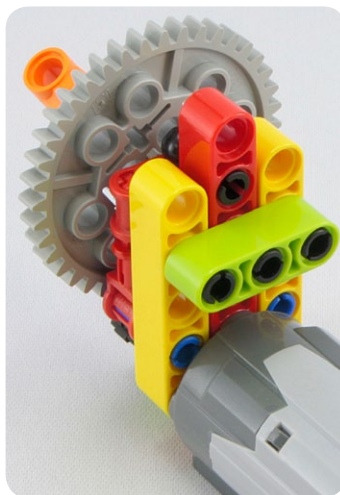


$8:24 = 1:3 \triangleright 0.33$



[illegible]

12:40 = 3:10 ▶ 0.30

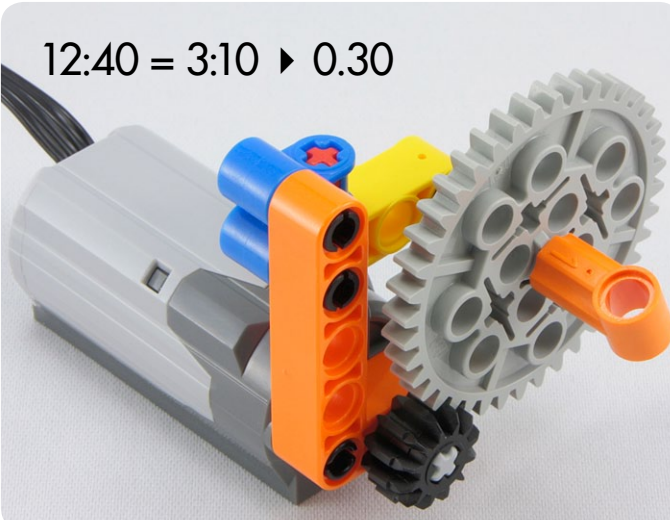
A LEGO Technic assembly featuring a grey motor, a large grey gear, and various colored connectors (red, yellow, green, orange, black). The assembly is shown from a side-on perspective, highlighting the gear mechanism and the motor housing.

#42

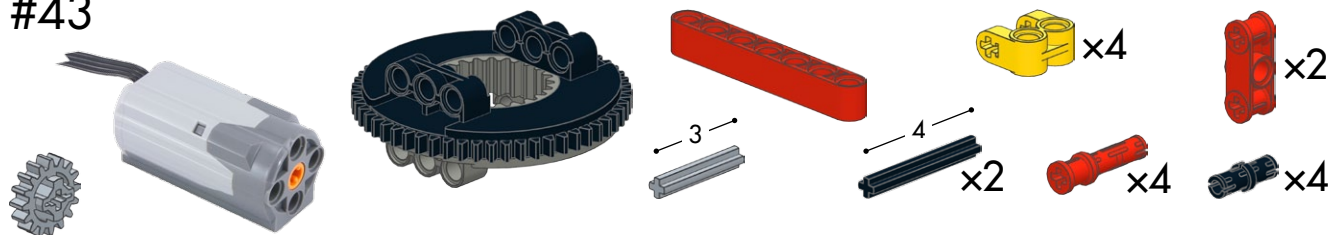
Parts list for step 42:

- 1 grey motor
- 1 large grey gear
- 1 orange 1x3 L-technic beam
- 1 yellow 1x3 L-technic beam
- 1 blue 3-way connector
- 1 orange 1x2 L-technic beam
- 1 grey 1x2 L-technic beam
- 1 black gear
- 4 black pins (indicated by 'x4')
- 1 red 1x2 L-technic beam
- 3 grey 1x10 L-technic beams (indicated by '3')
- 4 grey 1x10 L-technic beams (indicated by '4')

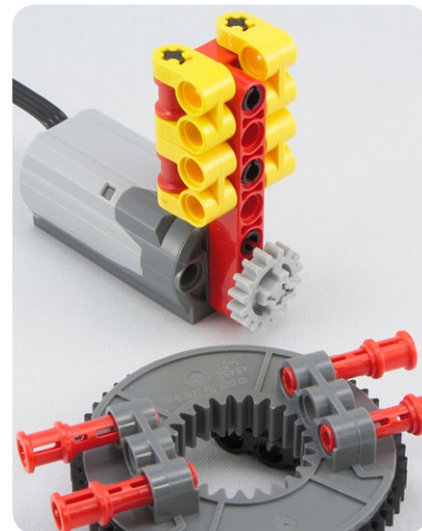
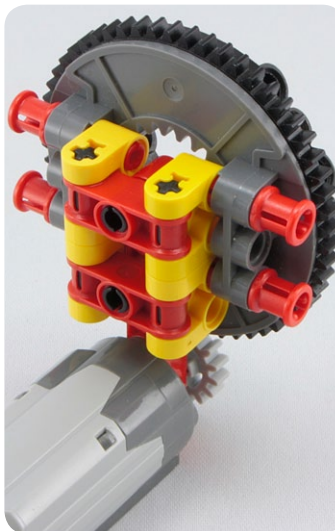
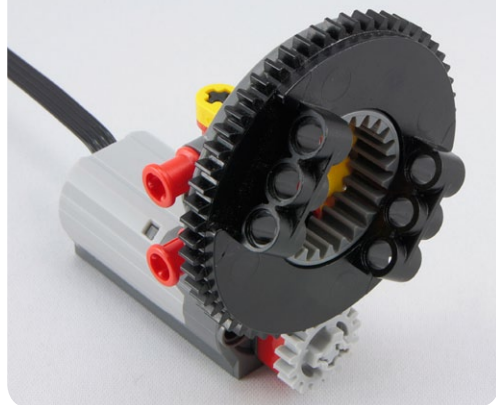
12:40 = 3:10 ▶ 0.30

A LEGO Technic assembly featuring a grey motor block connected to a black cable. The motor is mounted on a grey base. A blue pin is connected to a yellow pin, which is further connected to an orange pin. A large grey gear is attached to the end of the assembly, and a smaller black gear is visible below it. An orange cap is also present.

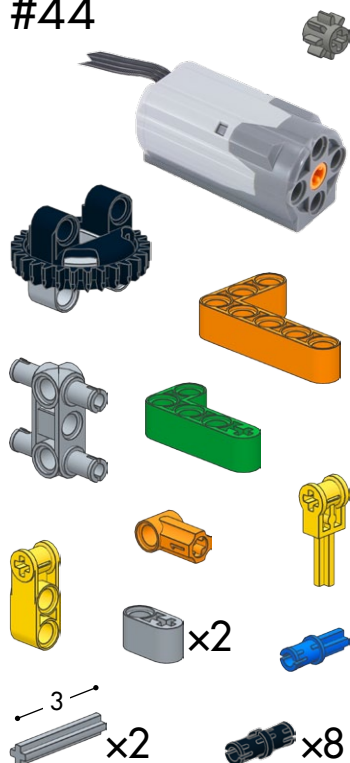
#43



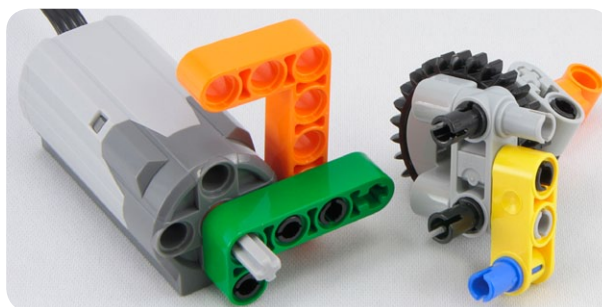
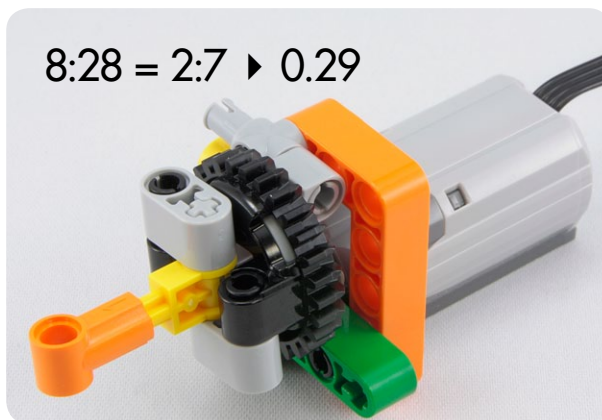
$16:56 = 4:14 \triangleright 0.29$



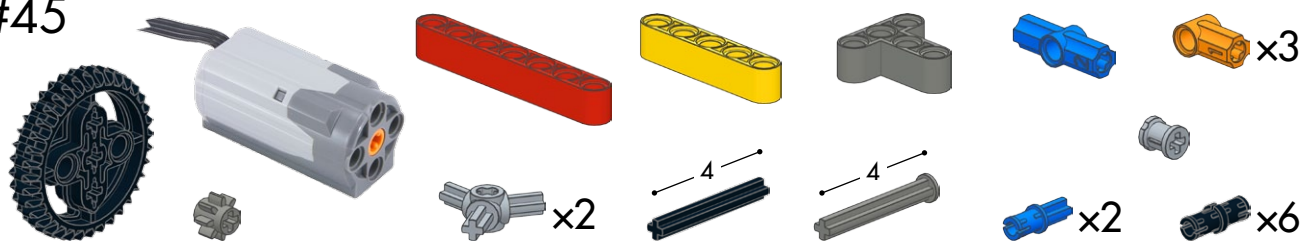
#44



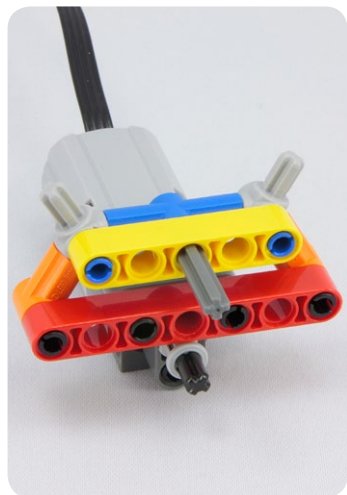
$8:28 = 2:7 \triangleright 0.29$



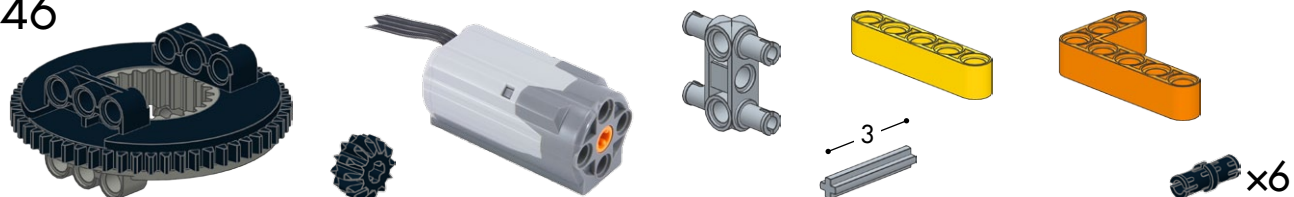
#45



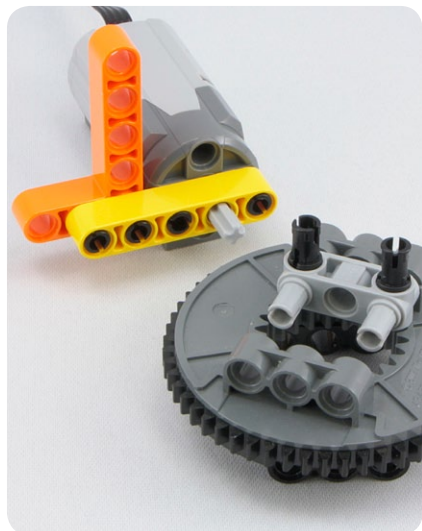
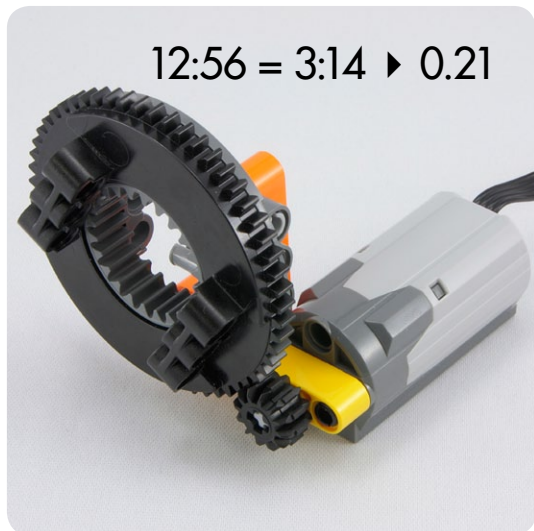
$8:36 = 2:9 \triangleright 0.22$



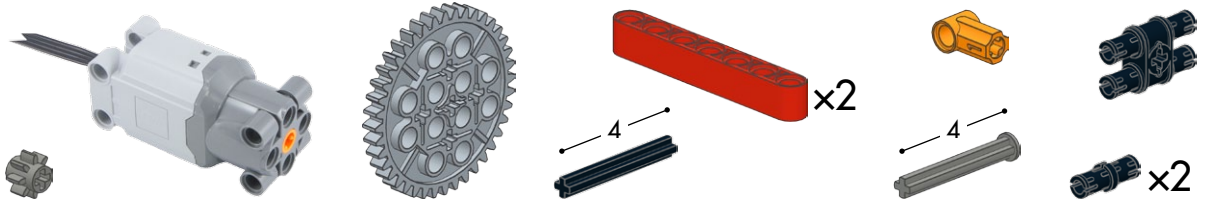
#46



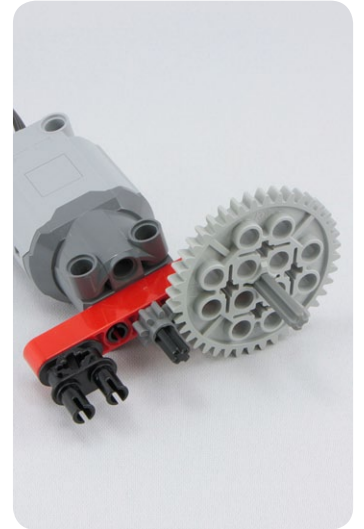
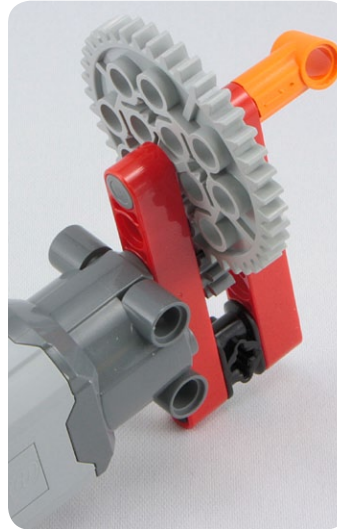
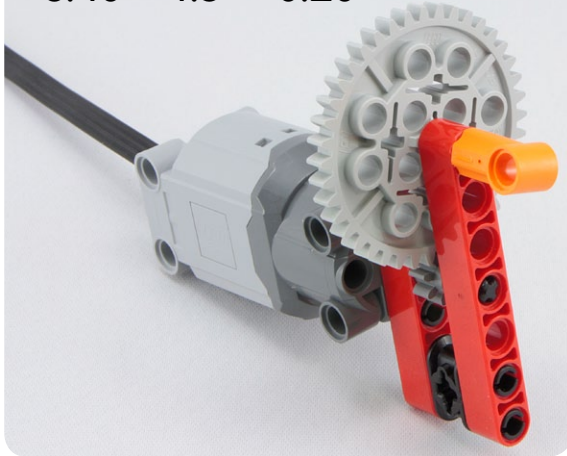
$12:56 = 3:14 \triangleright 0.21$



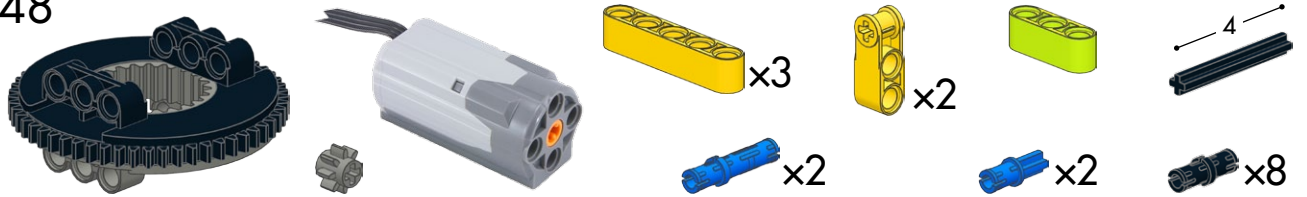
#47



$8:40 = 1:5 \triangleright 0.20$

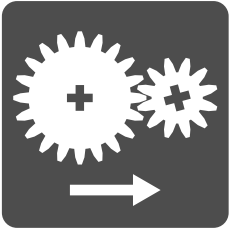


#48



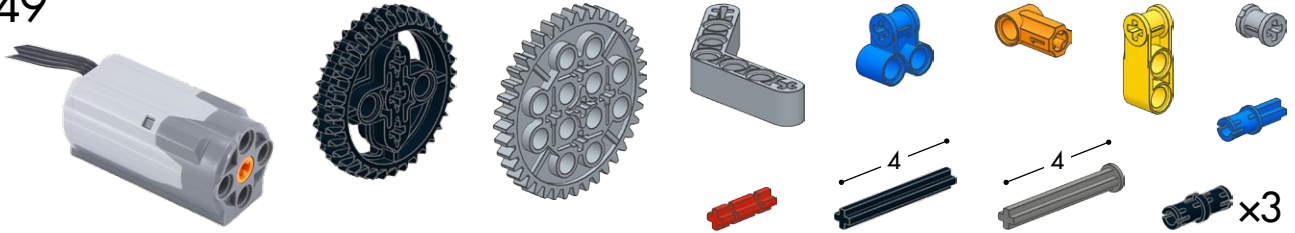
$8:56 = 1:7 \triangleright 0.14$





Gearing up (speeding up)

#49



$40:36 = 10:9 \triangleright 1.11$

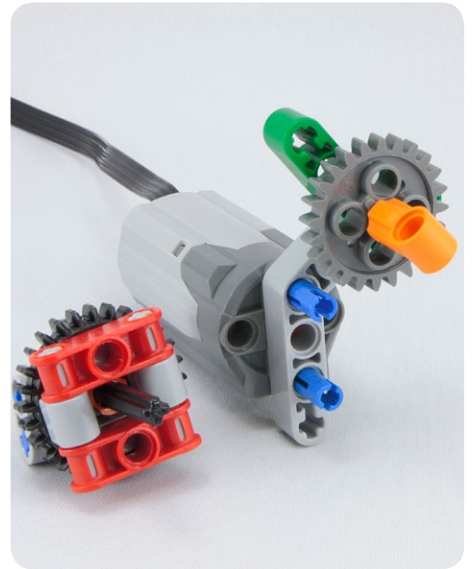


#50


This image shows the parts required for step 50. The parts are arranged as follows:

- A dark blue gear assembly.
- A tan axle.
- A grey motor.
- A grey gear.
- A grey L-shaped Technic beam (1x6).
- A green L-shaped Technic beam (1x6).
- A red 3-way connector (x2).
- A grey 1/2 round Technic bush (x2).
- An orange 1/2 round Technic bush (x2).
- A grey long axle with a stop (length 3) (x2).
- A black long axle with a stop (length 4) (x2).
- A blue pin (x3).
- A blue short axle (x3).
- A black short axle.

28:24 = 7:6 ▶ 1.17

A LEGO Technic model of a duck-like head. It features a grey motor at the back, connected to a series of gears. A large grey gear is mounted on a green axle, which is connected to a smaller grey gear. This smaller gear is part of a gear train that includes a black gear and a white gear with blue pins. An orange beak is attached to the front. The model is built using various colored Technic bricks and axles, including red, black, and grey.

#51



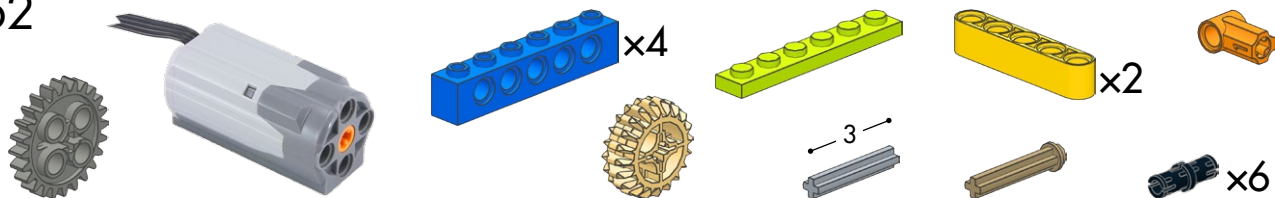
1 small orange connector, 1 grey motor, 1 grey gear, 1 yellow gear, 1 orange 1x3 Technic beam, 1 grey axle with a stop, 1 tan axle, and 2 black connectors.

24:20 = 6:5 ▶ 1.20

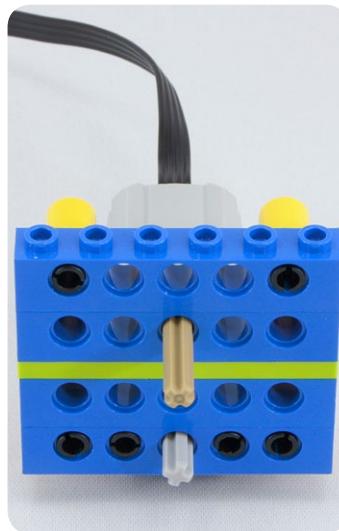
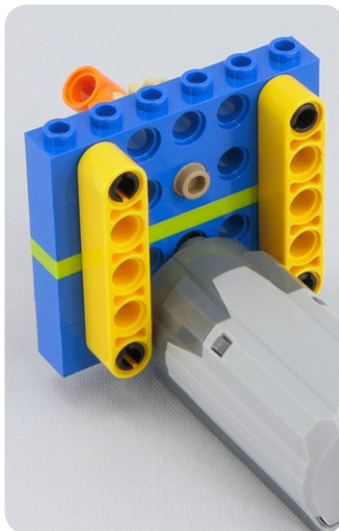
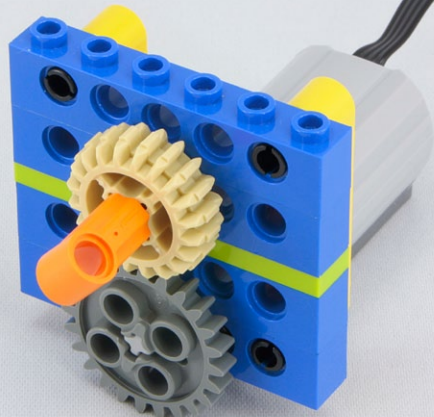
A close-up photograph of a LEGO Technic gear assembly. It features a grey motor housing on the left, connected to a grey 24-tooth gear. This gear is meshed with a smaller grey 20-tooth gear. The 20-tooth gear is mounted on an orange axle, which also has a yellow 12-tooth gear attached to its end. The entire assembly is built using orange and grey Technic beams and connectors. The background is a plain, light-colored surface.



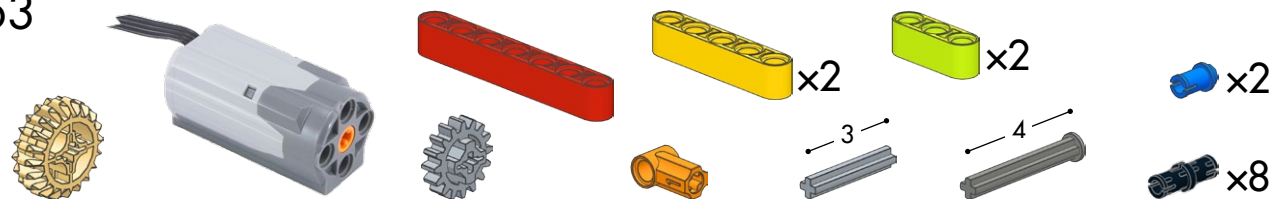
#52



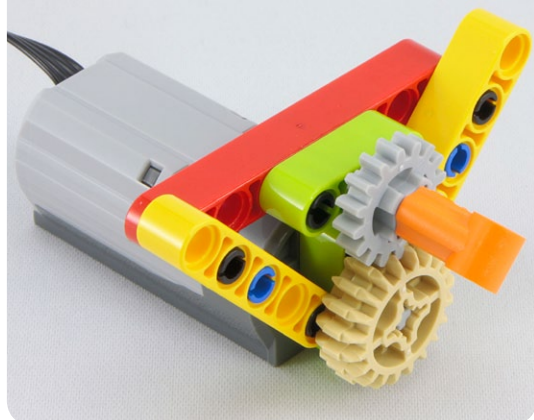
$24:20 = 6:5 \rightarrow 1.20$



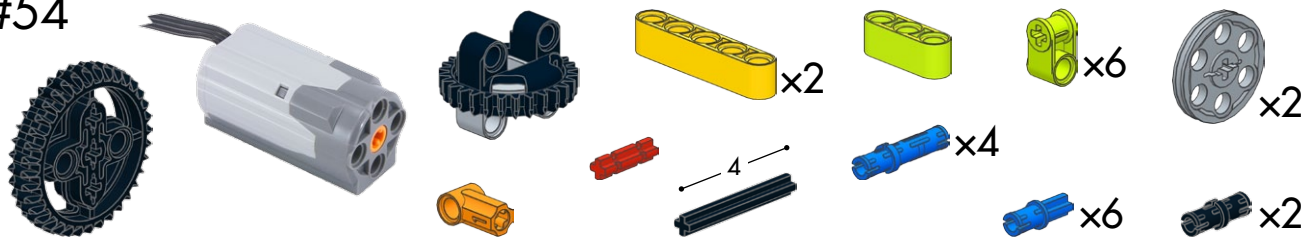
#53



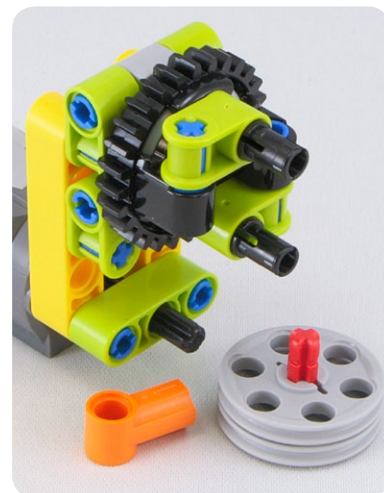
$20:16 = 5:4 \rightarrow 1.25$



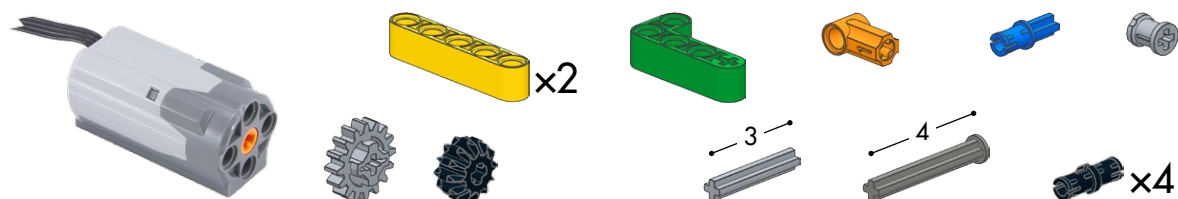
#54



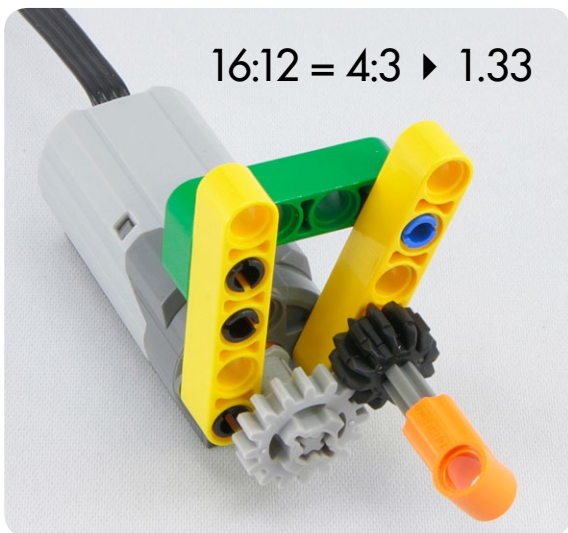
$36:28 = 9:7 \triangleright 1.29$



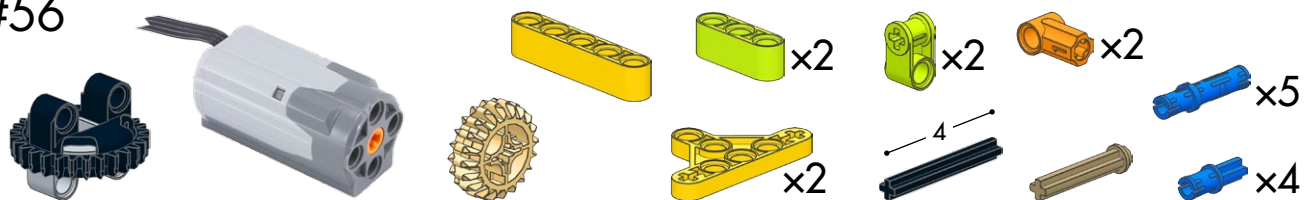
#55



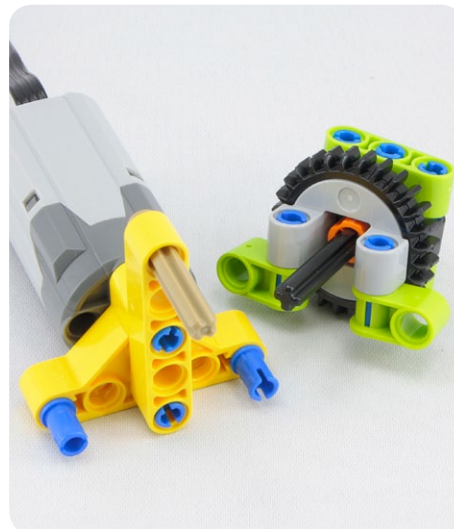
$16:12 = 4:3 \triangleright 1.33$



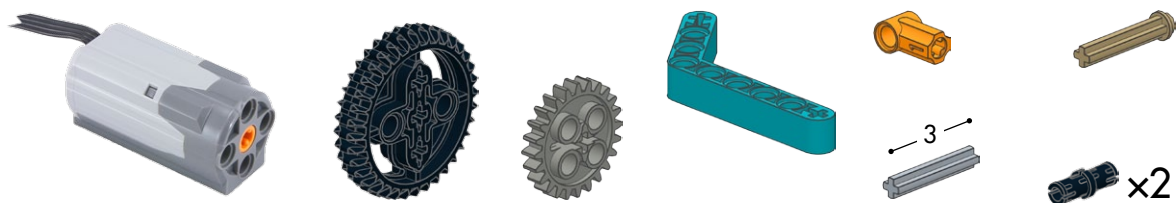
#56



28:20 = 7:5 ▶ 1.40



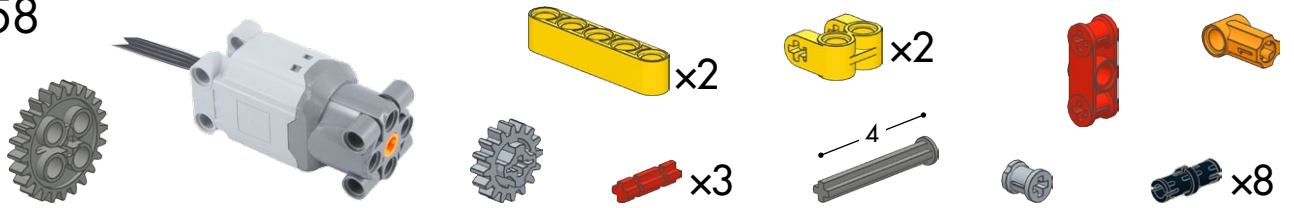
#57



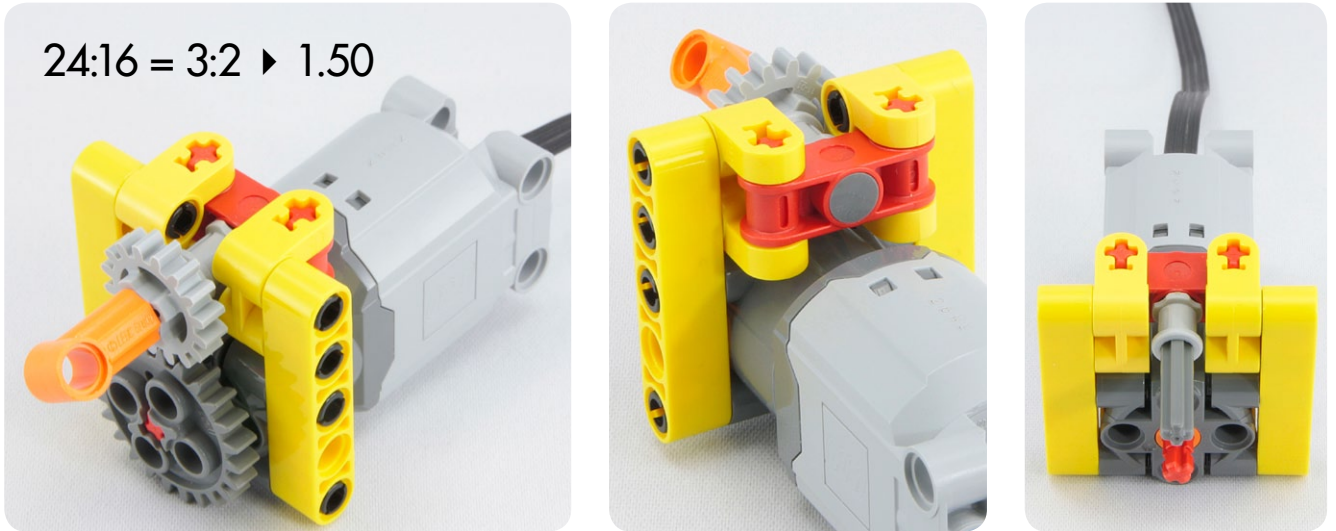
36:24 = 3:2 ▶ 1.50



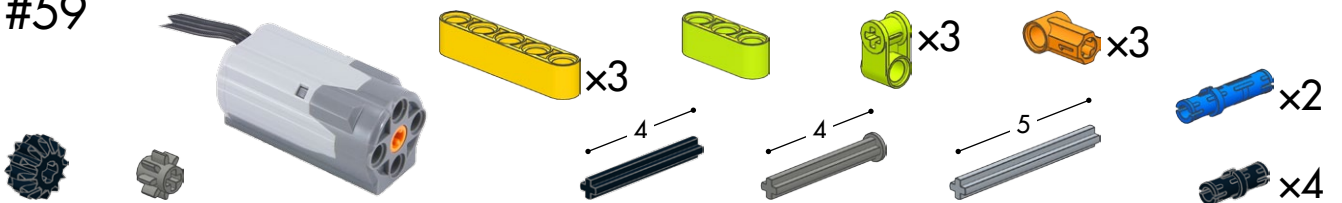
#58



$24:16 = 3:2 \triangleright 1.50$



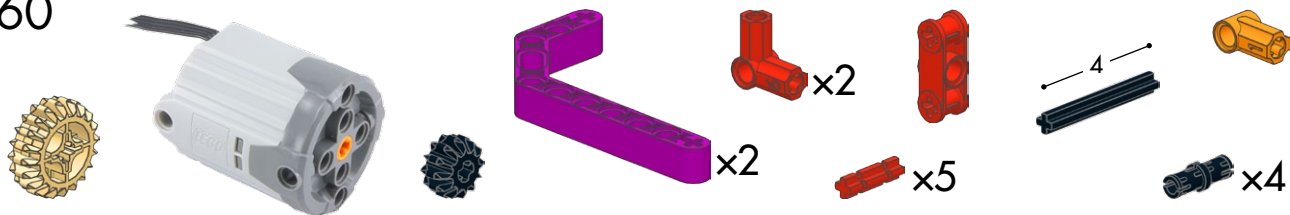
#59



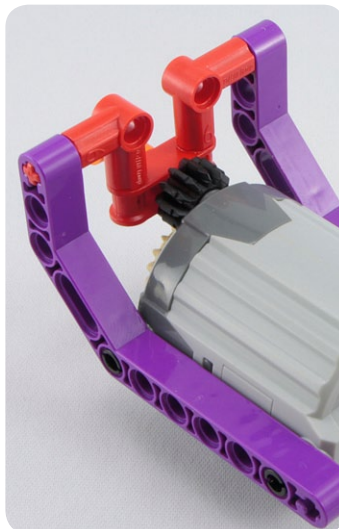
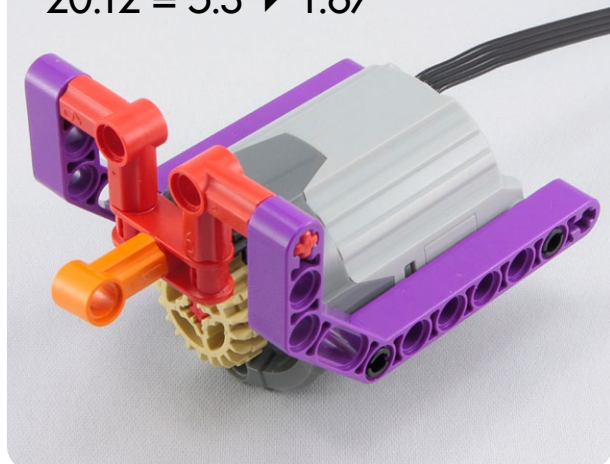
$12:8 = 3:2 \triangleright 1.50$



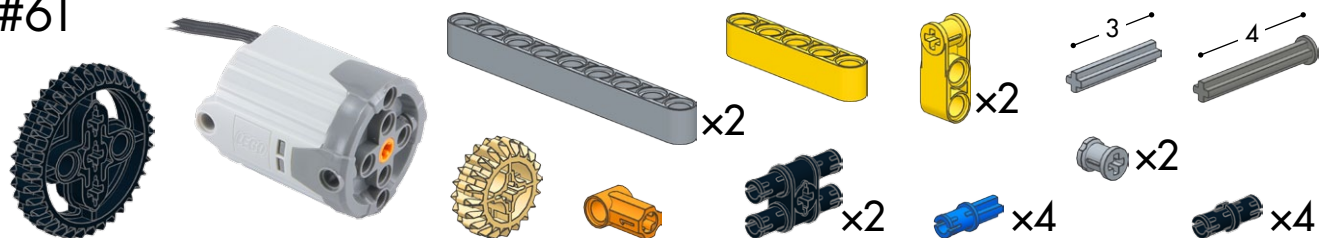
#60



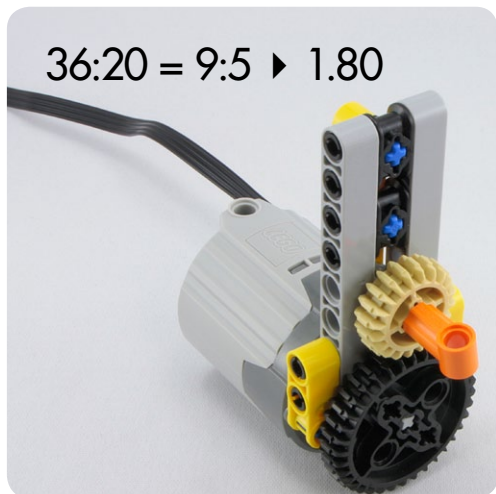
$20:12 = 5:3 \triangleright 1.67$



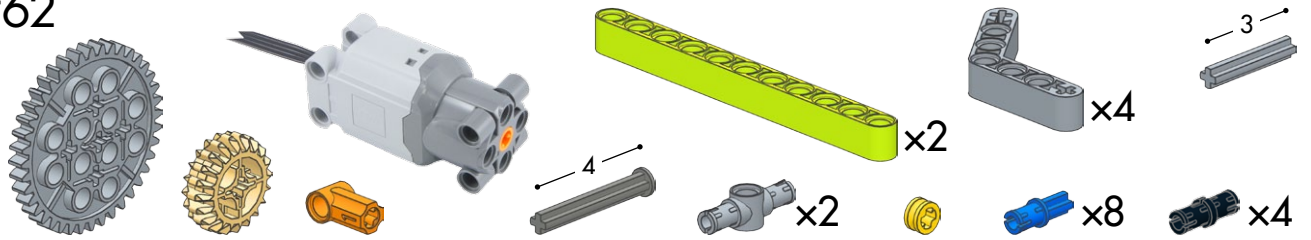
#61



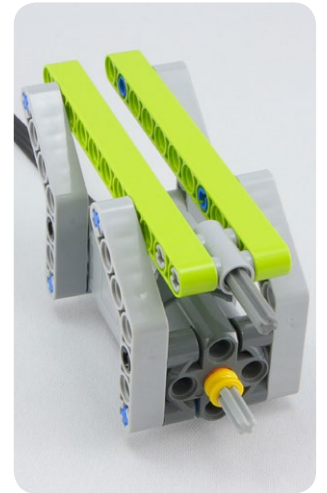
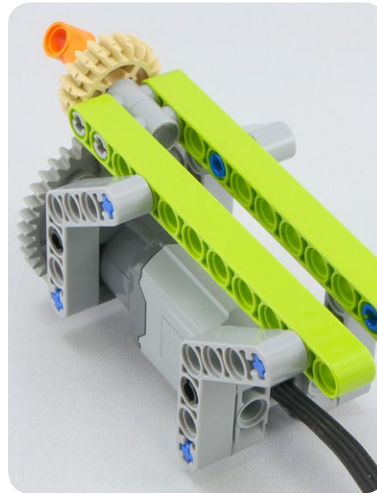
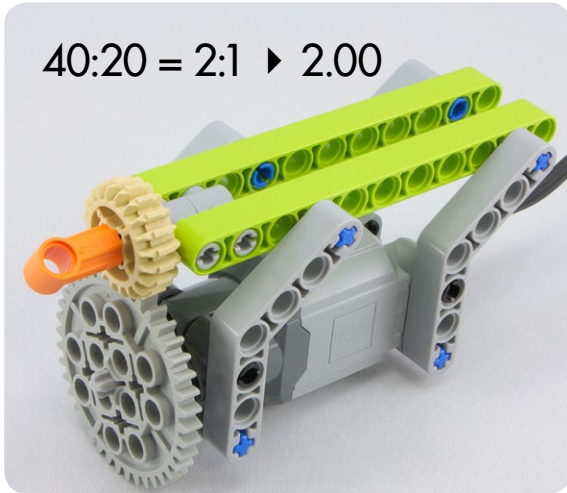
$36:20 = 9:5 \triangleright 1.80$



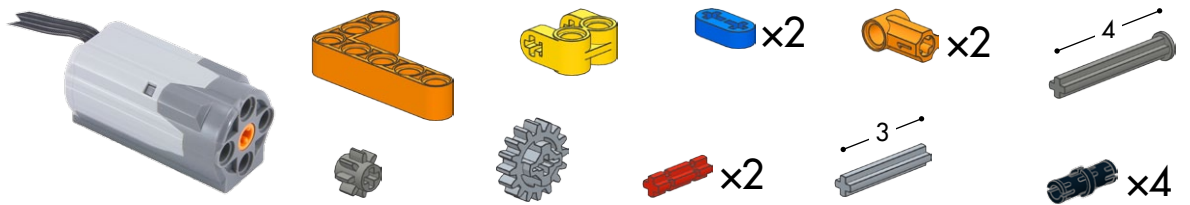
#62



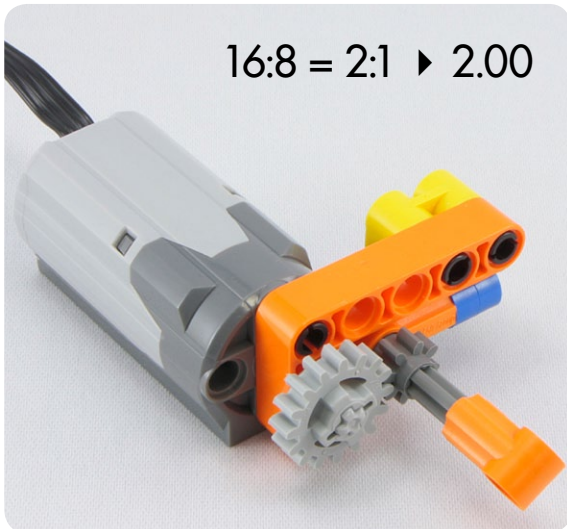
40:20 = 2:1 ▶ 2.00



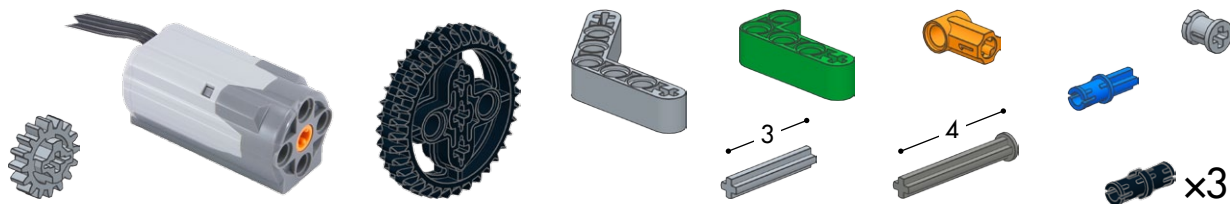
#63



16:8 = 2:1 ▶ 2.00



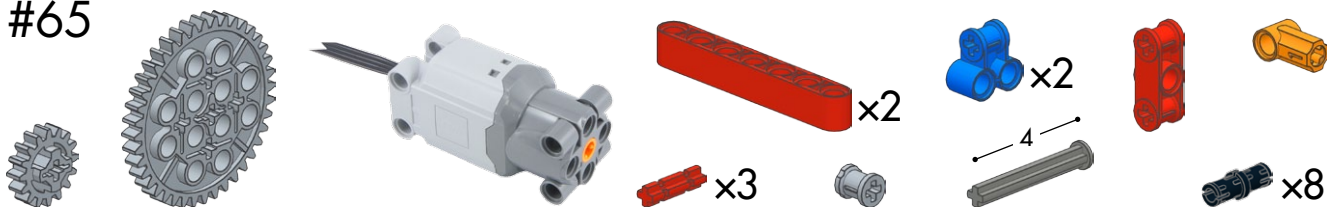
#64



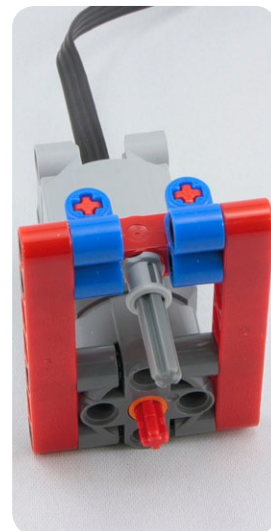
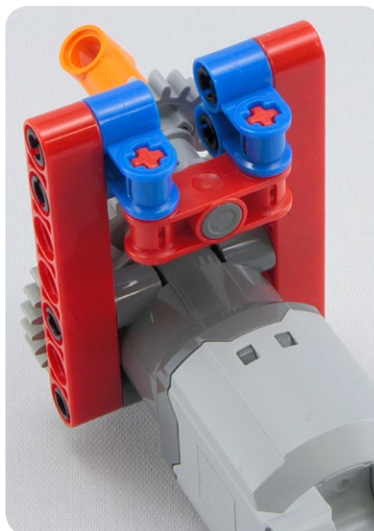
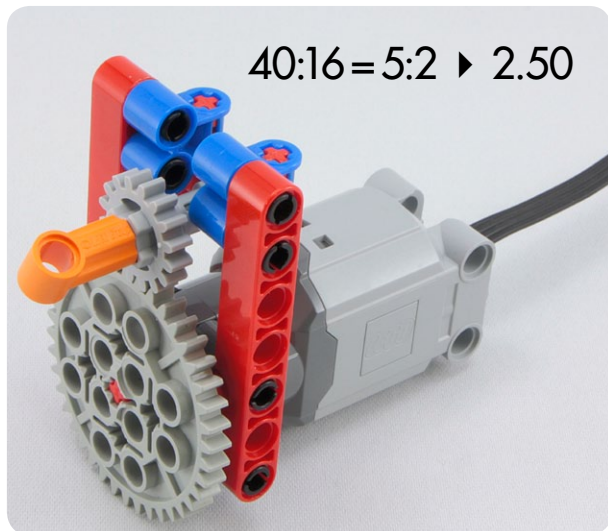
$36:16 = 9:4 \triangleright 2.25$



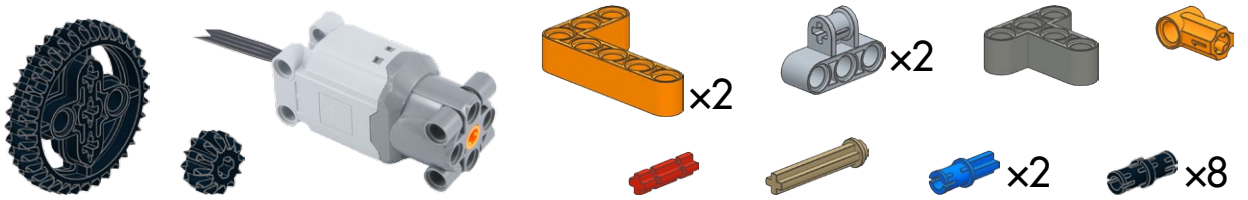
#65



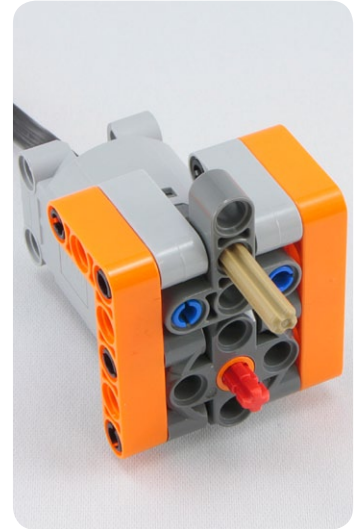
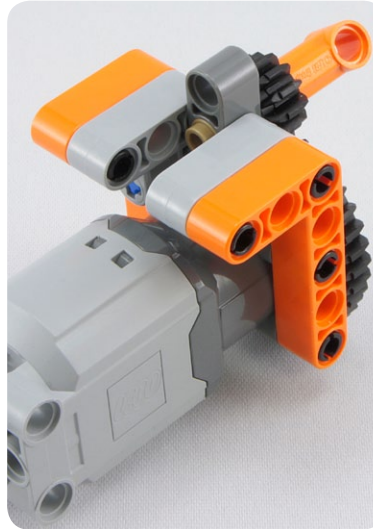
$40:16 = 5:2 \triangleright 2.50$



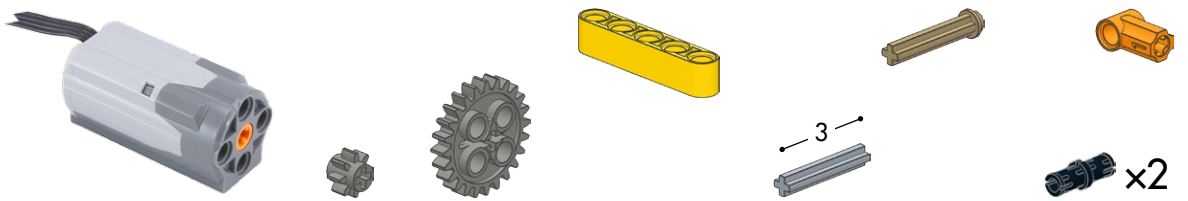
#66



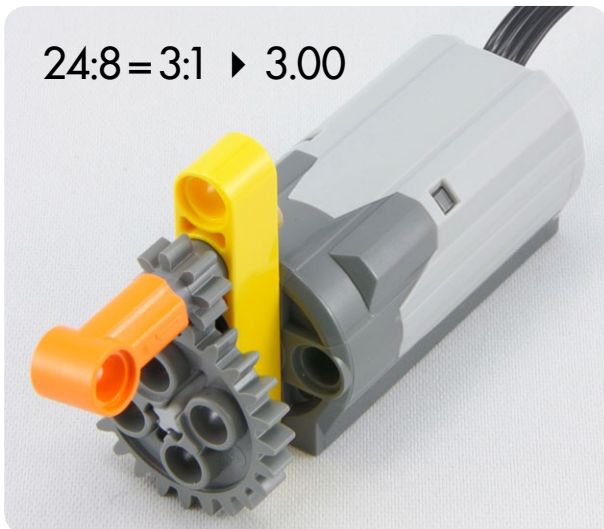
$36:12 = 3:1 \rightarrow 3.00$




#67



$24:8 = 3:1 \rightarrow 3.00$



#68



This image shows the parts list for step 68. It includes two grey 12-tooth gears (labeled 'x2'), a grey motor, a grey 24-tooth gear, a black 12-tooth gear, a black axle of length 4 (labeled '4'), an orange 1x3 Technic beam, a tan axle of length 3, a blue pin, a grey bush, an orange connector, and three black pins (labeled 'x3').

40:12 = 10:3 ► 3.33

A photograph of a LEGO Technic assembly. It features a grey motor connected to a grey 40-tooth gear. This gear is meshed with a smaller grey 12-tooth gear. An orange pin is inserted into the axle of the 12-tooth gear. The assembly is shown from a side-on perspective, highlighting the gear ratio.

#69



1 grey motor, 1 black gear, 1 grey L-shaped beam, 1 tan axle, 1 orange connector, 1 grey axle with 3 pins, 1 grey connector, and 2 black connectors.

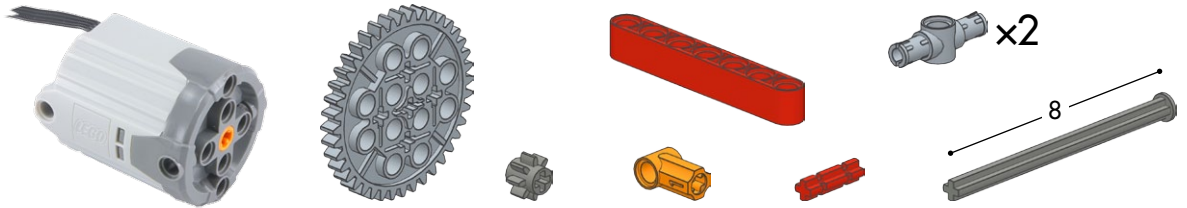
36:8 = 9:2 ▶ 4.50



A close-up photograph of a LEGO Technic assembly. It features a grey motor block connected to a black gear train. The gear train consists of a large black gear with 36 teeth meshed with a smaller black gear with 8 teeth. An orange Technic pin is visible, securing the assembly. The background is a plain, light-colored surface.



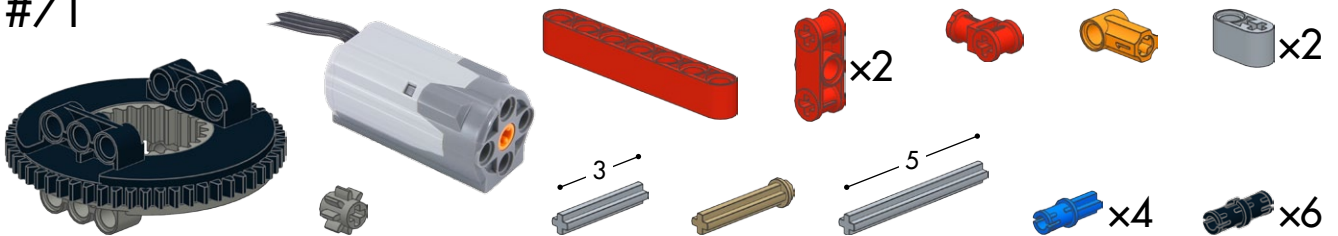
#70



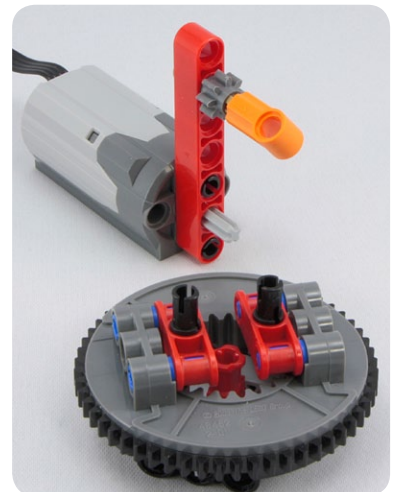
$40:8 = 5:1 \rightarrow 5.00$

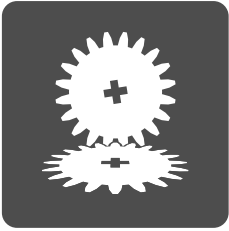


#71



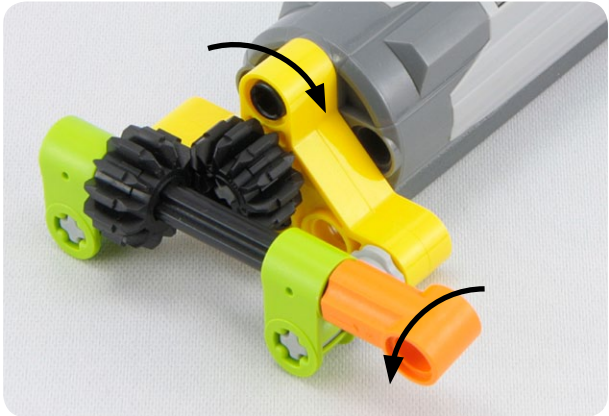
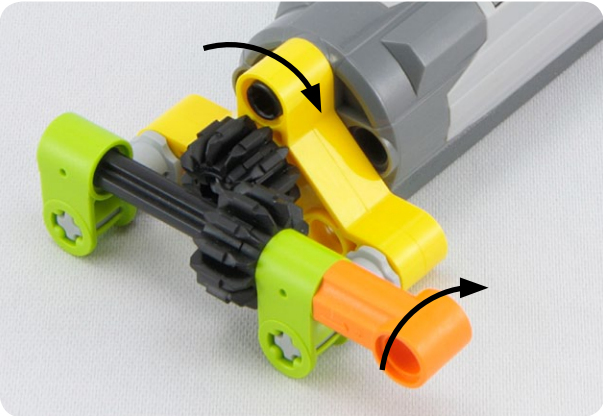
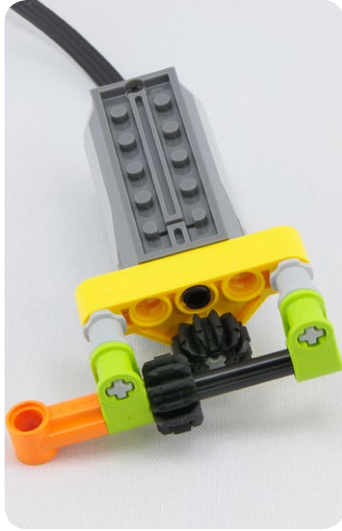
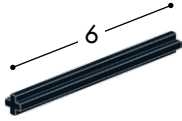
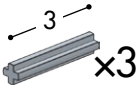
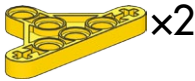
$56:8 = 7:1 \rightarrow 7.00$



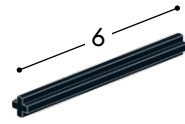
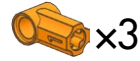
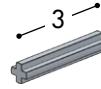
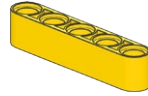
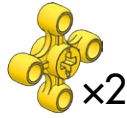


Changing the angle of rotation

#72



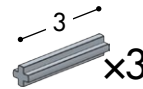
#73



4:4 = 1:1



#74



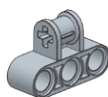
12:12 = 1:1



#75



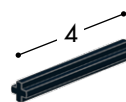
x2



x2

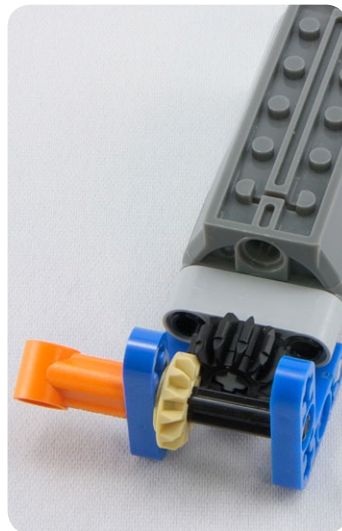


x2

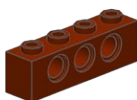


x2

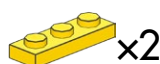
12:12 = 1:1



#76



x2



x2

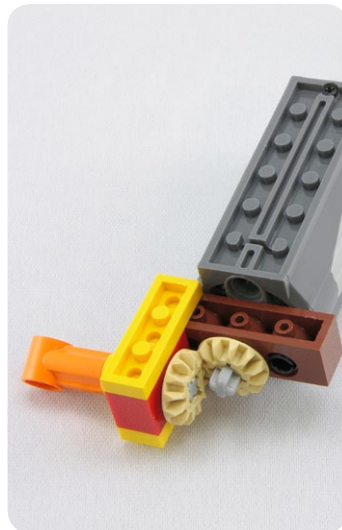
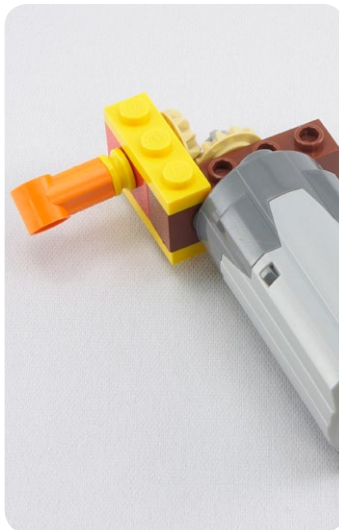
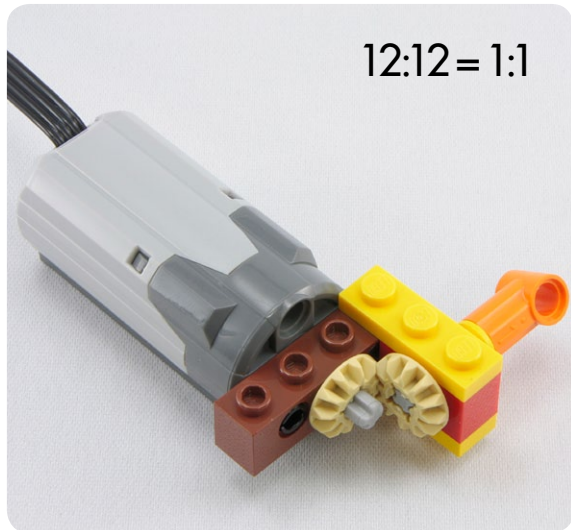


x2

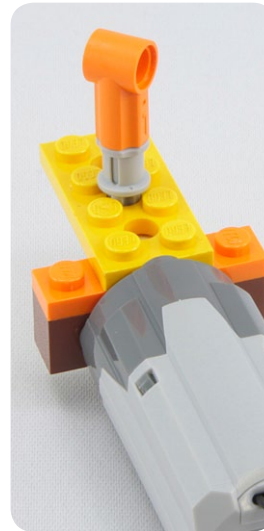
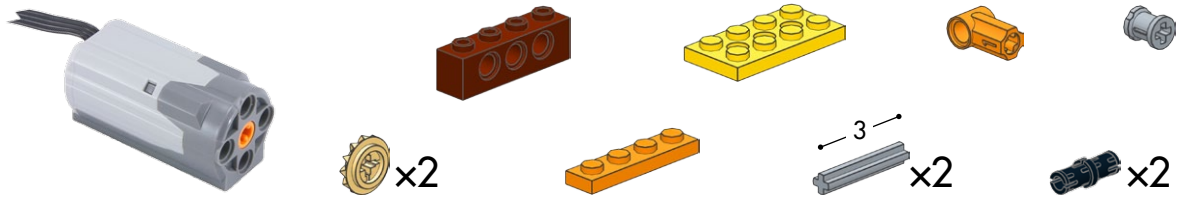


x2

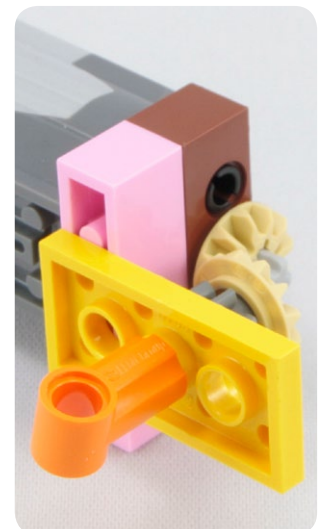
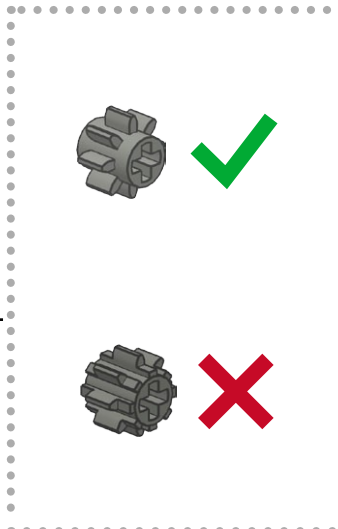
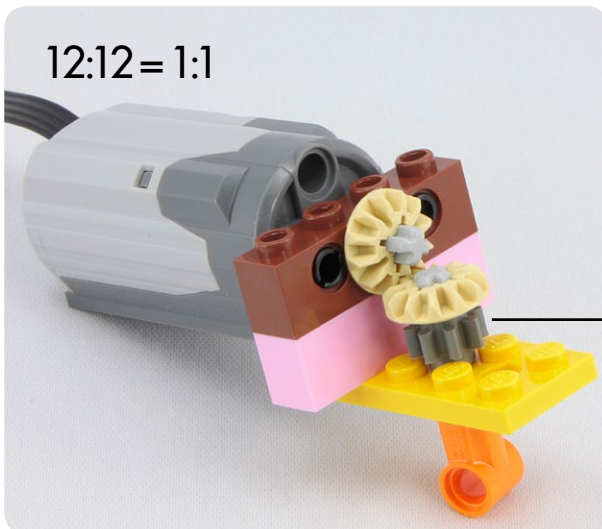
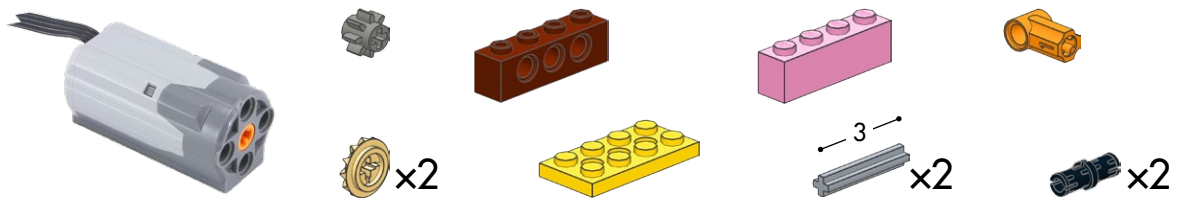
12:12 = 1:1



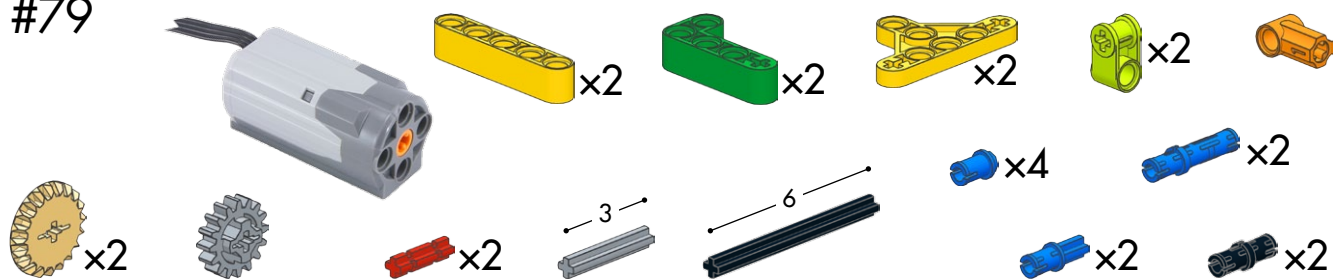
#77



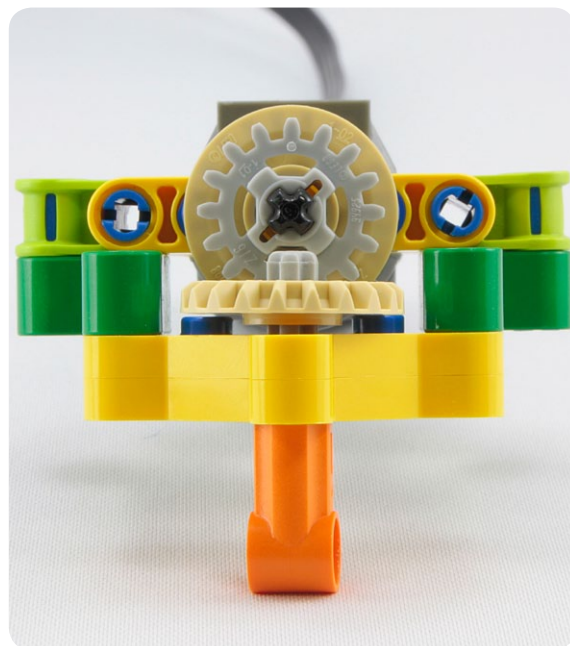
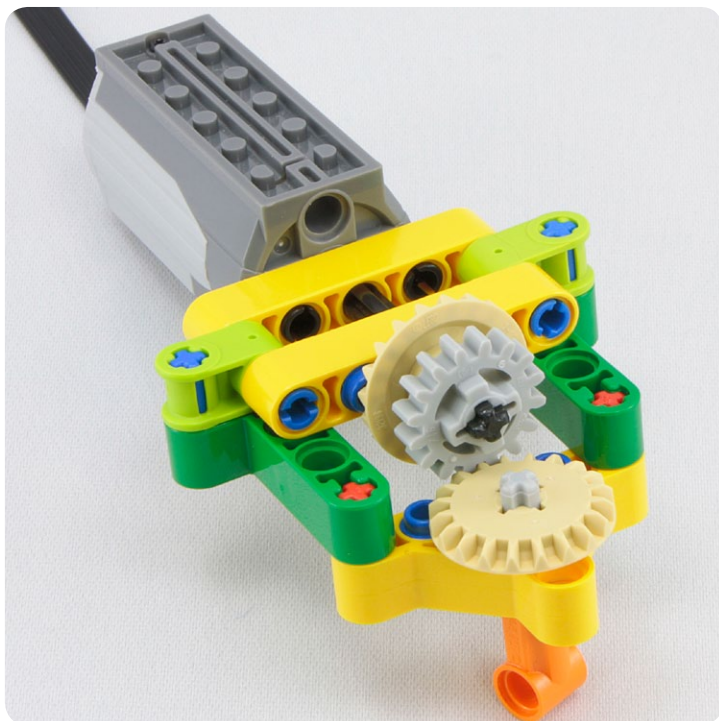
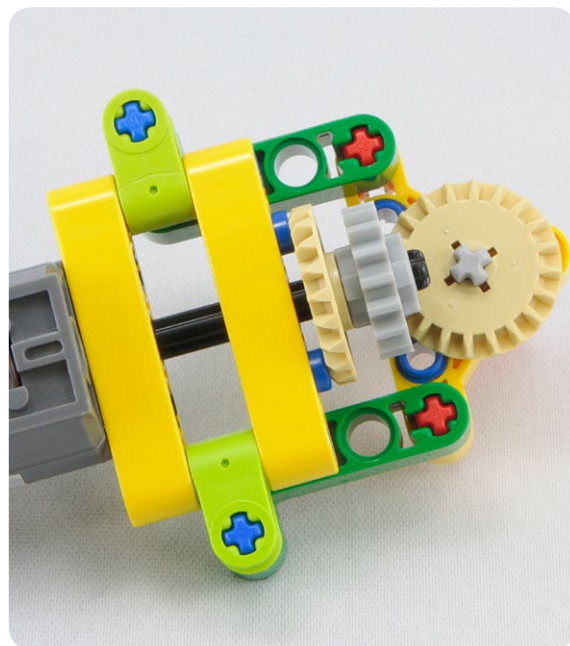
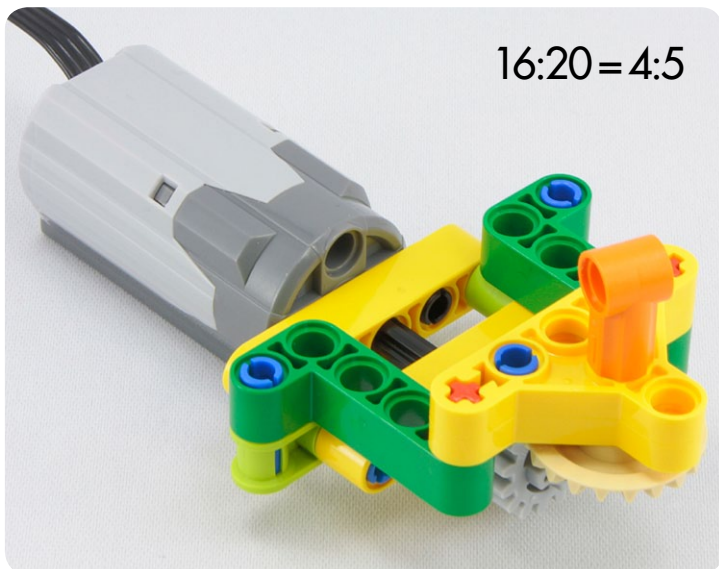
#78



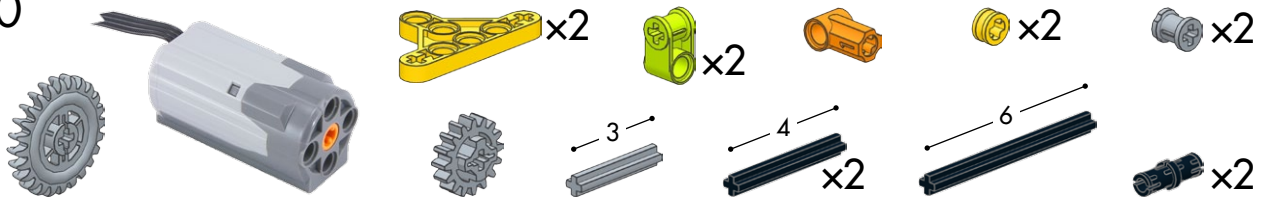
#79



16:20 = 4:5



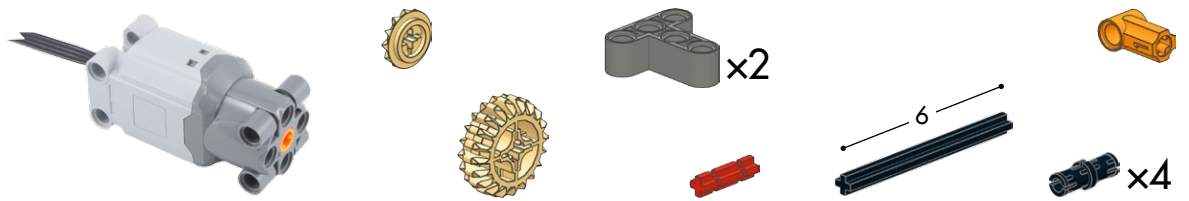
#80



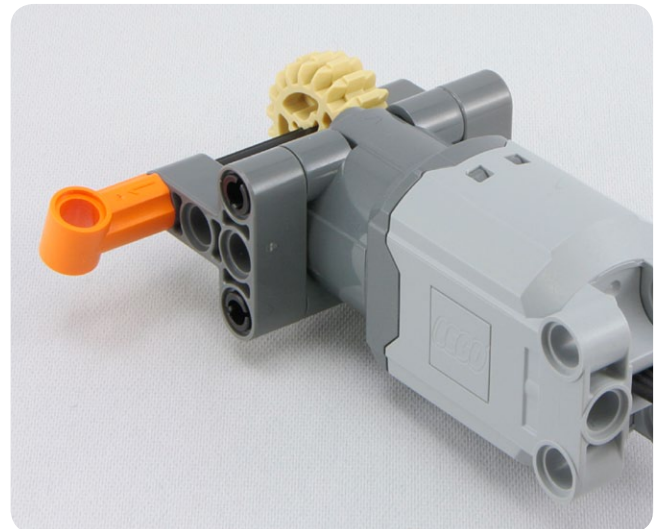
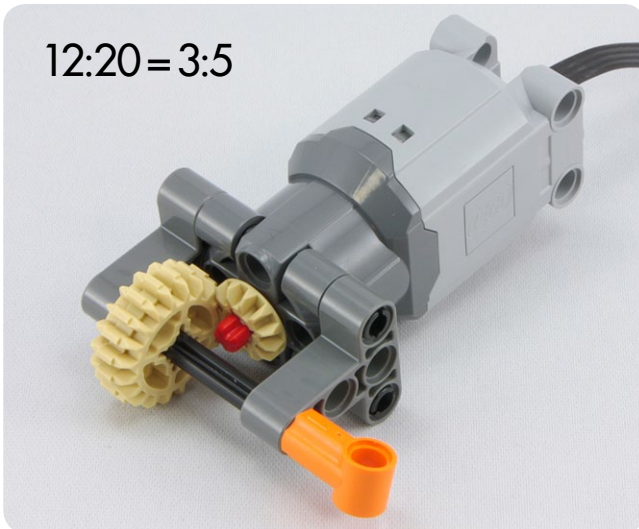
16:24 = 2:3



#81

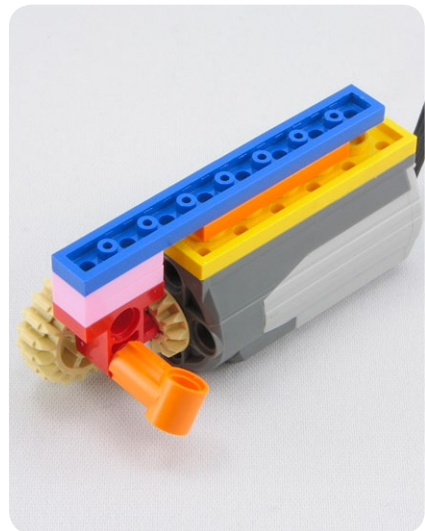
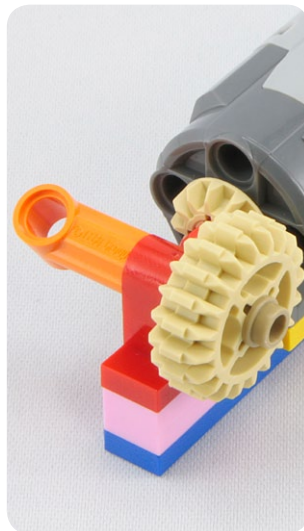
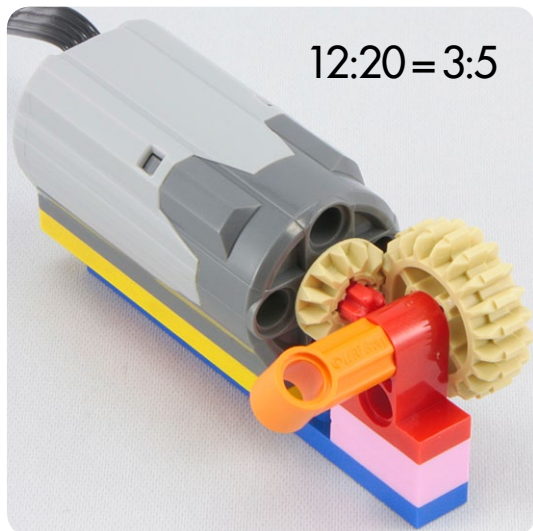


12:20 = 3:5




#82

1 grey motor, 1 blue 1x6 Technic beam, 1 orange 1x3 Technic beam, 1 yellow 1x6 Technic beam, 1 red 1x2 Technic brick with hole, 1 tan gear, 1 tan gear, 1 orange motor, 2 pink 1x2 Technic bricks, 1 red 1x2 Technic brick, 1 tan axle

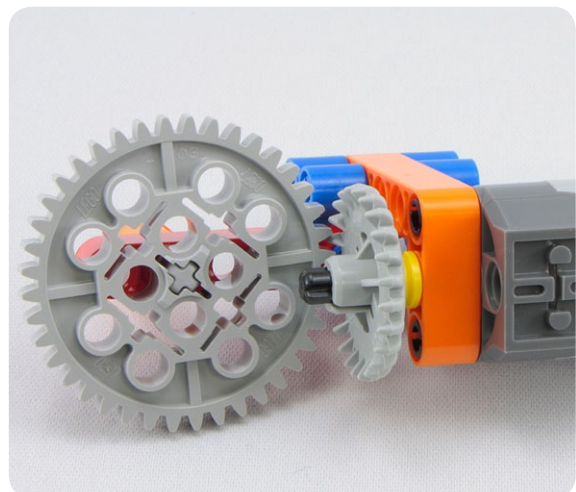
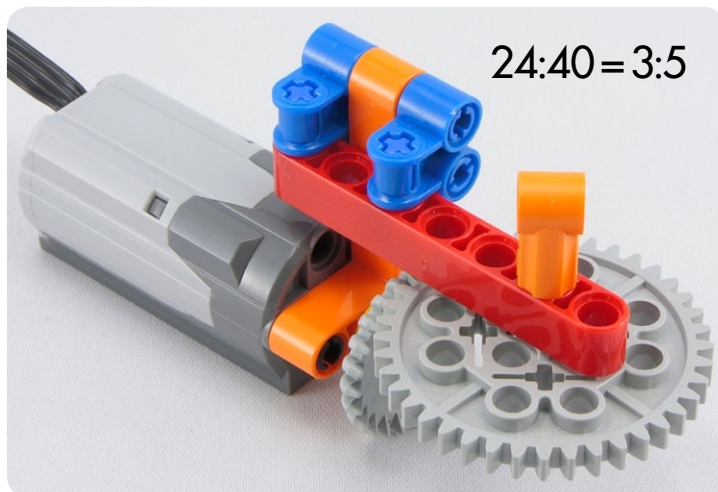


#83

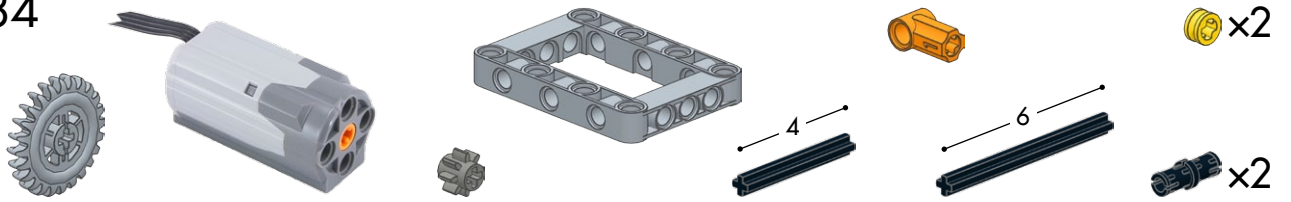


Parts list for step 83:

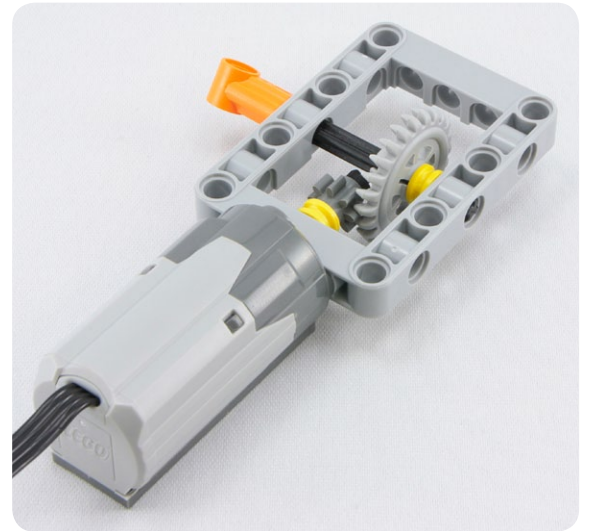
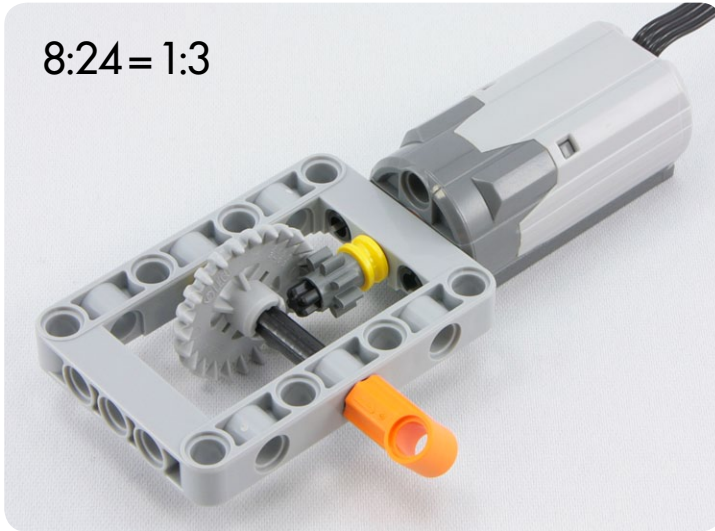
- 1 small grey gear
- 1 large grey gear
- 1 grey motor
- 1 red 1x5 Technic beam
- 1 orange 1x3 L-shaped Technic beam
- 2 blue 3-way connectors
- 1 orange 1x2 connector
- 2 blue pins
- 2 blue long pins
- 1 yellow pin
- 2 blue long pins
- 2 black pins



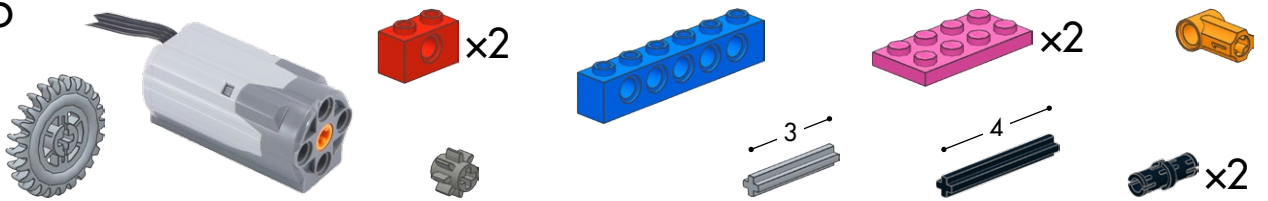
#84



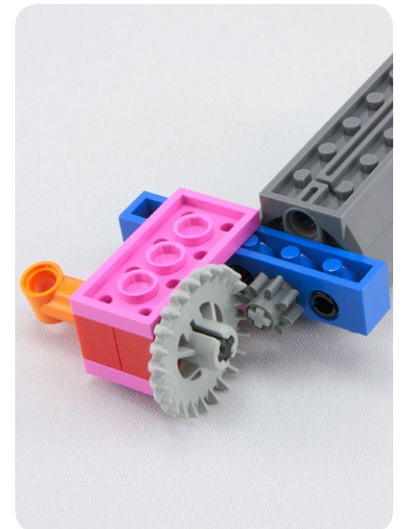
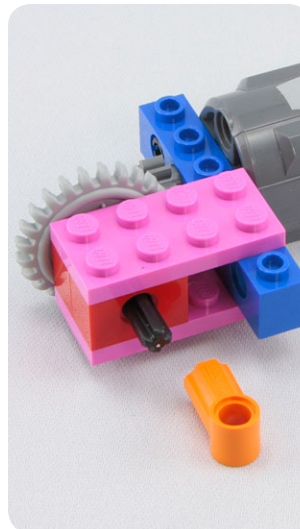
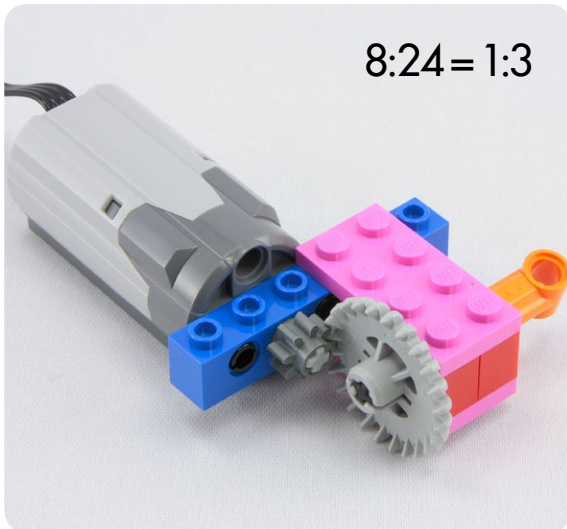
$8:24 = 1:3$



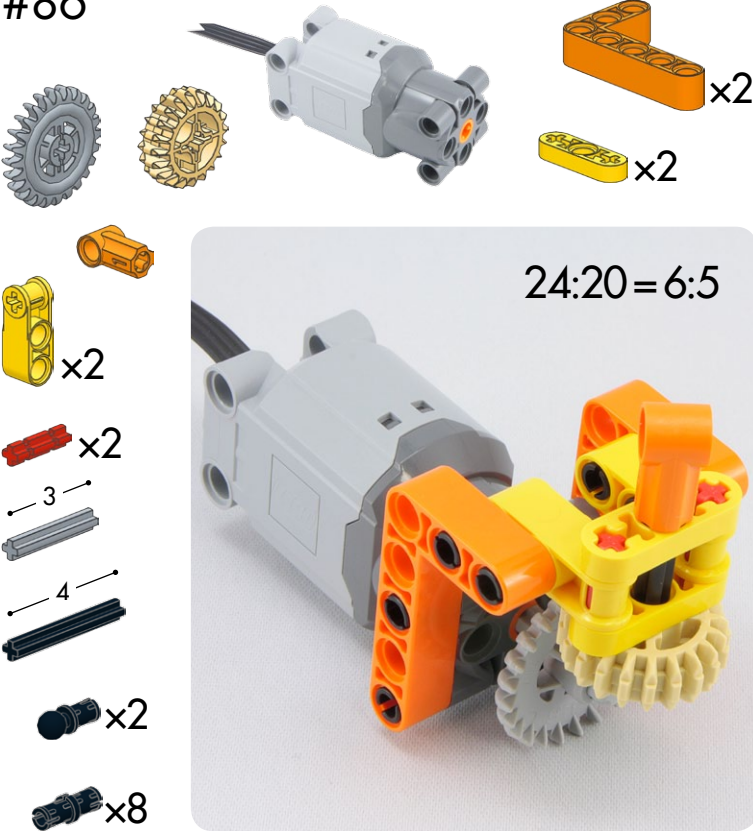
#85



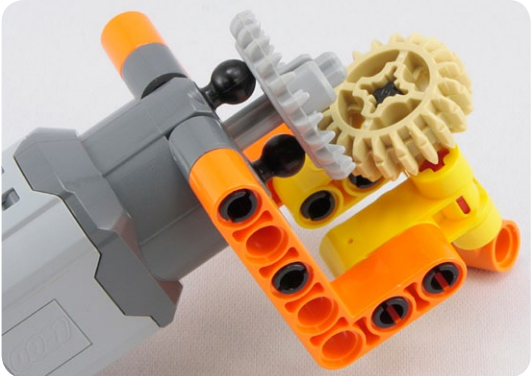
$8:24 = 1:3$



#86



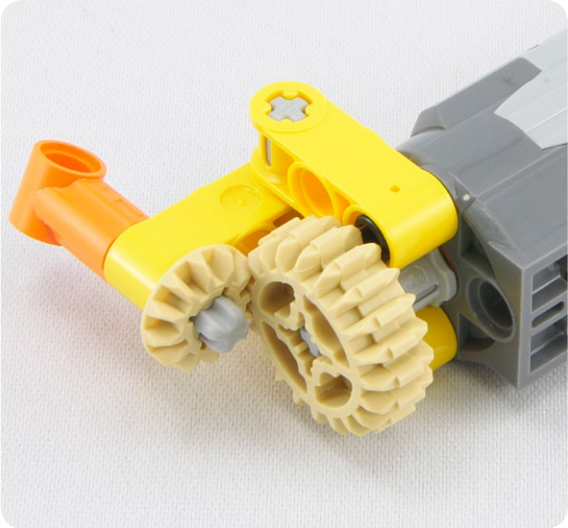
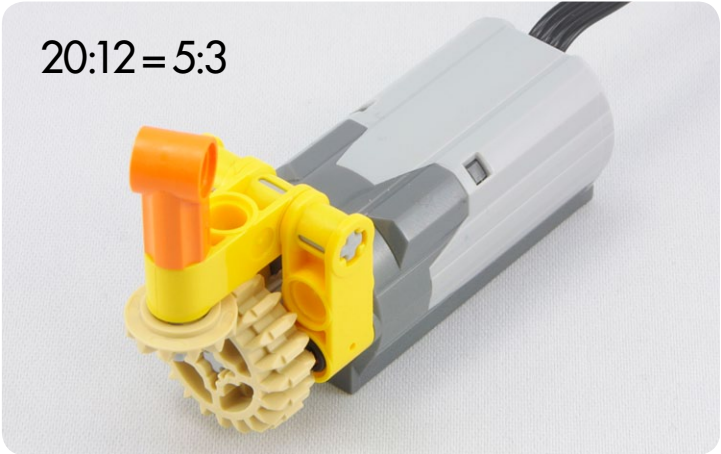
$24:20=6:5$



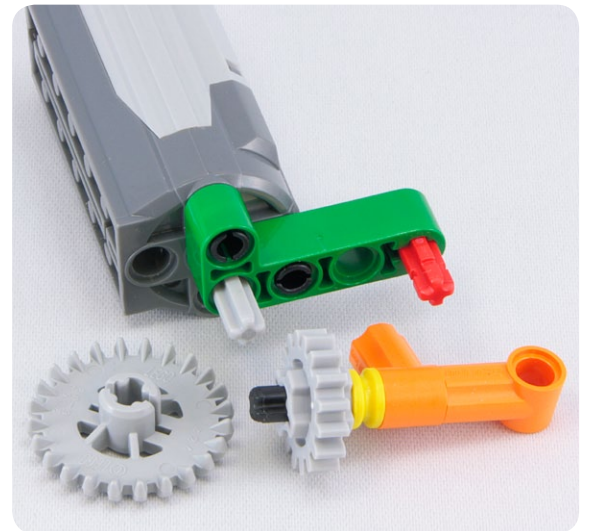
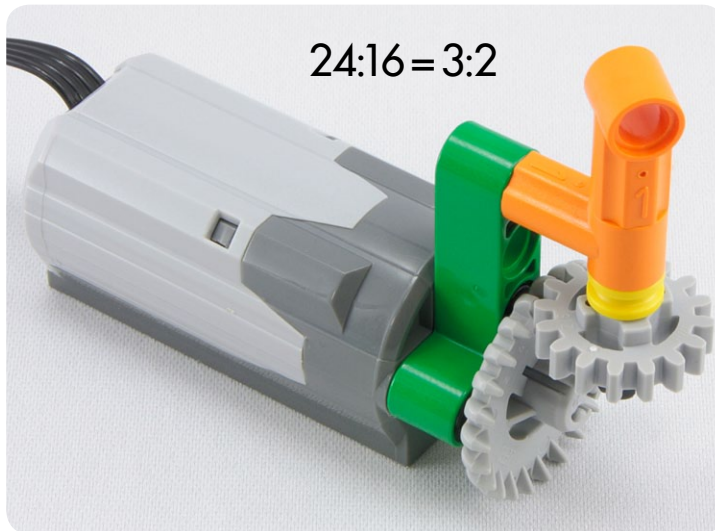
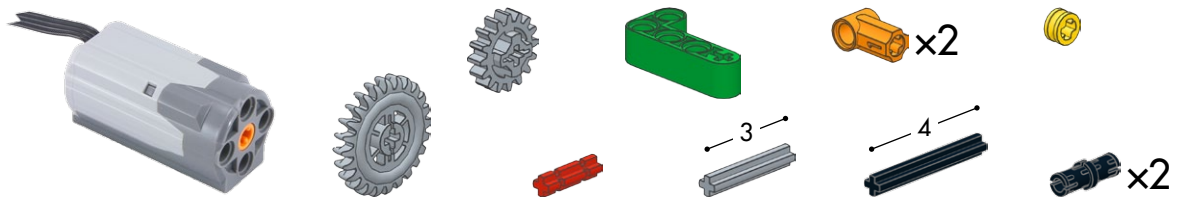
#87



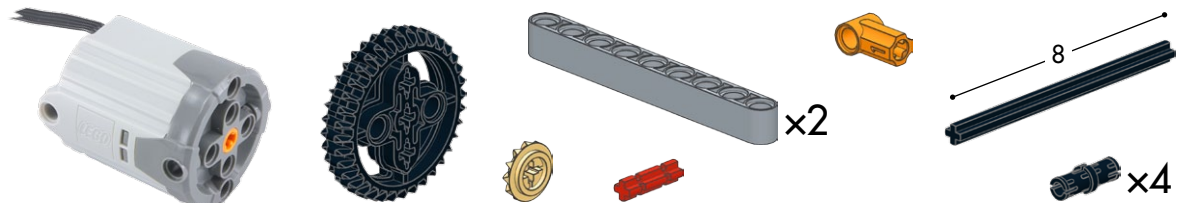
$20:12=5:3$

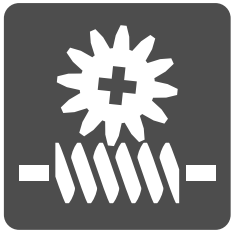


#88



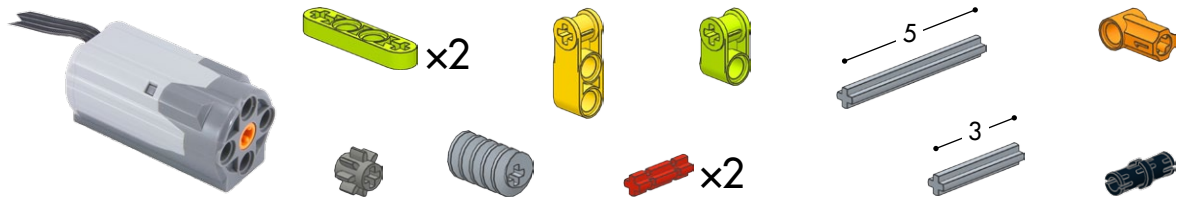
#89





Powering up with worm drives

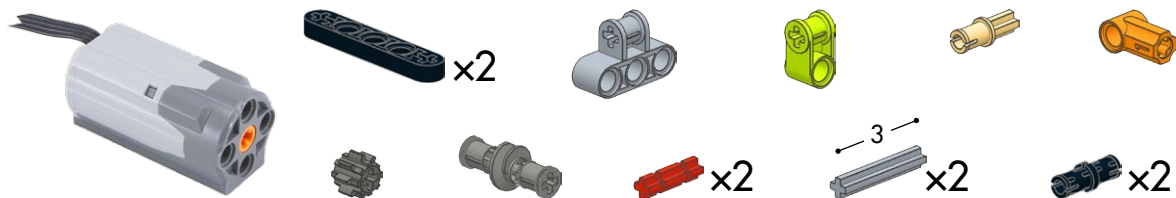
#90



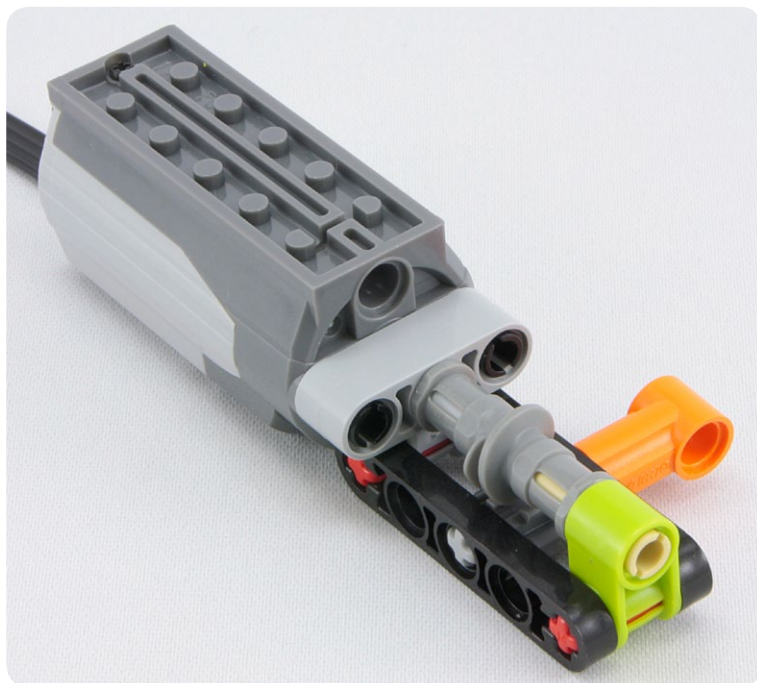
1:8

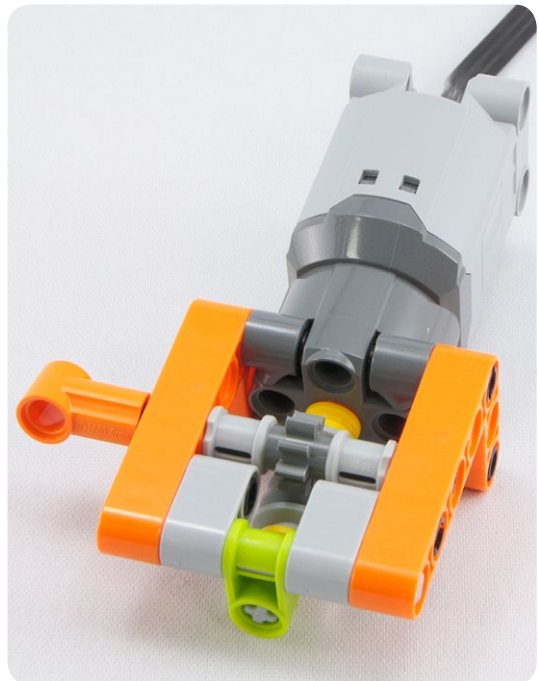


#91

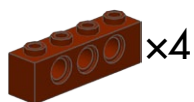


1:8

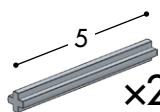


[illegible]

#93



x4

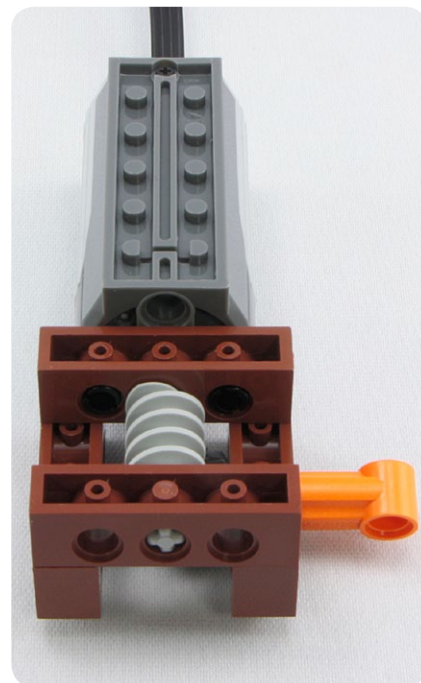
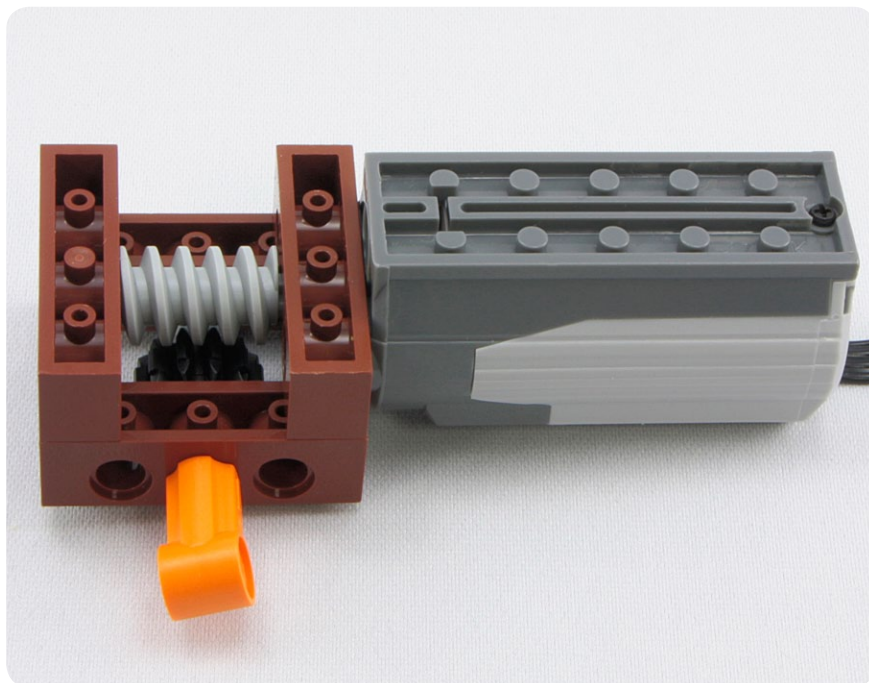
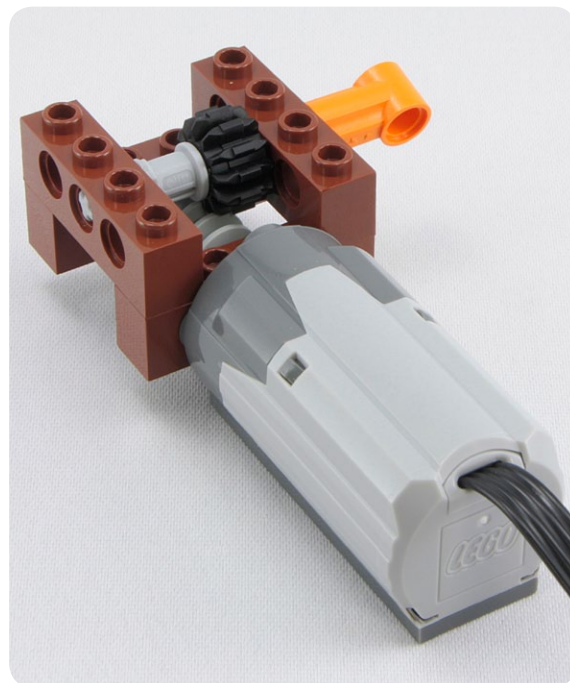
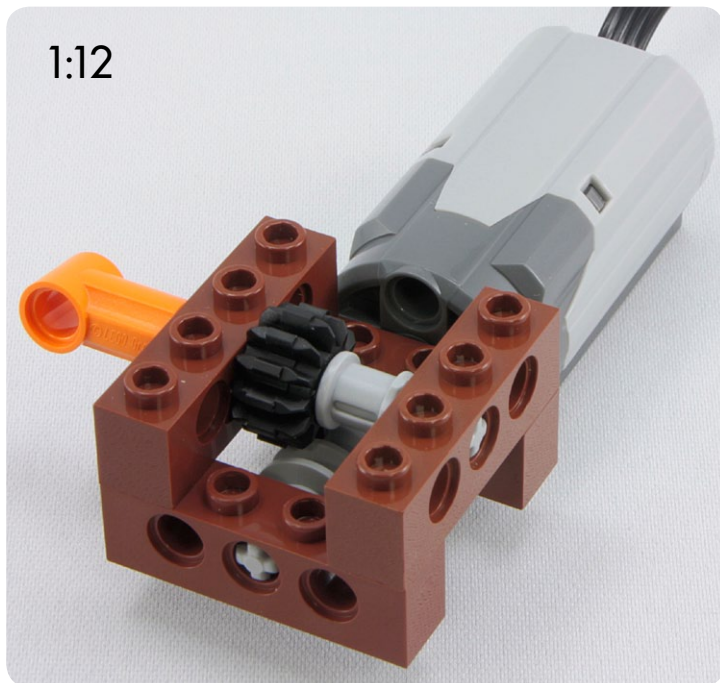


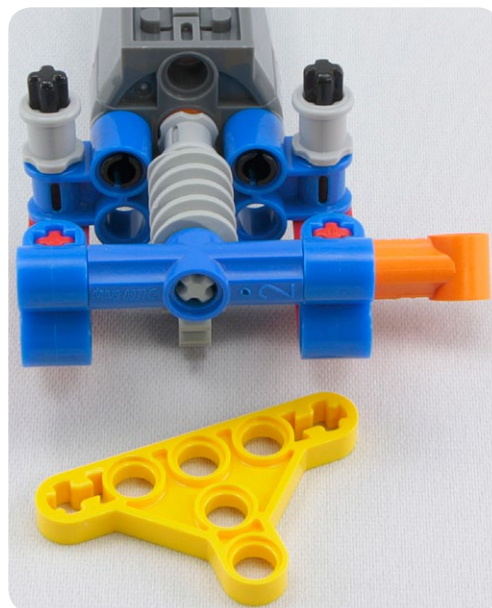
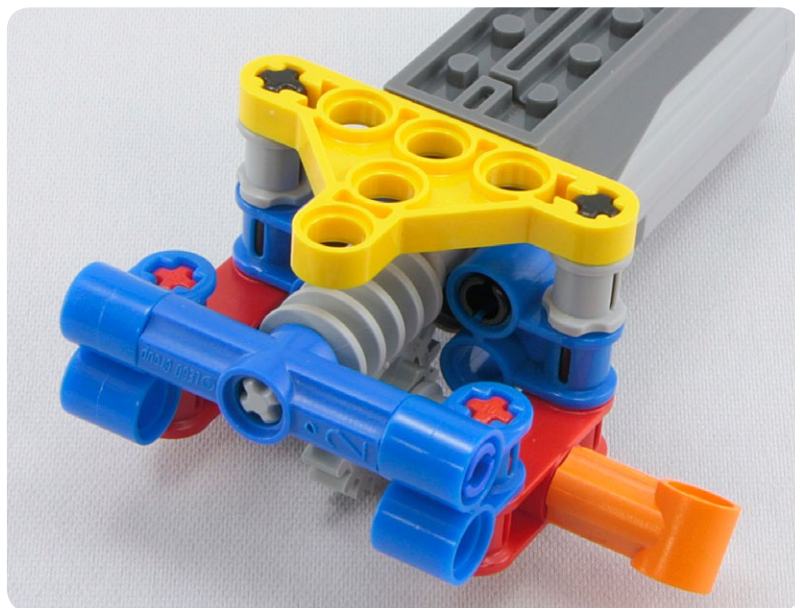
x2




x2

1:12



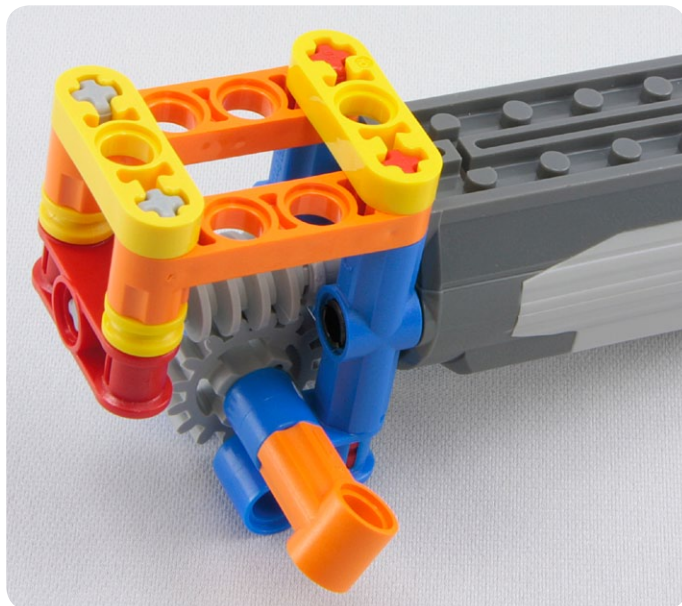
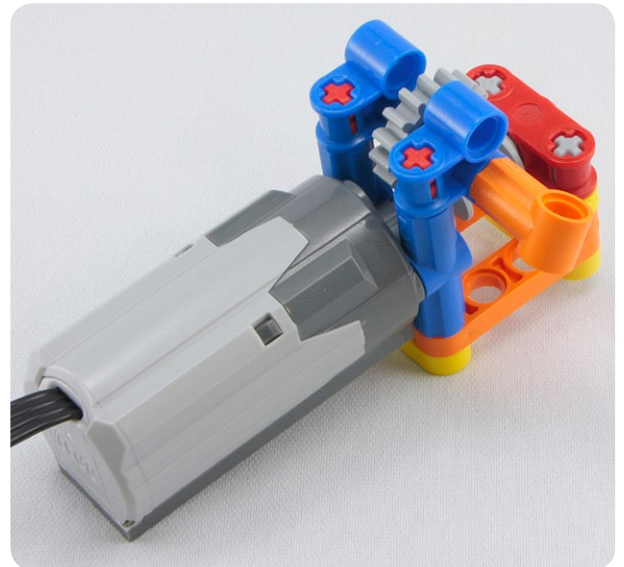
[illegible]

5

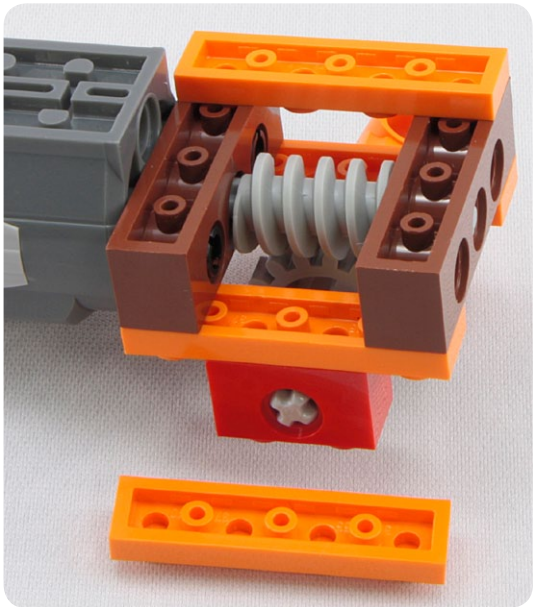
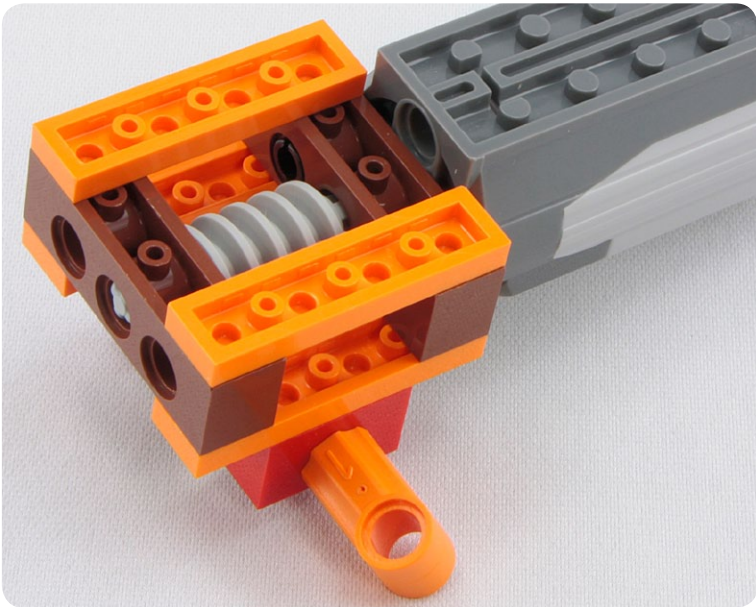
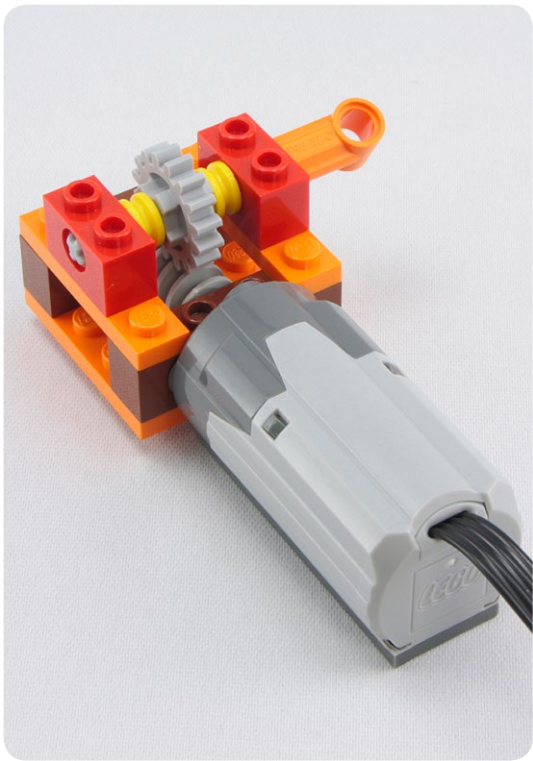
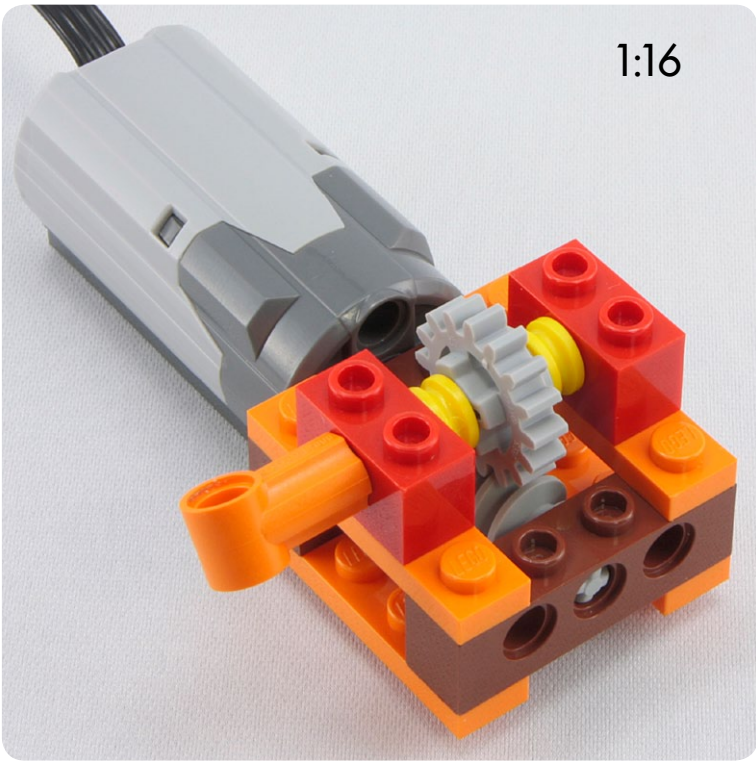
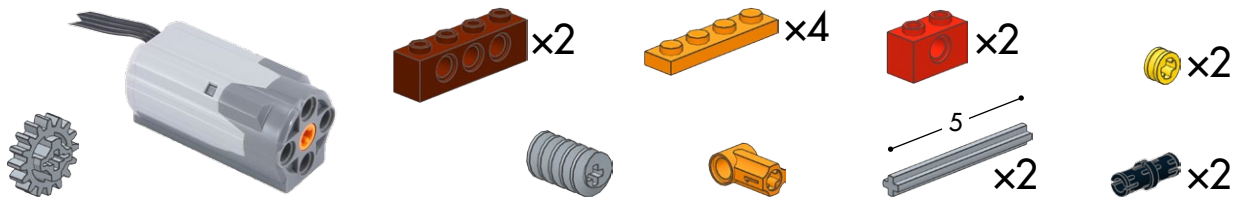


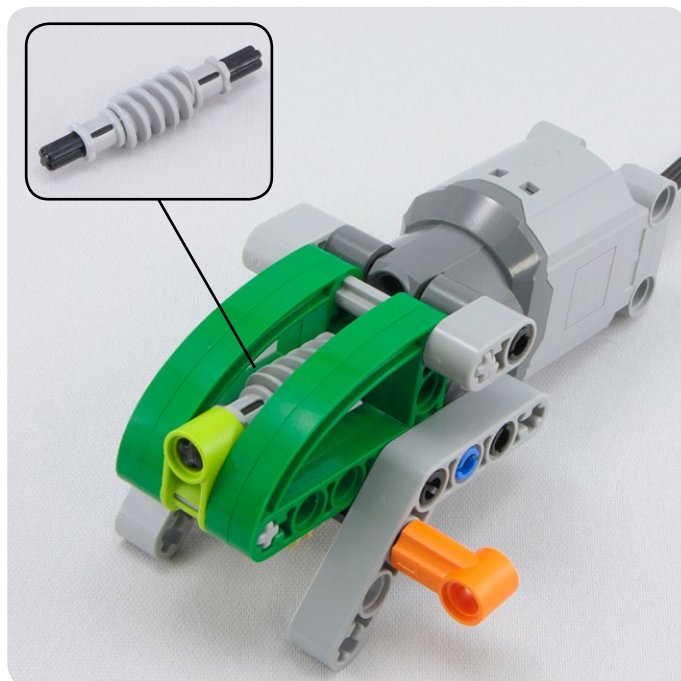
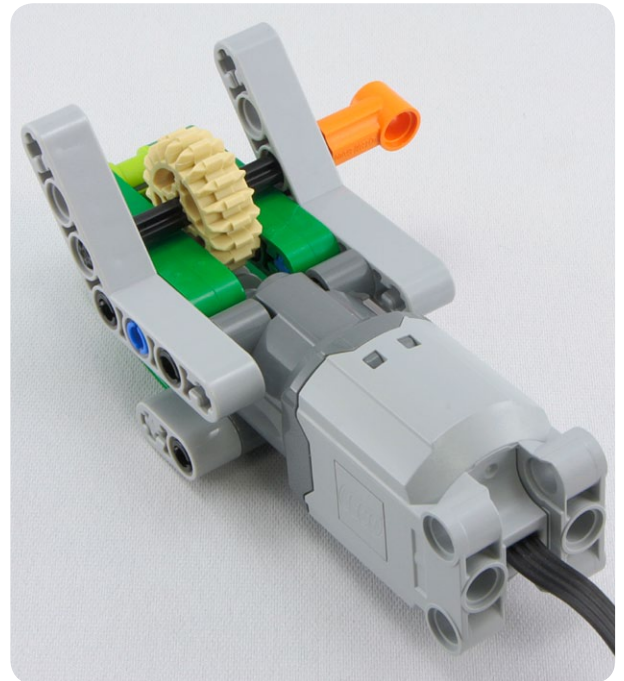
Parts list for step 5:

- 1x Motor
- 1x Orange Technic Connector
- 1x Grey Gear
- 1x Grey Axle
- 2x Orange Technic Beam (1x5)
- 2x Yellow Technic Beam (1x5)
- 2x Red Technic Connector
- 2x Blue Technic Connector
- 2x Blue Technic Connector
- 2x Yellow Technic Connector
- 4x Red Technic Connector
- 2x Grey Technic Beam (1x3)
- 2x Black Technic Beam (1x4)
- 2x Grey Technic Beam (1x5)
- 2x Black Technic Connector



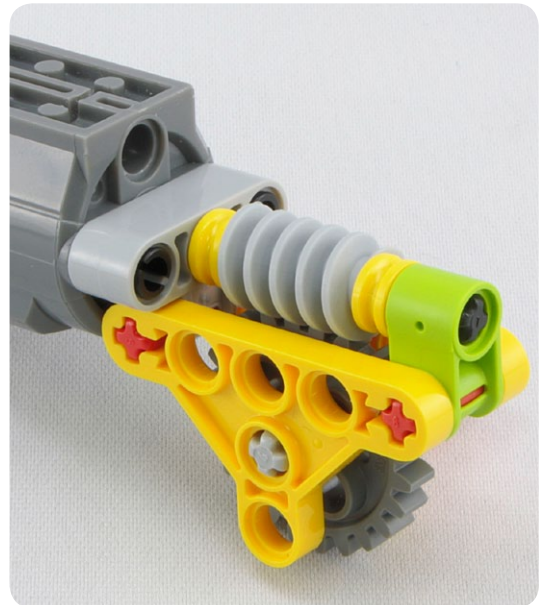
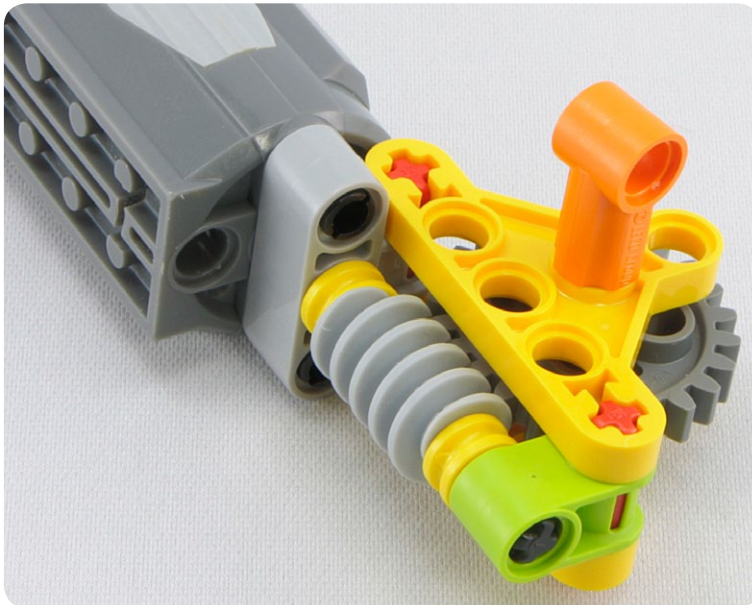
#96



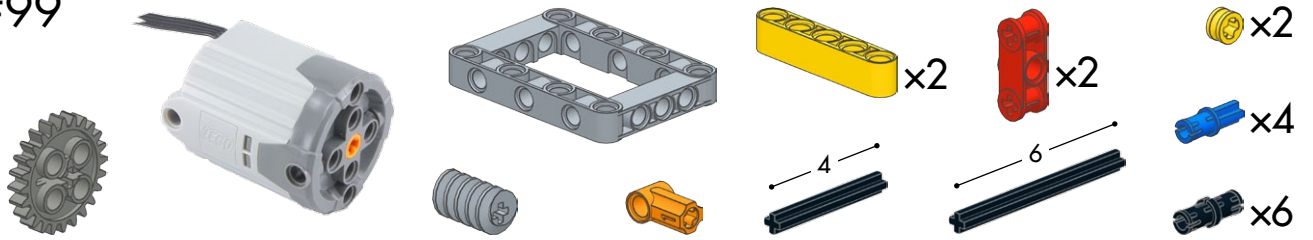
[illegible]

#98

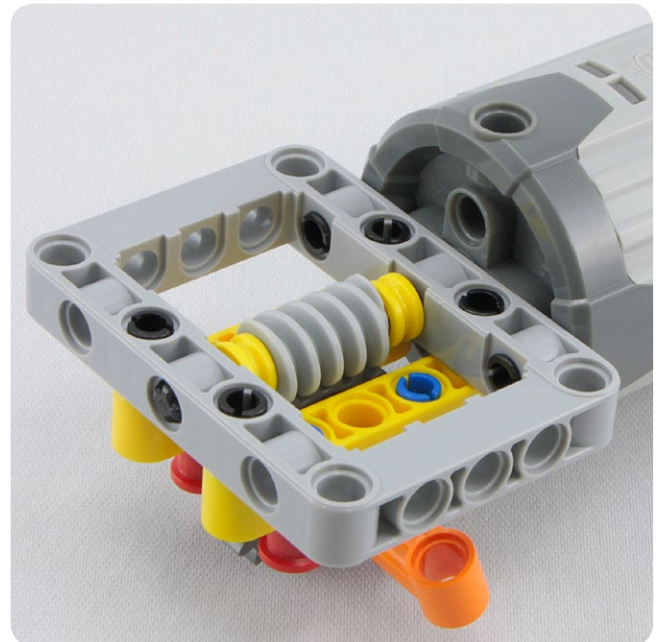
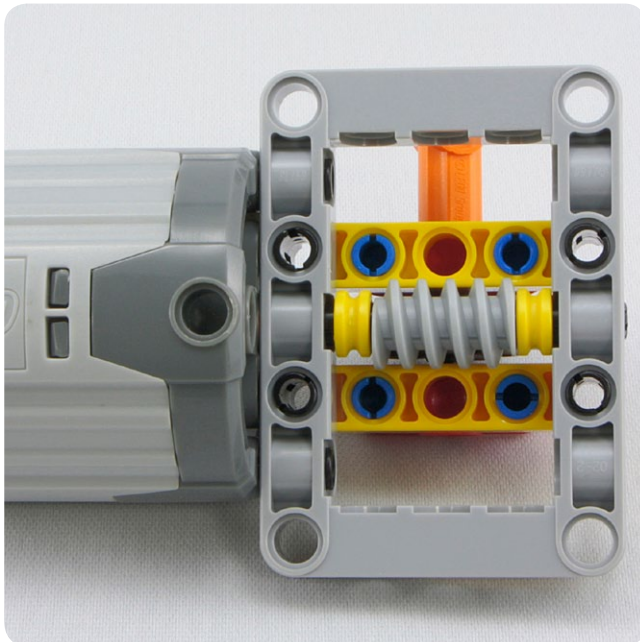
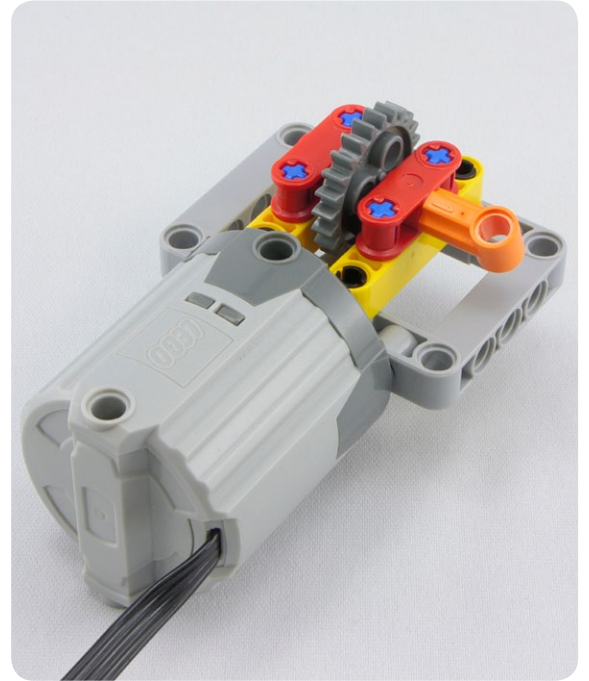
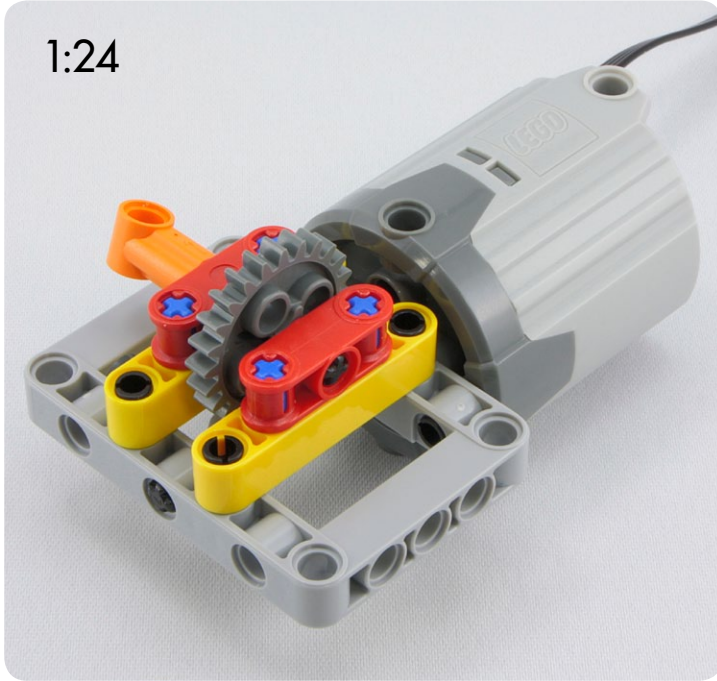
1 grey motor, 1 grey gear, 2 yellow 1x3 Technic beams, 2 grey 1x3 Technic connectors, 1 green 1x2 Technic connector, 1 orange 1x2 Technic connector, 2 yellow 1x2 Technic pins, 1 grey 1x2 Technic pin, 2 red 1x2 Technic pins, 3 grey 1x2 Technic pins, 6 black 1x6 Technic pins, and 2 black 1x2 Technic pins.

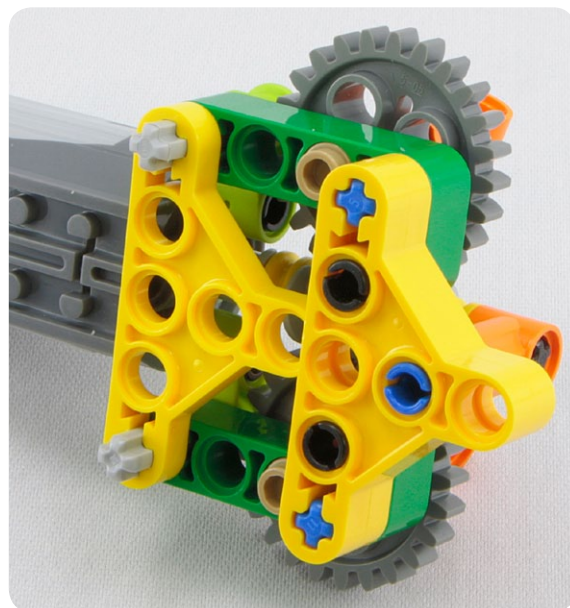
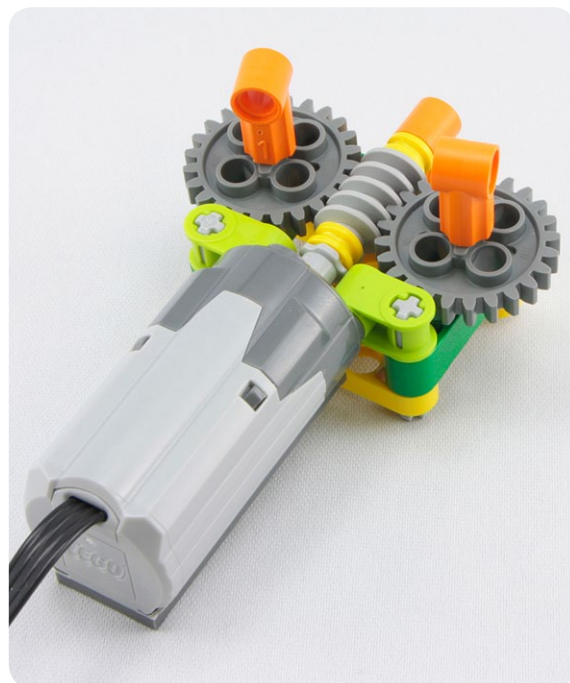


#99

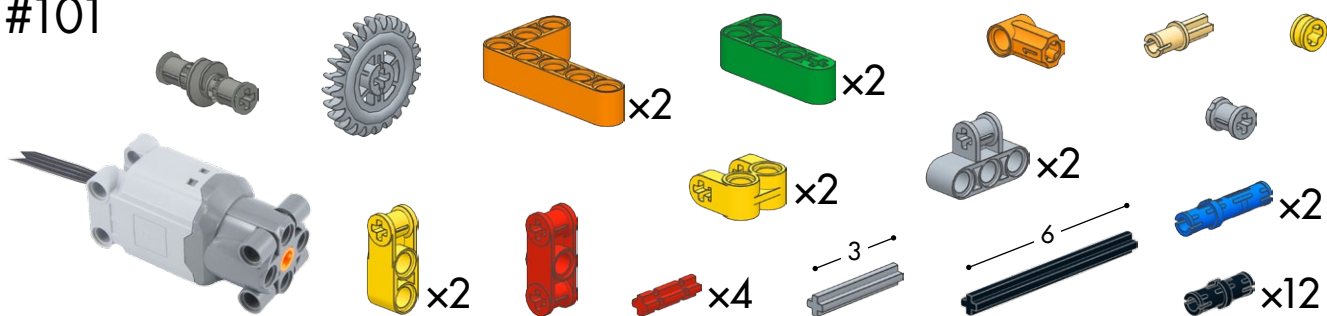


1:24

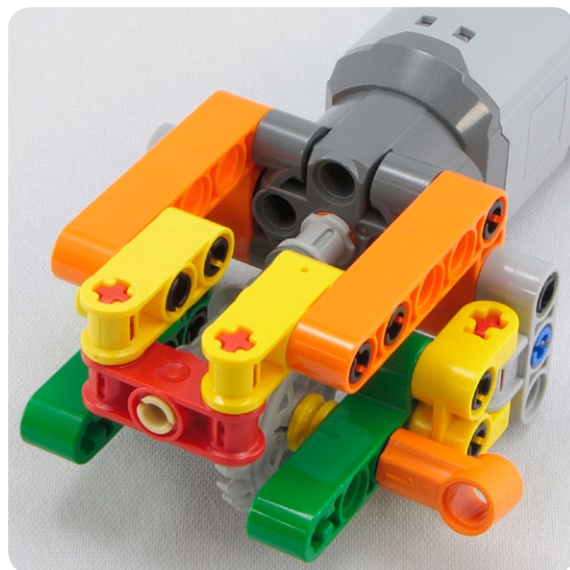
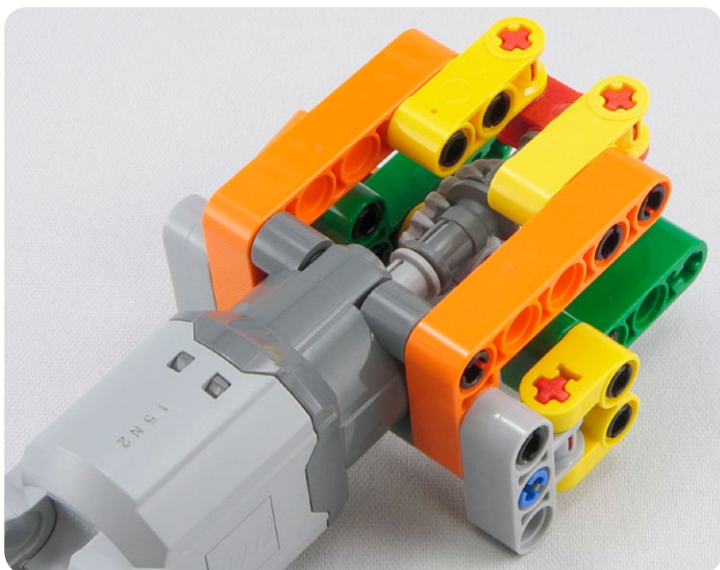
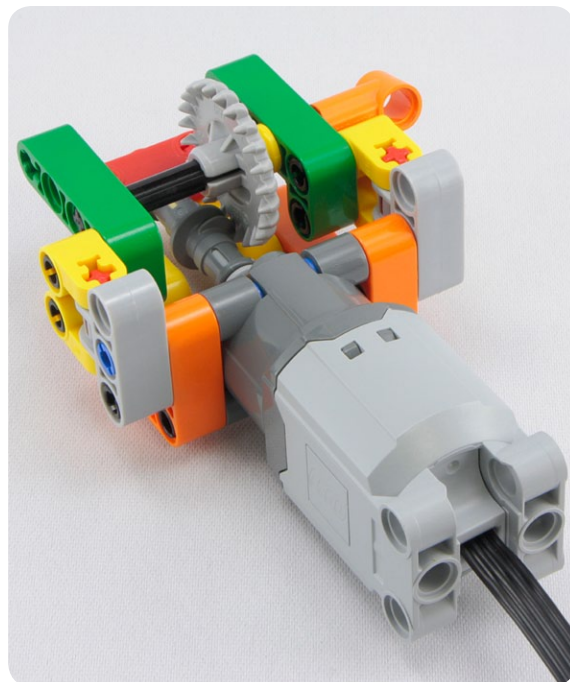
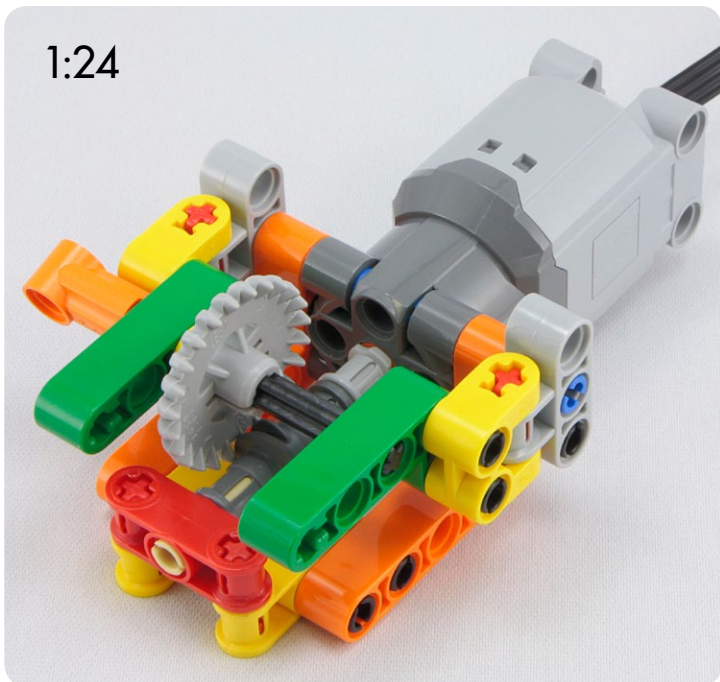


[illegible]

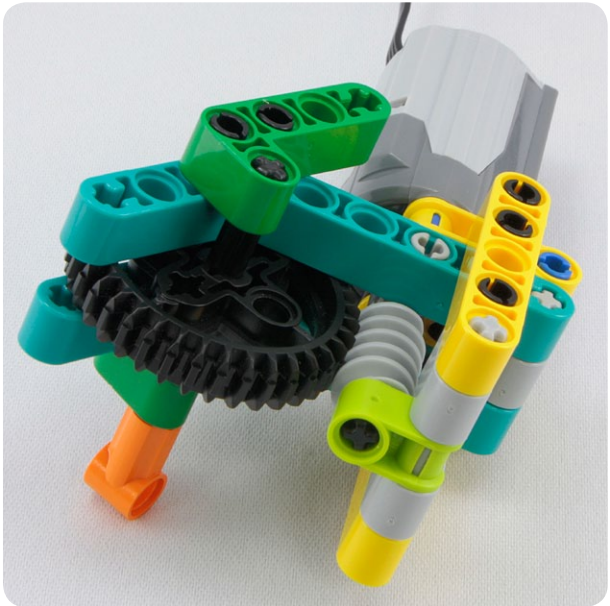
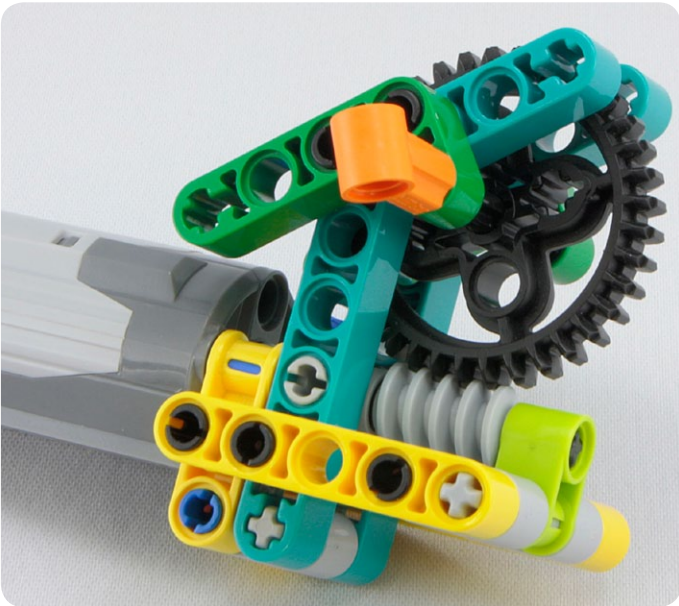
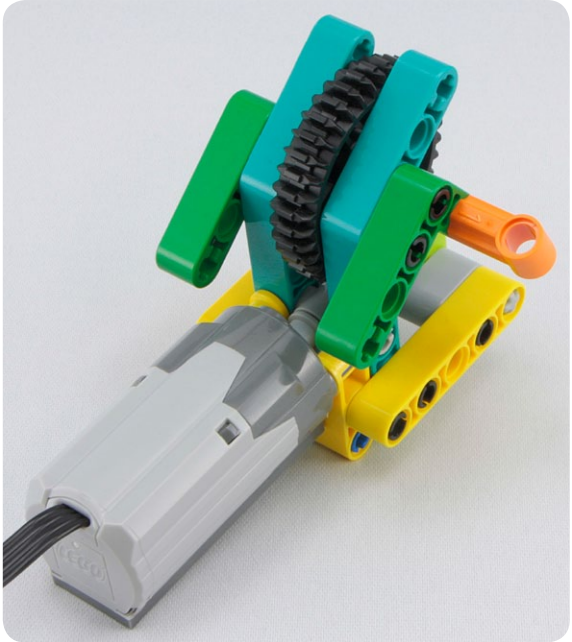
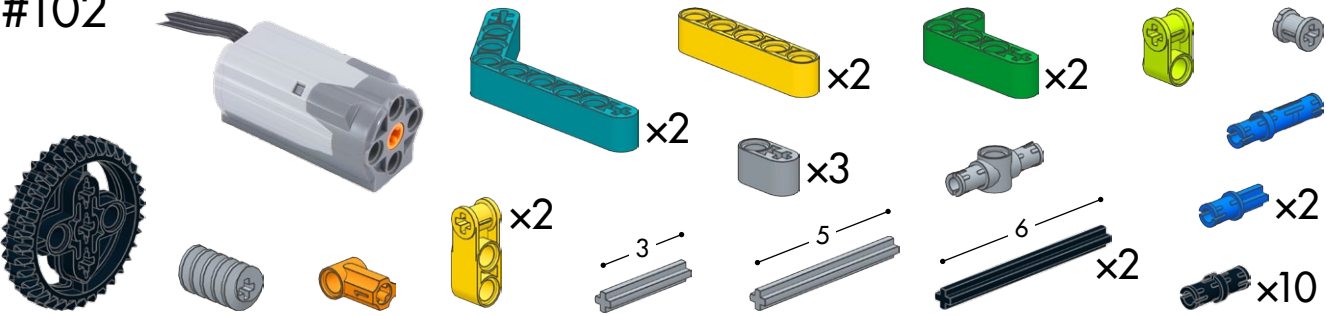
#101




1:24



#102



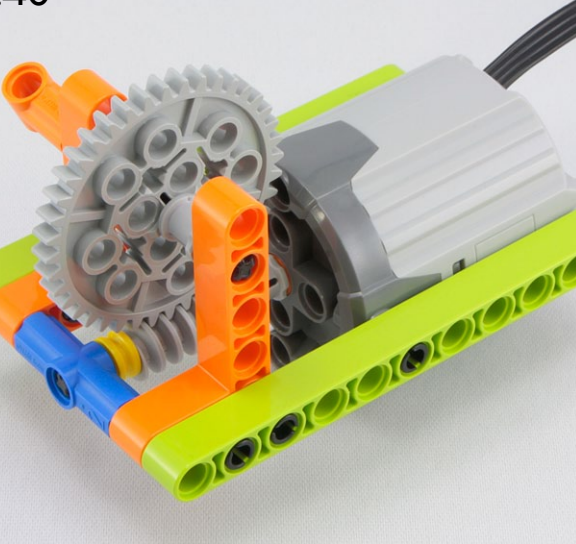
#103



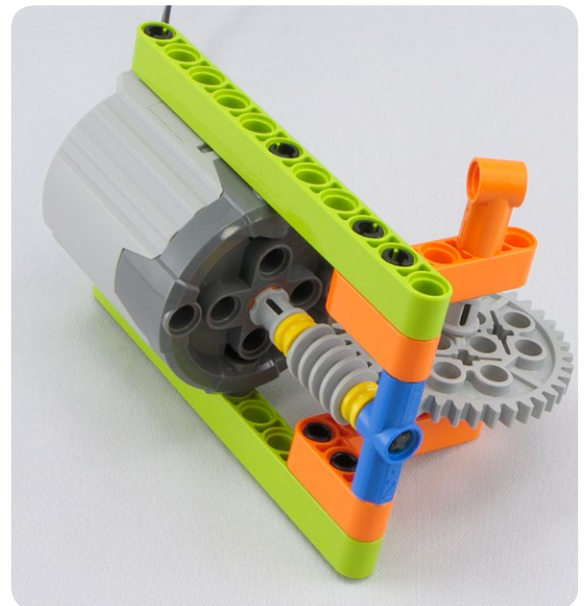
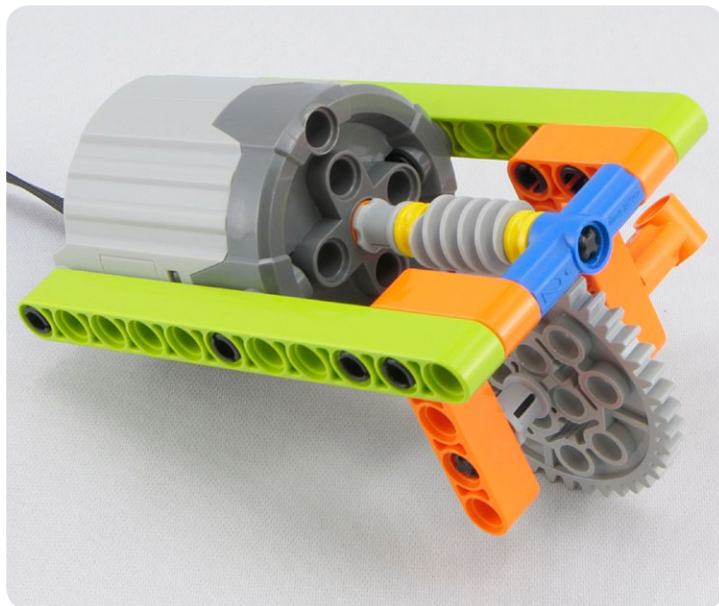
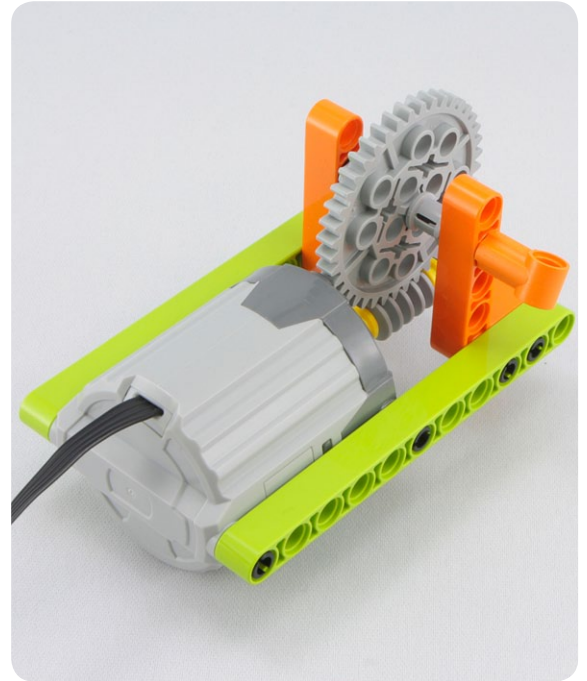
LEGO parts list for step 103:

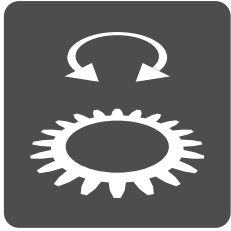
- 1x Large grey motor
- 1x Grey gear
- 1x Grey axle
- 1x Yellow 1x6 Technic beam
- 2x Orange 1x3 Technic beam
- 3x Grey axle connector
- 2x Yellow axle connector
- 2x Blue axle connector
- 2x Blue axle connector
- 2x Black axle (length 6)
- 8x Black axle connector

1:40



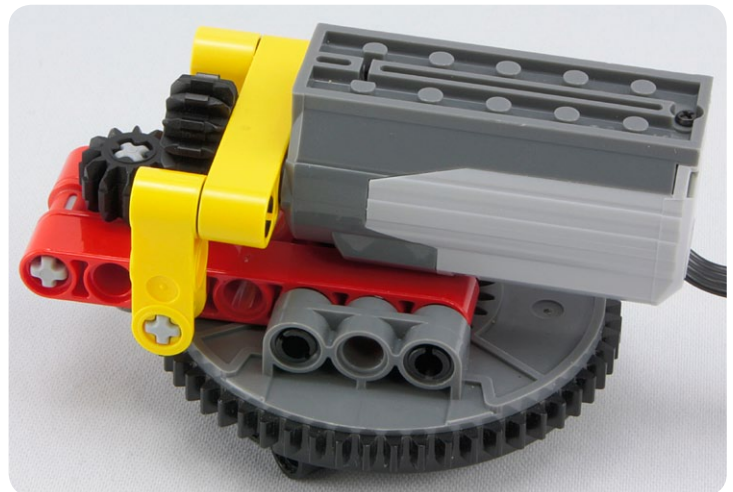
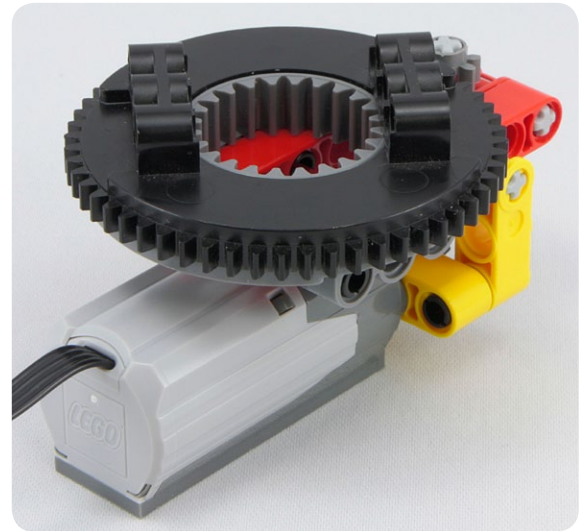
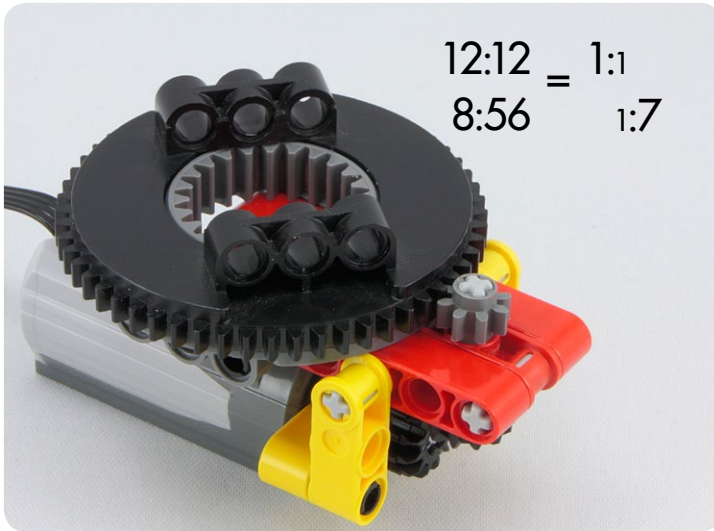
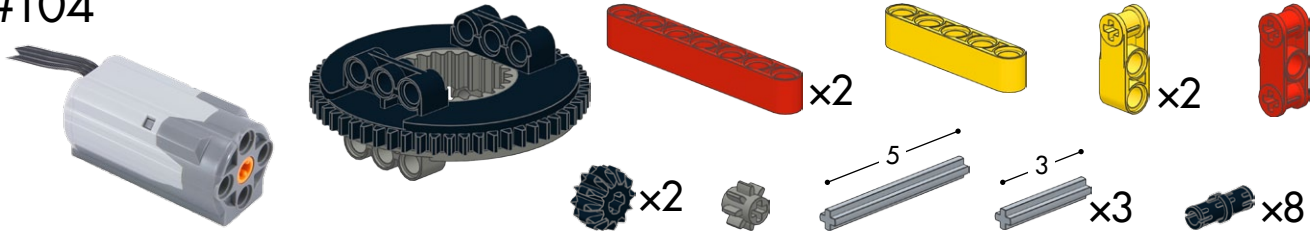
A LEGO Technic assembly featuring a grey motor mounted on a yellow Technic beam. A large grey gear is connected to the motor's output shaft. An orange Technic beam is attached to the side of the gear, and a blue Technic beam is attached to the bottom. A black cable is connected to the motor's terminal block.



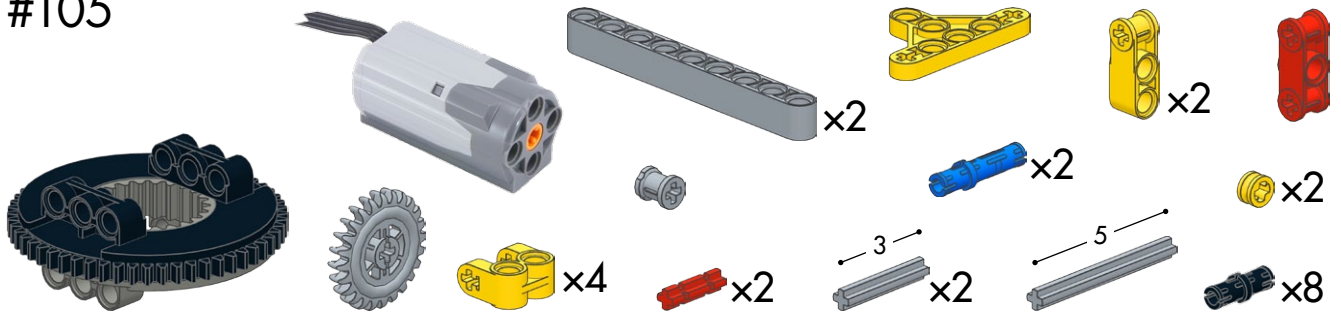
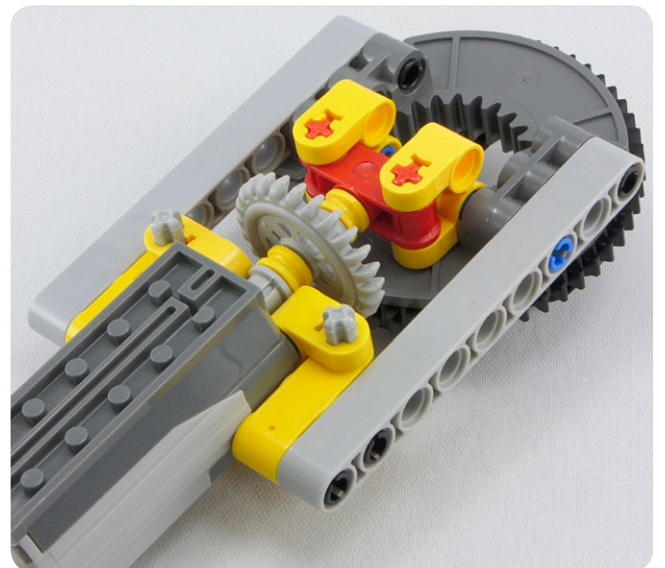
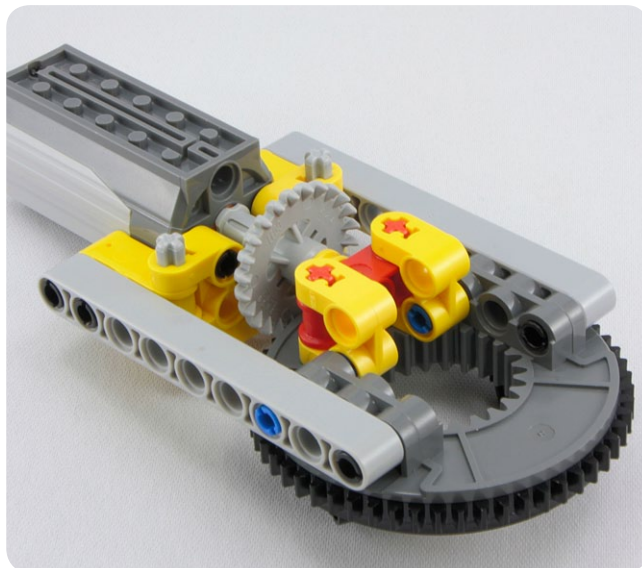
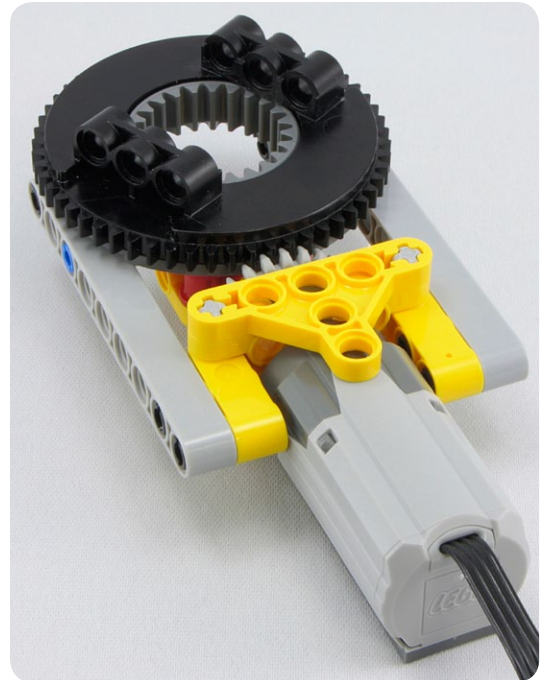
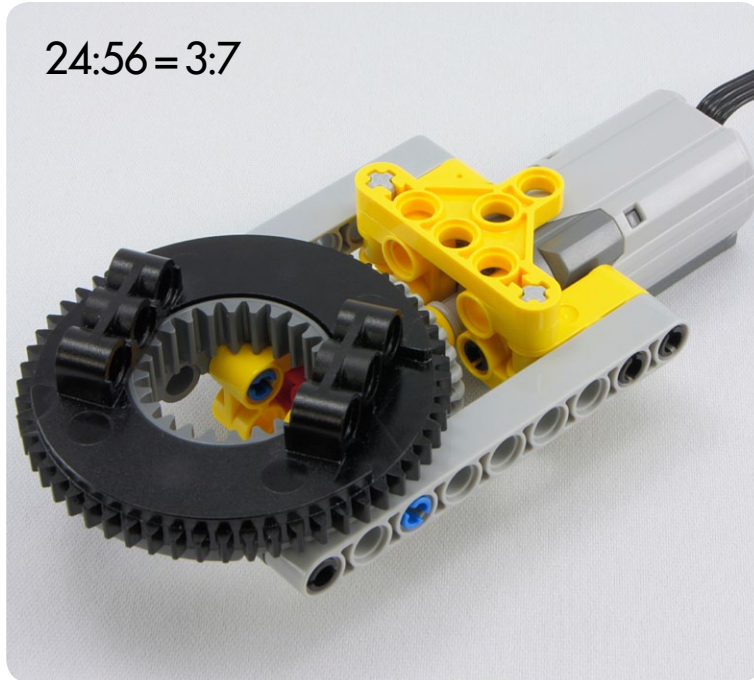


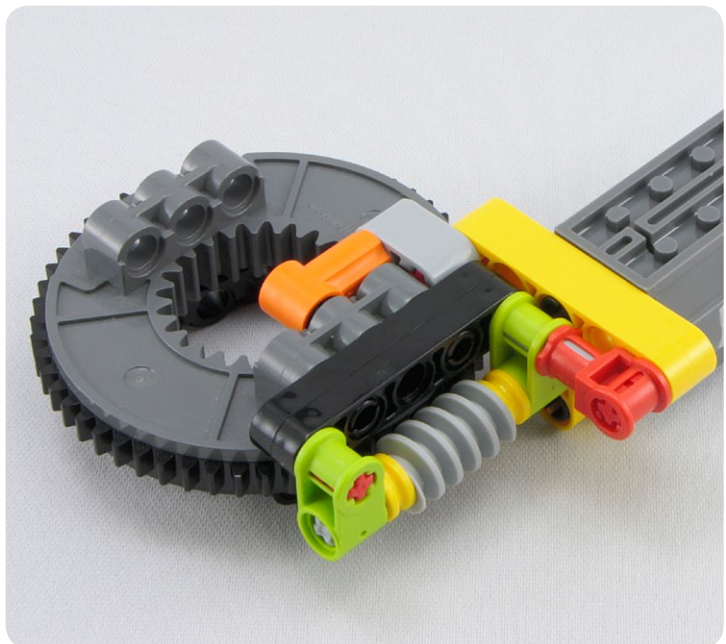
Using turntables

#104

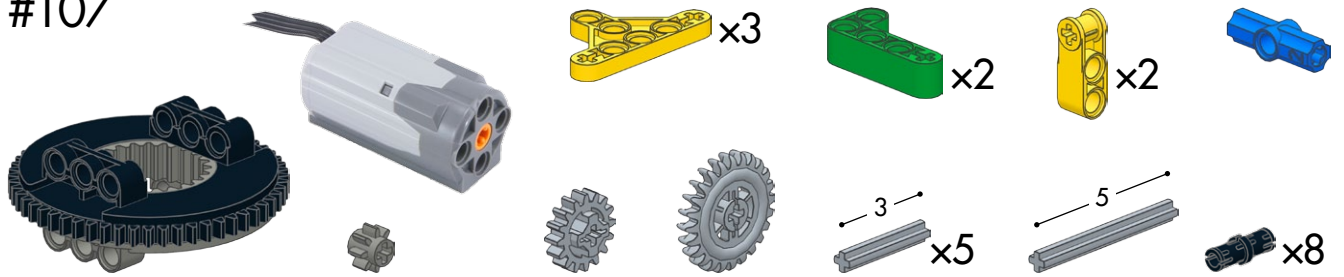


#105

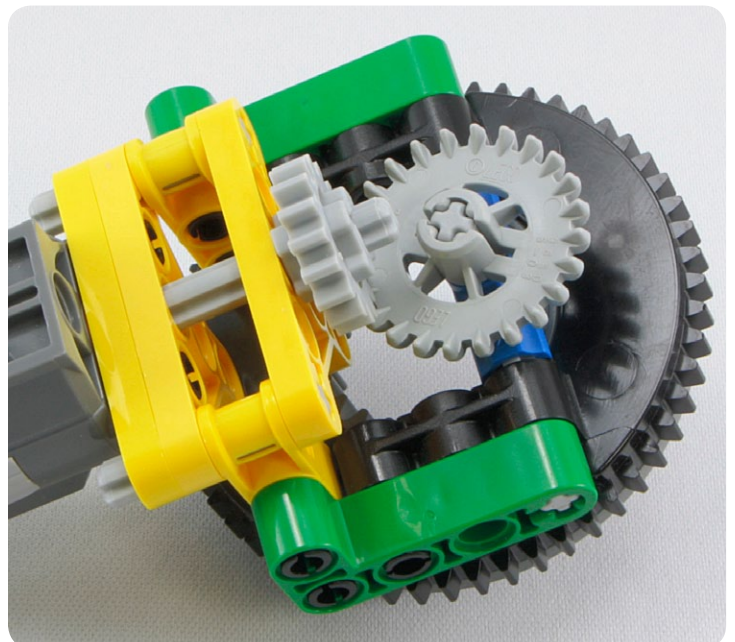
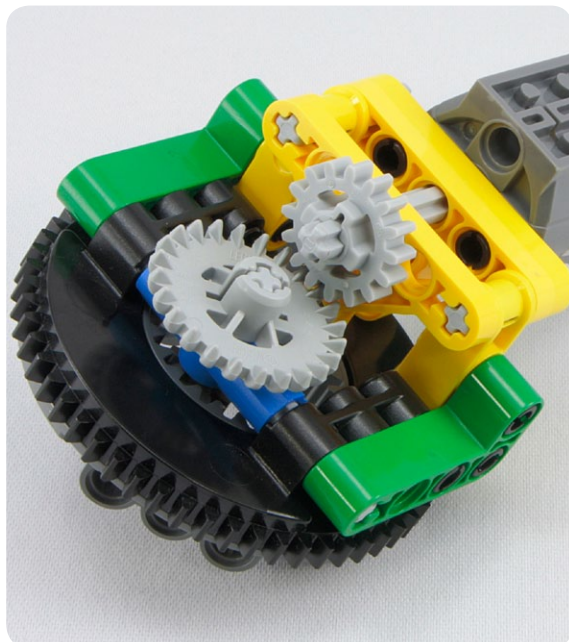
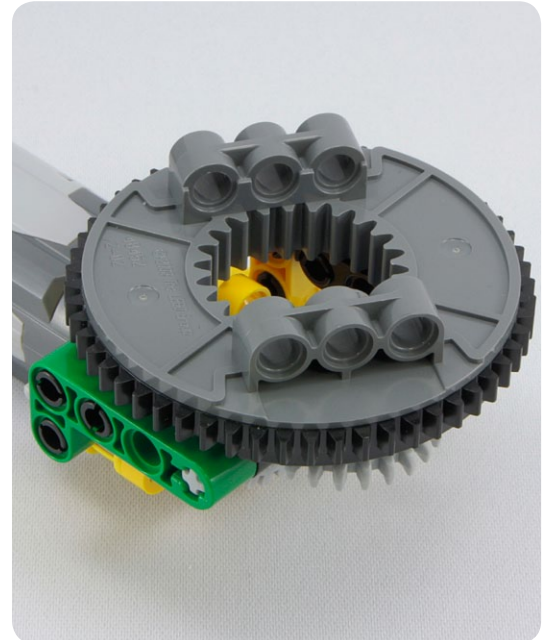
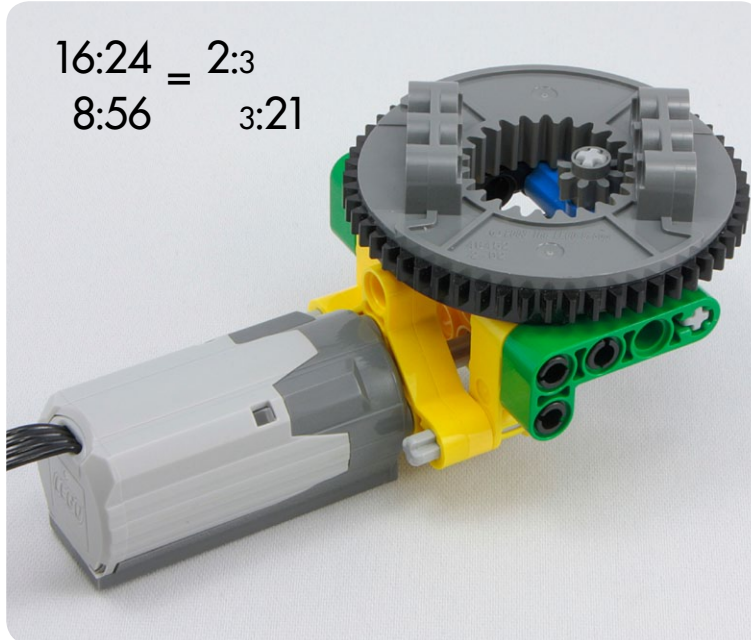

$$24:56 = 3:7$$


[illegible]

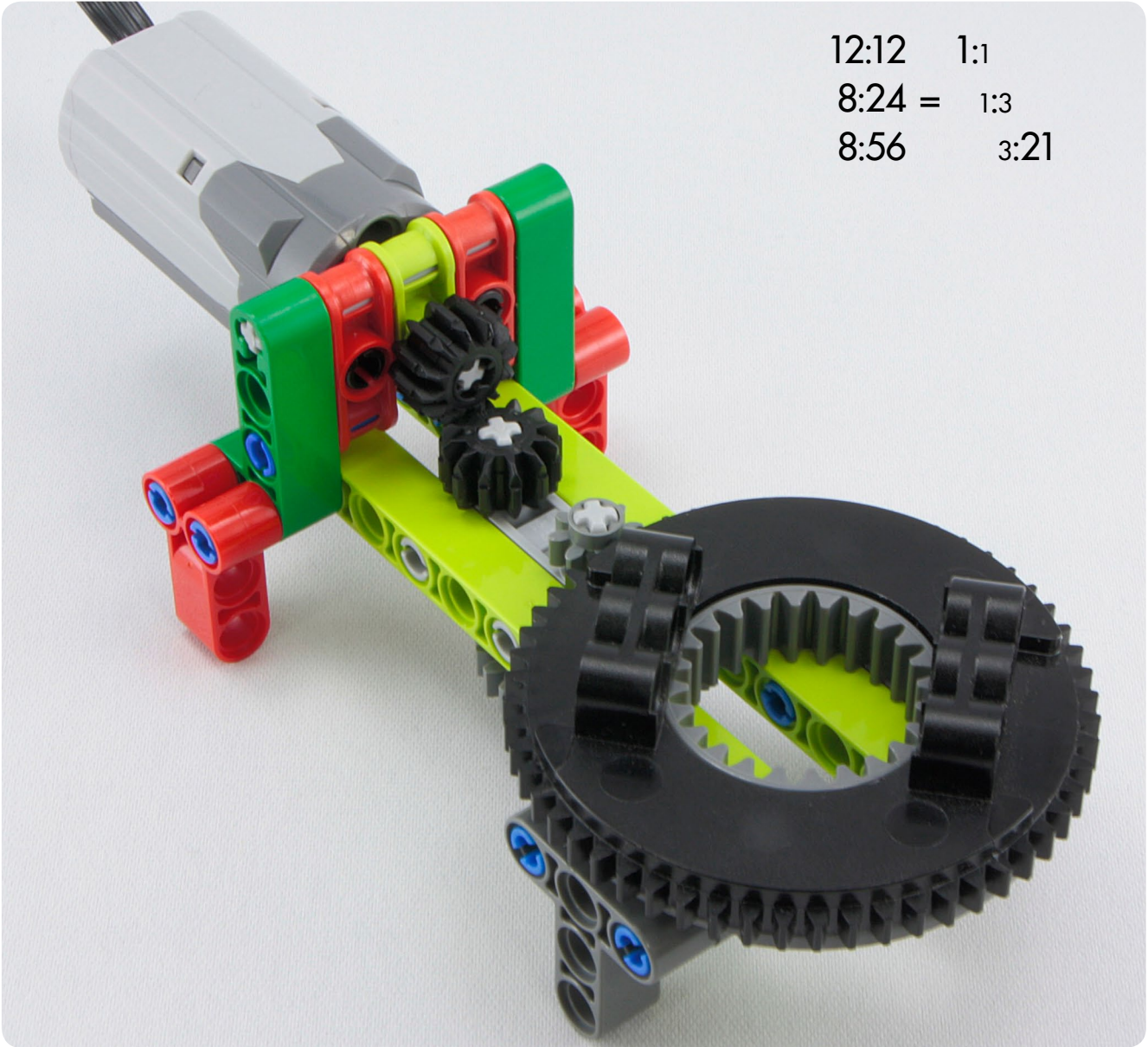
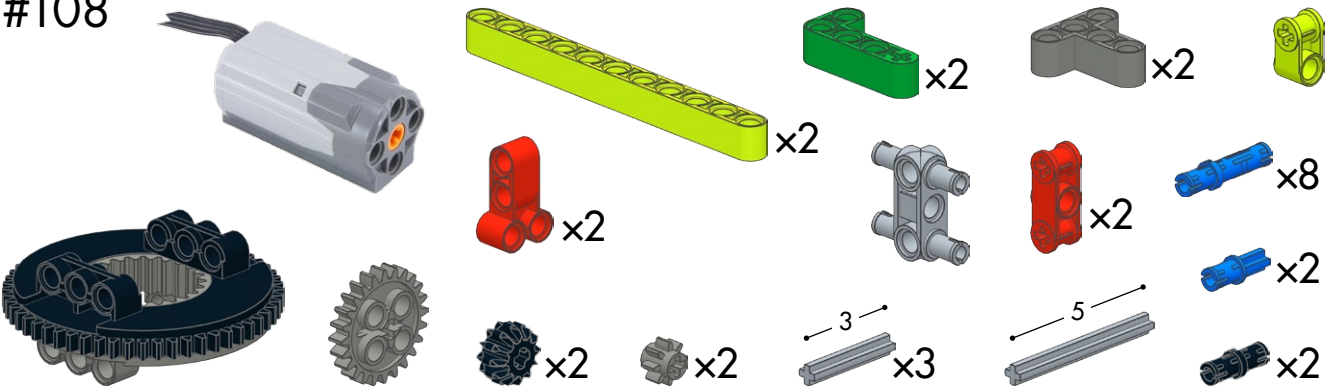
#107

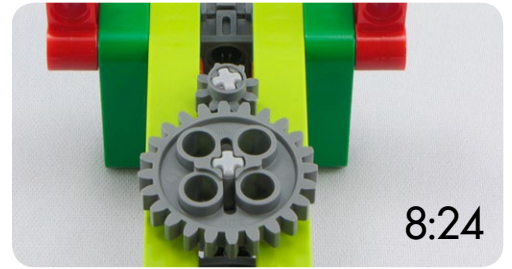
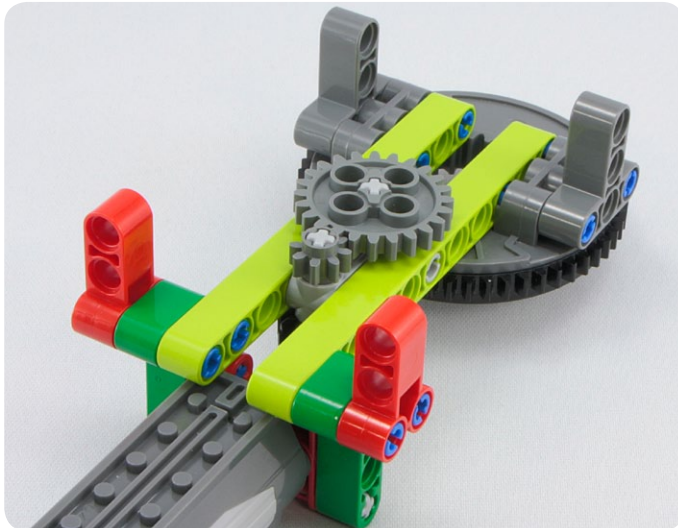
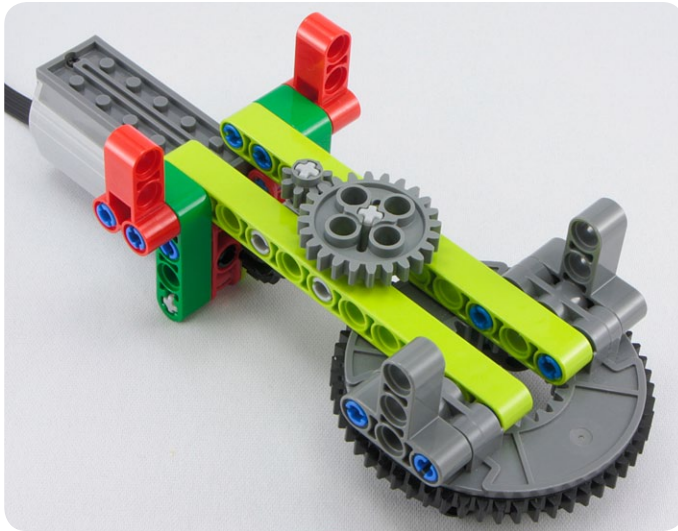
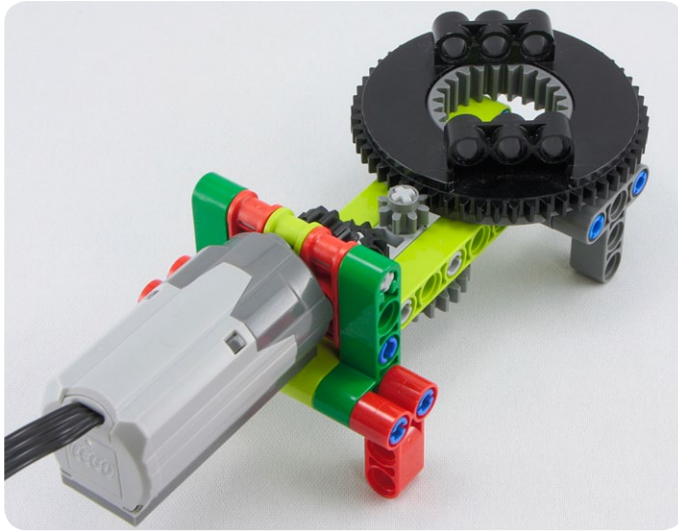


$\frac{16:24}{8:56} = \frac{2:3}{3:21}$

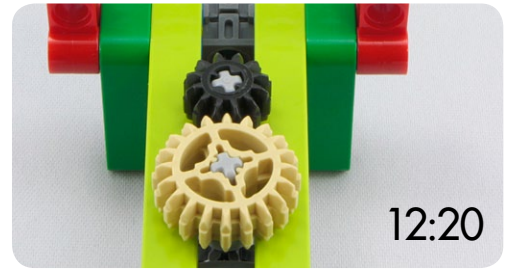


#108

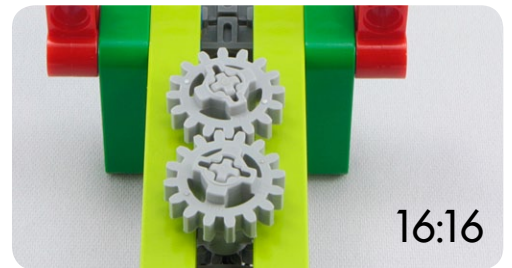




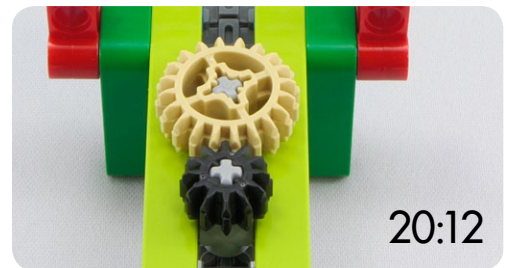
8:24



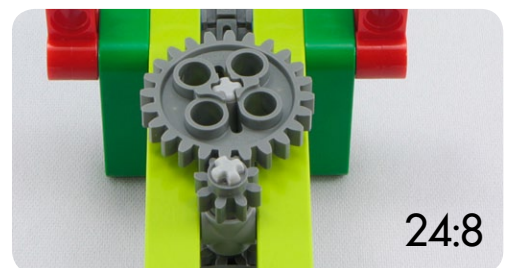
12:20



16:16

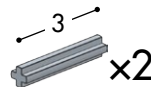
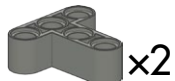
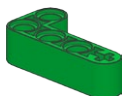


20:12

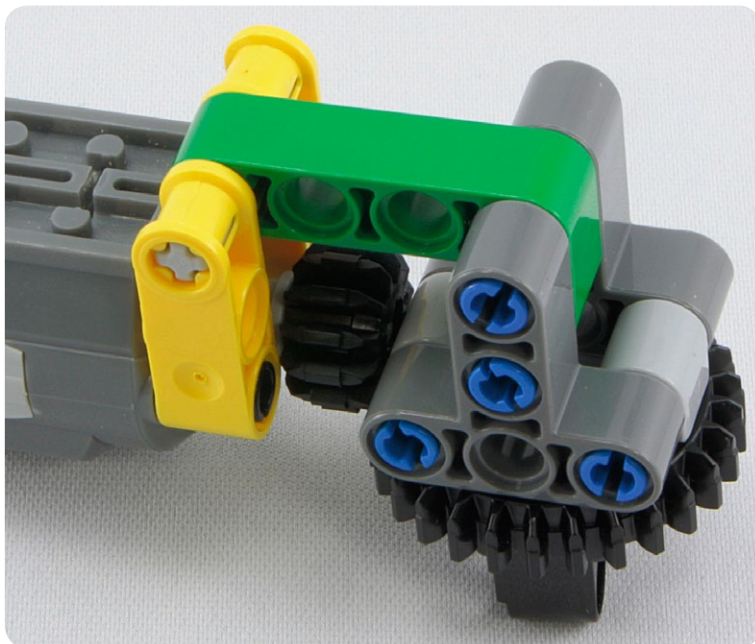
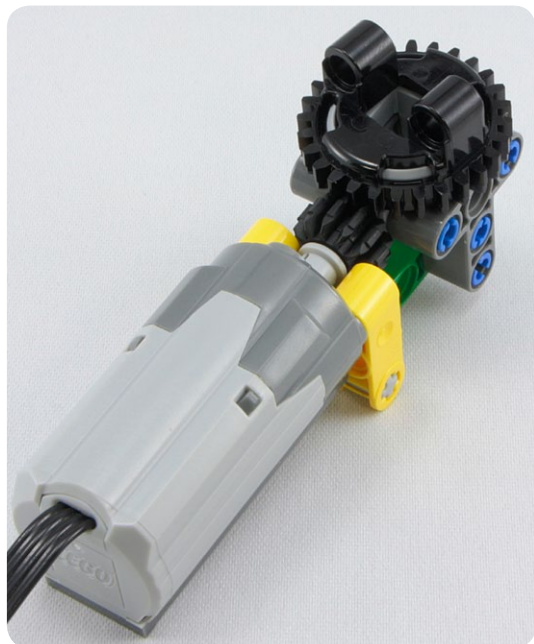
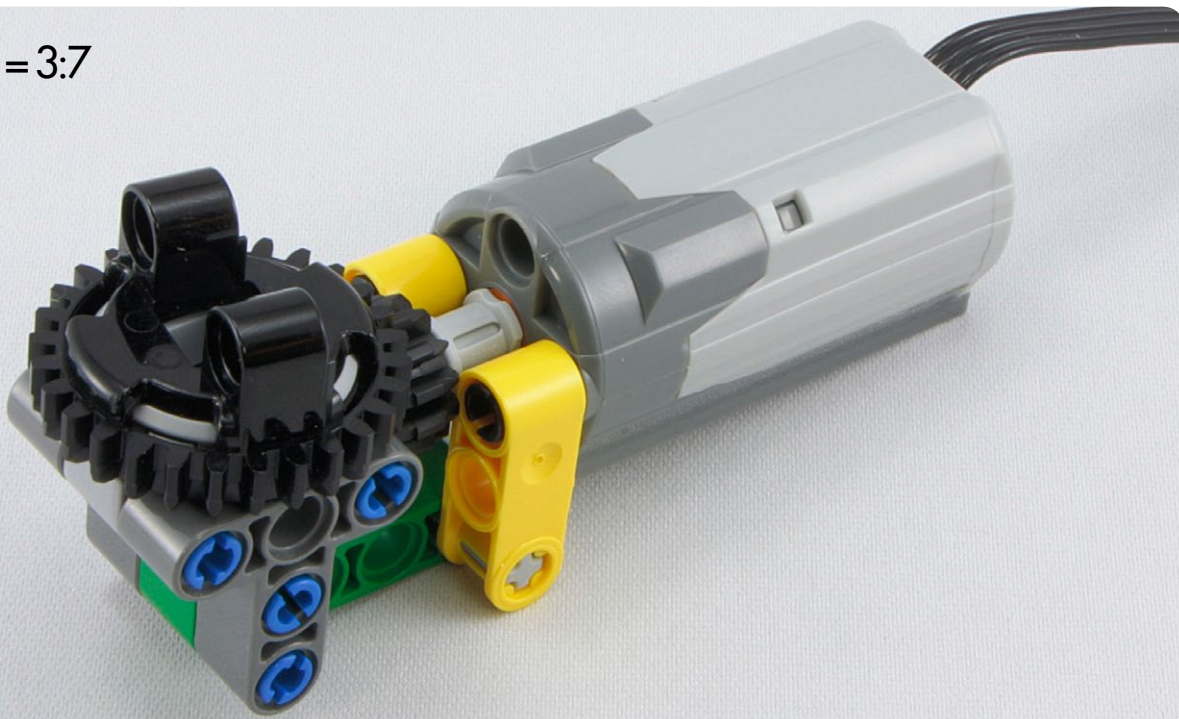


24:8

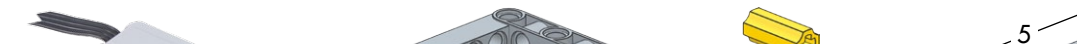
#109



12:28 = 3:7

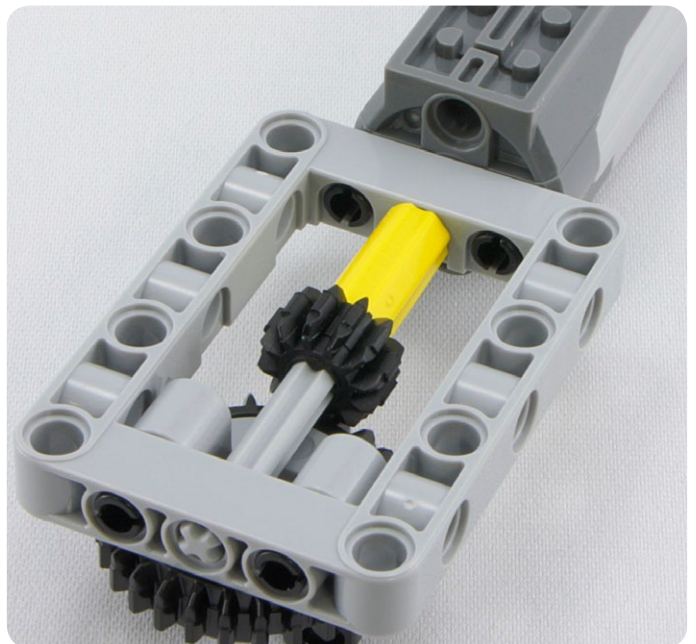
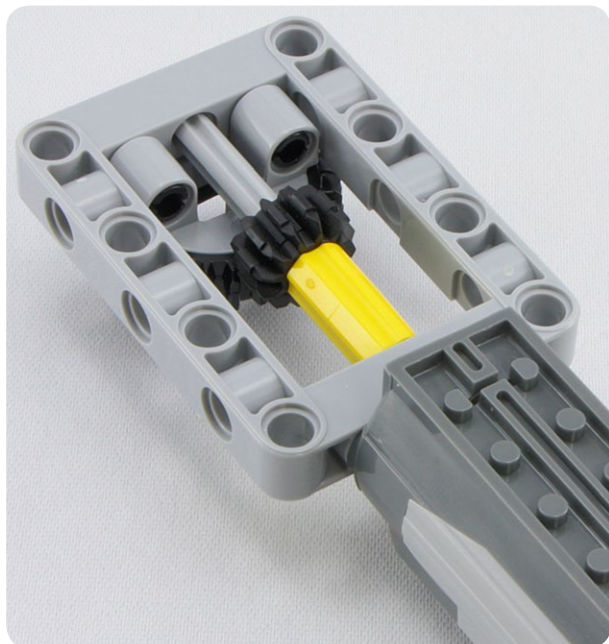
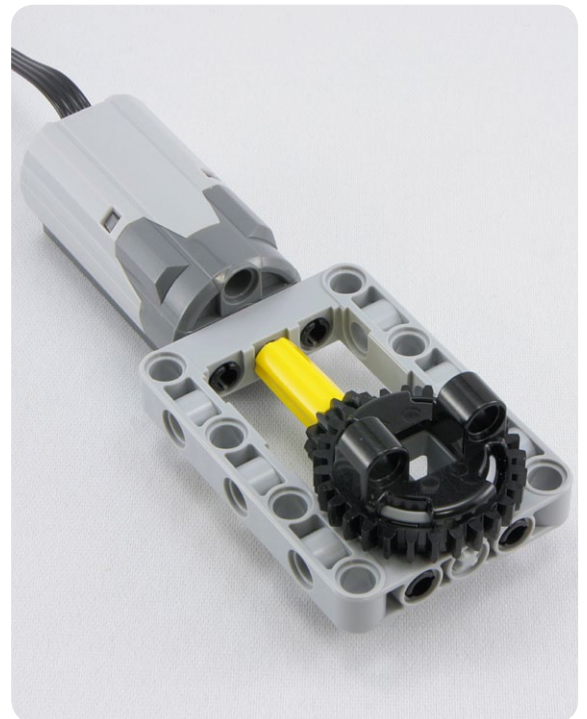


#110

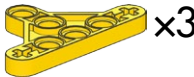


Parts list for step 110:

- 1x Dark Blue Gear (24 teeth)
- 1x Grey Motor
- 1x Black Gear (12 teeth)
- 1x Grey 3x3 Frame
- 1x Yellow Technic Pin
- 1x Grey Technic Beam (5 holes)
- 1x Grey Technic Beam (3 holes)
- 4x Black Technic Pin (long)



#111



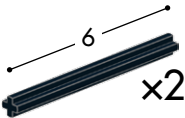
x3



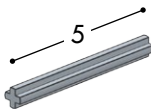
x2



x2



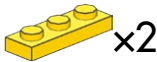
x2



5

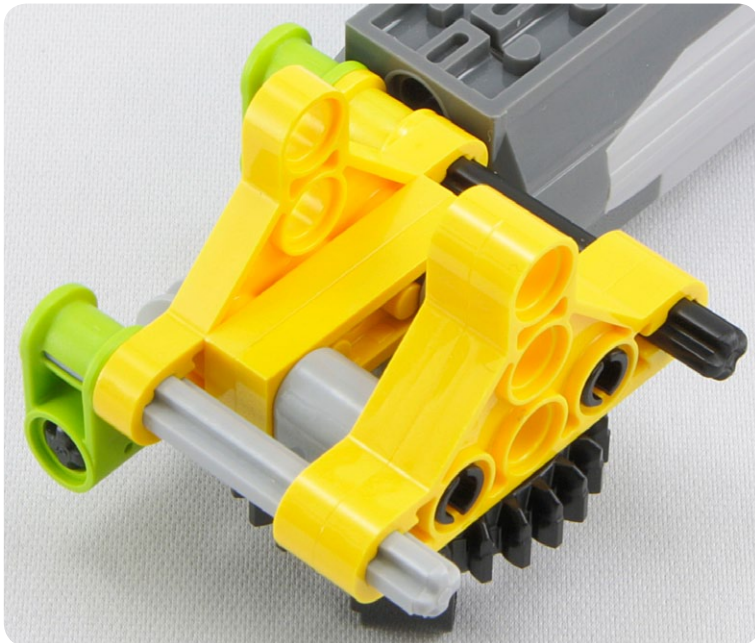
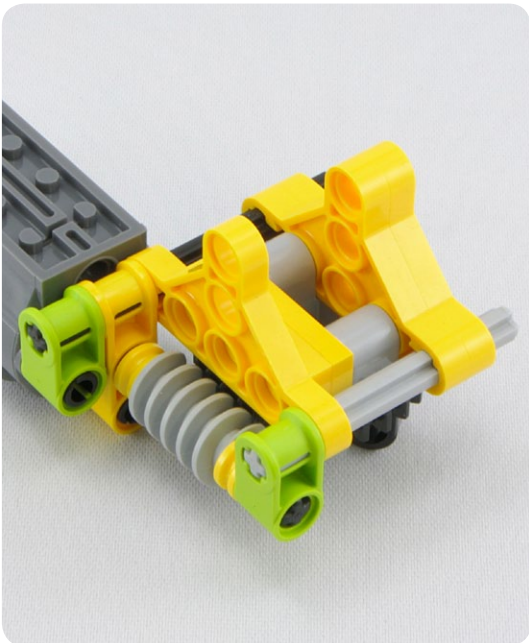
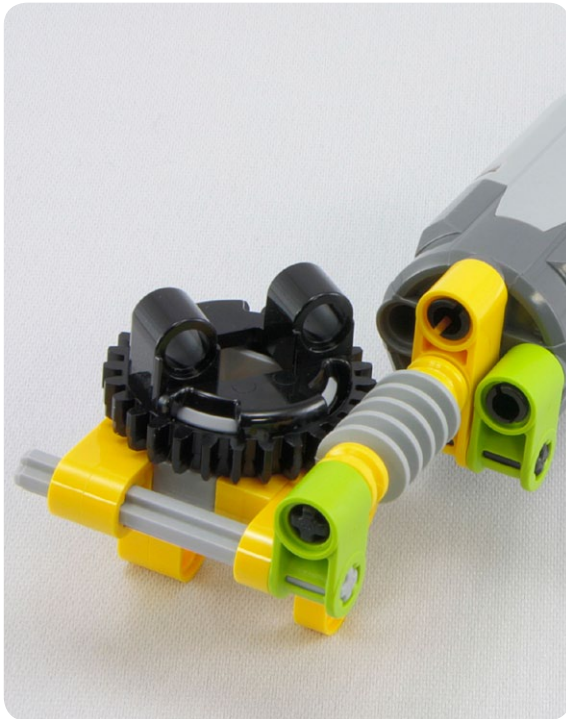


x4

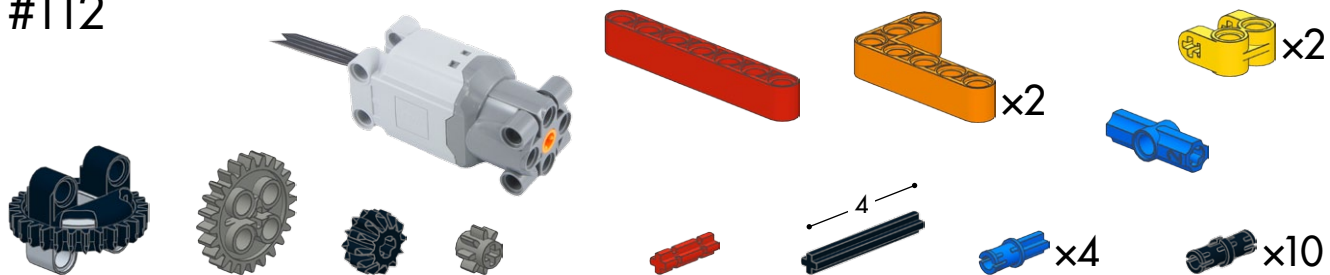


x2

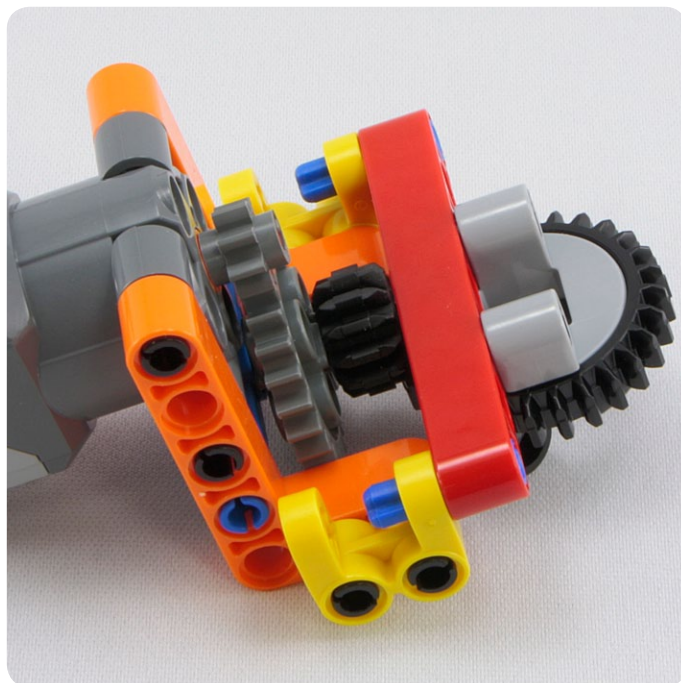
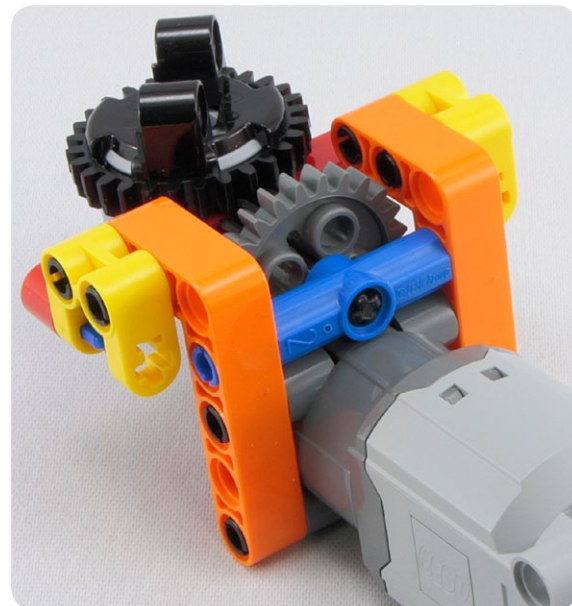
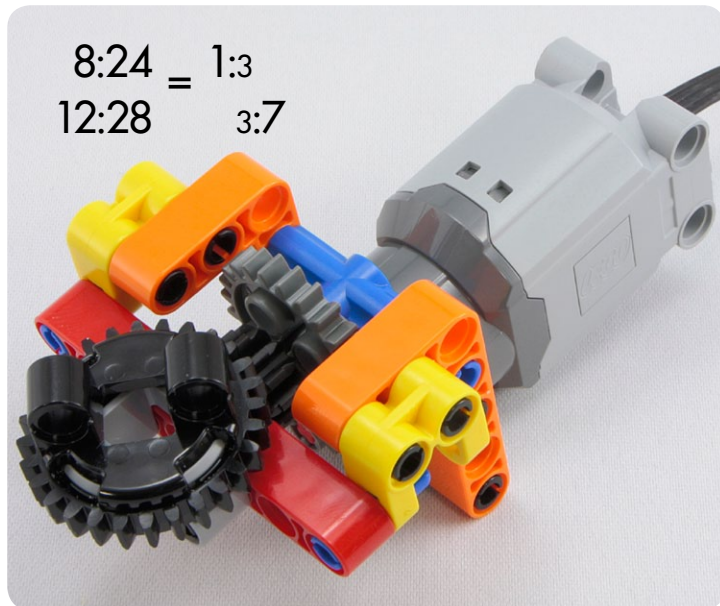
1:28

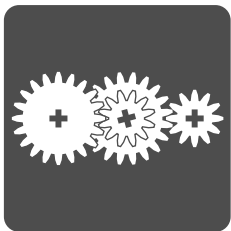


#112



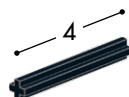
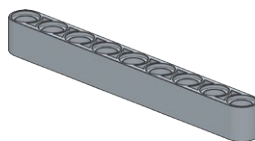
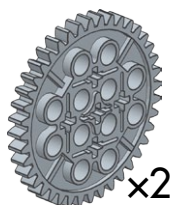
$\frac{8:24}{12:28} = \frac{1:3}{3:7}$



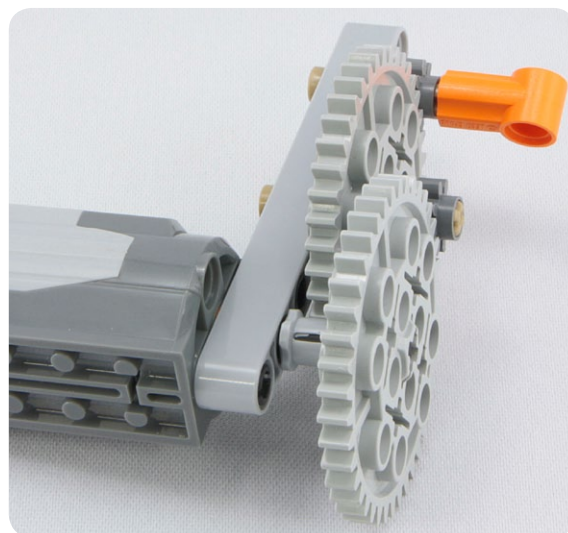
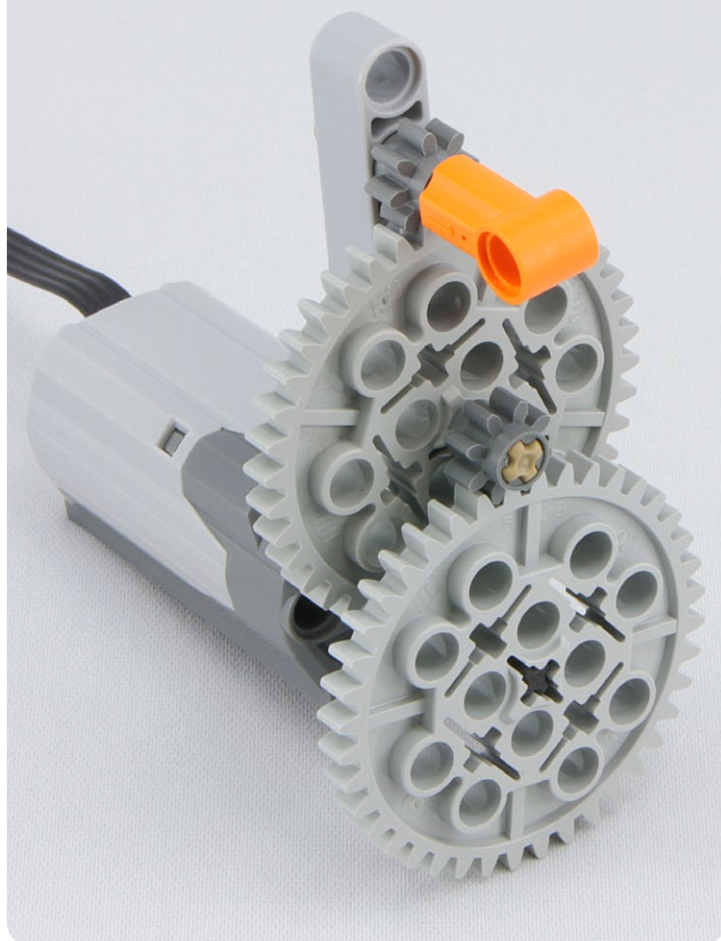


Gear systems

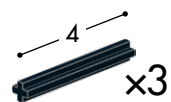
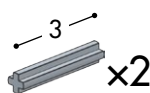
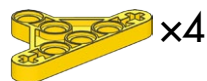
#113



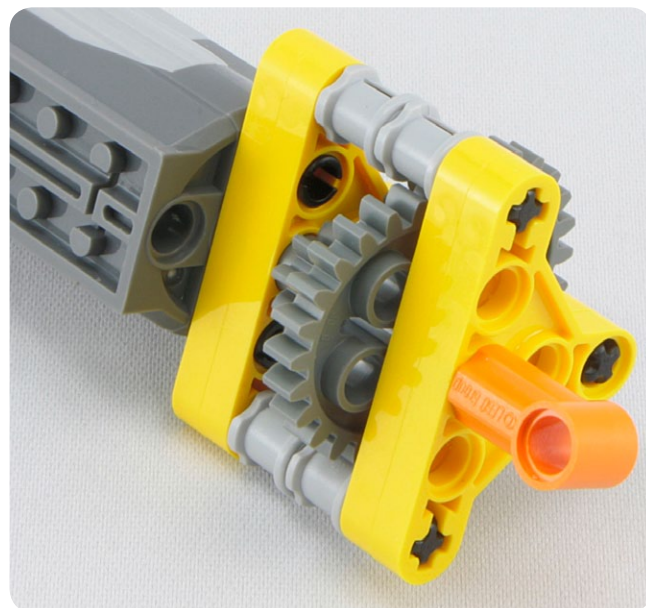
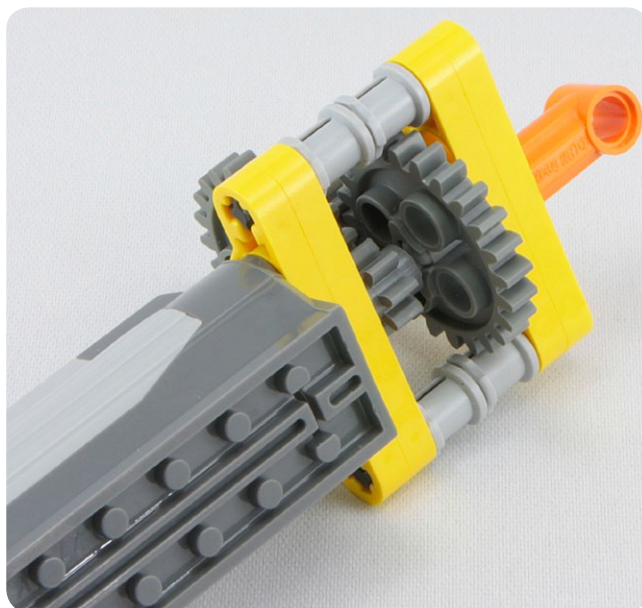
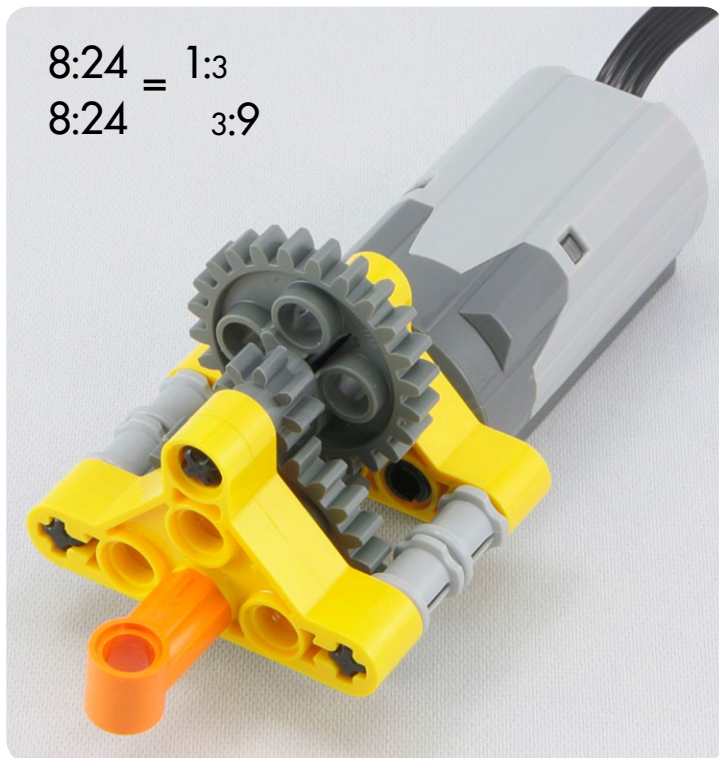
$$\frac{40:8}{40:8} = \frac{25:5}{5:1}$$



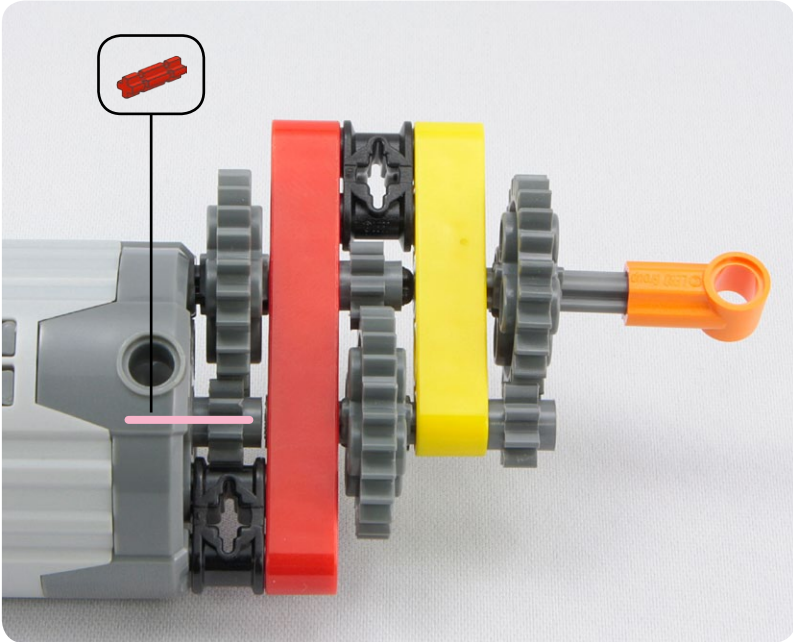
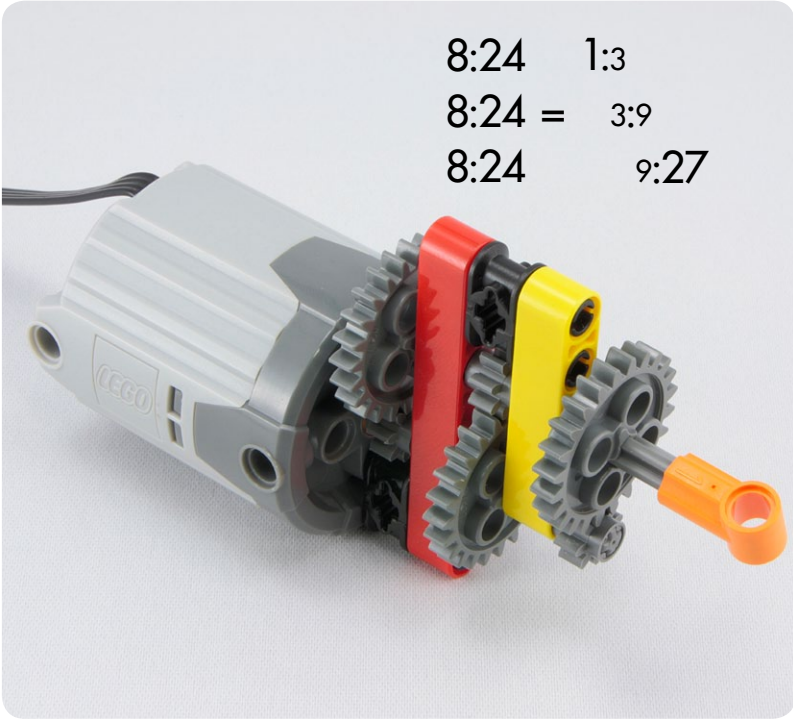
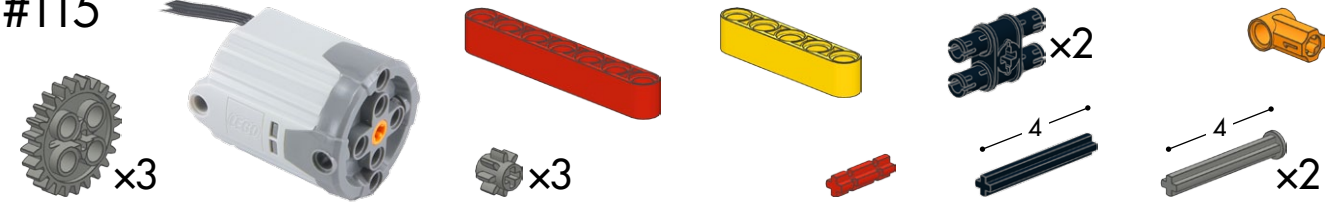
#114



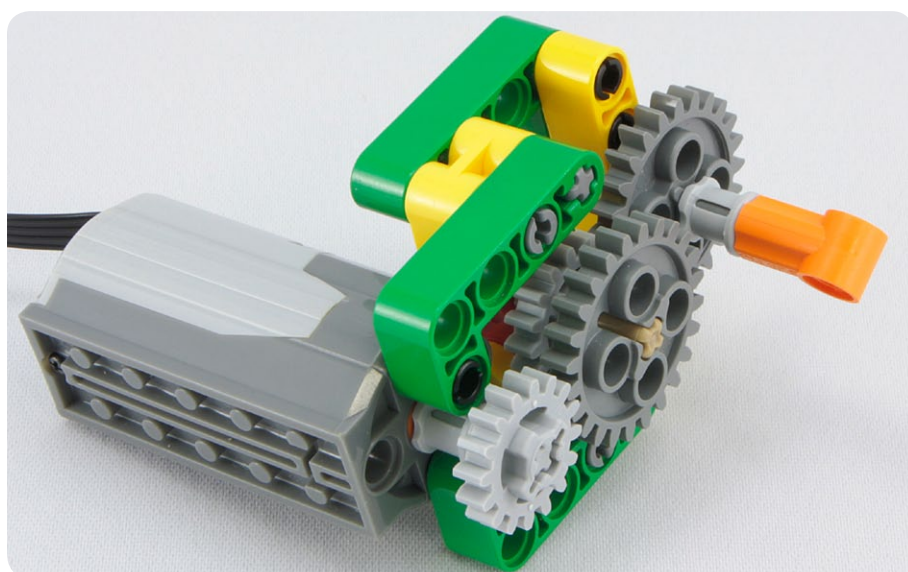
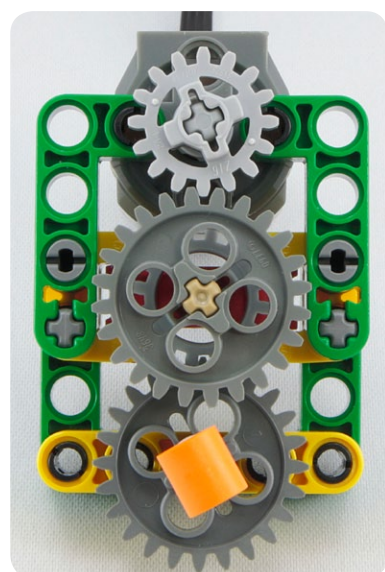
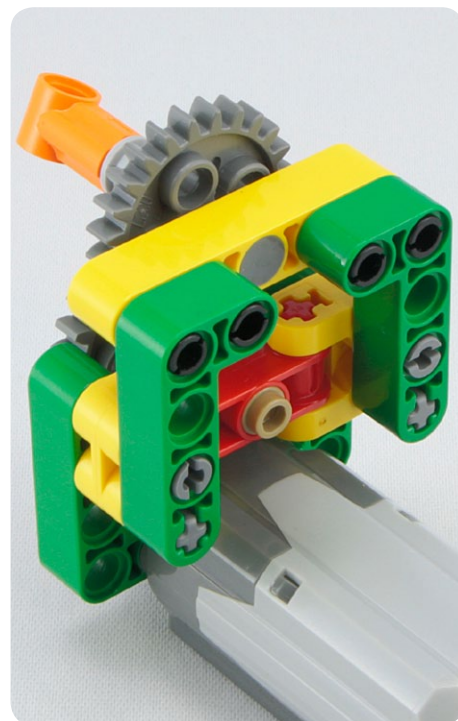
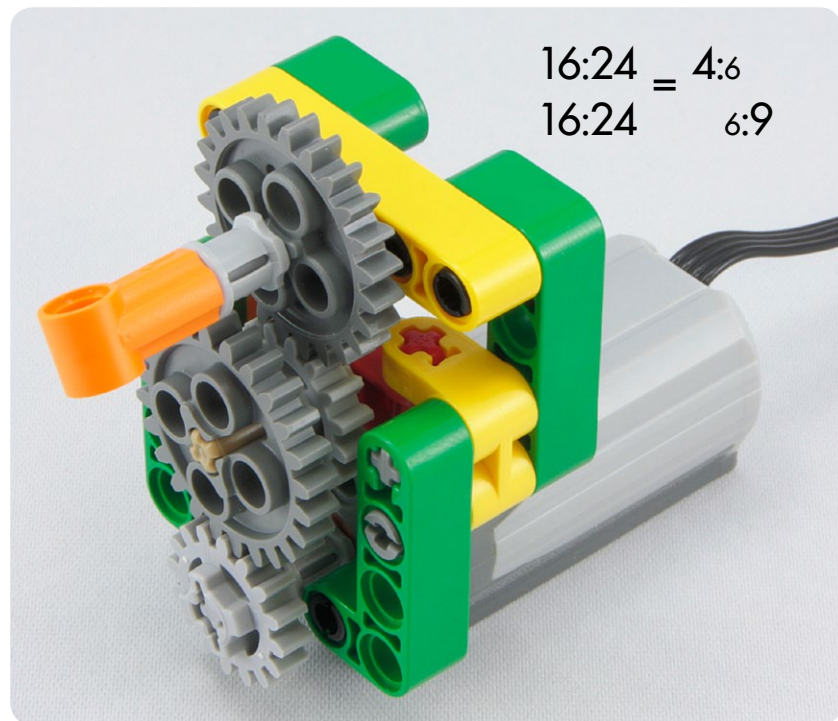
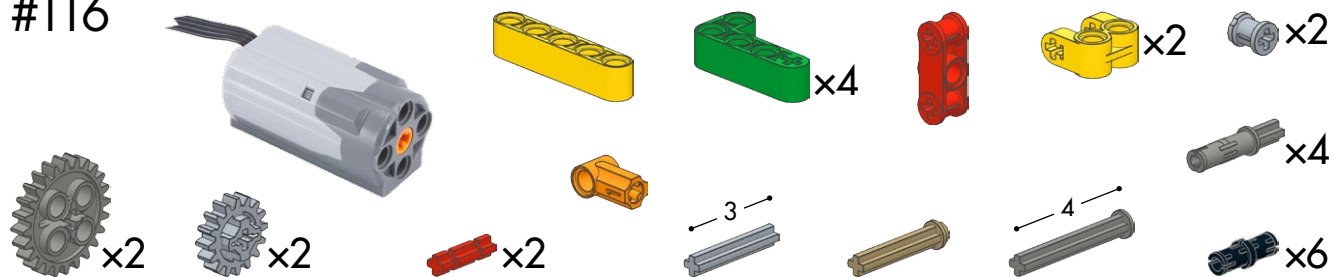
$8:24 = 1:3$
 $8:24 = 3:9$



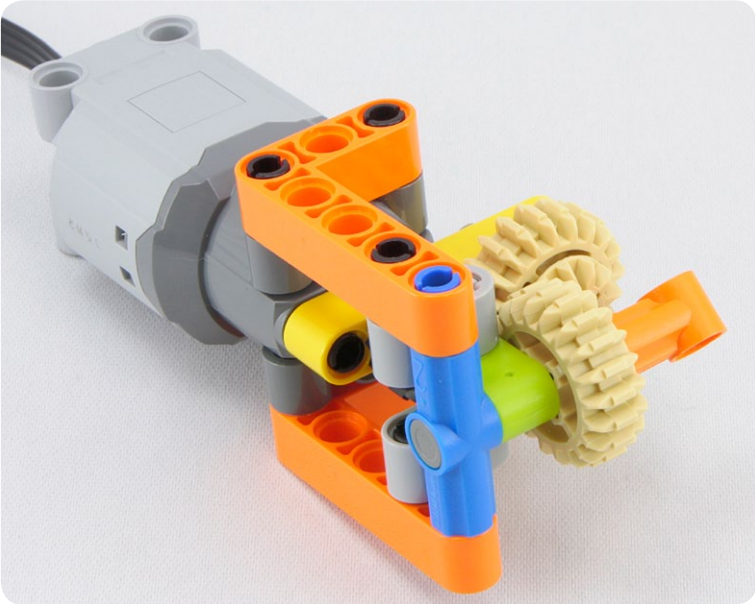
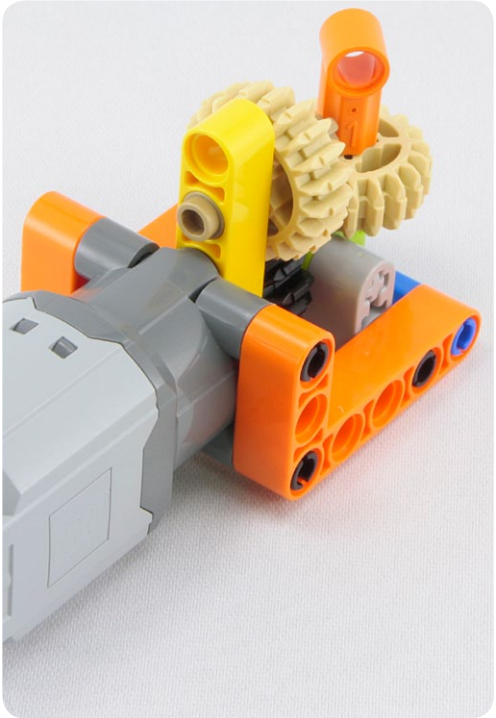
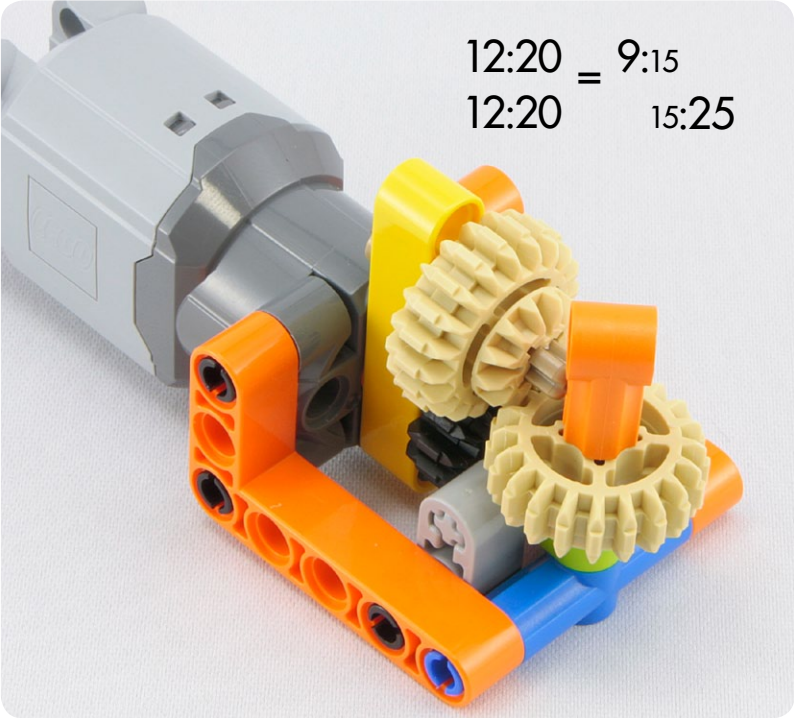
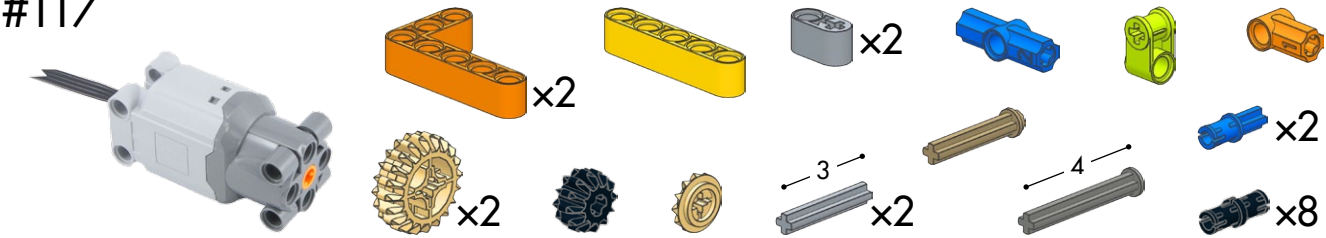
#115



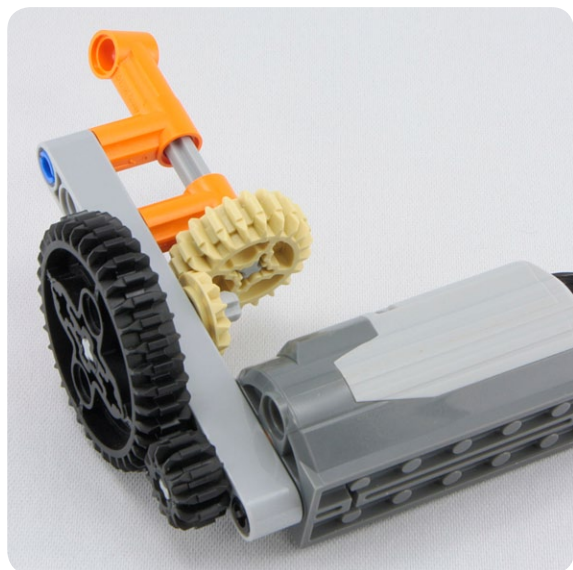
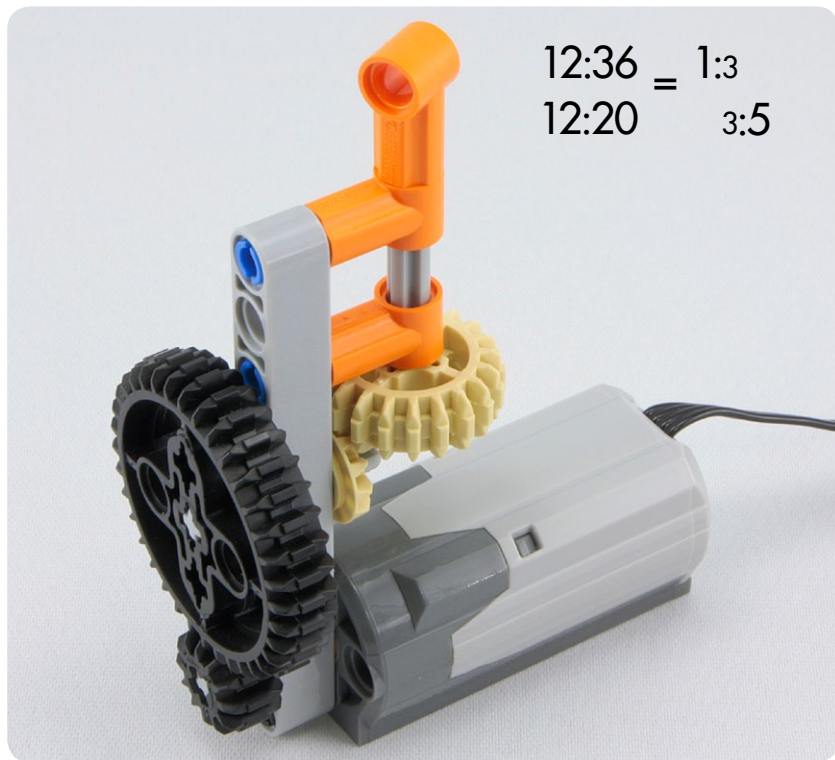
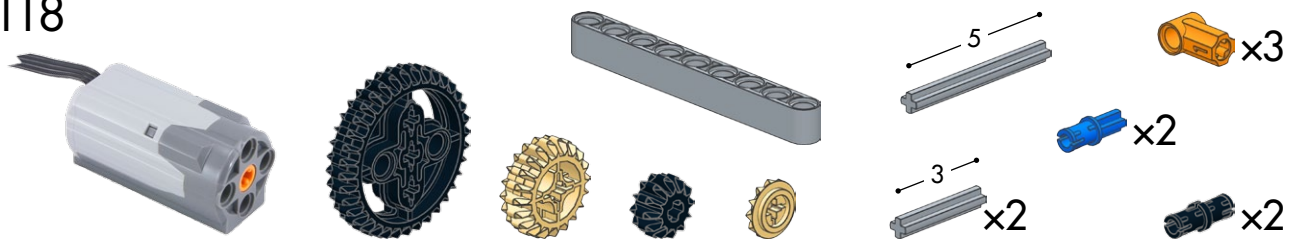
#116



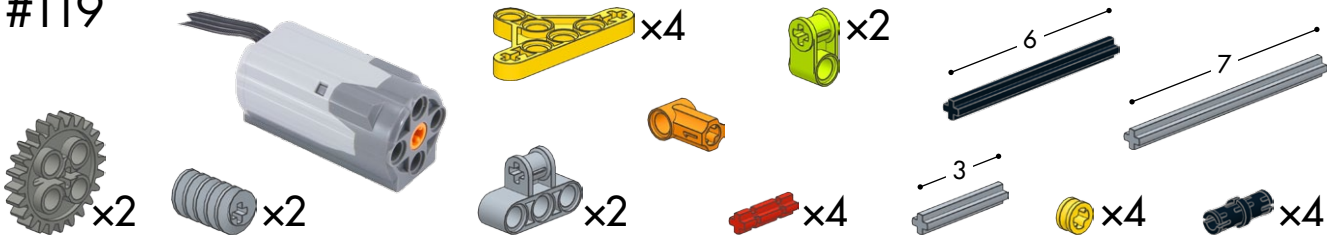
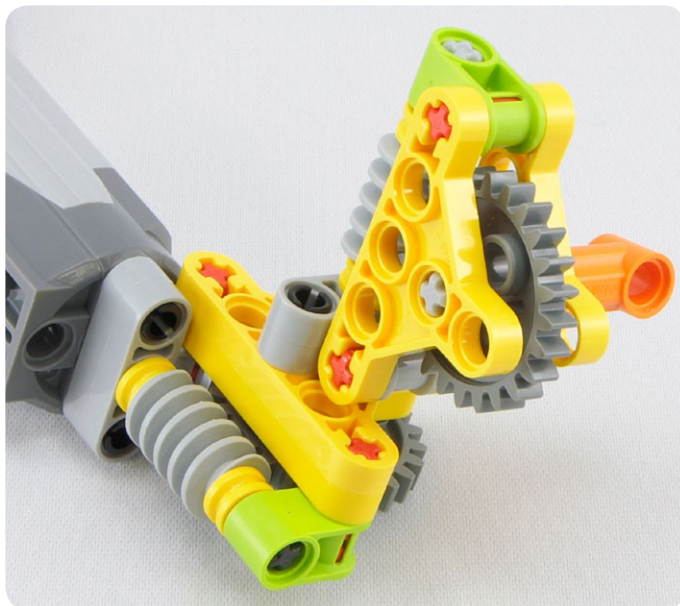
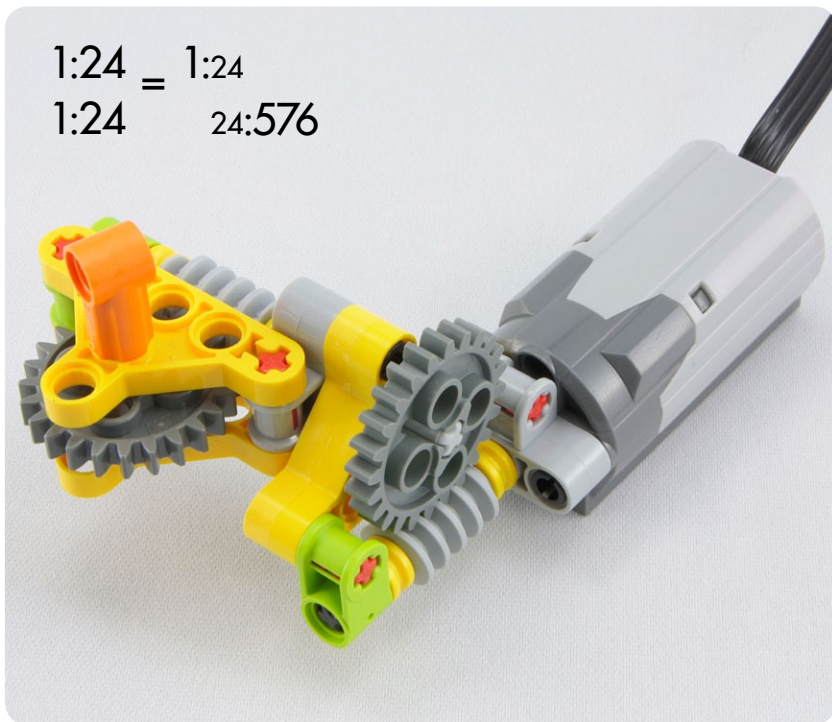
#117



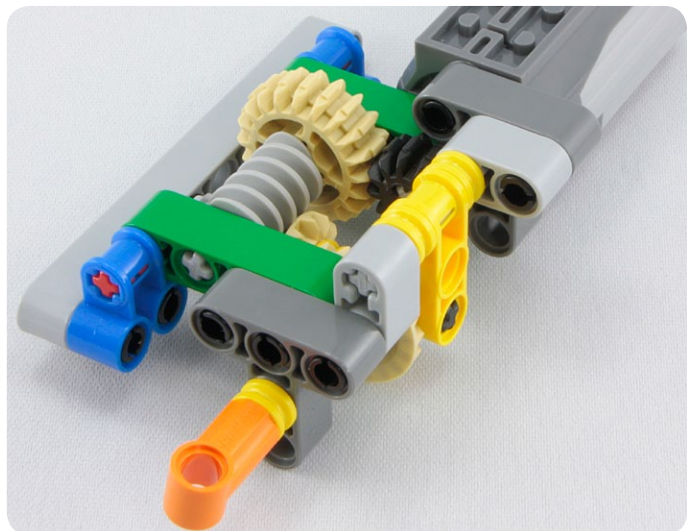
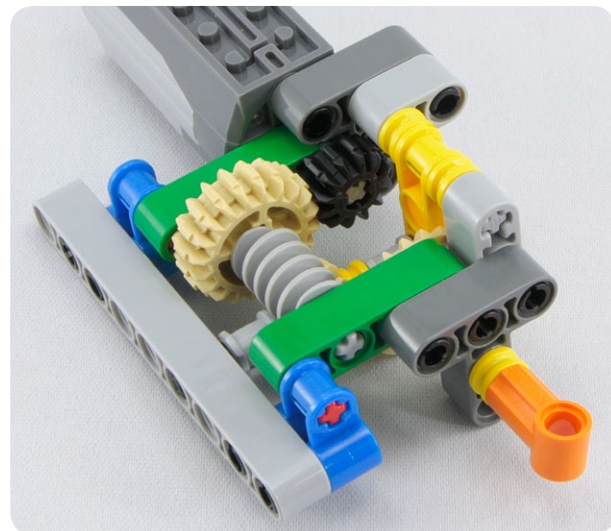
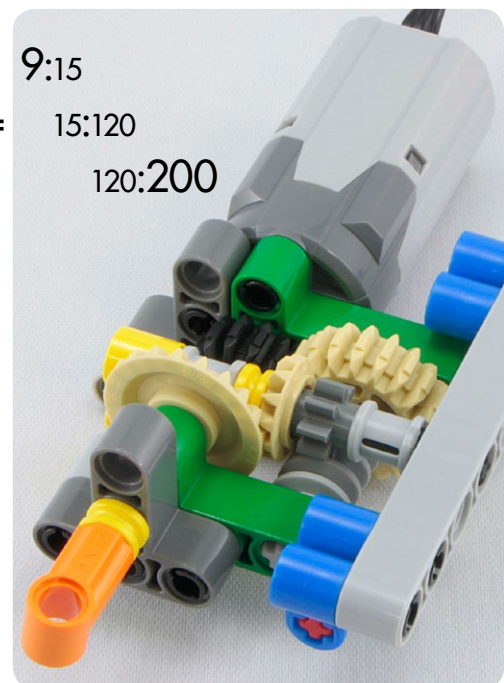
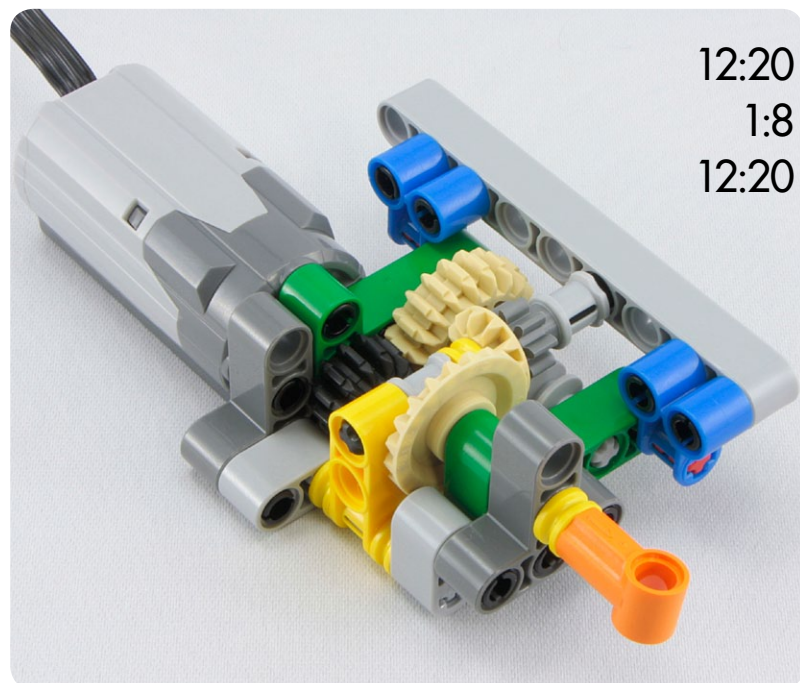
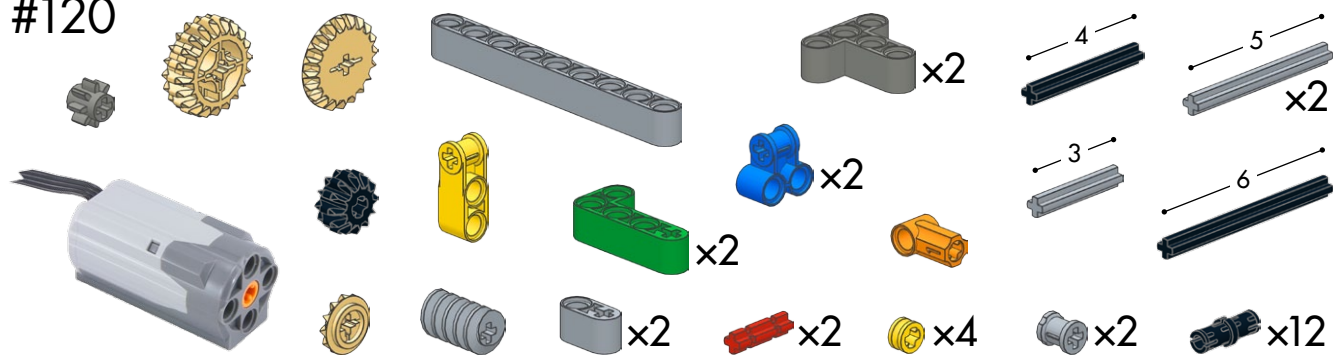
#118

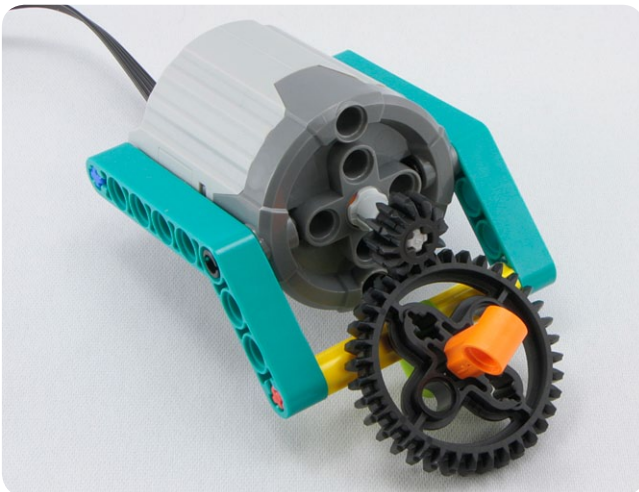
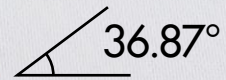
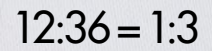
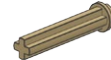
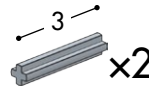
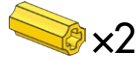
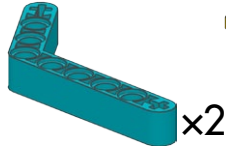


#119

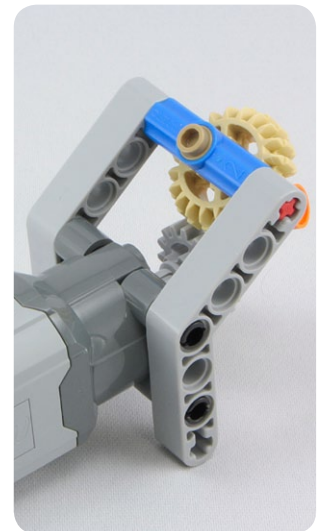
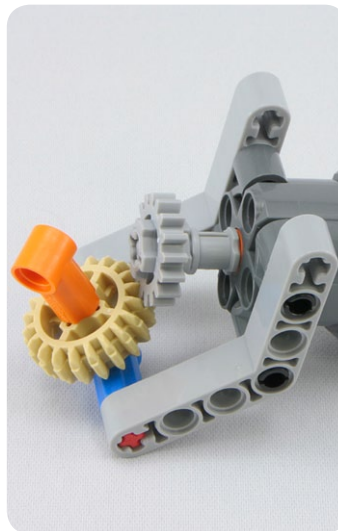
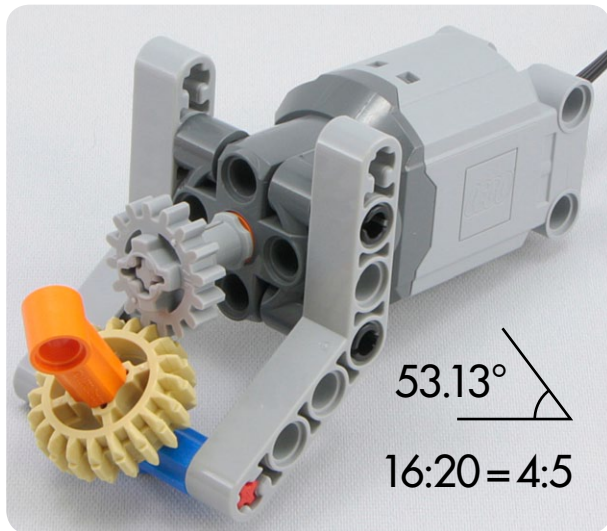
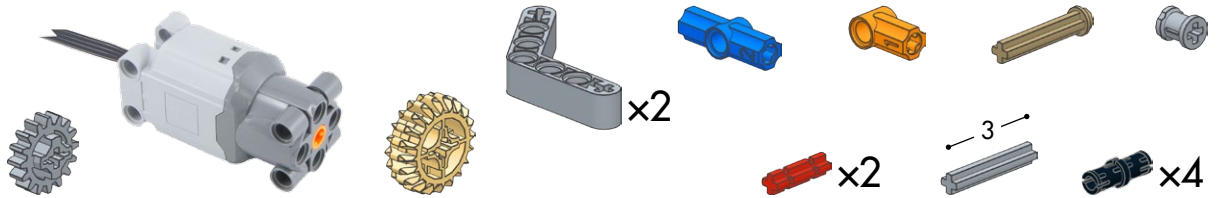

$$\frac{1:24}{1:24} = \frac{1:24}{24:576}$$


#120

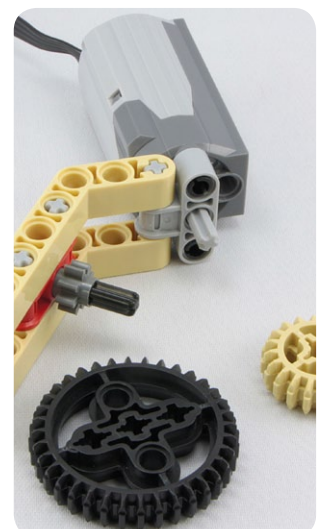
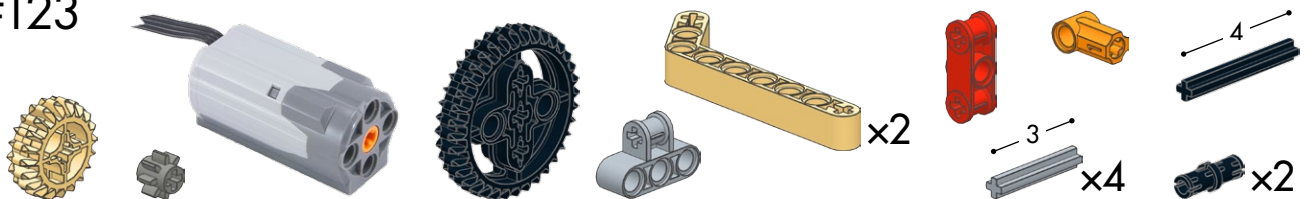


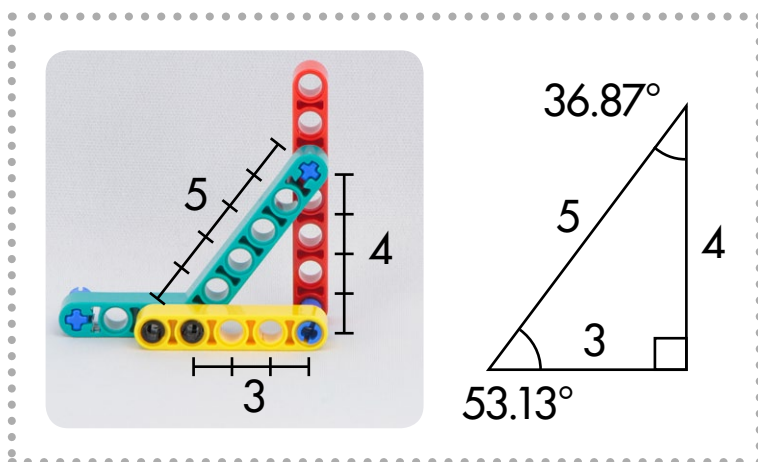
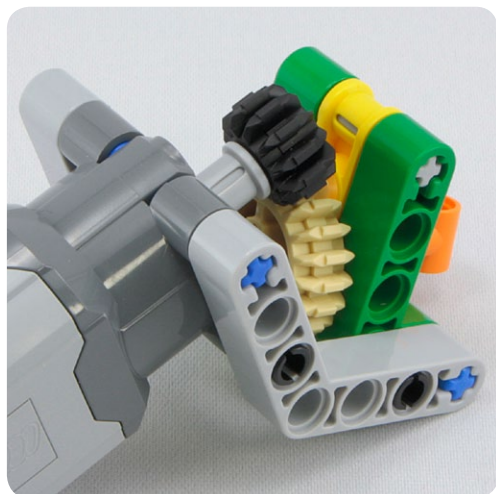
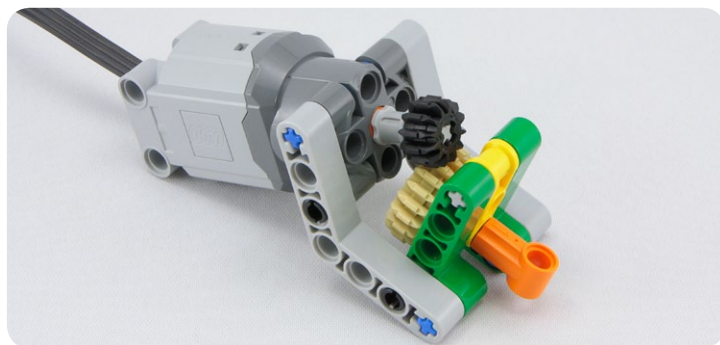
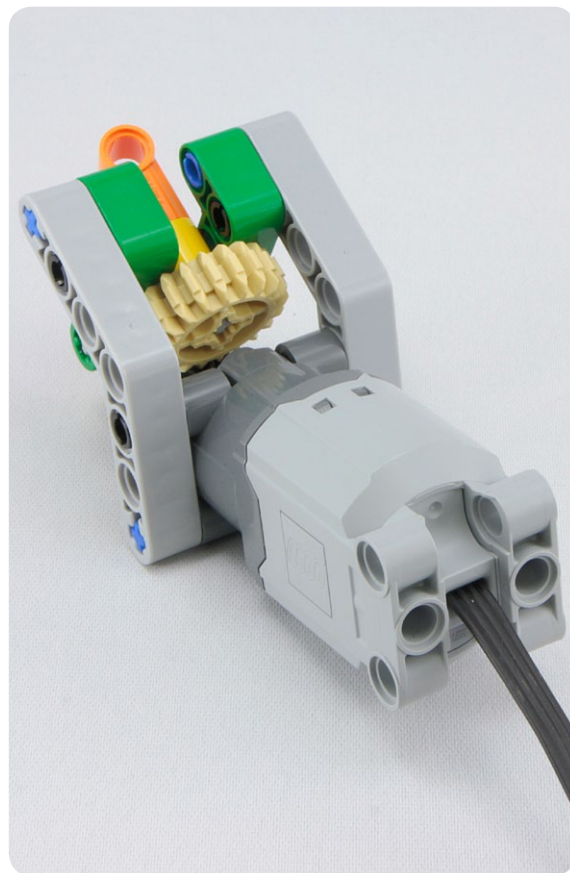


#122



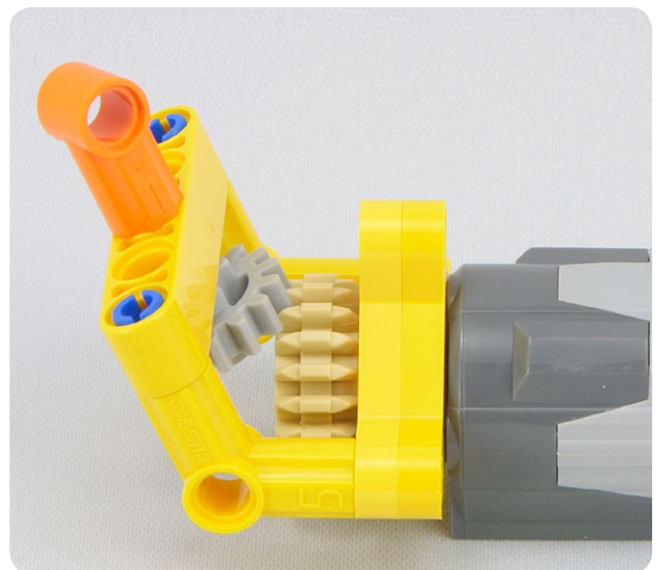
#123



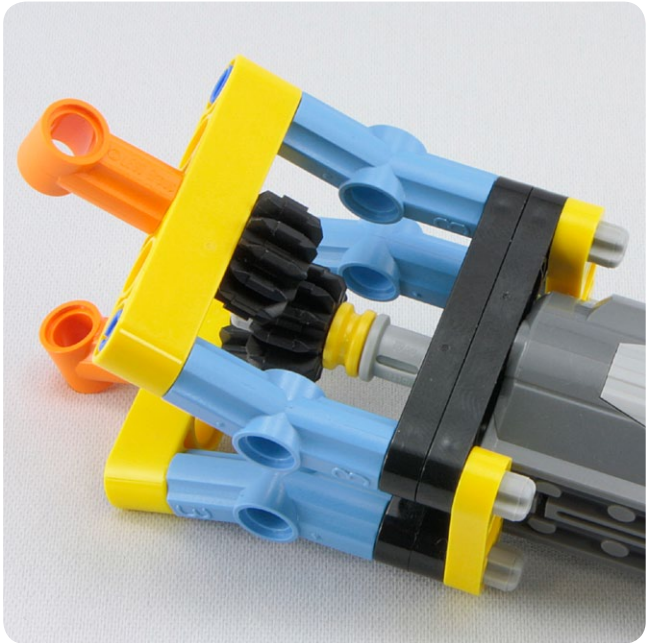
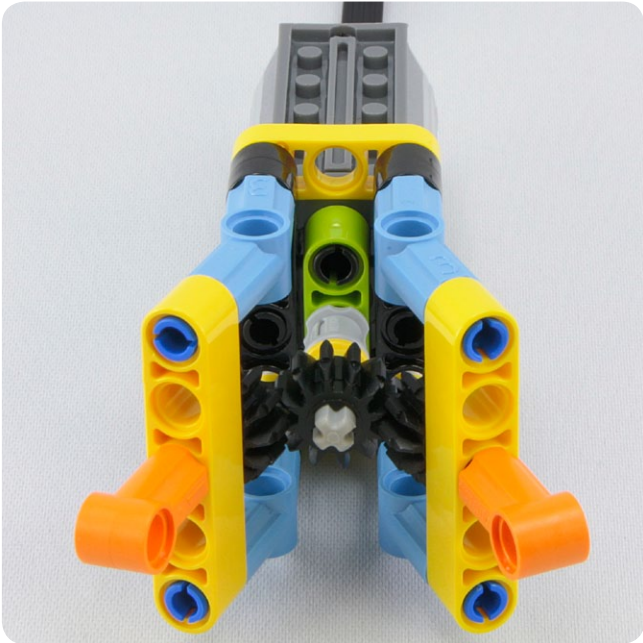
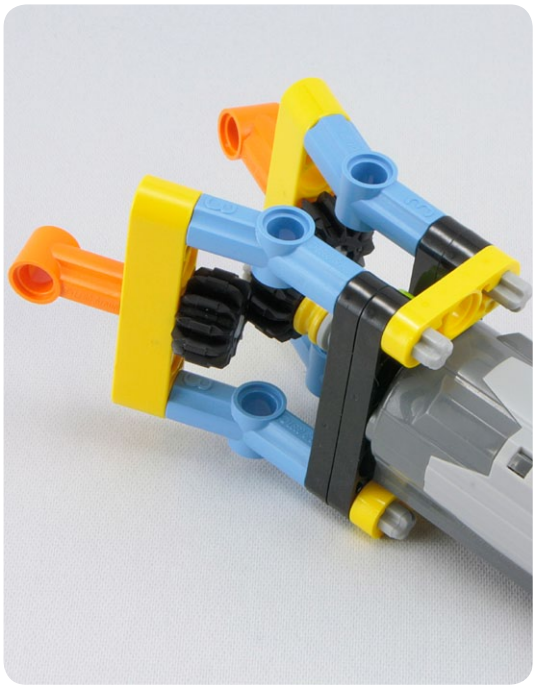
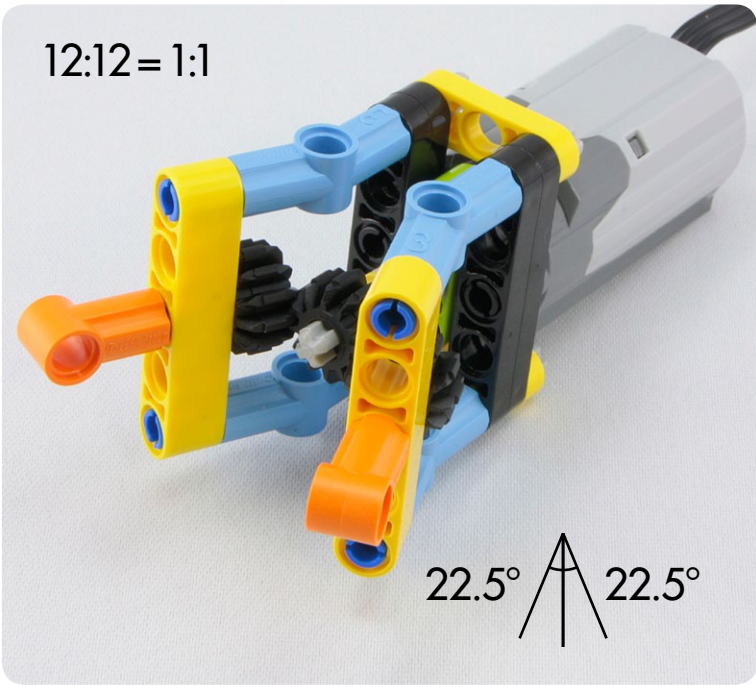
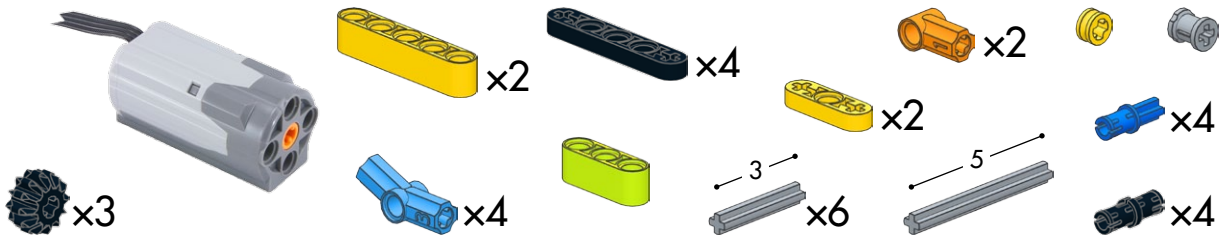
[illegible]

5

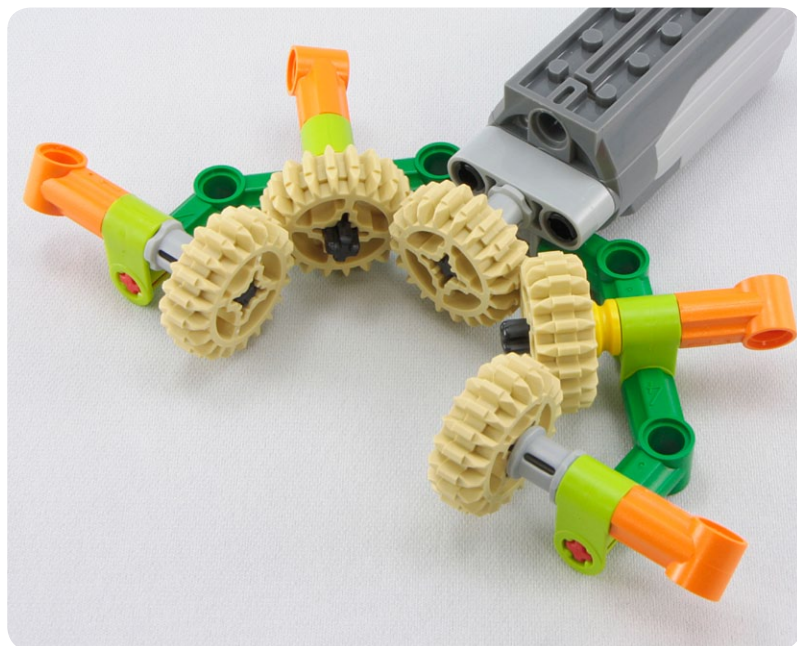
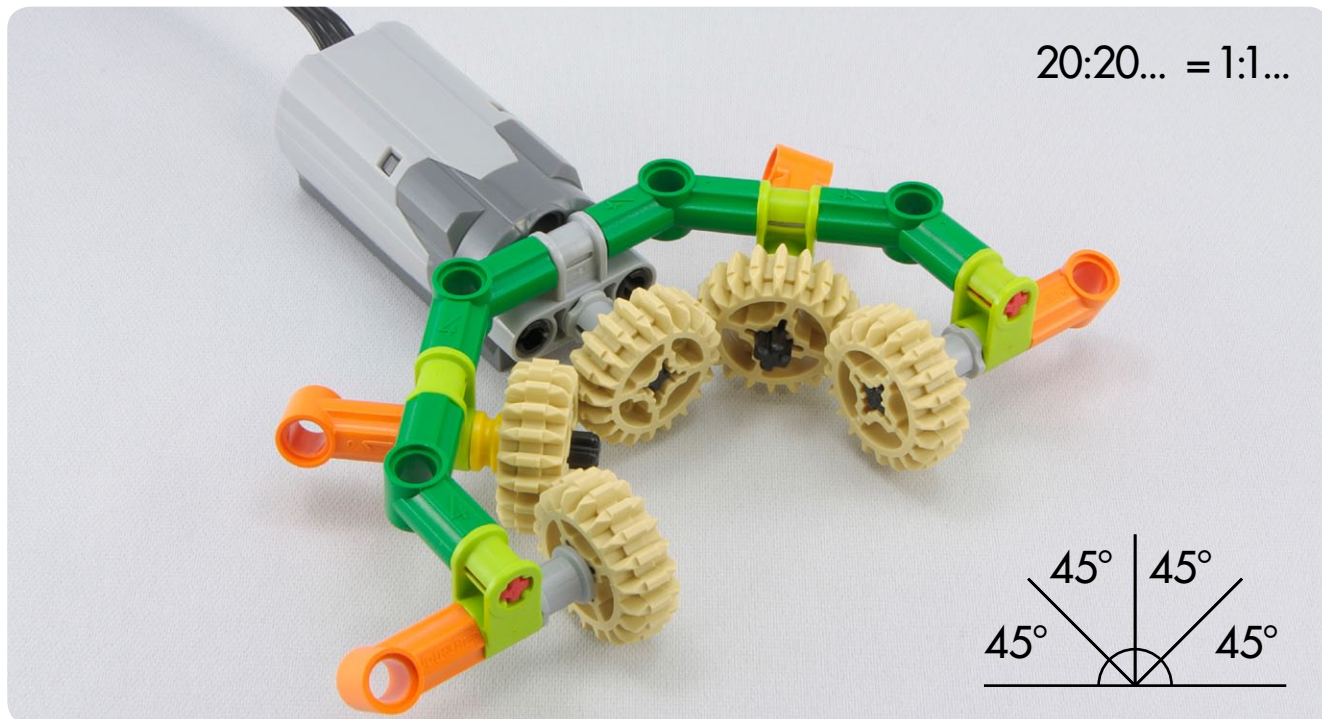
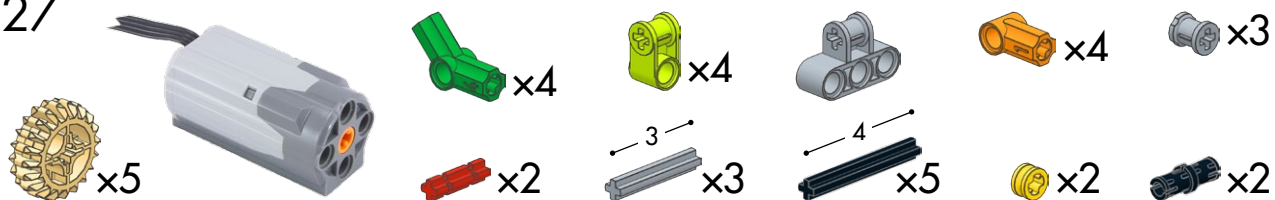
1 grey motor, 1 tan gear, 1 grey gear, 1 yellow 1x5 Technic beam, 1 yellow 1x3 Technic beam, 2 yellow 1x3 Technic beams, 2 yellow 1x2 Technic connectors, 2 grey 1x3 Technic axles, 2 red 1x2 Technic pins, 2 blue 1x2 Technic pins, 2 black 1x2 Technic pins

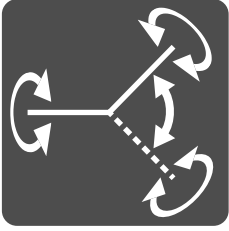


#126



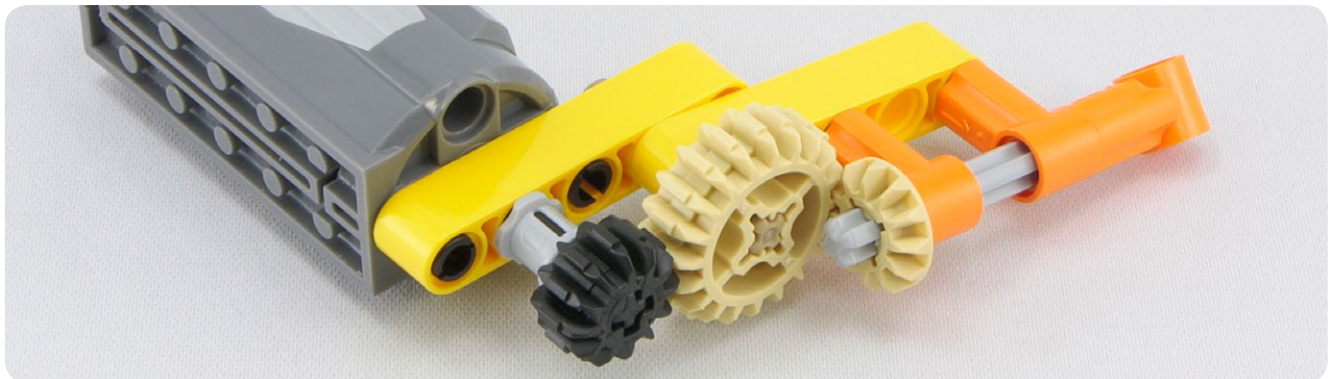
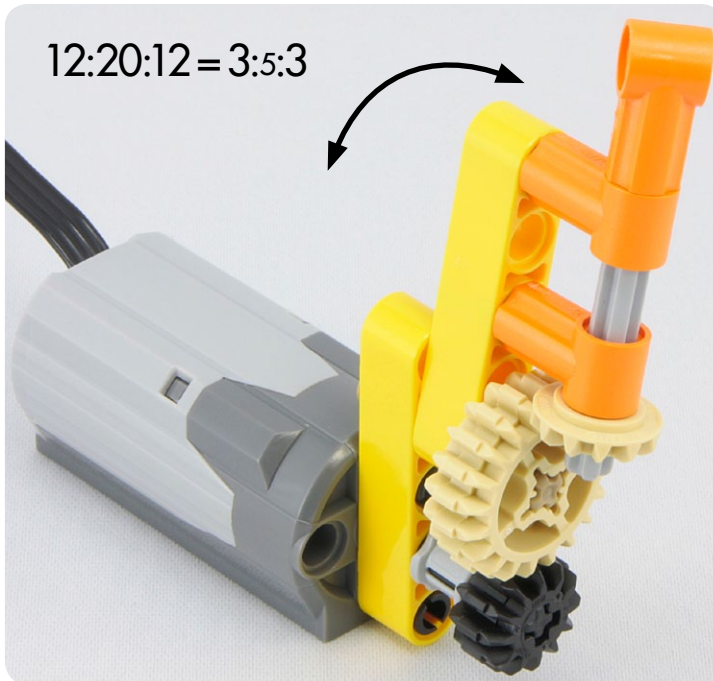
#127



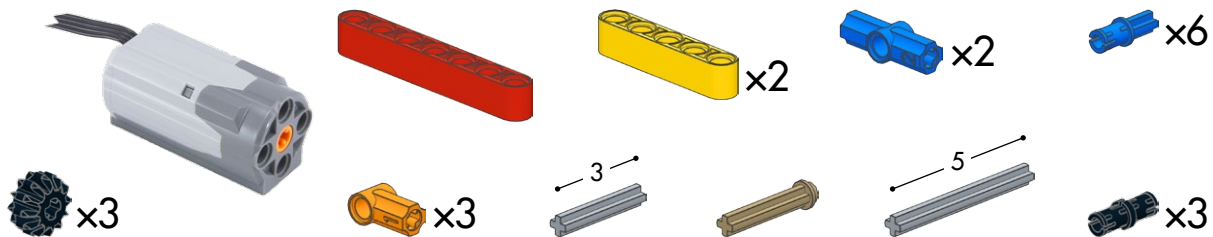


Changing the angle of the axle freely

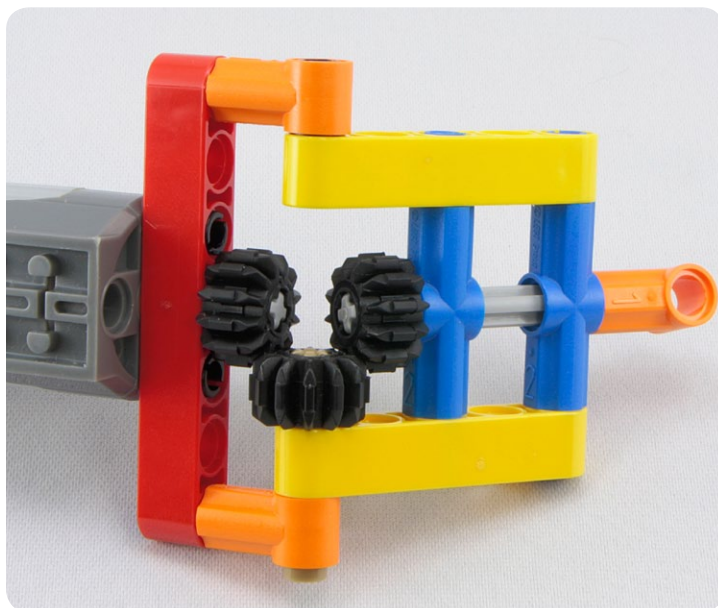
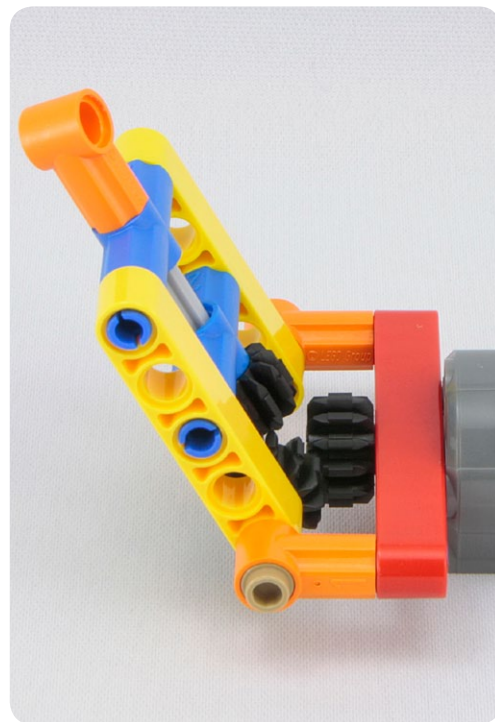
#128



#129

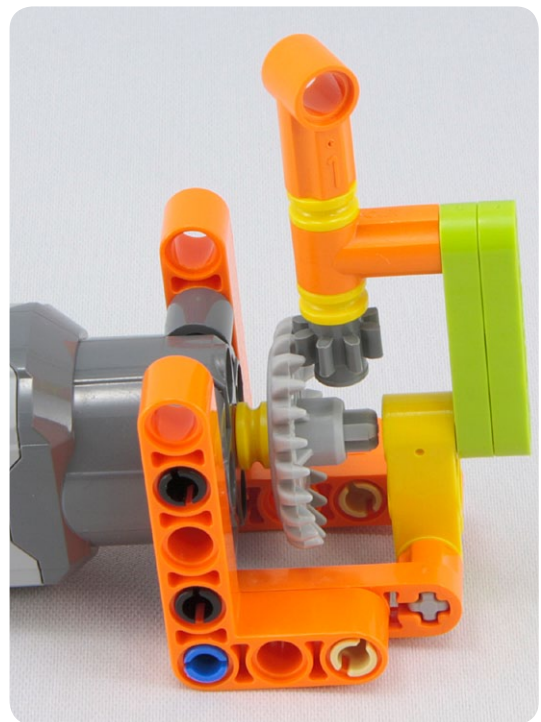


12:12:12 = 1:1:1

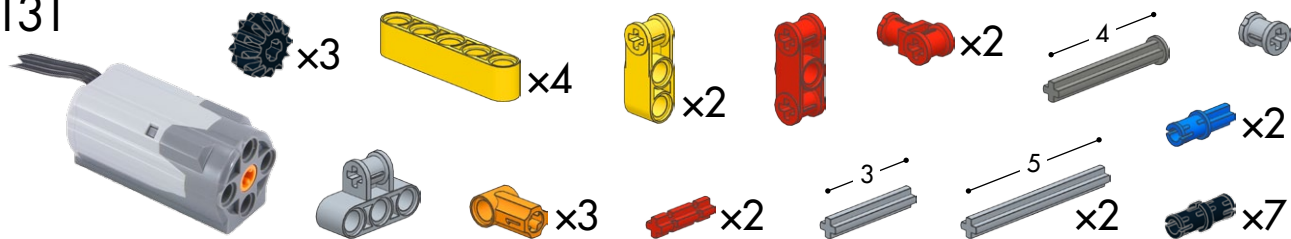


#130

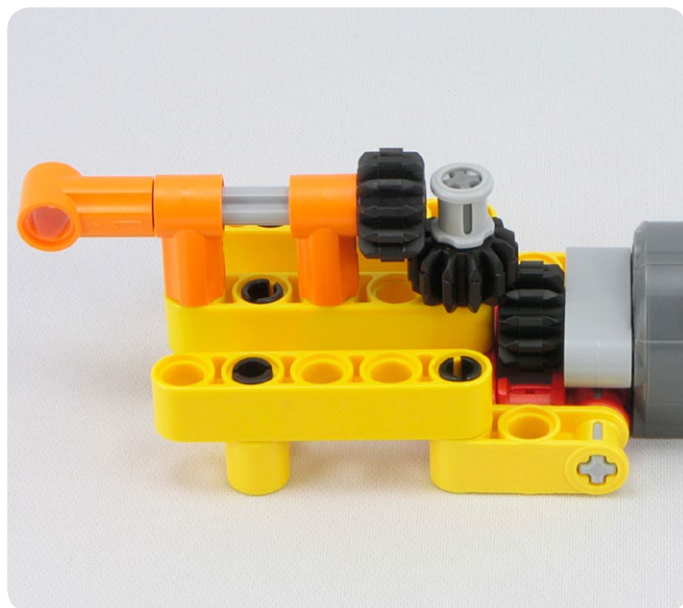
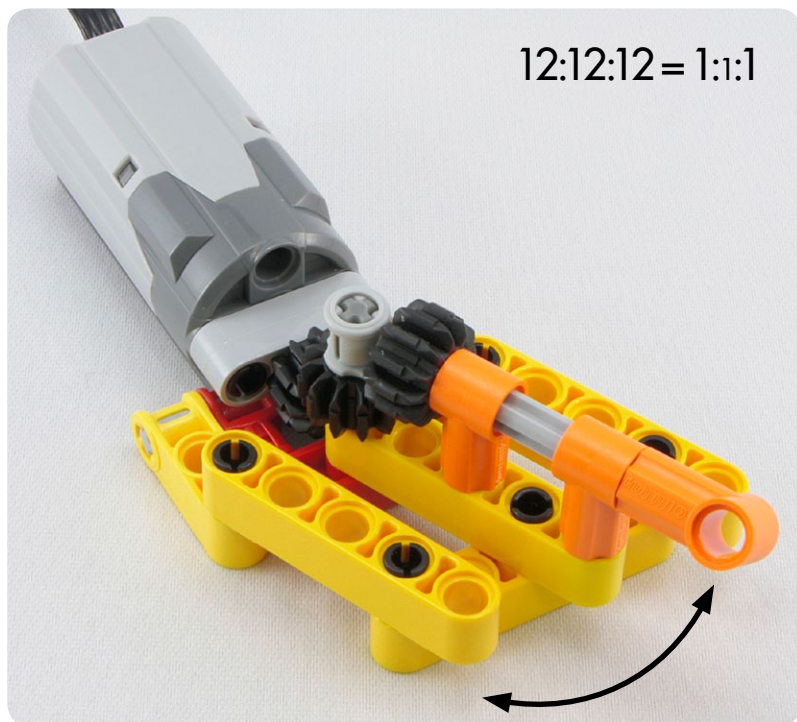
1 grey motor, 1 grey gear, 1 grey connector, 2 orange 1x3 Technic bricks, 1 yellow 1x3 Technic brick, 2 orange 1x3 Technic bricks with a hole, 2 green 1x3 Technic bricks, 2 tan pins, 2 blue pins, 2 grey pins of length 3, 4 grey pins of length 4, 2 orange pins, 1 red pin, 3 yellow pins, and 4 black pins.



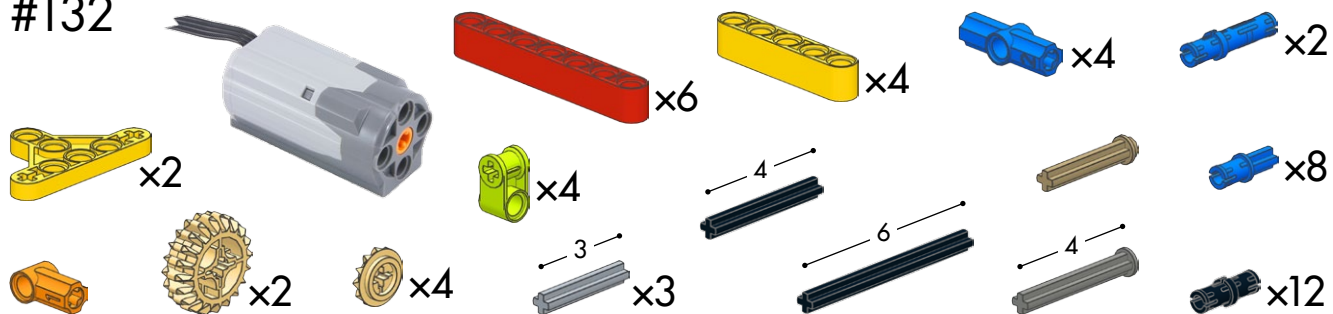
#131



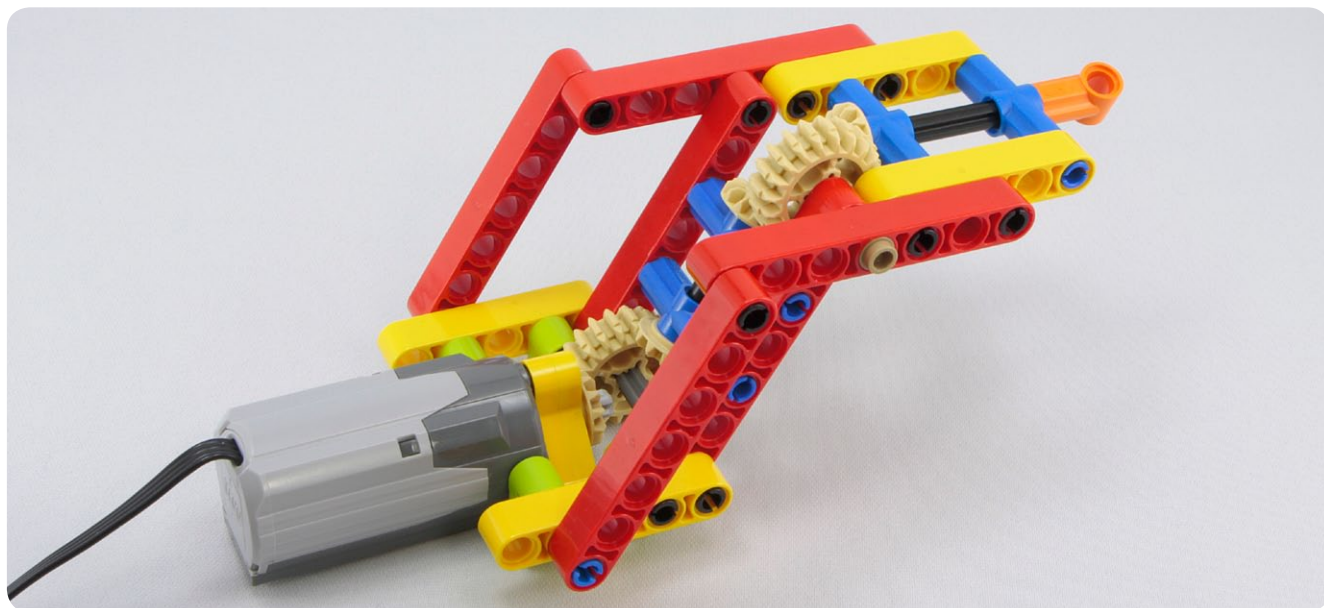
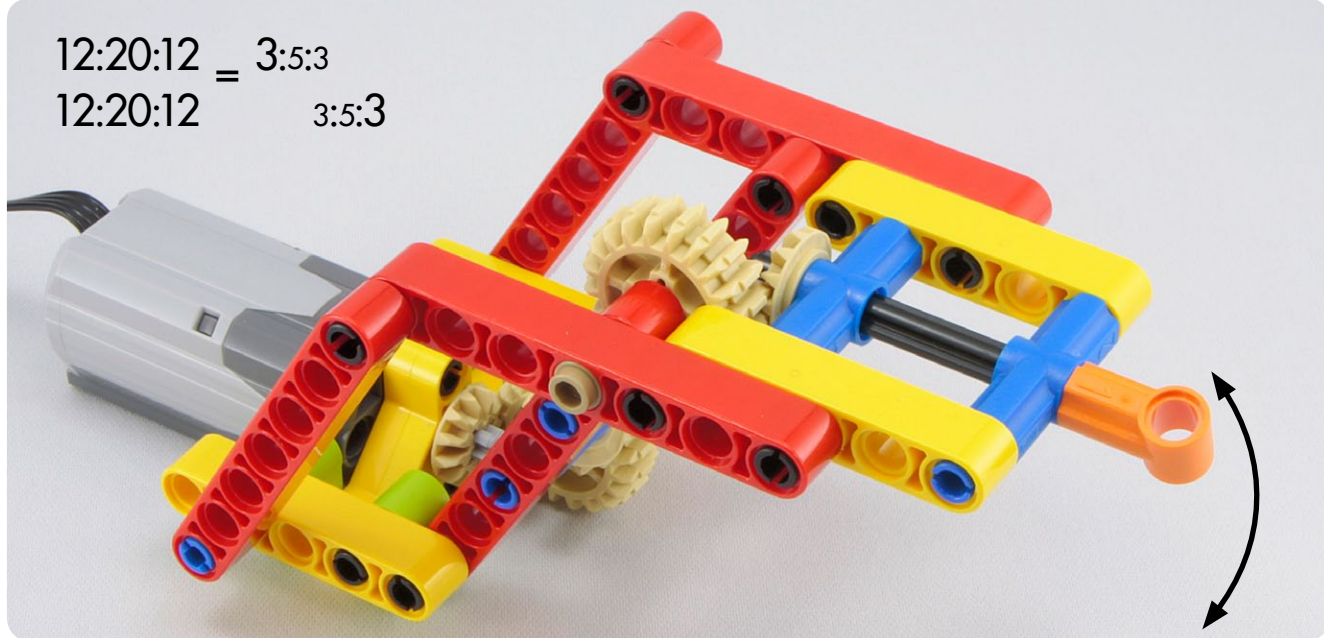
12:12:12 = 1:1:1

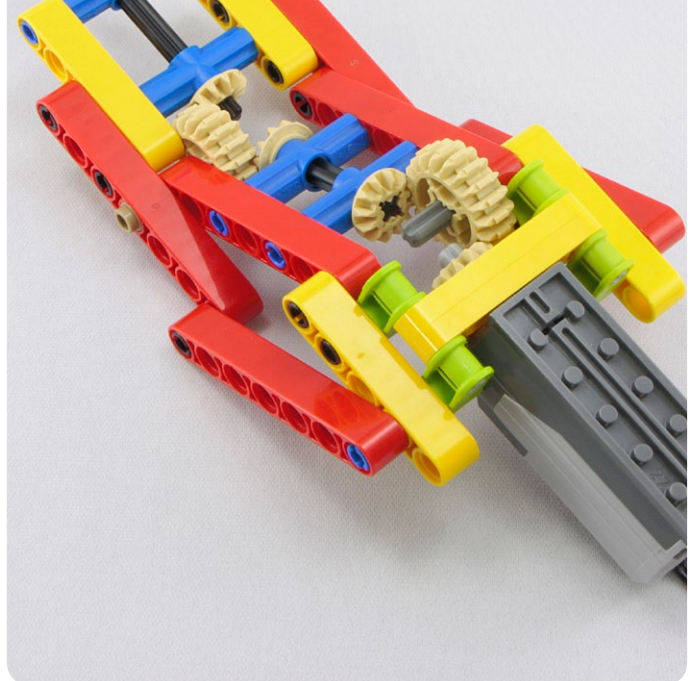
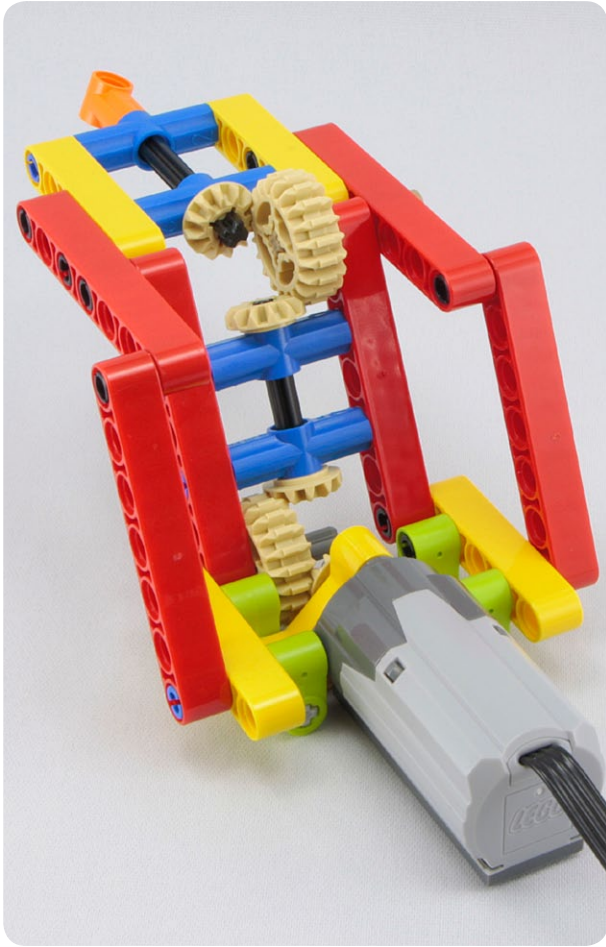


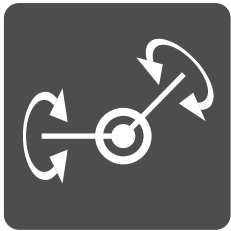
#132



12:20:12 = 3:5:3
12:20:12 3:5:3

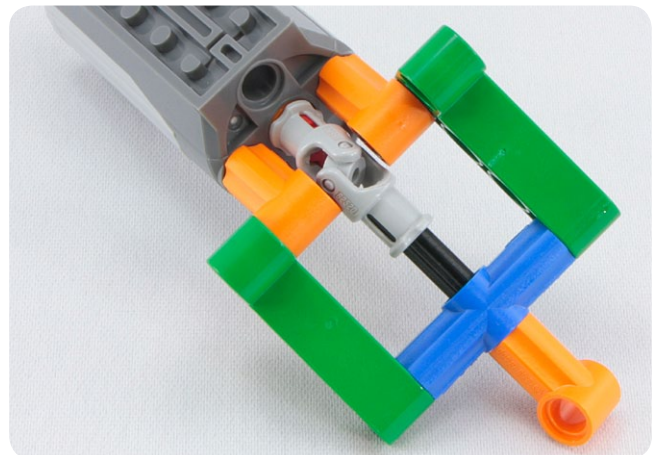
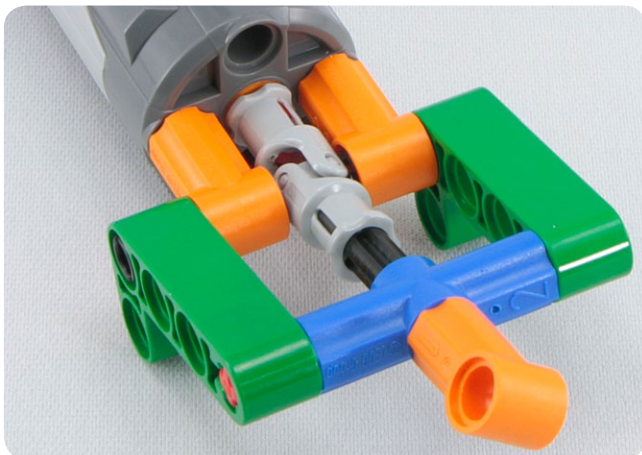
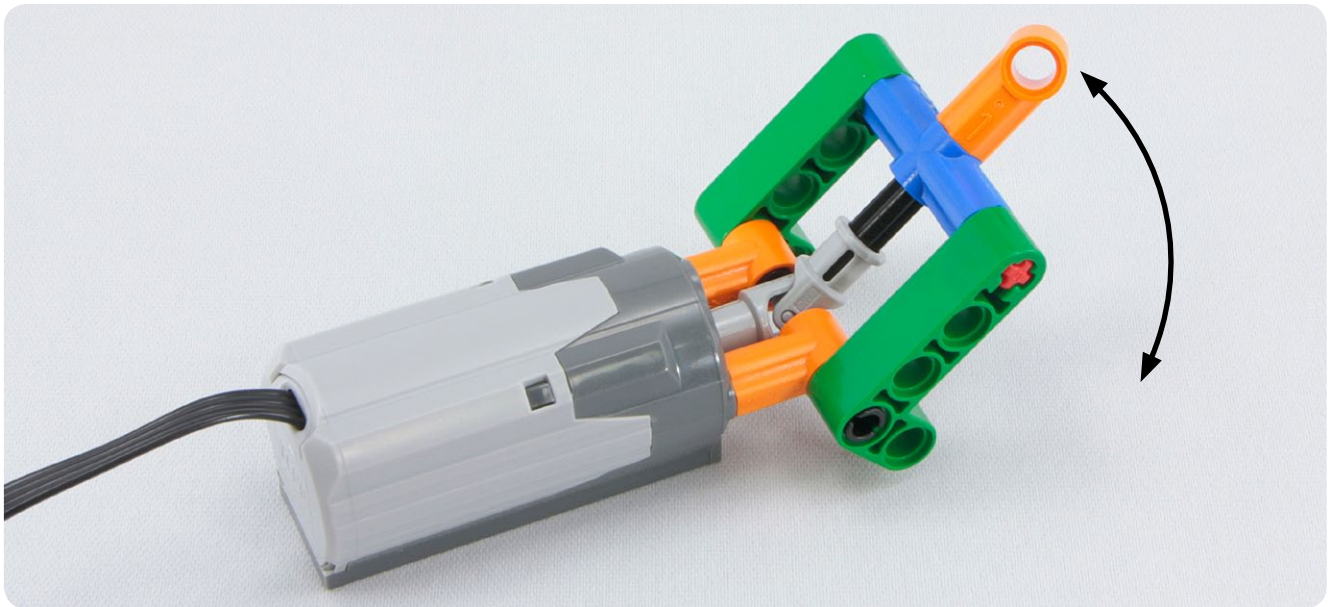
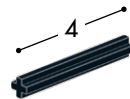
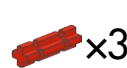
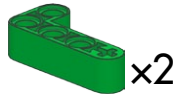




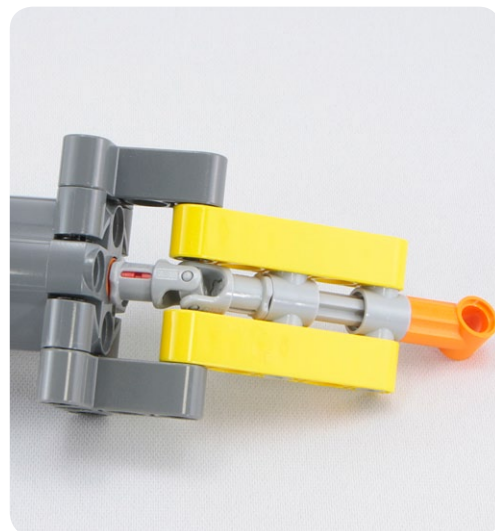
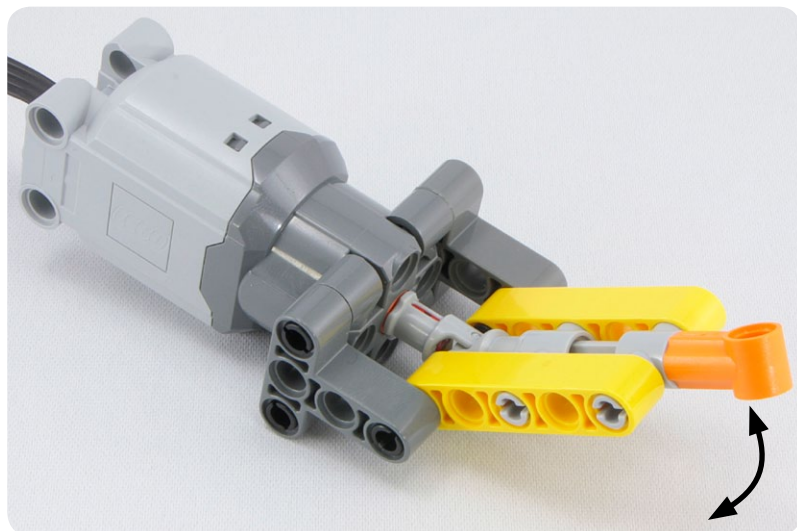
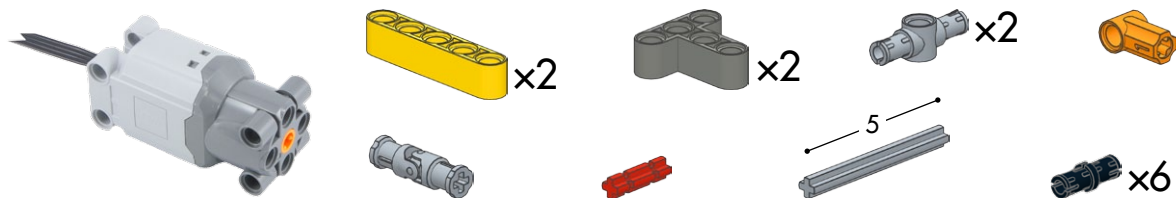


Universal joints

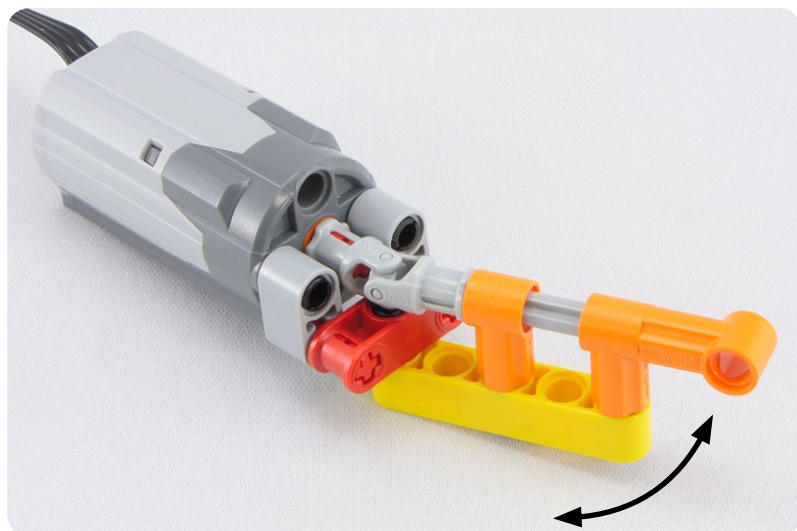
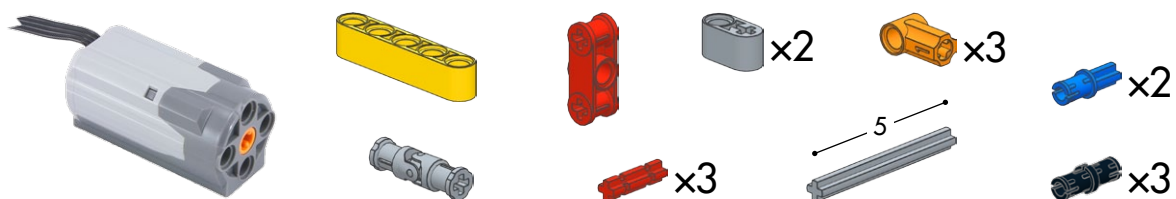
#133



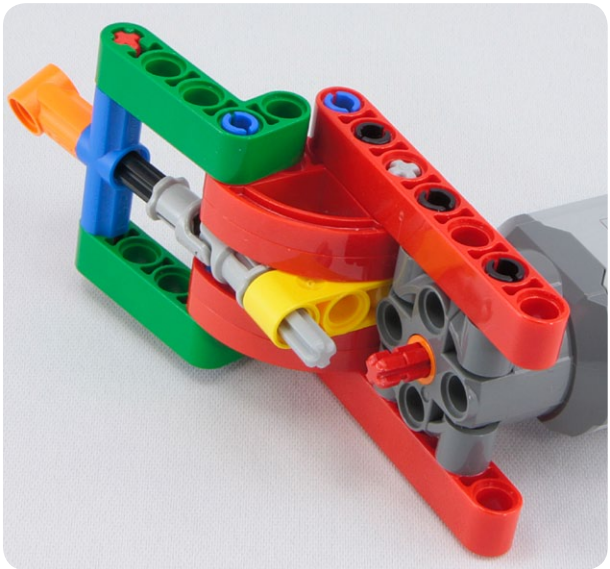
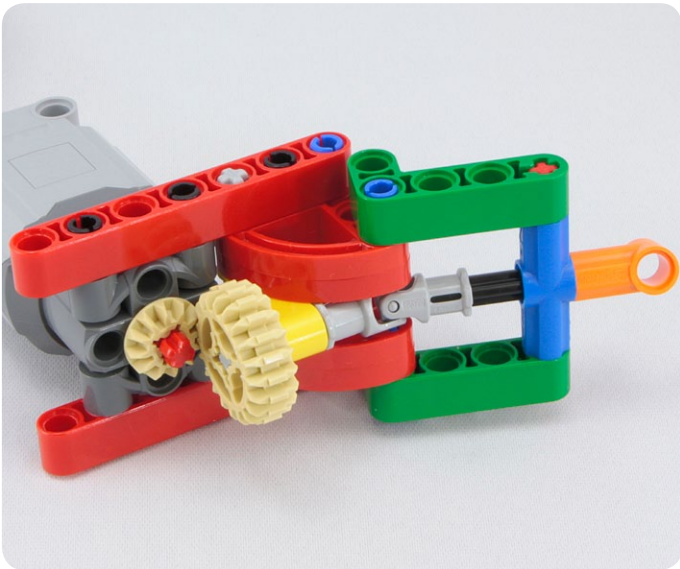
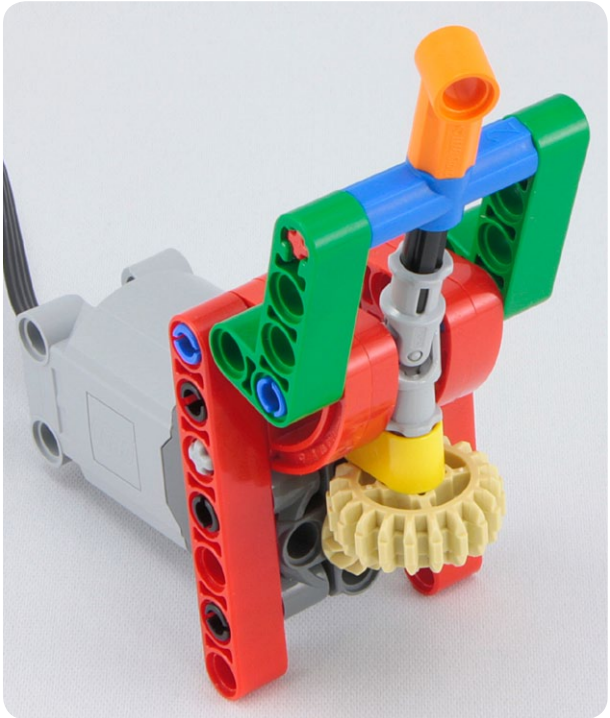
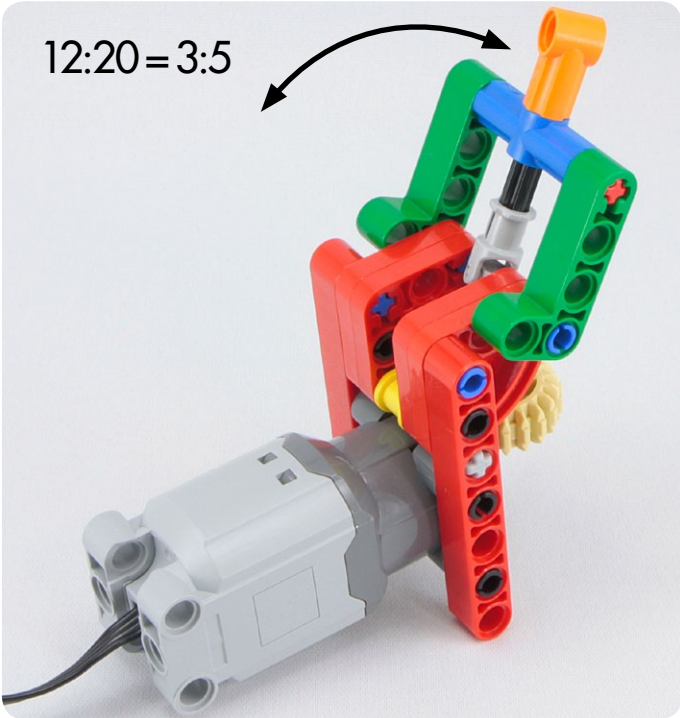
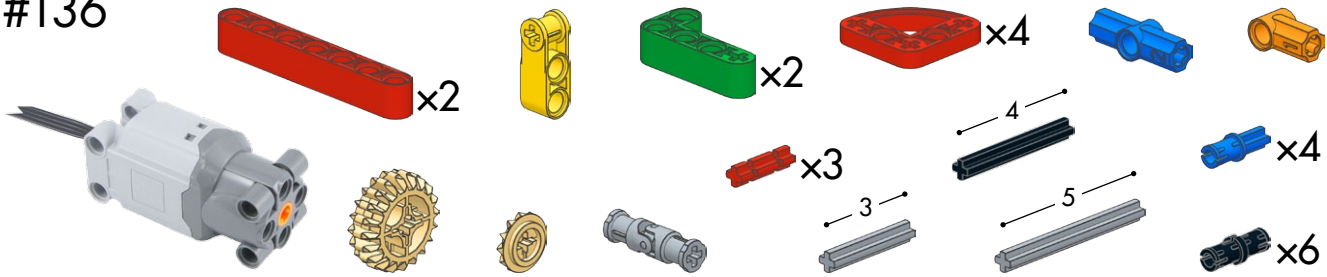
#134



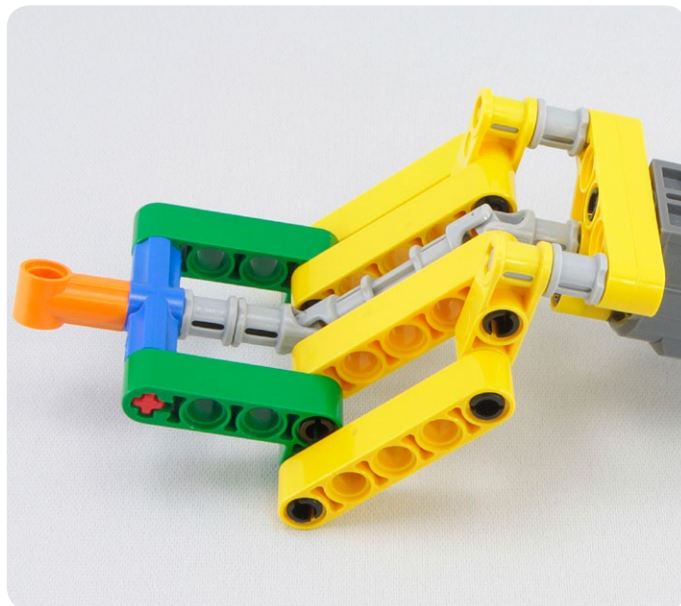
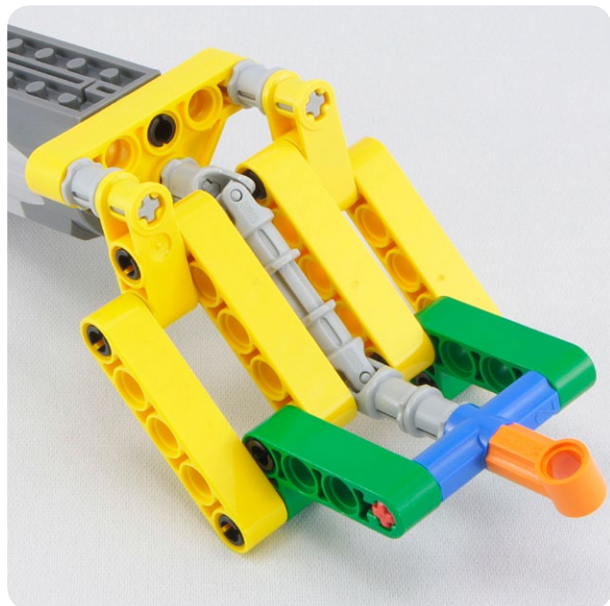
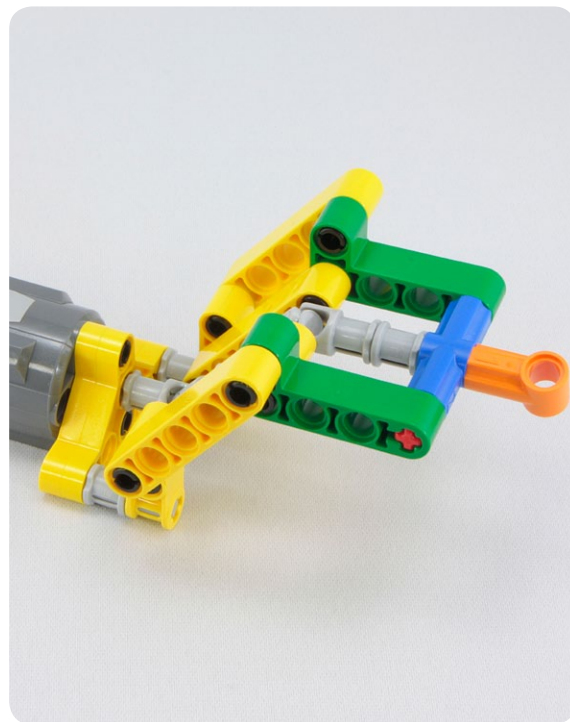
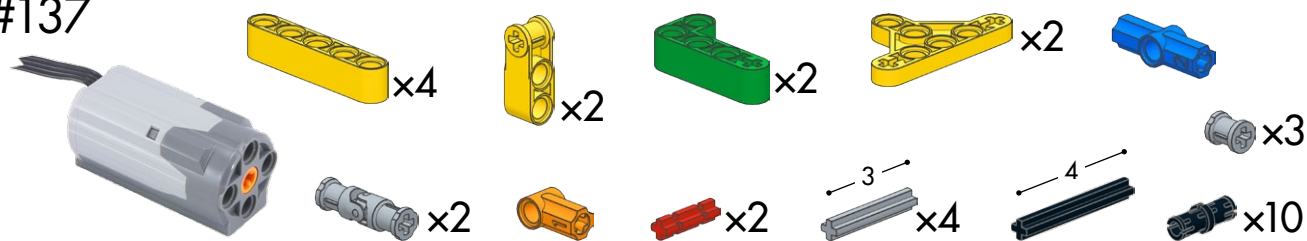
#135

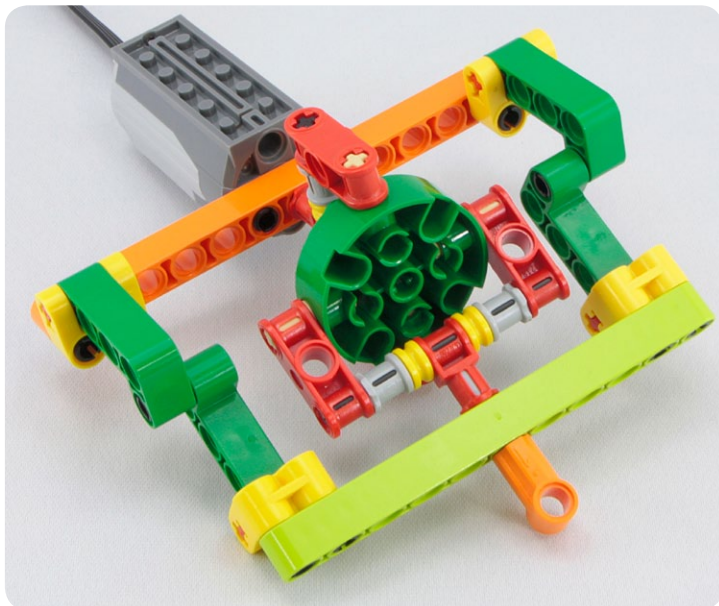
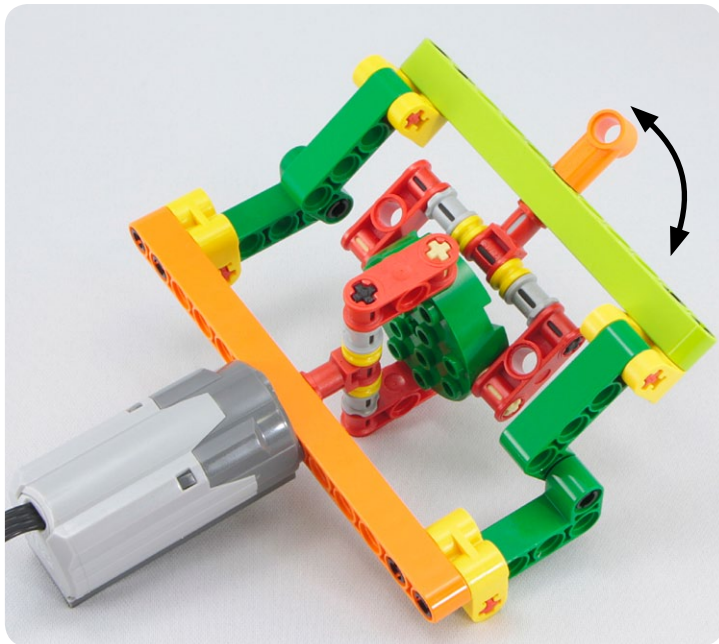


#136

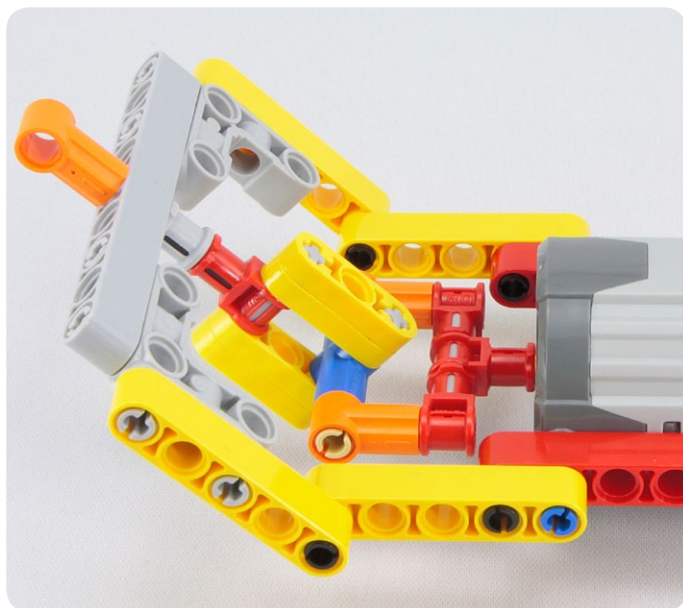
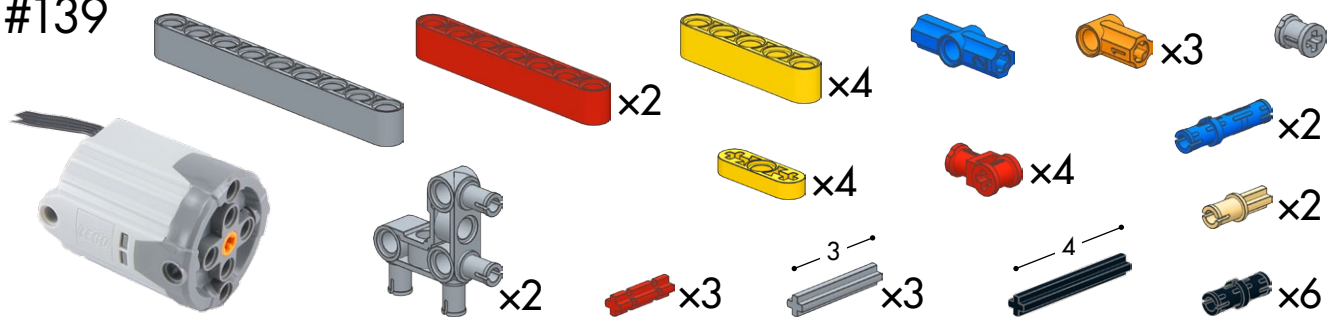


#137

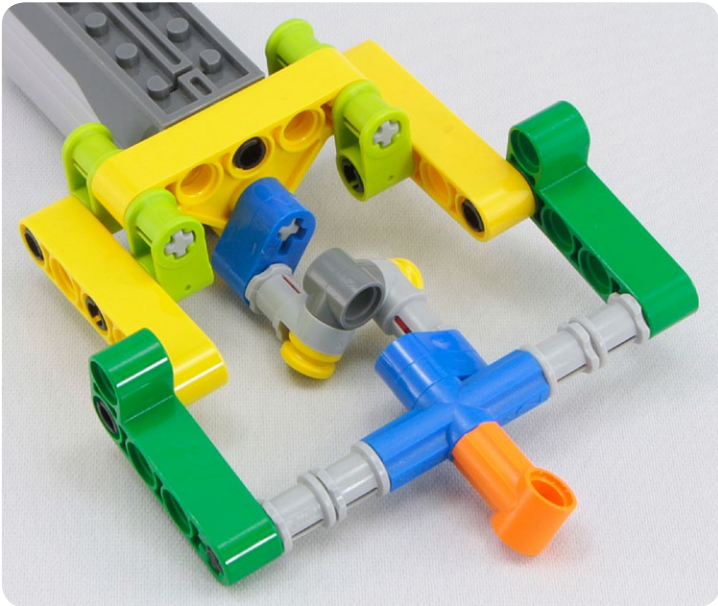
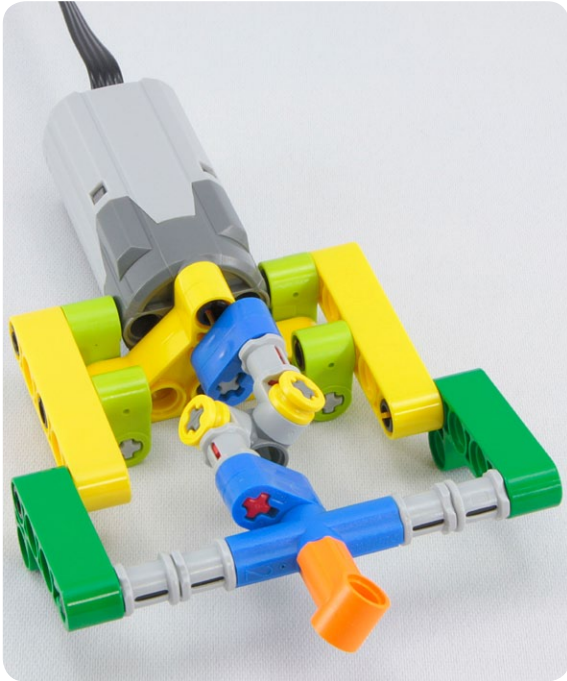
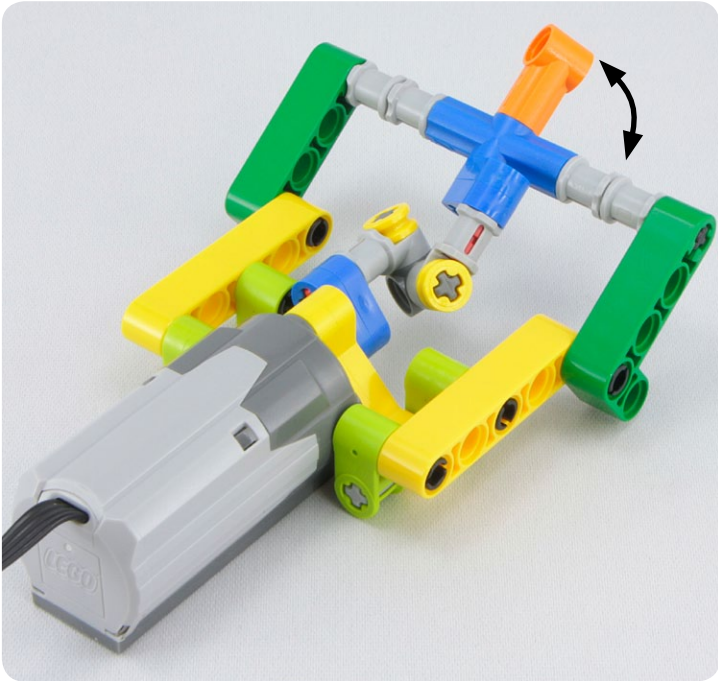
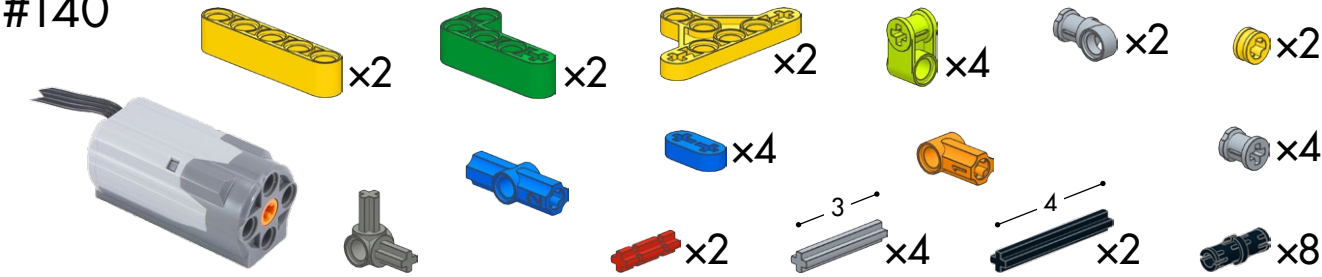


[illegible]

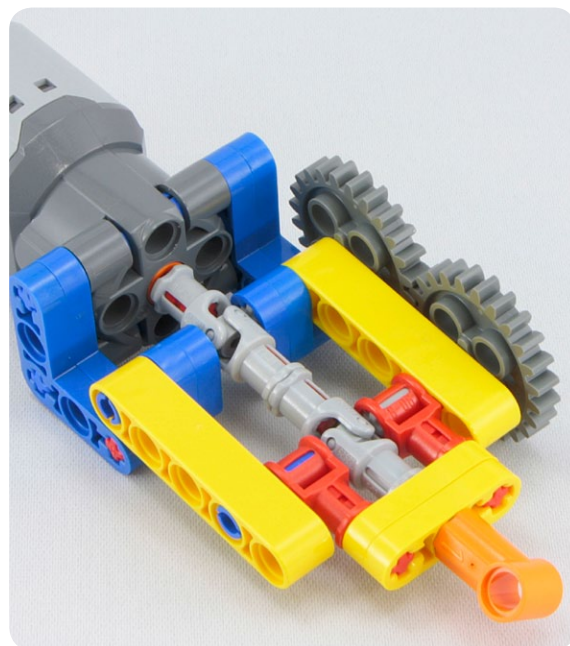
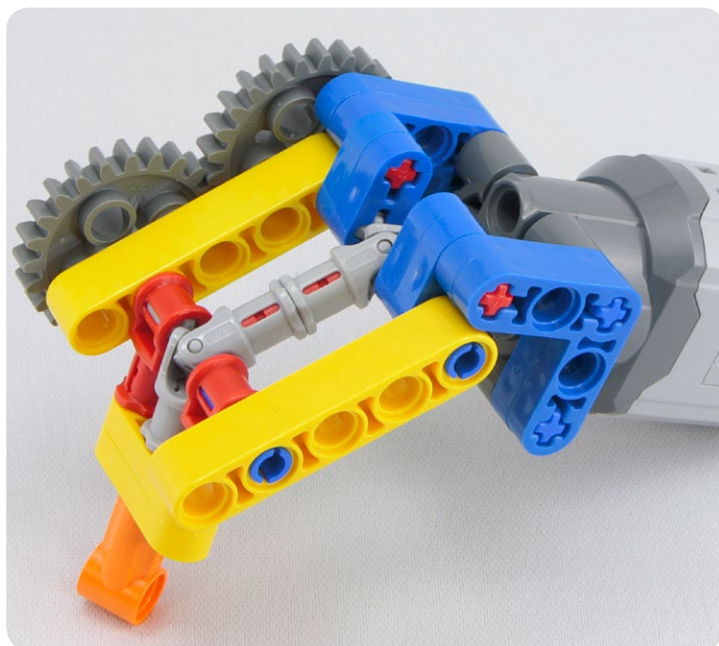
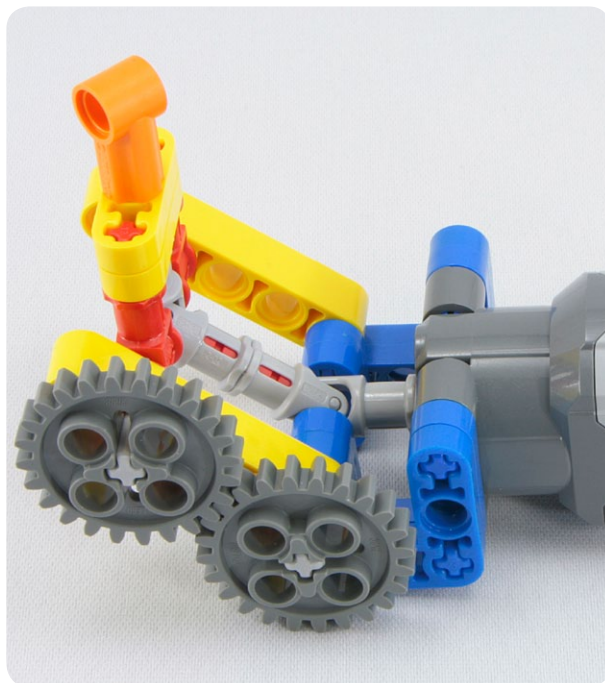
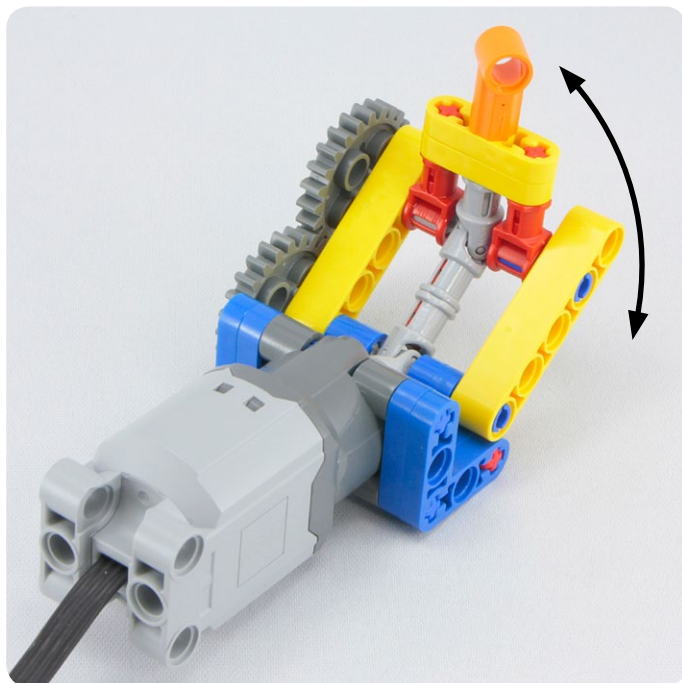
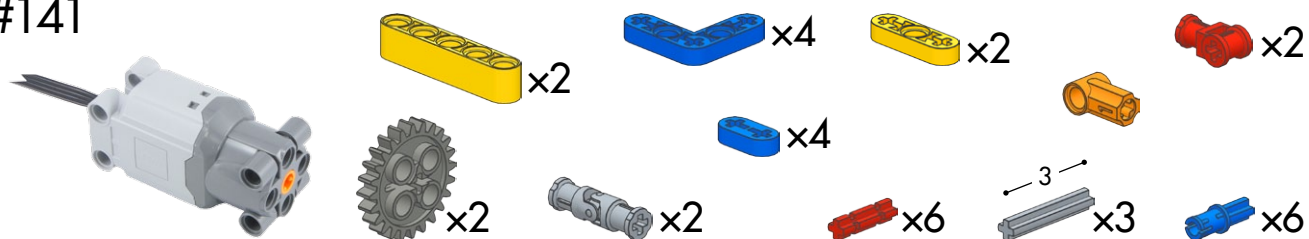
#139



#140



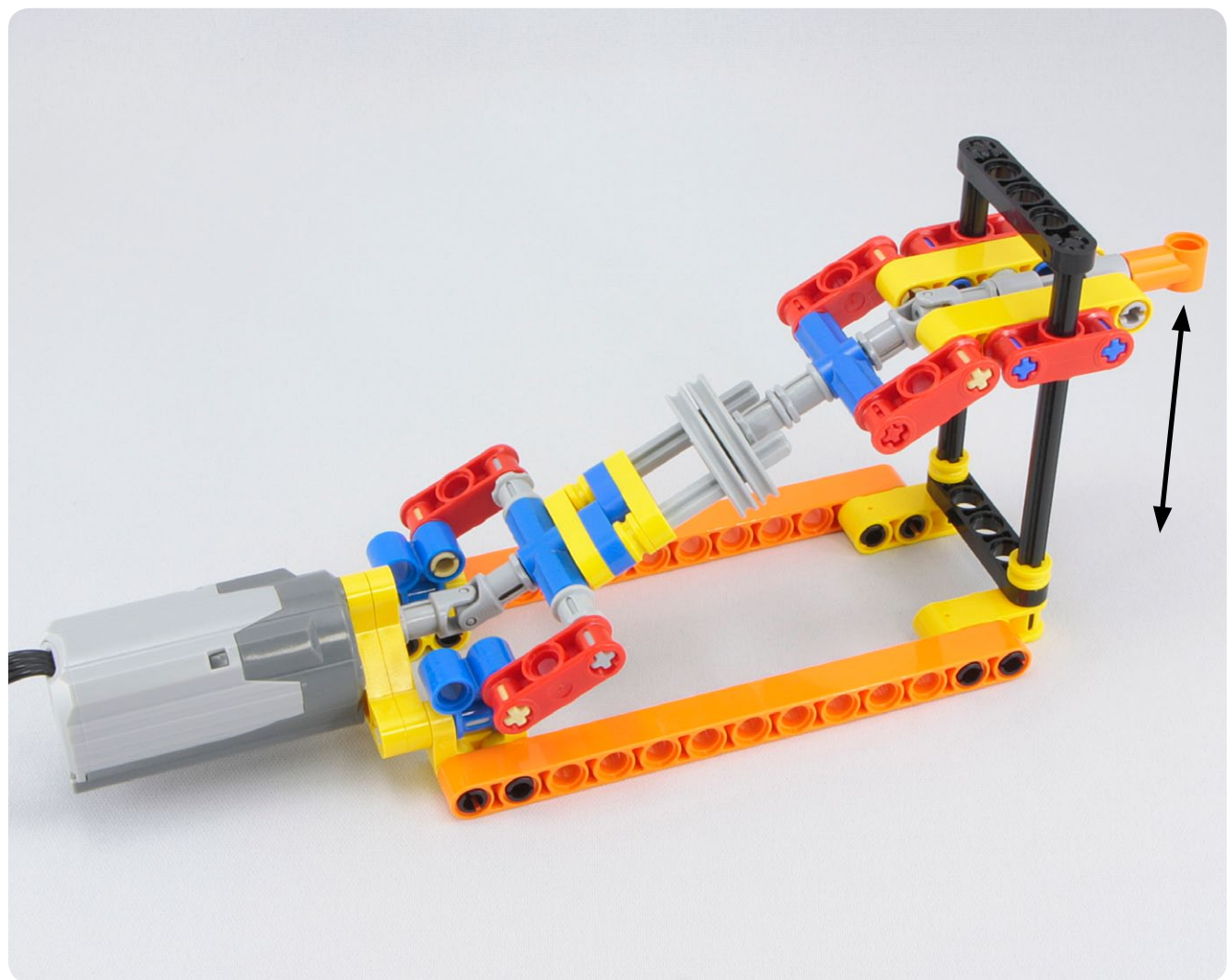
#141

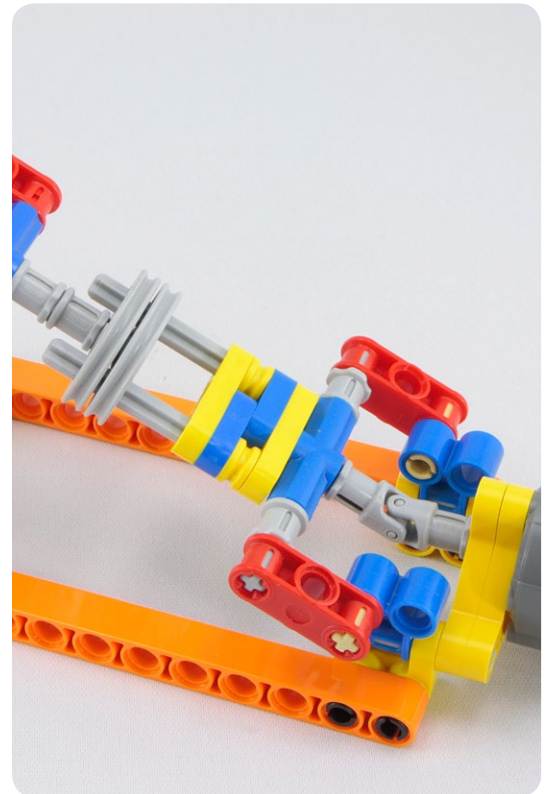
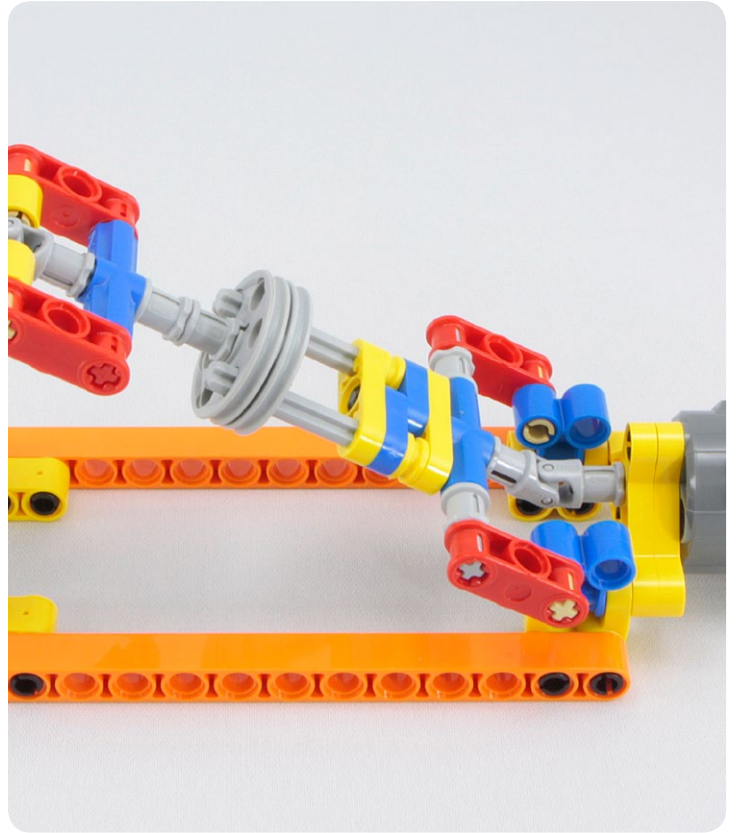


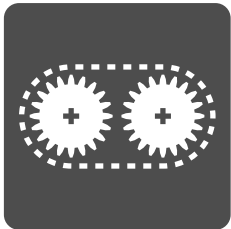
#142

This image displays the required LEGO components for step 142, arranged in rows. The parts include:

- Yellow Technic Beam 1x6: x2
- Orange Technic Beam 1x18: x2
- Grey Wheel: x2
- Red Technic Pin Long: x6
- Yellow Technic Pin Long: x2
- Blue Technic Connector 3-Way: x2
- Orange Technic Connector 2-Way: x1
- Yellow Technic Pin Short: x4
- Blue Technic Connector 2-Way: x2
- Blue Technic Connector 1-Way: x4
- Yellow Technic Connector 2-Way: x2
- Yellow Technic Connector 3-Way: x2
- Blue Technic Pin Long: x2
- Black Technic Pin Long: x2
- Grey Technic Pin Short: x4
- Black Technic Pin Long: x10
- Grey Motor: 1
- Grey Technic Pin Long: x2
- Grey Technic Connector 2-Way: x2
- Red Technic Pin Long: x2
- Grey Technic Pin Short: x5 (labeled with dimension 3)
- Black Technic Pin Long: x4 (labeled with dimension 4)
- Grey Technic Pin Long: x4 (labeled with dimension 5)
- Black Technic Pin Long: x2 (labeled with dimension 10)

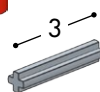
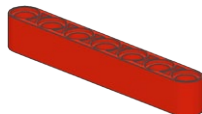




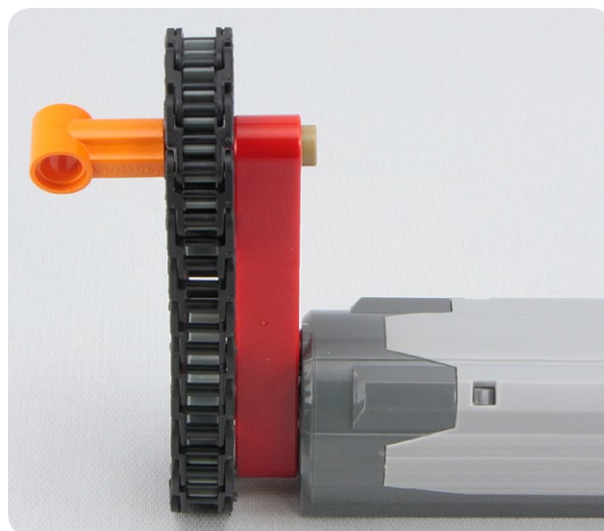


Transmitting rotation with chains and treads

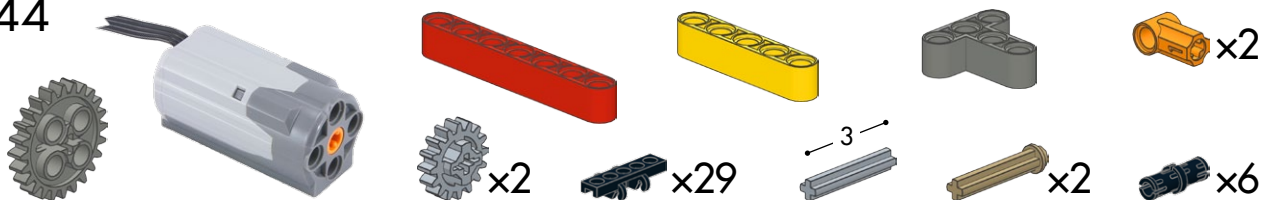
#143



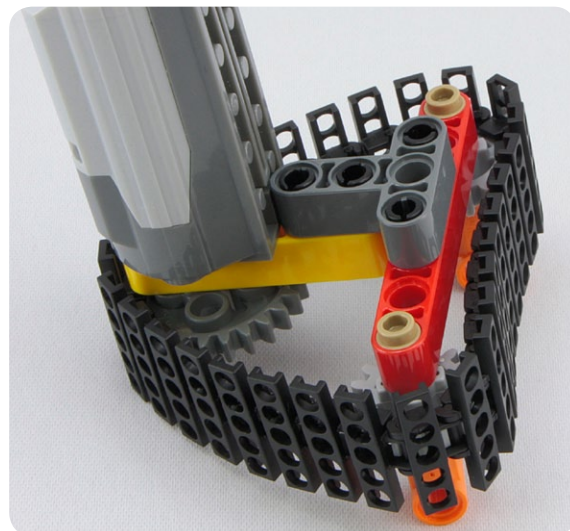
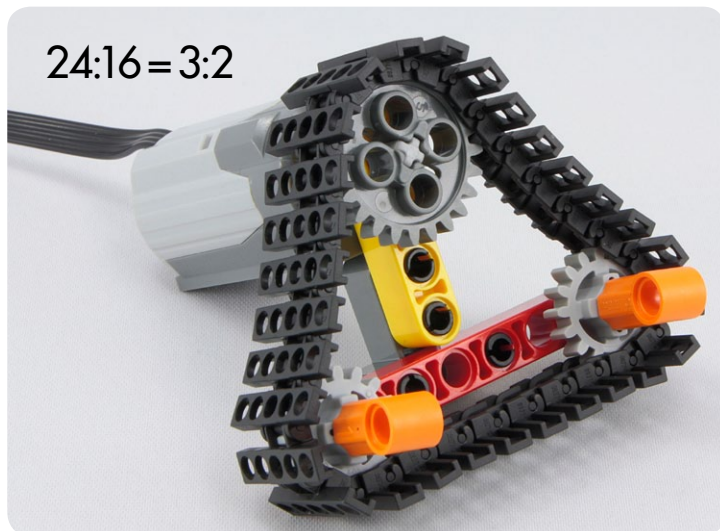
$24:24 = 1:1$



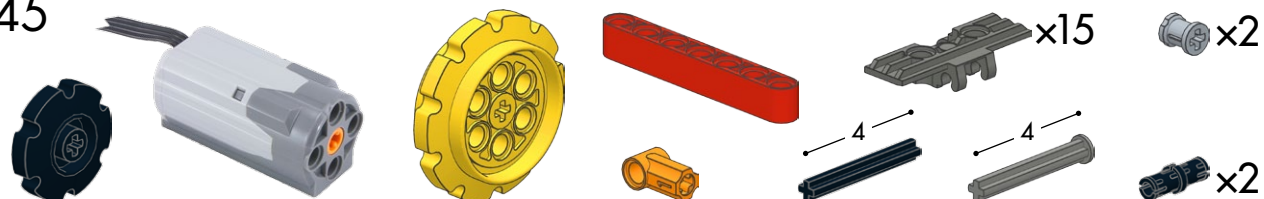
#144



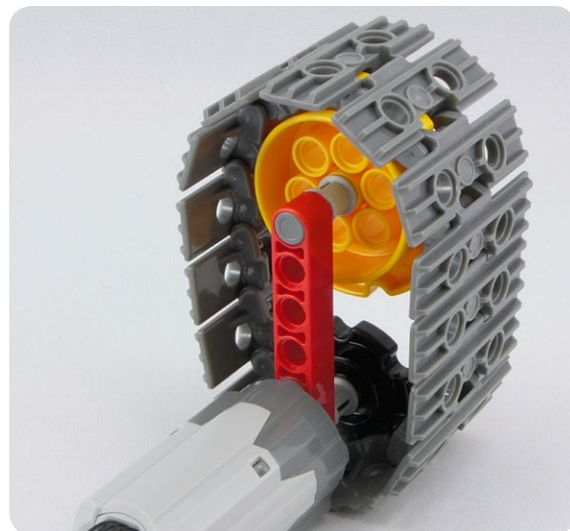
$24:16 = 3:2$



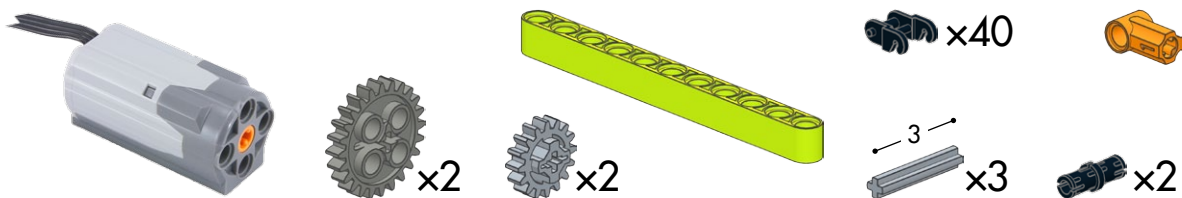
#145



$6:10 = 3:5$



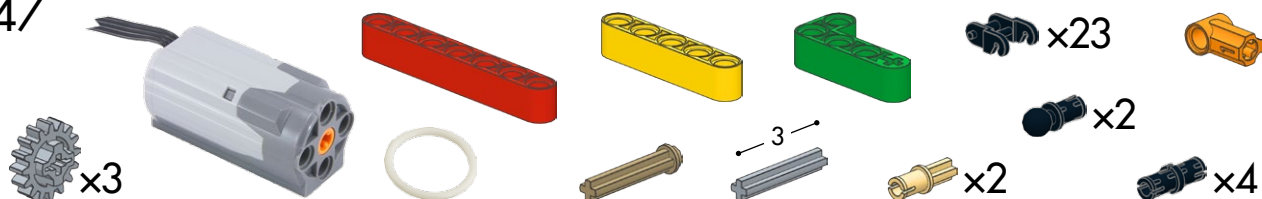
#146



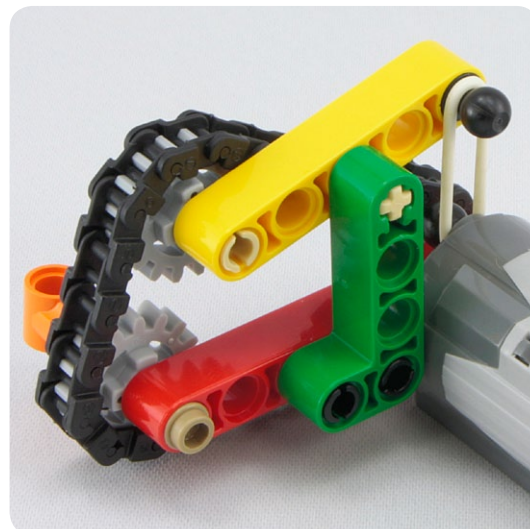
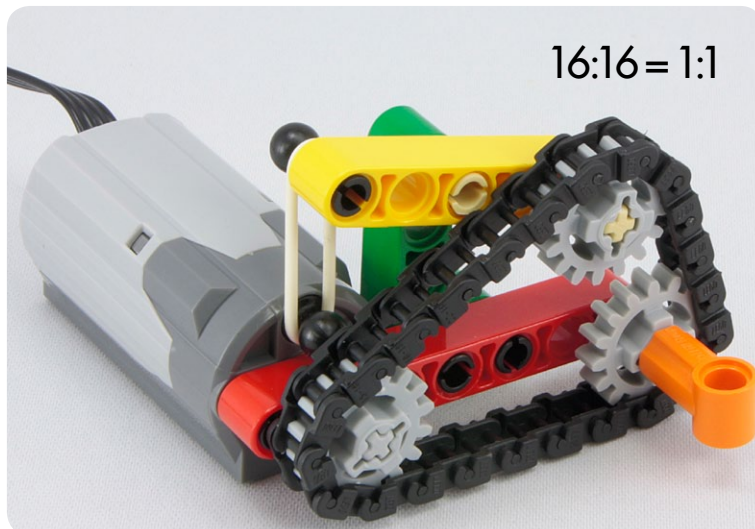
$16:24 = 4:6$
 $16:24 = 6:9$



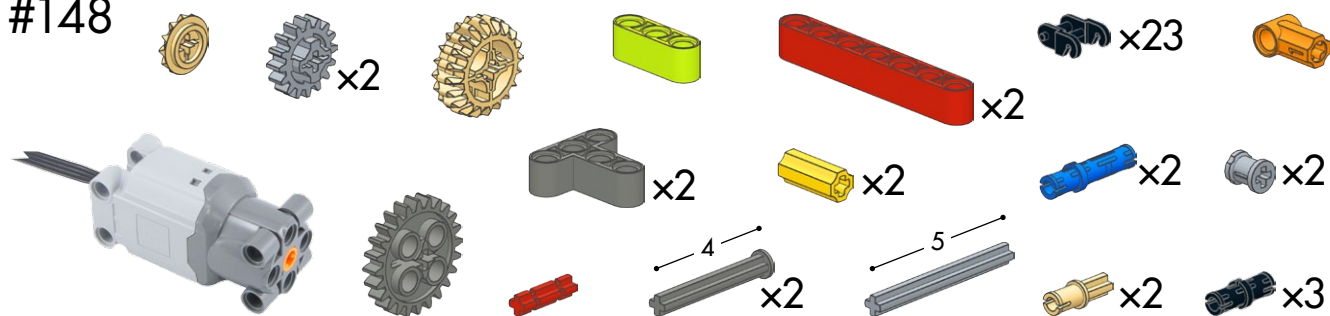
#147



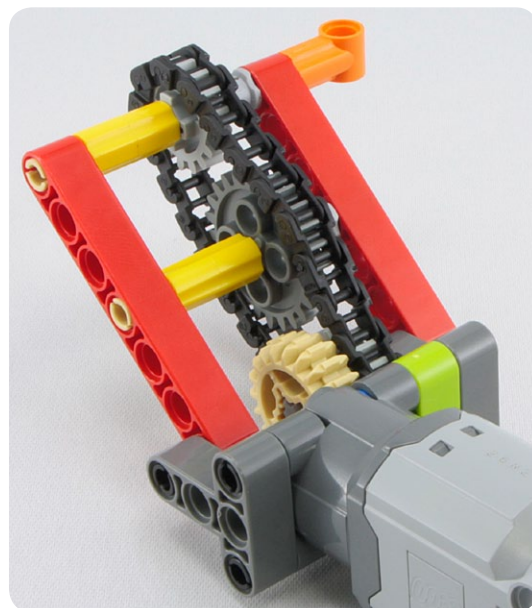
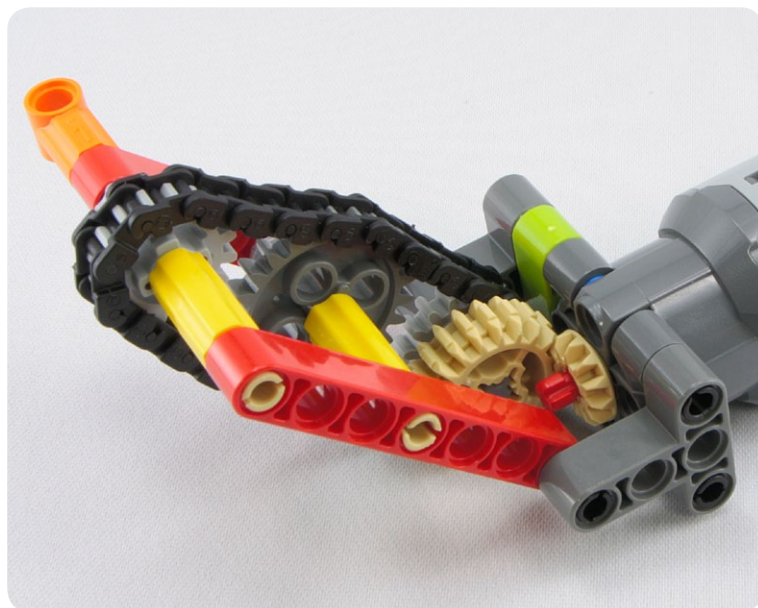
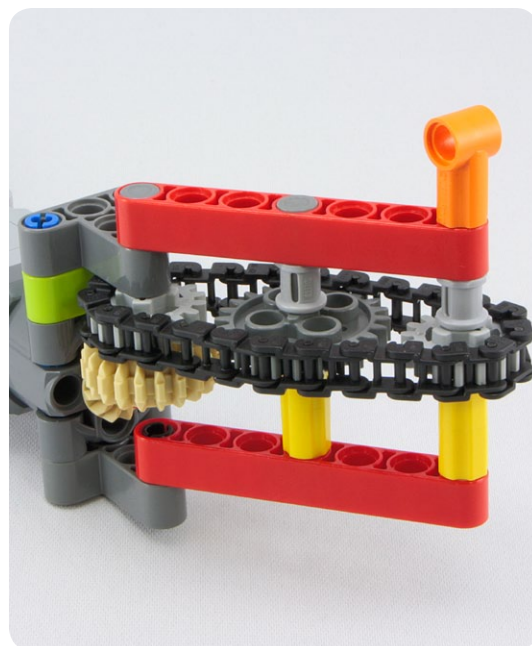
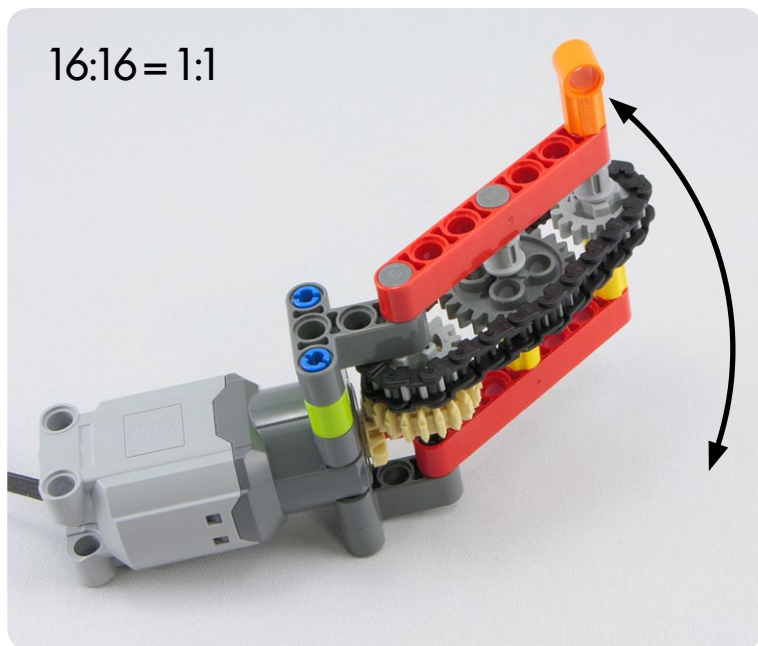
$16:16 = 1:1$

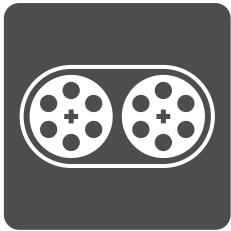


#148



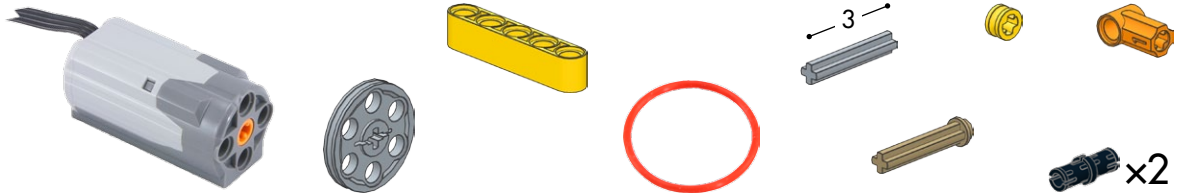
16:16 = 1:1



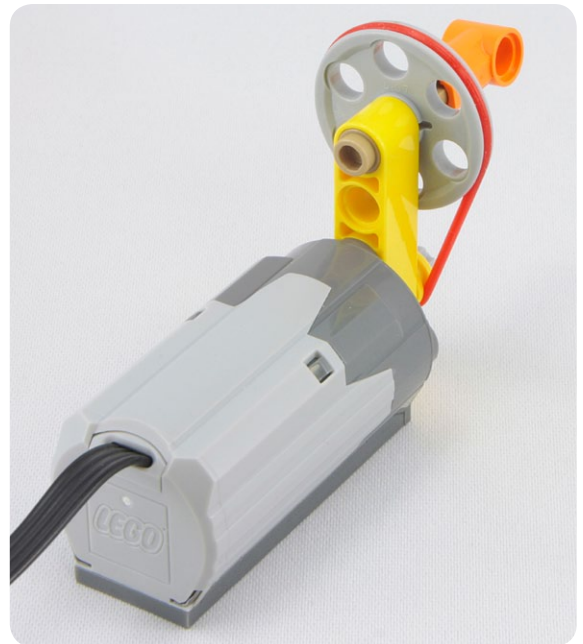
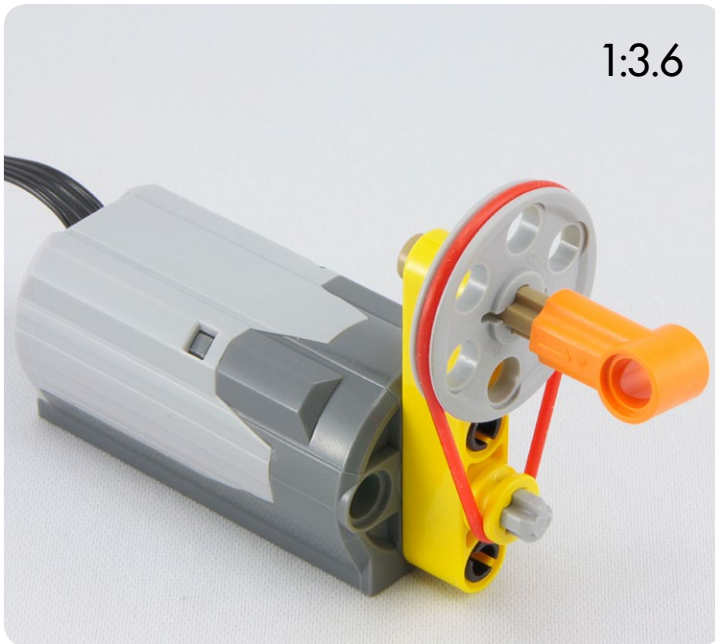



Transmitting rotation with rubber bands

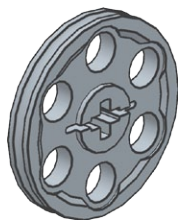
#149



1:3.6



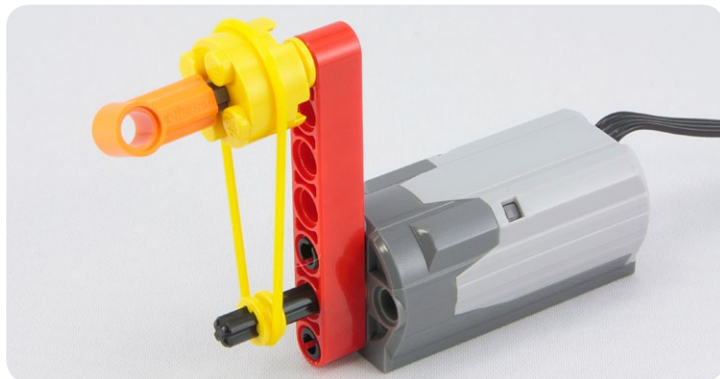
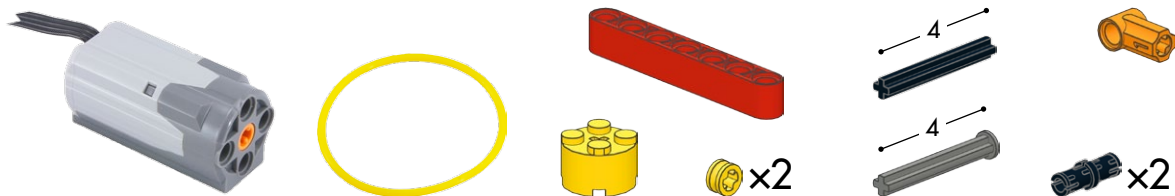
 6.2 mm



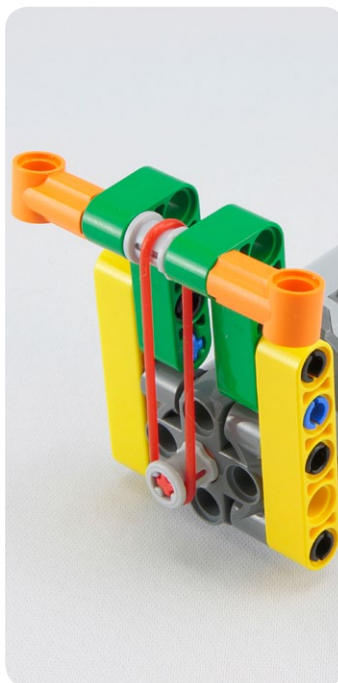
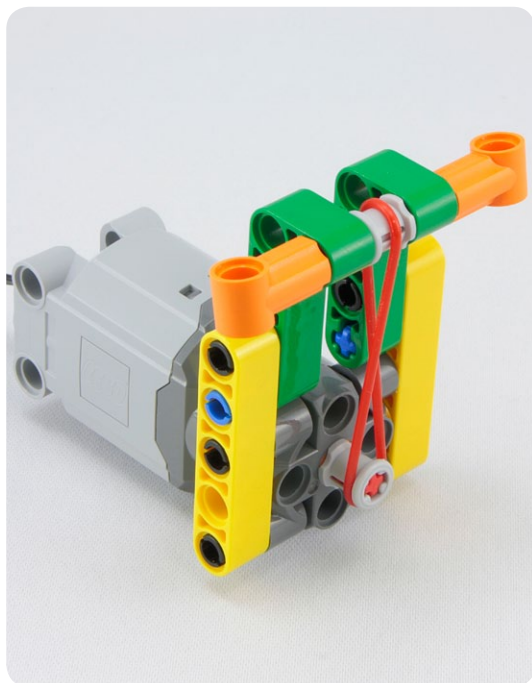
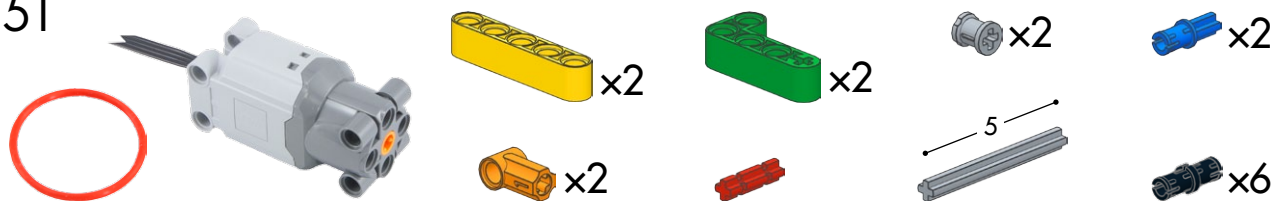
22.3 mm

$6.2:22.3 \approx 1:3.6$

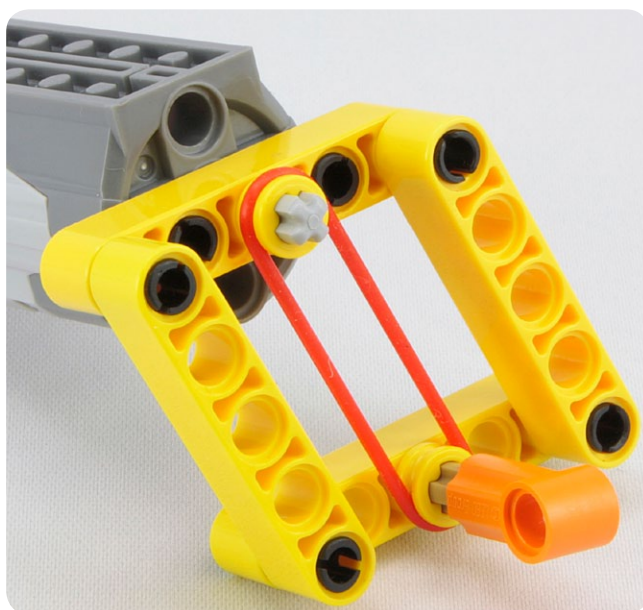
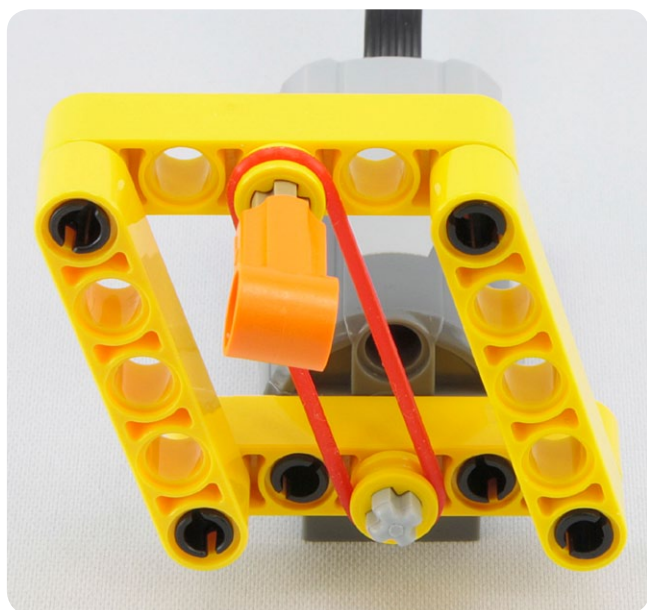
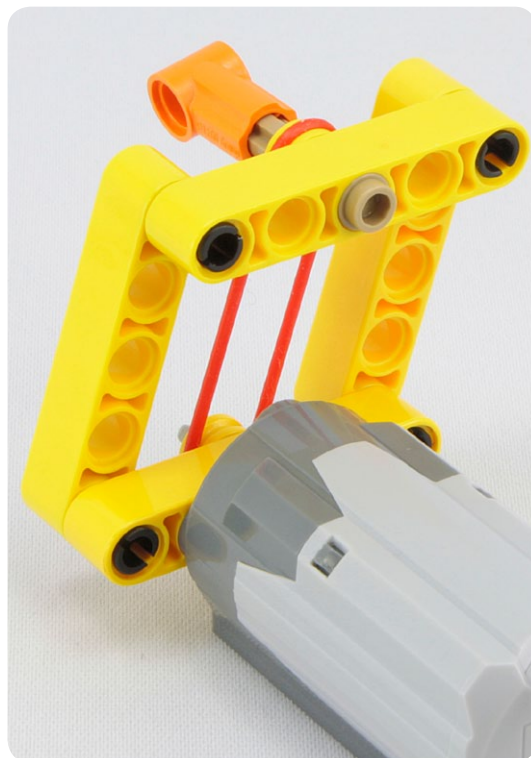
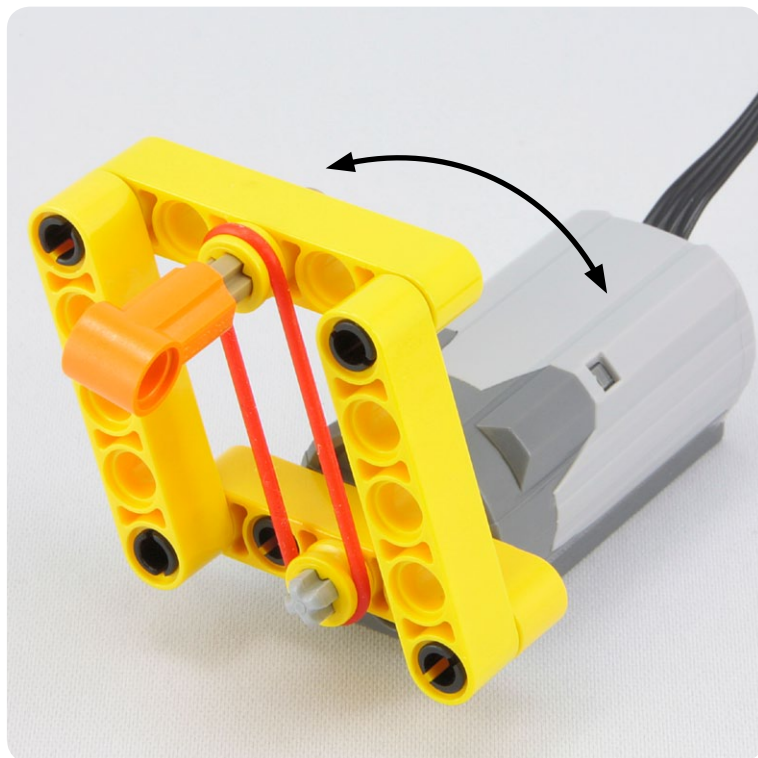
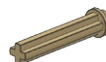
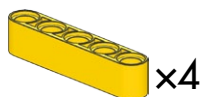
#150



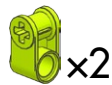
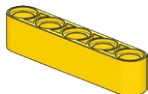
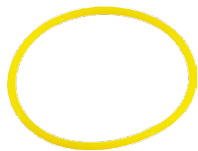
#151



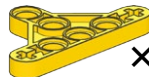
#152



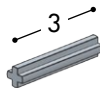
#153



x2



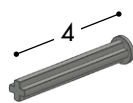
x2



x3



x3



4



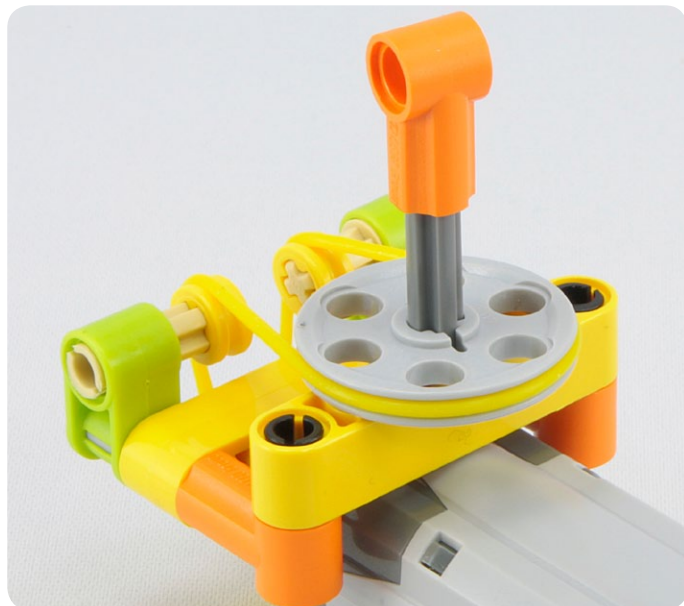
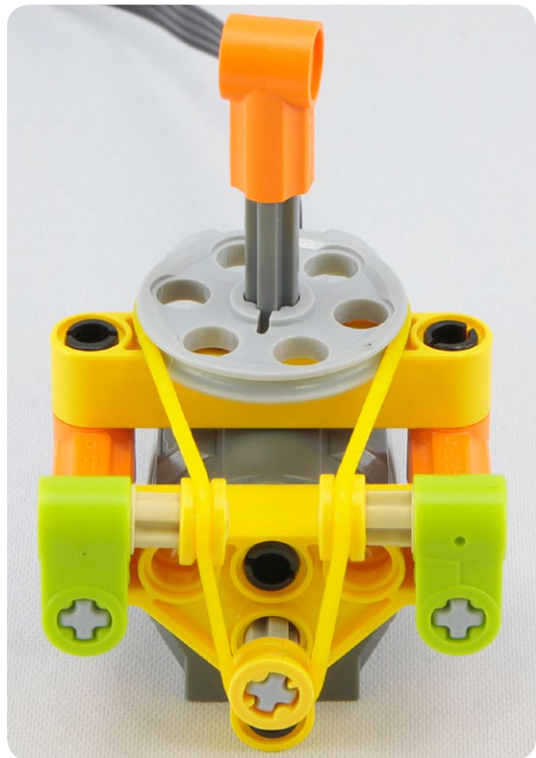
x3



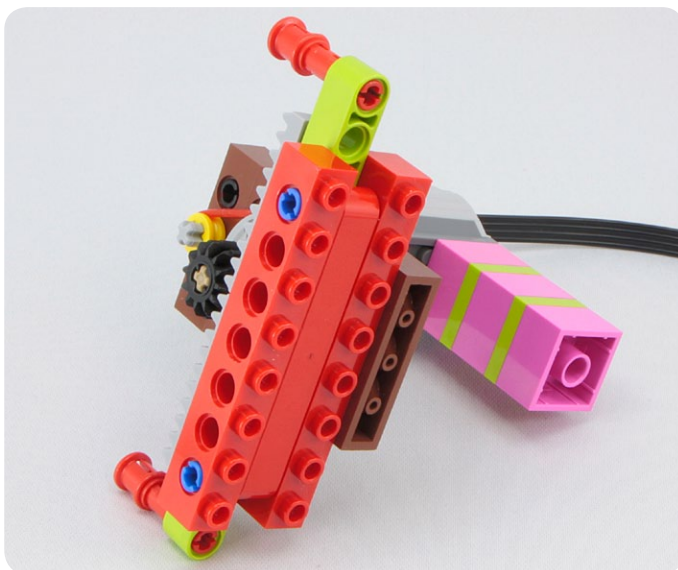
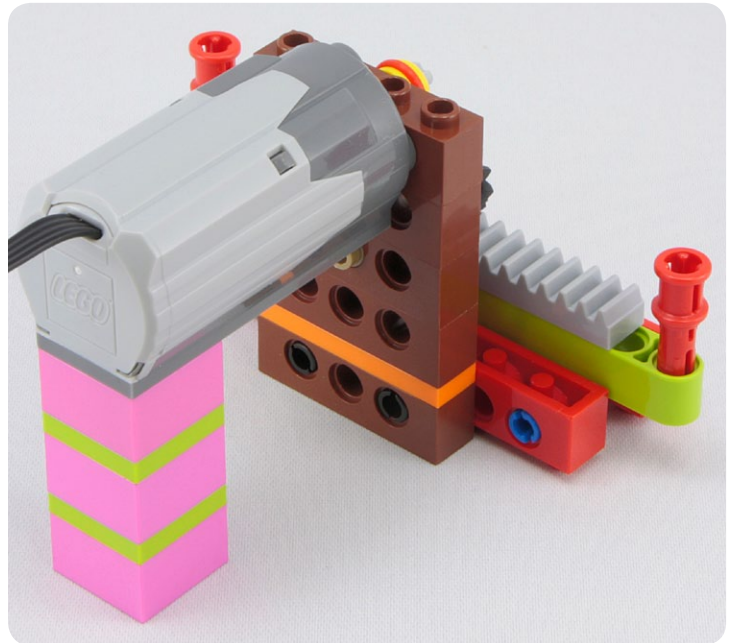
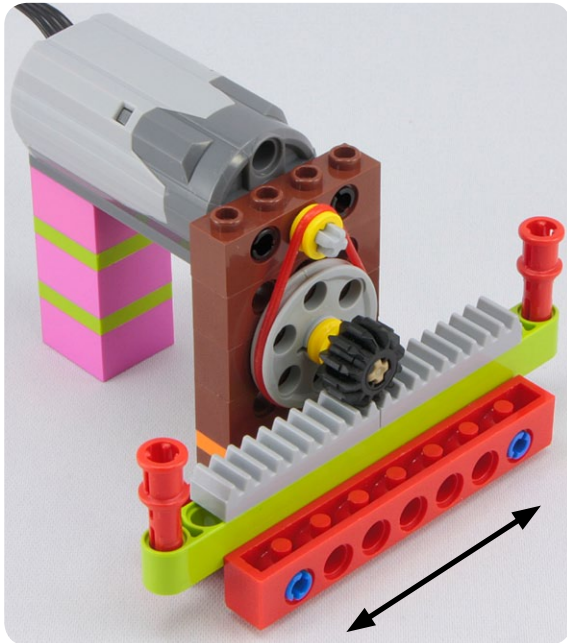
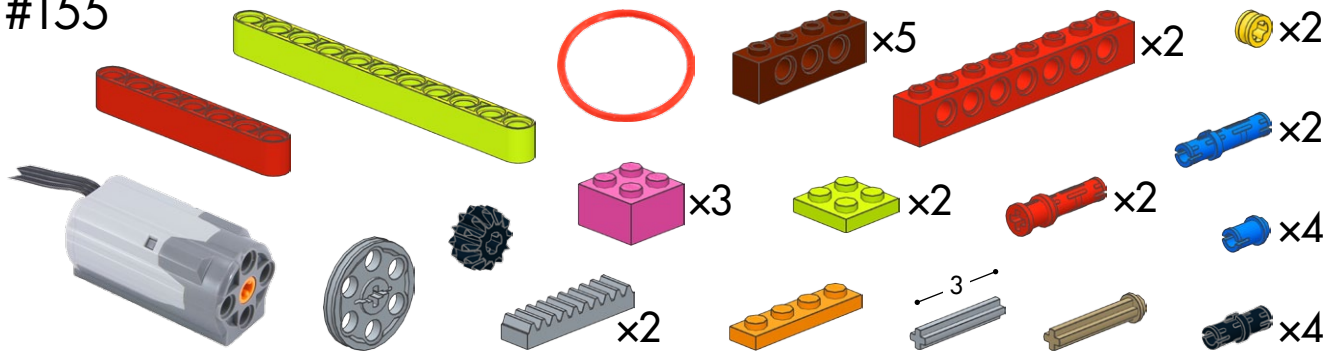
x2

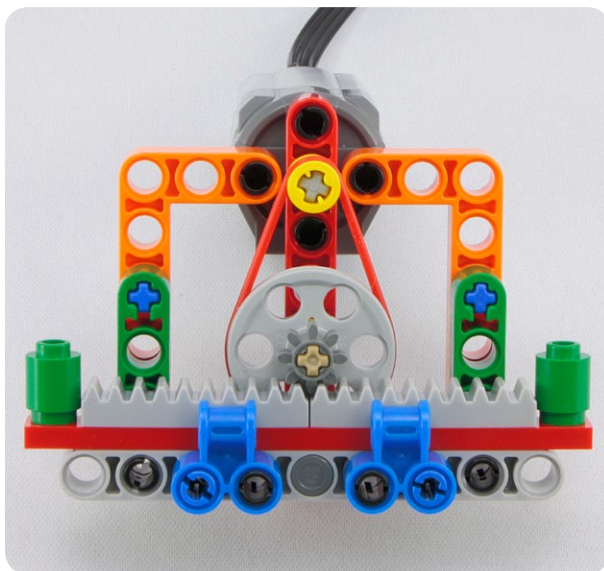
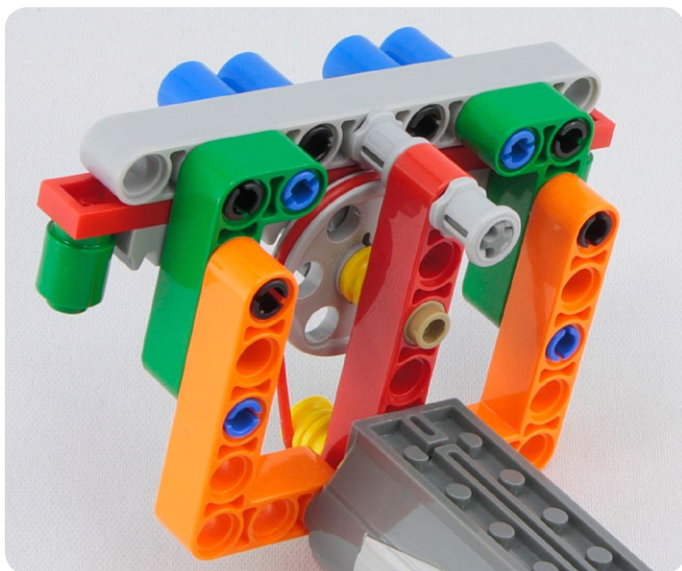
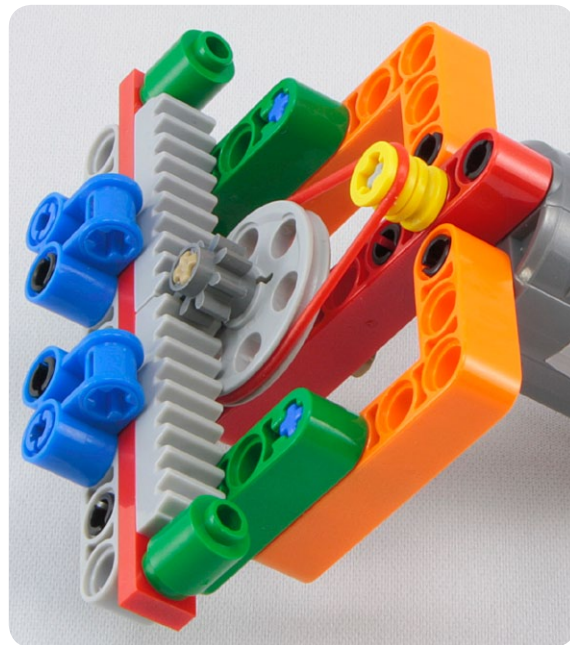
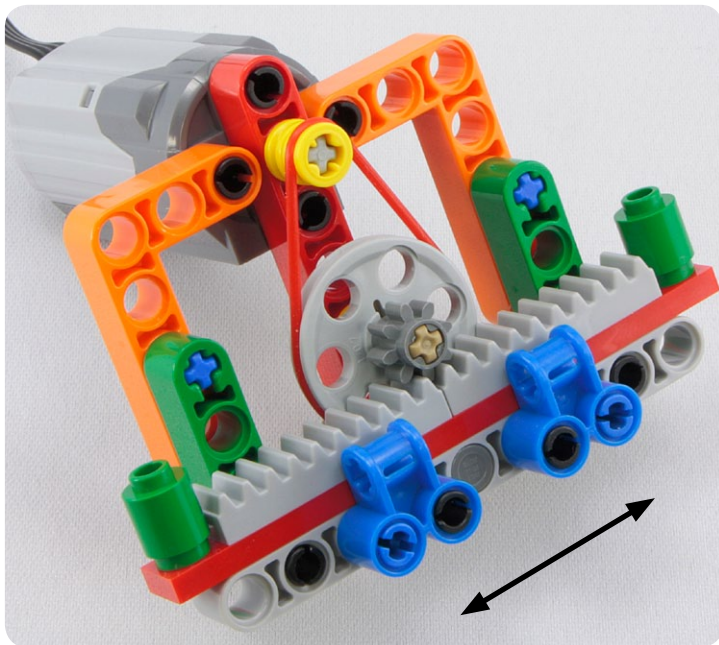


x4

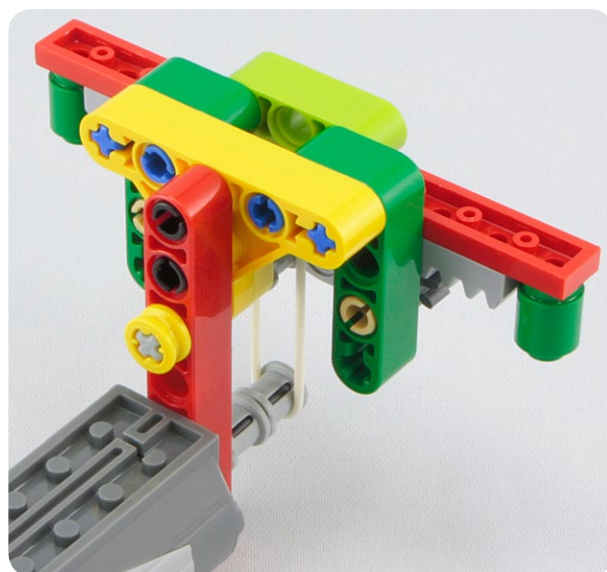
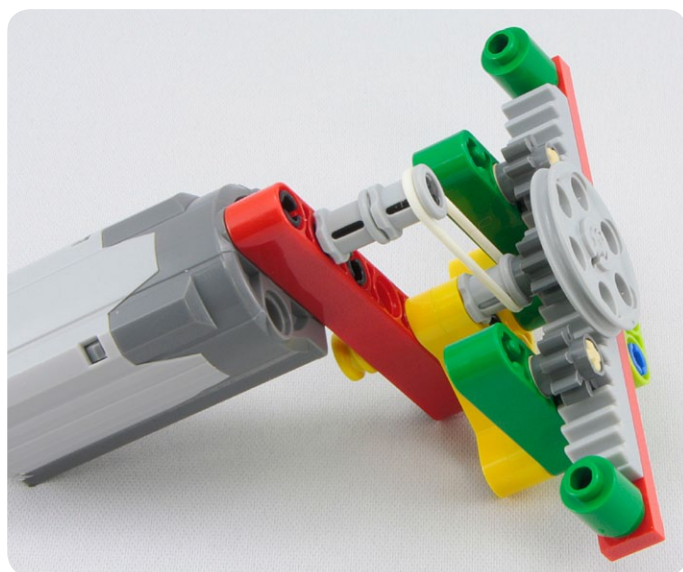
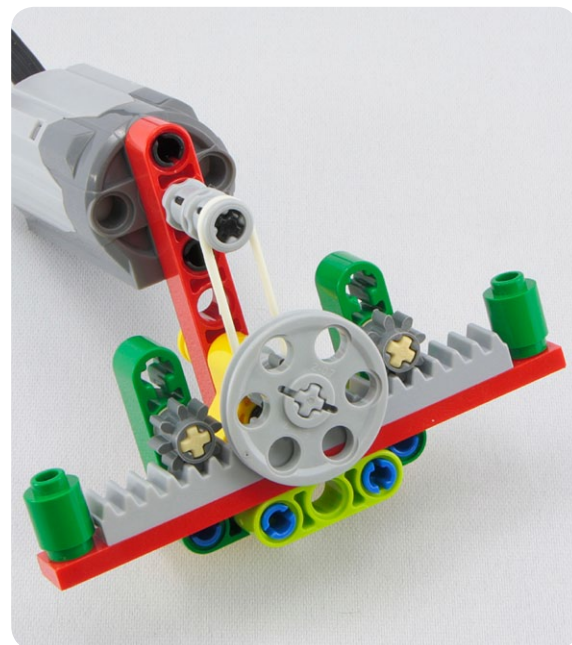
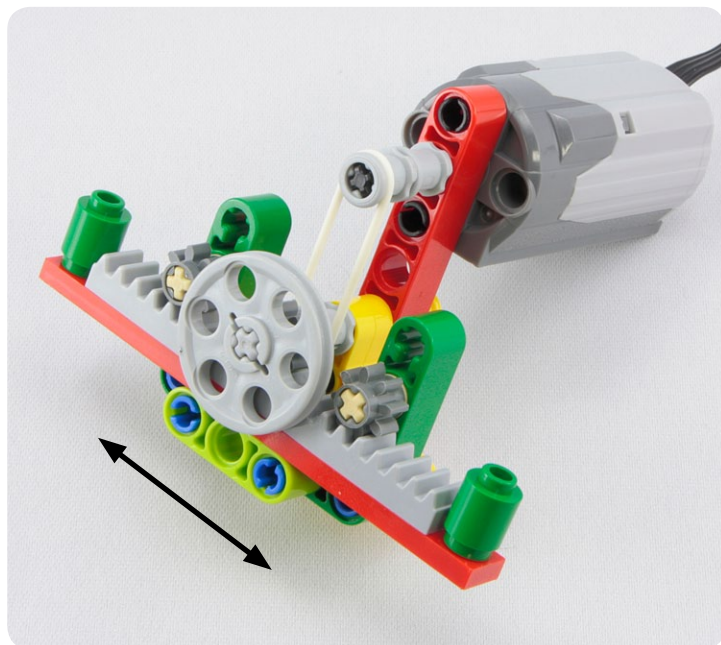
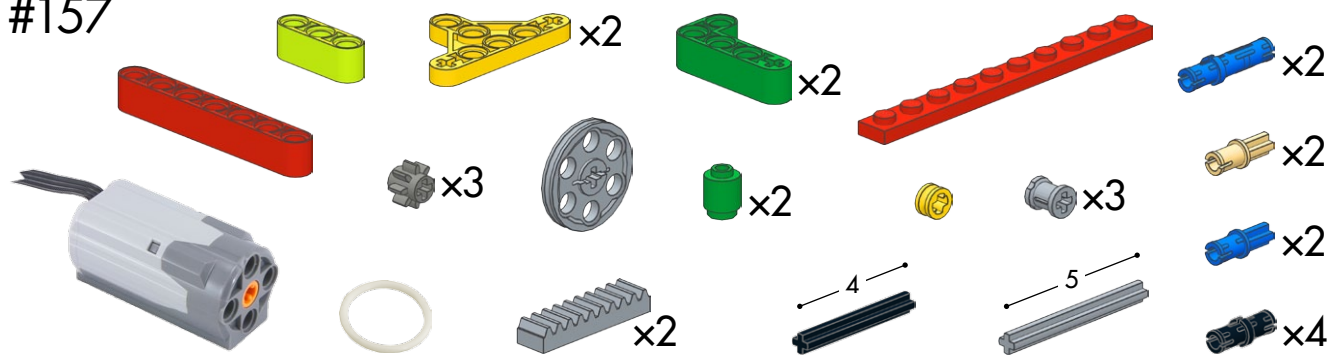


#155

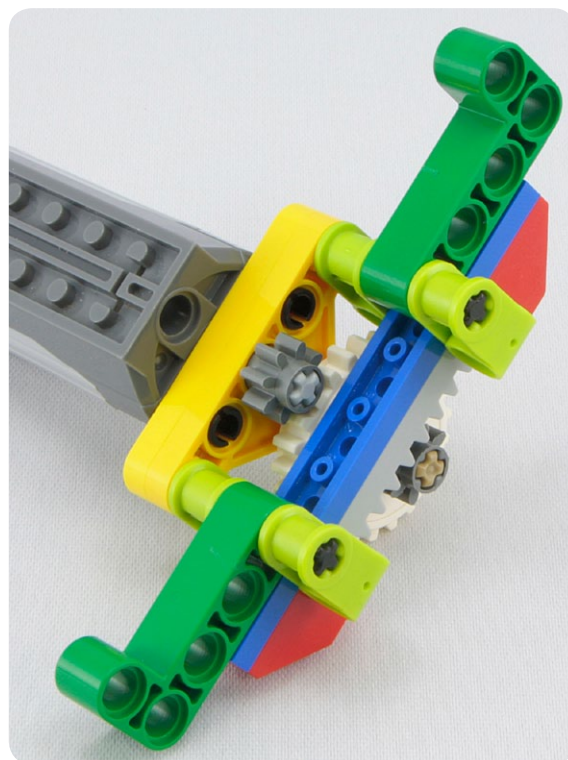
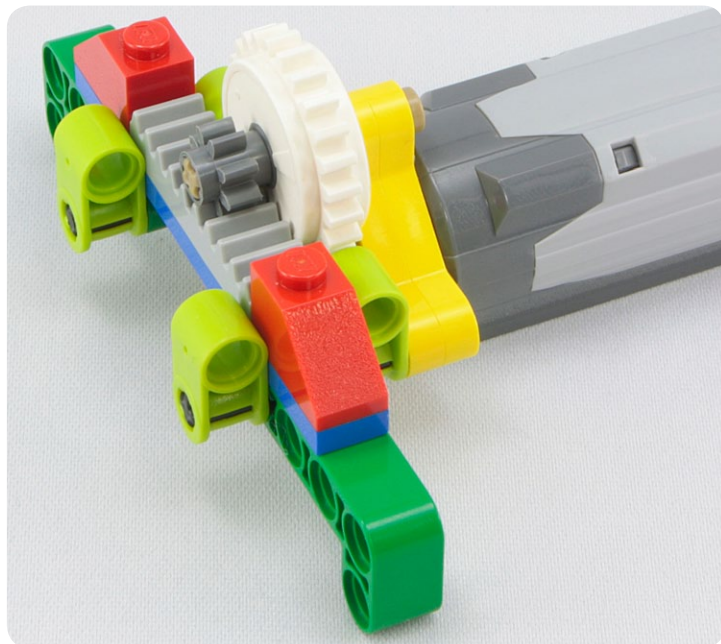
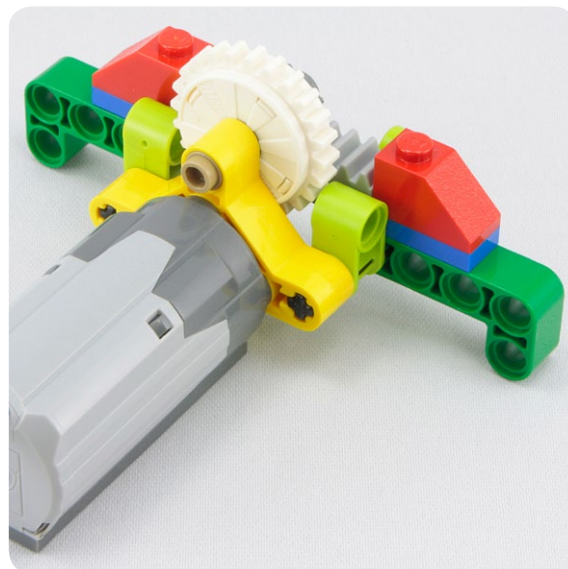
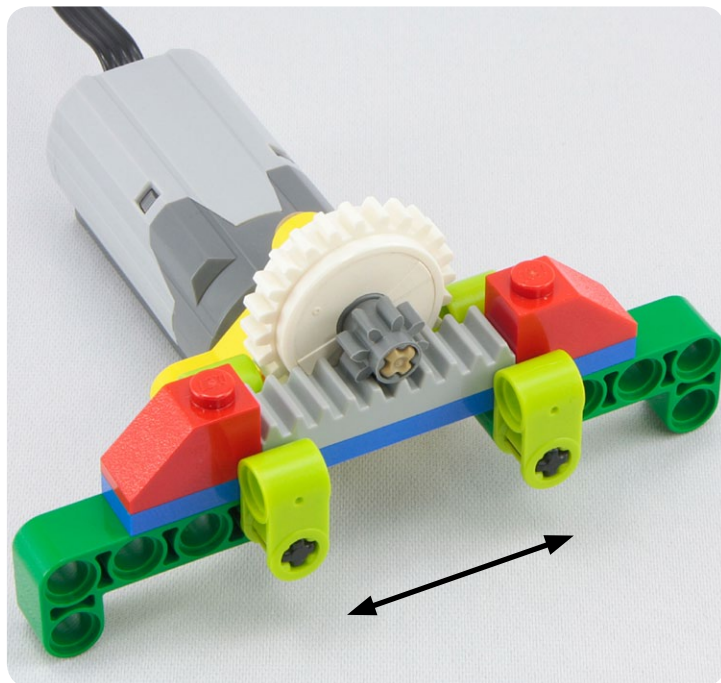
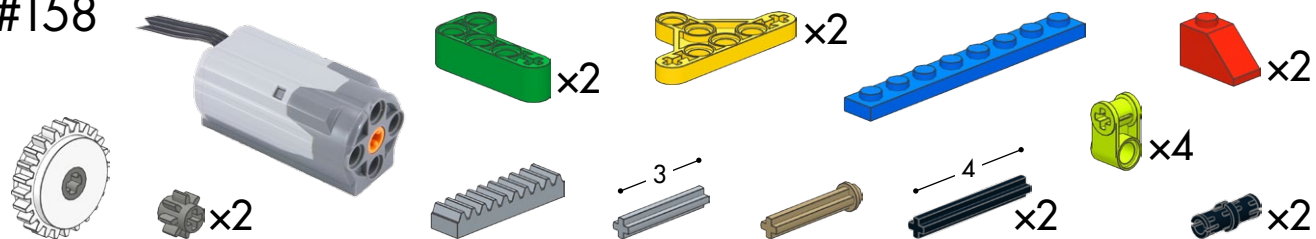


[illegible]

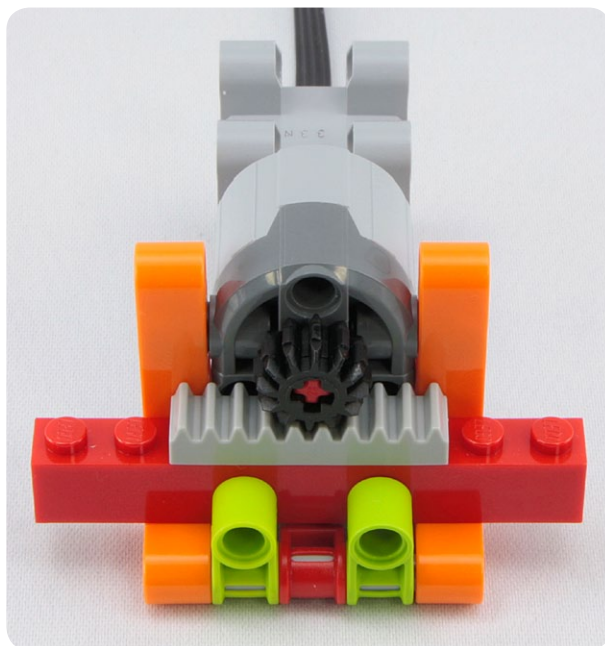
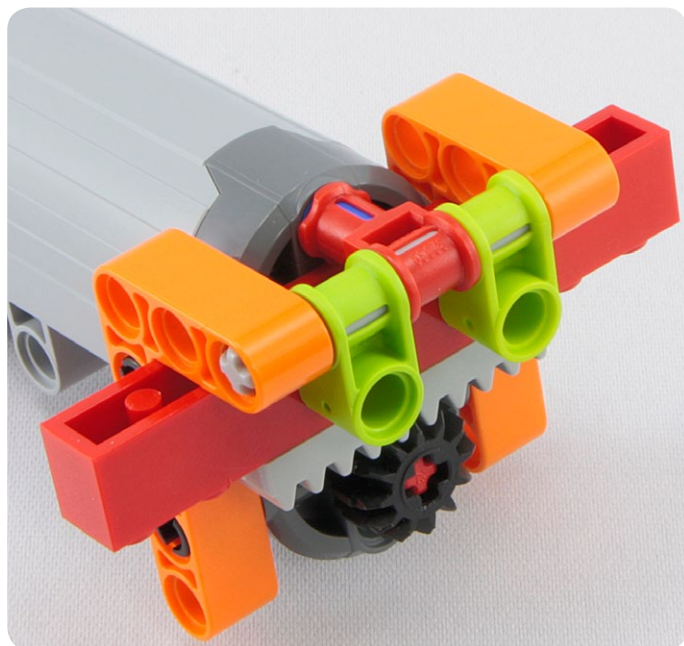
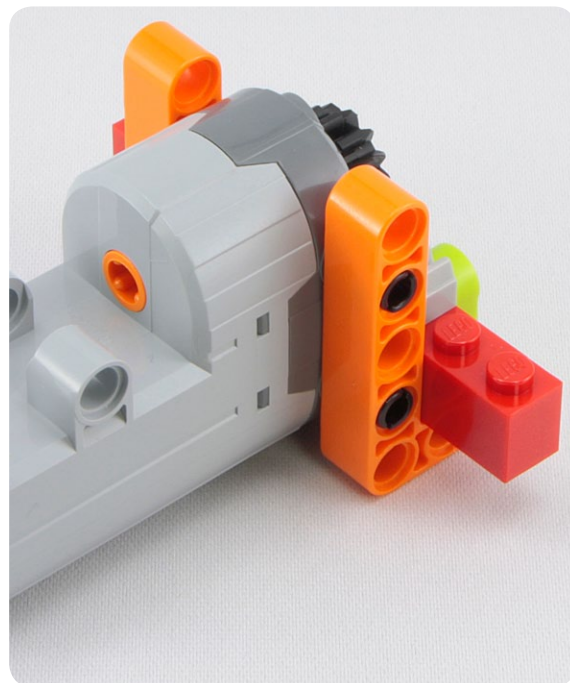
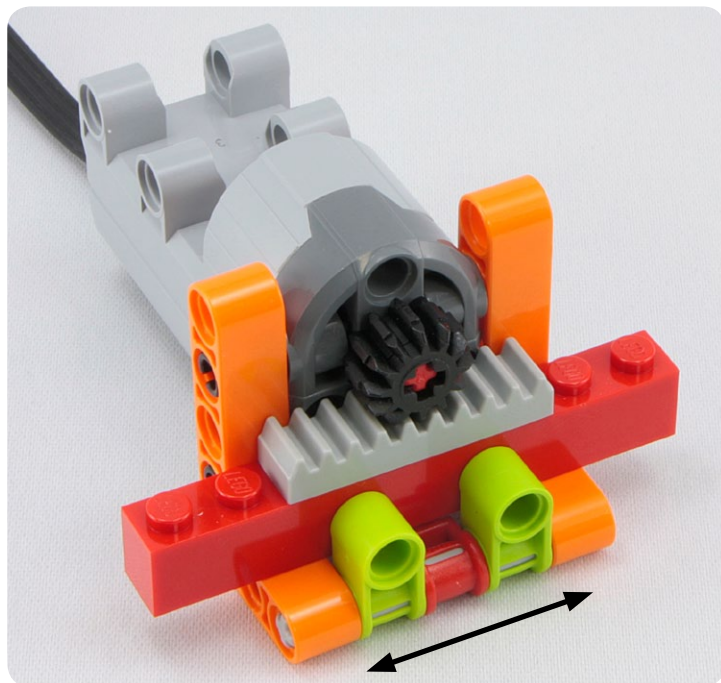
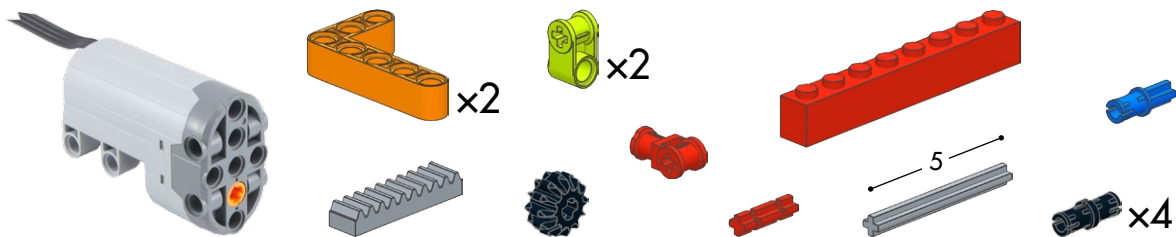
#157

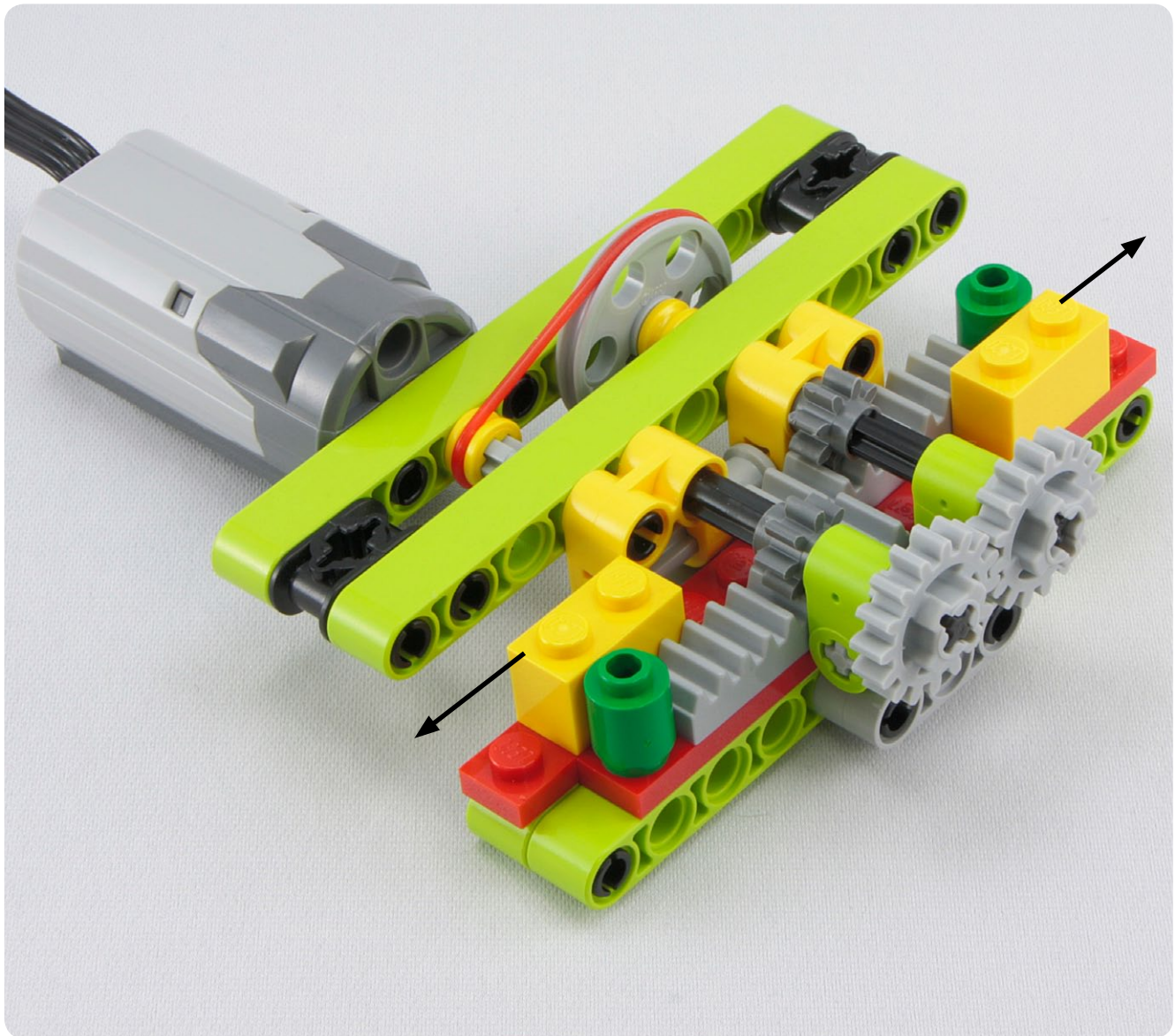


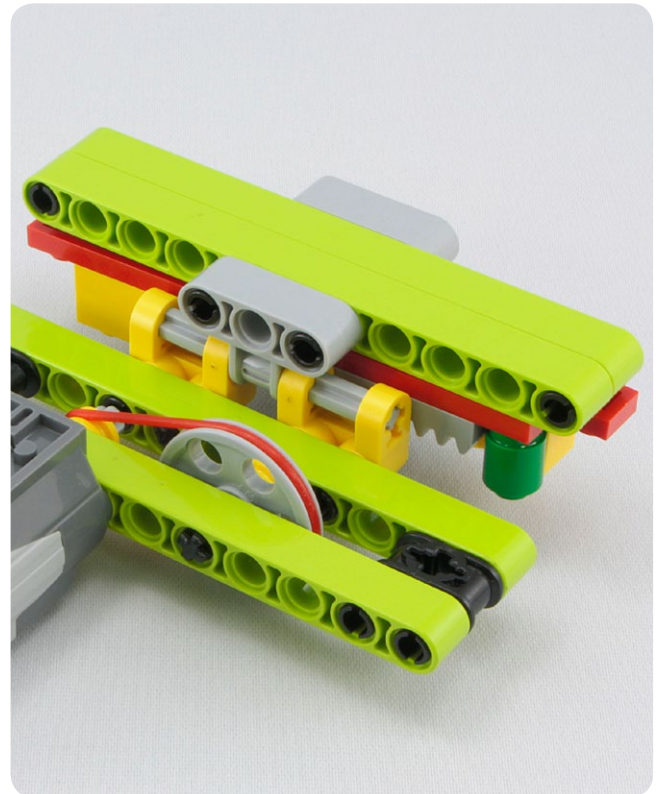
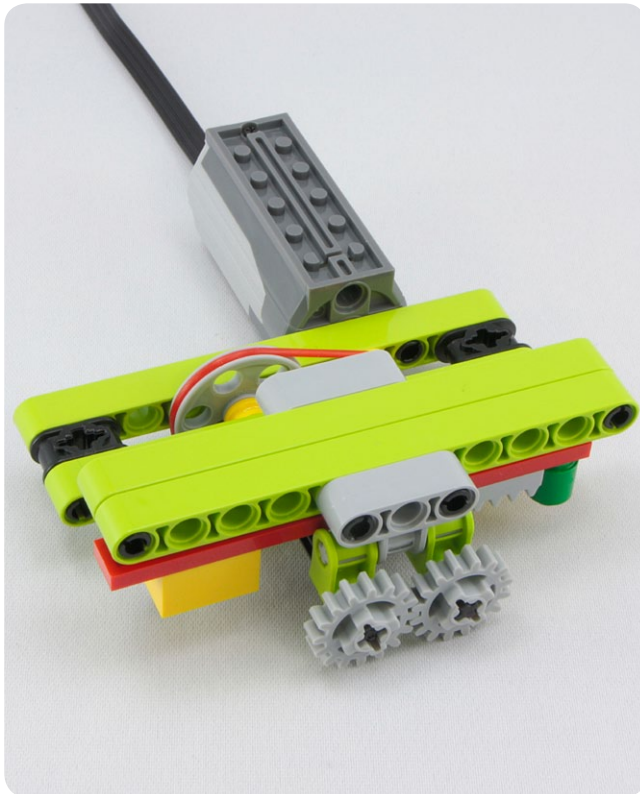
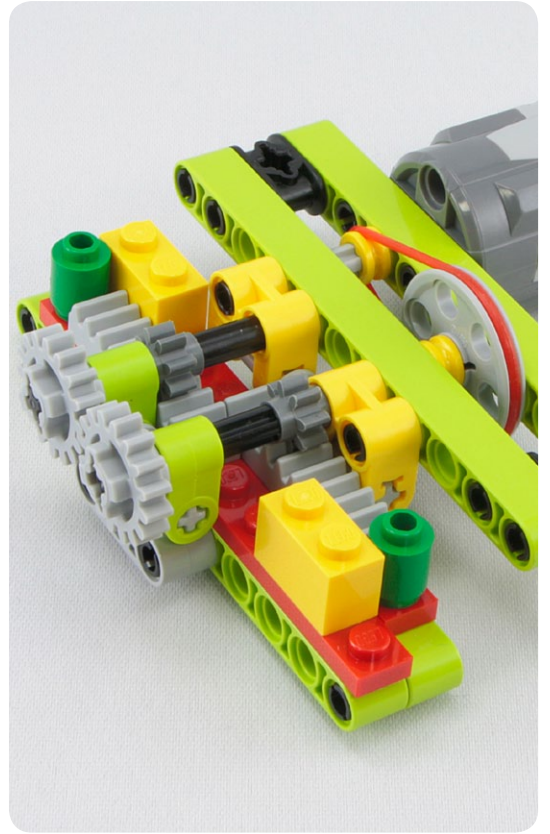
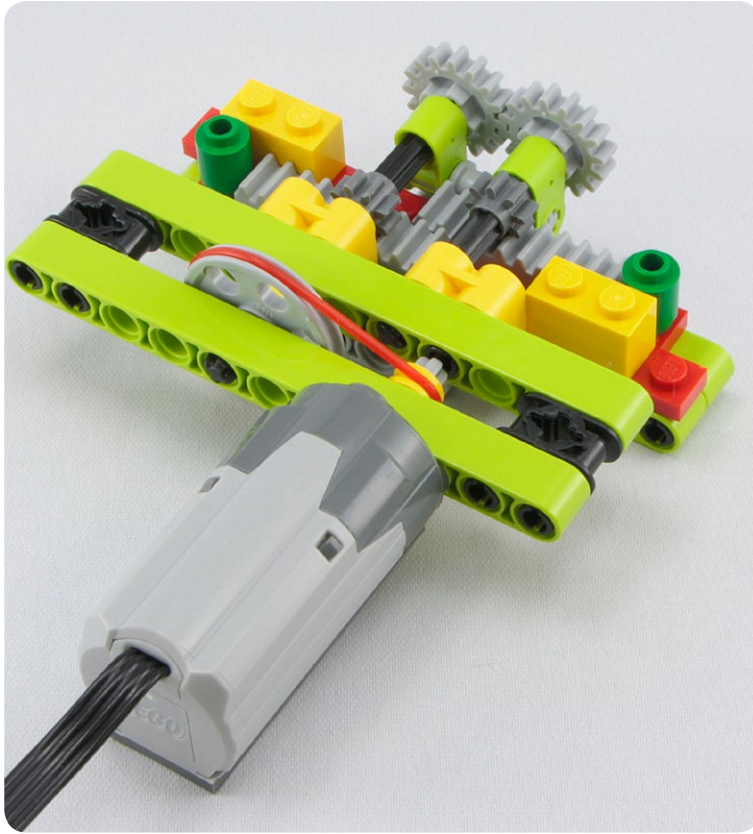
#158



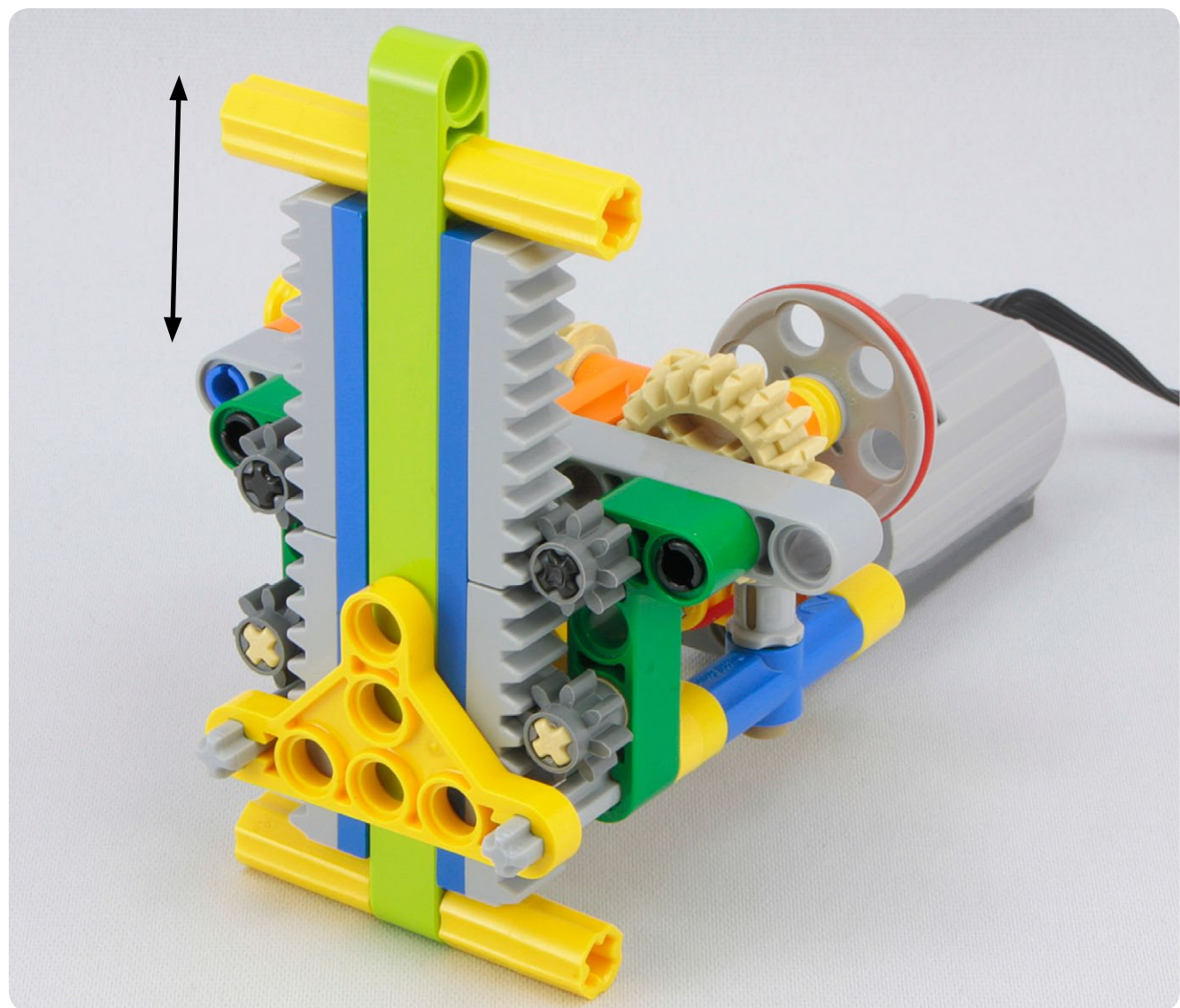
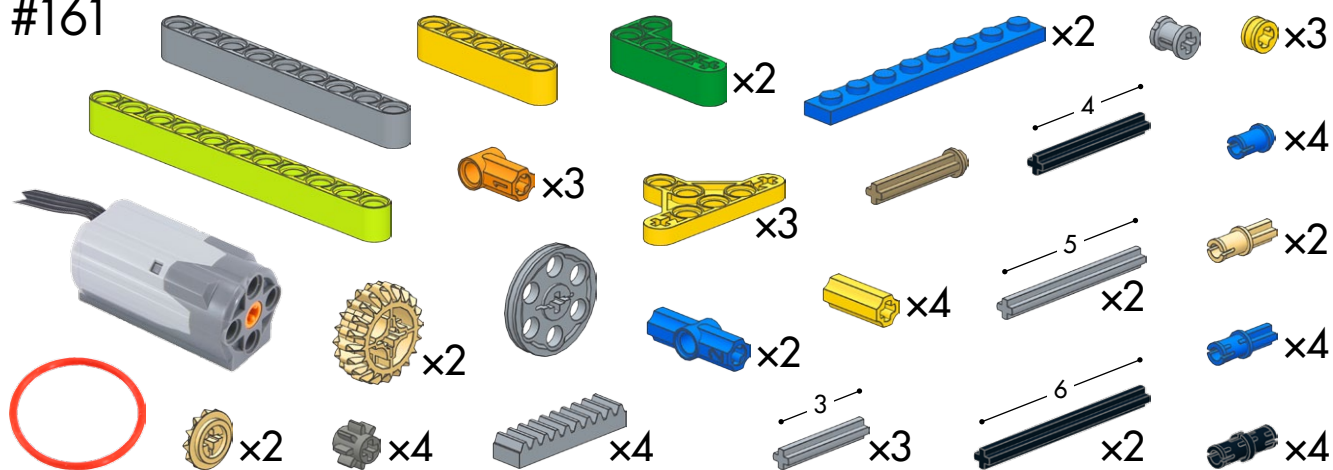
#159

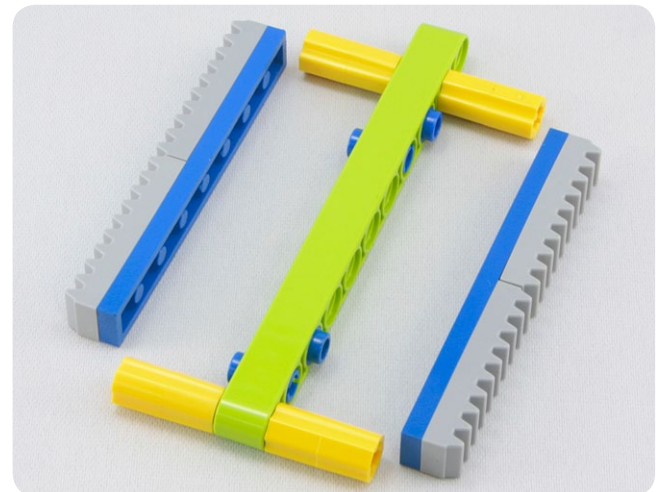
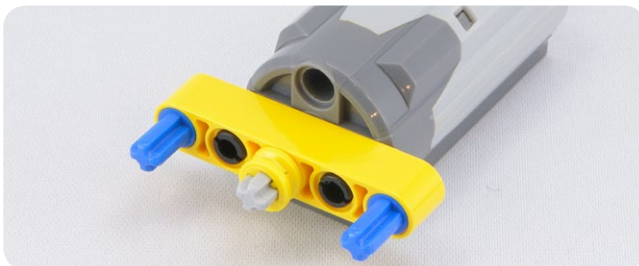
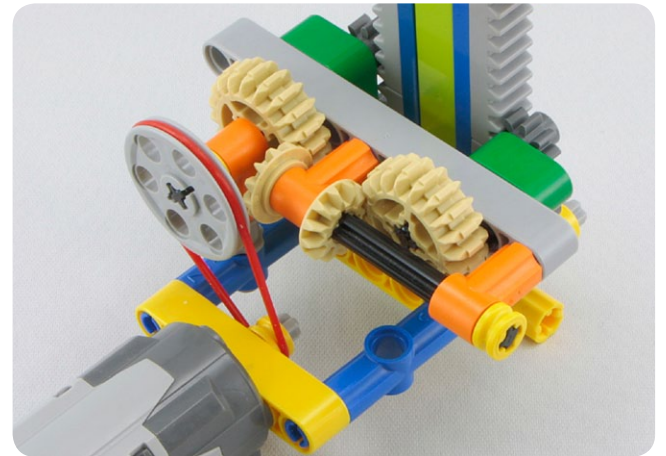
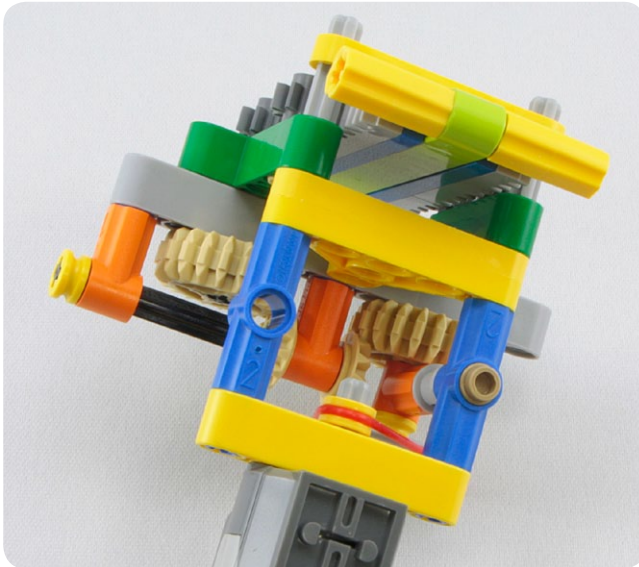
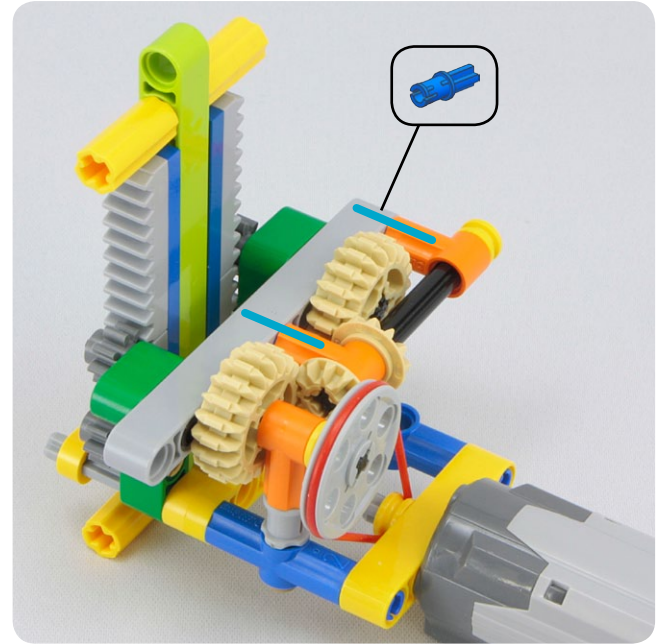
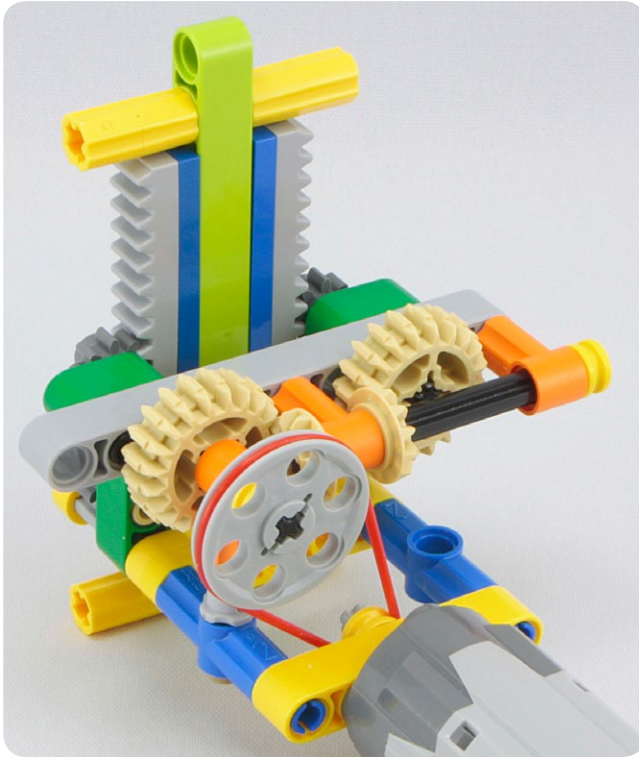


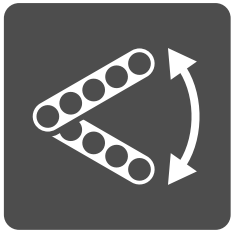
[illegible]



#161

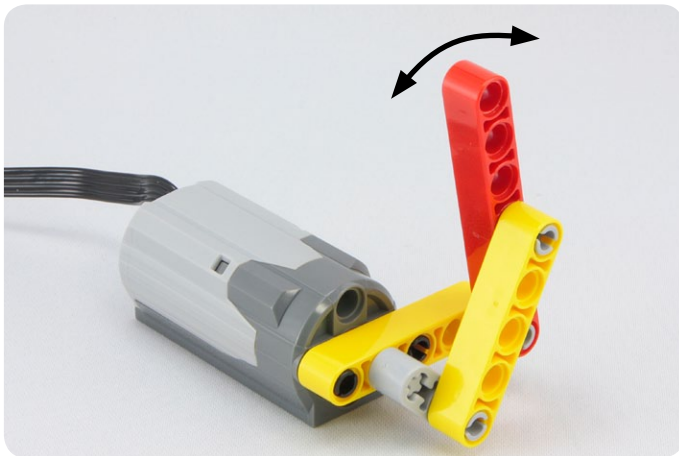
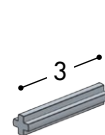
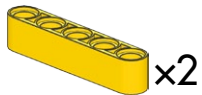
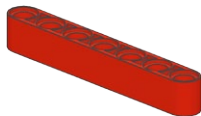




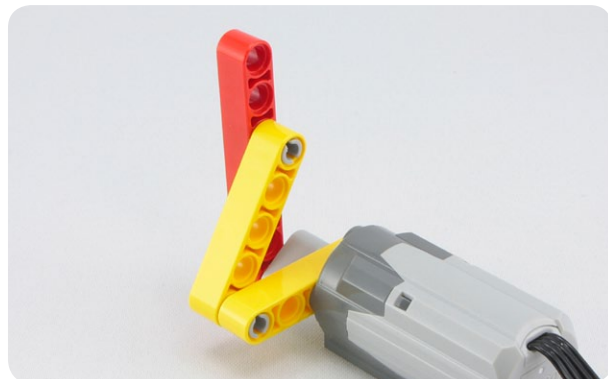
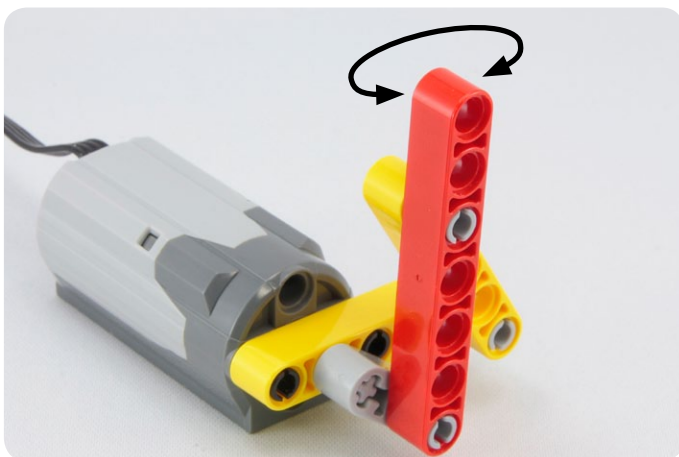
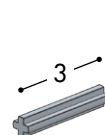
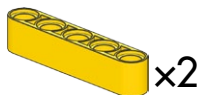


Swinging mechanisms

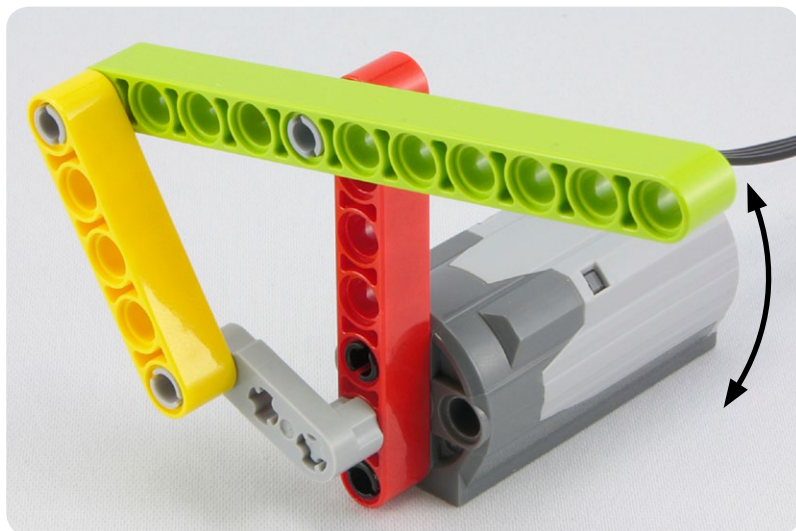
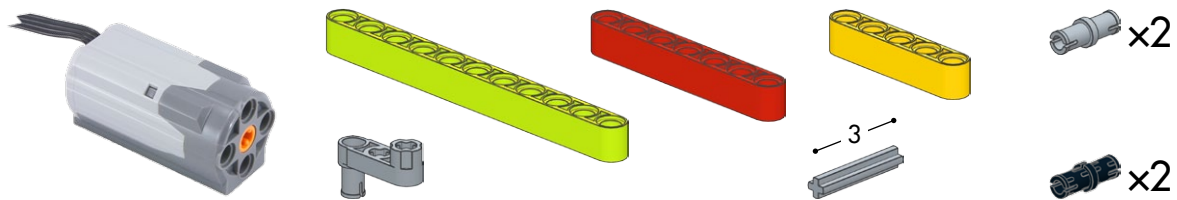
#162



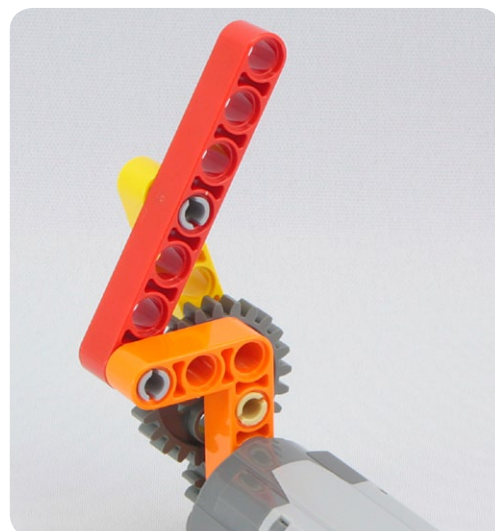
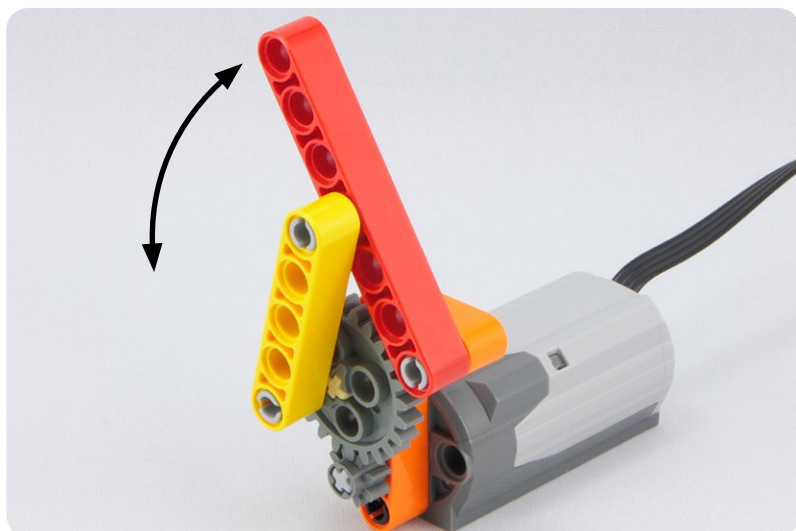
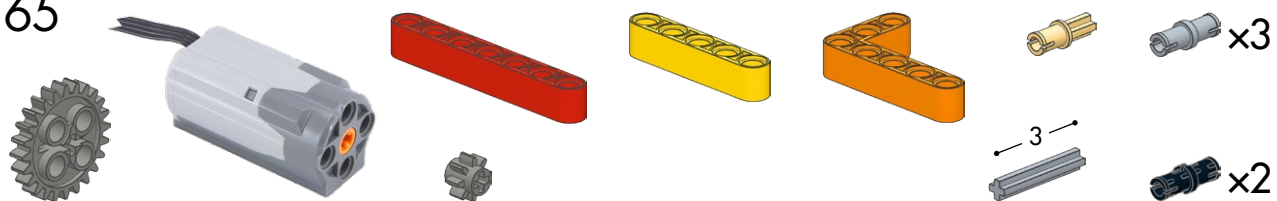
#163



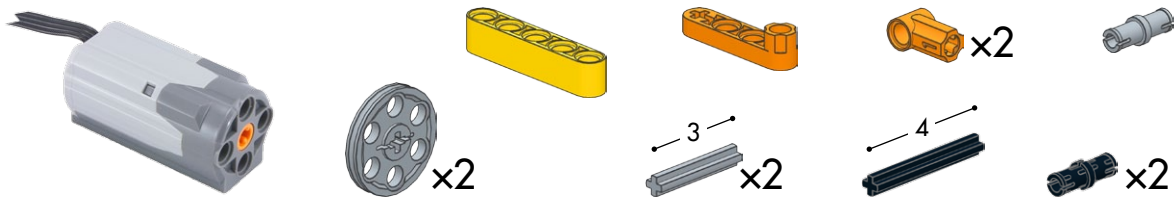
#164



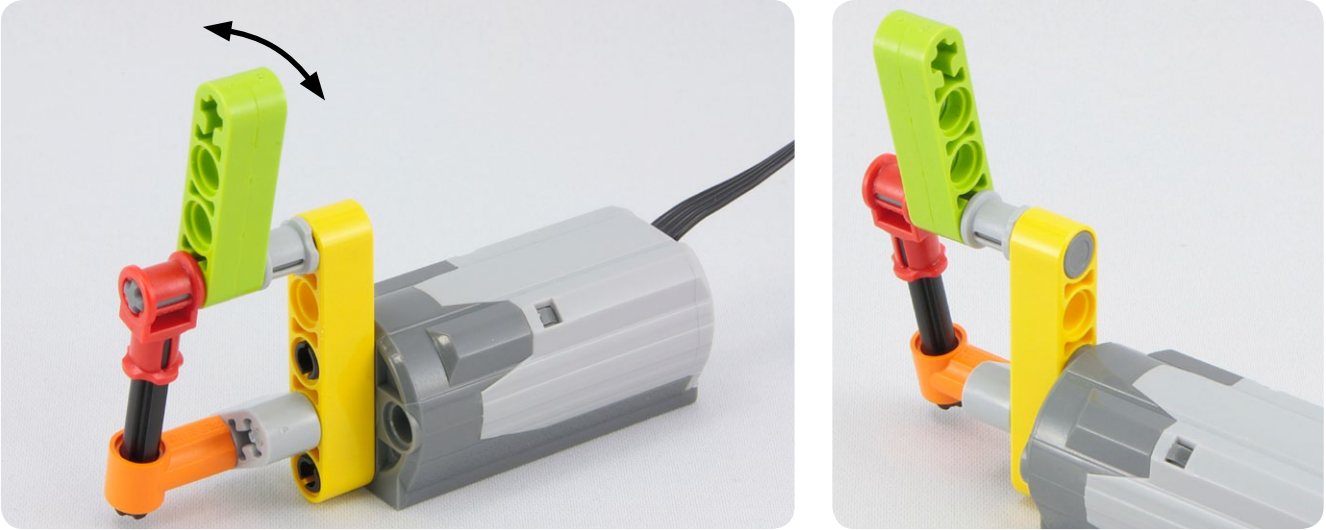
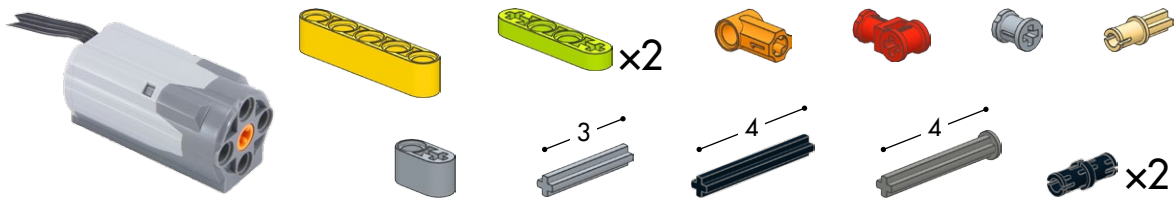
#165



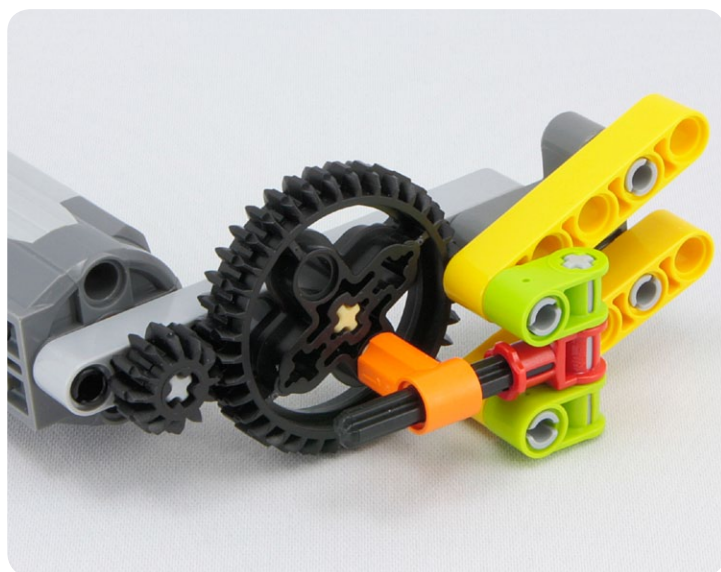
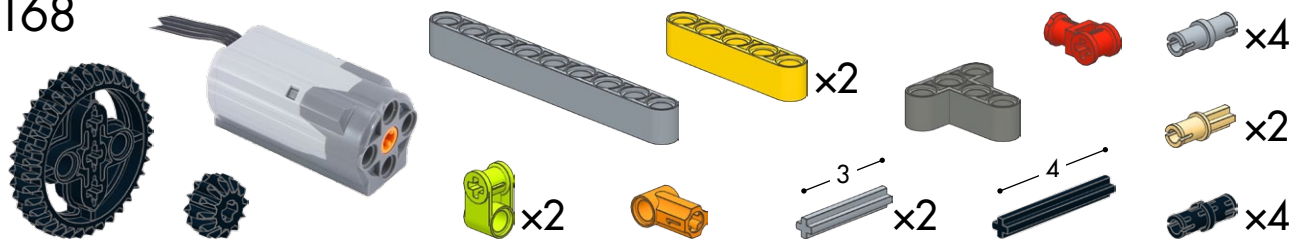
#166



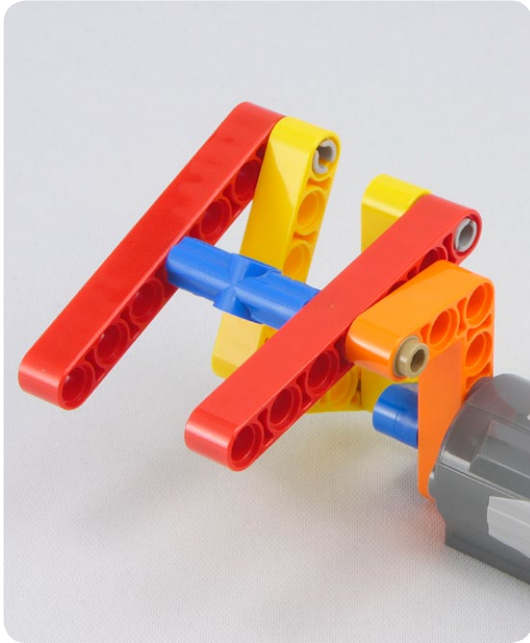
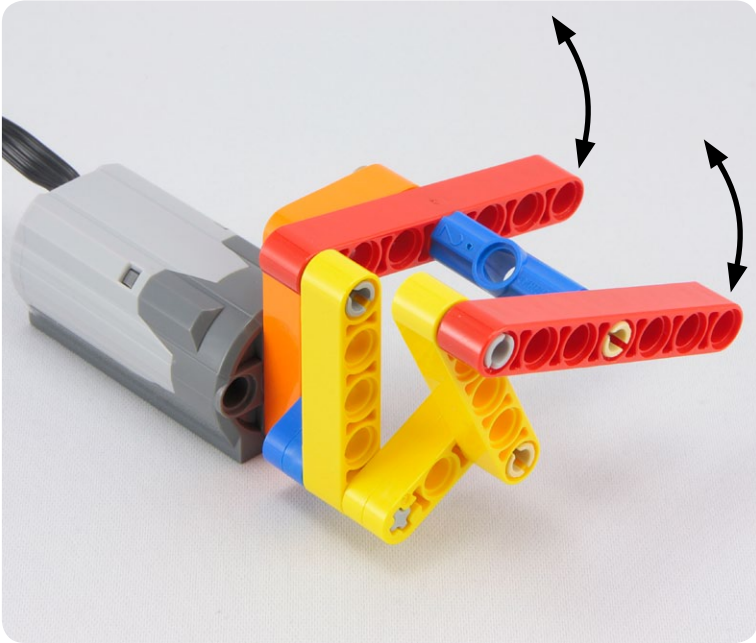
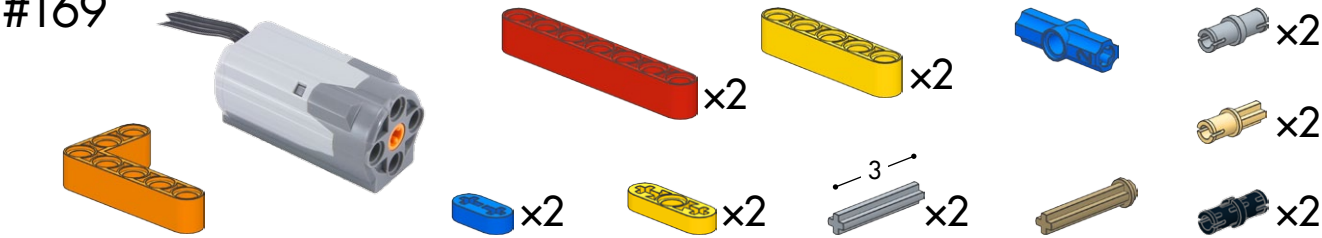
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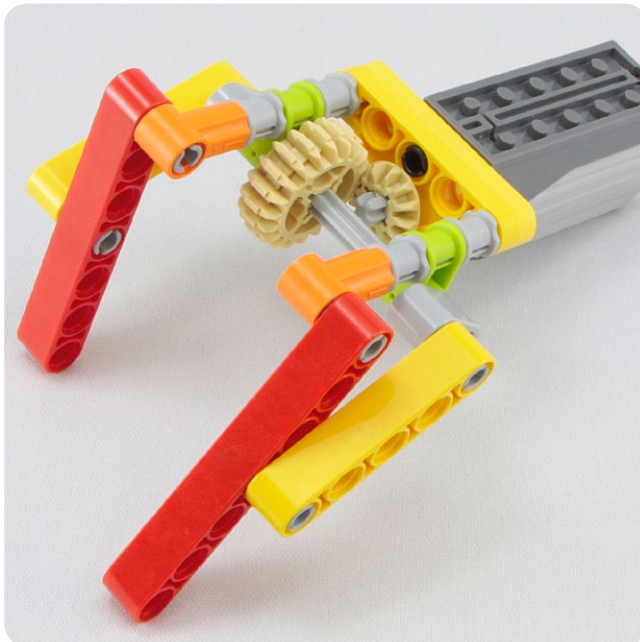
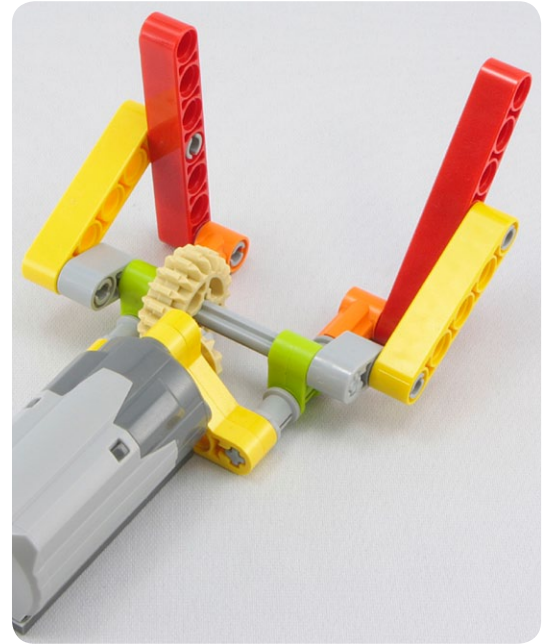
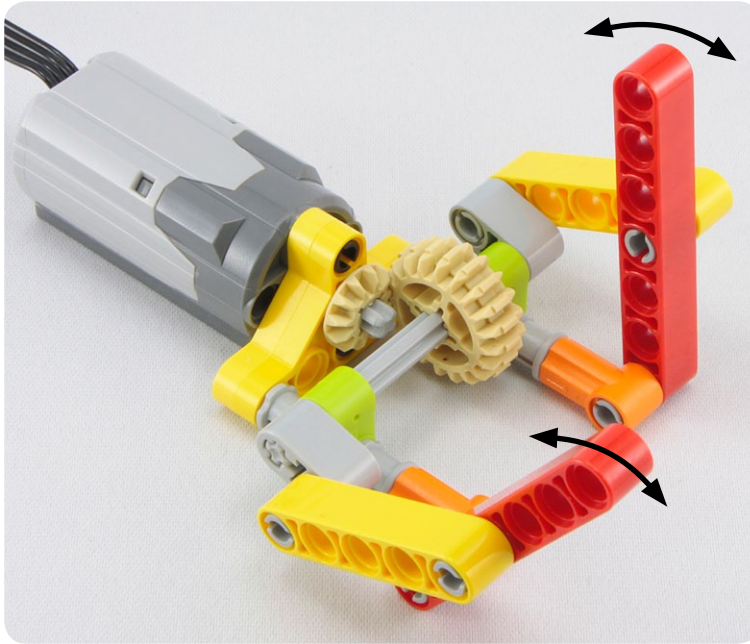
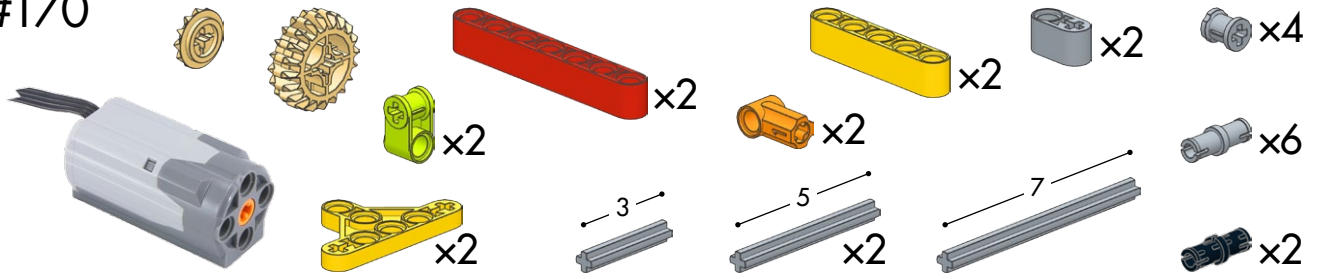
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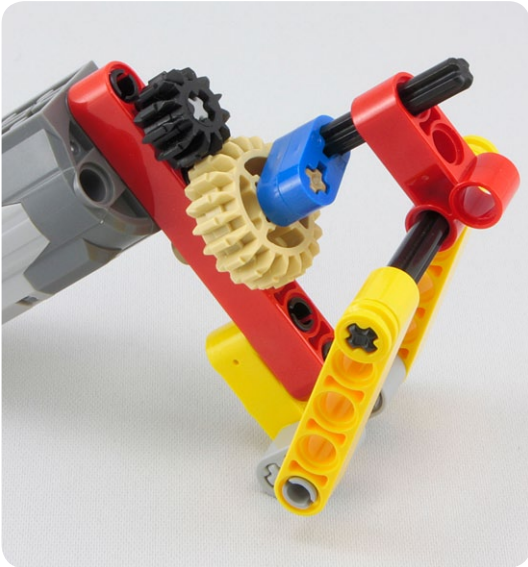
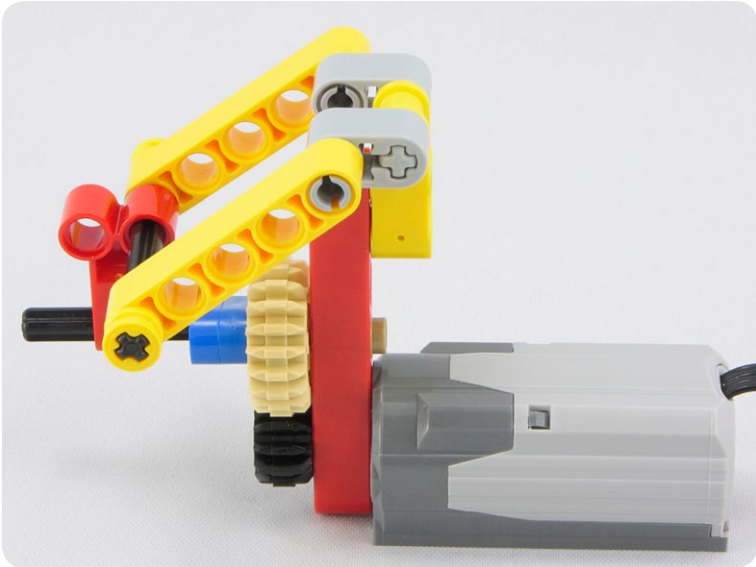
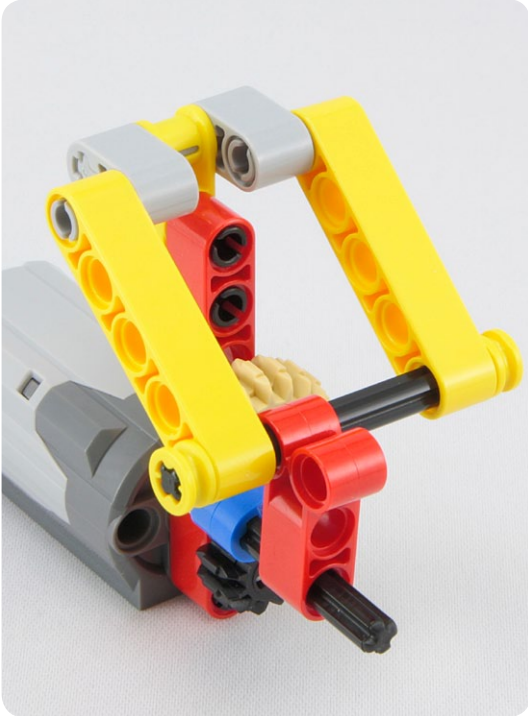
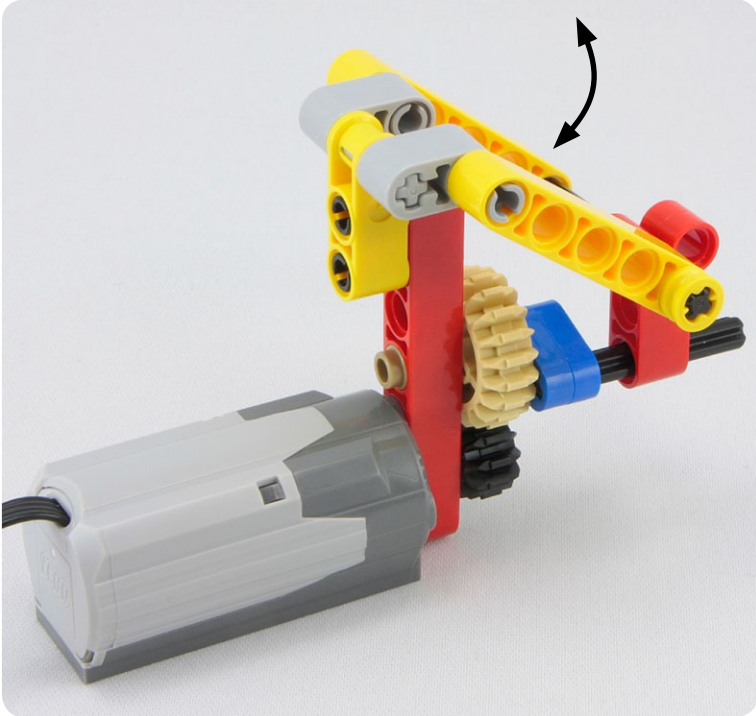
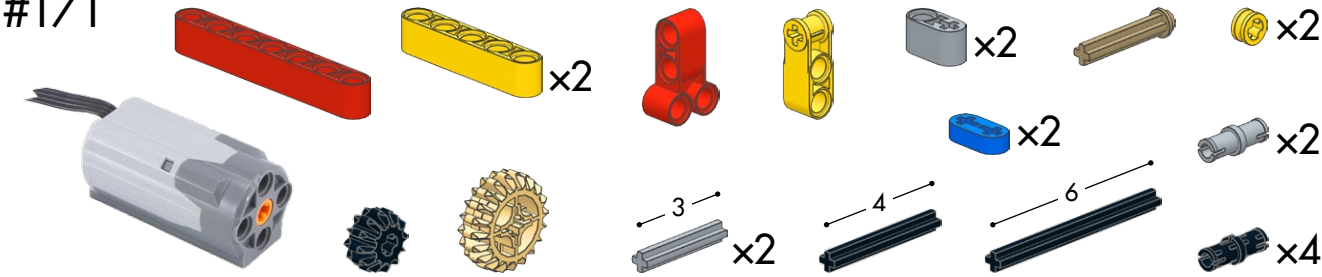
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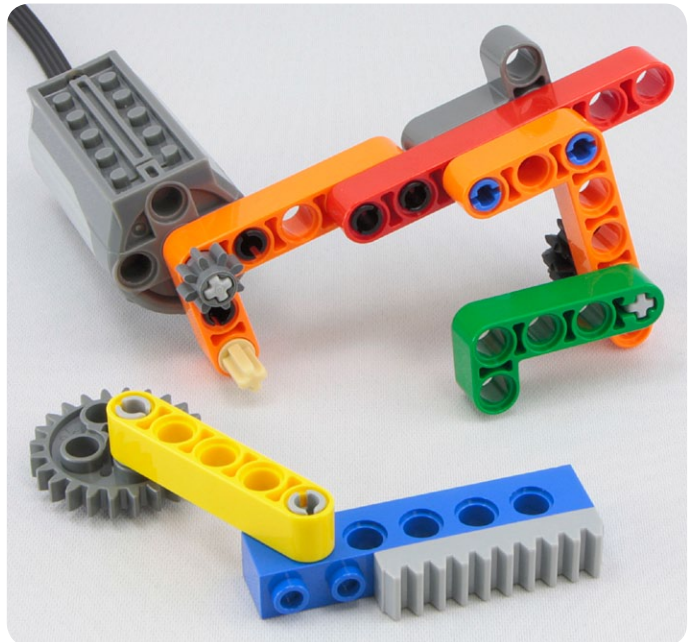
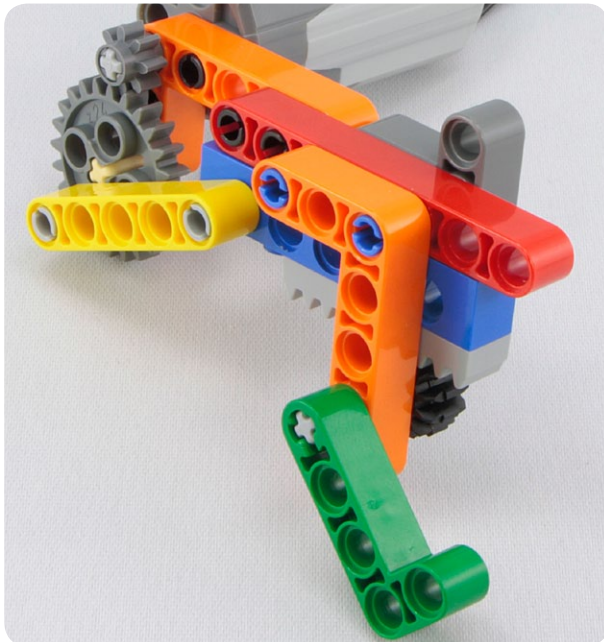
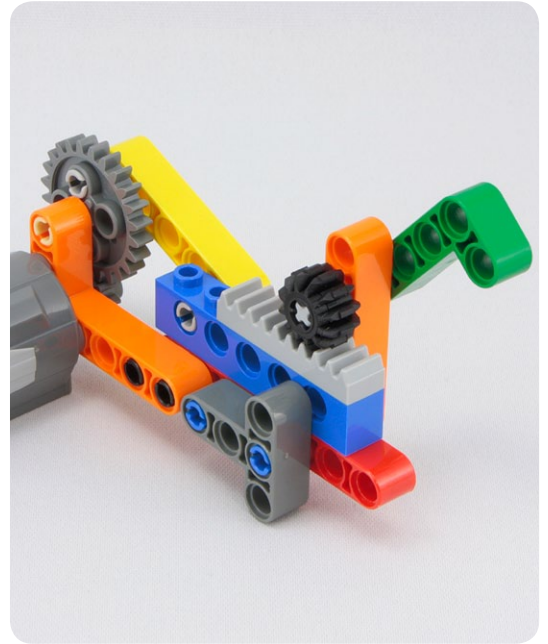
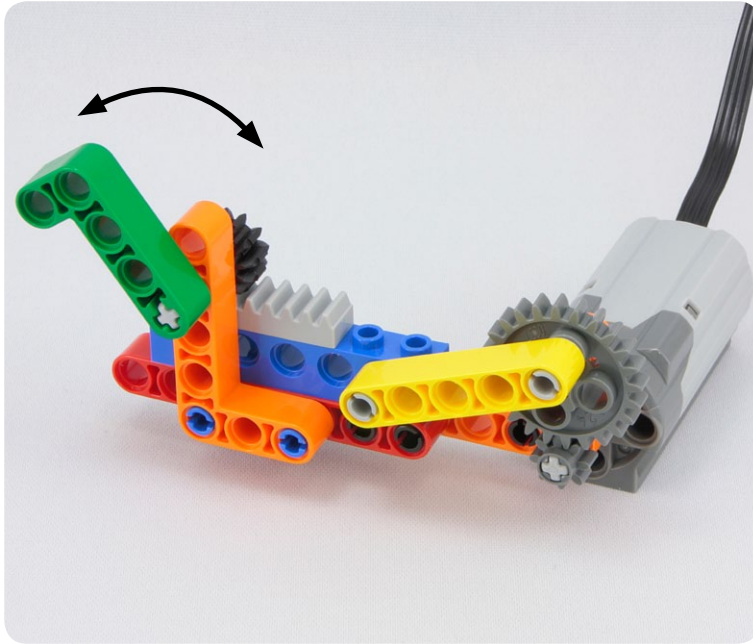
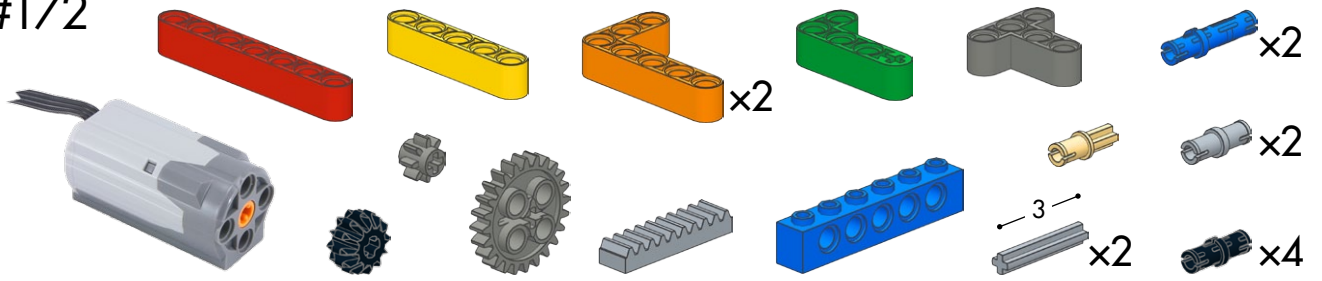
#170




#171



#172

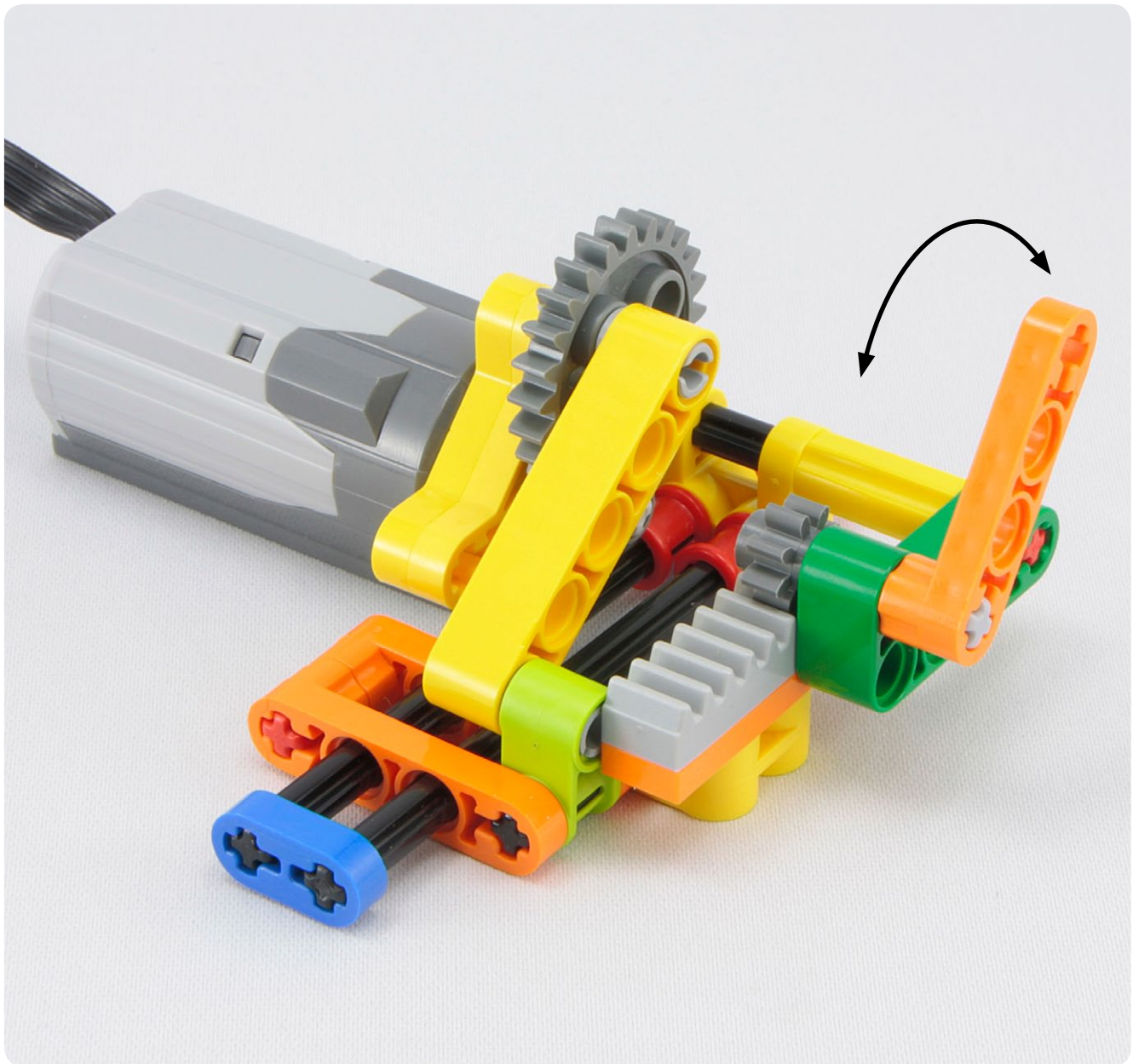


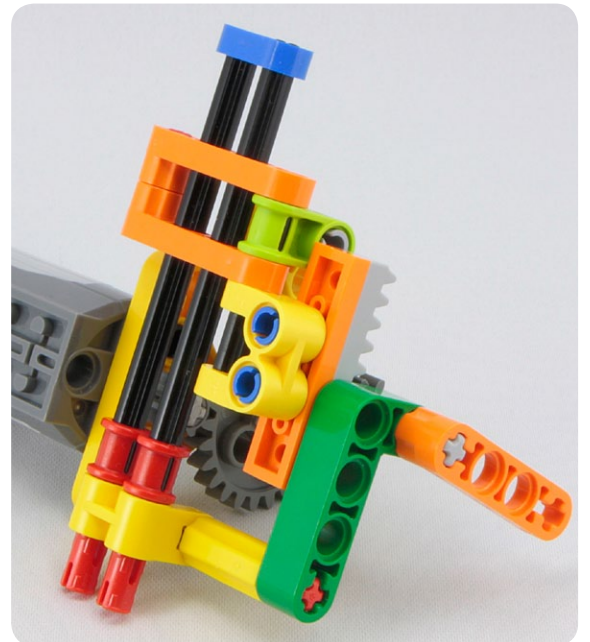
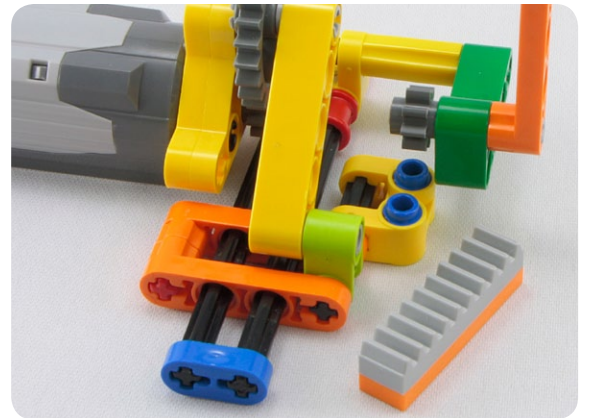
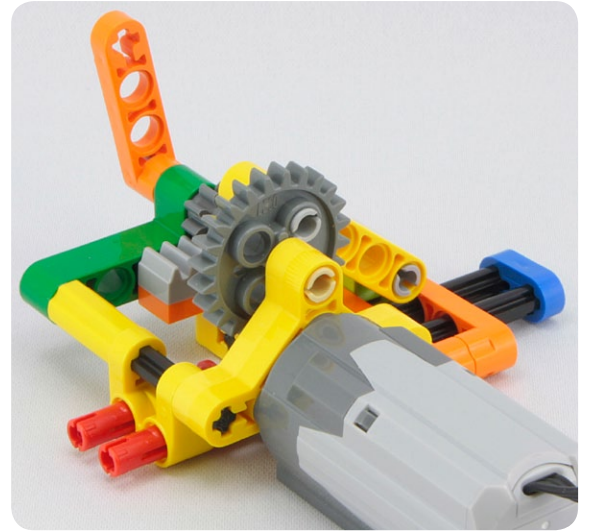
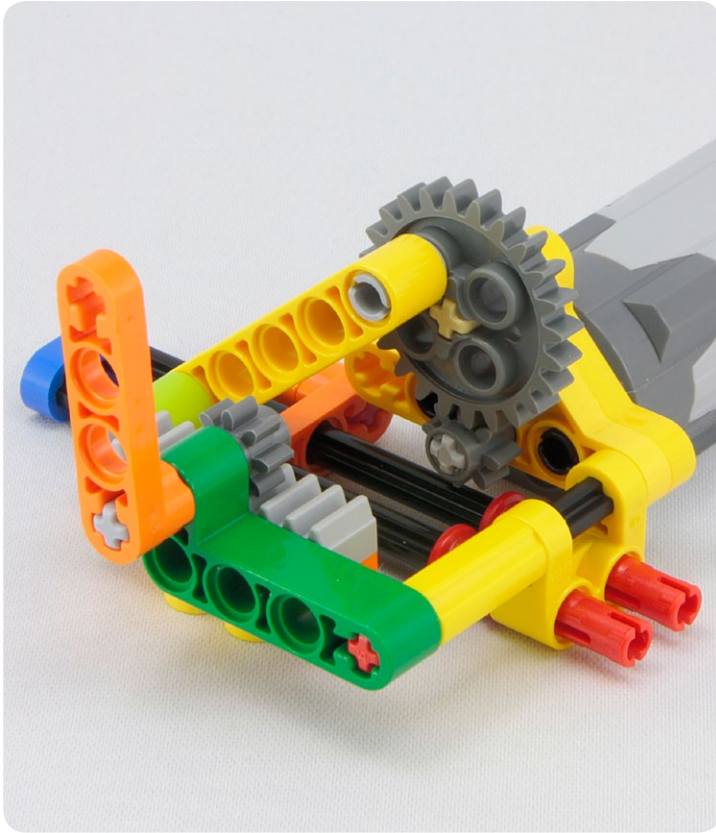
#173



LEGO parts list for step 173:

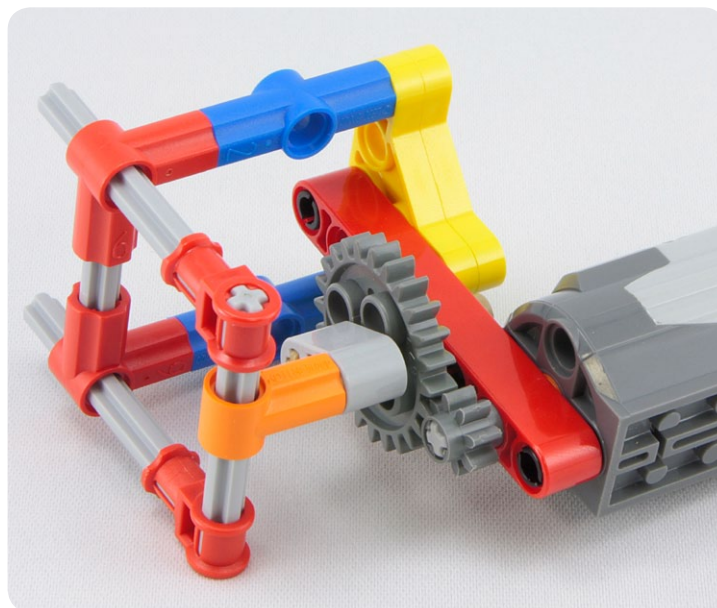
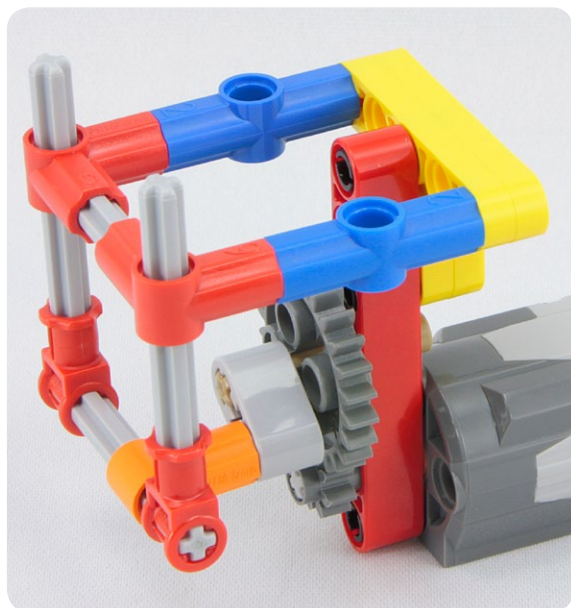
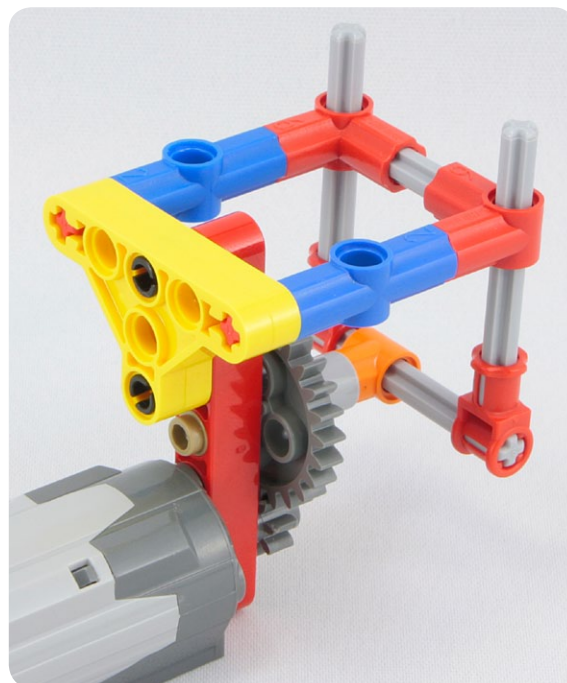
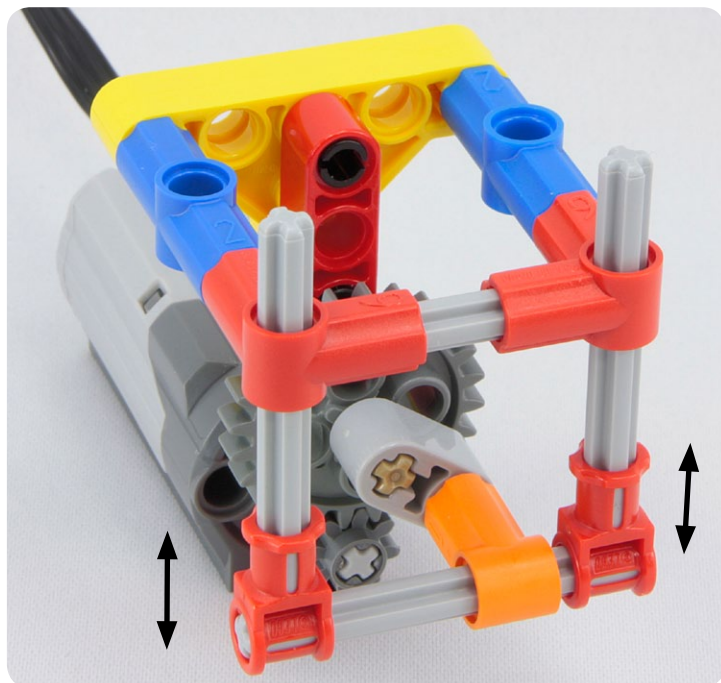
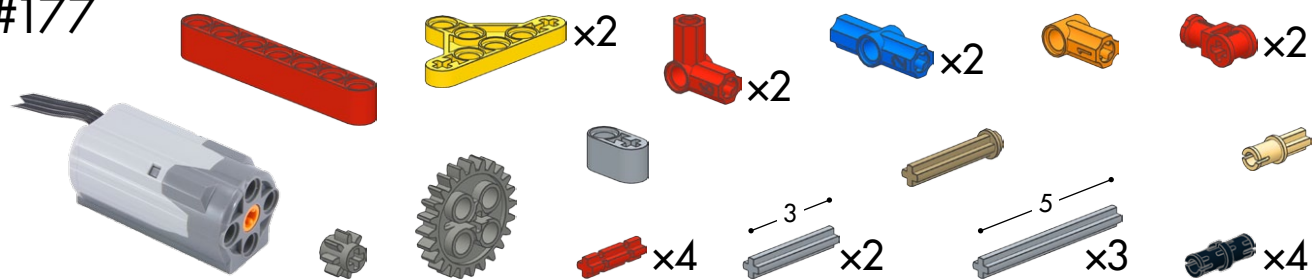
- 1x Grey Motor
- 1x Grey Gear (24 teeth)
- 1x Yellow 1x5 Technic Beam
- 2x Yellow 1x3 Technic Beam with 2 Holes
- 1x Green 1x3 Technic Beam with 2 Holes
- 1x Blue 1x2 Technic Beam
- 2x Grey 1x3 Technic Beam with 2 Holes
- 1x Yellow 1x3 Technic Beam with 2 Holes
- 2x Yellow 1x2 Technic Beam with 2 Holes
- 2x Red 1x2 Technic Beam with 2 Holes
- 2x Orange 1x3 Technic Beam with 2 Holes
- 3x Orange 1x2 Technic Beam with 2 Holes
- 2x Yellow 1x2 Technic Beam with 2 Holes
- 1x Yellow 1x2 Technic Beam with 2 Holes
- 2x Red 1x2 Technic Beam with 2 Holes
- 2x Orange 1x3 Technic Beam with 2 Holes
- 2x Black 1x3 Technic Beam with 2 Holes
- 2x Black 1x3 Technic Beam with 2 Holes
- 1x Blue 1x2 Technic Beam
- 2x Blue 1x2 Technic Beam
- 2x Grey 1x2 Technic Beam with 2 Holes
- 2x Black 1x2 Technic Beam with 2 Holes



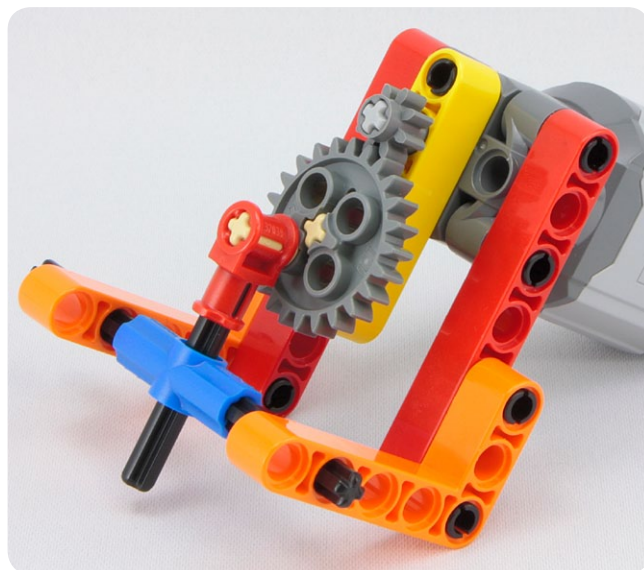
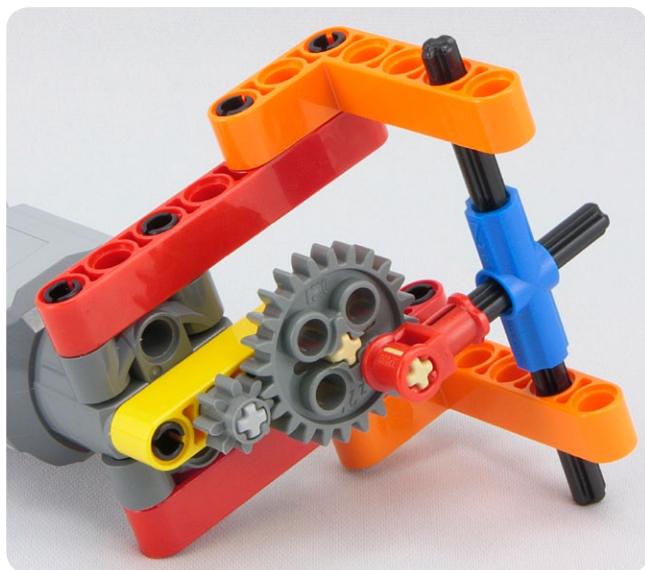
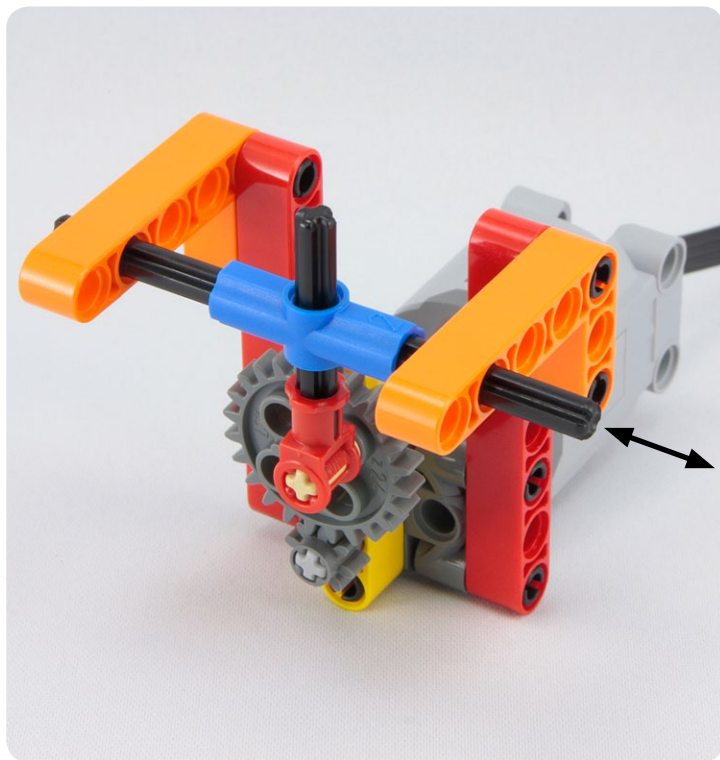
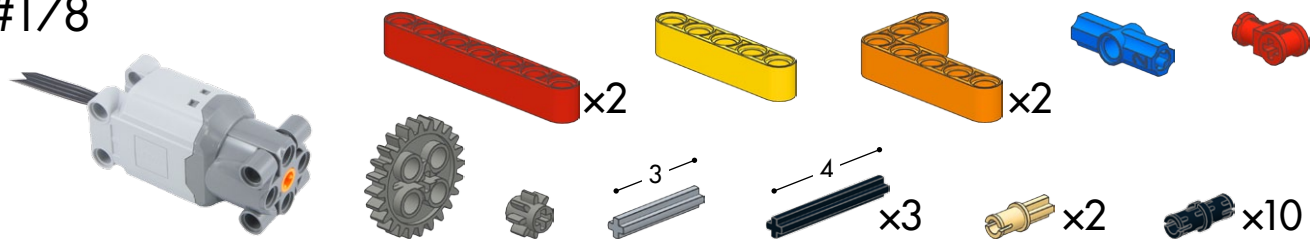


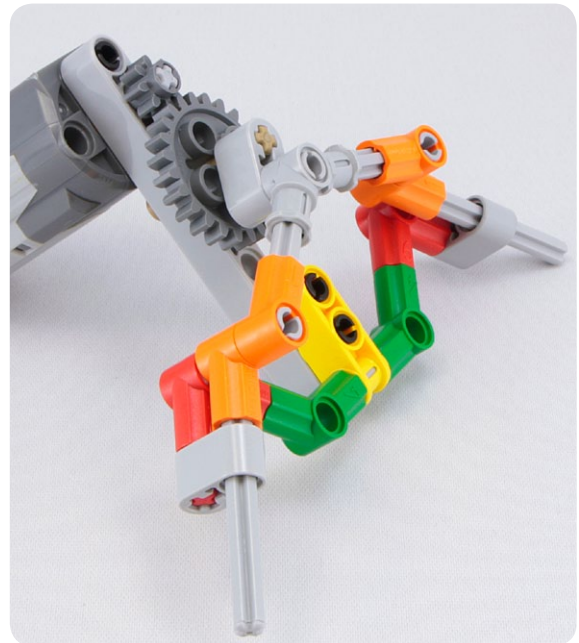
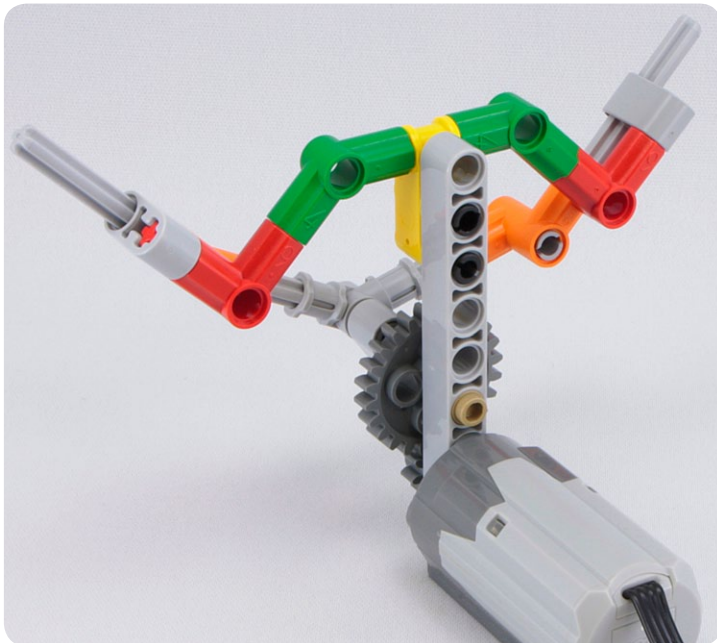
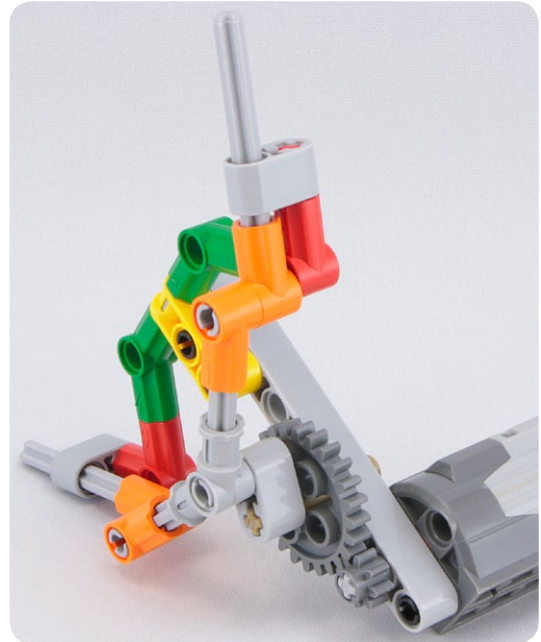
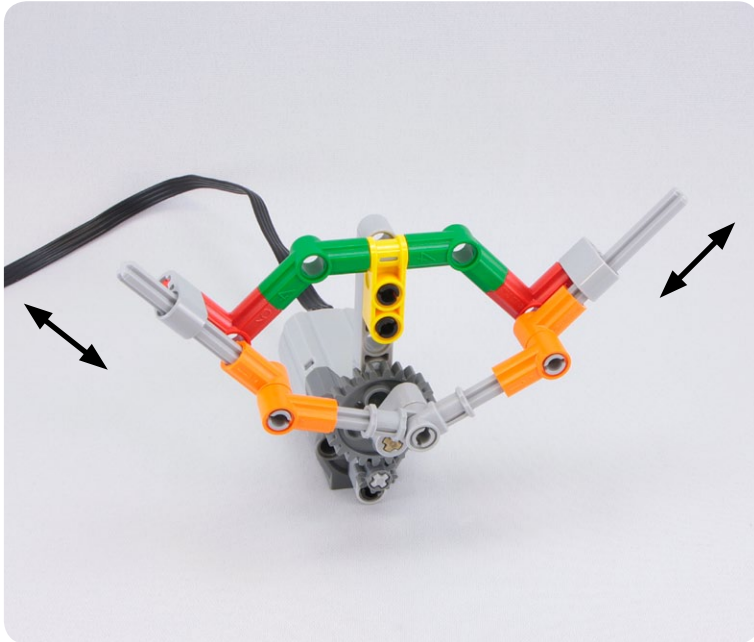
[illegible][illegible]

#177

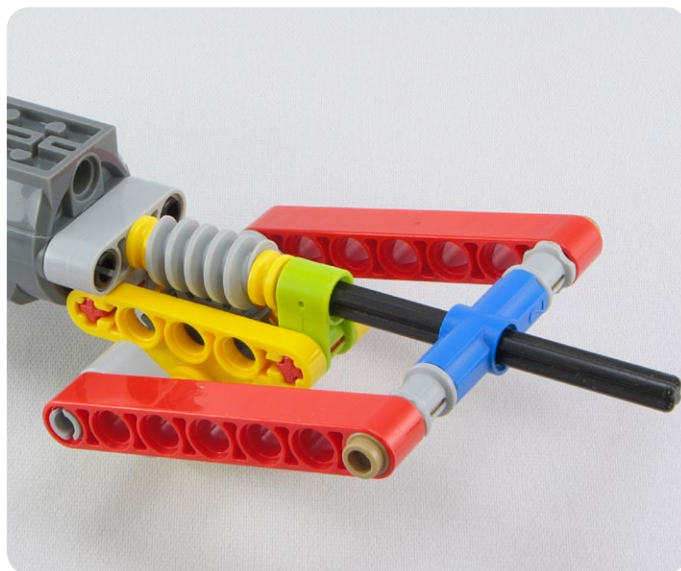
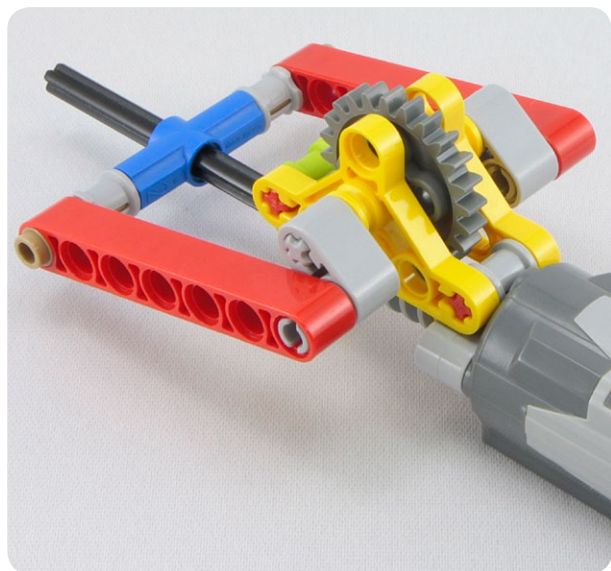
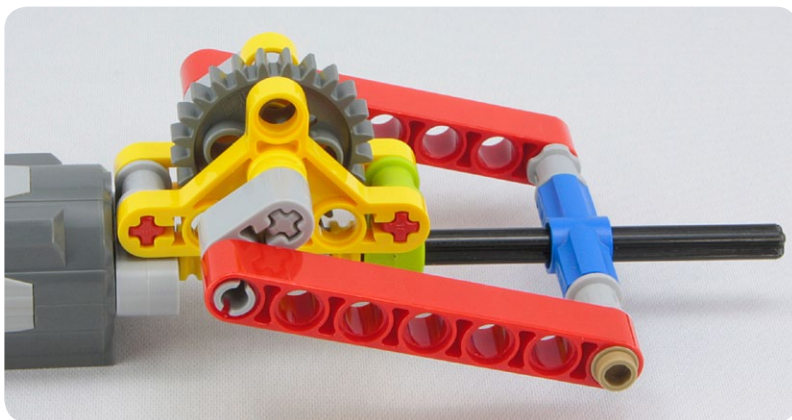
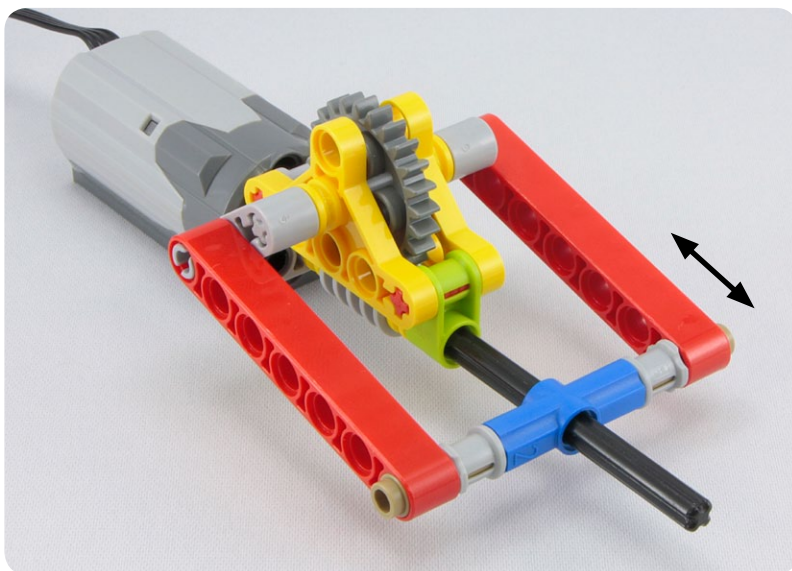
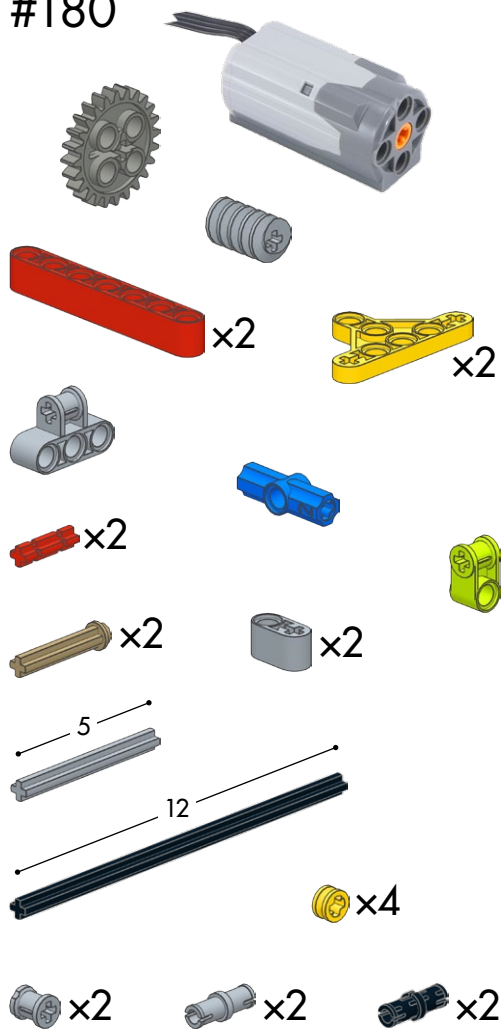


#178



[illegible]

#180

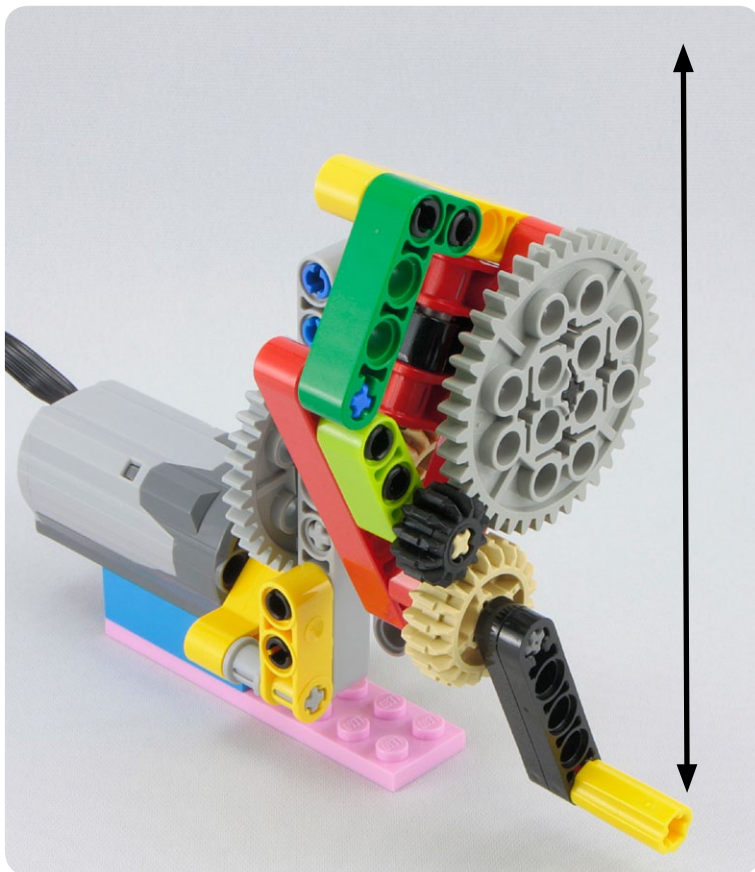
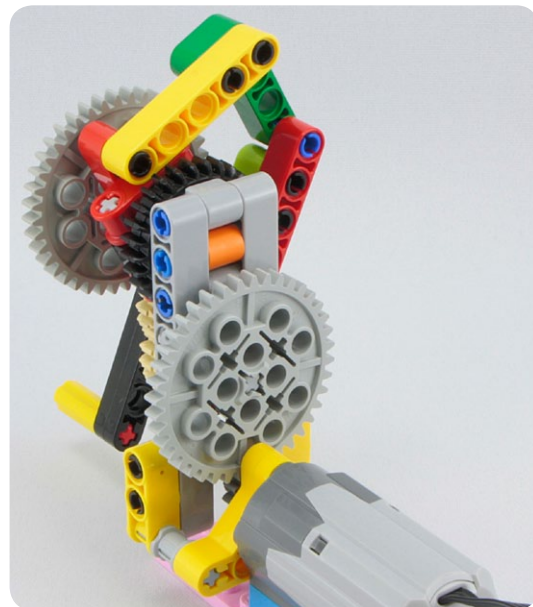


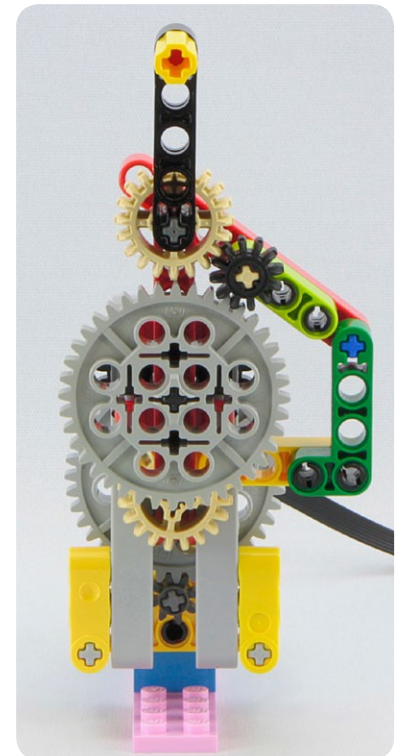
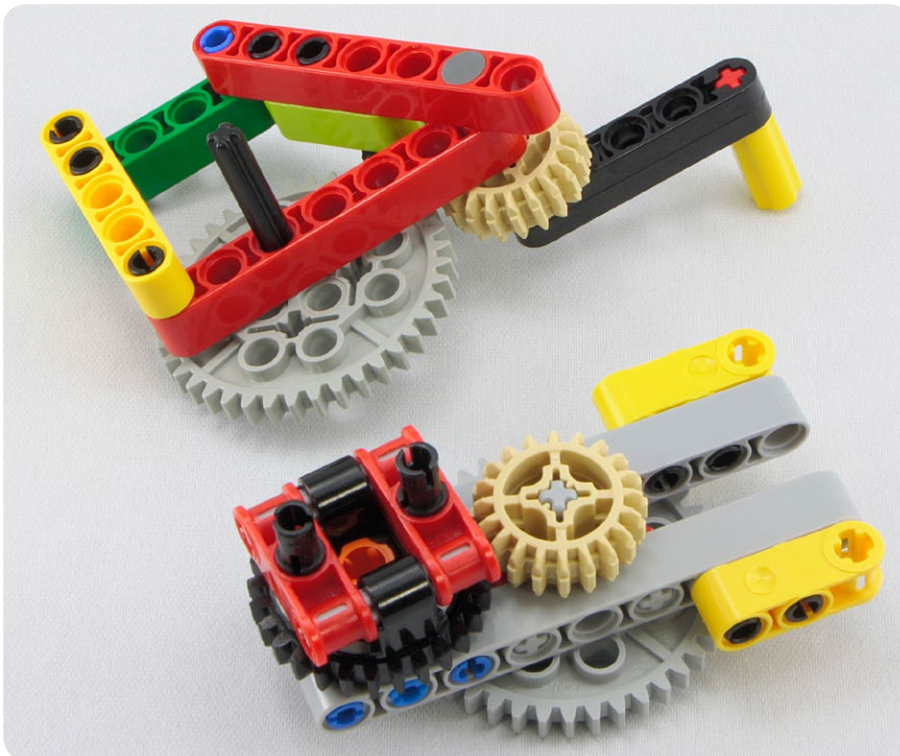
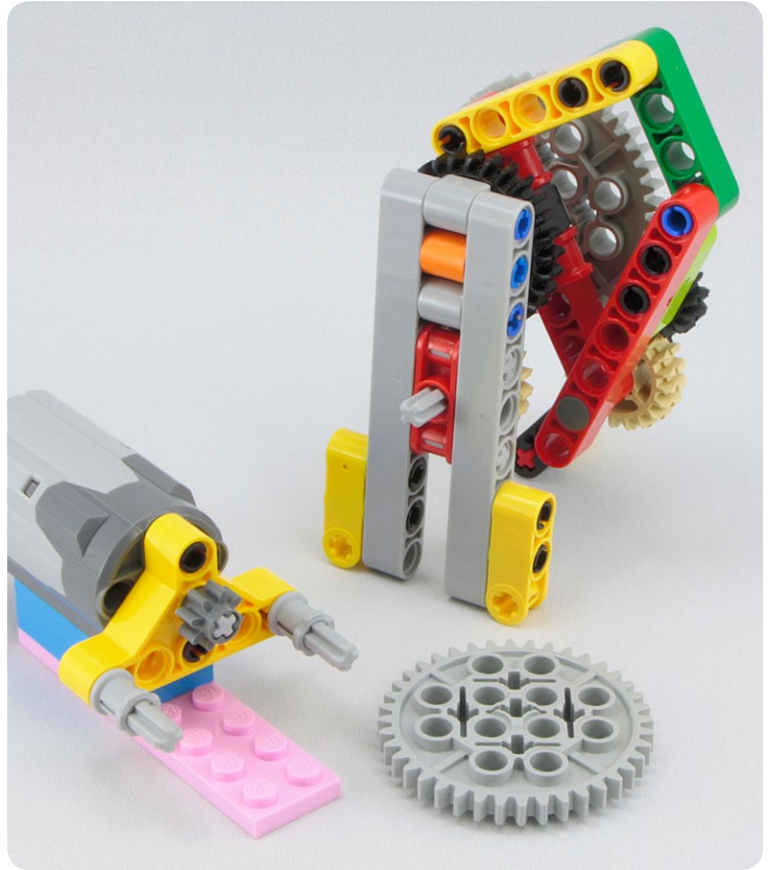
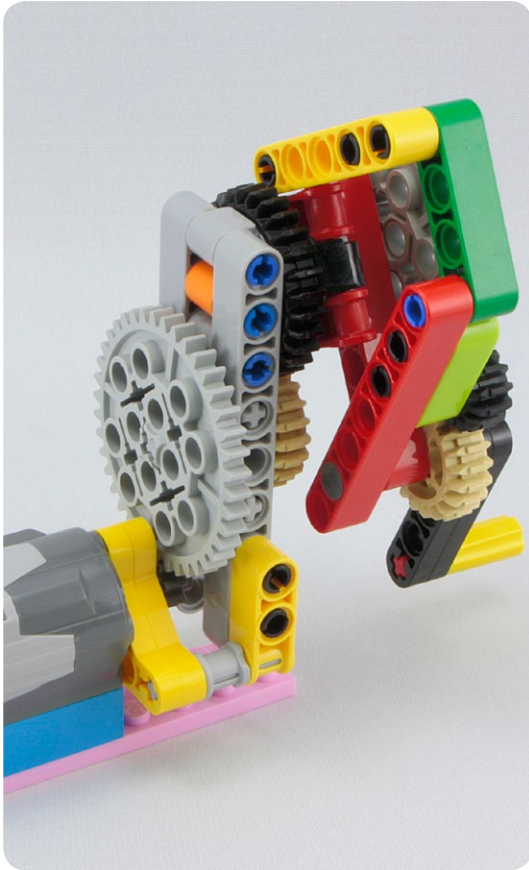
#181

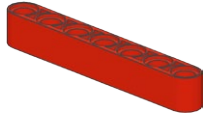
This image shows the parts required for step 181 of the LEGO Technic assembly process. The parts are as follows:

- 1x Grey Motor
- 2x Grey Gear (24 teeth)
- 1x Small Black Gear (8 teeth)
- 1x Dark Blue Gear (24 teeth)
- 1x Yellow Gear (24 teeth)
- 1x Red 1x6 Beam
- 1x Green 1x3 L-Beam
- 1x Yellow 1x3 L-Beam
- 1x Blue 2x4 Plate
- 1x Yellow 1x3 Beam
- 1x Light Green 1x3 Beam
- 1x Yellow 1x2 Pin
- 1x Blue 2x4 Plate
- 1x Tan 1x2 Pin
- 1x Blue 1x2 Pin
- 2x Grey Axle (Length 3)
- 3x Blue Axle (Length 3)
- 13x Black Axle (Length 3)
- 3x Red 1x2 Pin
- 2x Yellow 1x2 Pin
- 1x Orange 1x2 Pin
- 2x Yellow 1x3 L-Beam
- 1x Pink 1x7 Plate
- 2x Black 1x6 Beam
- 8x Grey Axle (Length 3)
- 4x Black Axle (Length 4)
- 4x Grey Axle (Length 4)

The assembly diagram shows the motor connected to a series of gears. A large grey gear (24 teeth) is mounted on the motor's axle. This gear meshes with a smaller black gear (8 teeth), which in turn meshes with a dark blue gear (24 teeth). The dark blue gear is part of a larger mechanism that includes a yellow gear (24 teeth) and a red 1x6 beam. The entire assembly is supported by various beams and pins, including a green 1x3 L-beam, a yellow 1x3 L-beam, a blue 2x4 plate, and a tan 1x2 pin. The final assembly is shown in a perspective view at the bottom right.







x2



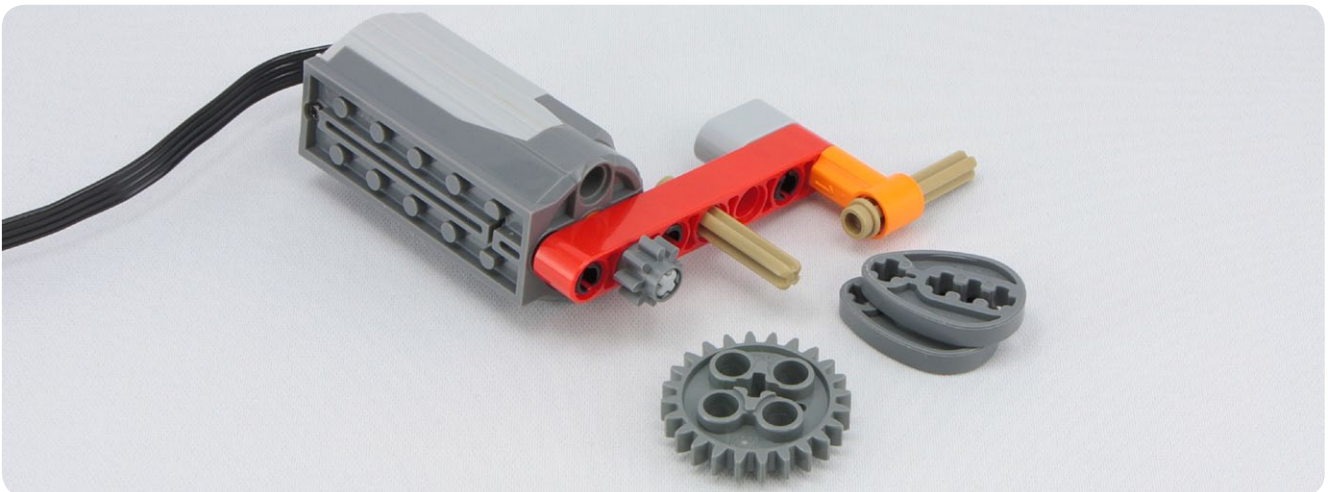
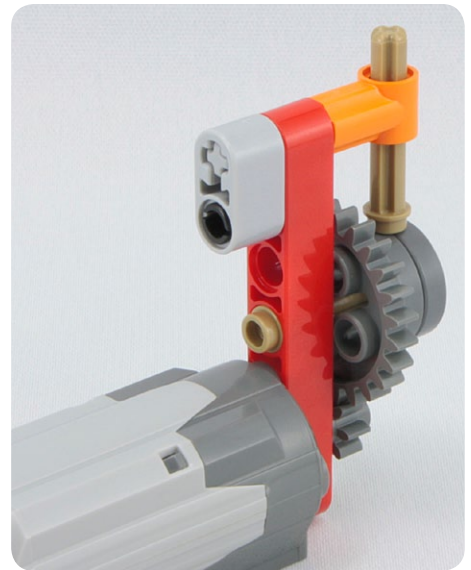
x2



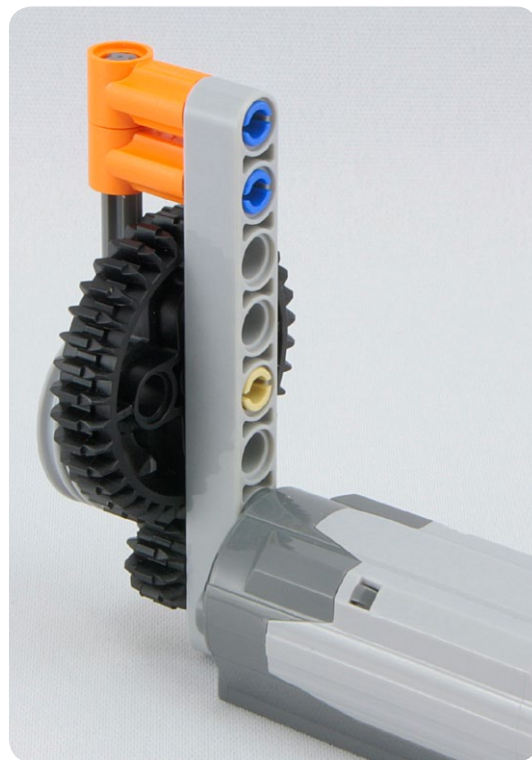
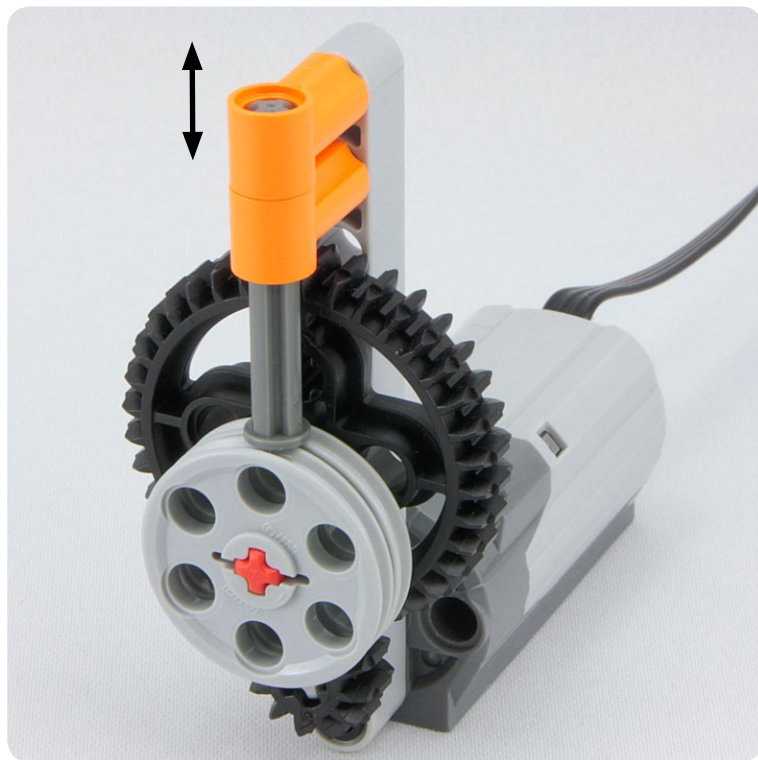
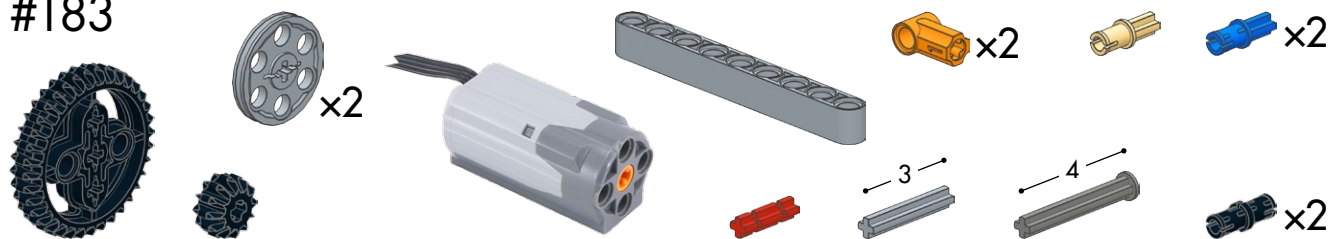
x2



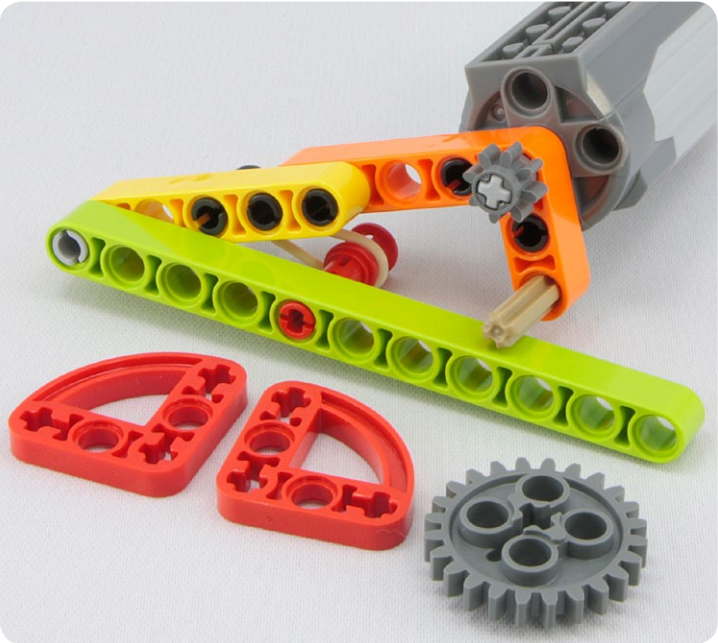
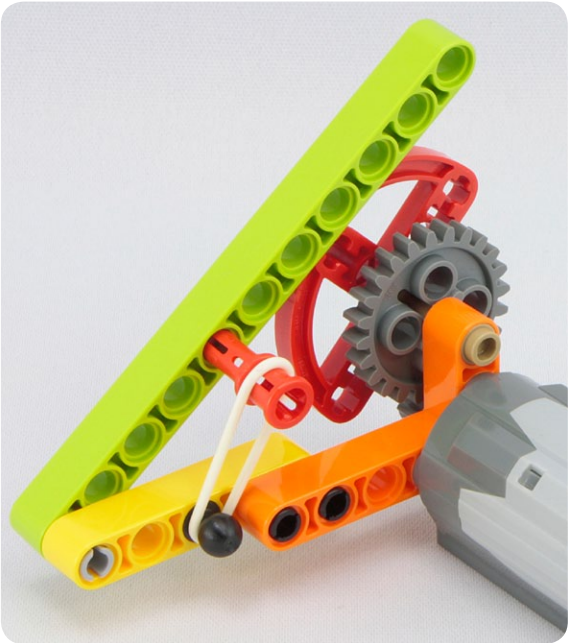
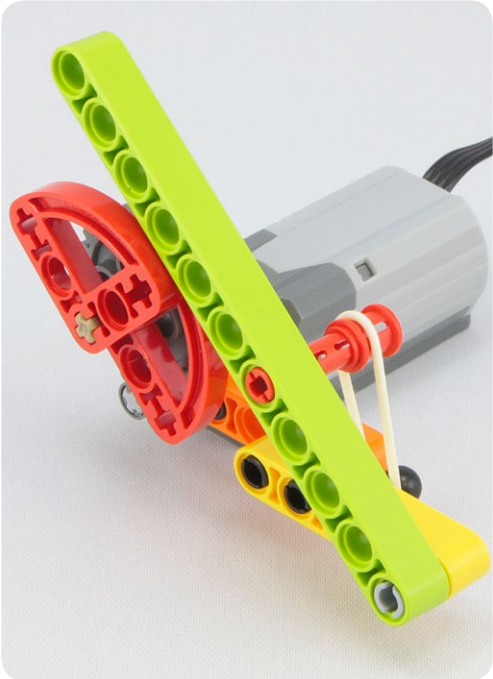
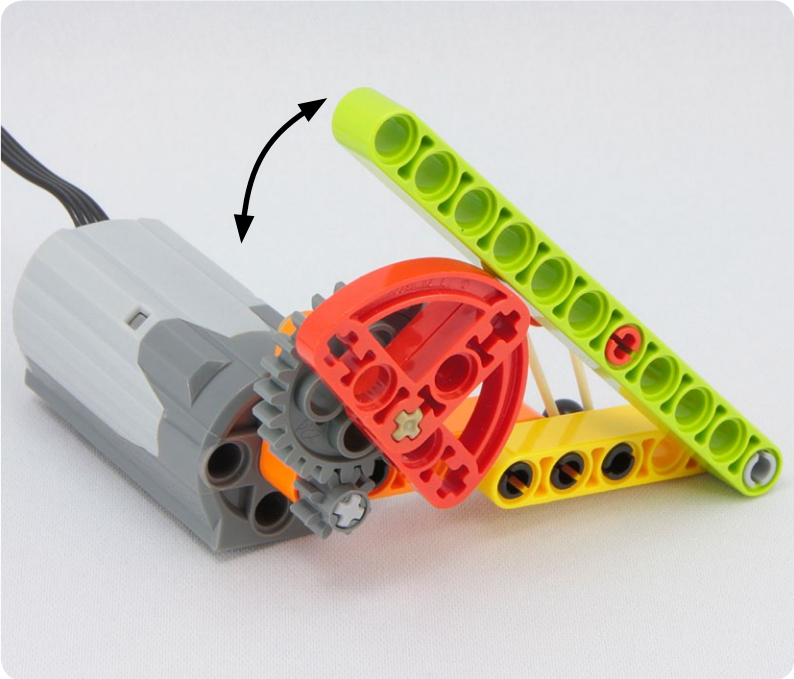
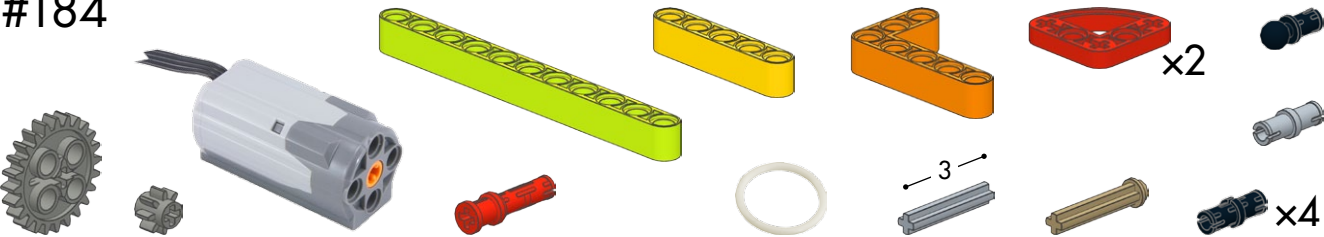
x3



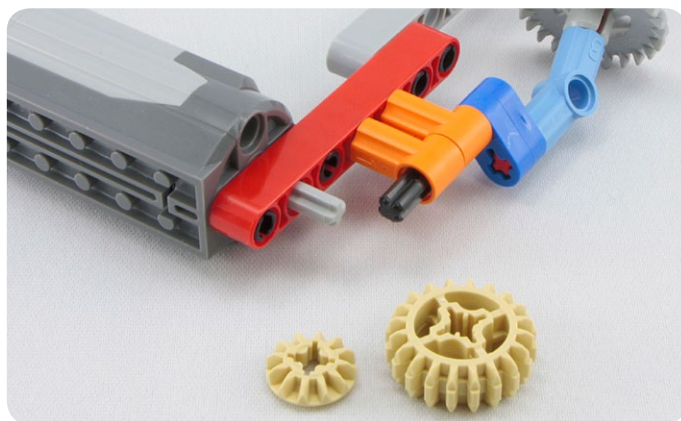
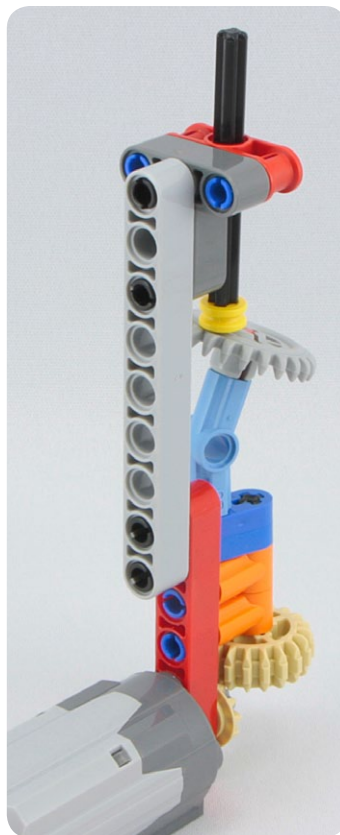
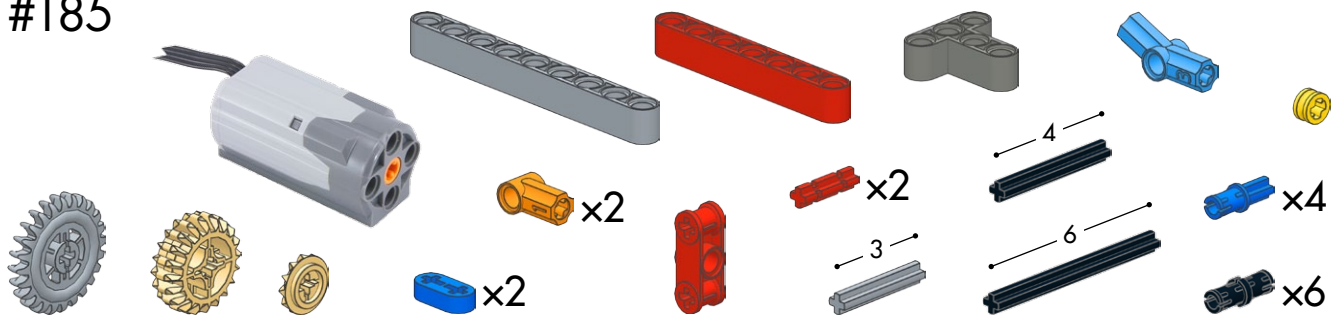
#183

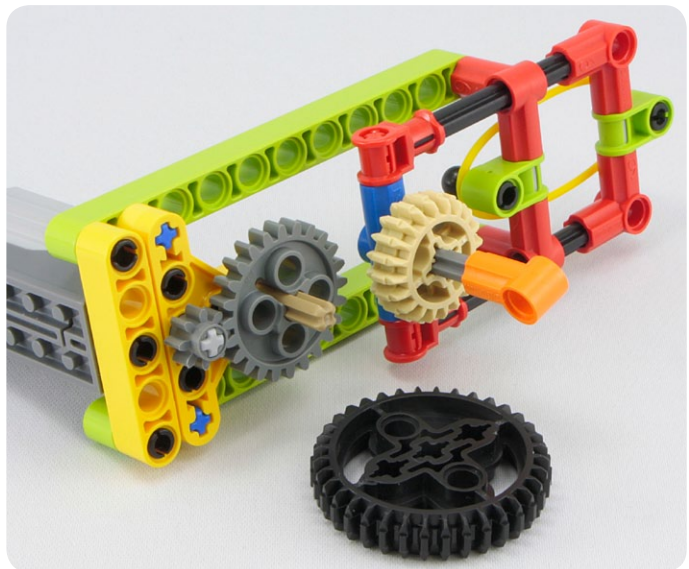
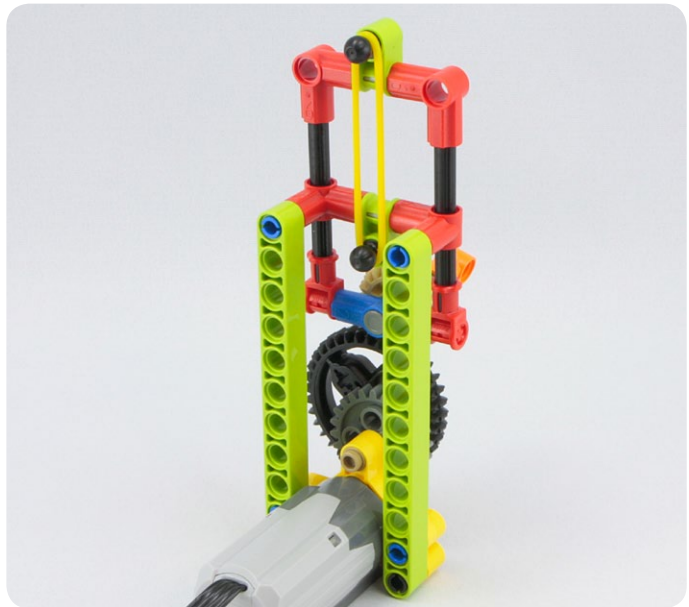


#184

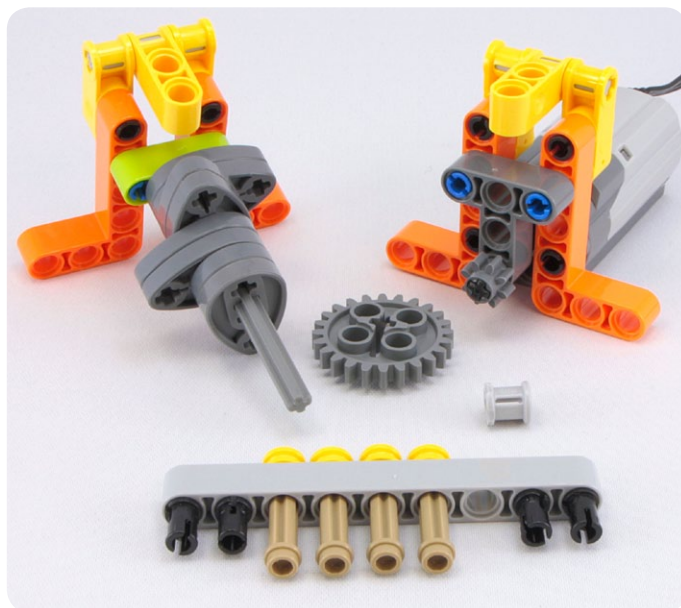
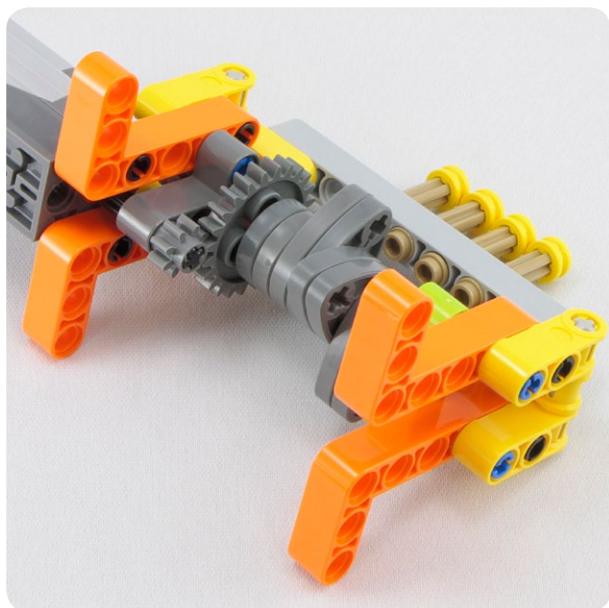
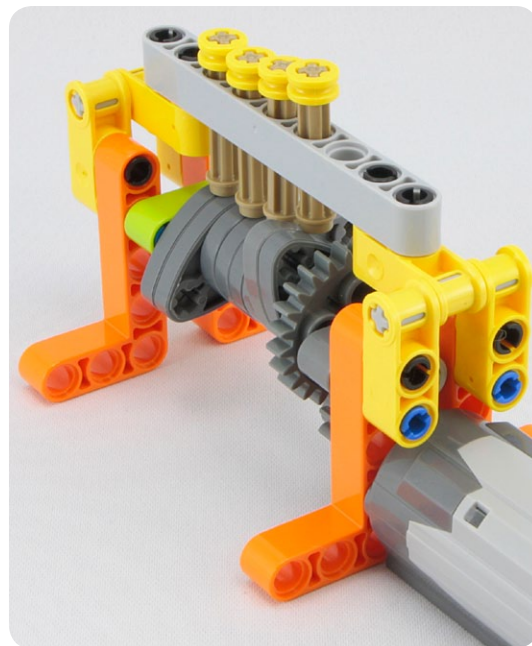
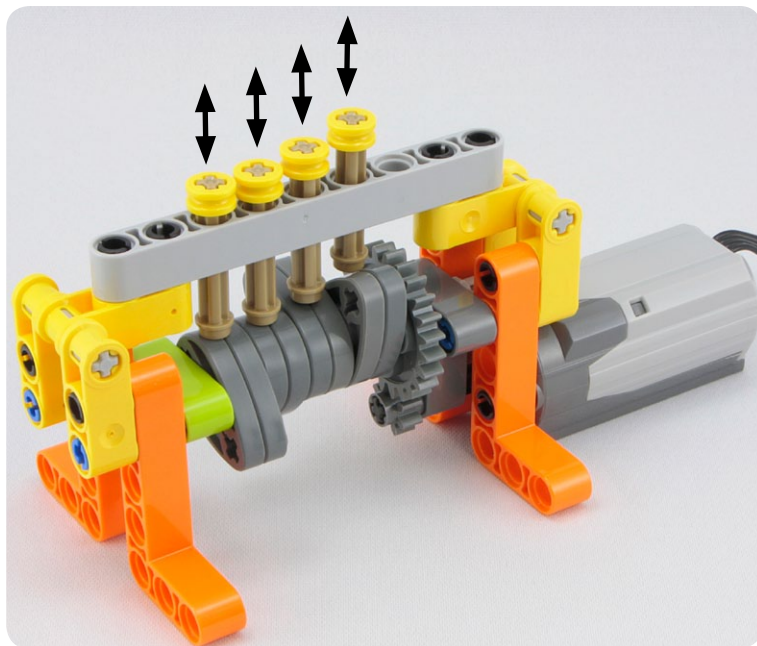
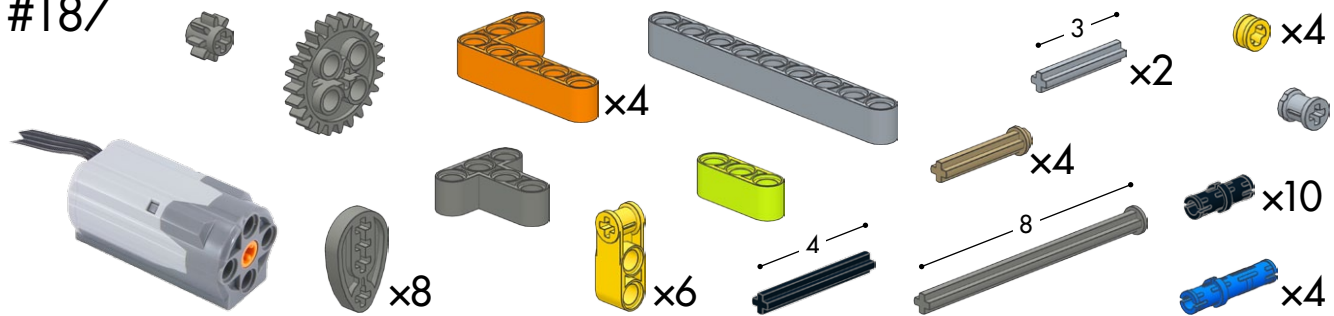



#185

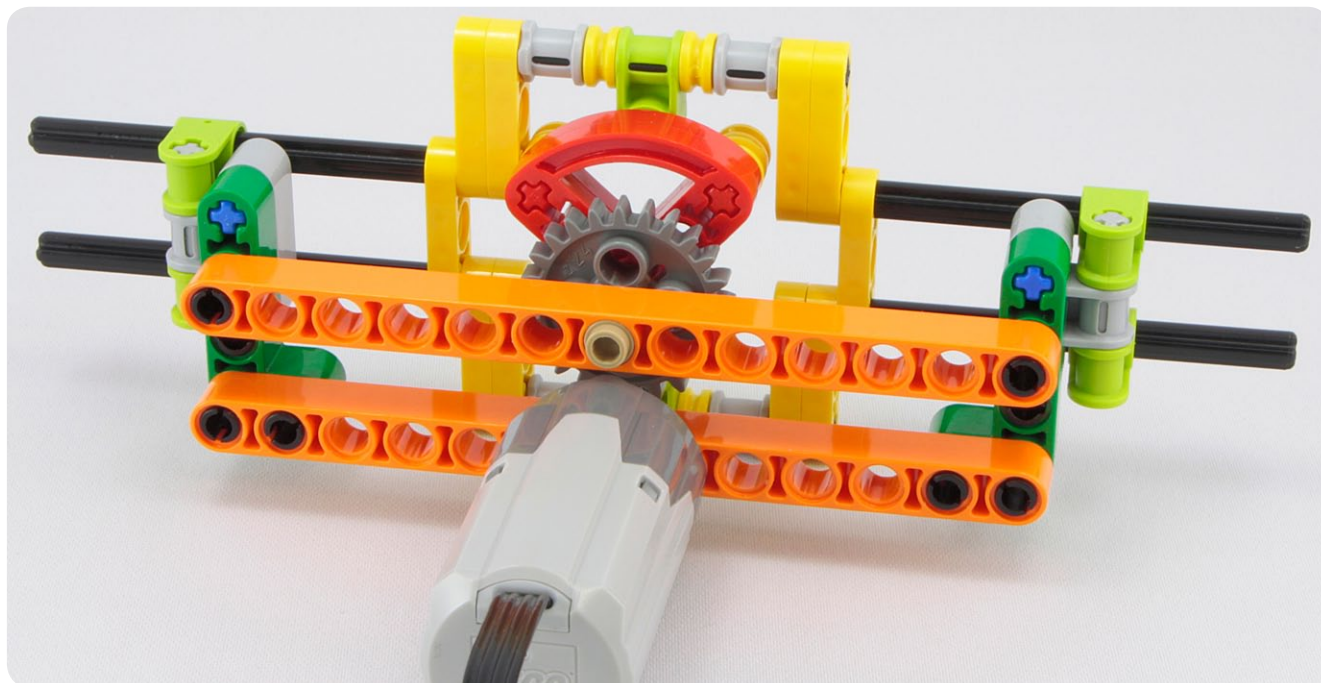
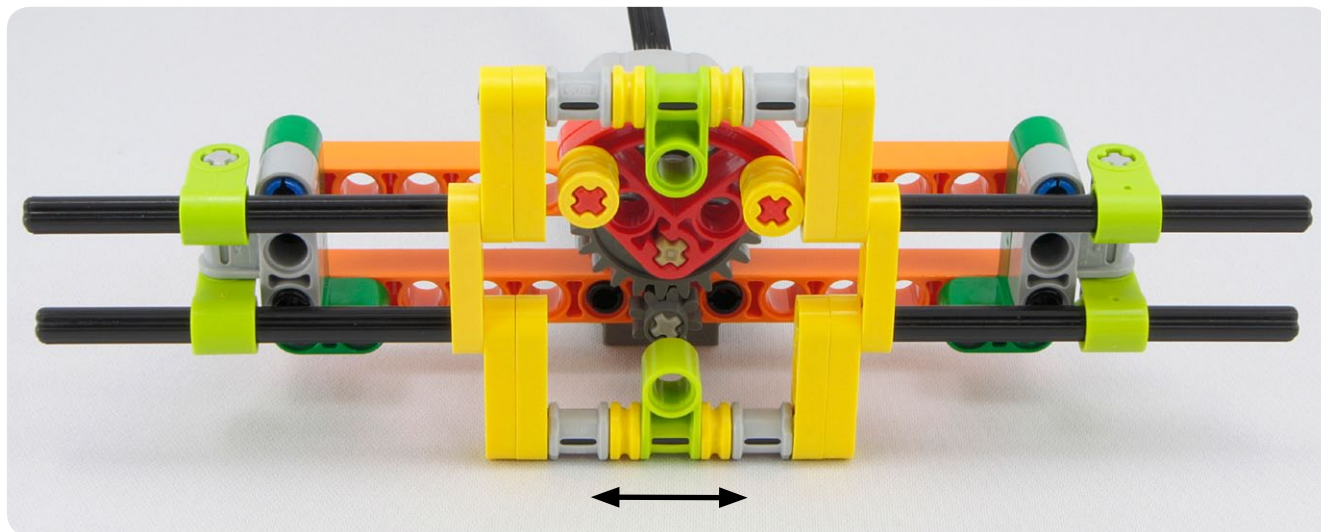


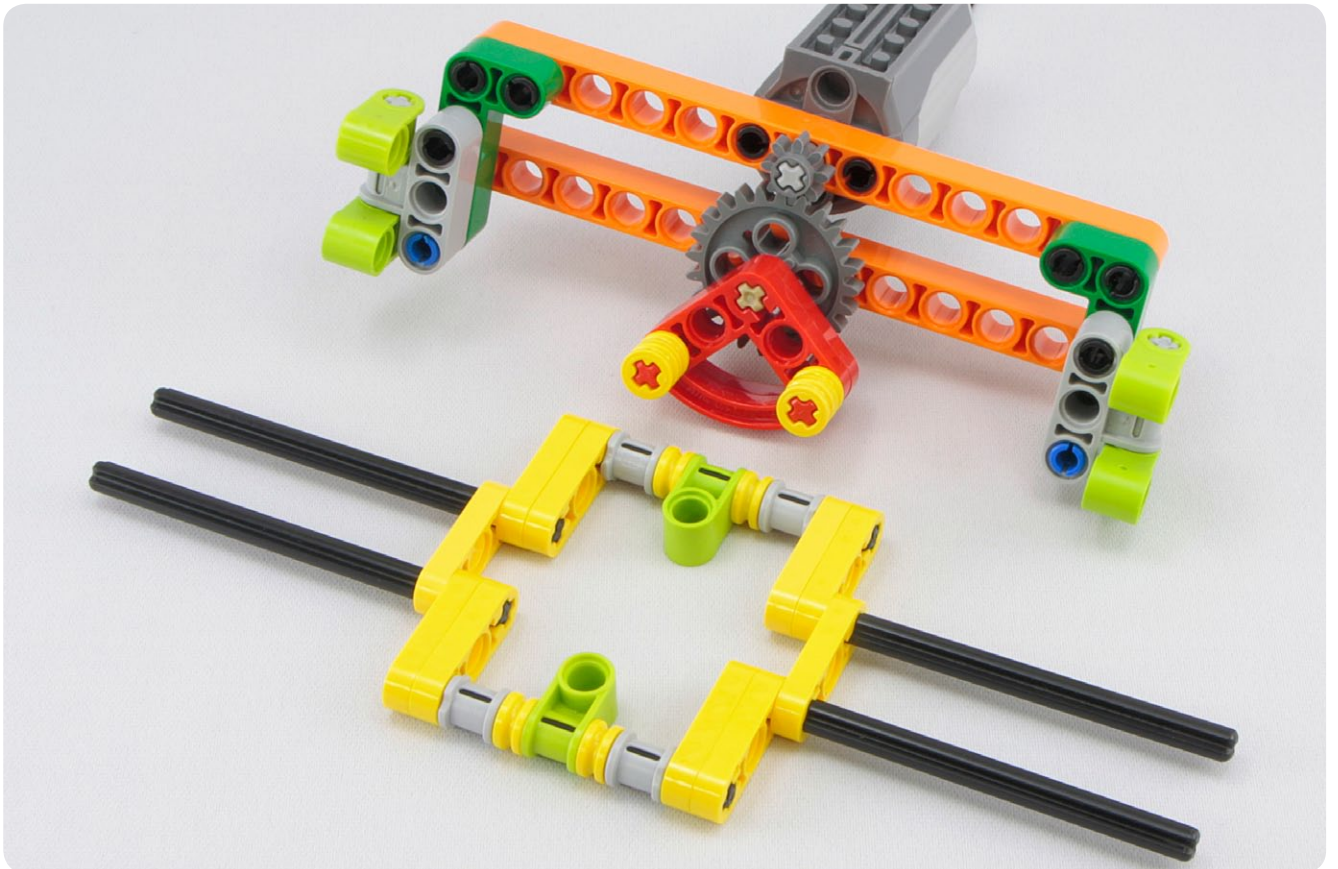
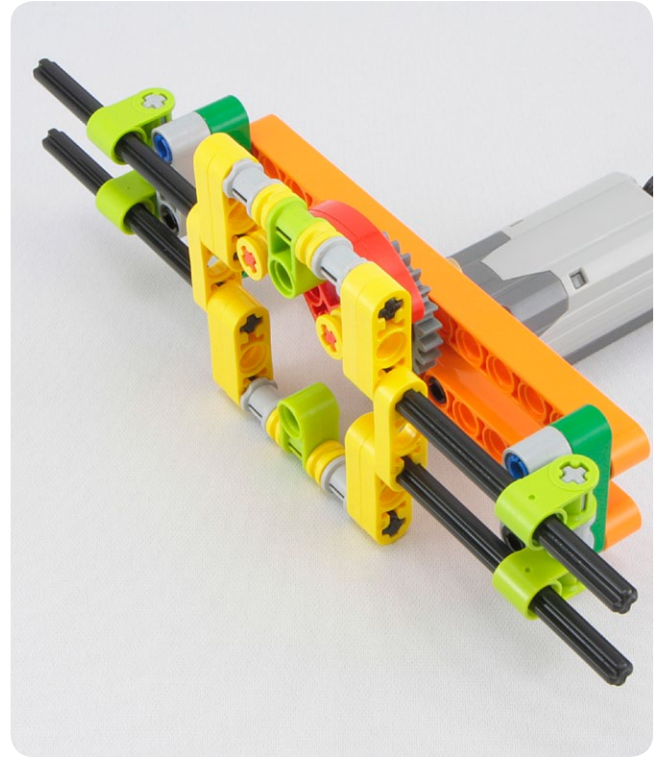
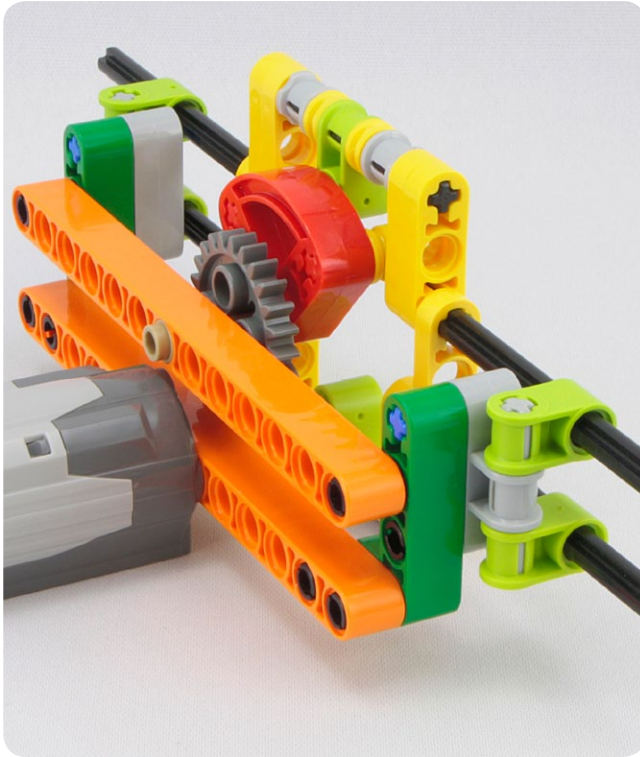
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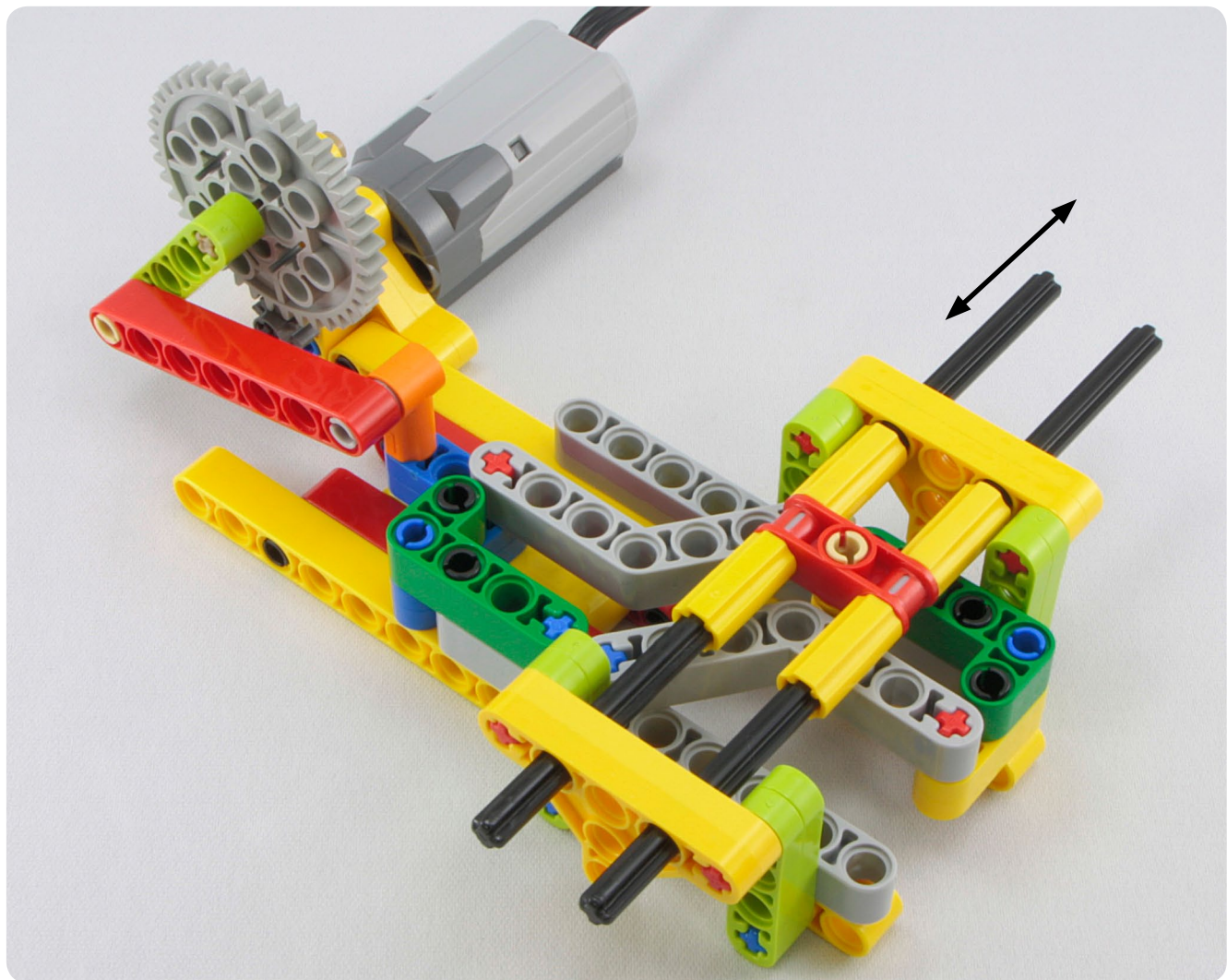
#187

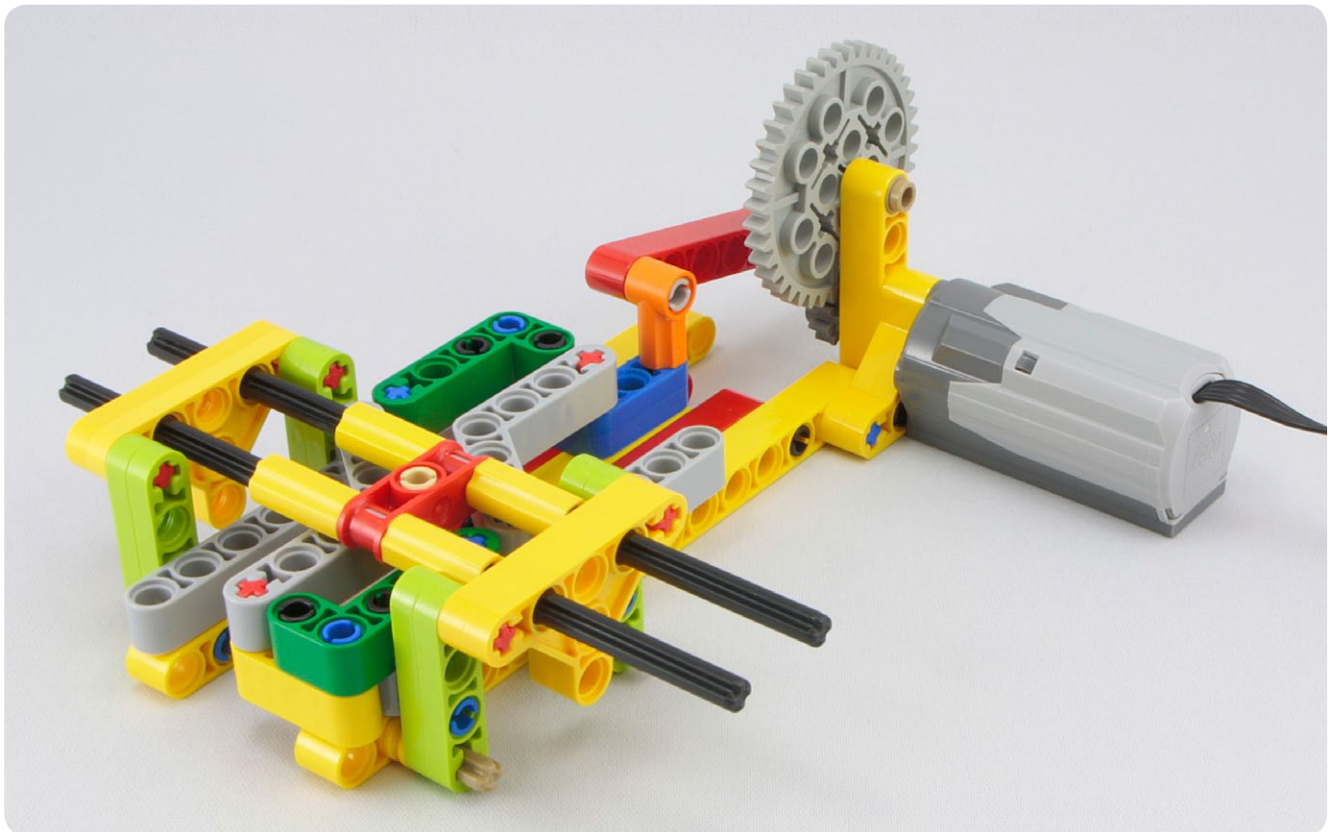
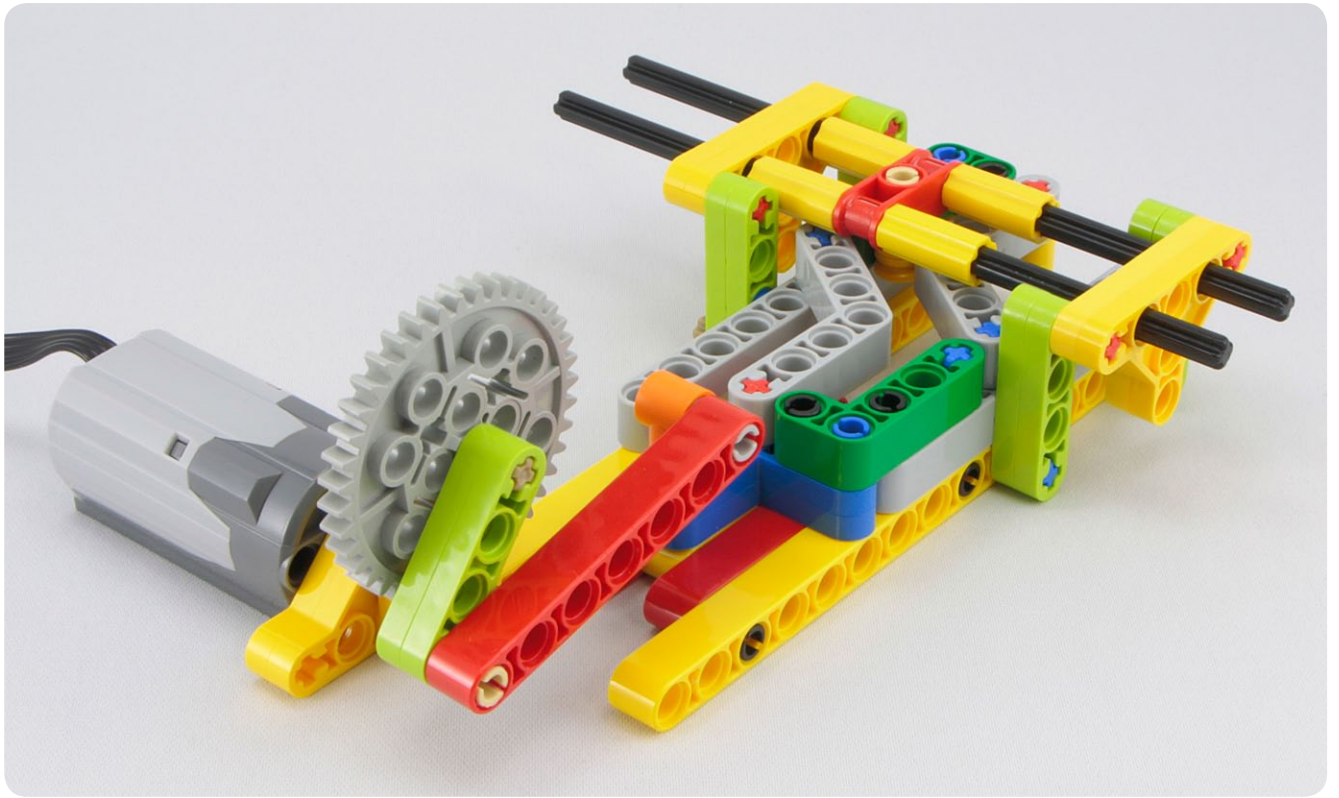


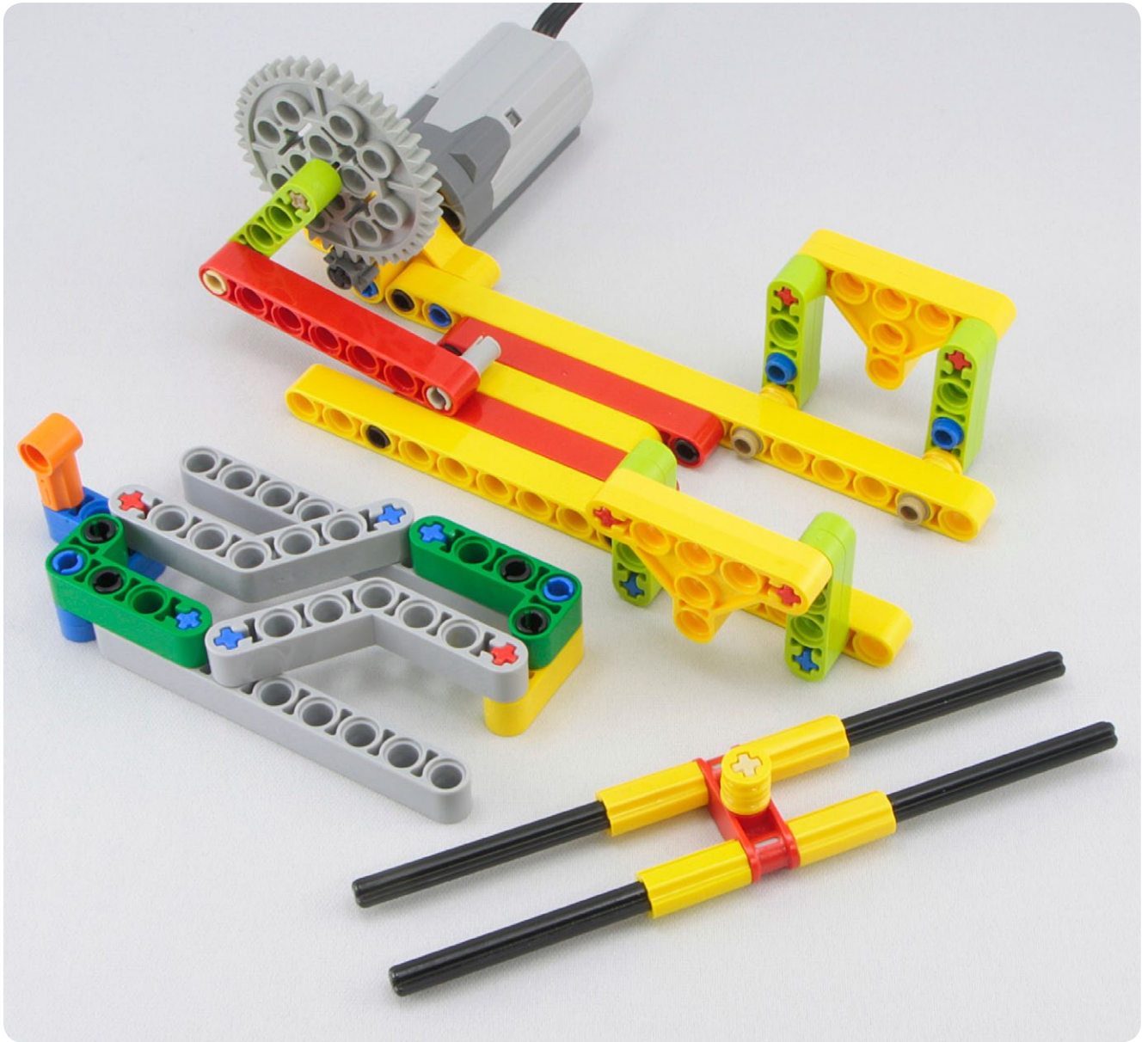

 This list shows the components for step 10. It includes: 2 orange 1x10 Technic beams, 2 green 1x3 Technic L-shaped connectors, 2 red 1x3 Technic L-shaped connectors, 2 grey 1x3 Technic connectors with a pin, 8 yellow 1x1 Technic pins, 1 grey motor, 10 yellow 1x3 Technic connectors, 6 yellow 1x2 Technic connectors, 4 grey 1x2 Technic pins, 2 red 1x2 Technic pins, 3 grey 1x3 Technic pins (length 3), 2 tan 1x3 Technic pins, 2 black 1x6 Technic pins (length 6), 4 black 1x8 Technic pins (length 8), 2 blue 1x2 Technic pins, and 10 black 1x2 Technic pins.

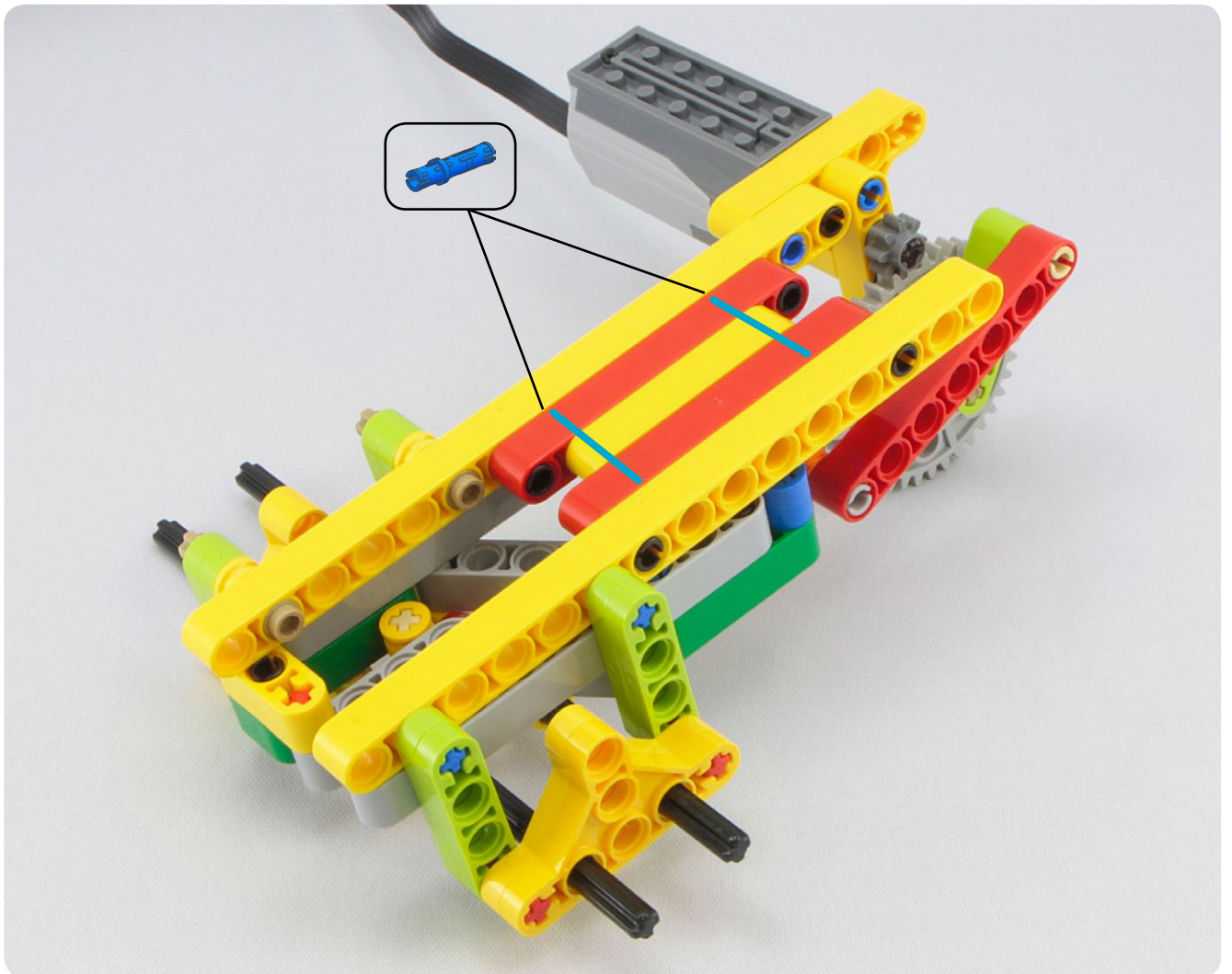
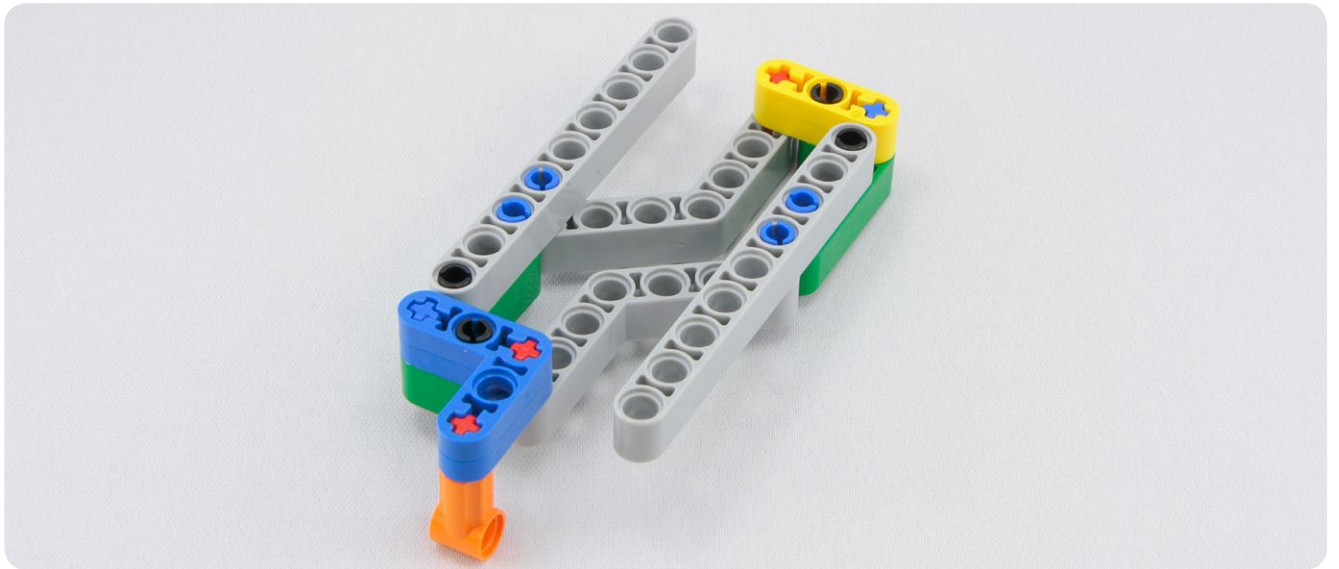




[illegible]



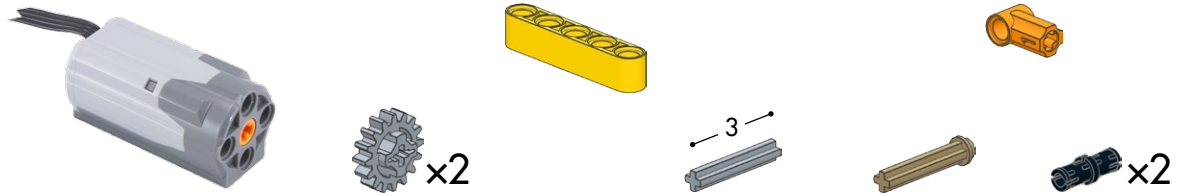




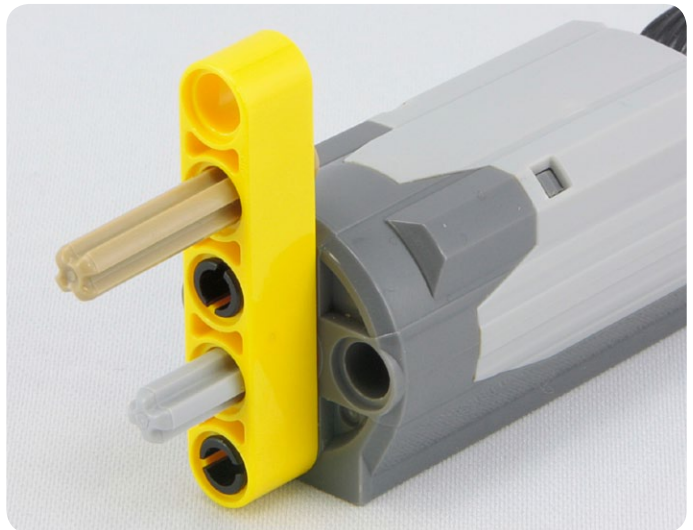
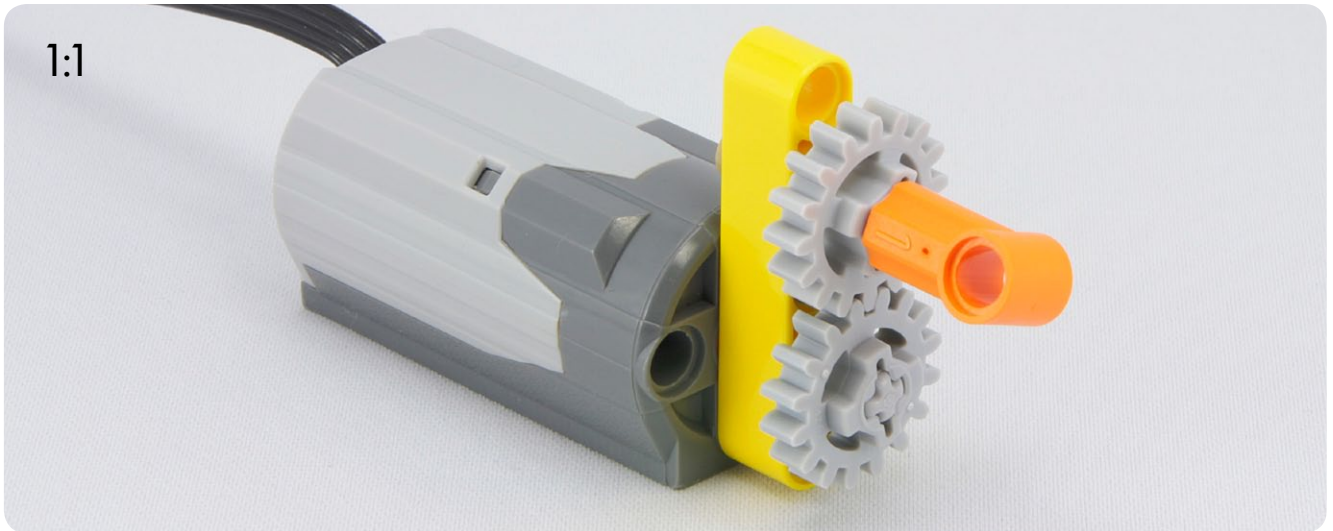
1:?

Gear systems with whole number ratios


#190



1:1

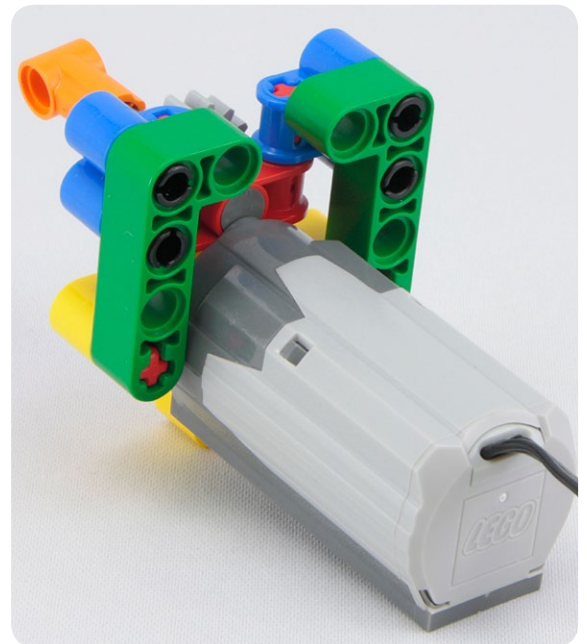


#191




LEGO parts list for step 191:

- 1 grey motor
- 1 grey gear
- 1 grey connector
- 2 green 1x3 Technic bricks
- 1 orange 1x2 Technic connector
- 1 red 1x3 Technic brick
- 2 yellow 1x5 Technic connectors
- 4 red 1x2 Technic connectors
- 2 blue 3-way Technic connectors
- 1 grey 3-way Technic connector
- 1 grey 1x4 Technic axle
- 1 grey 1x3 Technic axle
- 6 black 1x2 Technic pins

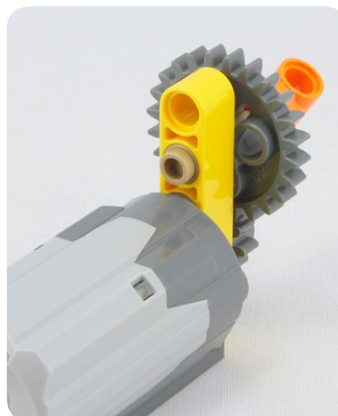


#192



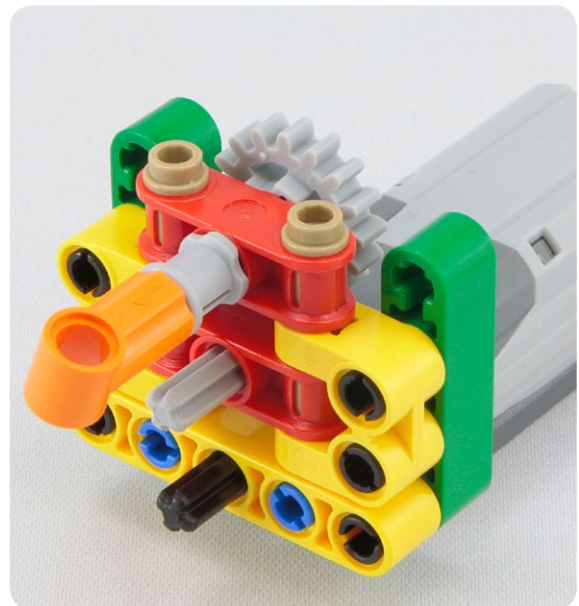
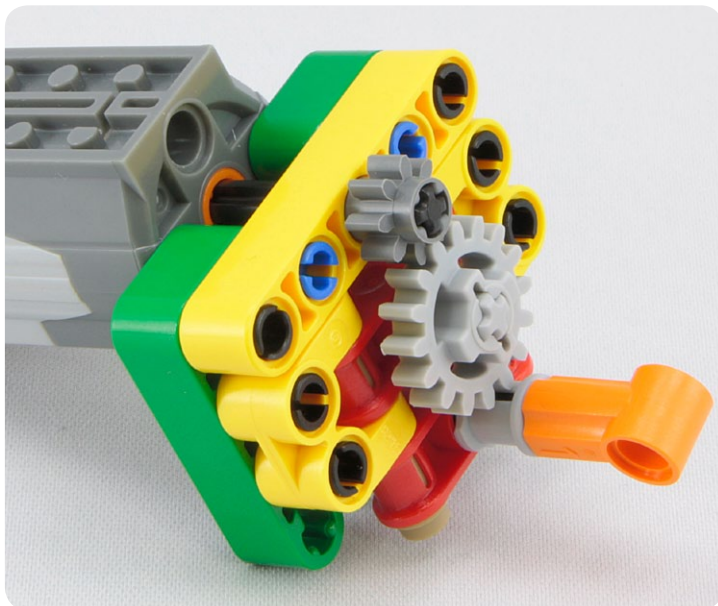
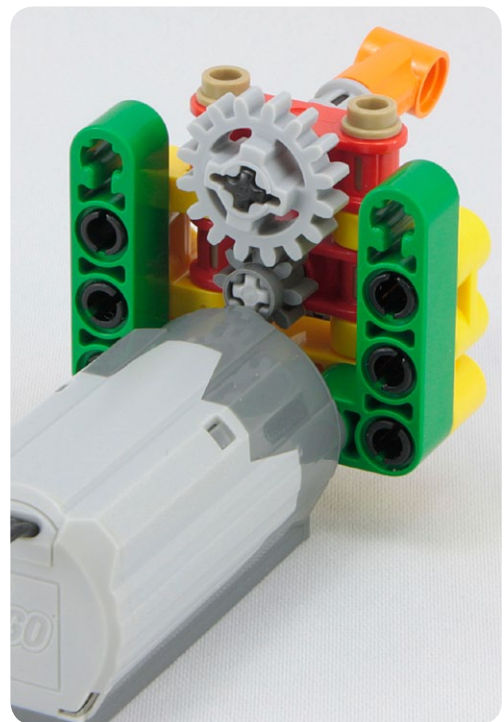
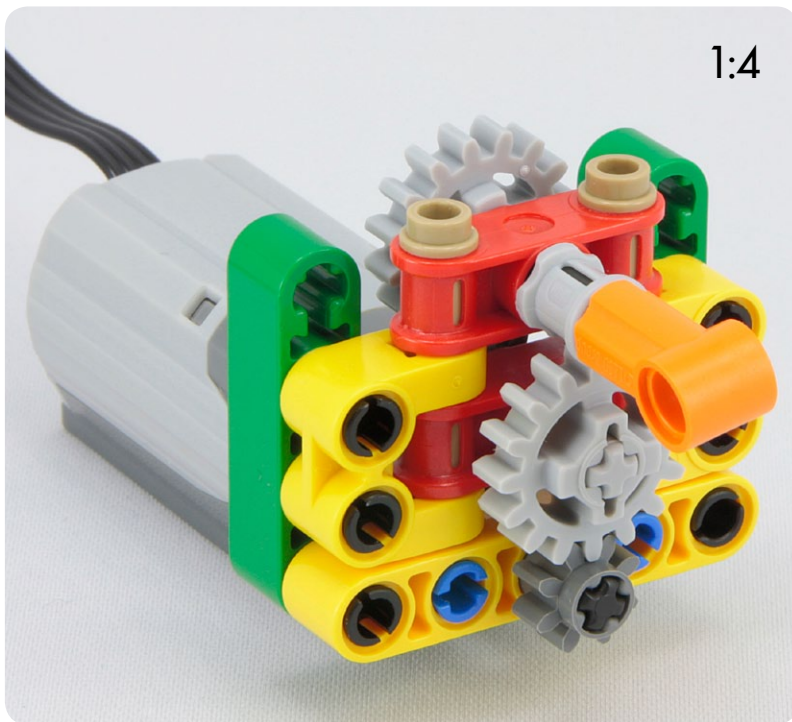
LEGO parts list for step 192:

- 1x Grey Motor
- 1x Grey Gear
- 1x Yellow 1x5 Technic Beam
- 1x Grey 1x2 Technic Pin
- 3x Grey 1x2 Technic Pin (indicated by a double-headed arrow and the number 3)
- 1x Orange 1x2 Technic Pin
- 1x Tan 1x2 Technic Pin
- 2x Black 1x2 Technic Pin (indicated by 'x2')

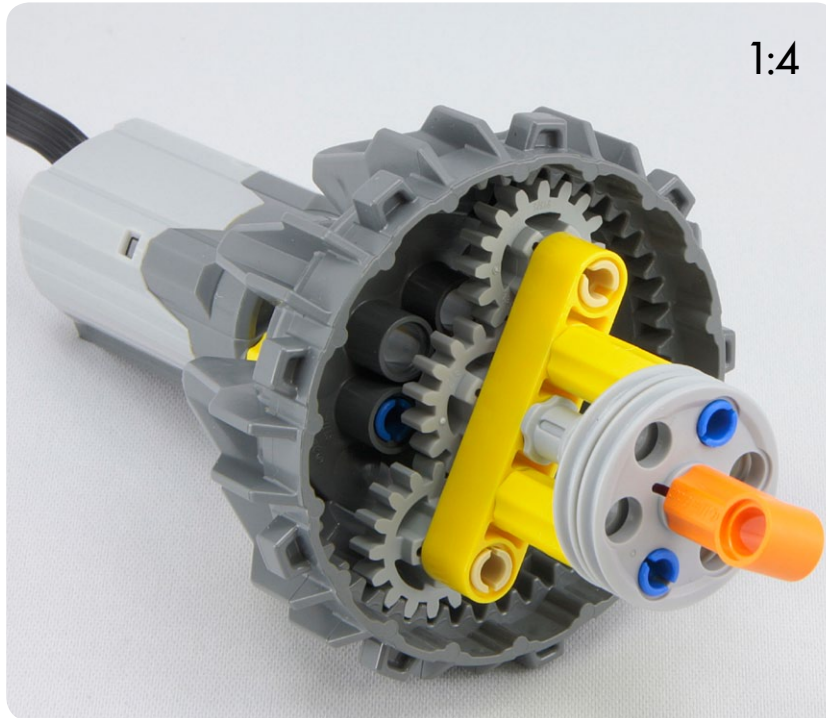
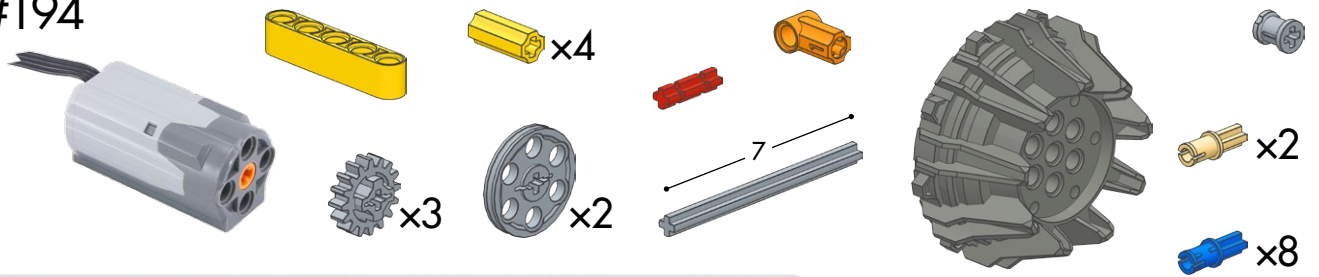


#193

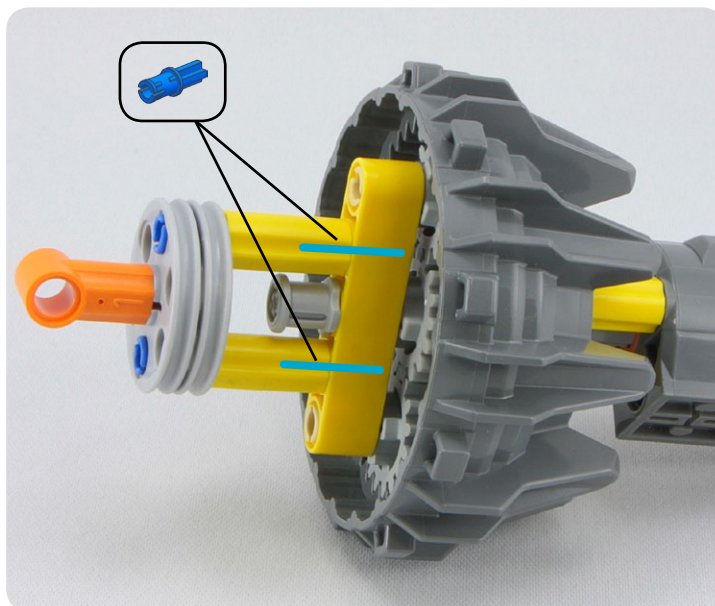
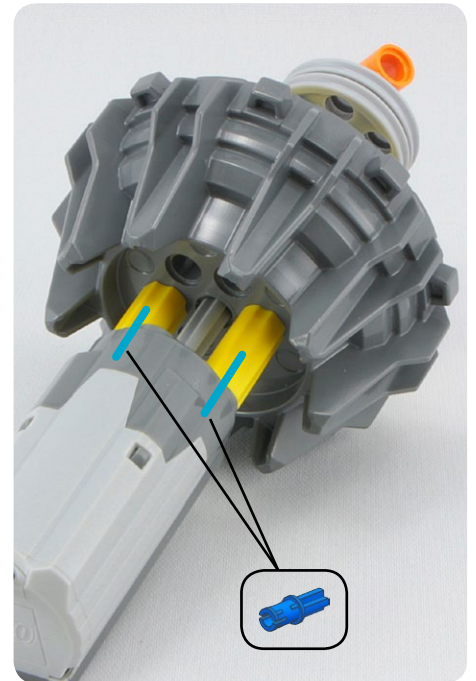
1 grey motor, 1 yellow 1x5 Technic beam, 1 green 1x3 Technic beam, 2 green 1x3 Technic beams, 2 yellow 1x2 Technic connectors, 2 red 1x2 Technic connectors, 1 orange 1x2 Technic connector, 1 grey 1x2 Technic connector, 2 grey 1x2 Technic connectors, 2 grey 1x2 Technic connectors, 3 grey 1x2 Technic connectors, 2 tan 1x2 Technic connectors, 2 black 1x2 Technic connectors, 2 blue 1x2 Technic connectors, and 6 black 1x2 Technic connectors.



#194



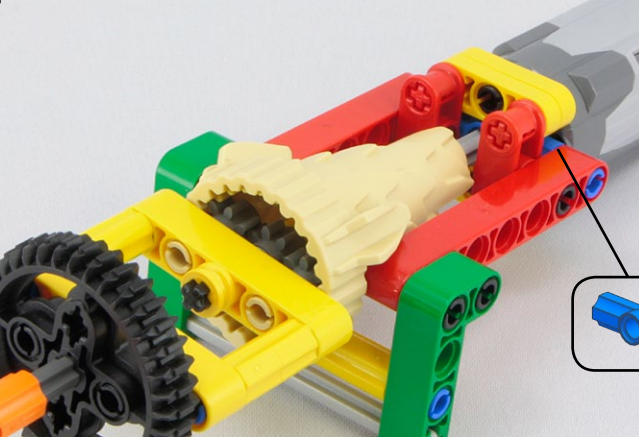
1:4



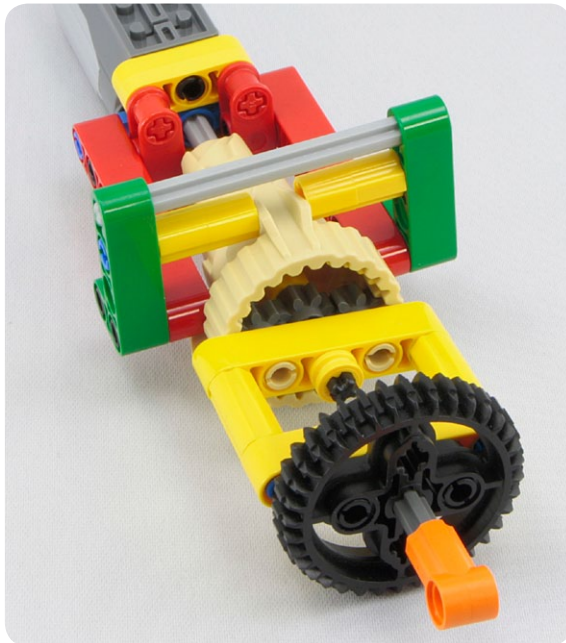
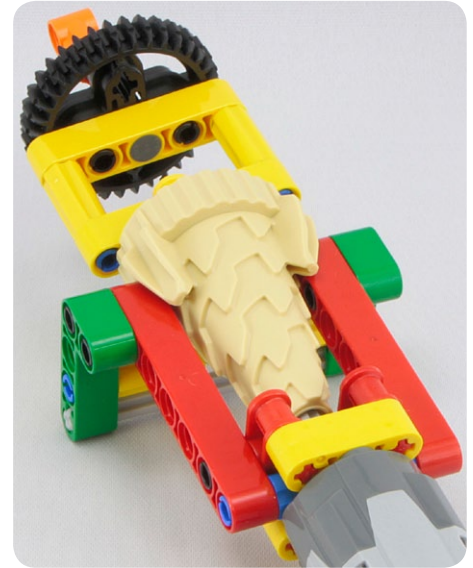
#195

1x6 red beam
2x5 yellow beam
2x2 red connector
2x3 green L-connector
2x2 blue connector
1x2 orange connector
1x4 grey axle with pin
1x2 yellow pin
2x2 red connector
2x2 yellow connector
4x2 red connector
5x2 yellow connector
4x2 yellow connector
4x4 black axle with pin
2x7 grey axle with pin
2x2 tan pin
2x2 blue connector
3x2 grey connector
1 motor
1 black gear
1 tan gear
3x2 tan pin
8x2 blue connector
10x2 black connector

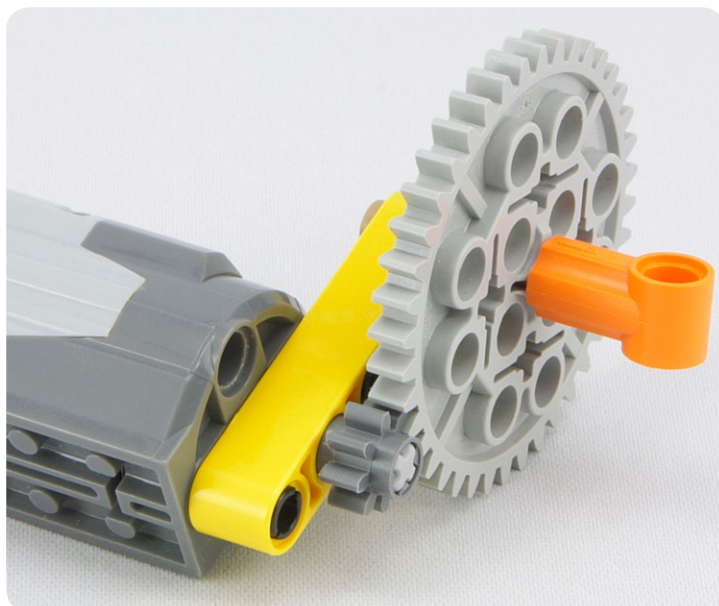
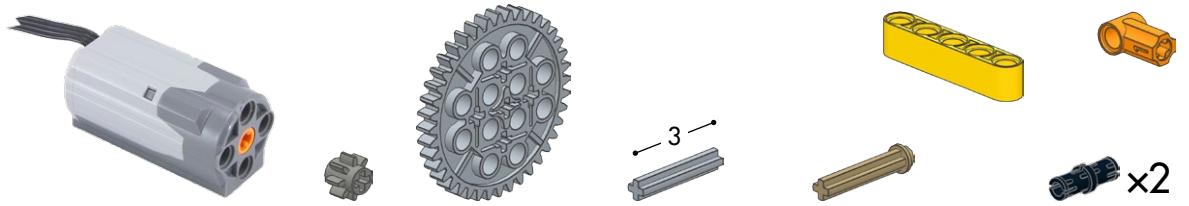
1:4



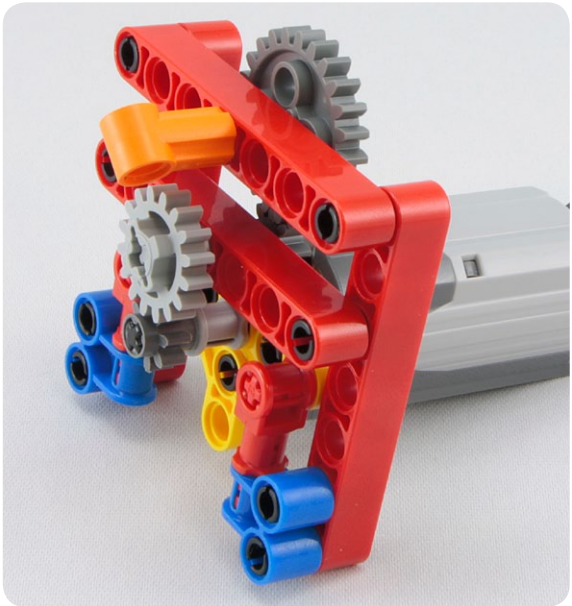
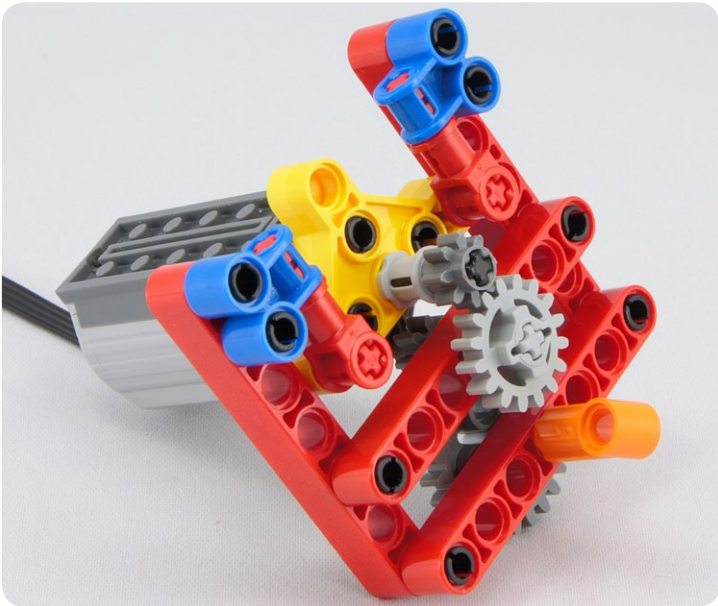
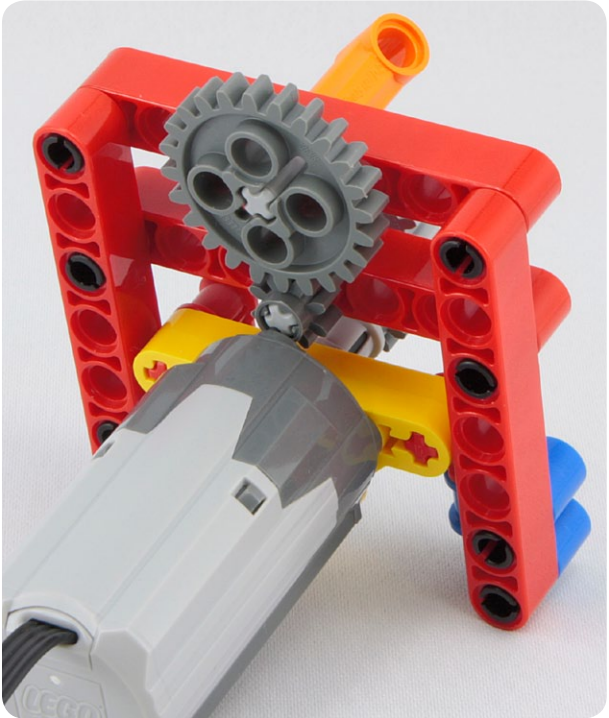
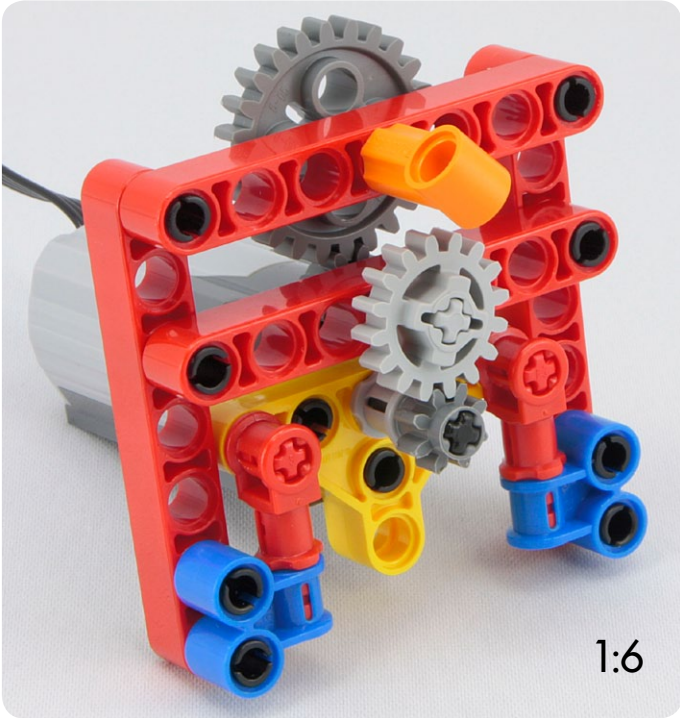
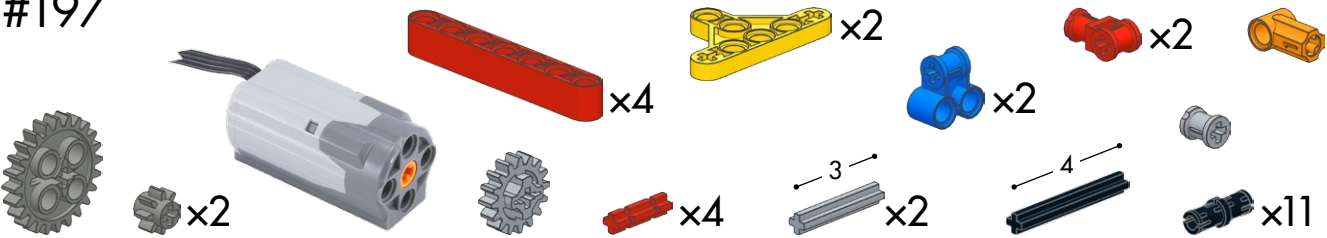
A perspective view of the completed LEGO Technic motor assembly. The assembly consists of a grey motor at the back, connected to a red Technic beam. A yellow beam runs along the top, supporting a large black gear with an orange pin. A green beam runs along the bottom, supporting a yellow gear. A blue pin is highlighted with a callout box, showing its connection to the red beam.



#196



#197



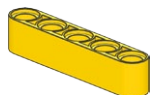
#200



x2



x2



3



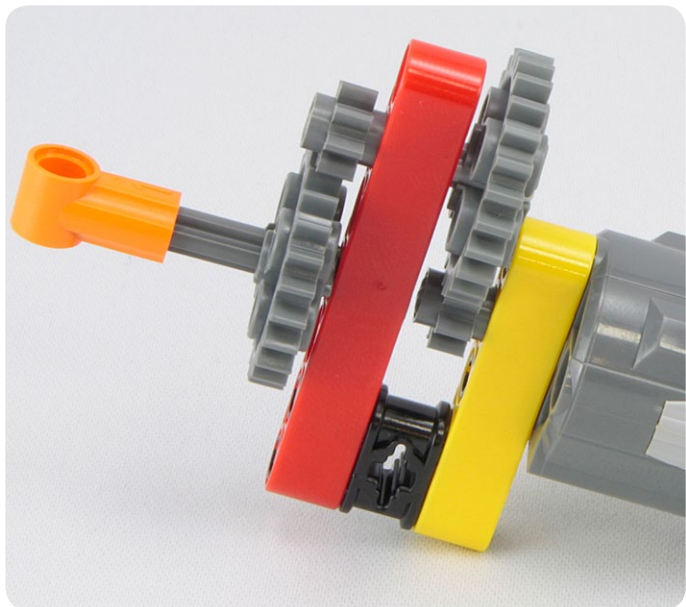
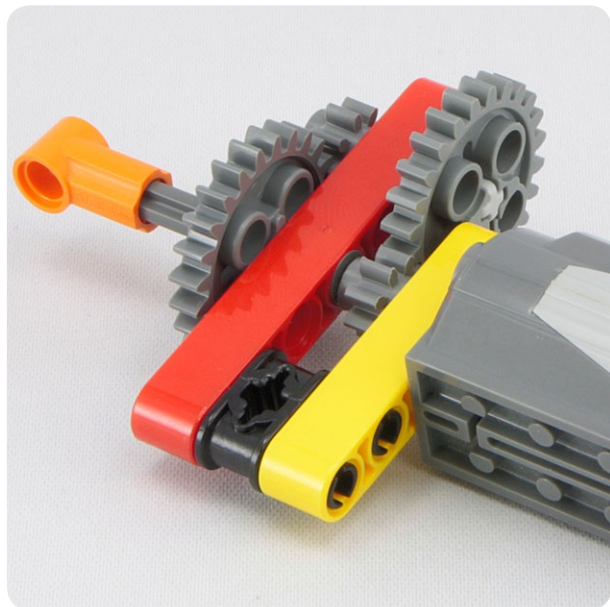
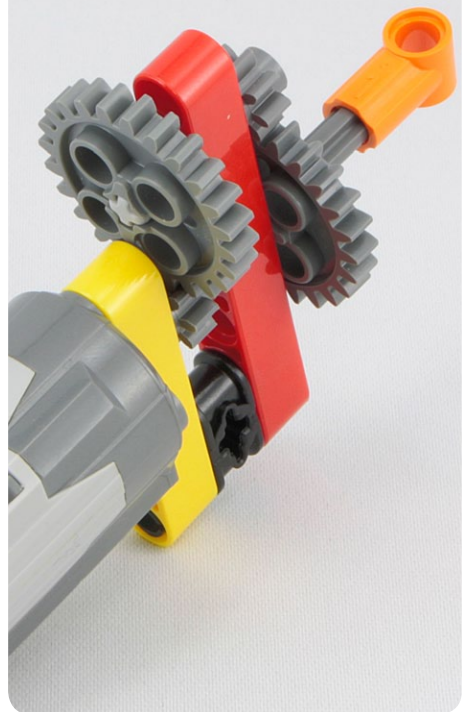
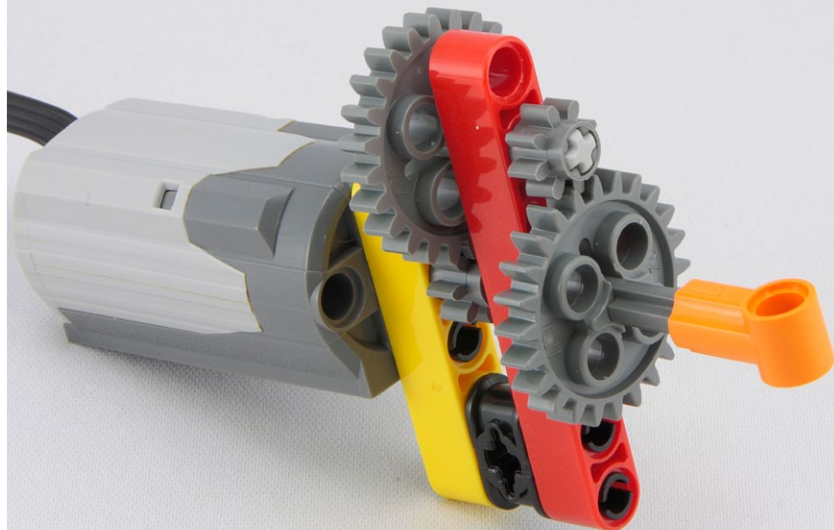
x2

4

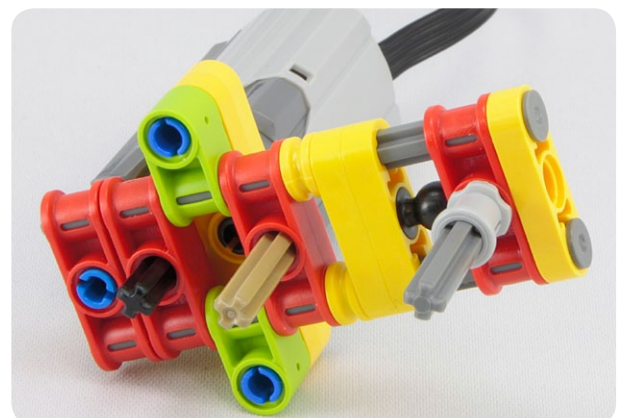
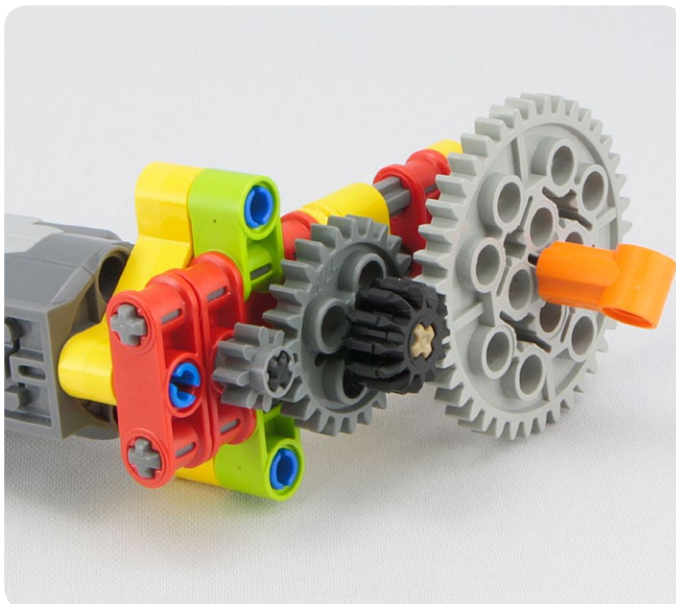
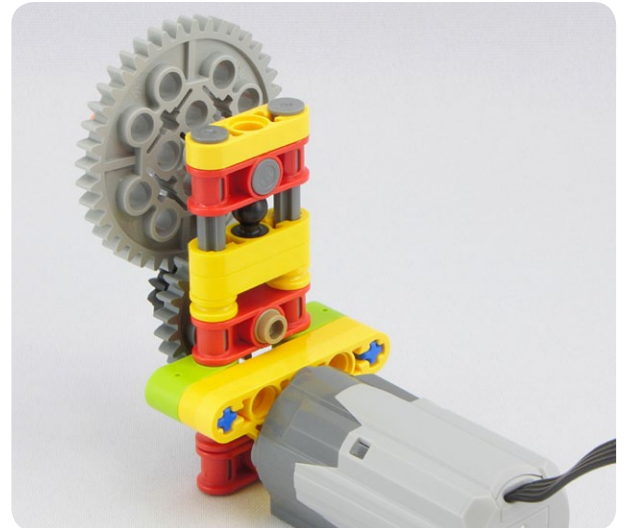
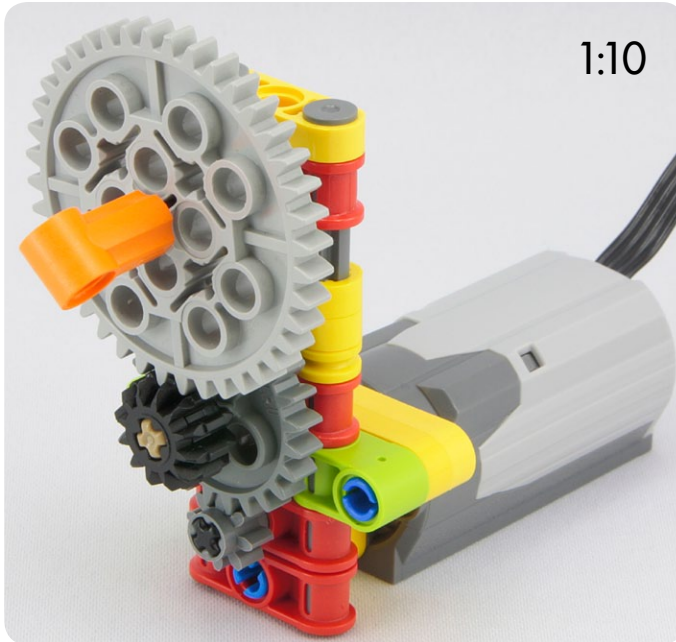
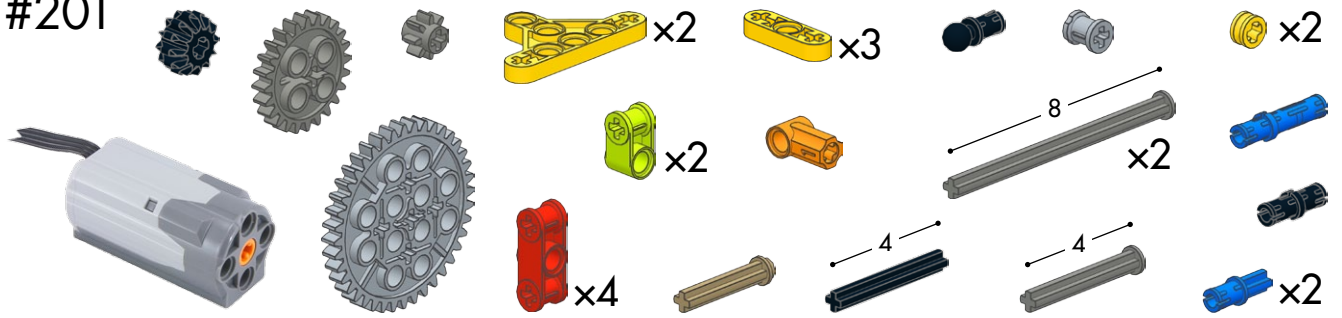


x2

1:9

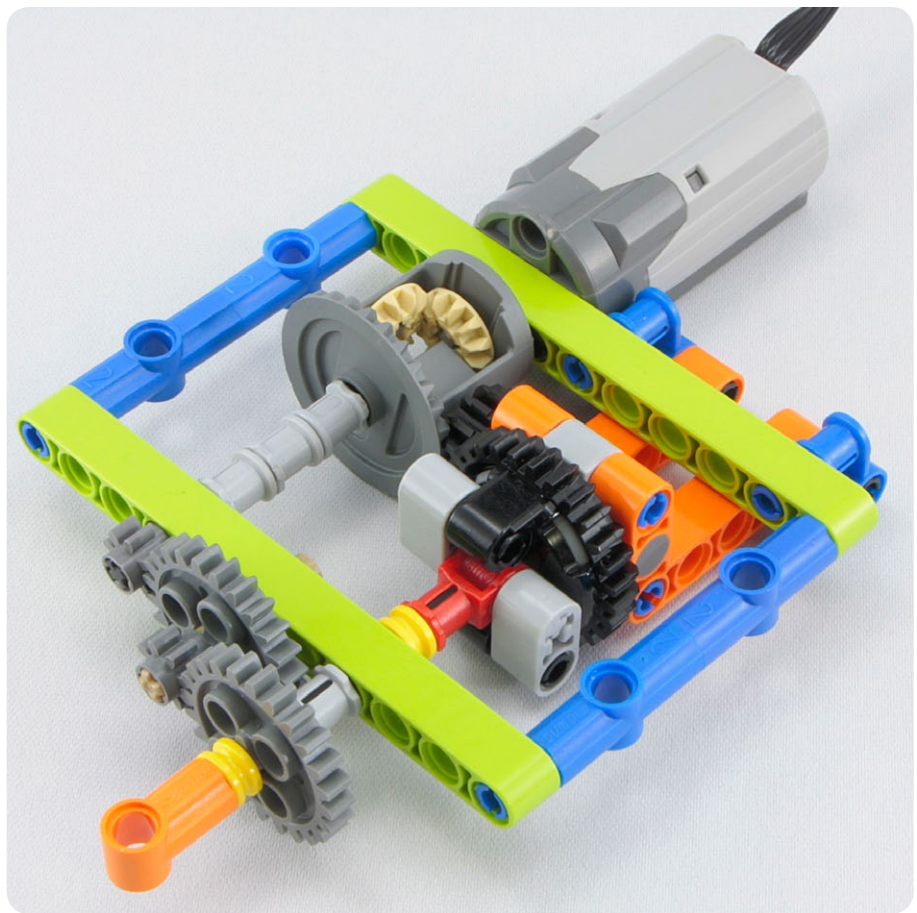
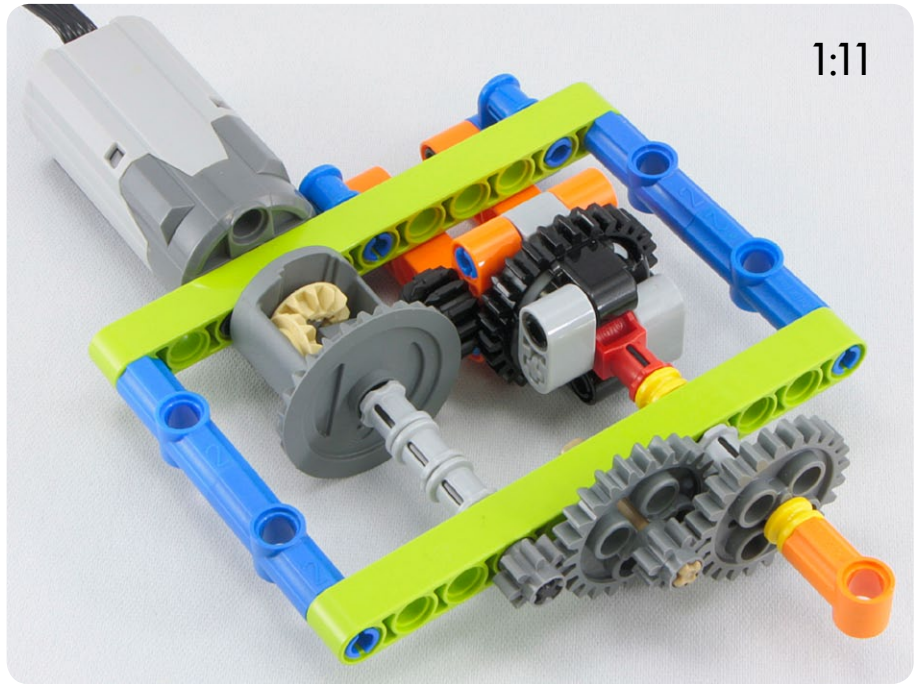
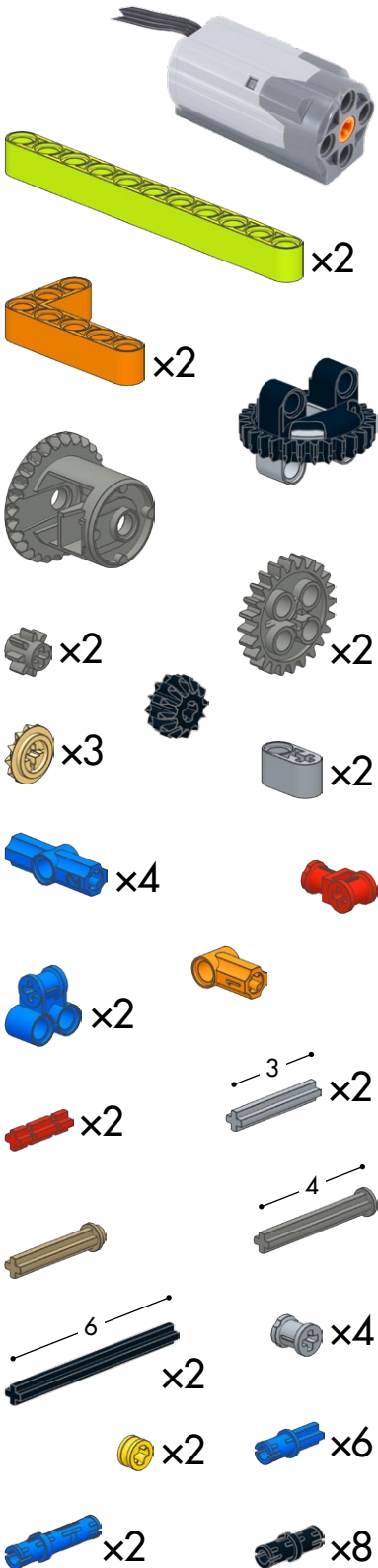


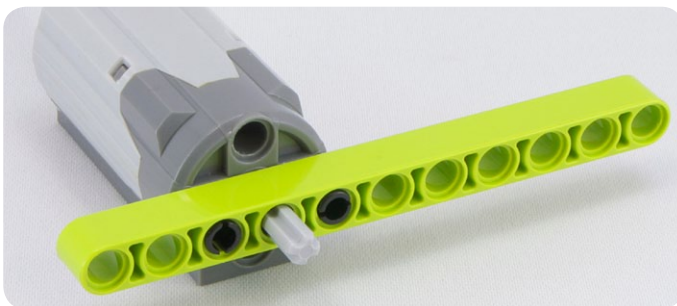
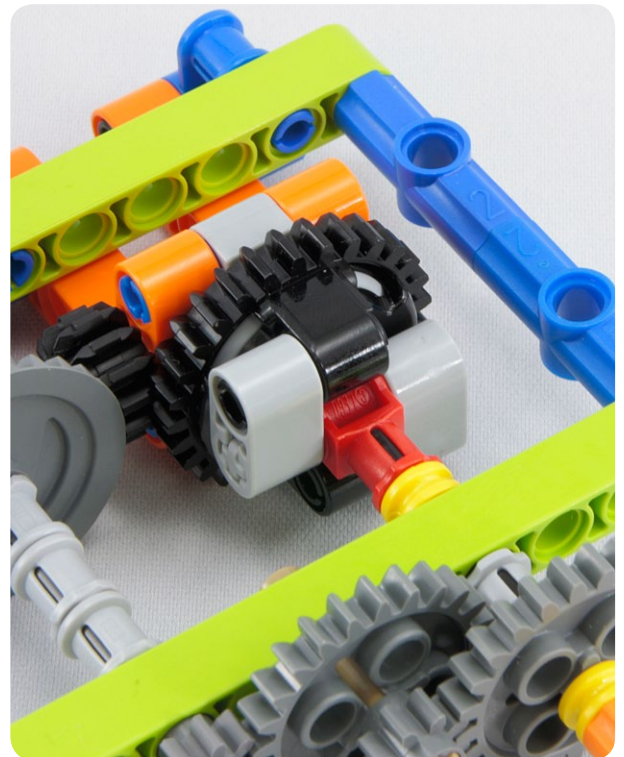
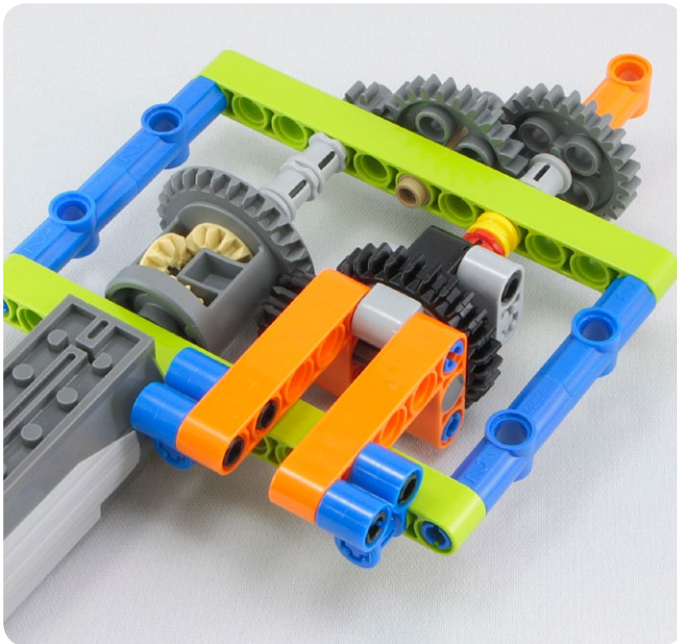
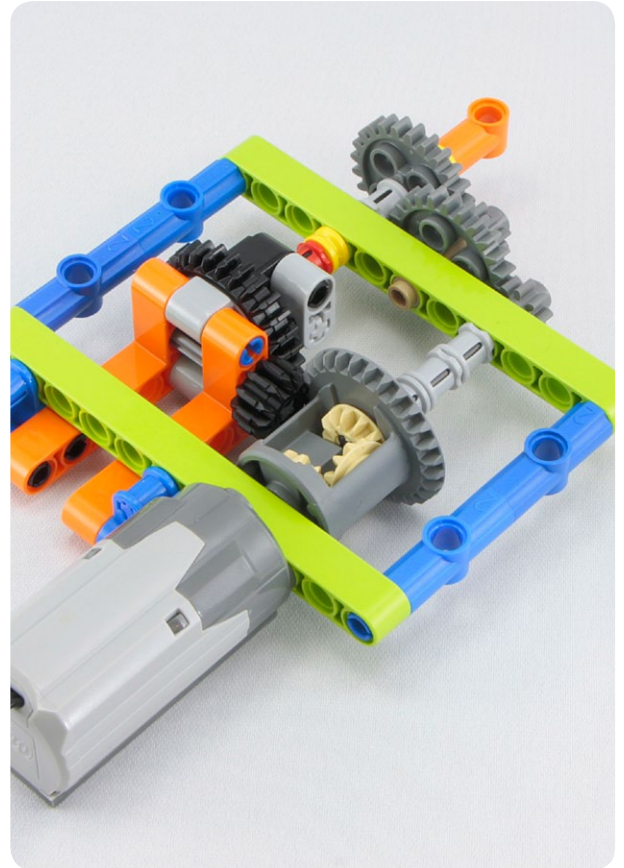
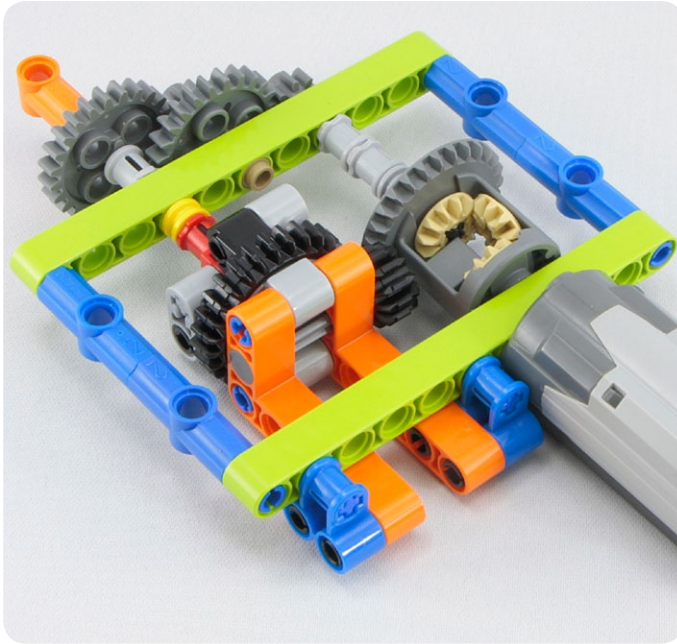
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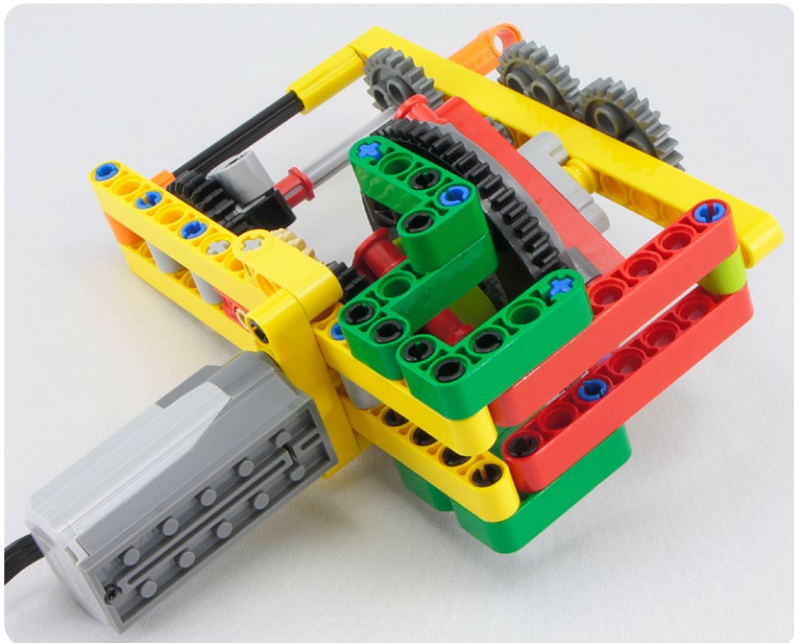
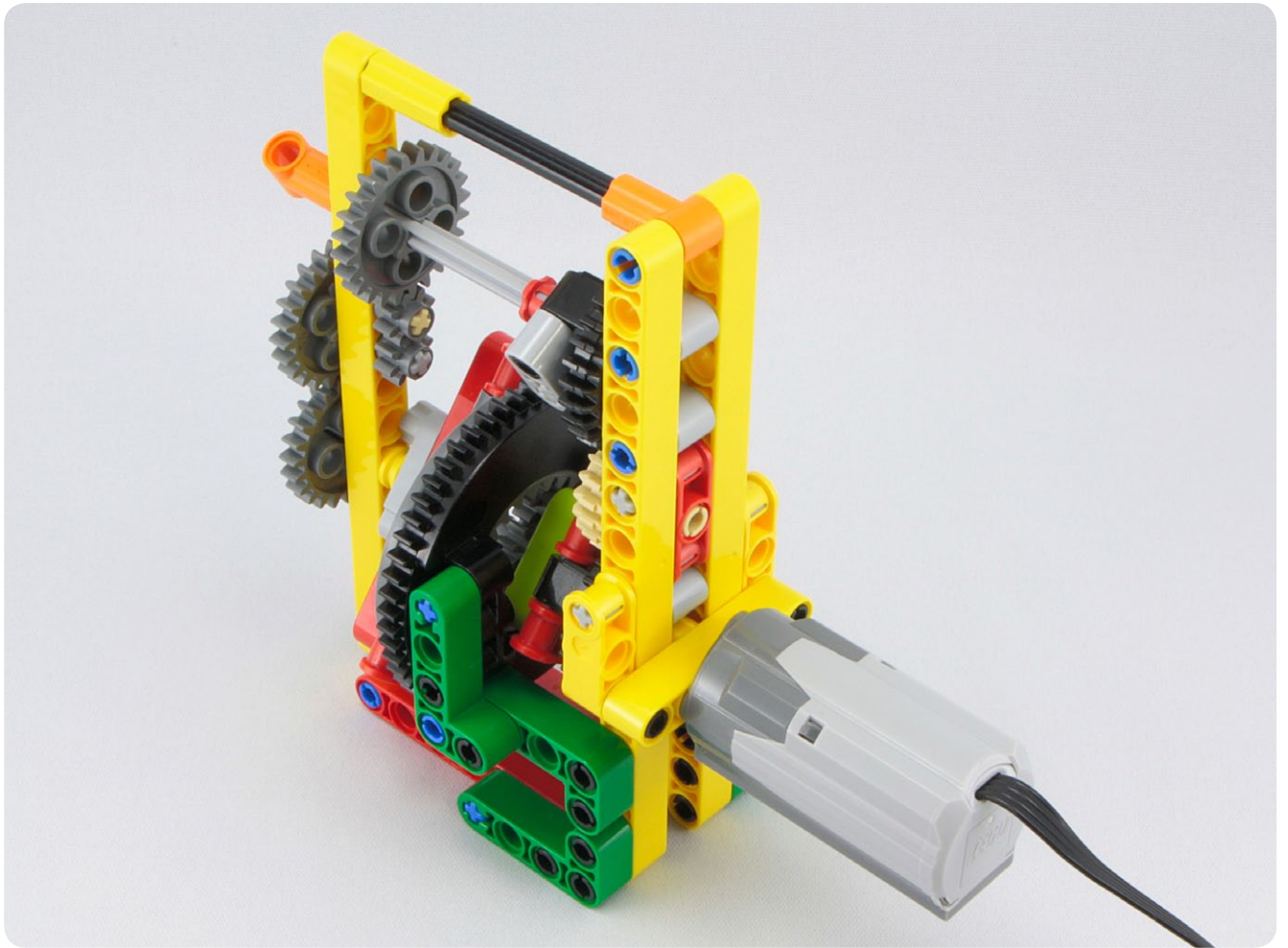
#202

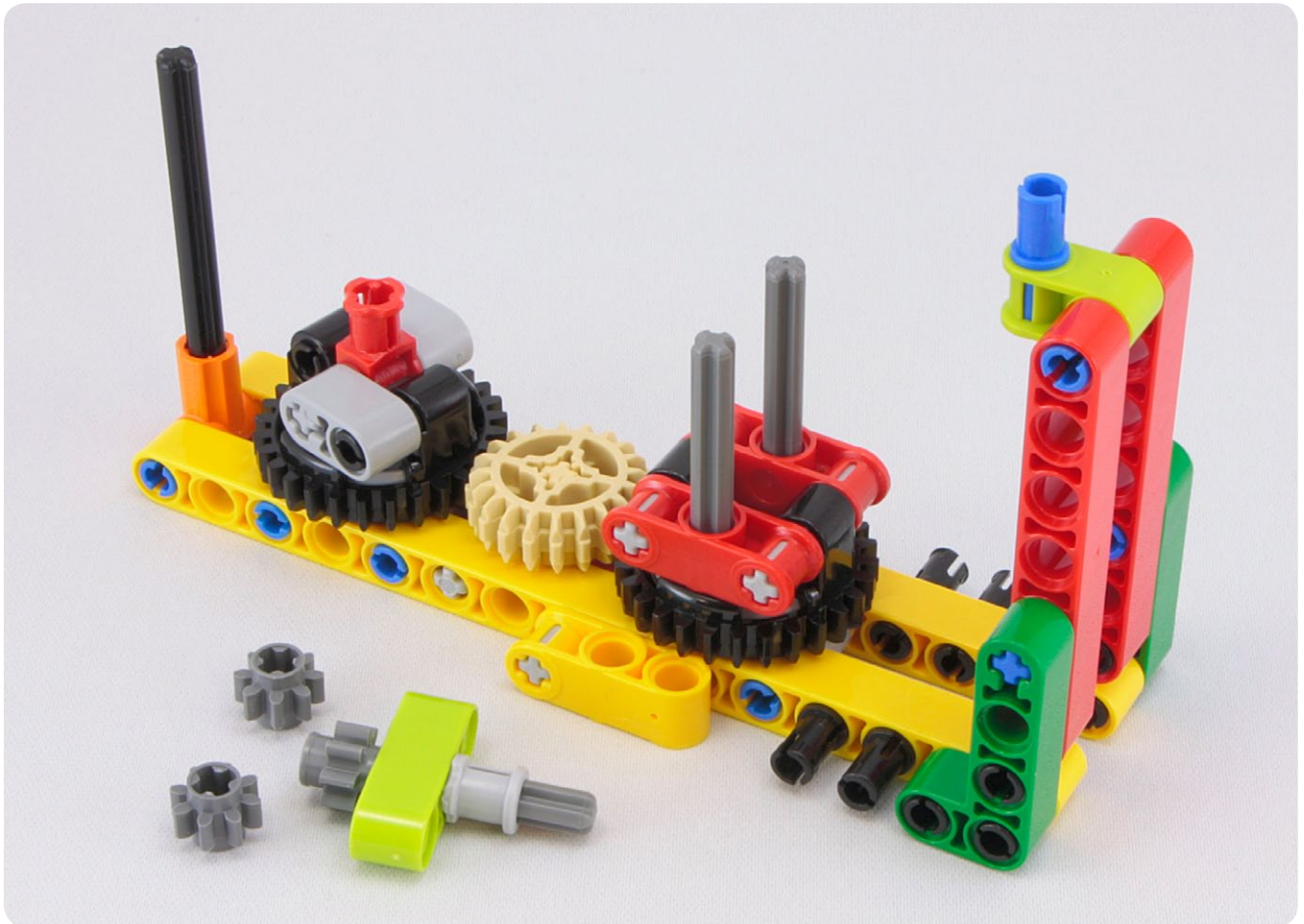
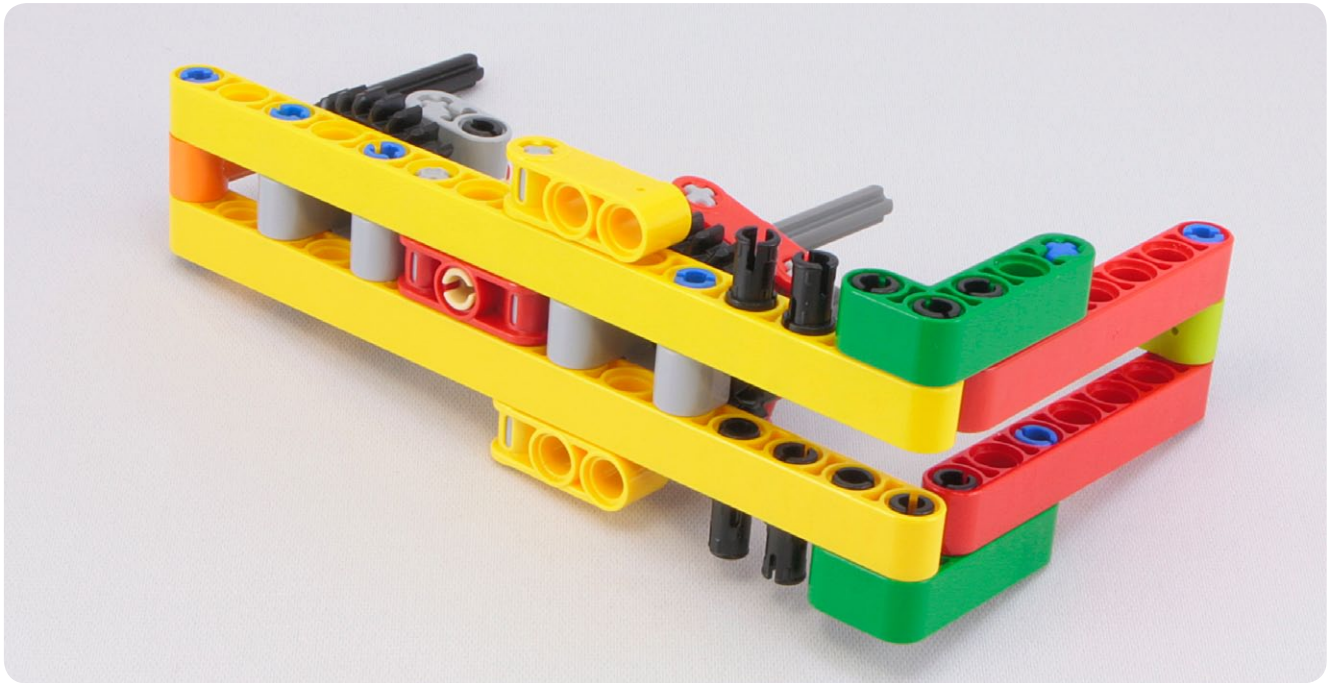
1:11

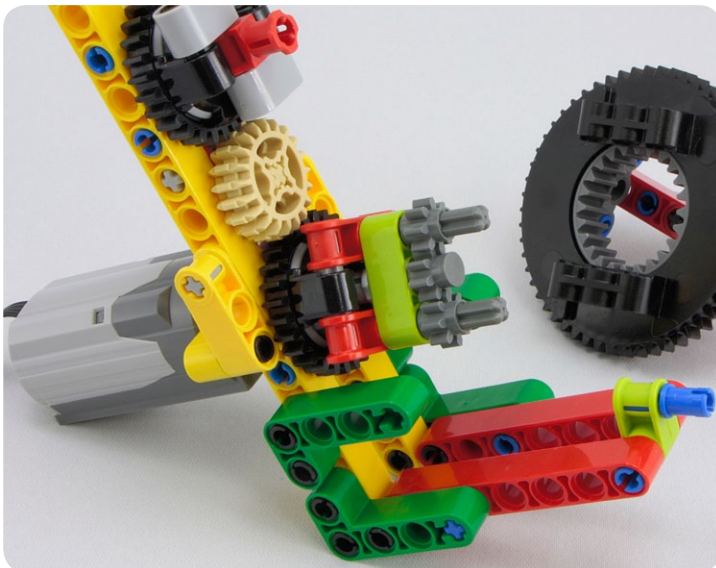
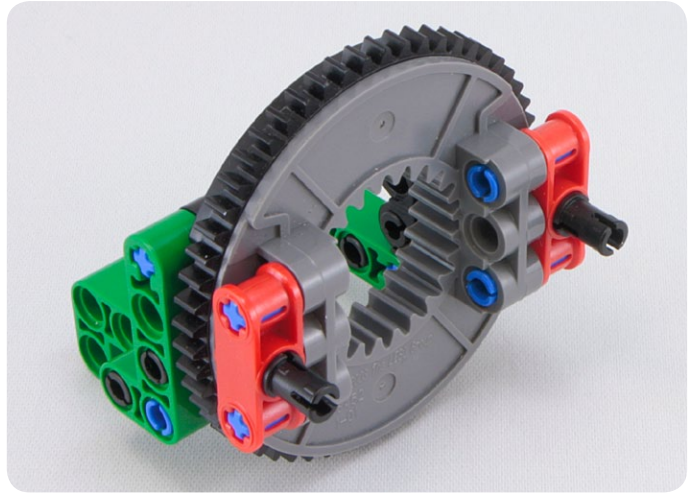
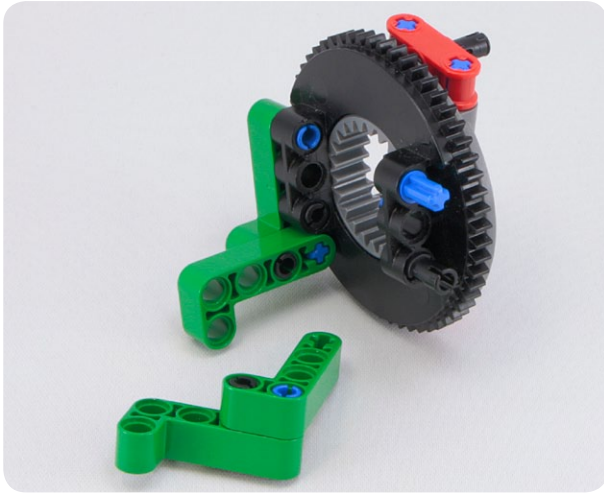


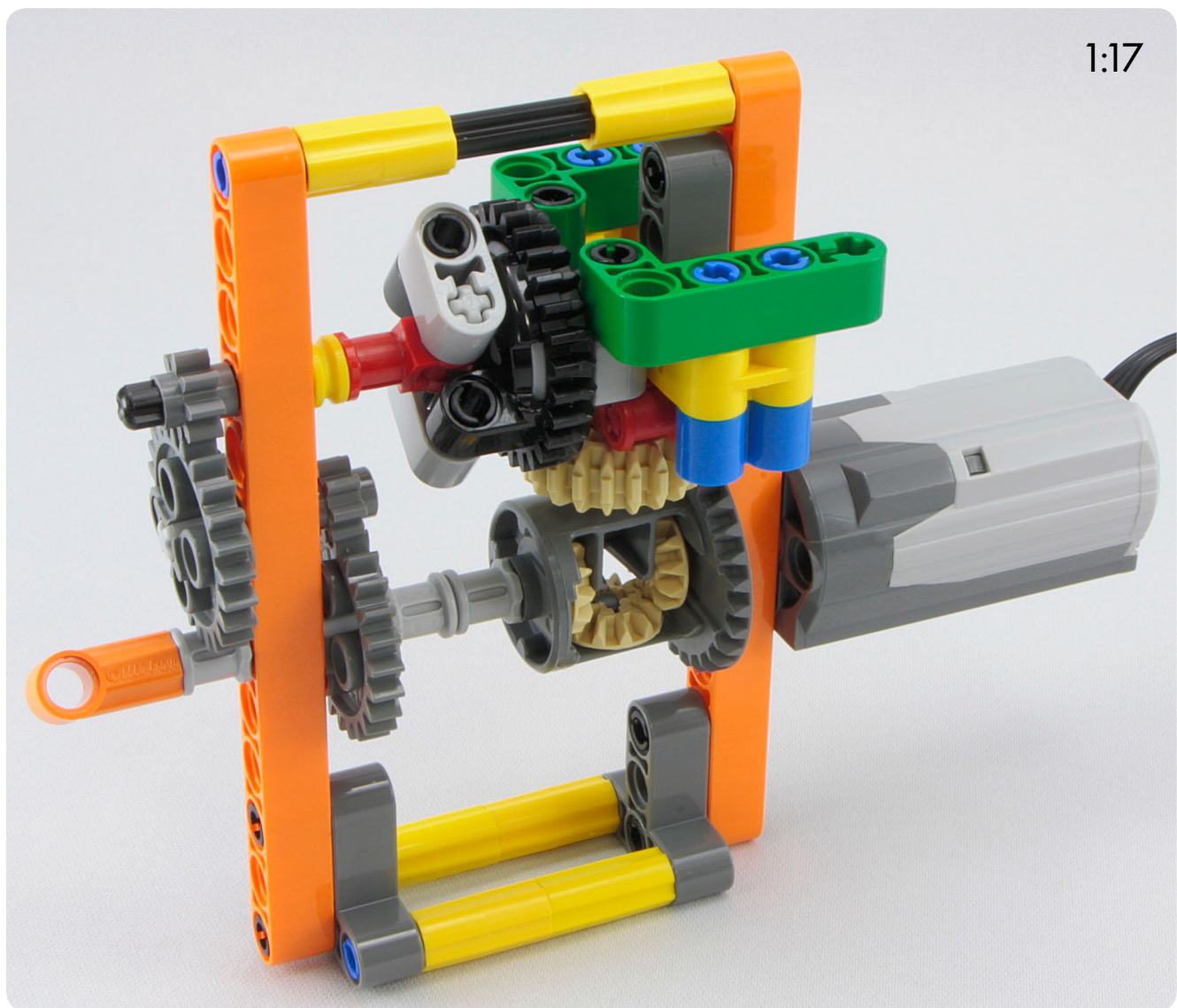


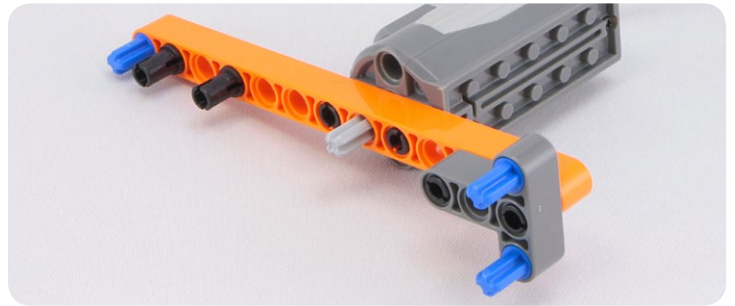
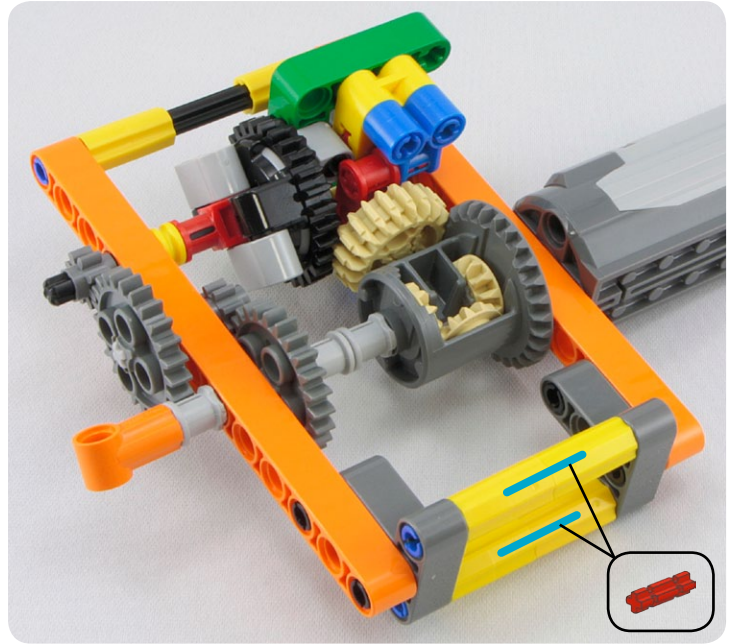
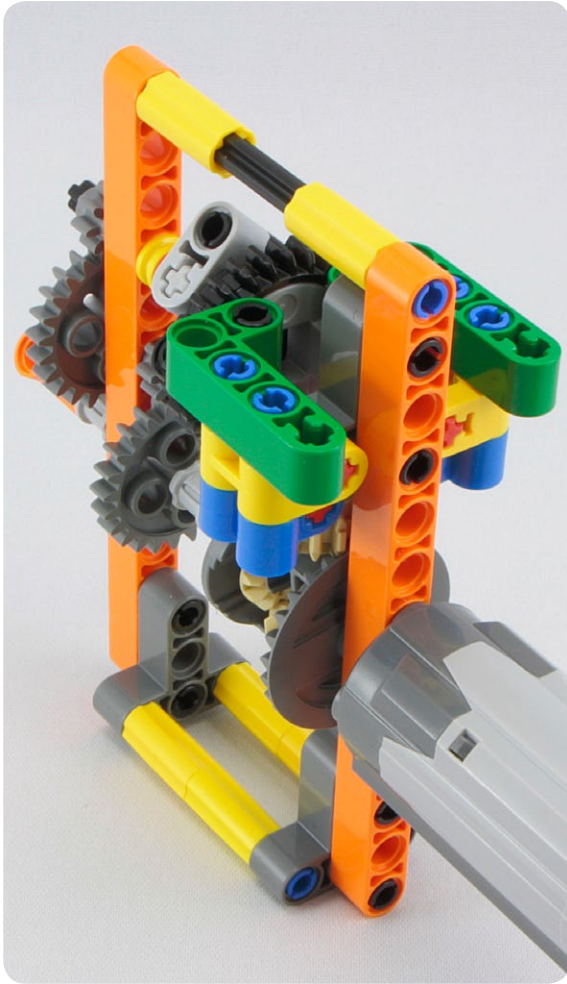
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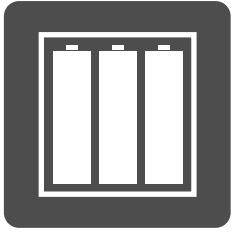






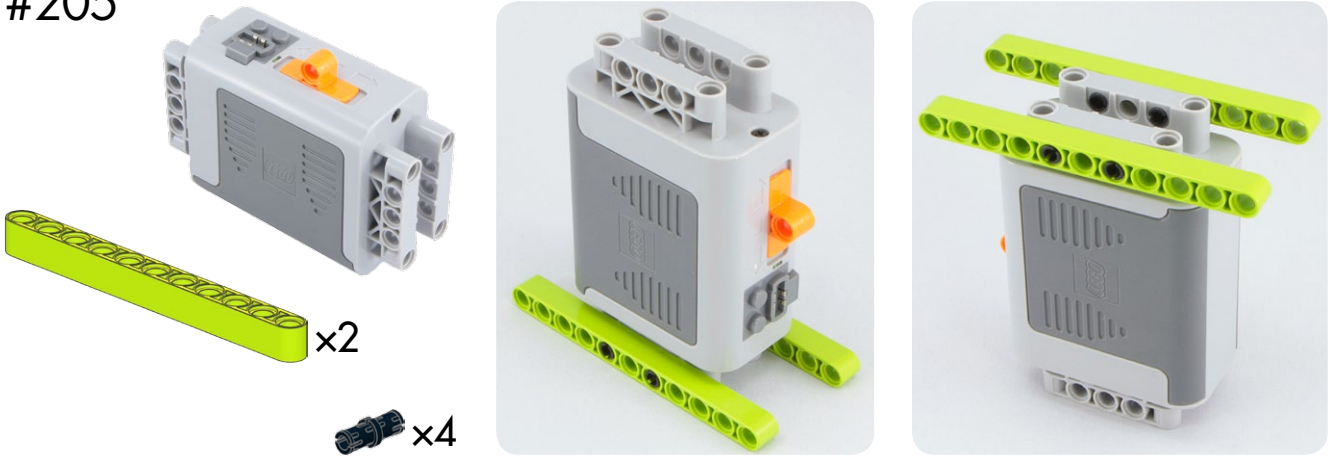
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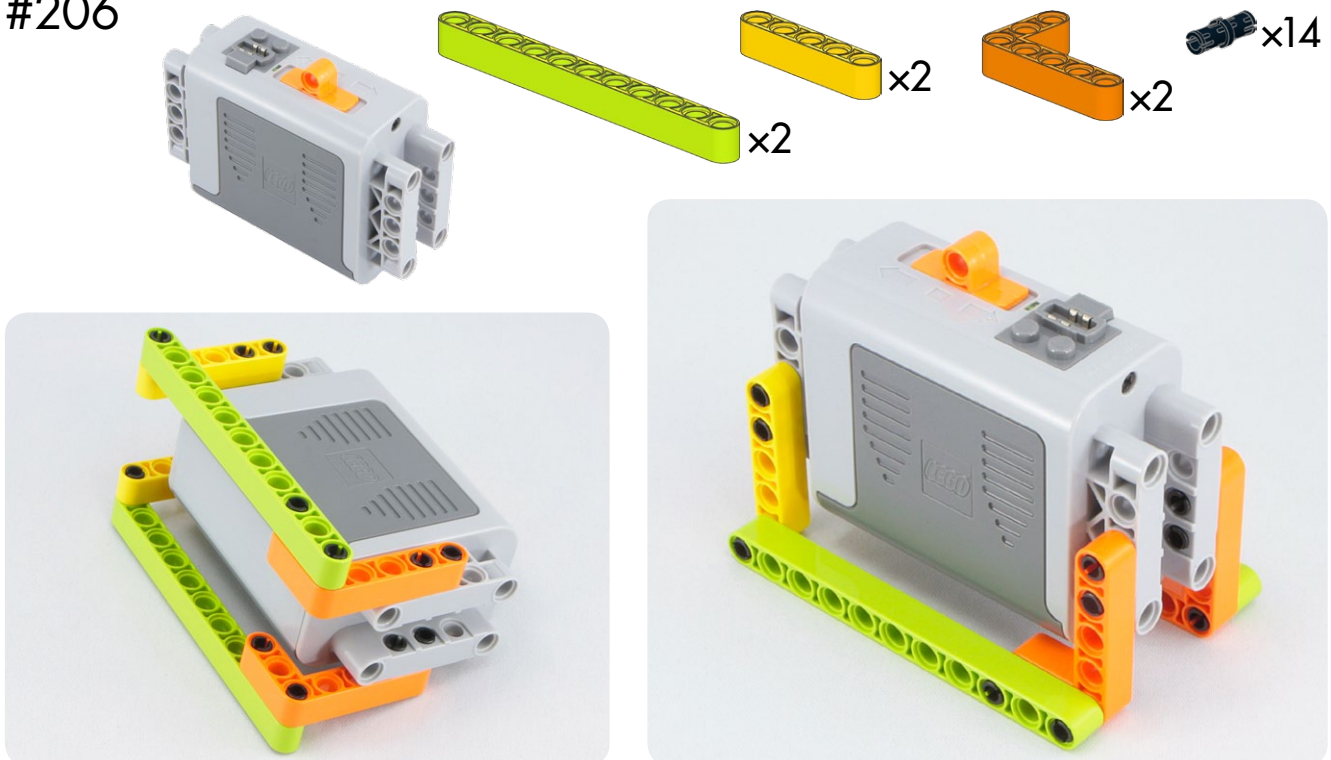


Attaching a battery box

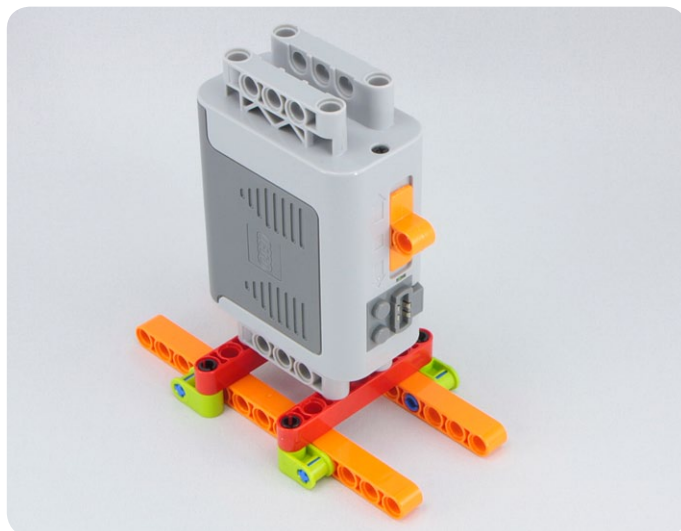
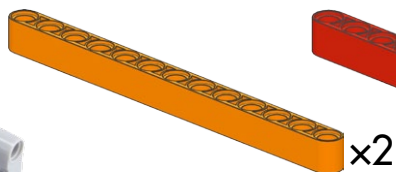
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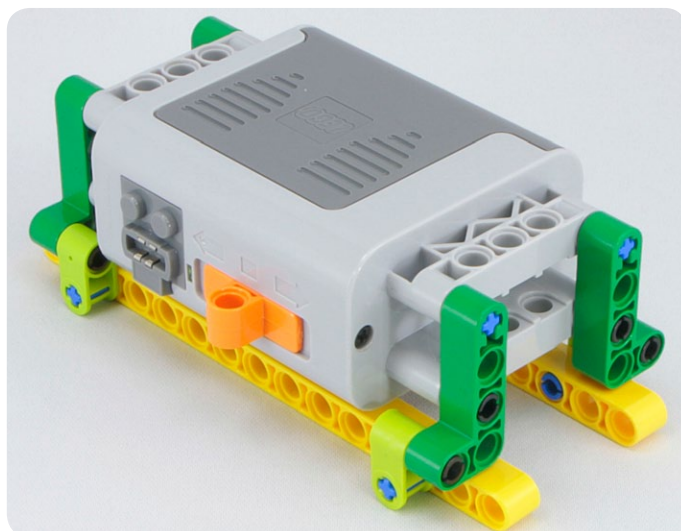
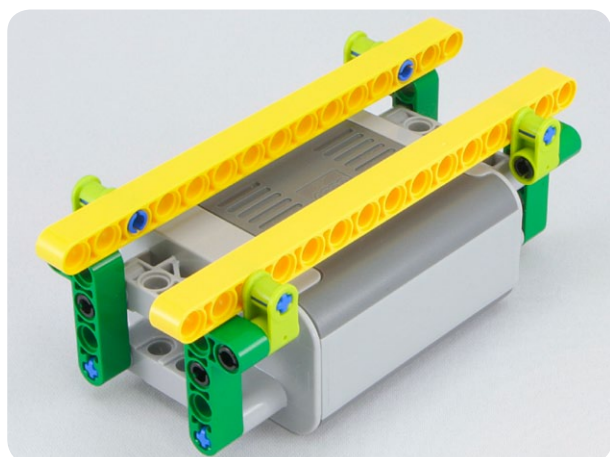
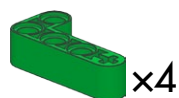
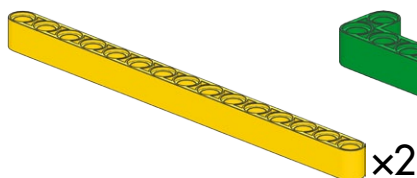
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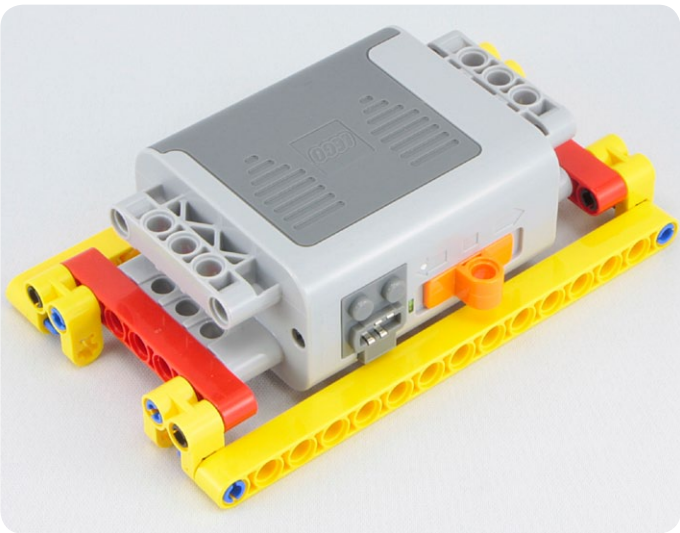
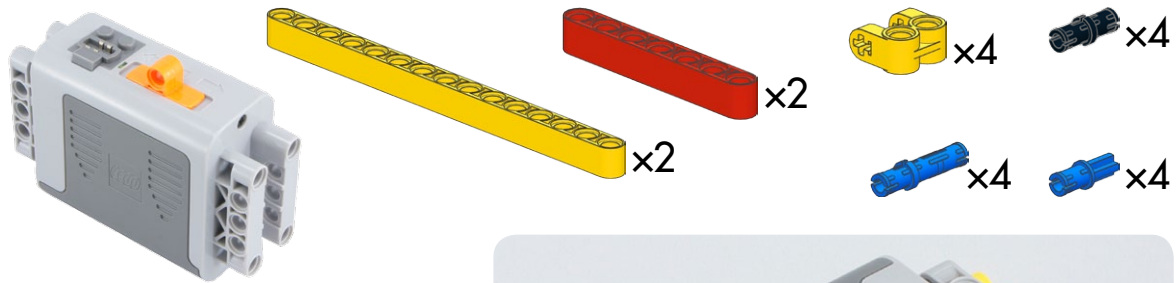
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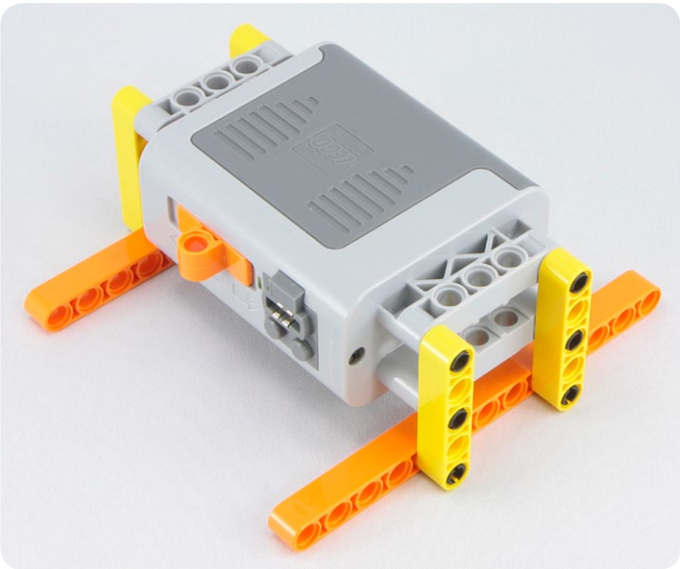
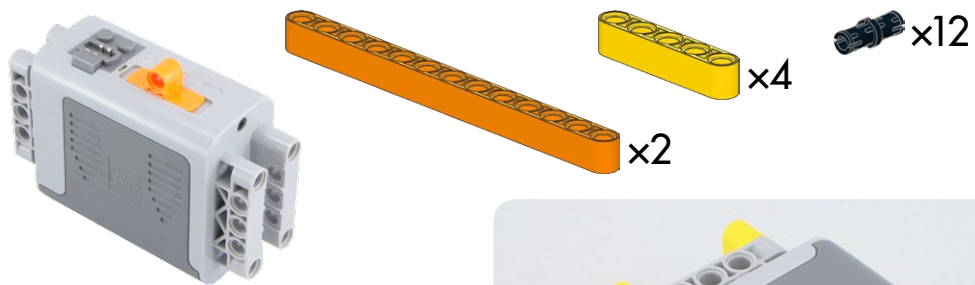
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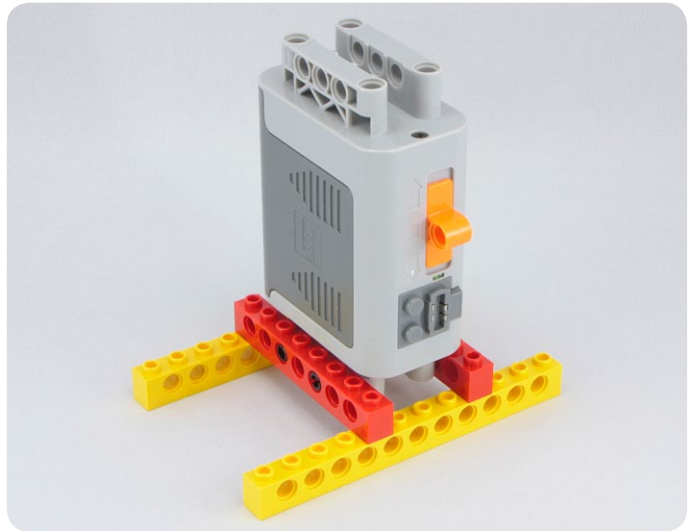
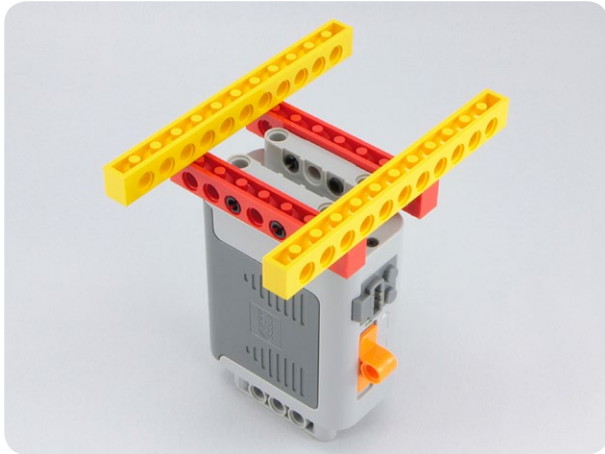
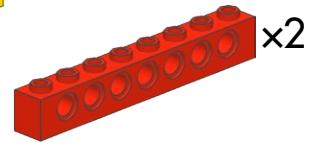
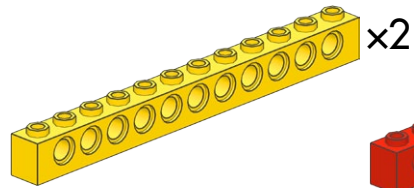
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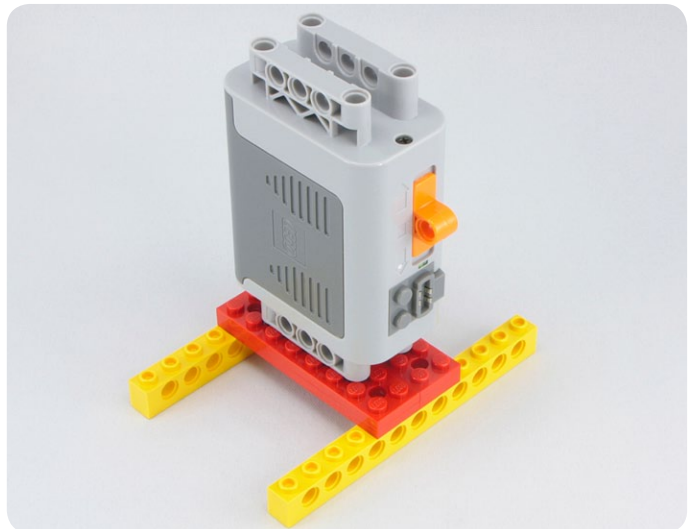
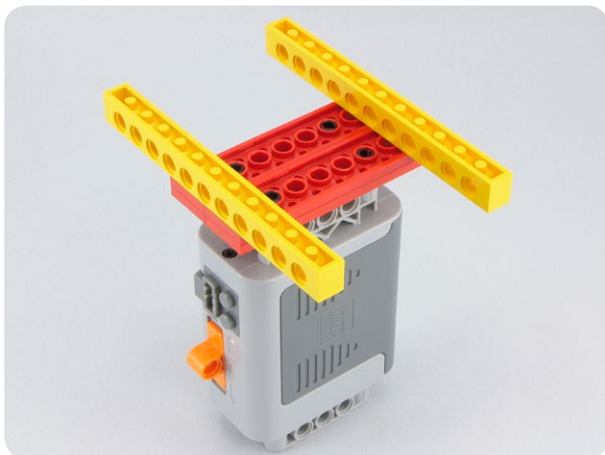
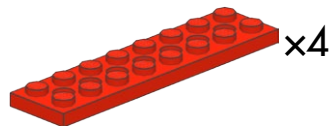
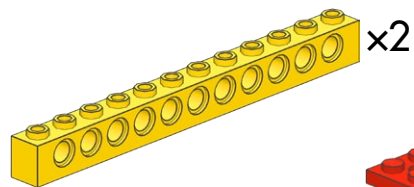
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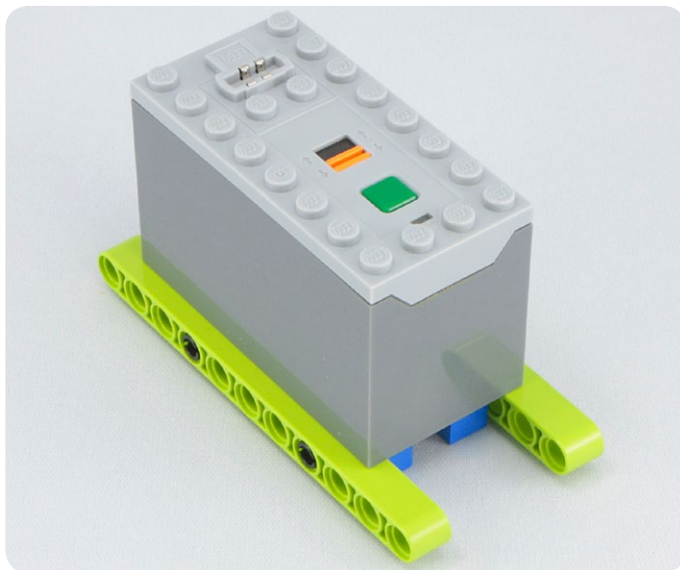
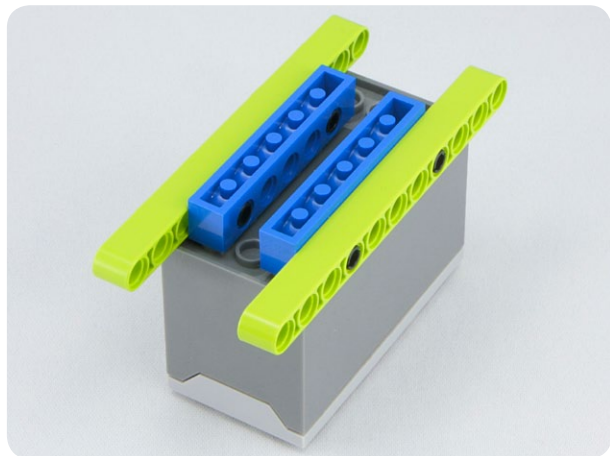
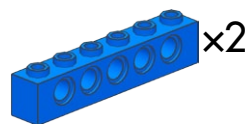
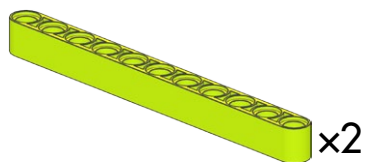
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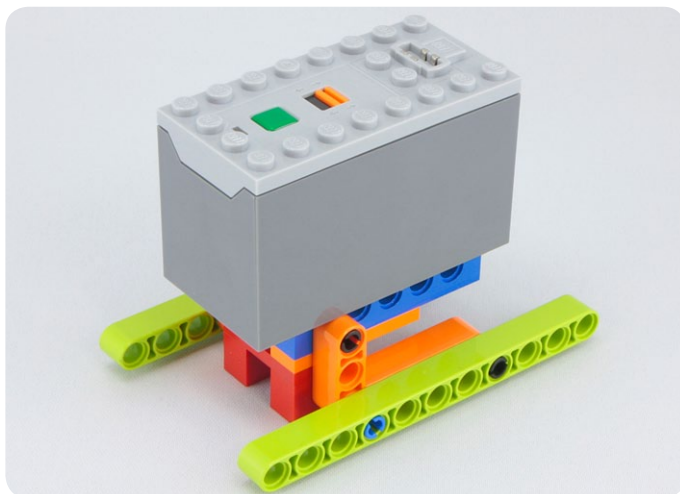
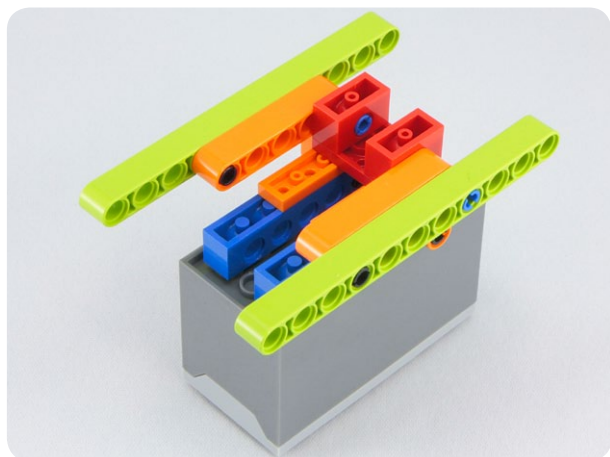
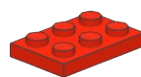
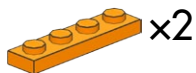
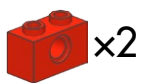
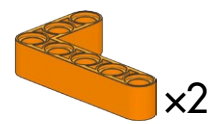
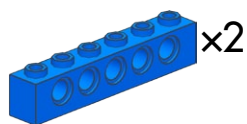
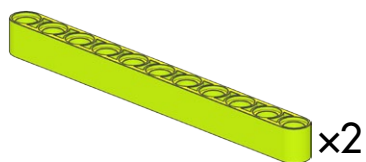
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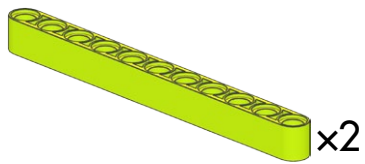
#213



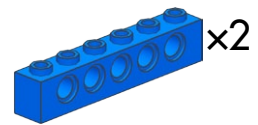
#214



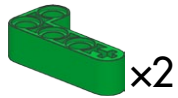
#215



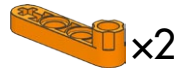
x2



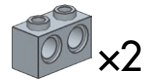
x2



x2



x2



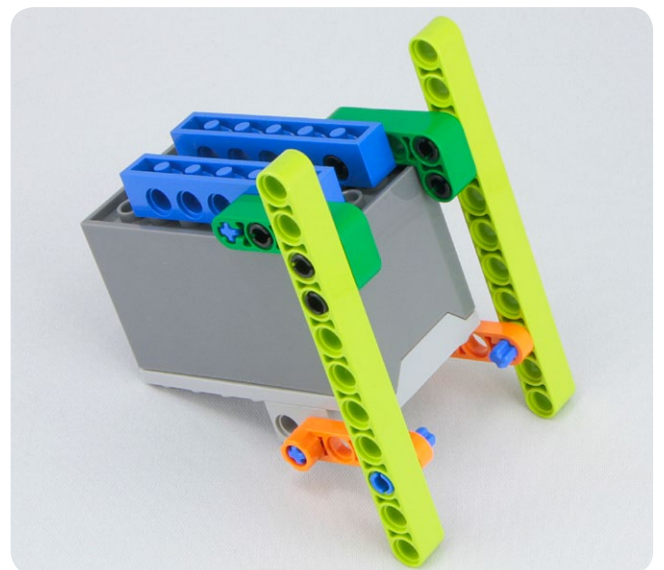
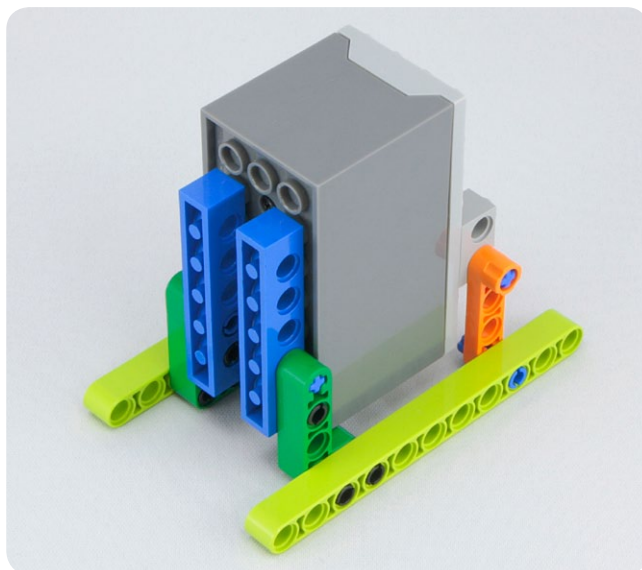
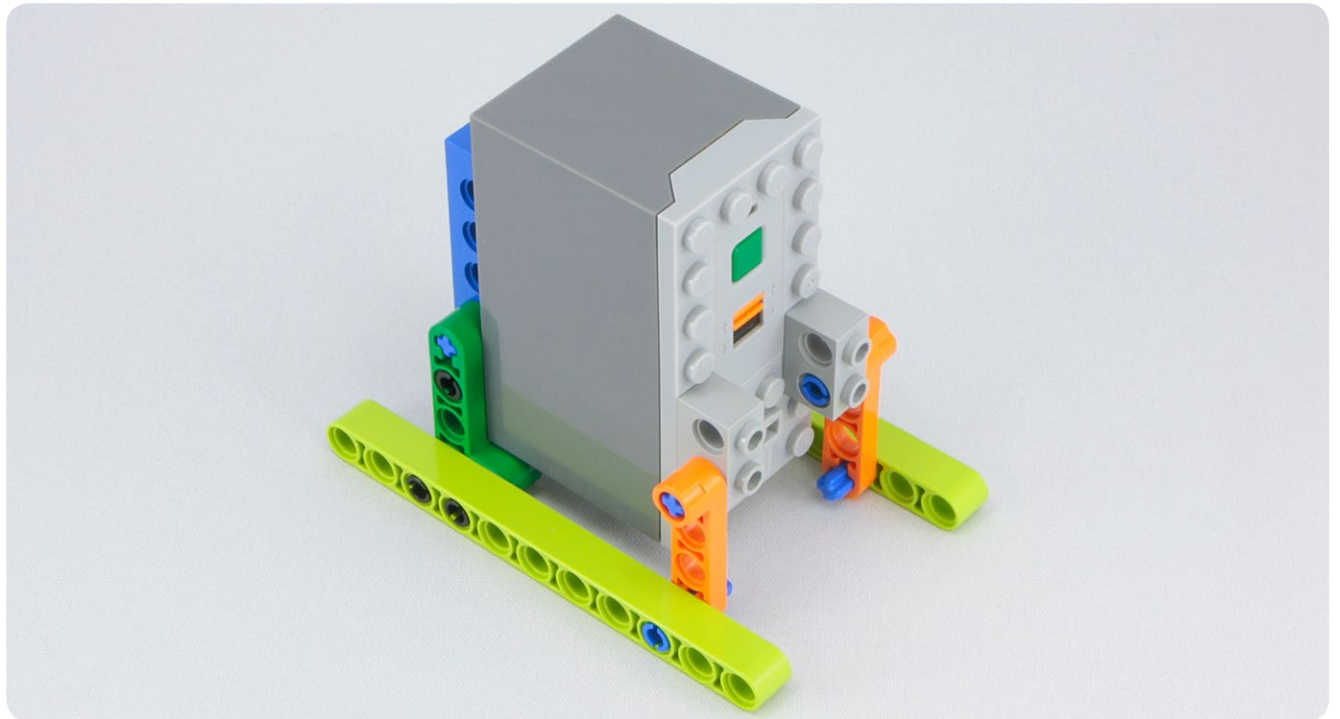
x2

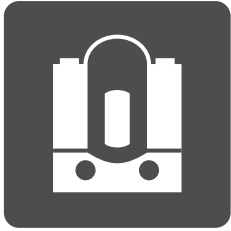


x6

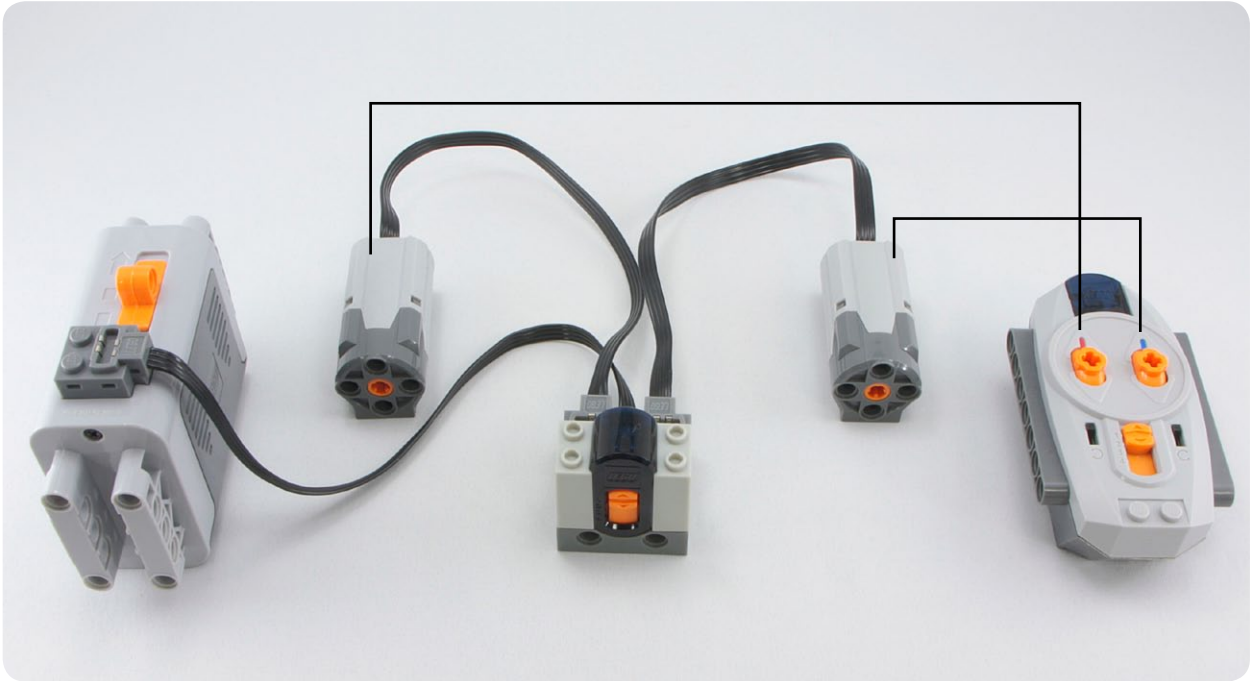


x6

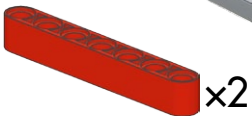




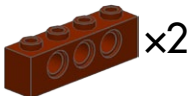
Attaching an infrared receiver



#216



x2



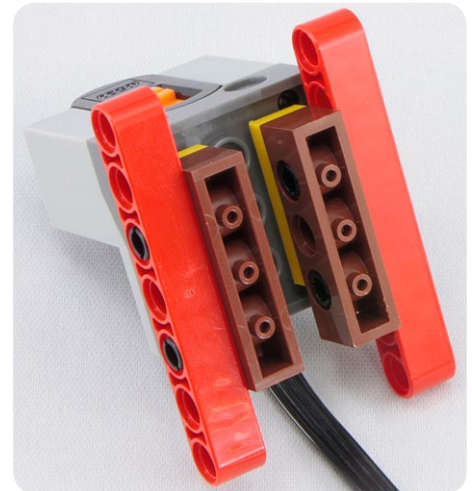
x2



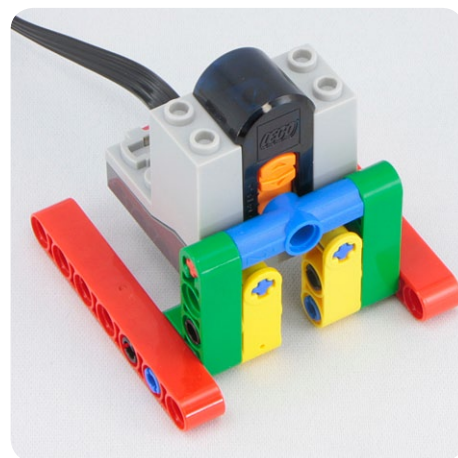
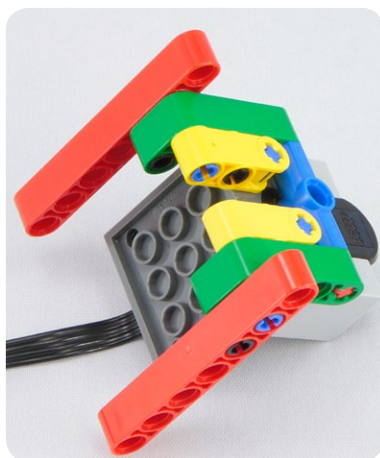
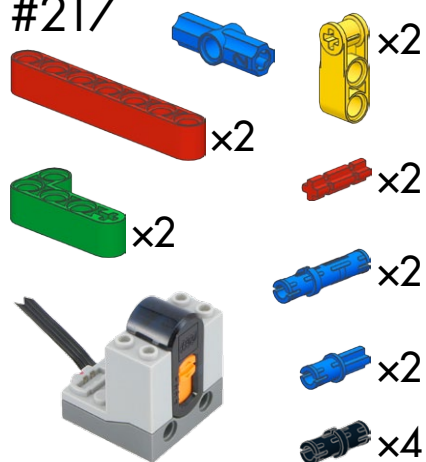
x2



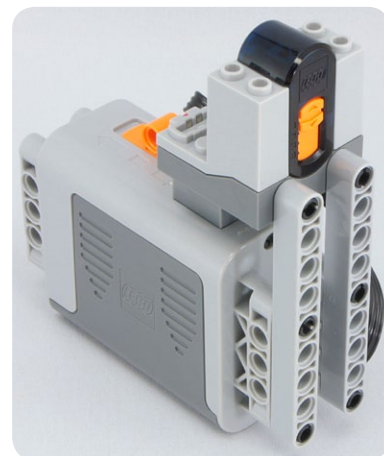
x4



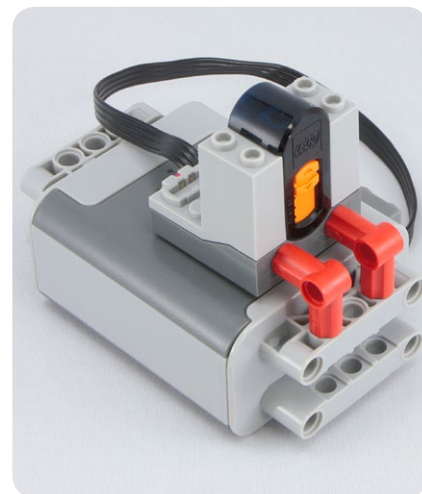
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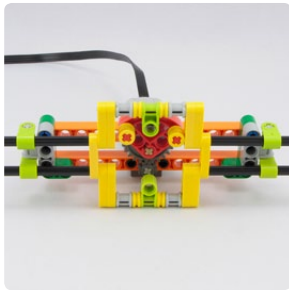
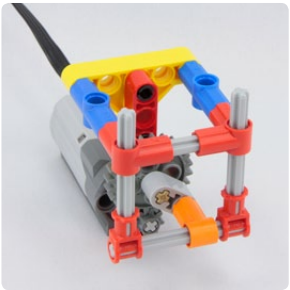
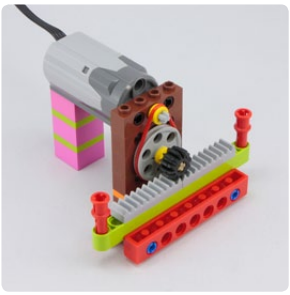


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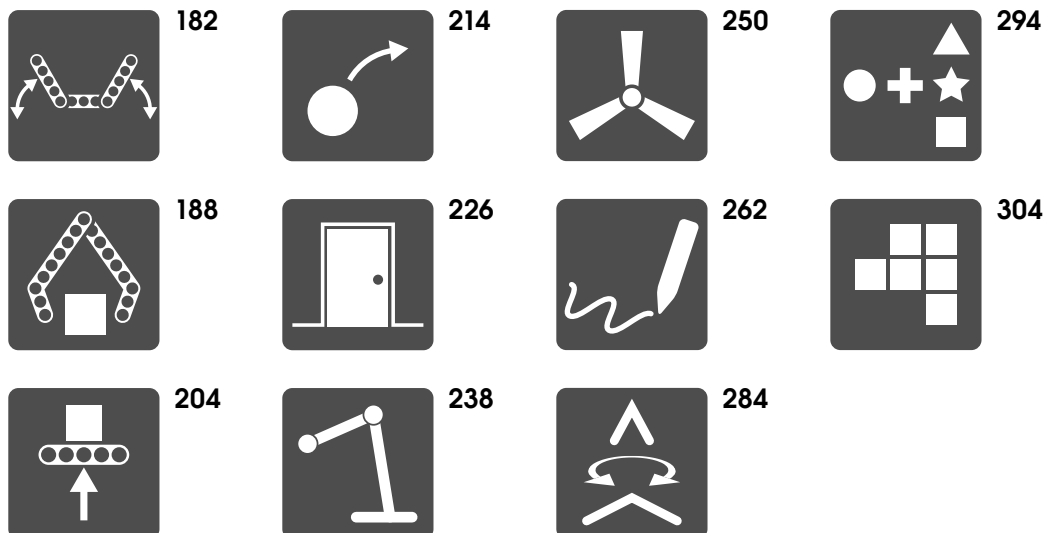
#219






PART 2

Arms, Wings, and Other Movements

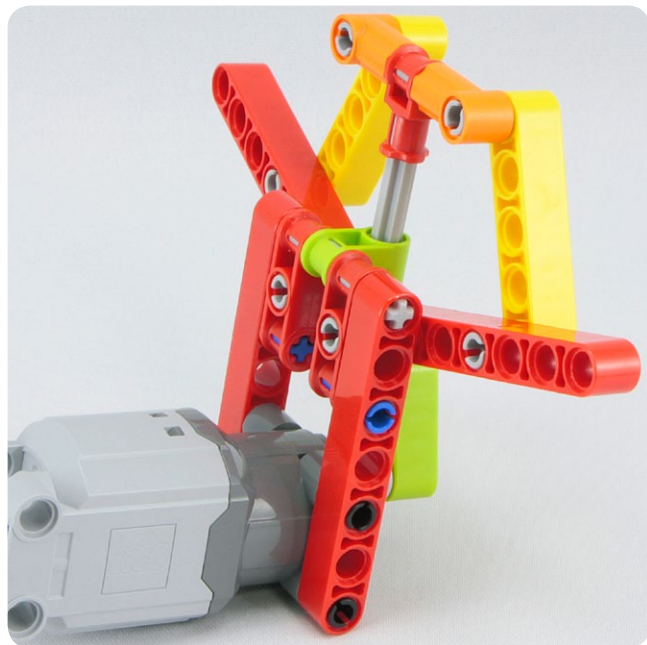


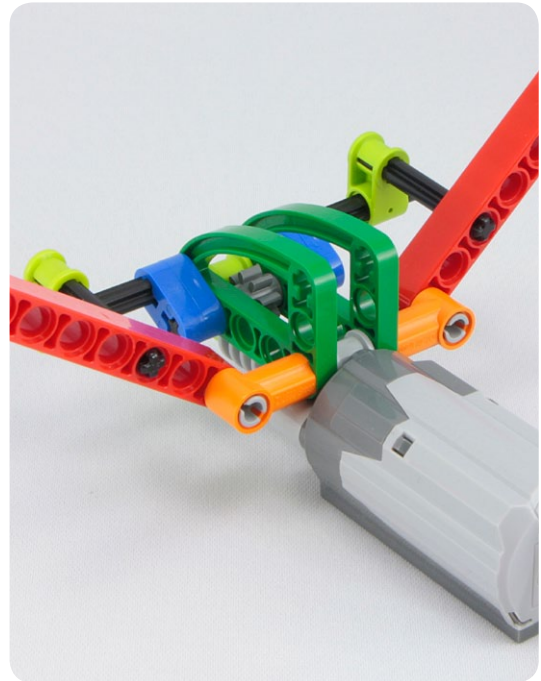
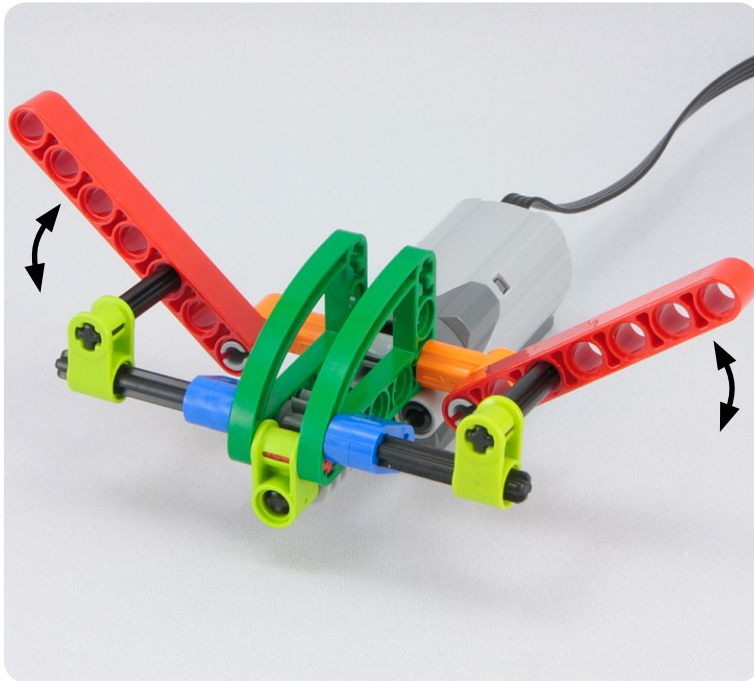
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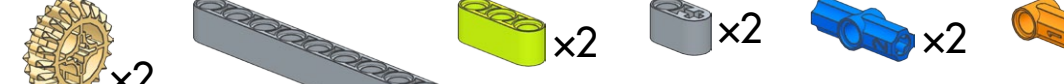
LEGO parts list for step 221:

- 1x Grey Motor
- 4x Red 1x5 Technic Beam
- 2x Yellow 1x5 Technic Beam
- 1x Green 1x3 Technic Beam
- 1x Grey 1x3 Technic Beam
- 8x Grey Pin
- 2x Red 1x2 Technic Pin
- 2x Blue 1x2 Technic Pin
- 4x Black 1x2 Technic Pin
- 2x Red 1x2 Technic Pin
- 3x Orange 1x2 Technic Pin
- 2x Grey 1x5 Technic Beam
- 2x Grey 1x7 Technic Beam
- 2x Green 1x2 Technic Pin
- 2x Red 1x2 Technic Pin
- 2x Grey 1x2 Technic Pin
- 2x Grey 1x3 Technic Pin
- 2x Grey 1x4 Technic Pin
- 2x Grey 1x5 Technic Pin
- 2x Grey 1x6 Technic Pin
- 2x Grey 1x7 Technic Pin
- 2x Grey 1x8 Technic Pin
- 2x Grey 1x9 Technic Pin
- 2x Grey 1x10 Technic Pin
- 2x Grey 1x11 Technic Pin
- 2x Grey 1x12 Technic Pin
- 2x Grey 1x13 Technic Pin
- 2x Grey 1x14 Technic Pin
- 2x Grey 1x15 Technic Pin
- 2x Grey 1x16 Technic Pin
- 2x Grey 1x17 Technic Pin
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- 2x Grey 1x20 Technic Pin
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- 2x Grey 1x22 Technic Pin
- 2x Grey 1x23 Technic Pin
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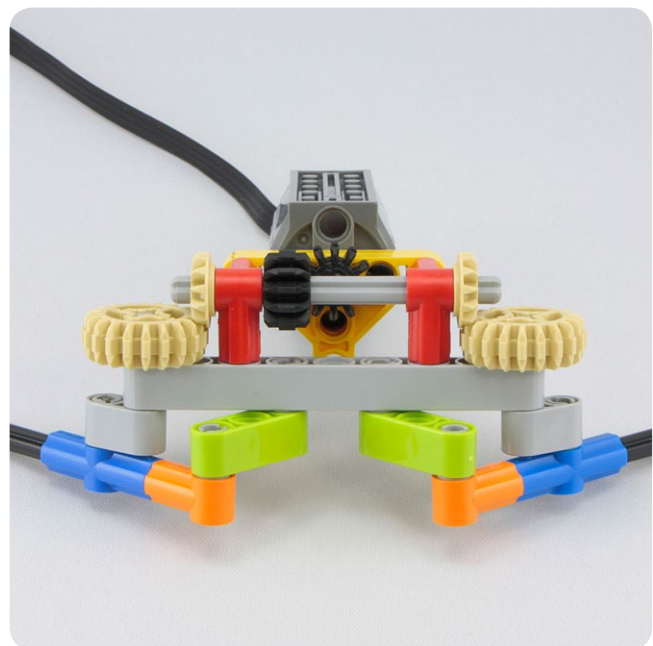
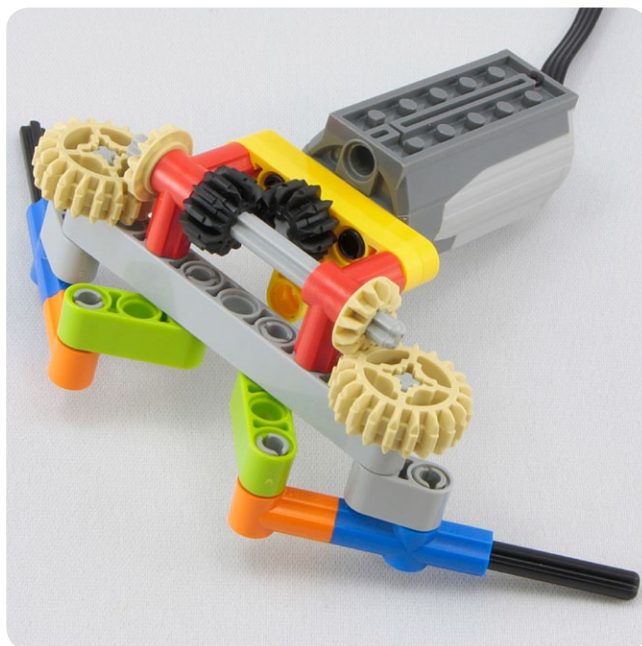
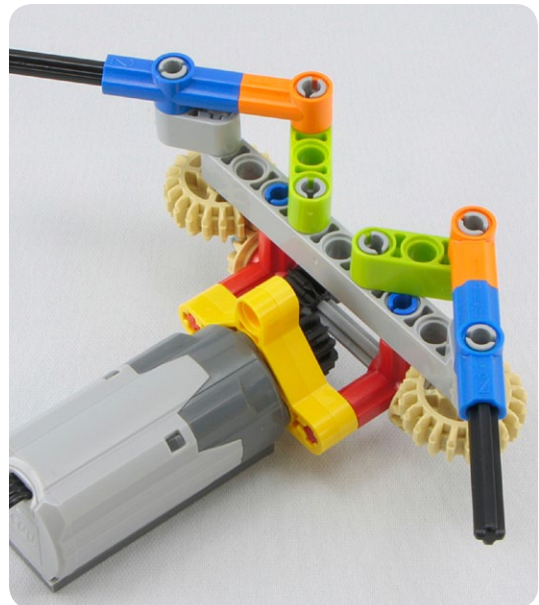
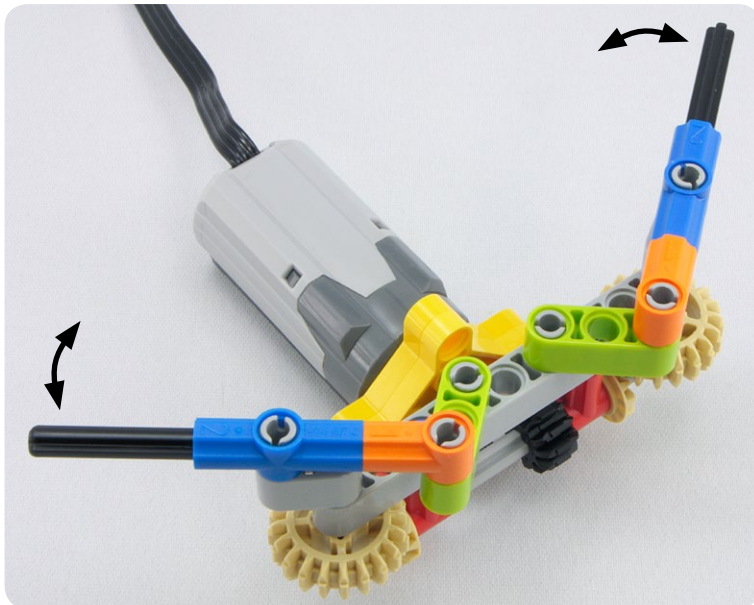
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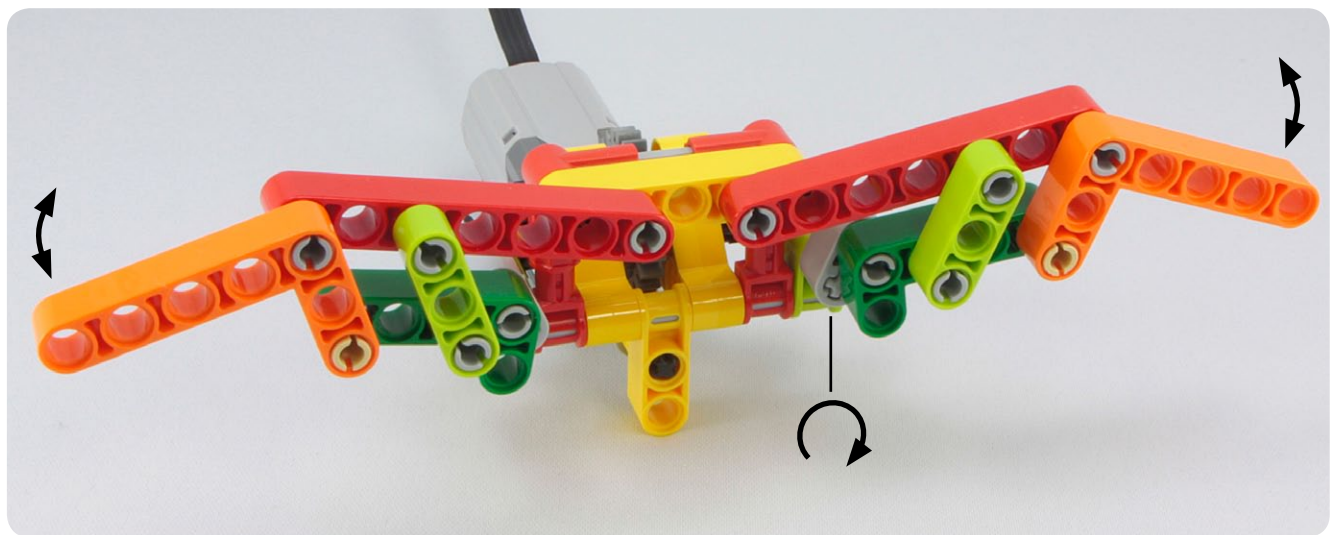
#223



LEGO parts list for step 223:

- 1x Motor
- 2x Gear (yellow, 24 teeth)
- 1x Gear (black, 24 teeth)
- 2x Gear (yellow, 12 teeth)
- 1x Beam (grey, 11 holes)
- 2x Beam (yellow, 3 holes)
- 2x Beam (grey, 3 holes)
- 2x Connector (blue, 2-way)
- 2x Connector (orange, 2-way)
- 2x Connector (blue, 1-way)
- 2x Connector (grey, 1-way)
- 2x Connector (black, 1-way)
- 2x Connector (red, 1-way)
- 4x Connector (red, 1-way)
- 2x Connector (red, 1-way)
- 2x Connector (yellow, 1-way)
- 3x Beam (grey, 3 holes)
- 2x Beam (black, 4 holes)
- 1x Beam (grey, 7 holes)




[illegible]



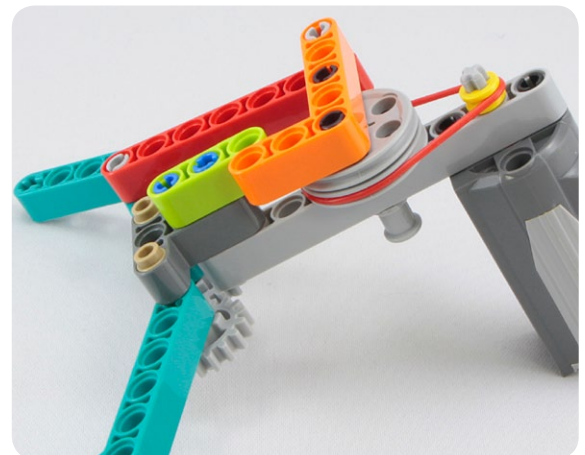
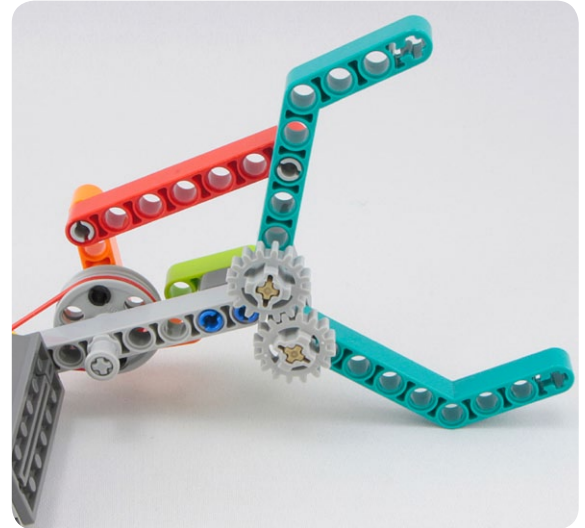


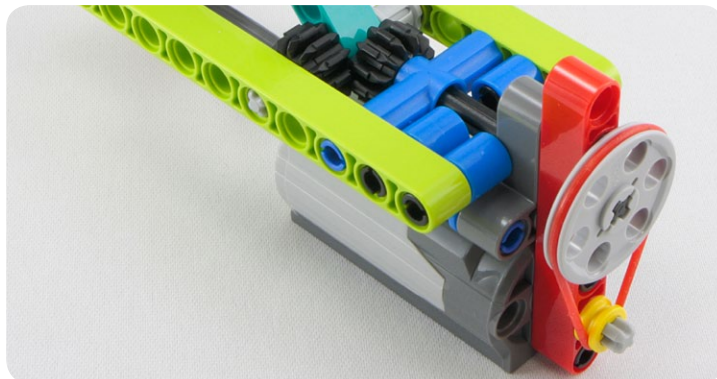
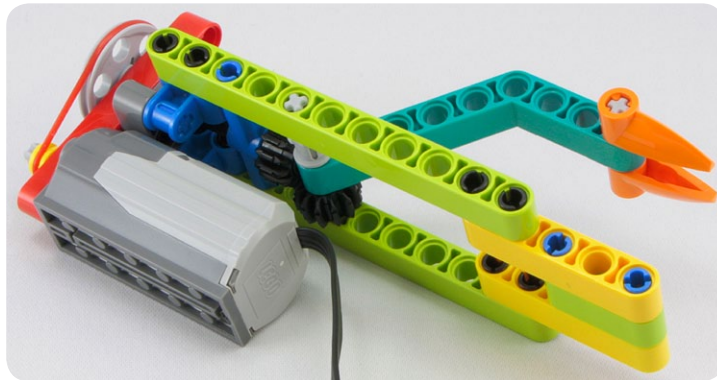
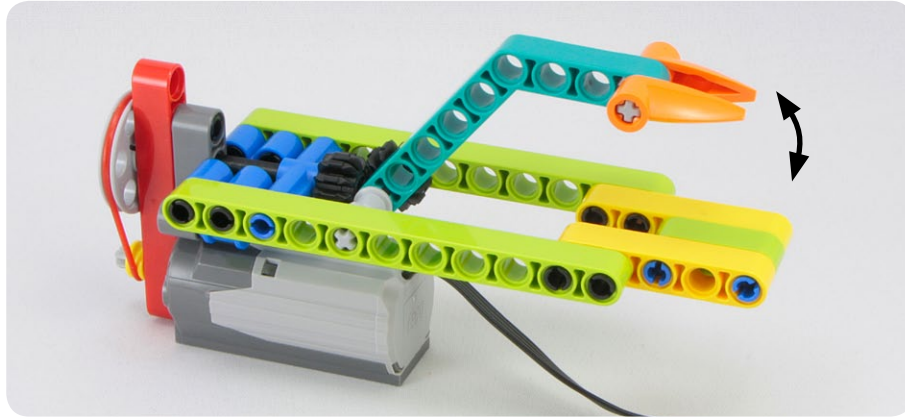
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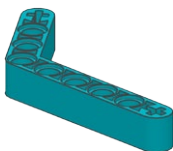
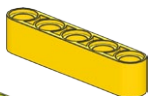
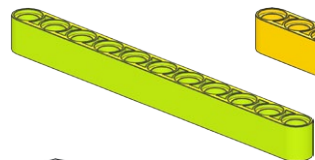
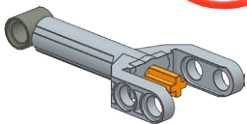
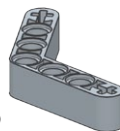


LEGO parts list for step 225:

- 1x Motor
- 2x Gear (grey)
- 2x Wheel (grey)
- 1x Beam (grey, 11 holes)
- 1x Beam (red, 5 holes)
- 2x Beam (teal, L-shaped)
- 1x Pin (yellow)
- 1x Pin (grey)
- 2x Pin (grey)
- 2x Pin (blue)
- 4x Pin (black)
- 1x Beam (orange, L-shaped)
- 1x Beam (green, 3 holes)
- 1x Connector (grey, T-shaped)
- 2x Pin (grey, long)
- 2x Pin (tan)
- 1x Ring (red)



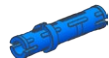


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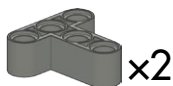
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 x8

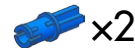
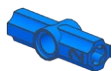
x2

 $\times 2$ 

x5



x2



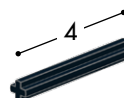
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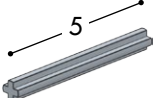
x3



x3



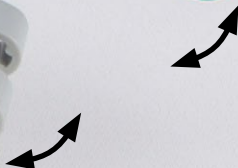
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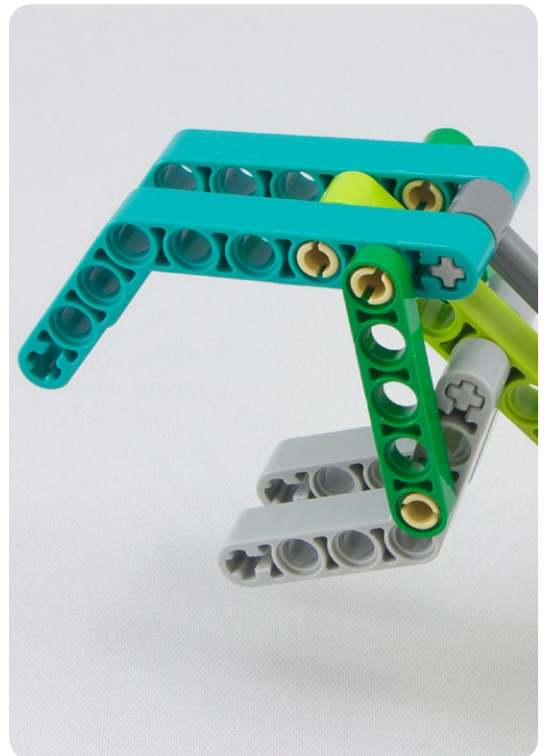
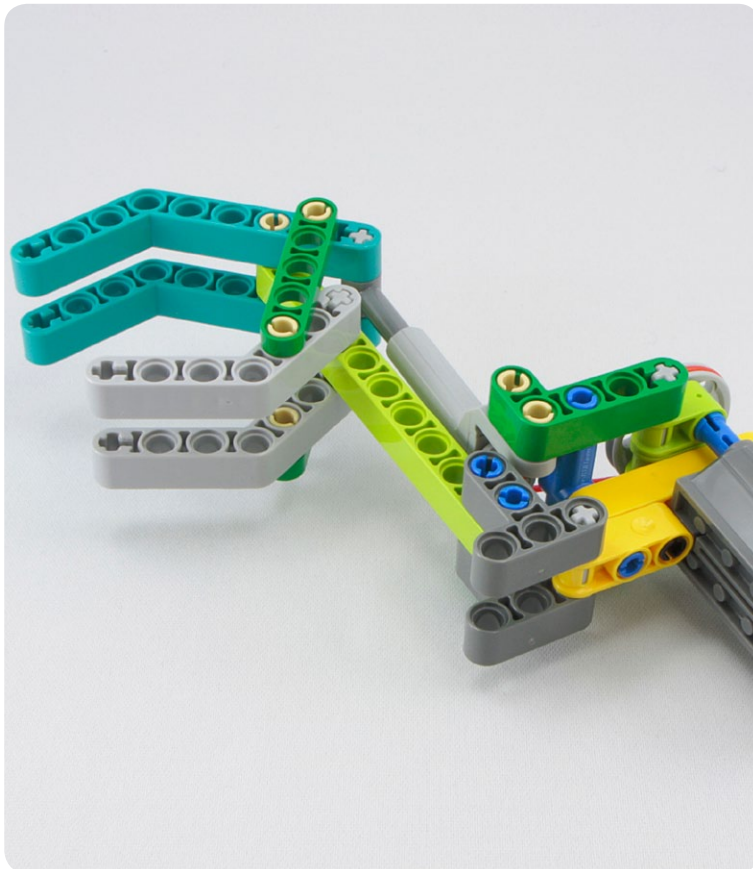
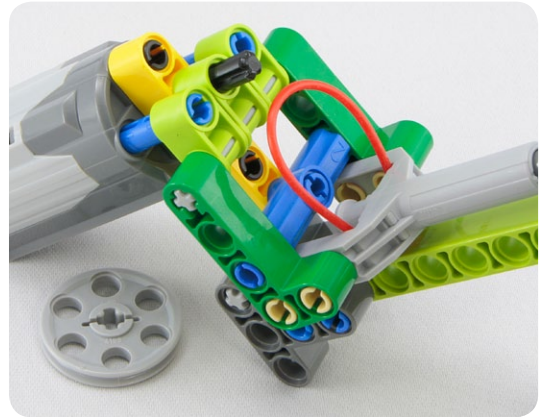
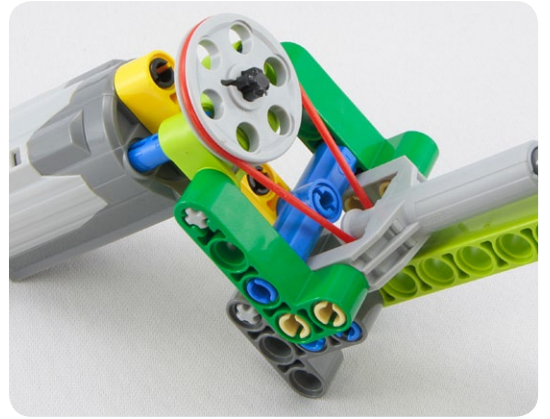
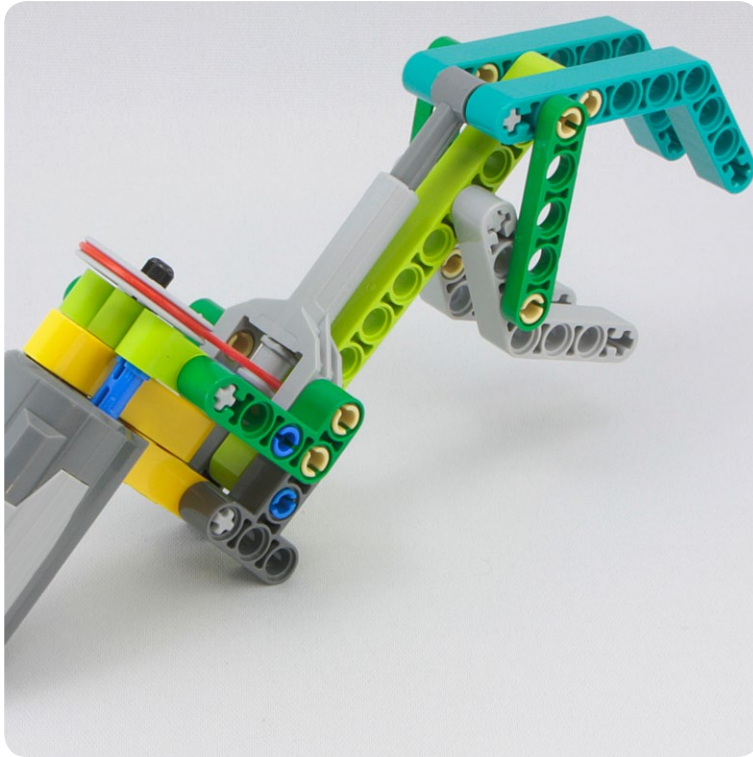


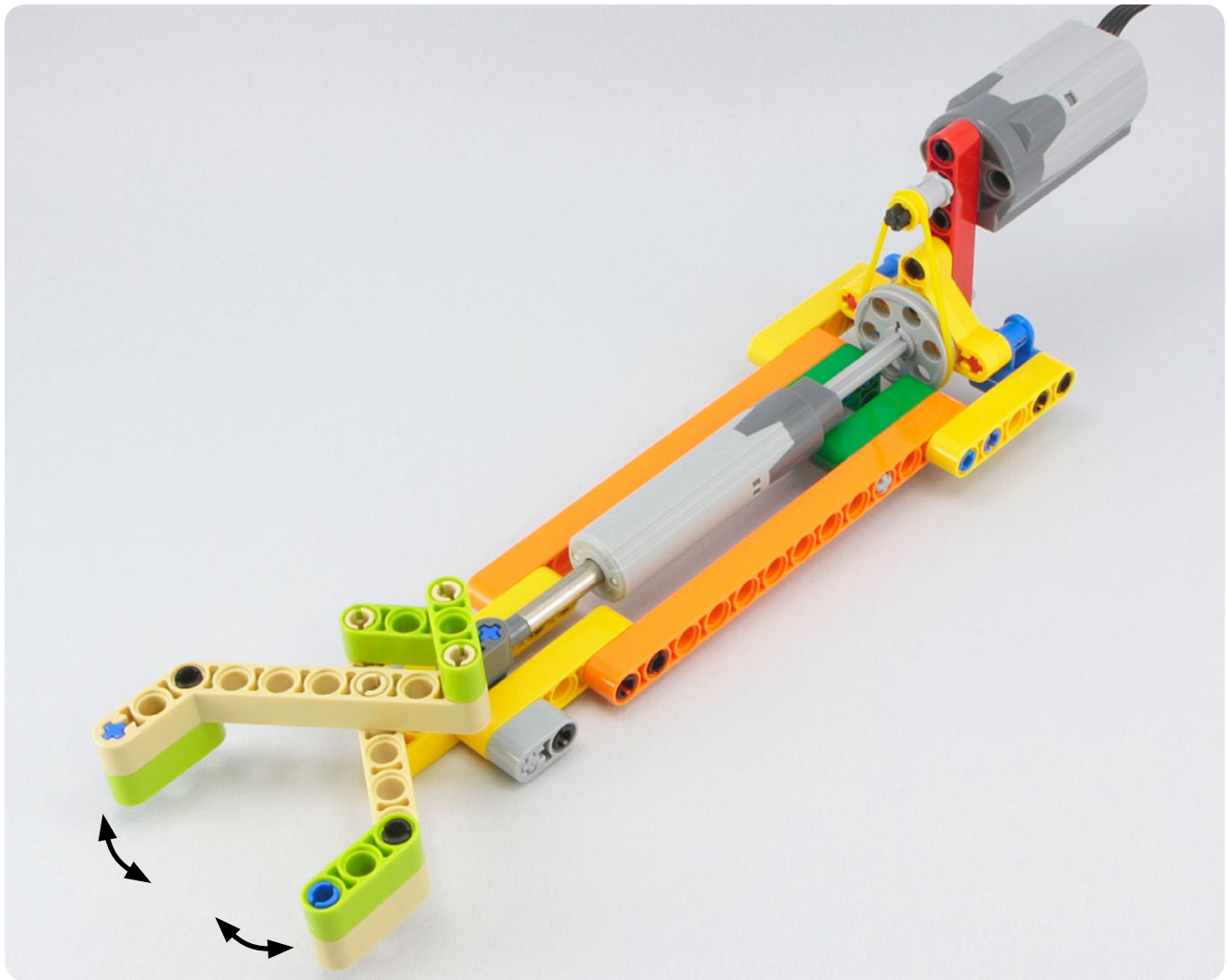
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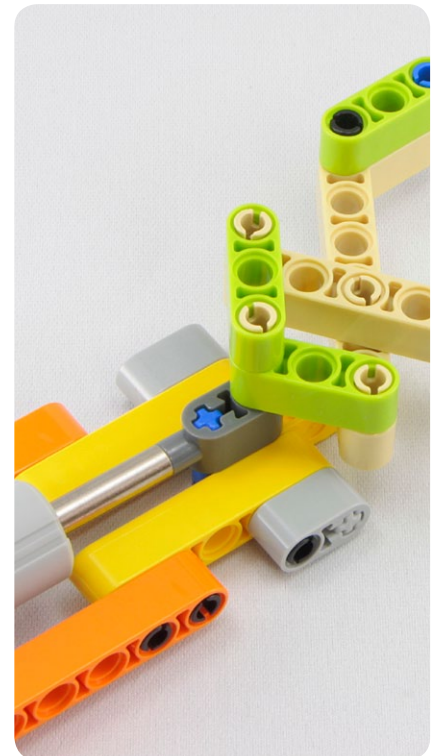
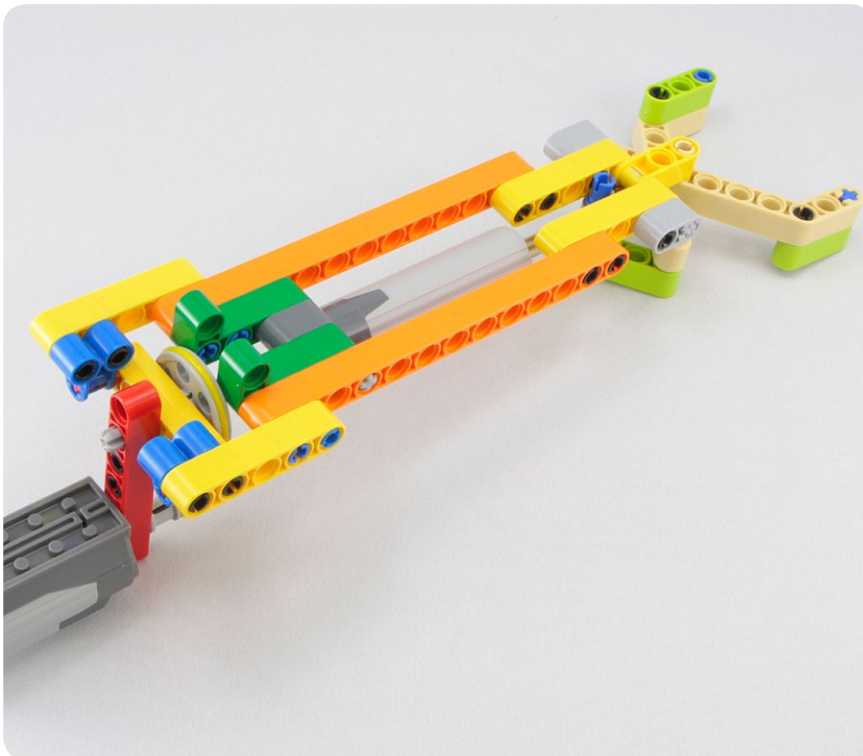
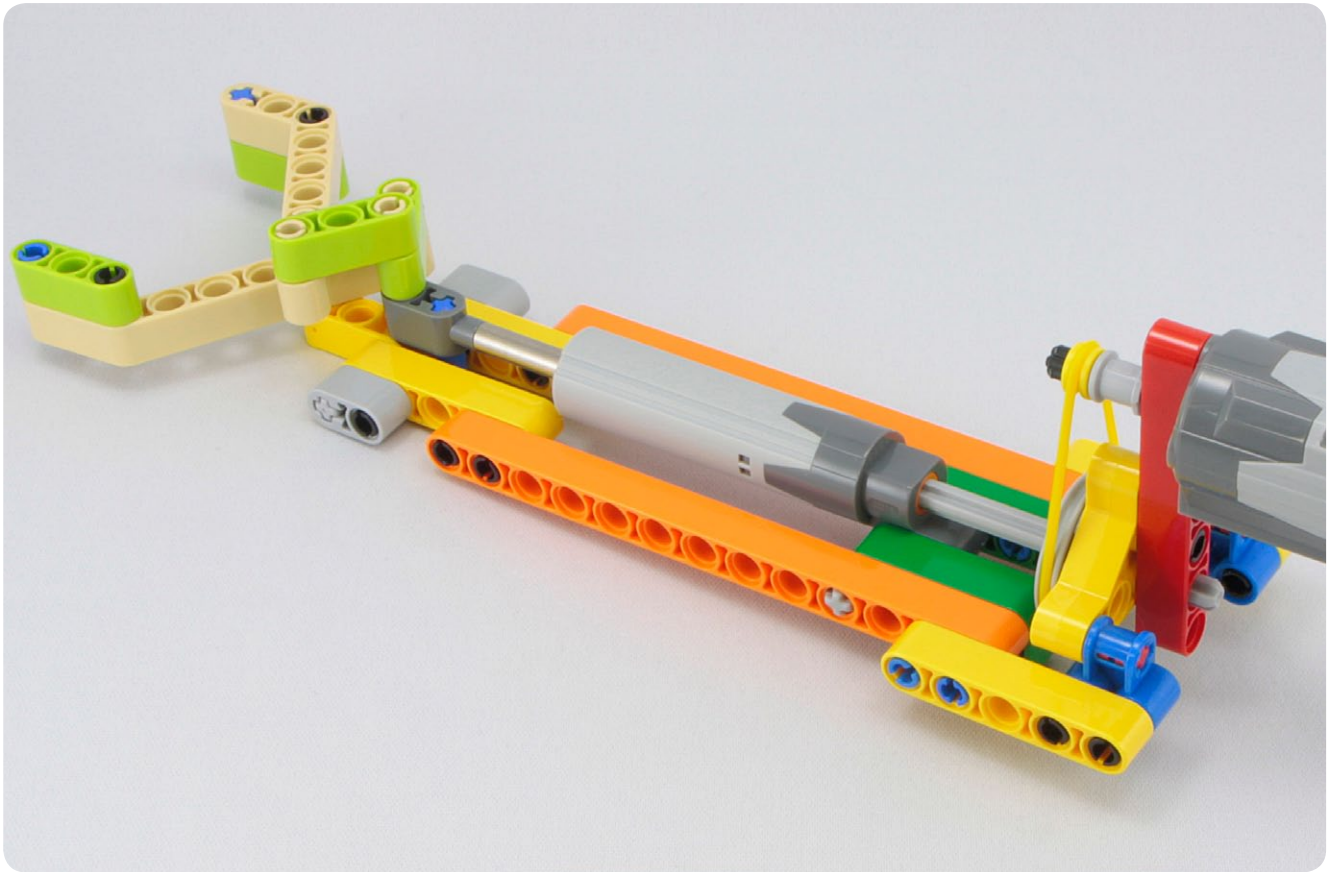


x3

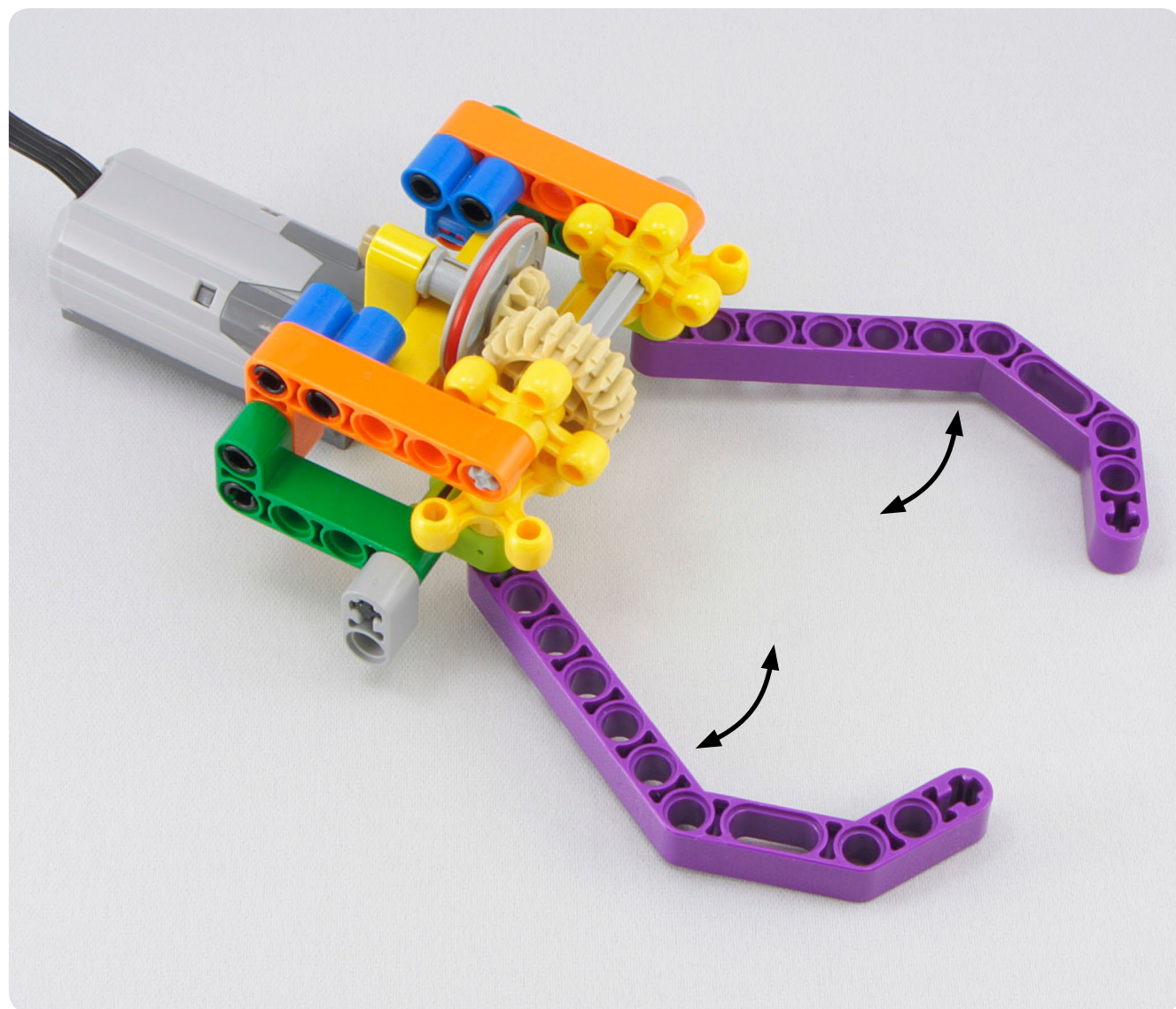
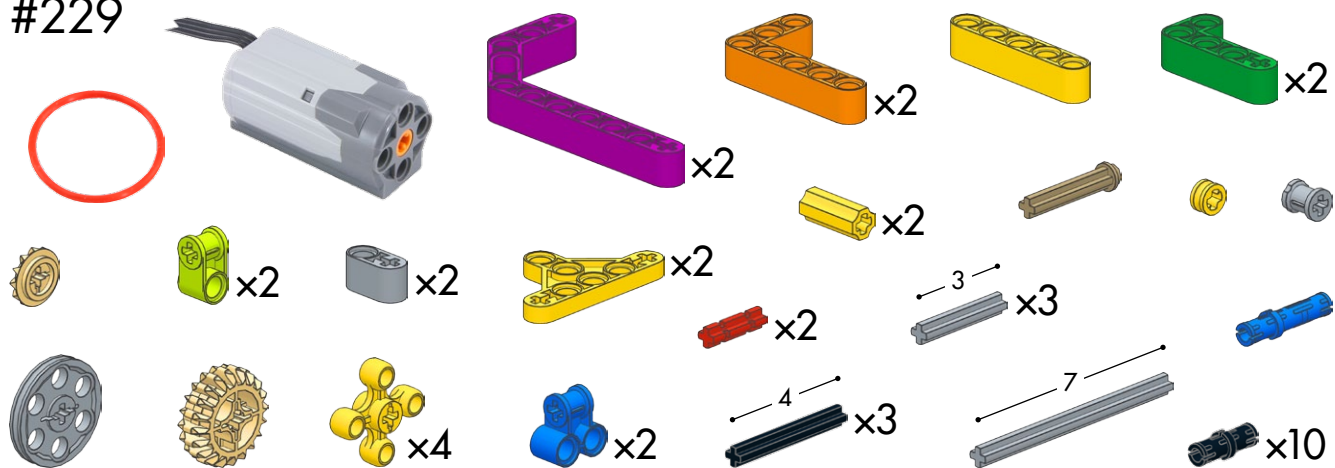


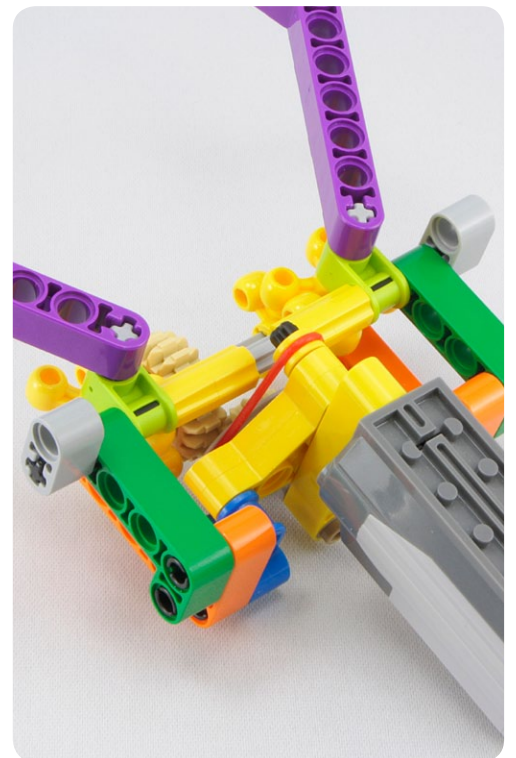
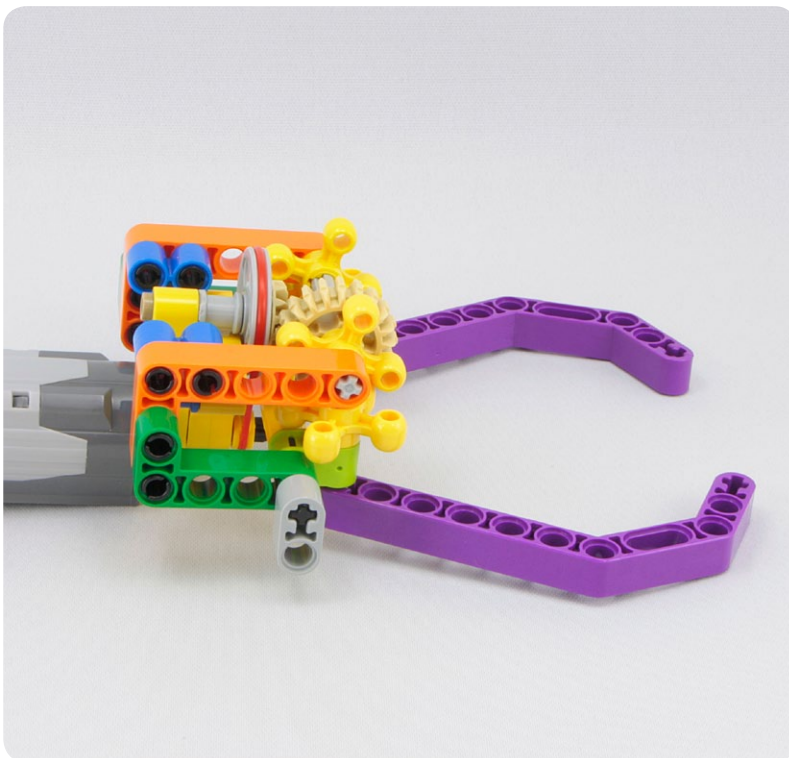
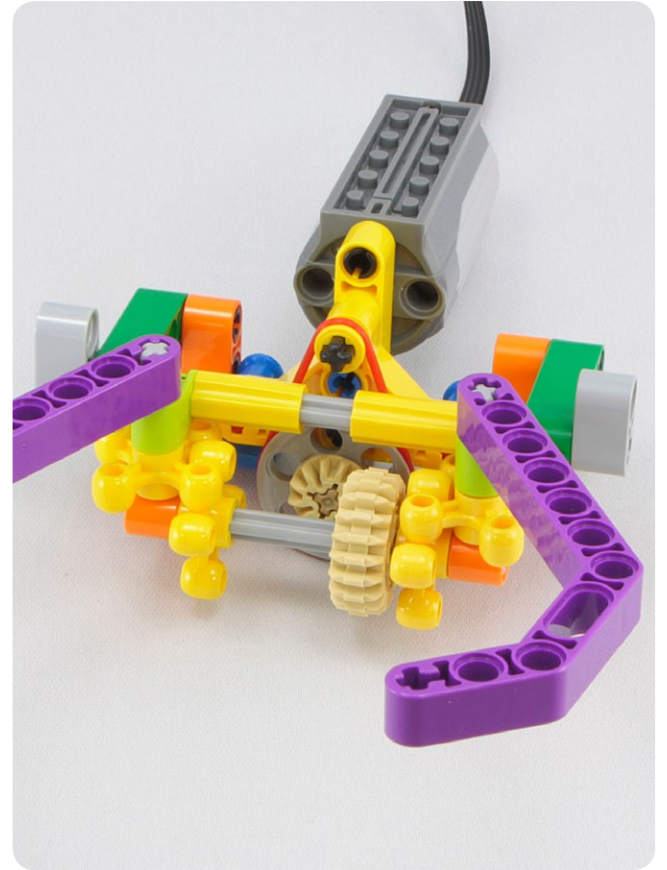


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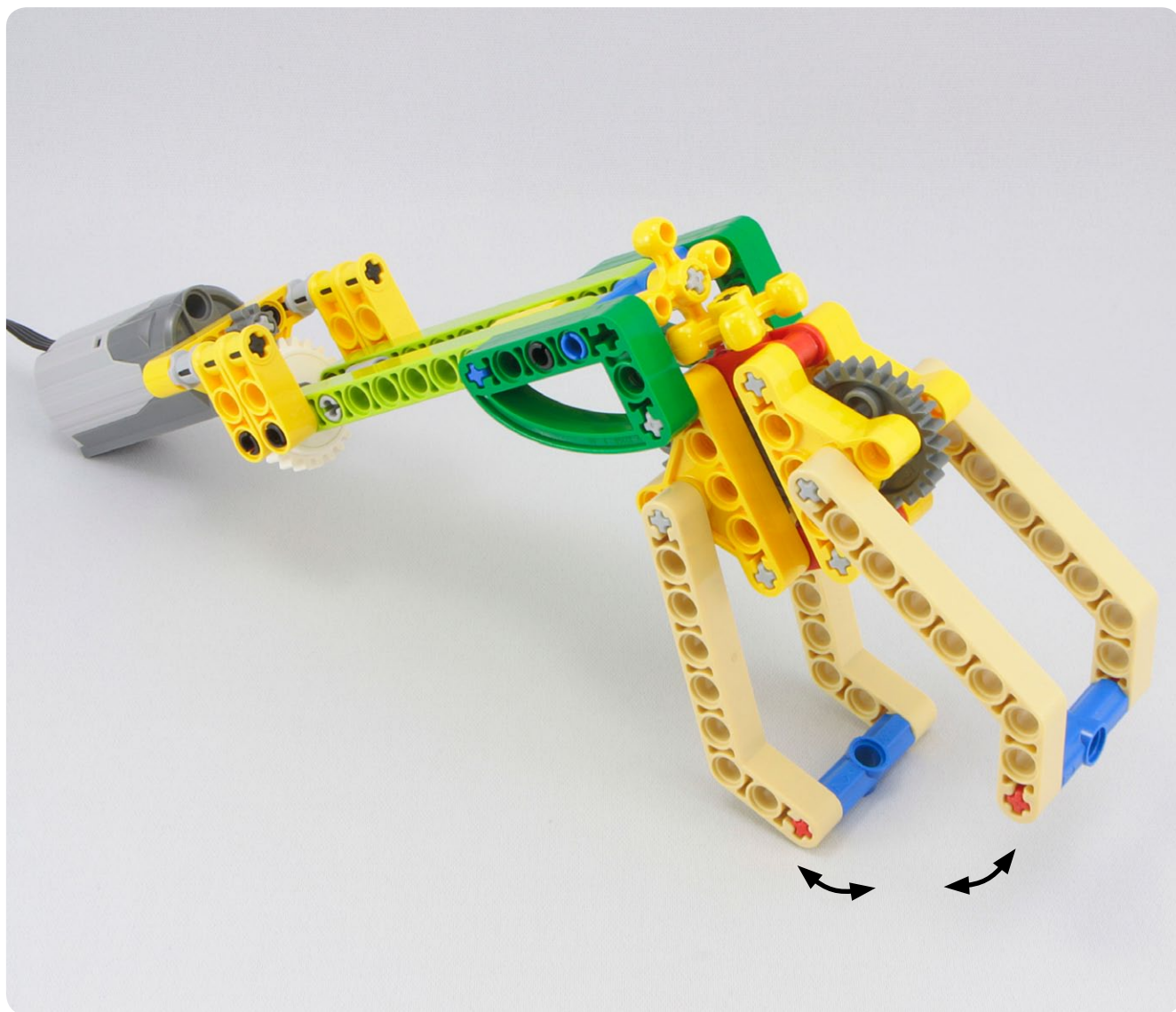
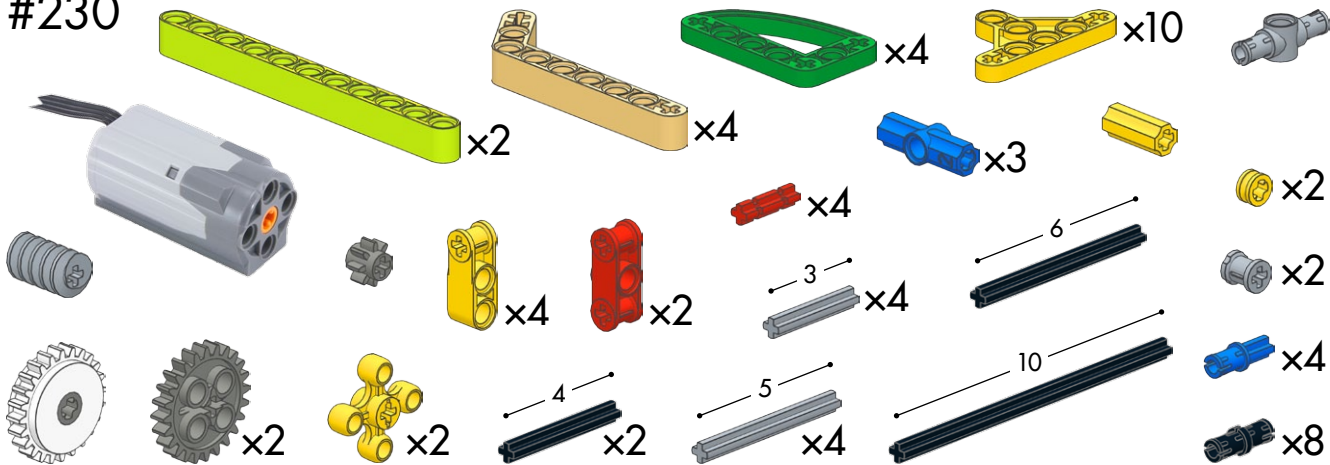


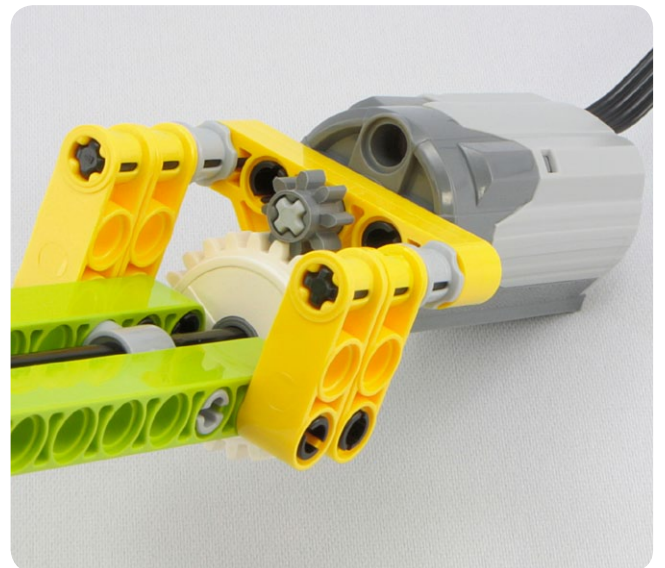
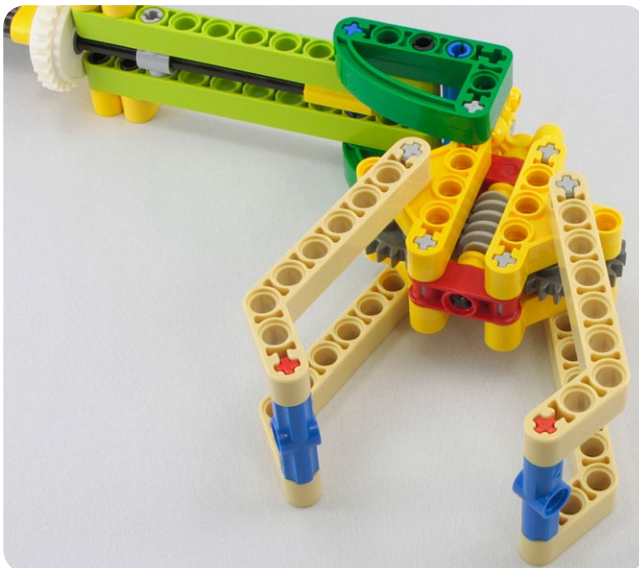
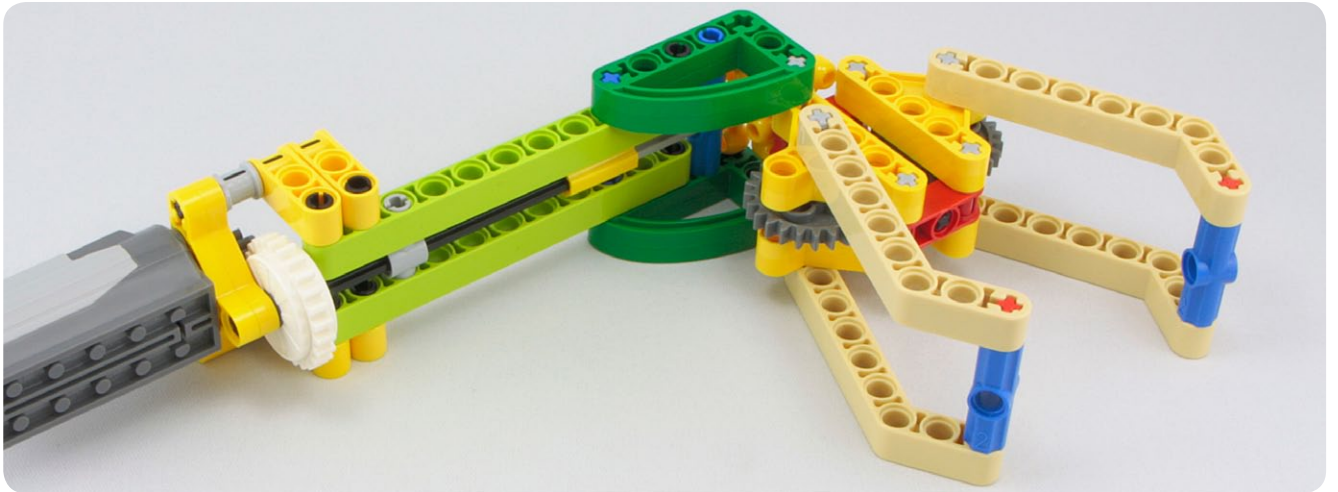
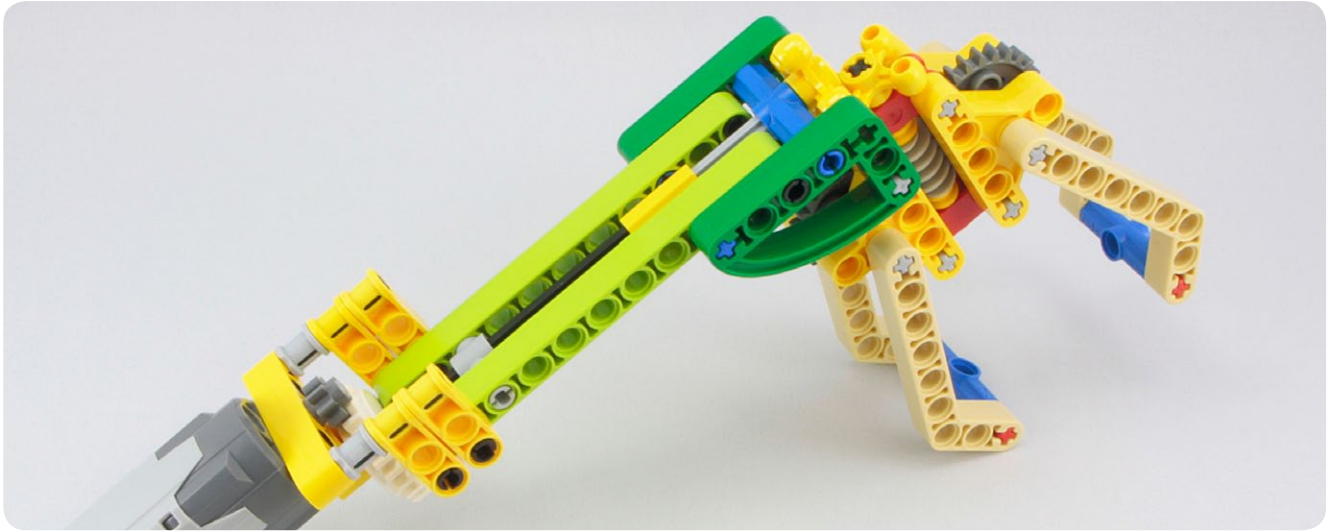
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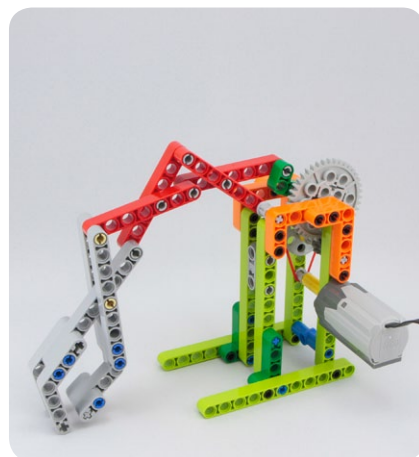
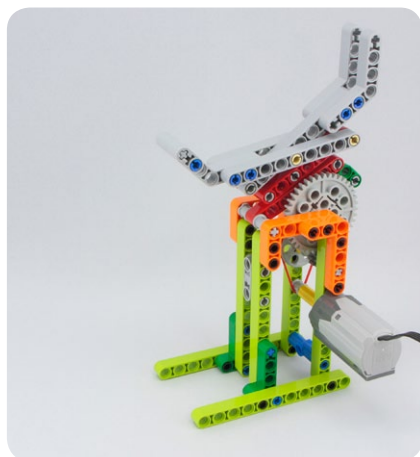
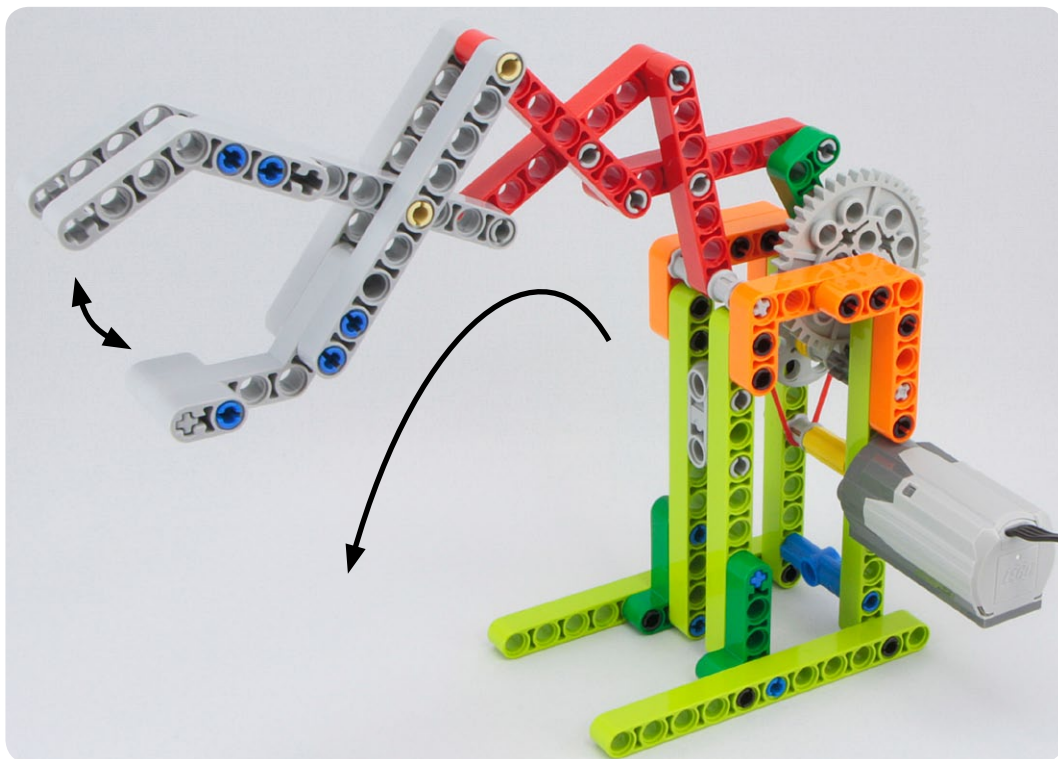


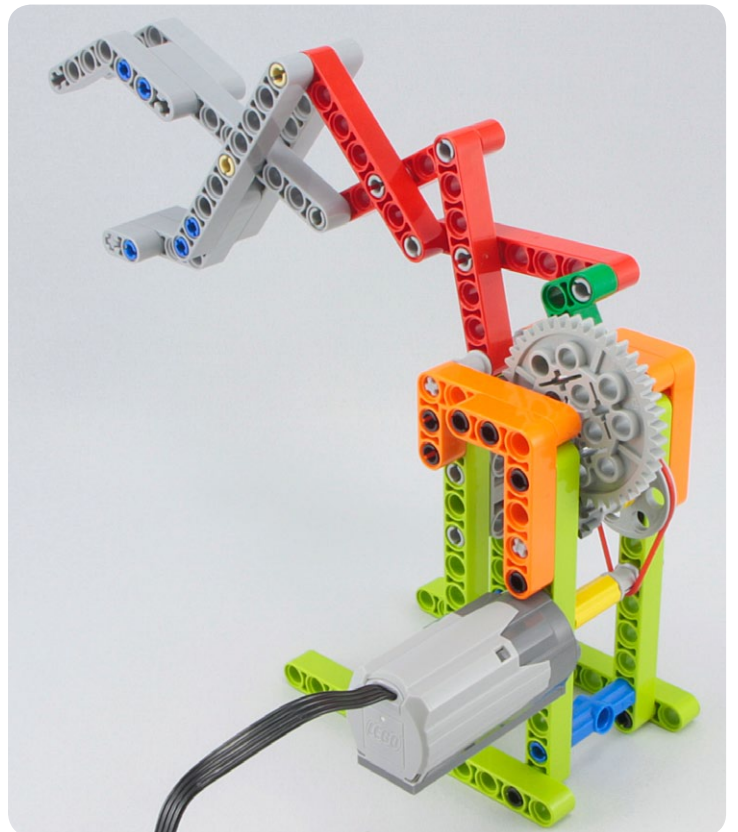
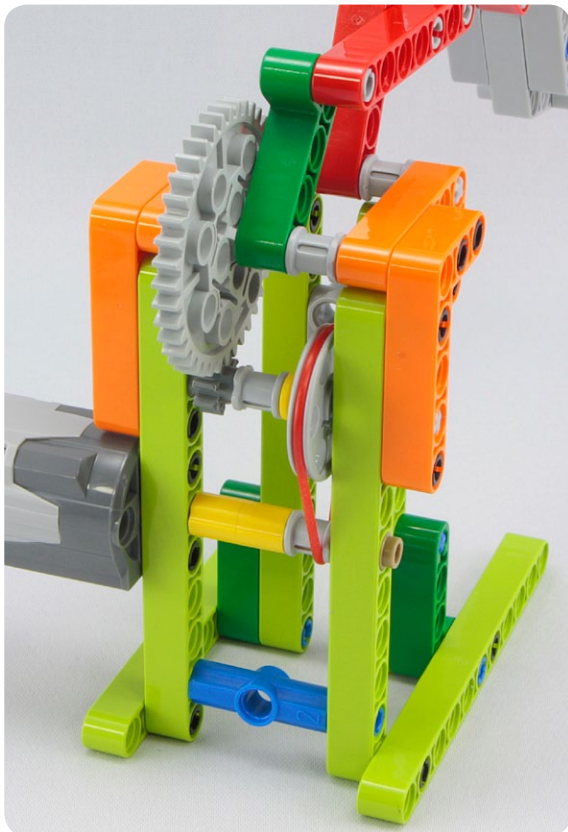
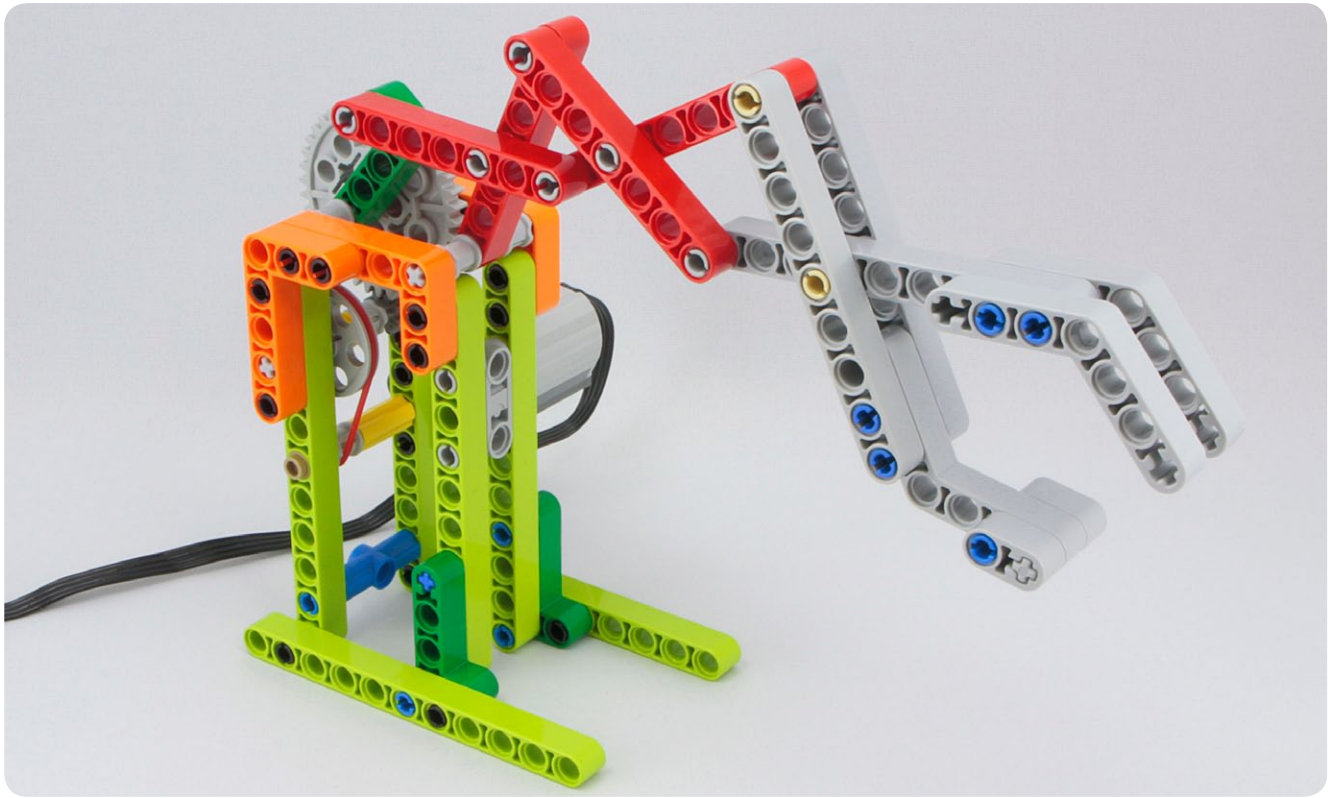


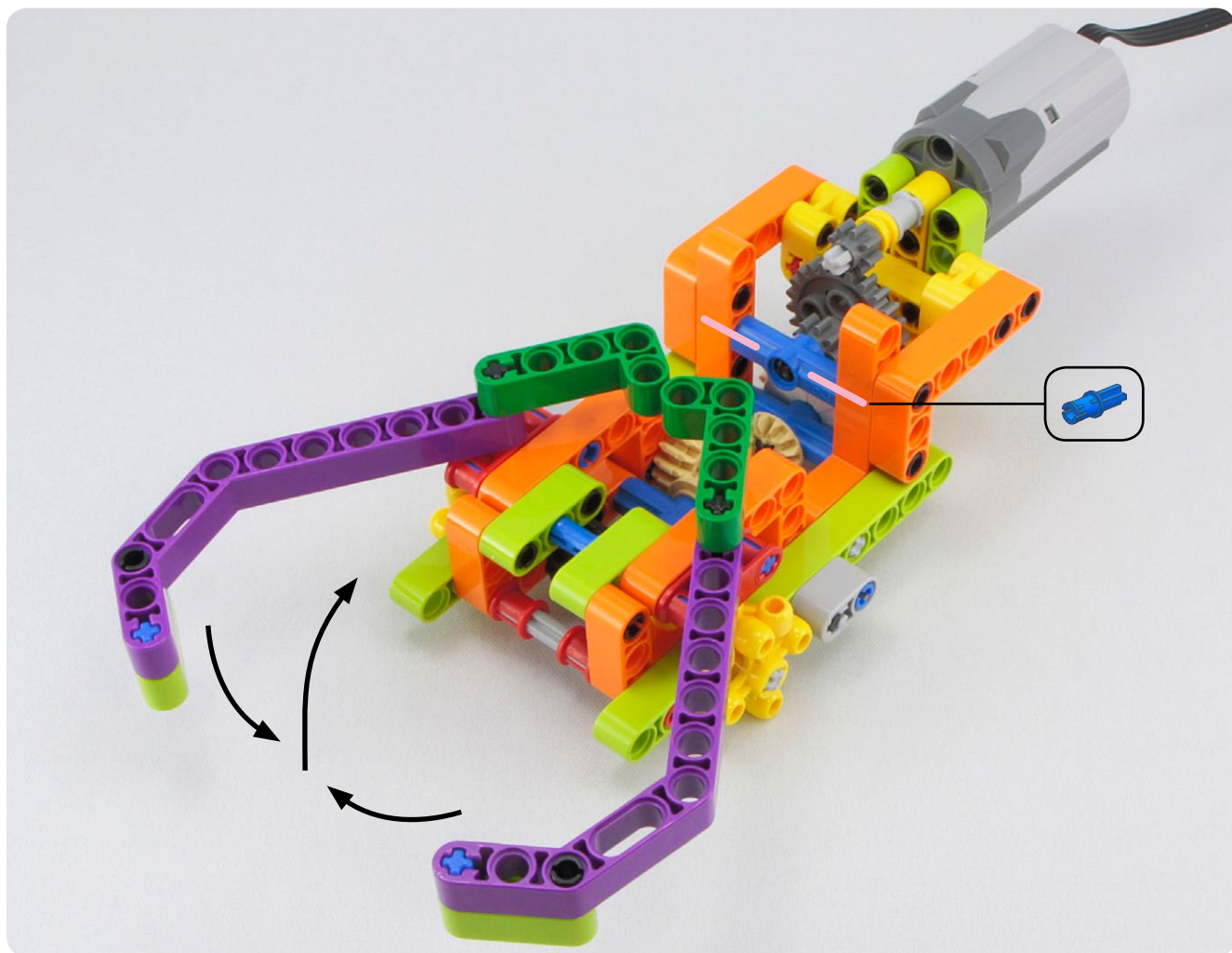
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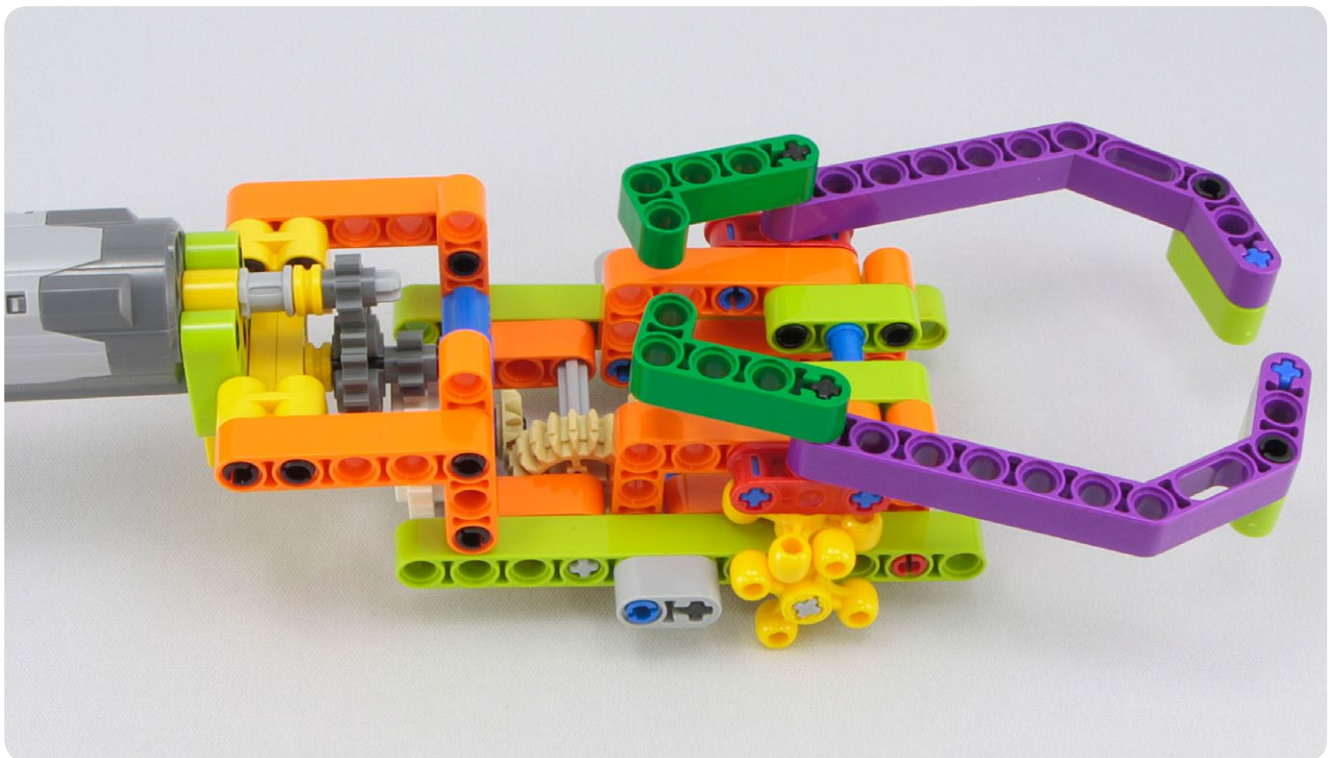
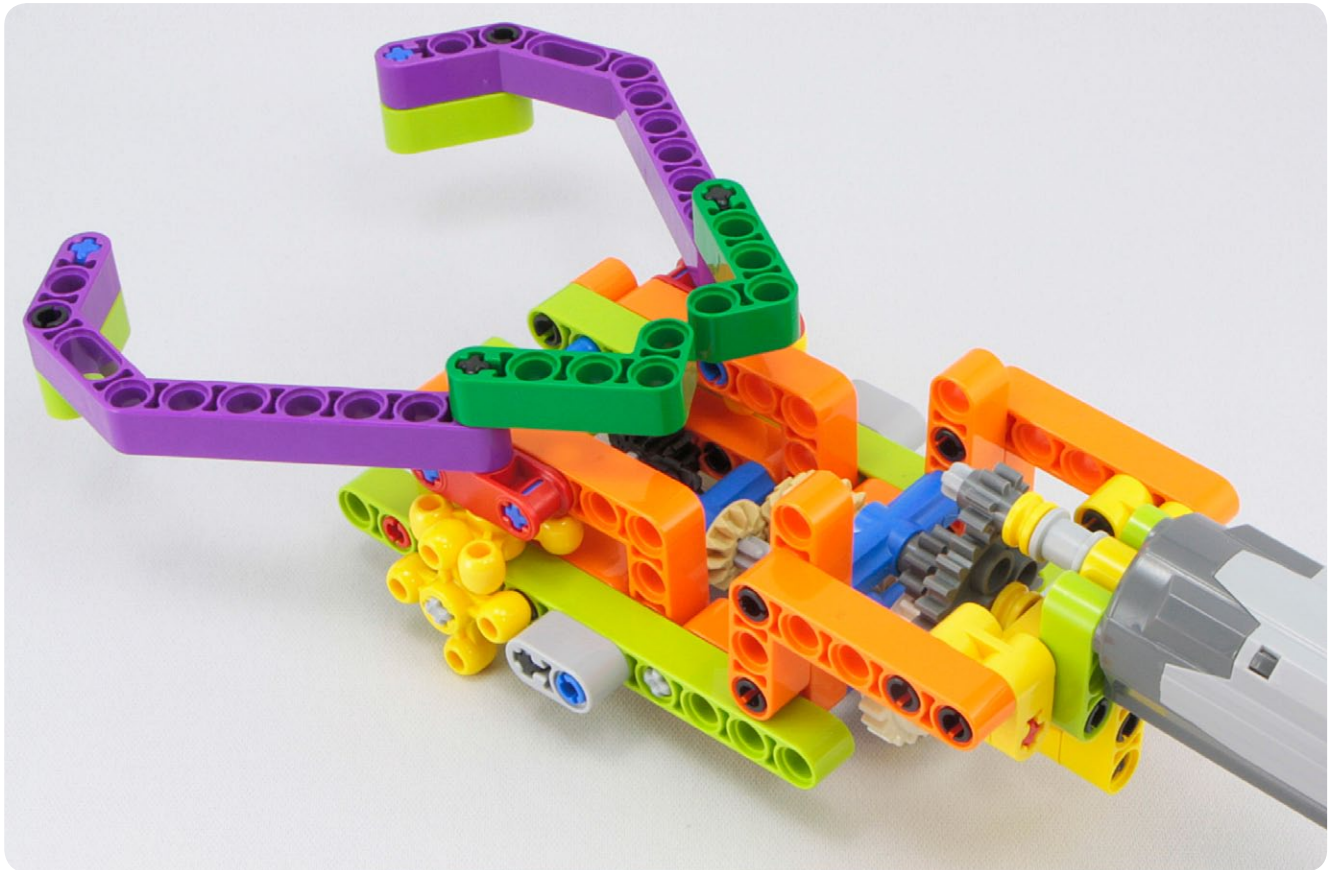


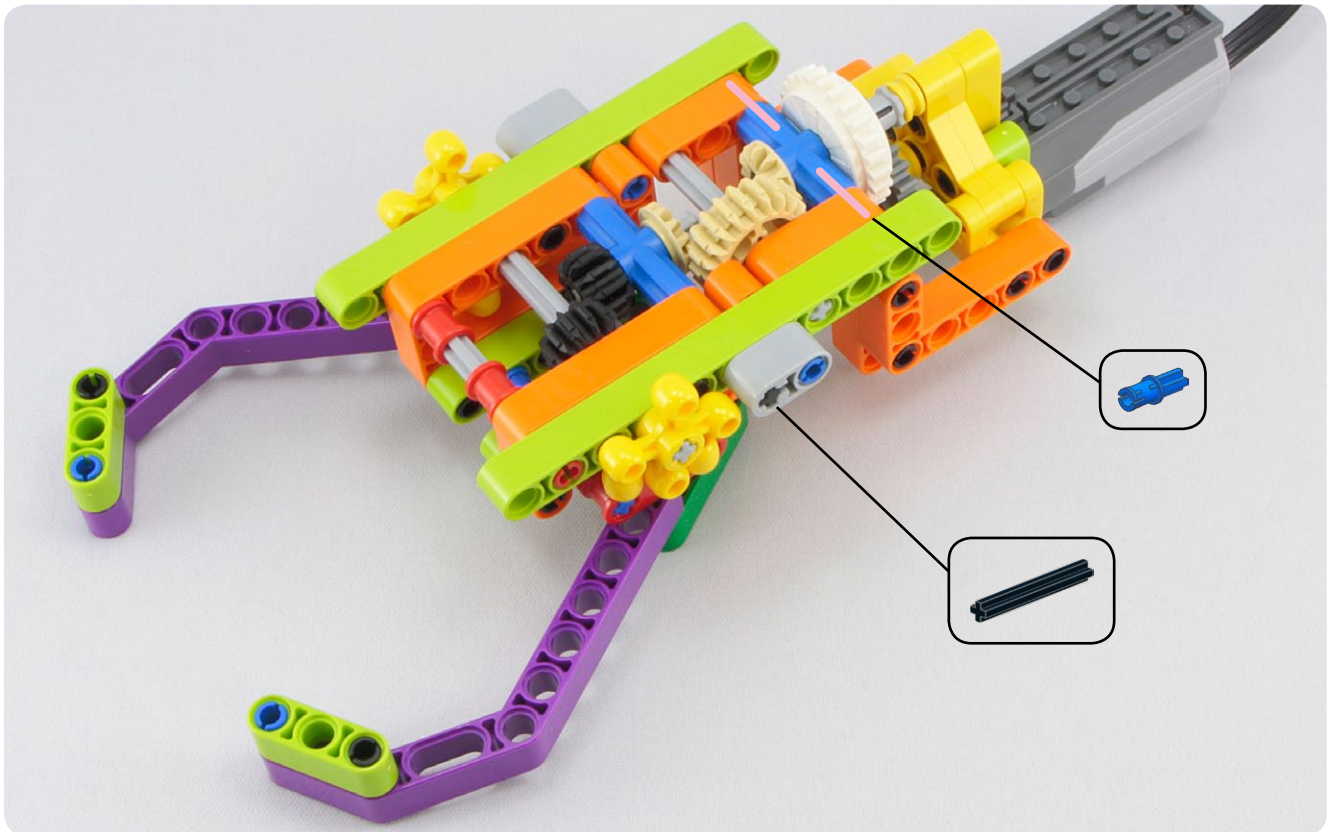
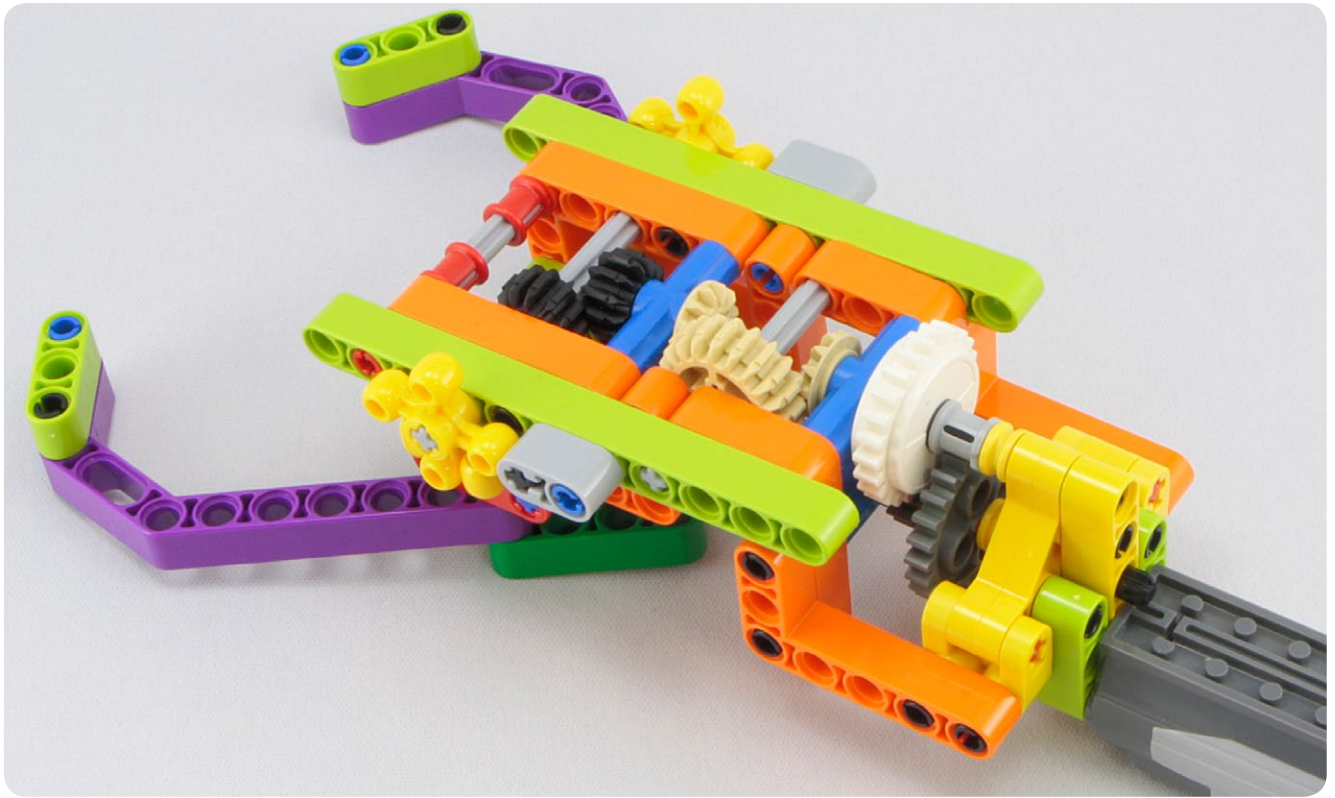


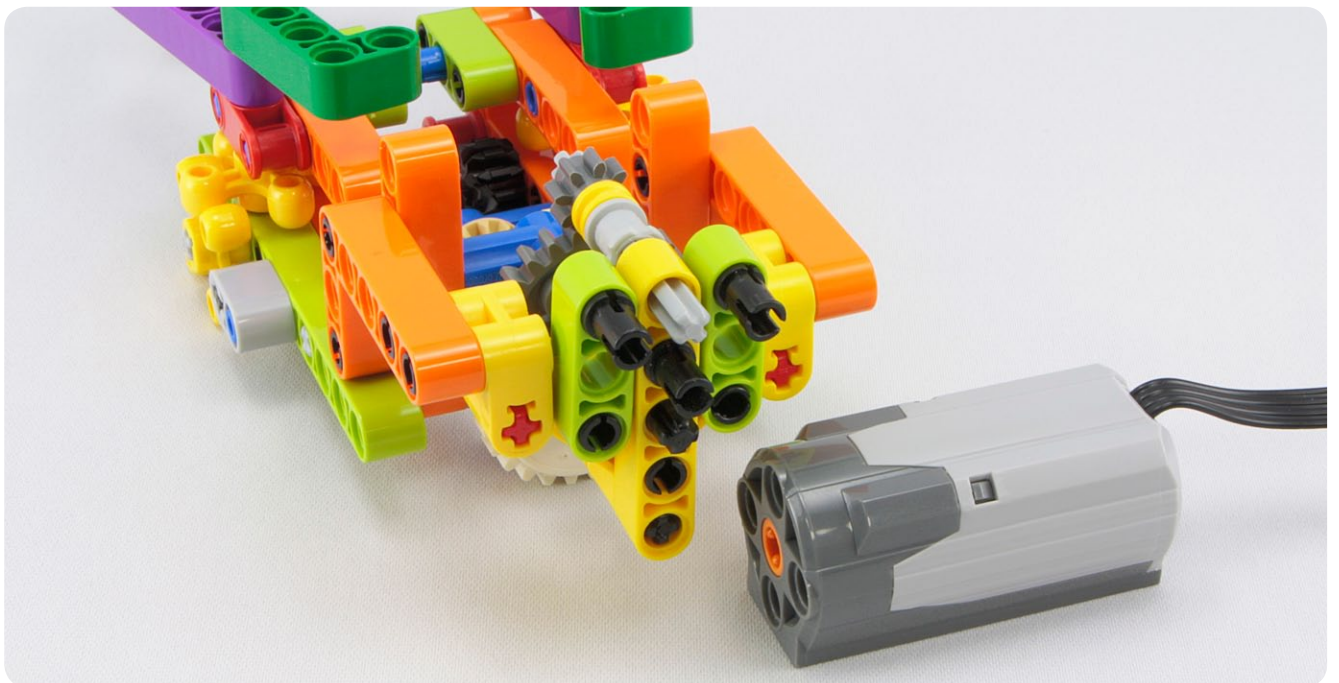
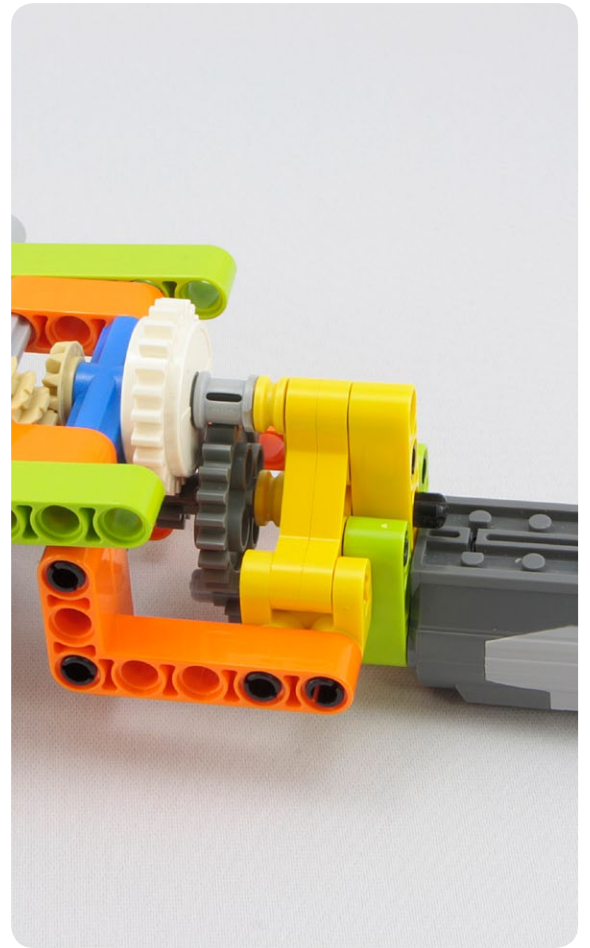
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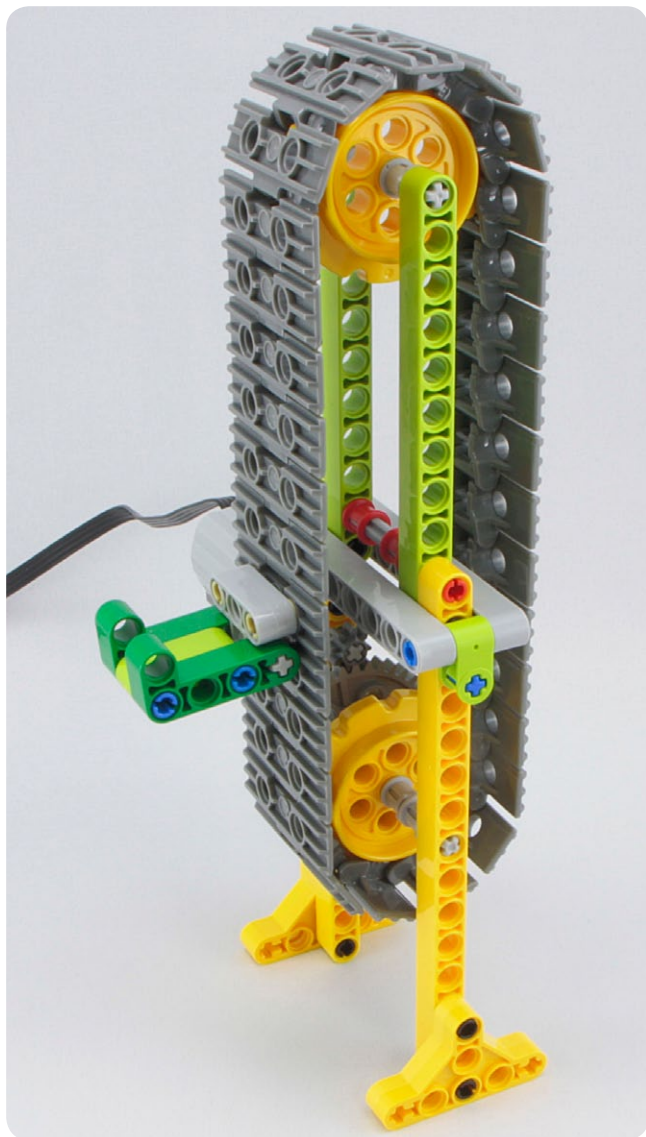
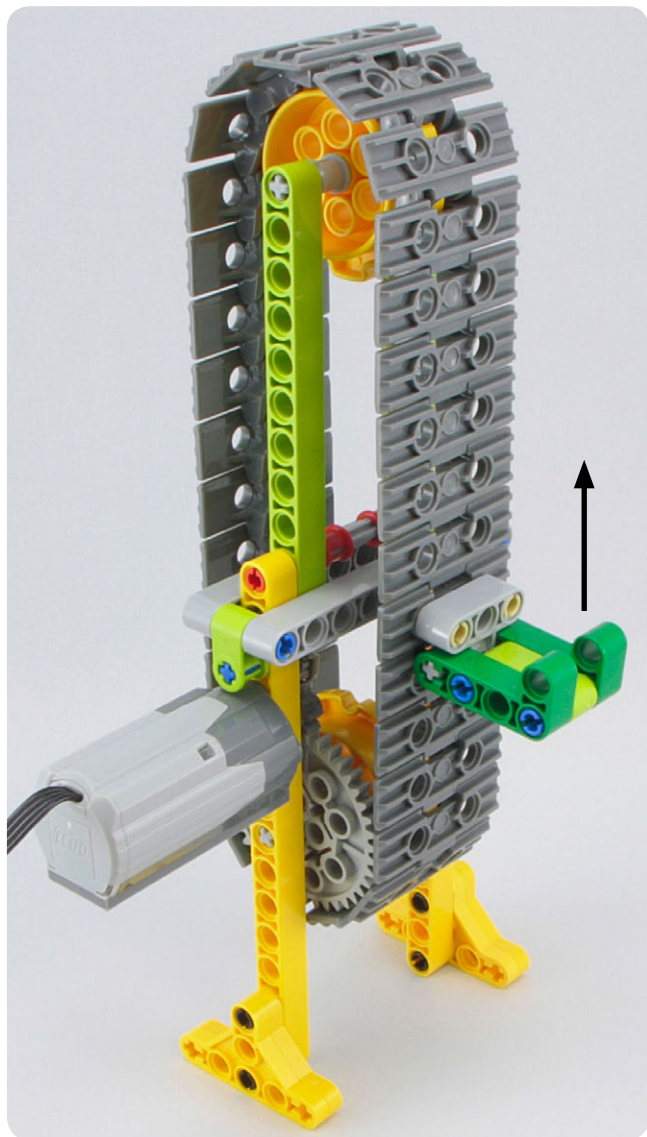
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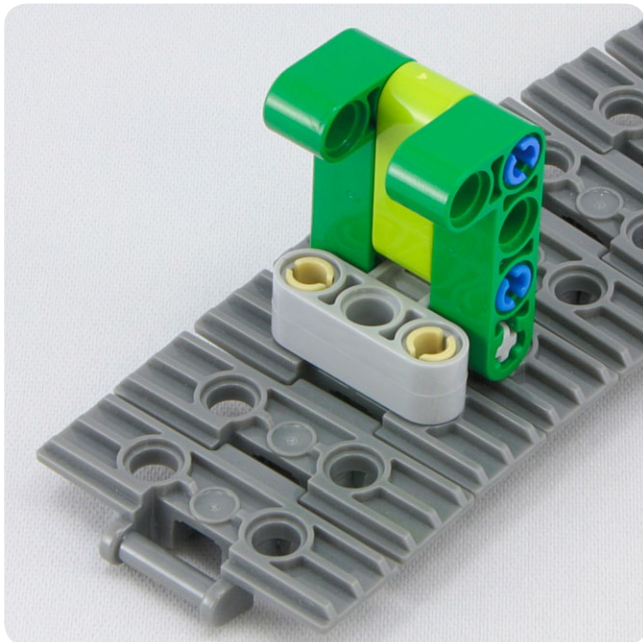
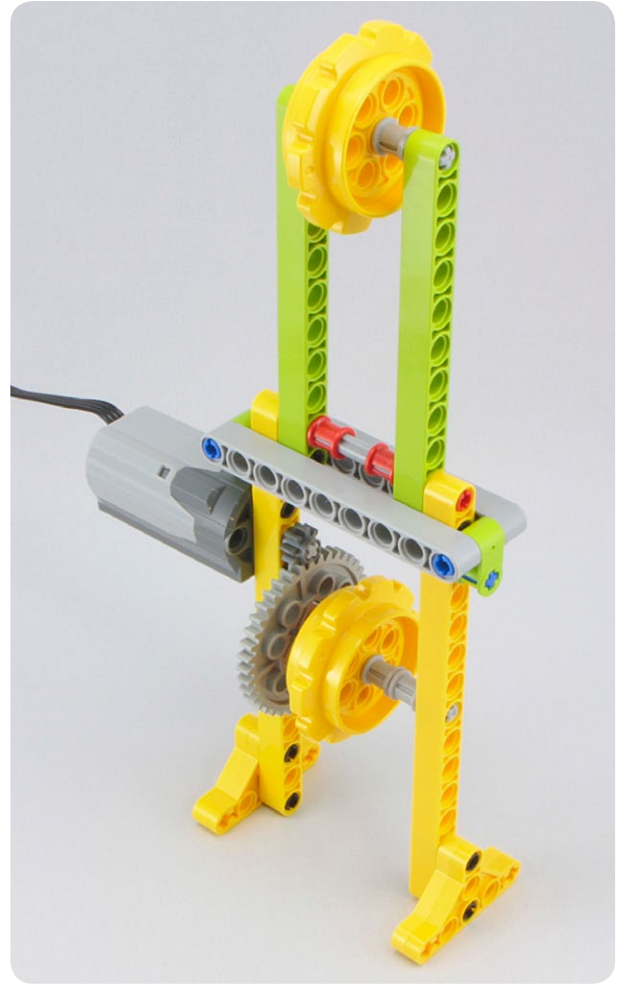


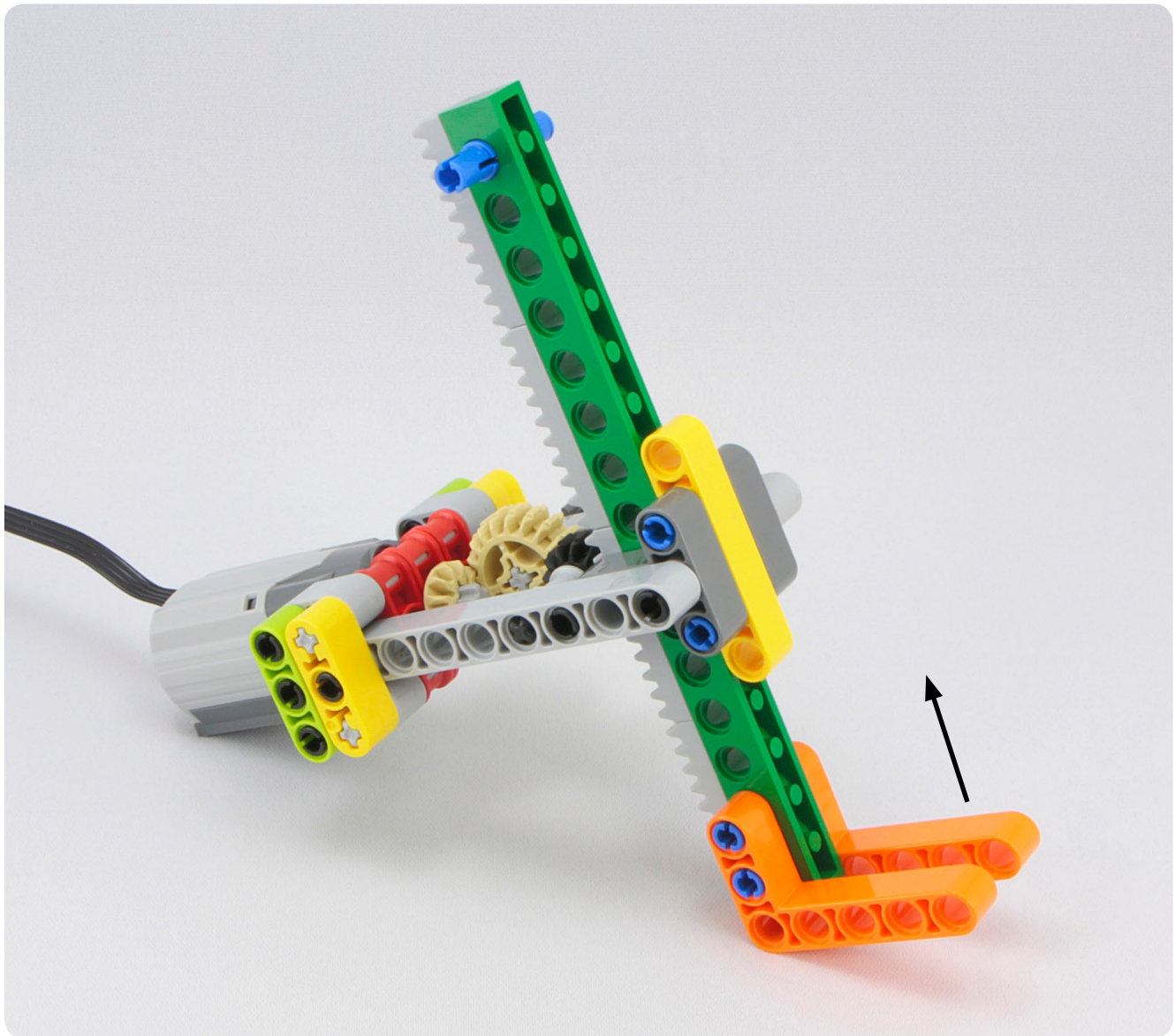


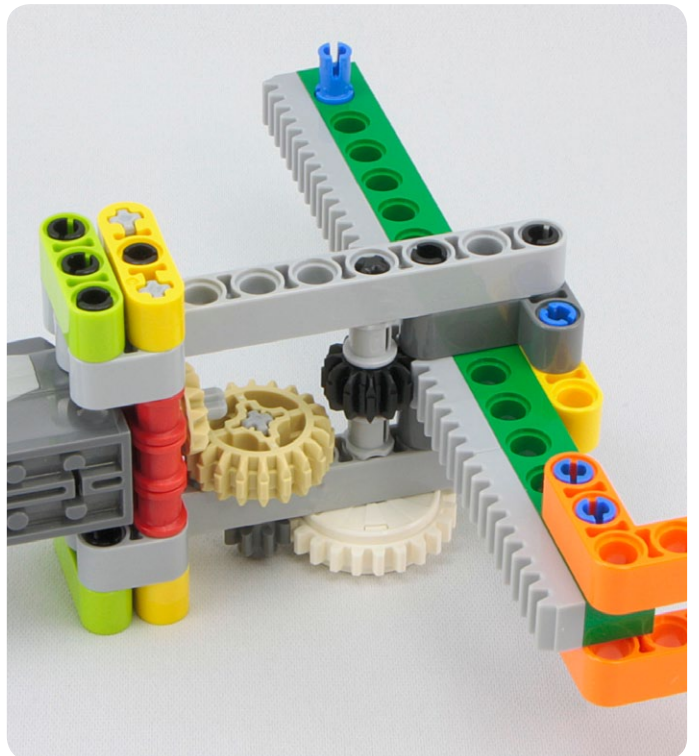
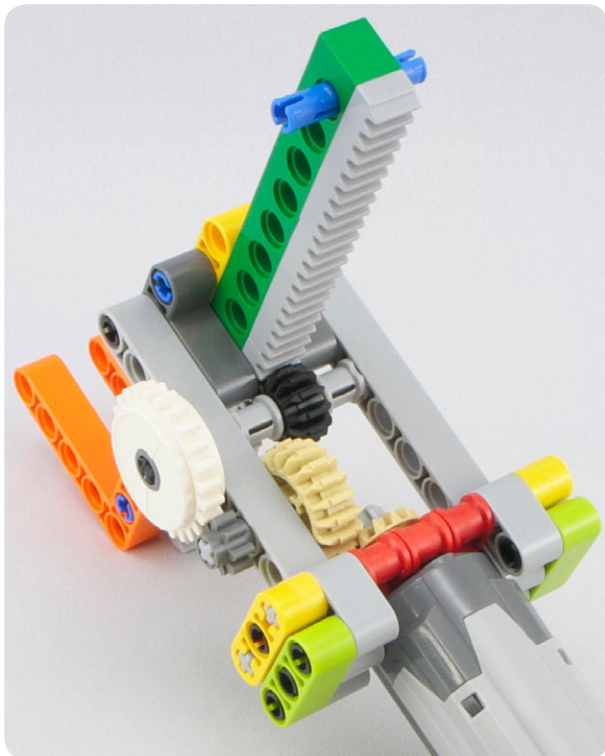
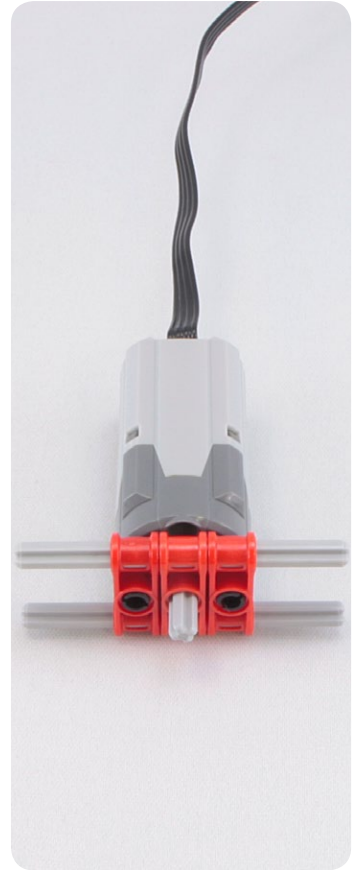




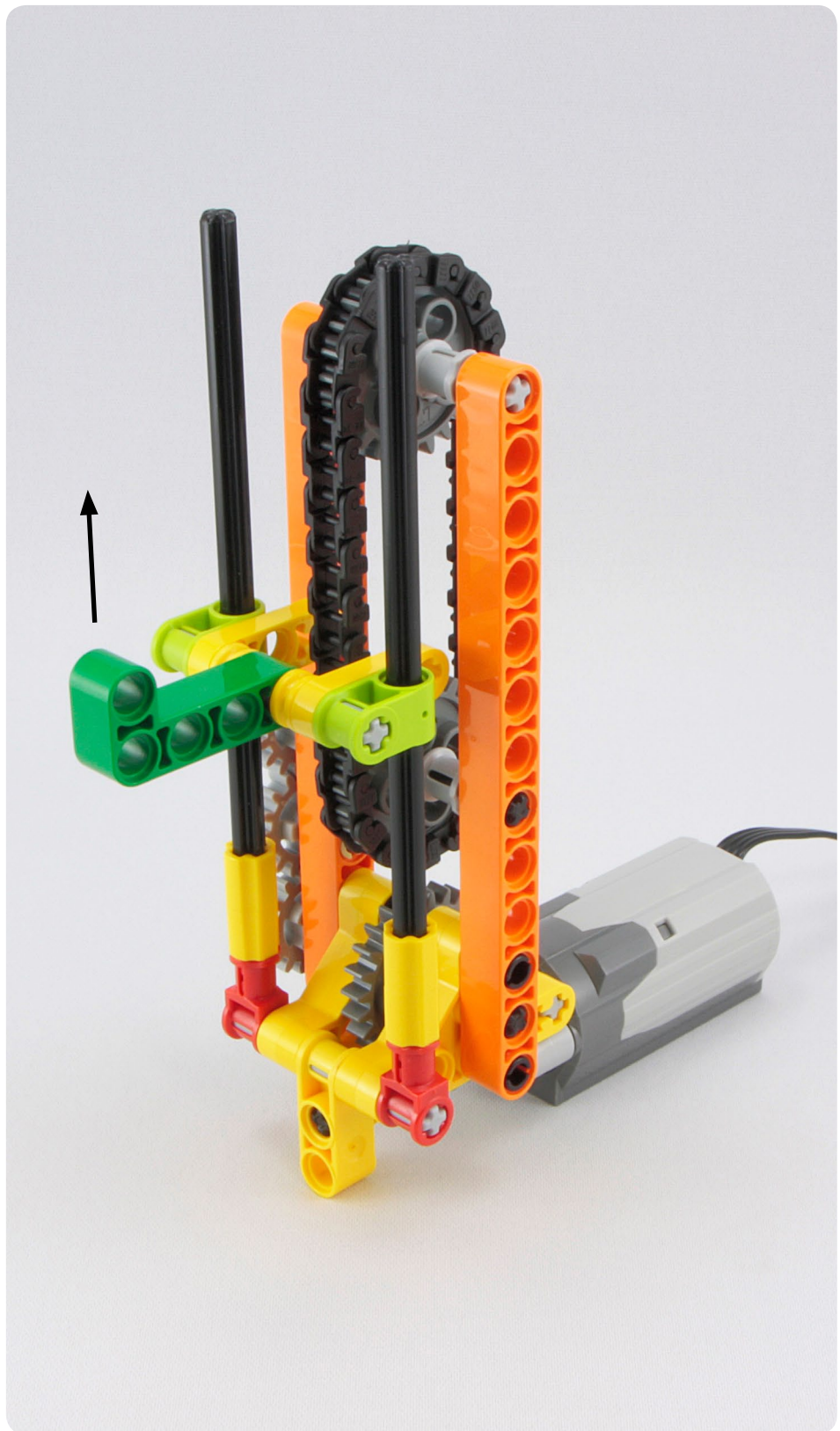
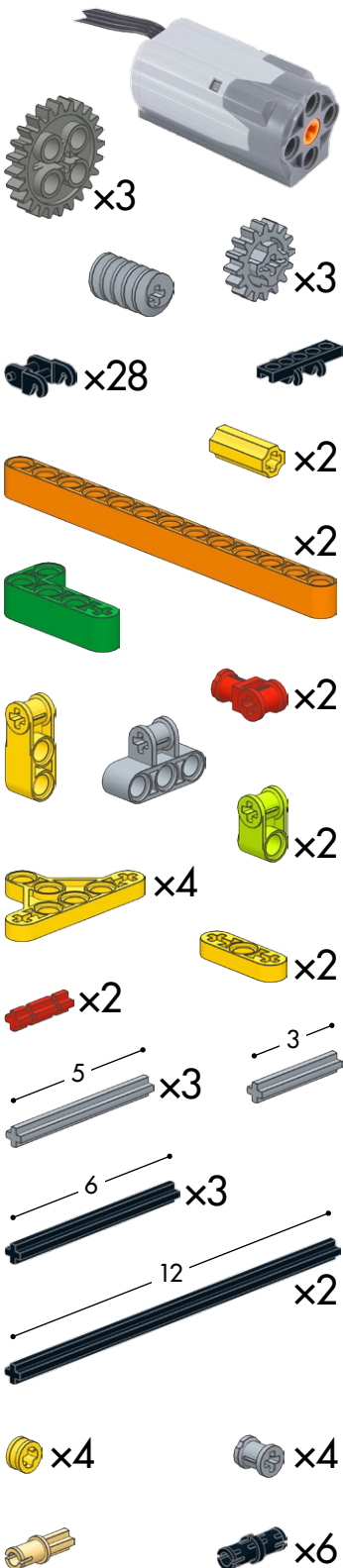
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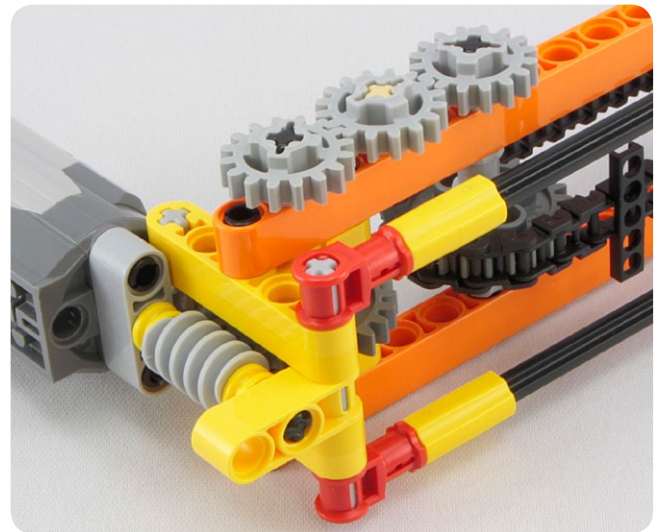
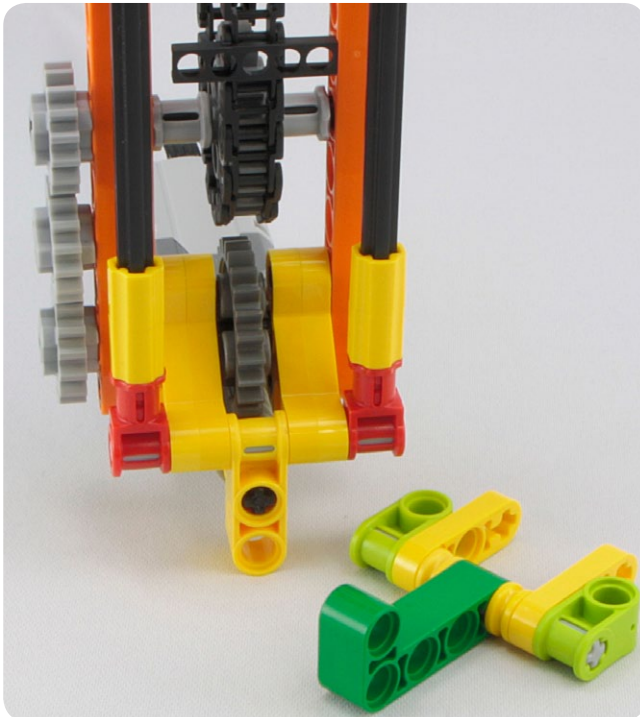


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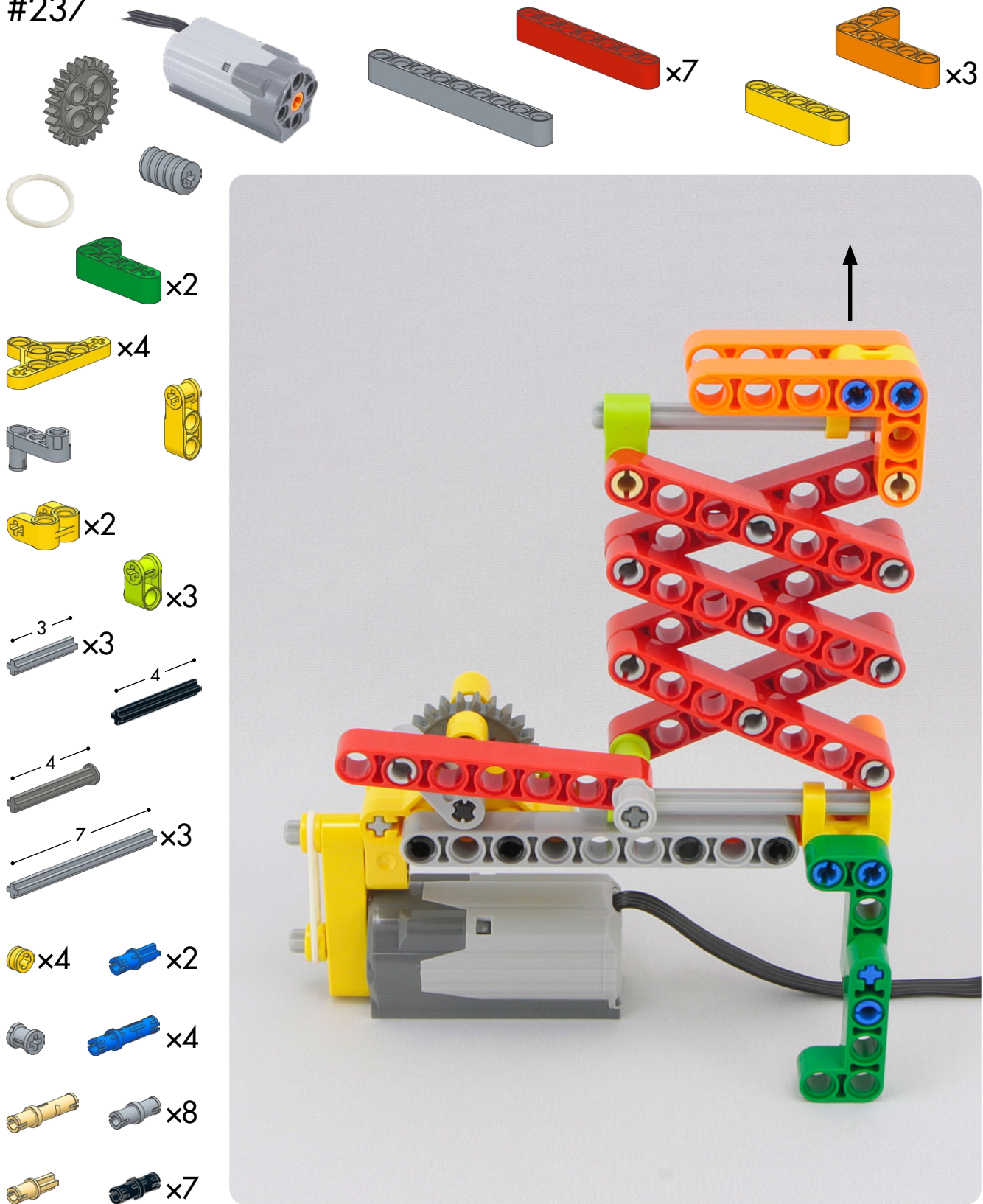


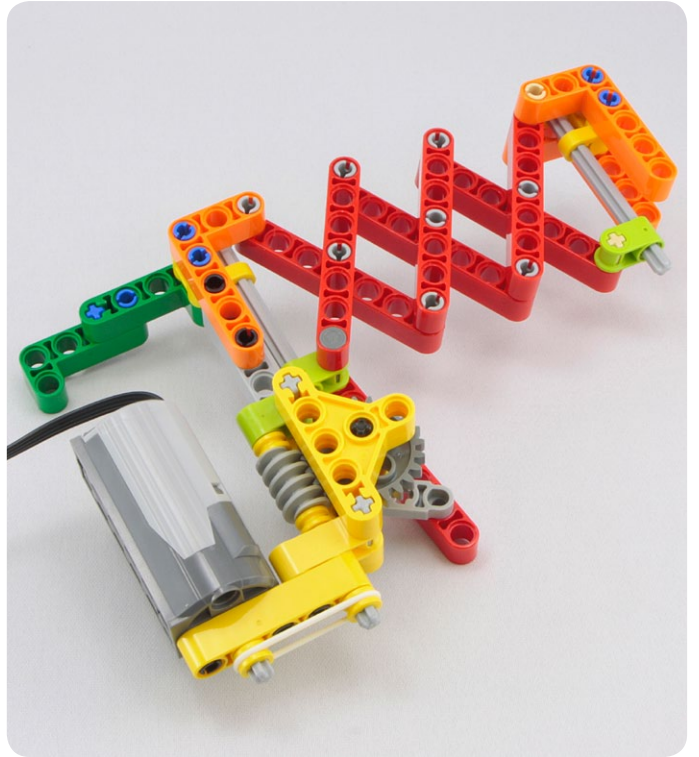
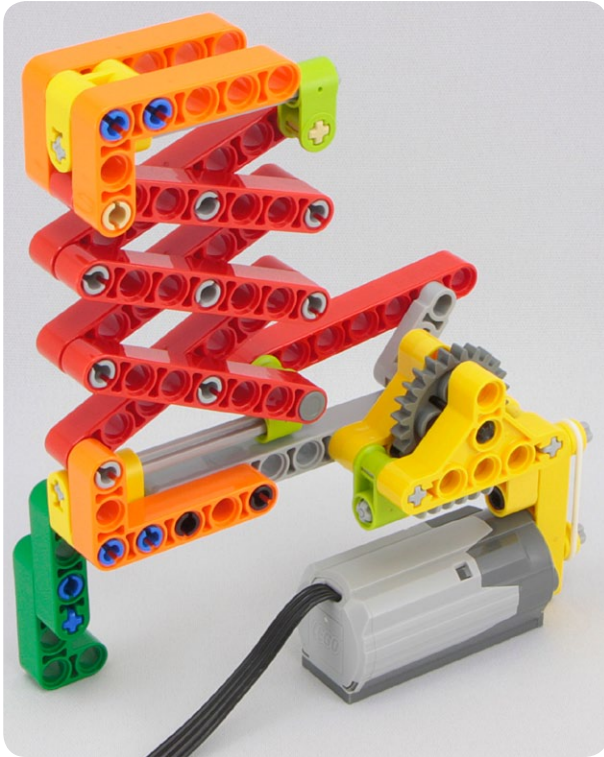
#236

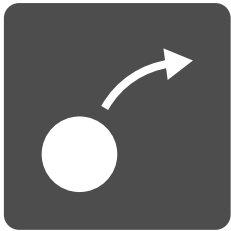




#237





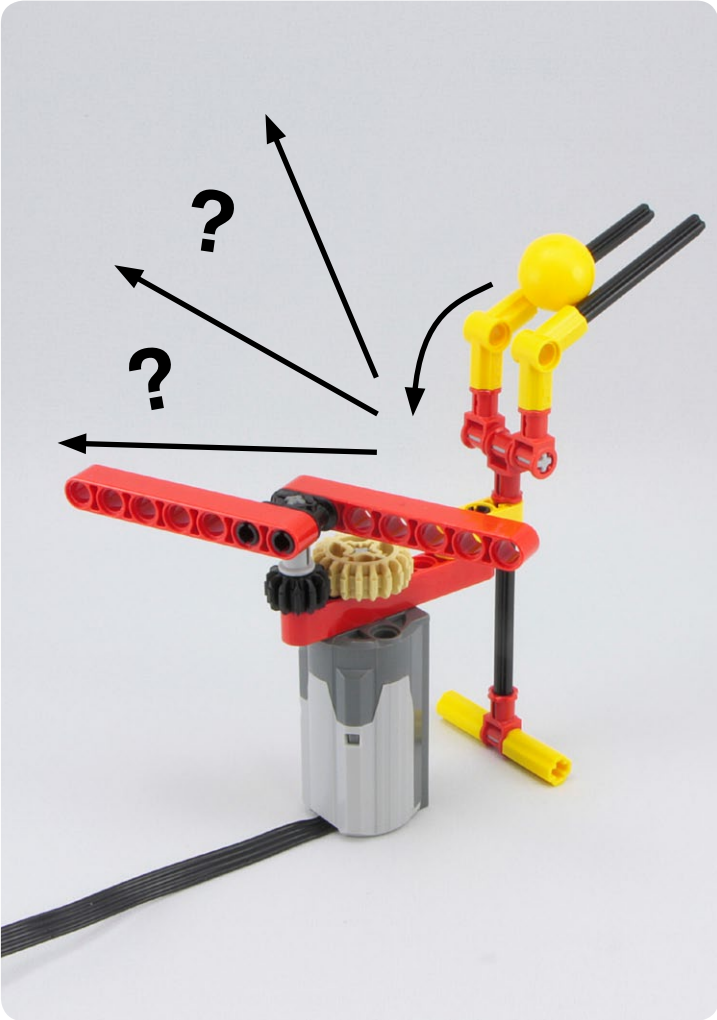


Shooting things

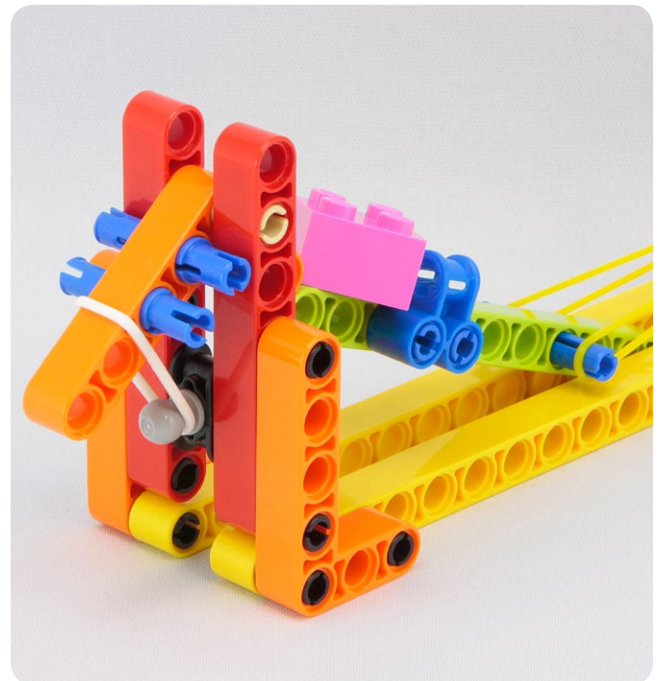
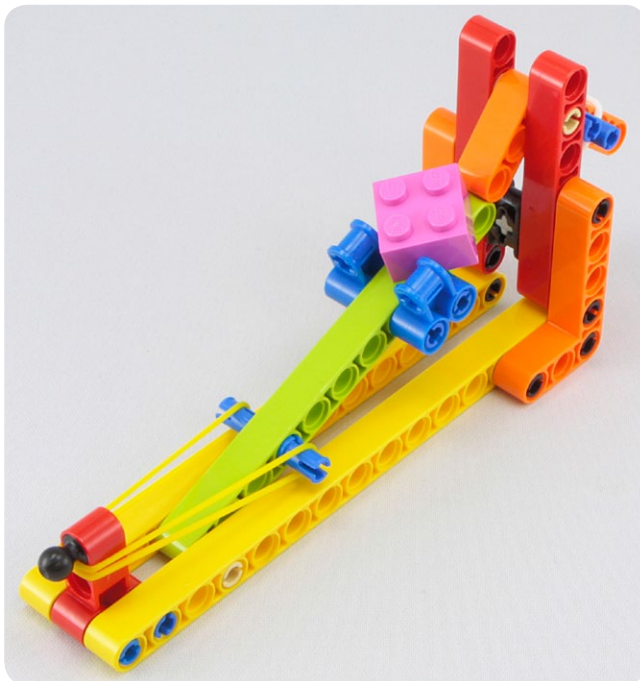
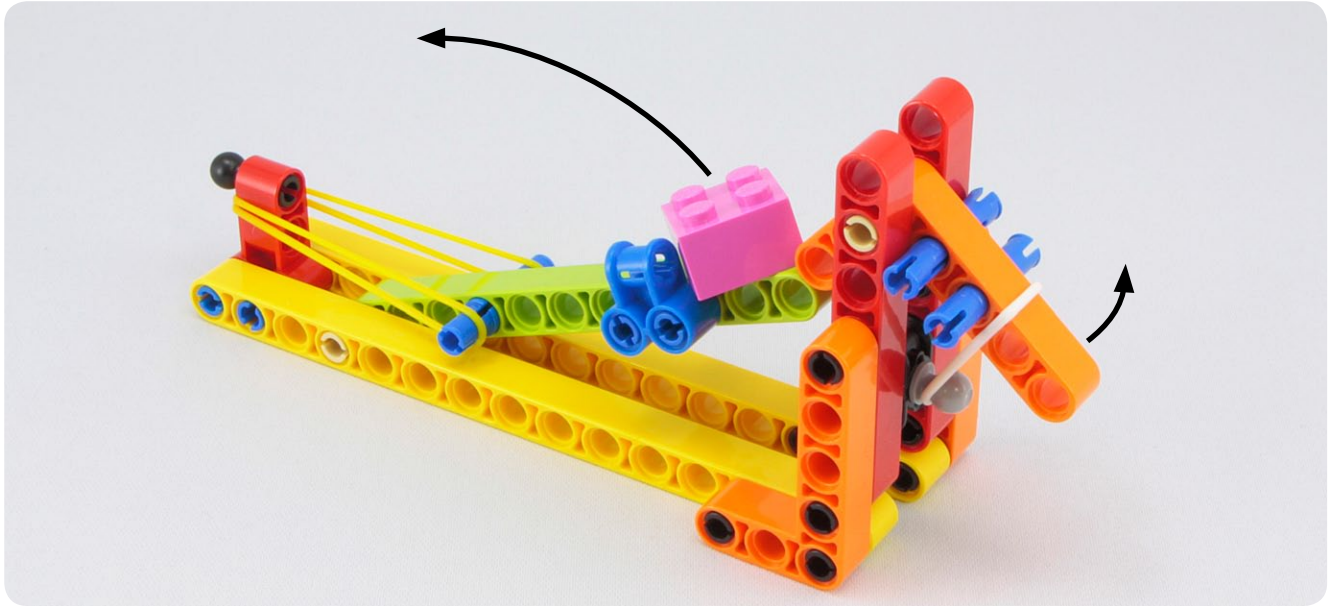
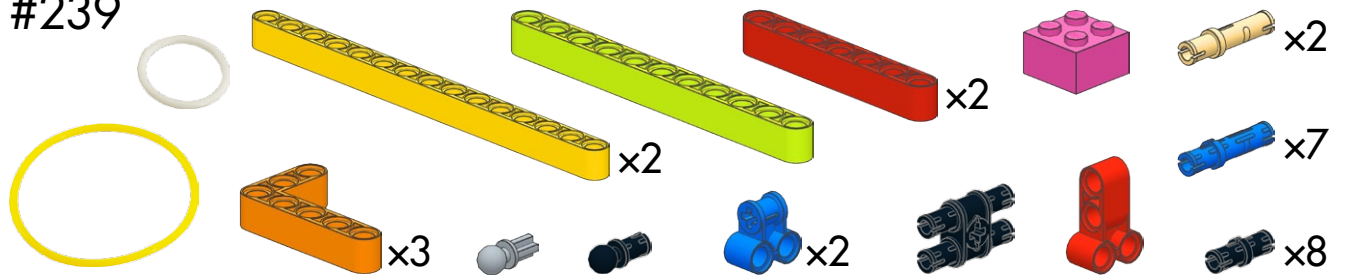
#238

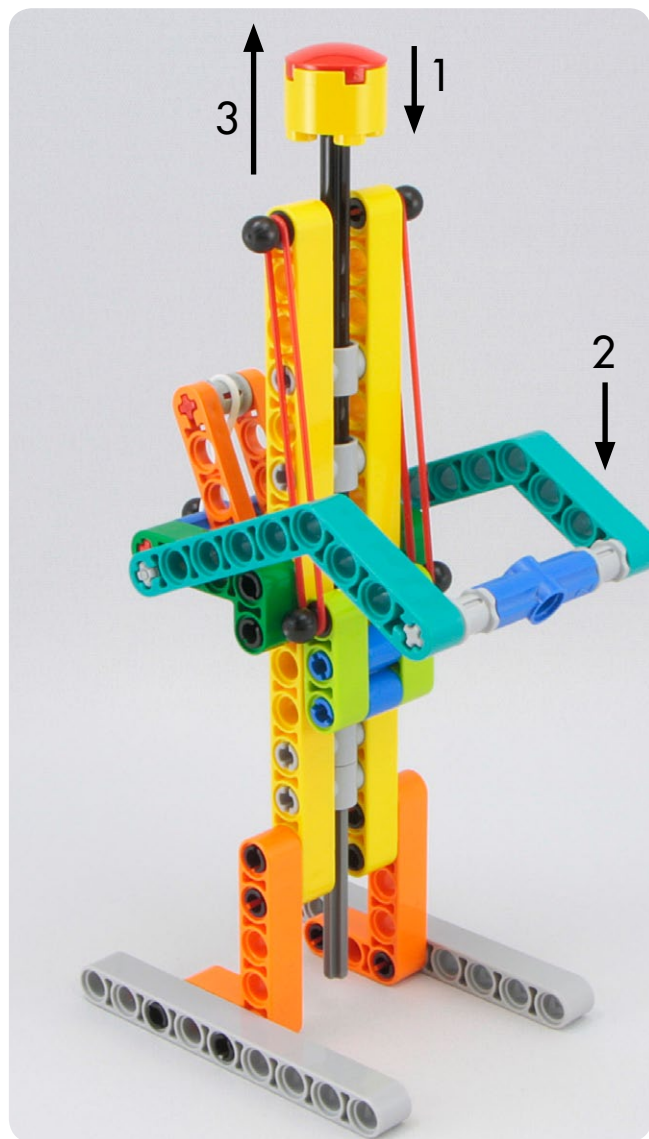
Parts list for step 238:

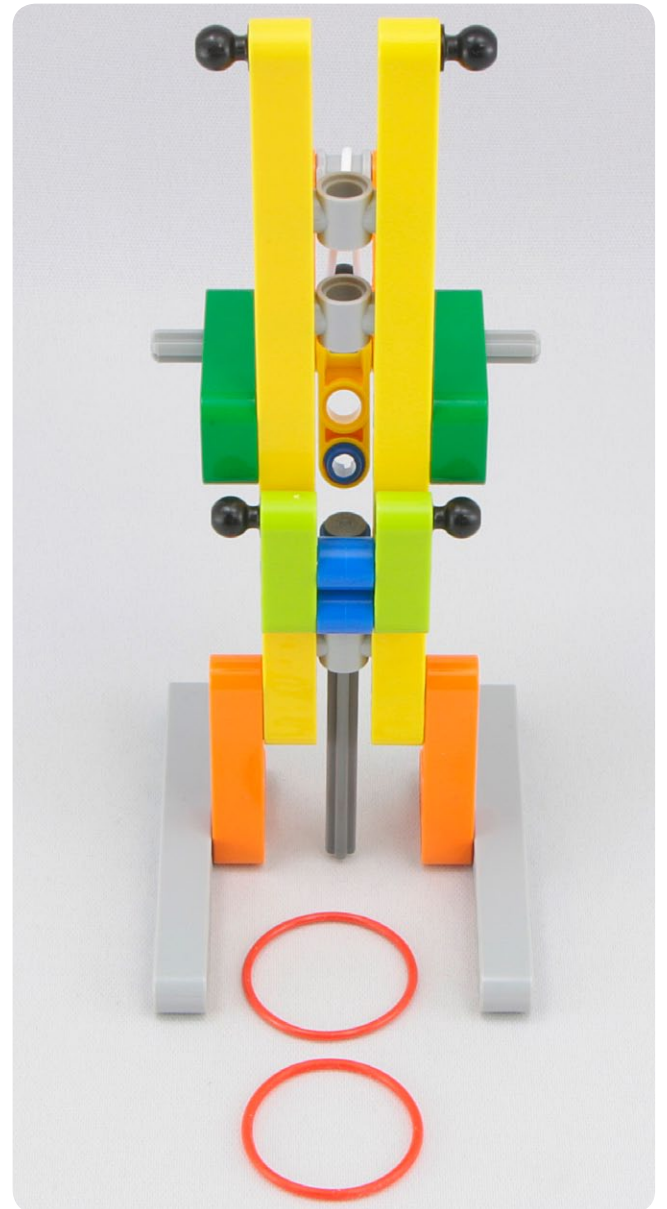
- 1x 12-tooth yellow gear
- 1x 12-tooth black gear
- 1x Yellow sphere
- 2x Yellow L-shaped connectors
- 3x Red 1x6 Technic beam
- 2x Yellow 1x3 Technic beam
- 2x Yellow 1x2 Technic beam
- 4x Red 1/2 round pins
- 2x Red 1/2 round pins
- 3x Grey 3-hole Technic axle
- 2x Grey 6-hole Technic axle
- 2x Grey 8-hole Technic axle
- 3x Grey 1/2 round pins
- 2x Black 1/2 round pins
- 3x Black 1/2 round pins
- 1x Blue 1/2 round pin
- 3x Black 1/2 round pins

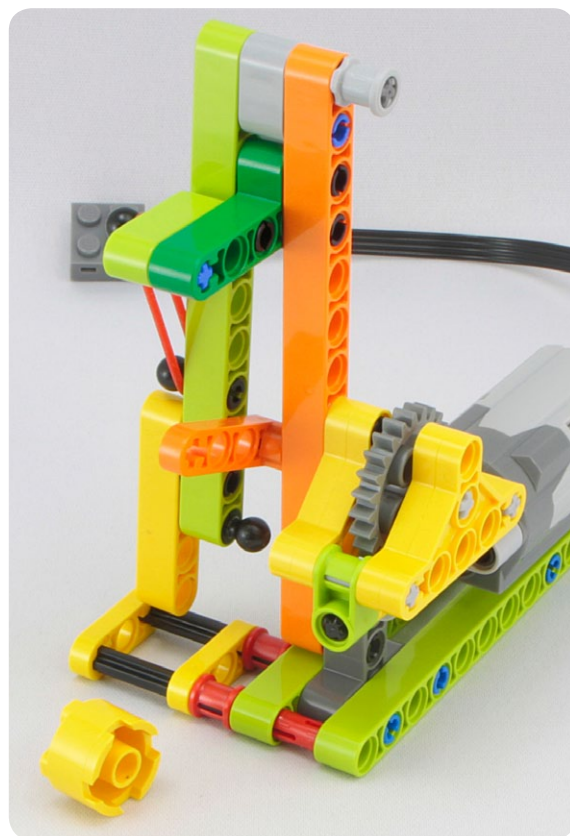
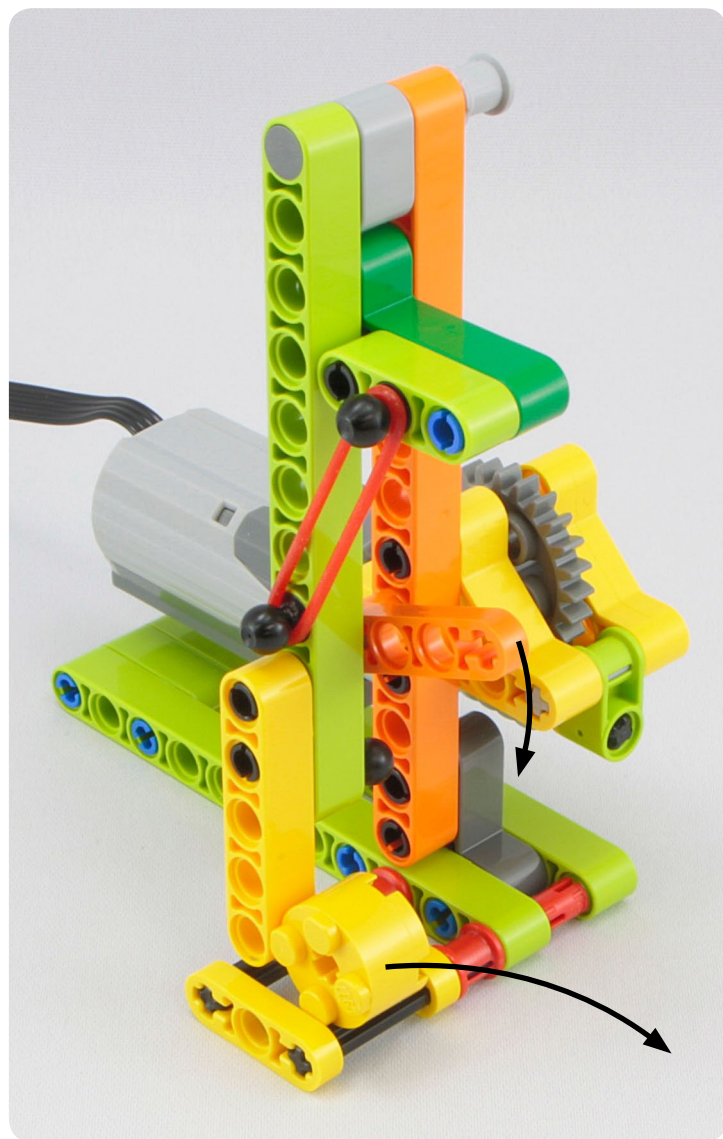


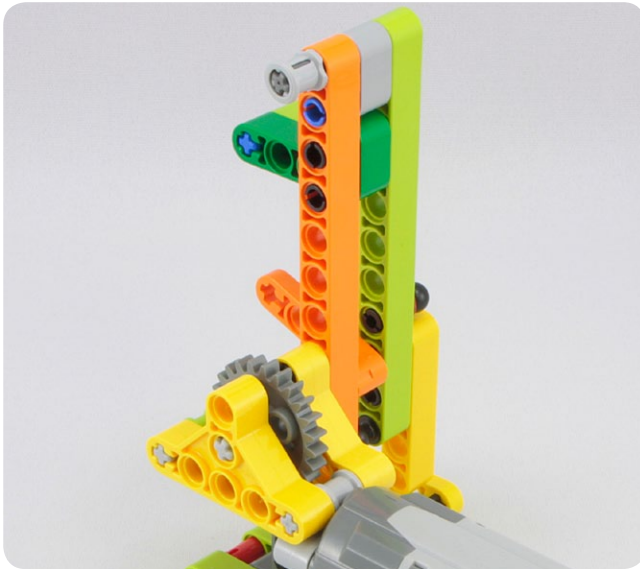
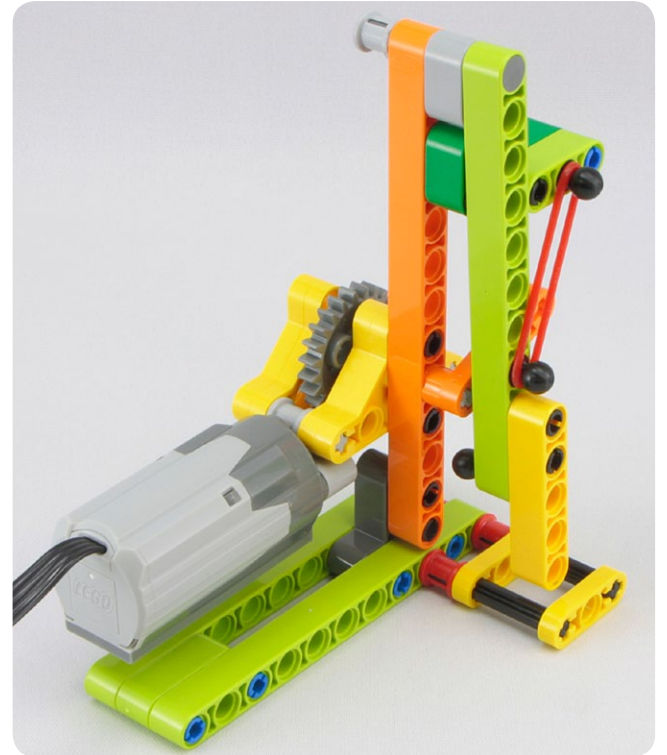
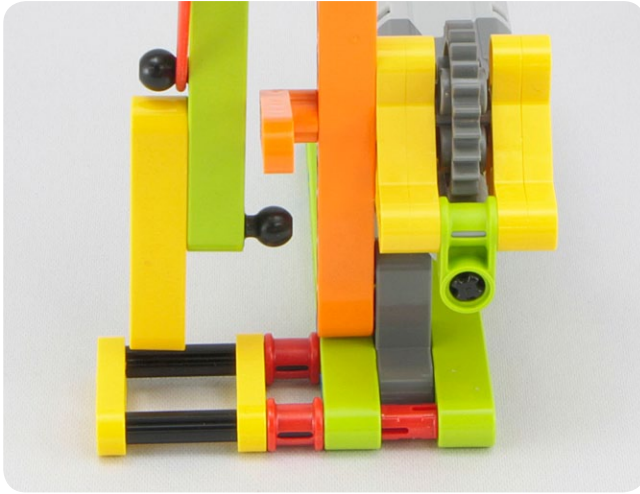
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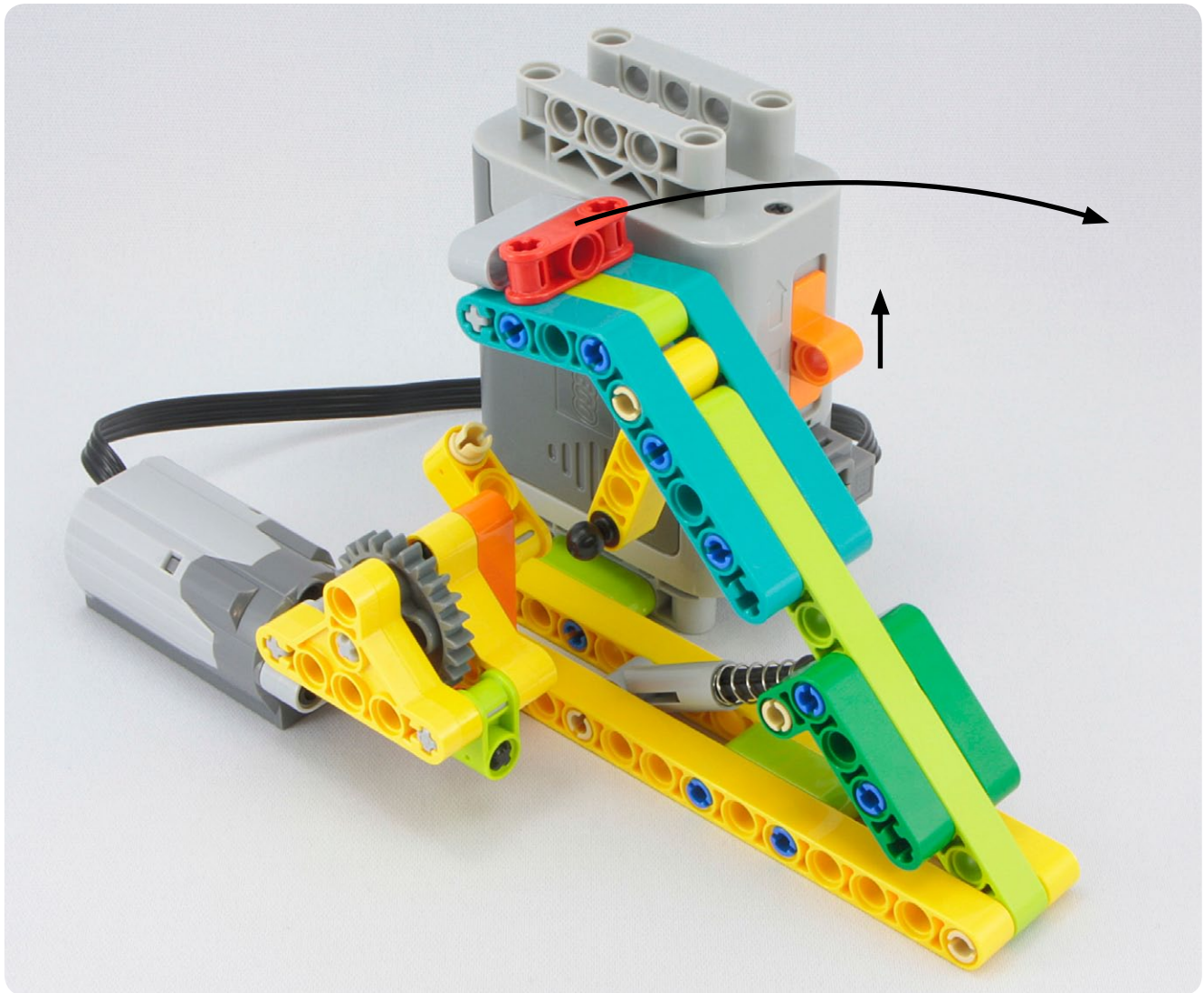


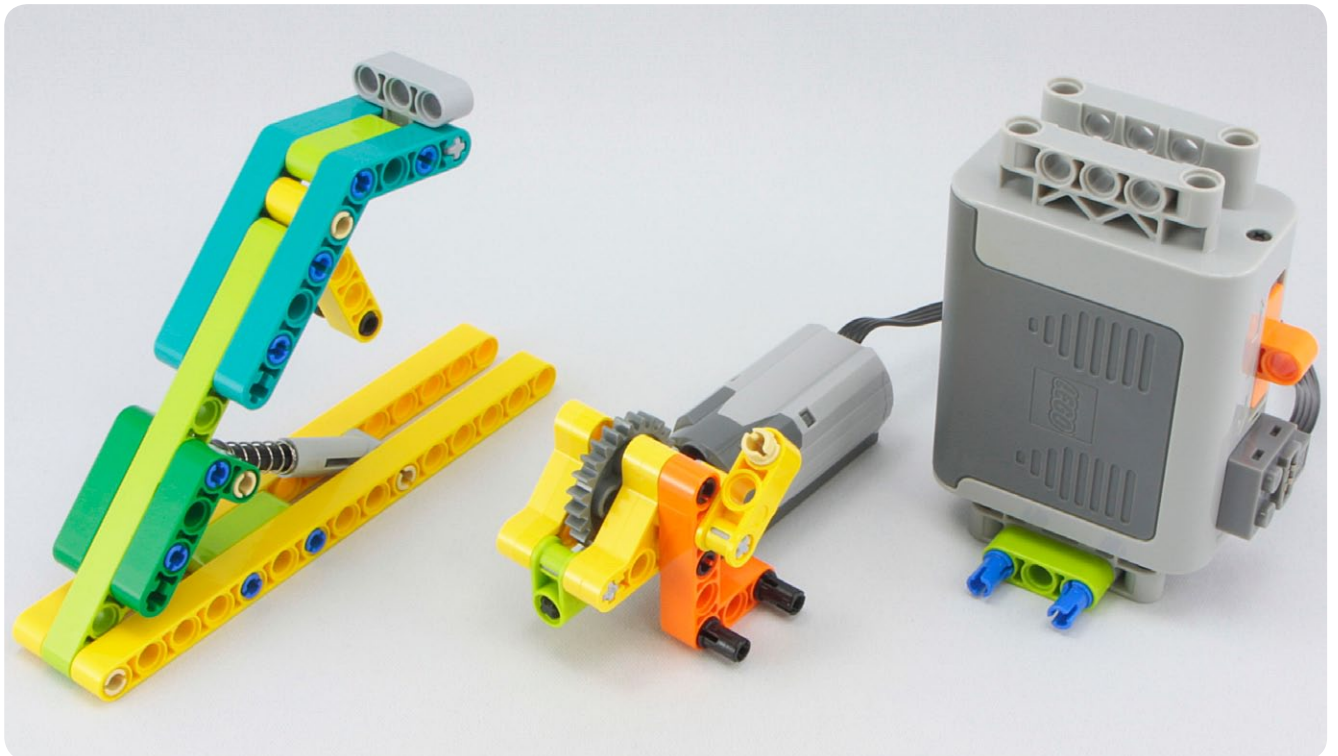
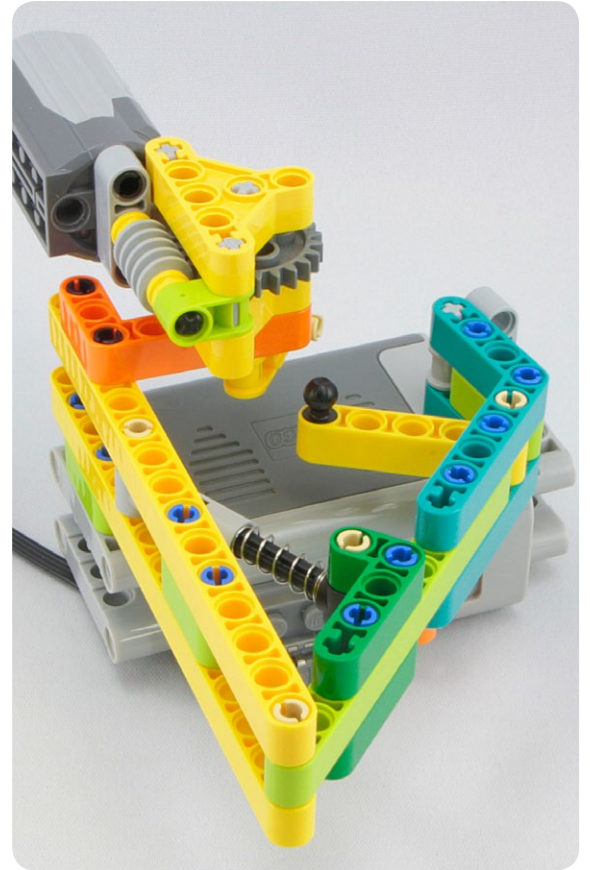
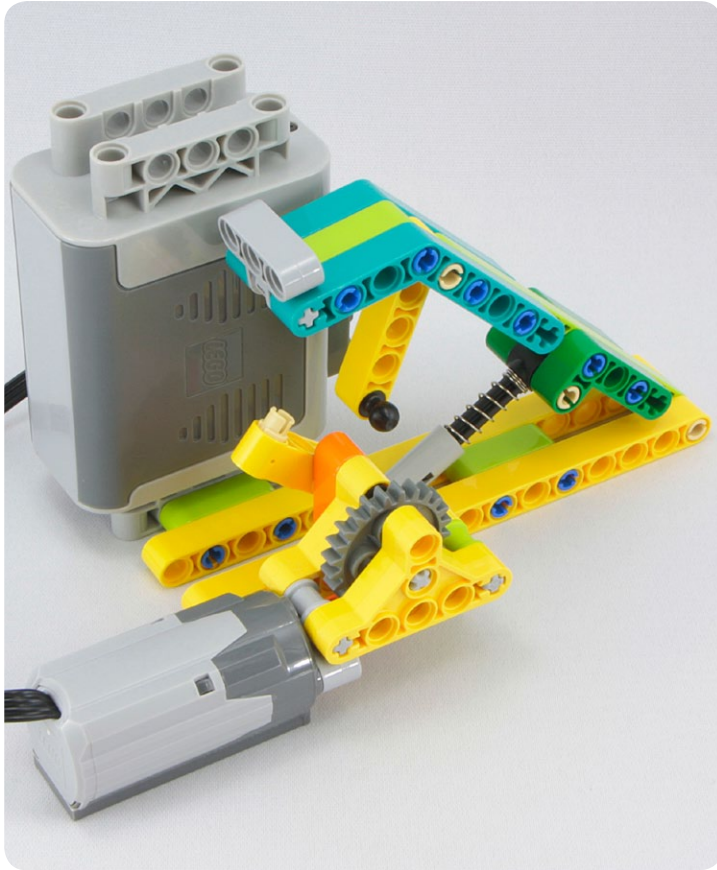
[illegible]

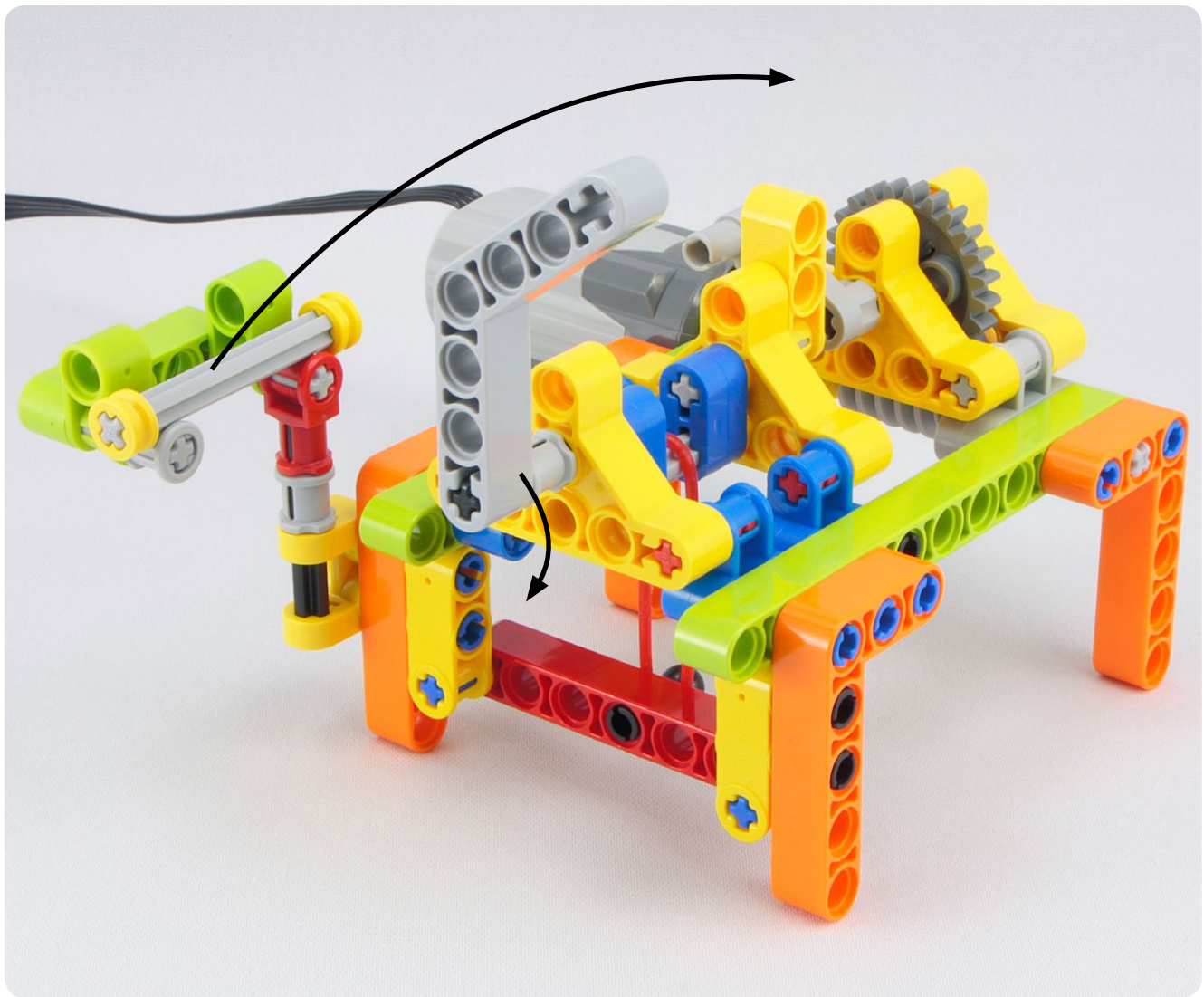


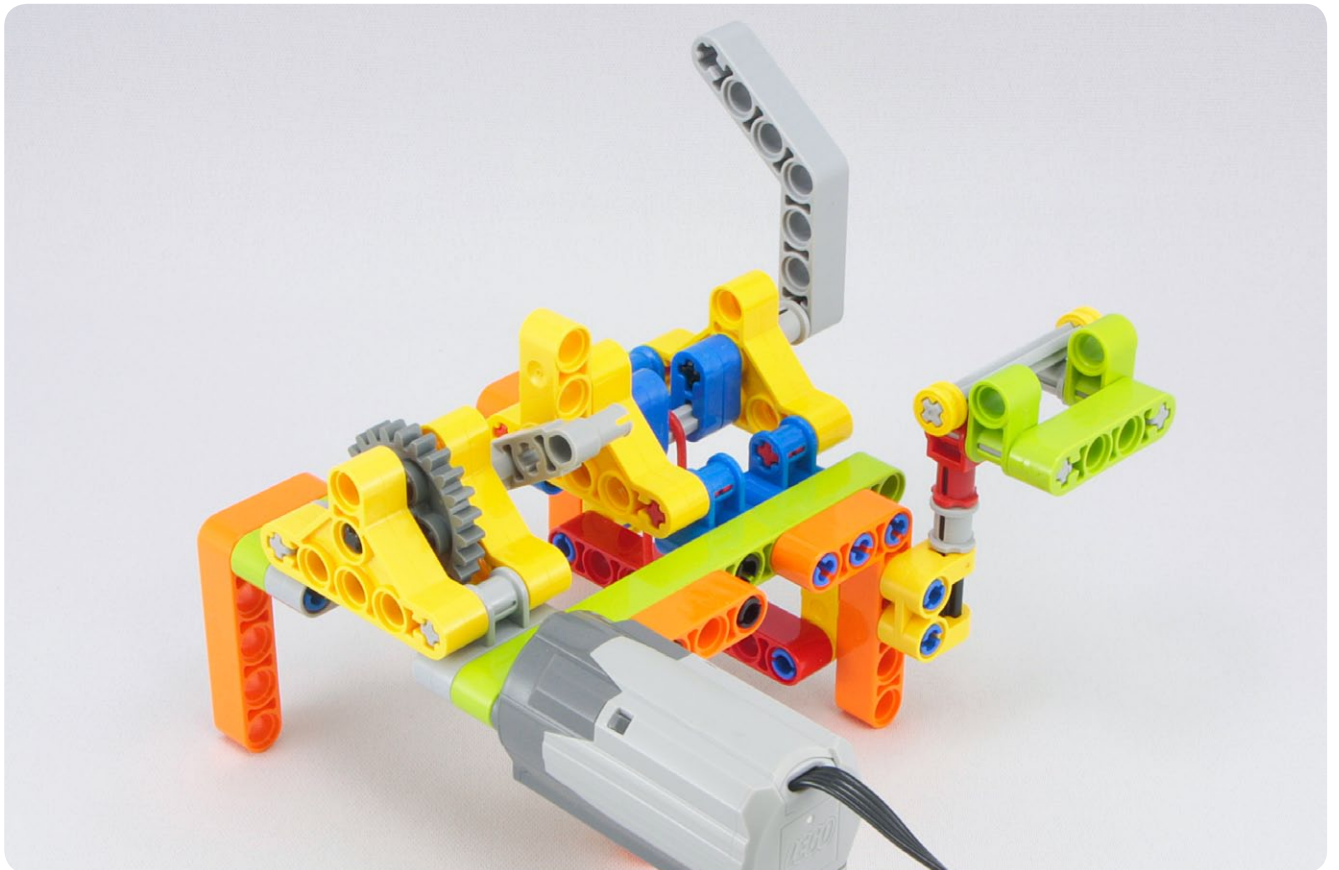
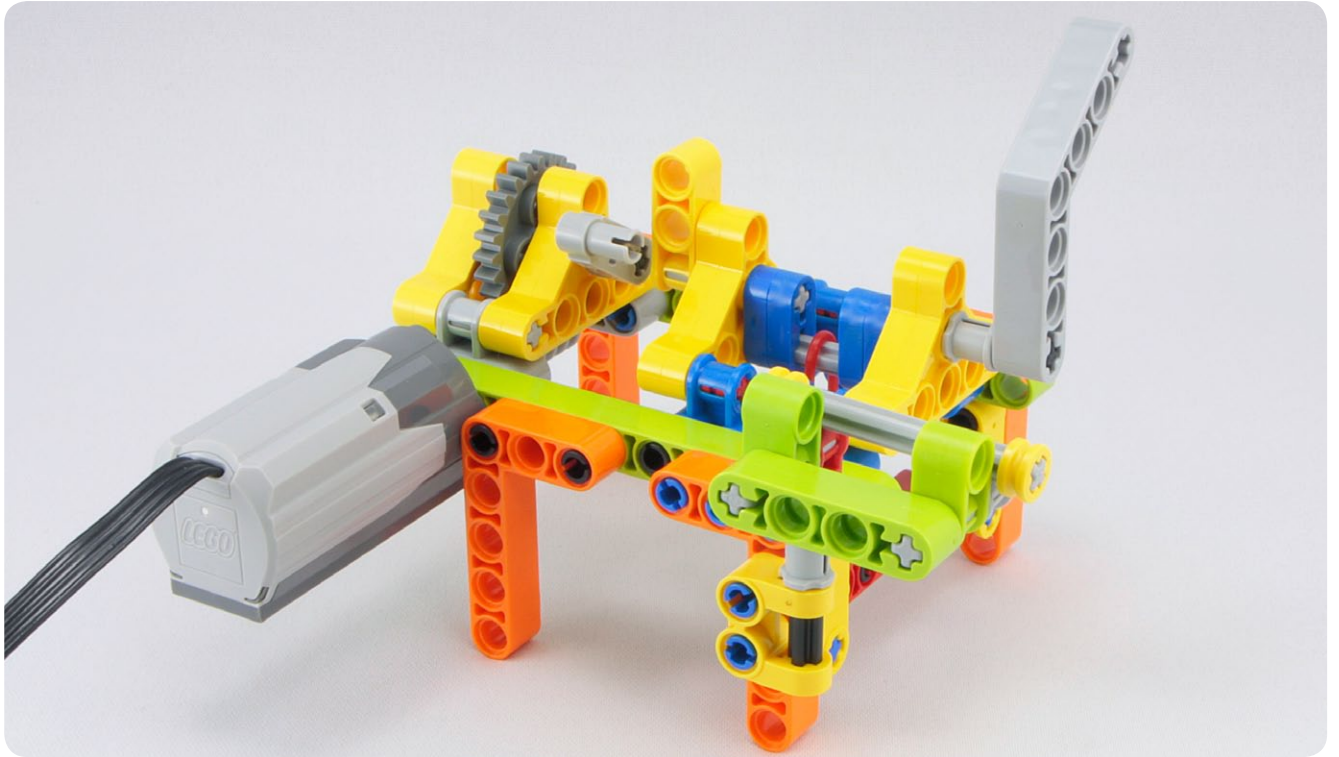
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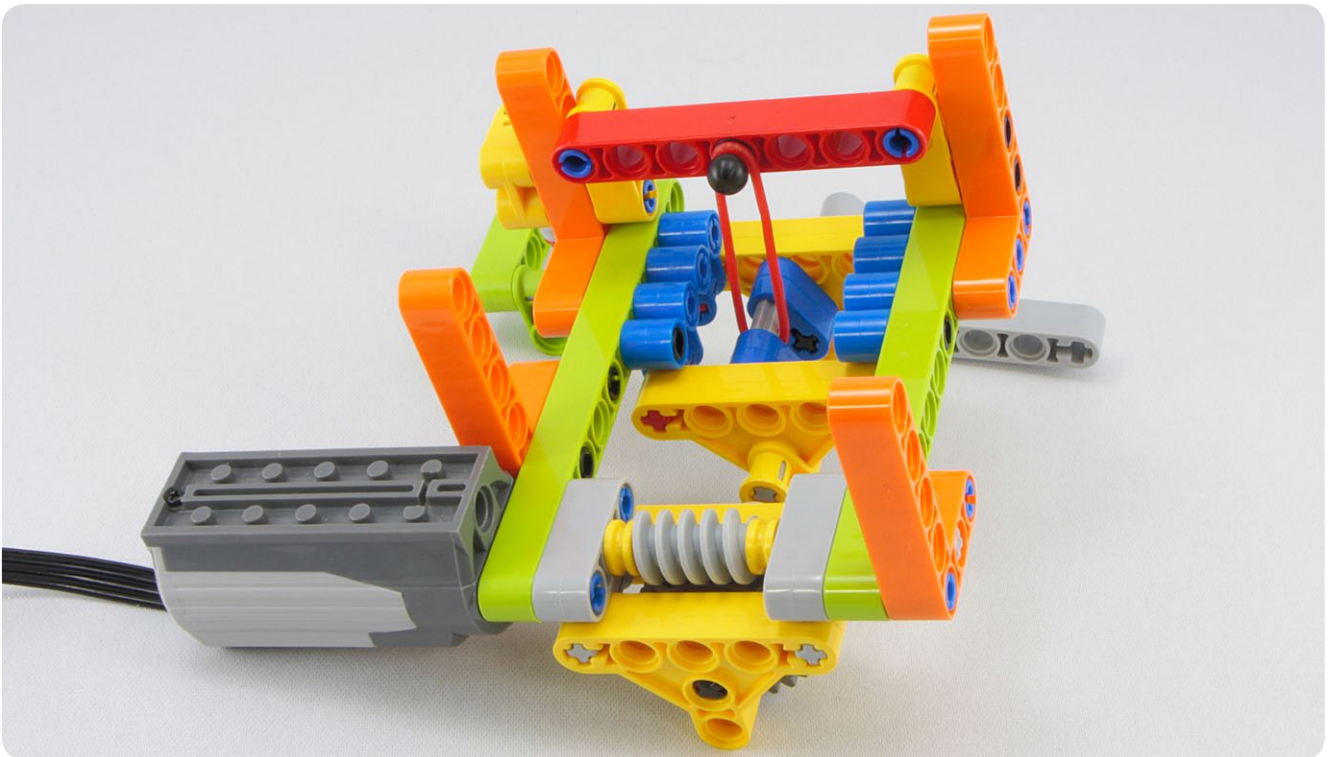
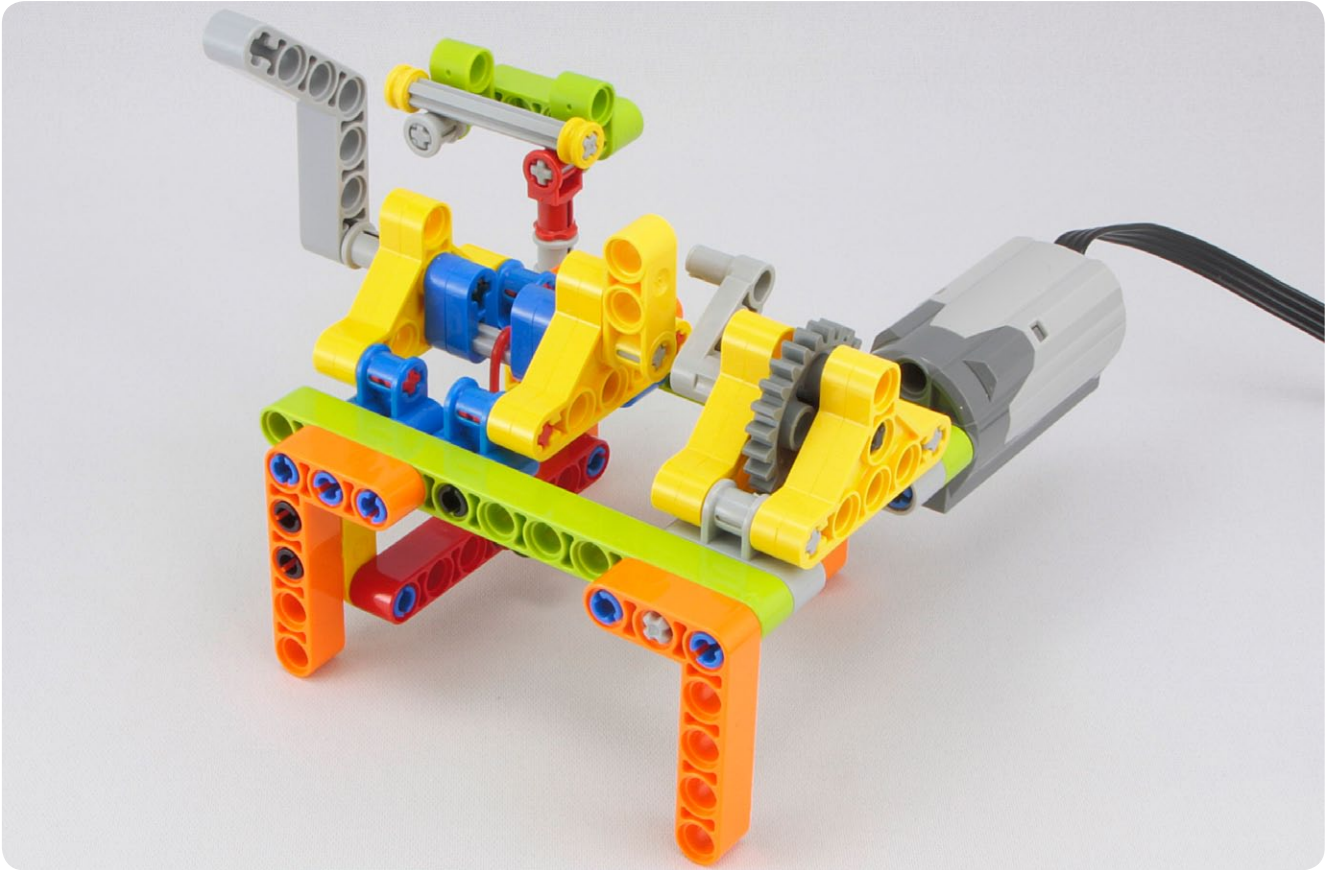


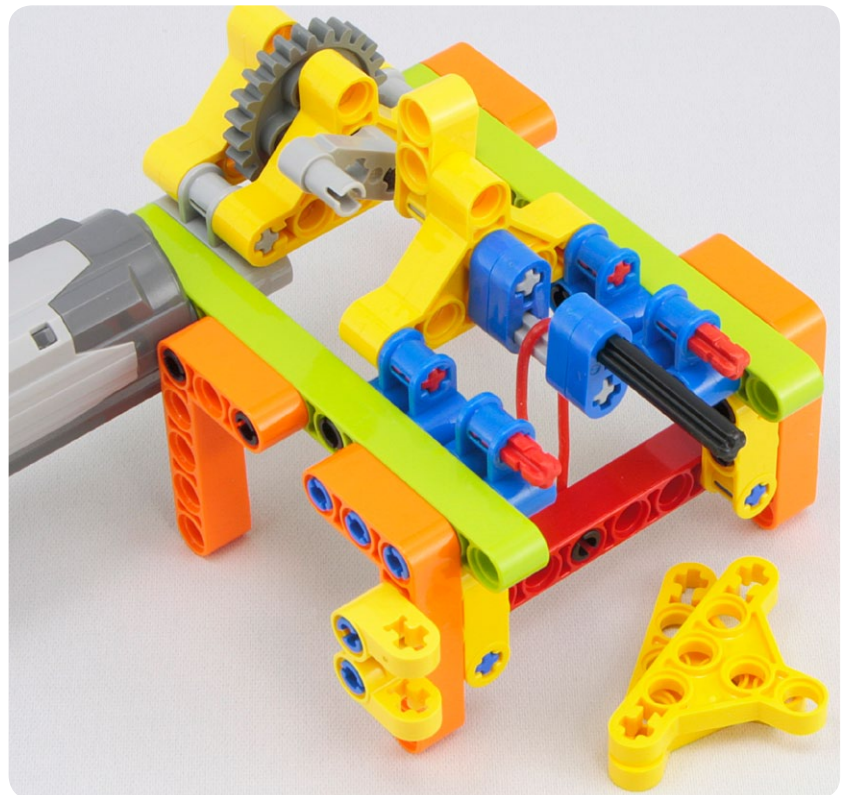
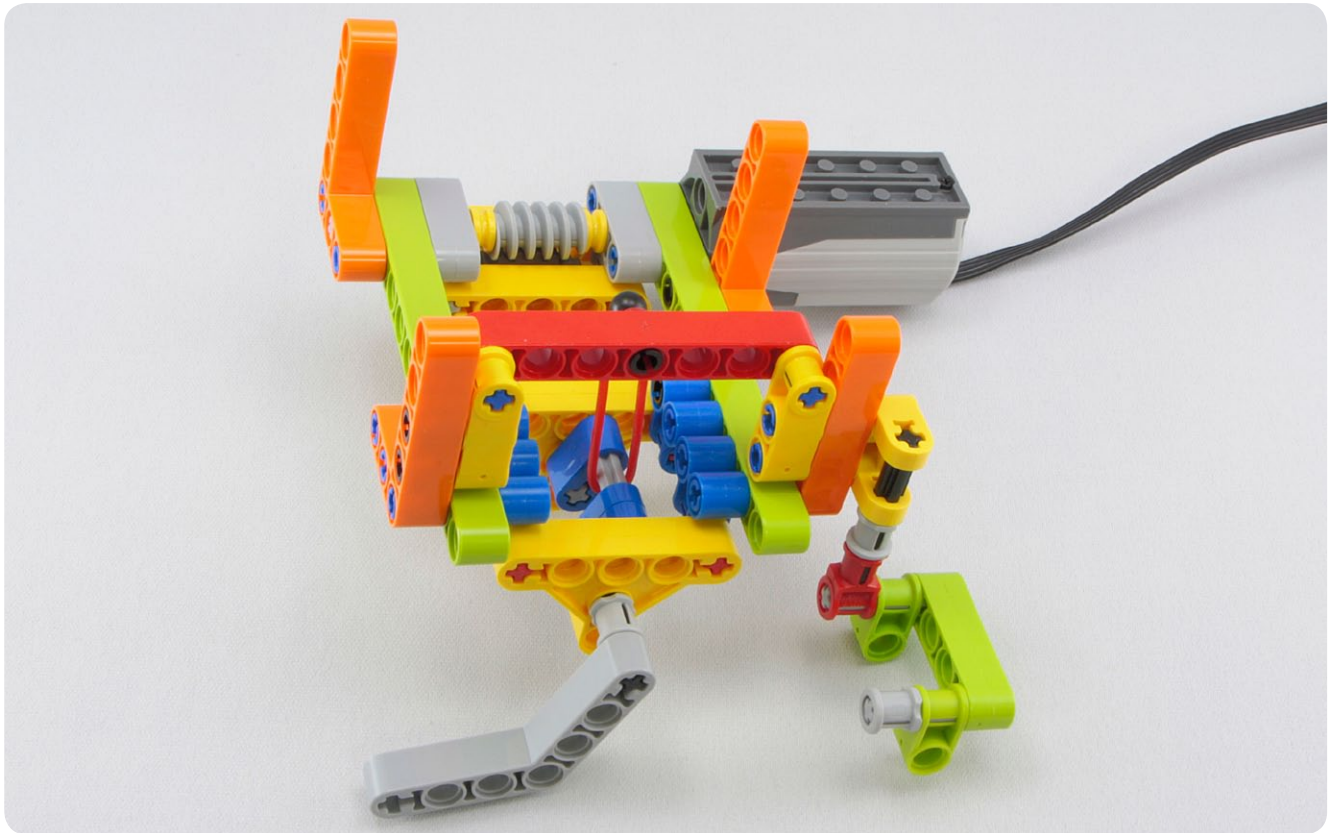
[illegible]

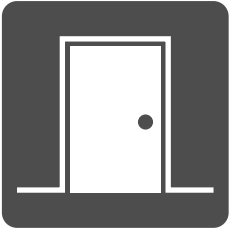


[illegible]



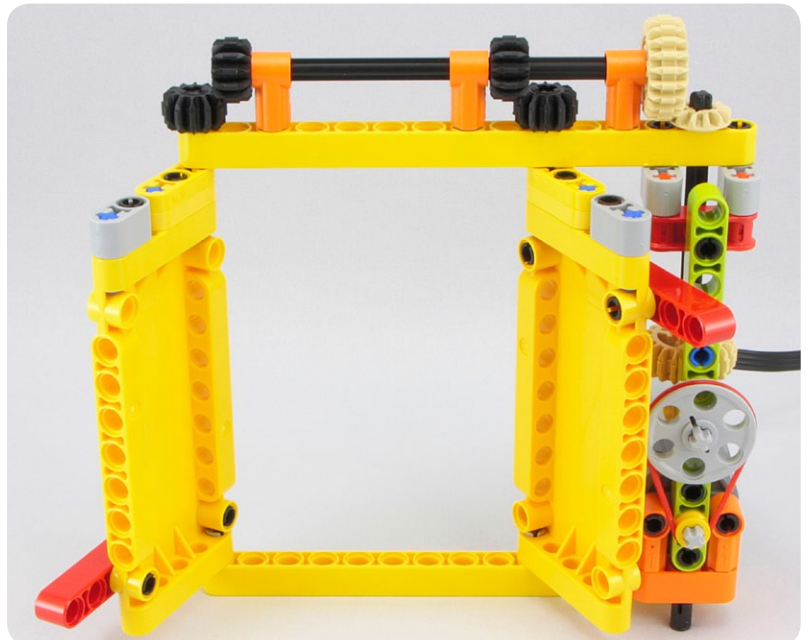
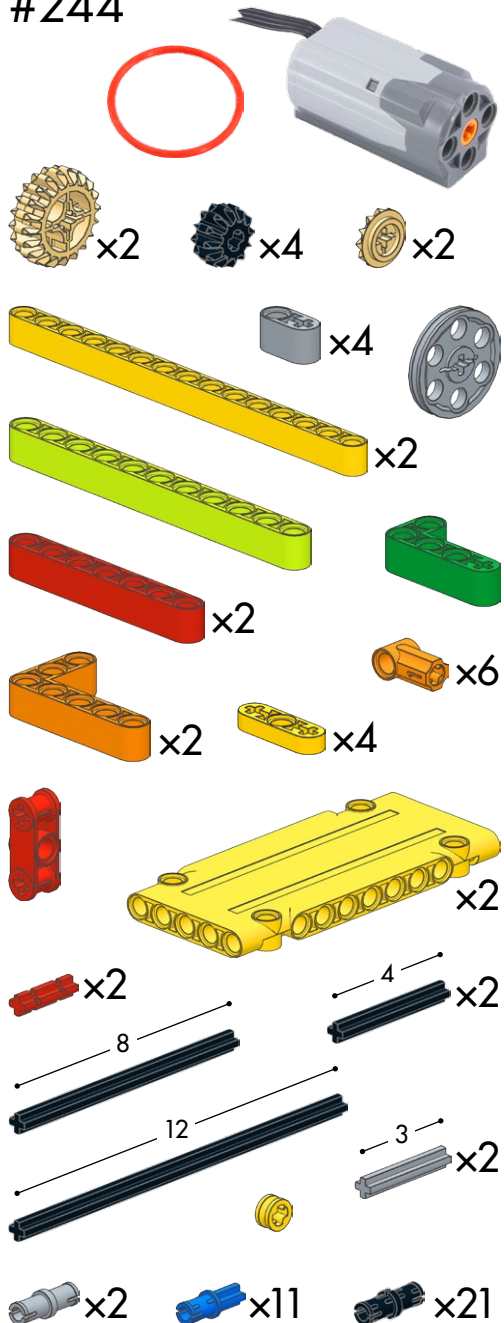


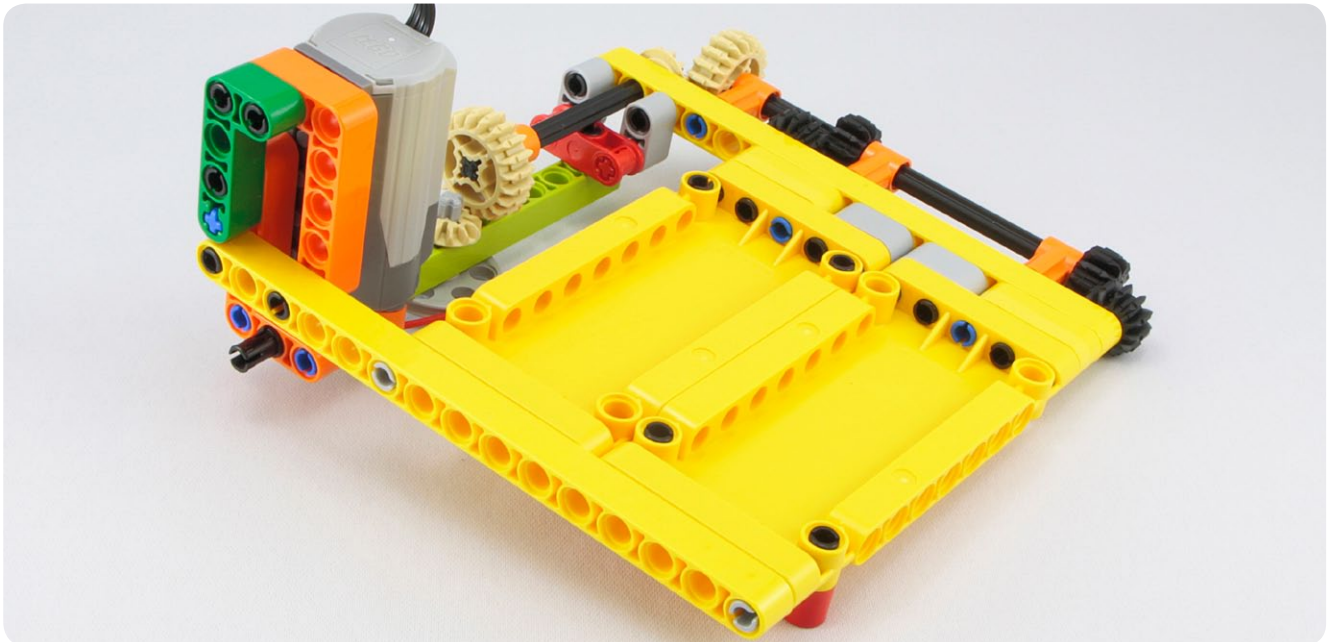
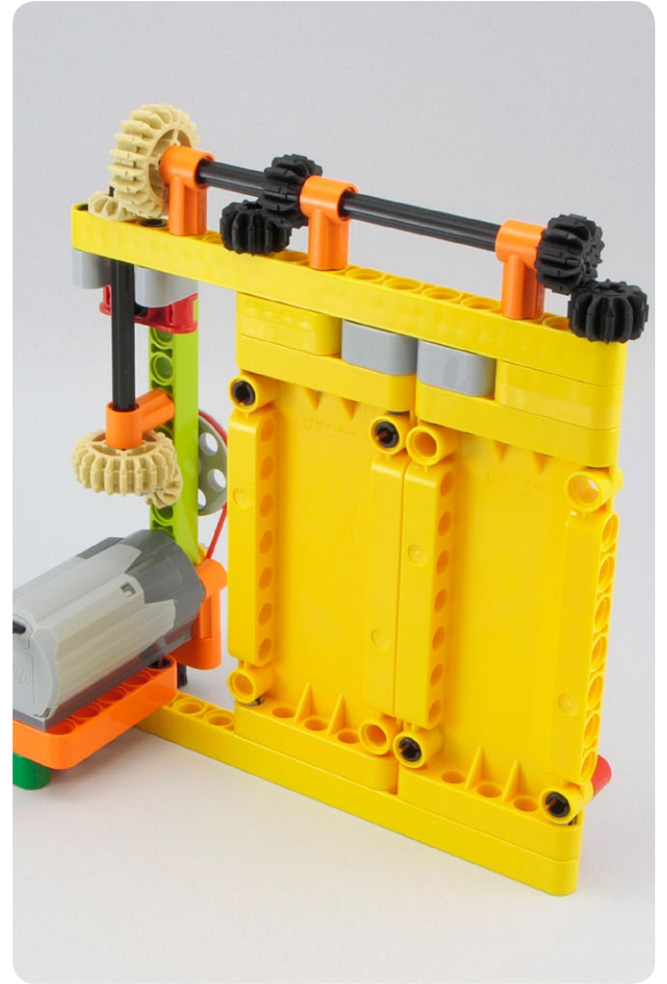


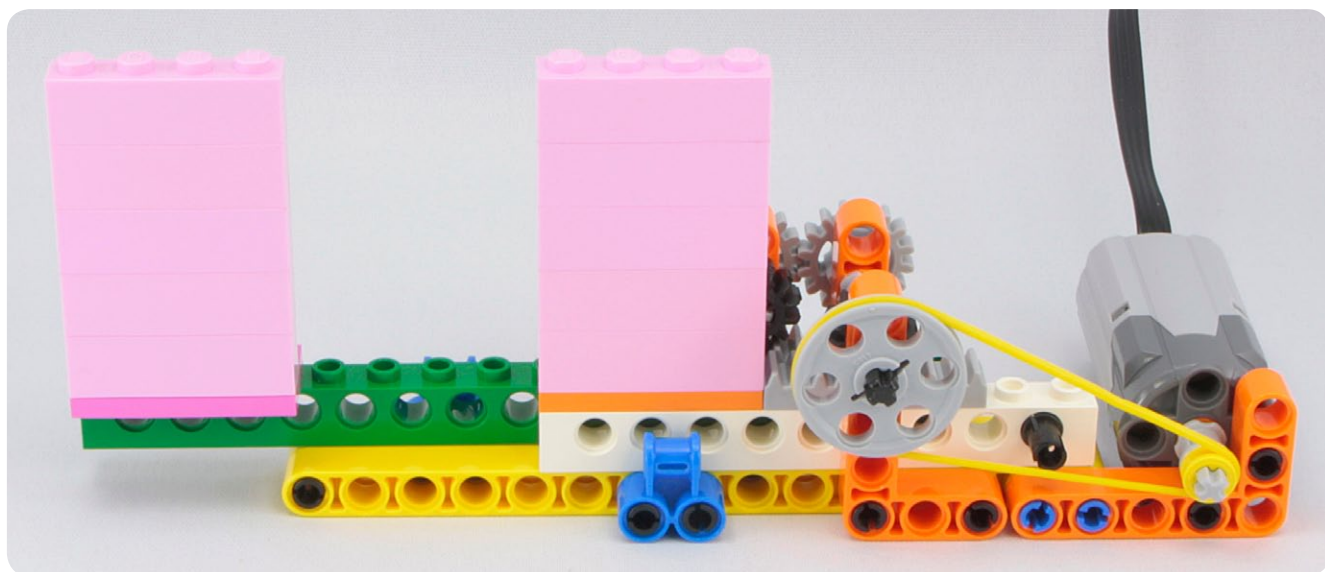
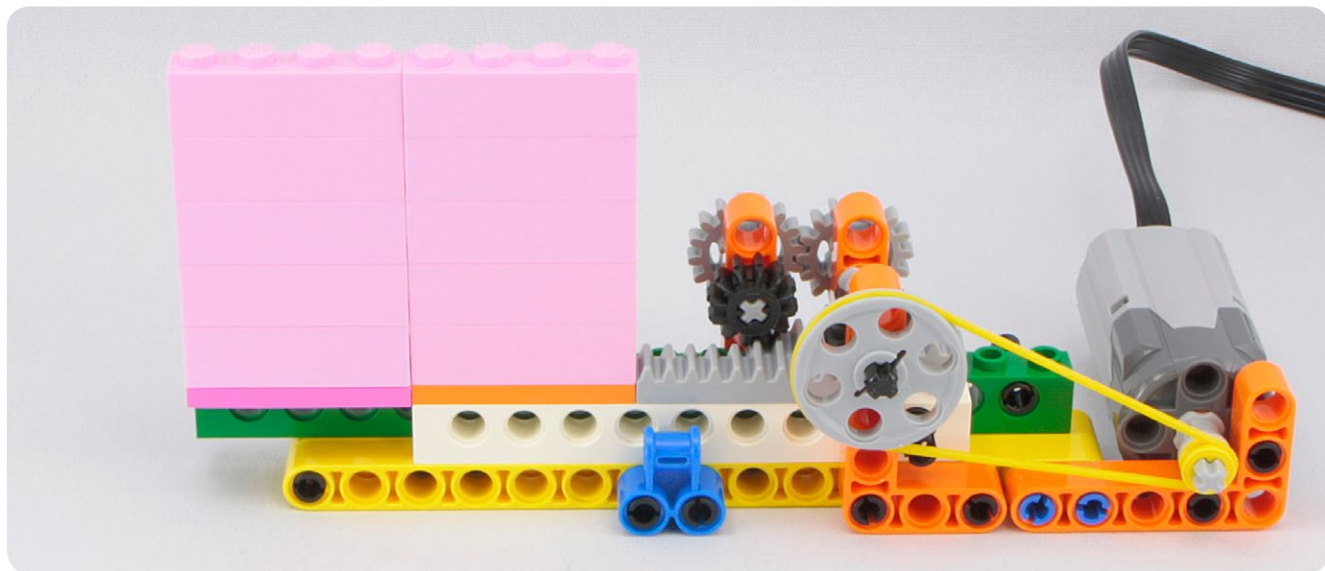



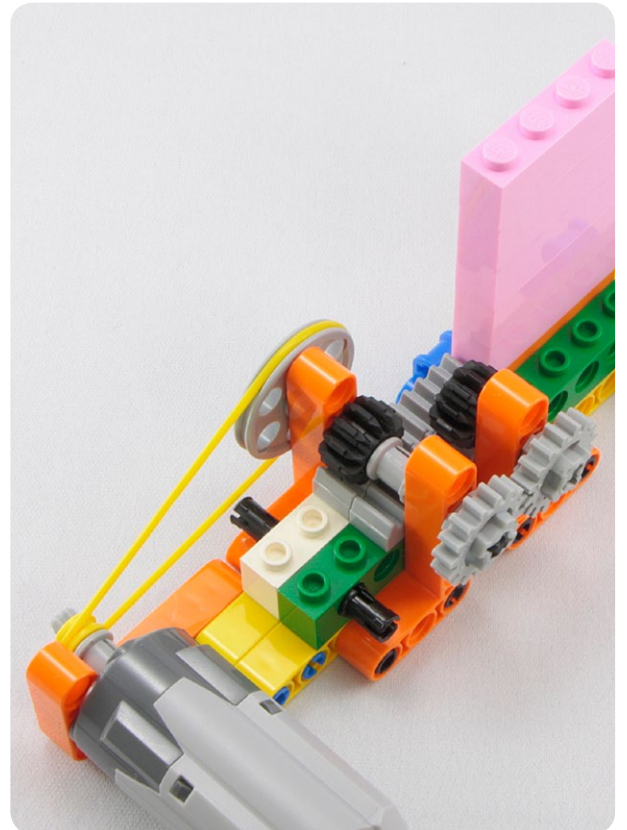
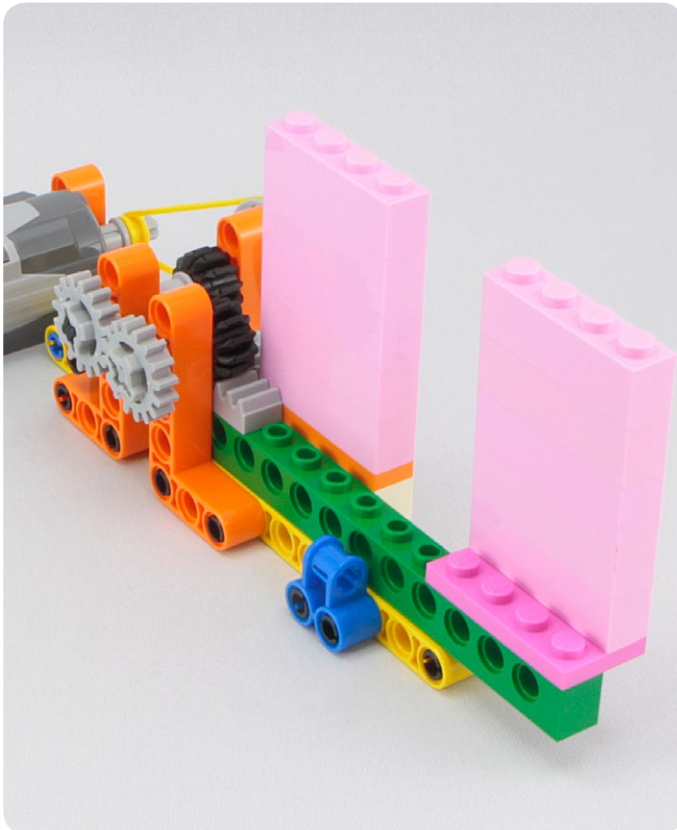
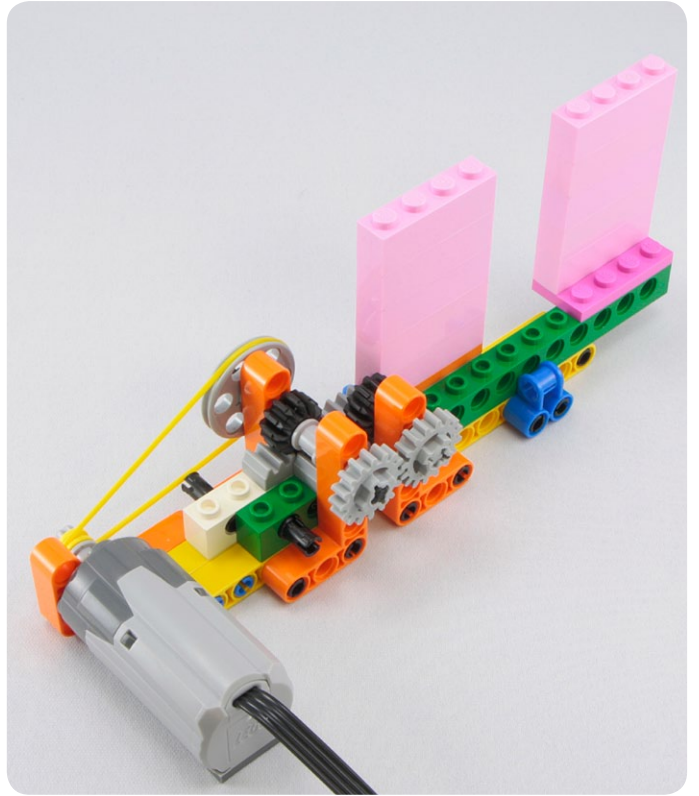
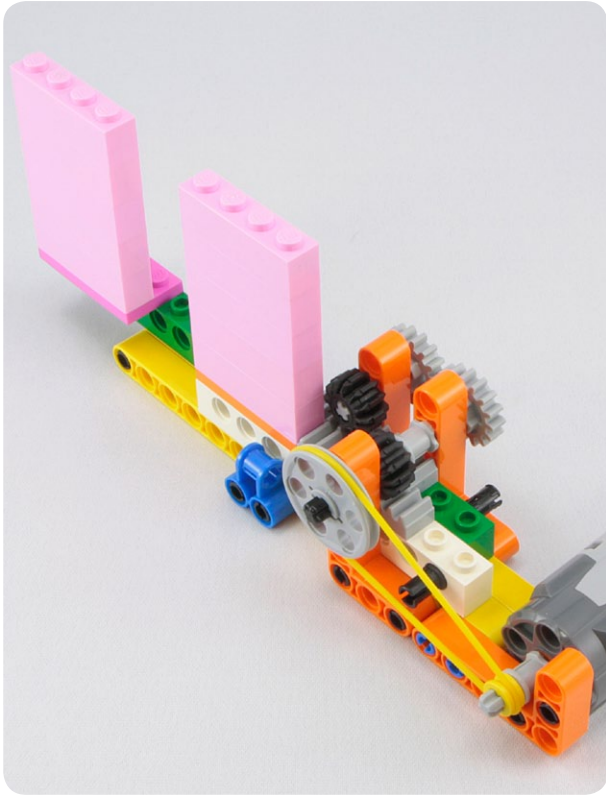
Automatic doors

#244

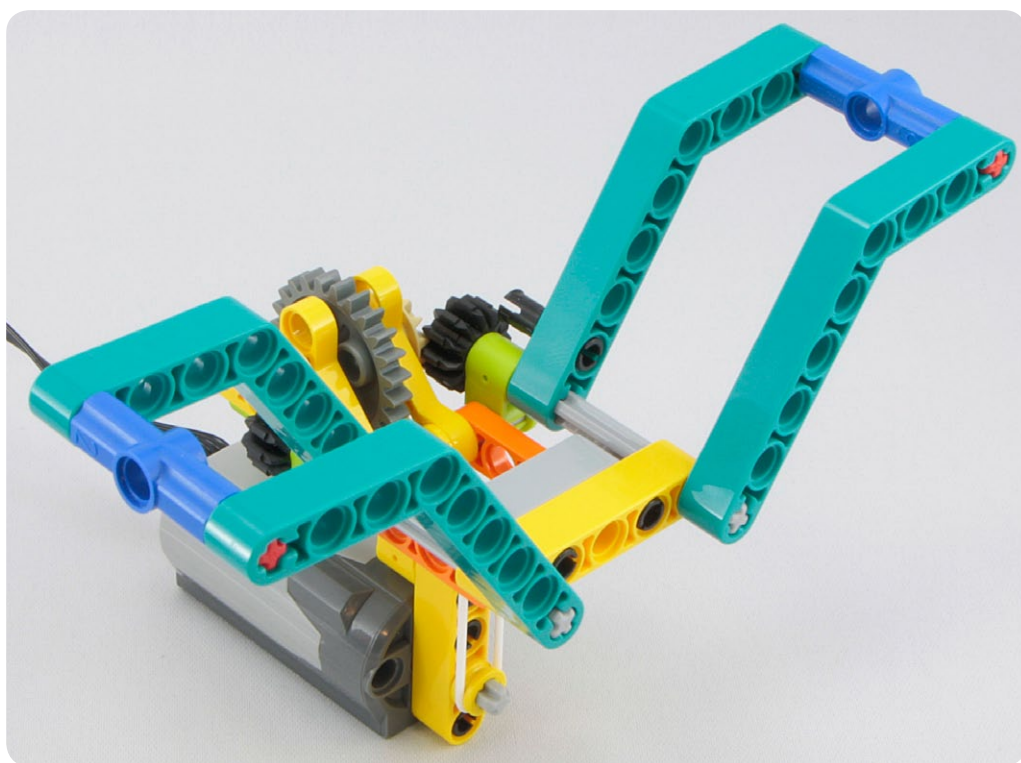
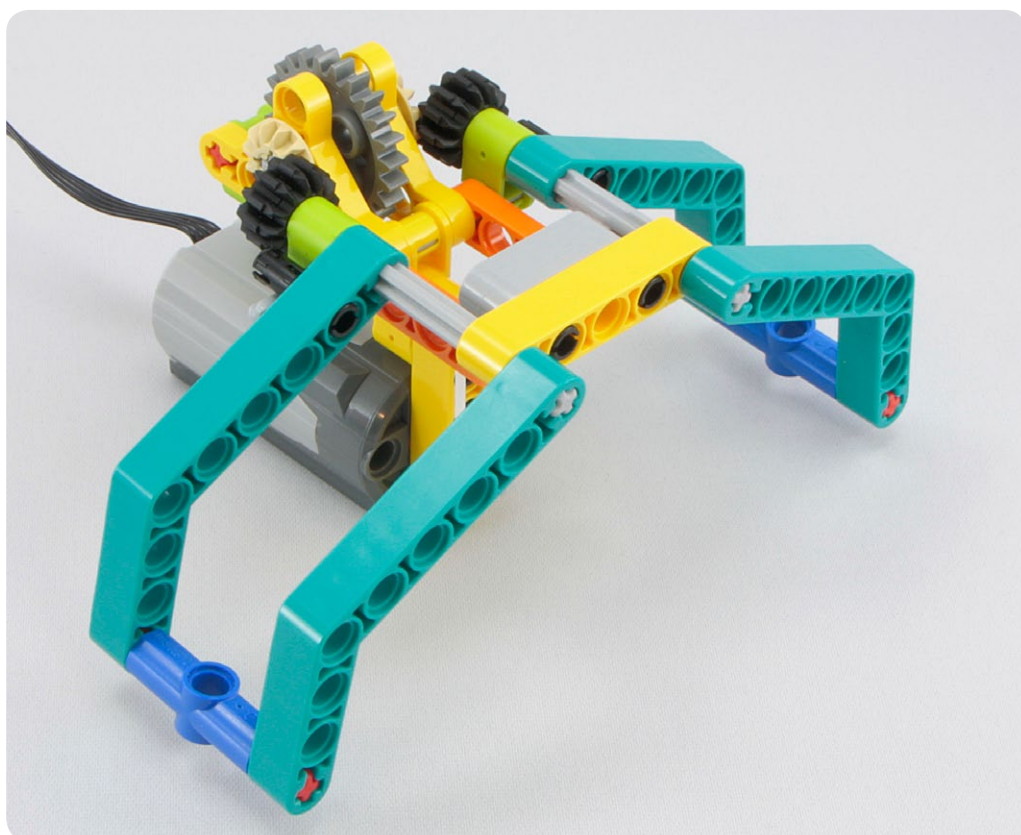
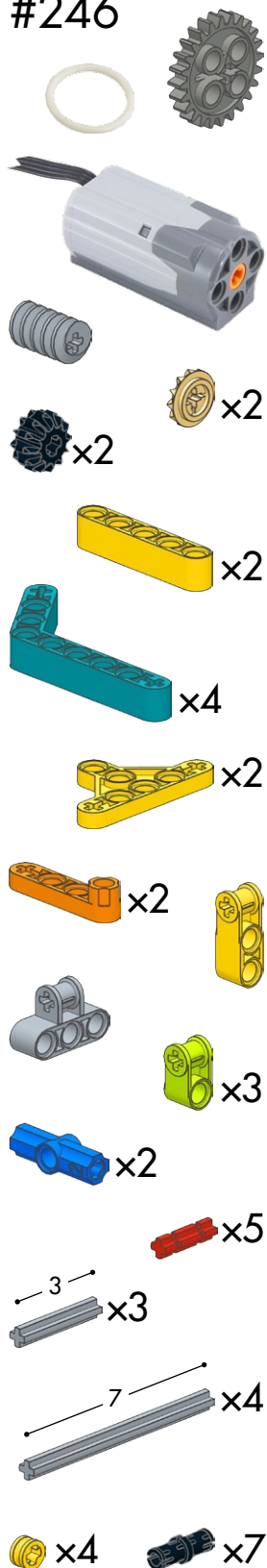


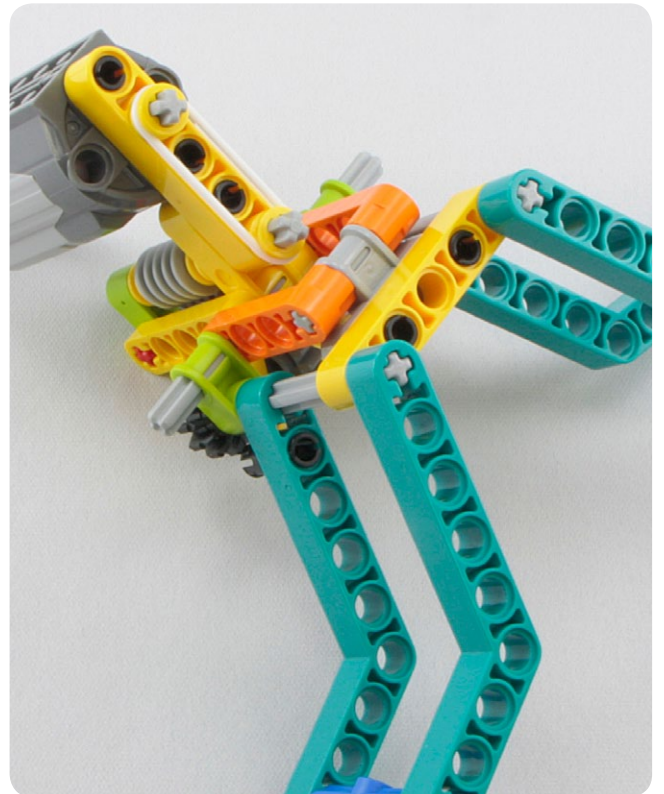
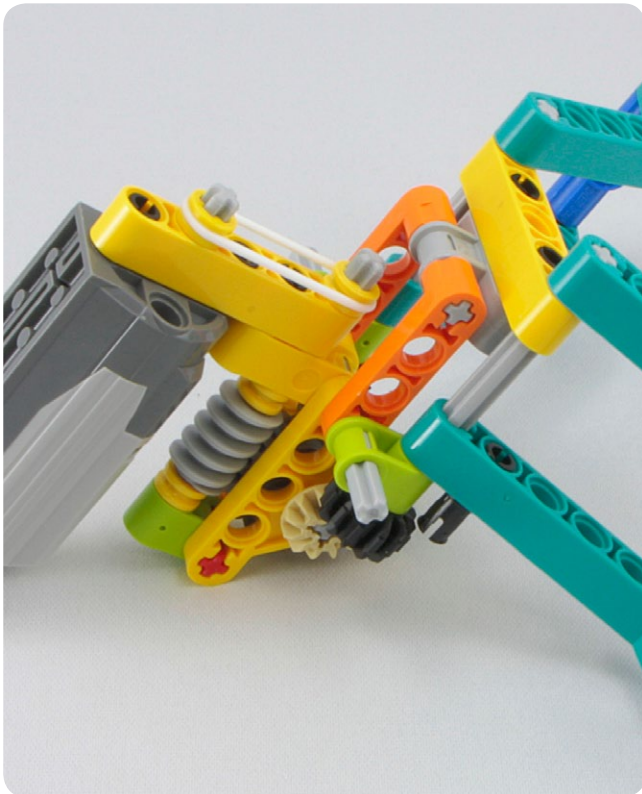
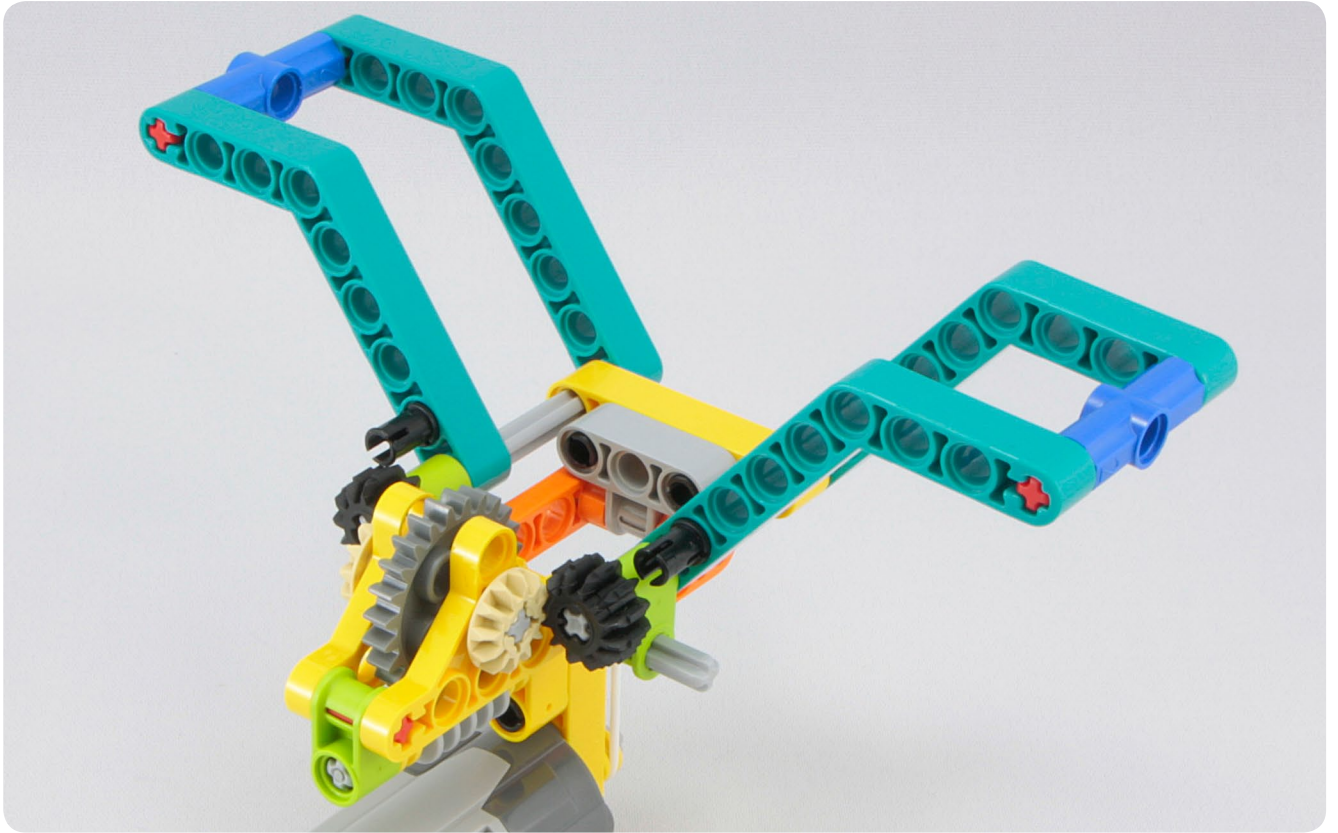






#246





#24/

1 yellow ring

1 grey motor

1 grey gear

1 grey wheel

2 light green 1x10 Technic beams

2 grey 1x10 Technic beams

1 orange 1x4 Technic beam

4 light green 1x2 Technic beams

2 yellow 1x4 Technic beams

4 red 1x2 Technic beams

3 black 4-hole Technic axles

3 grey 4-hole Technic axles

2 grey 5-hole Technic axles

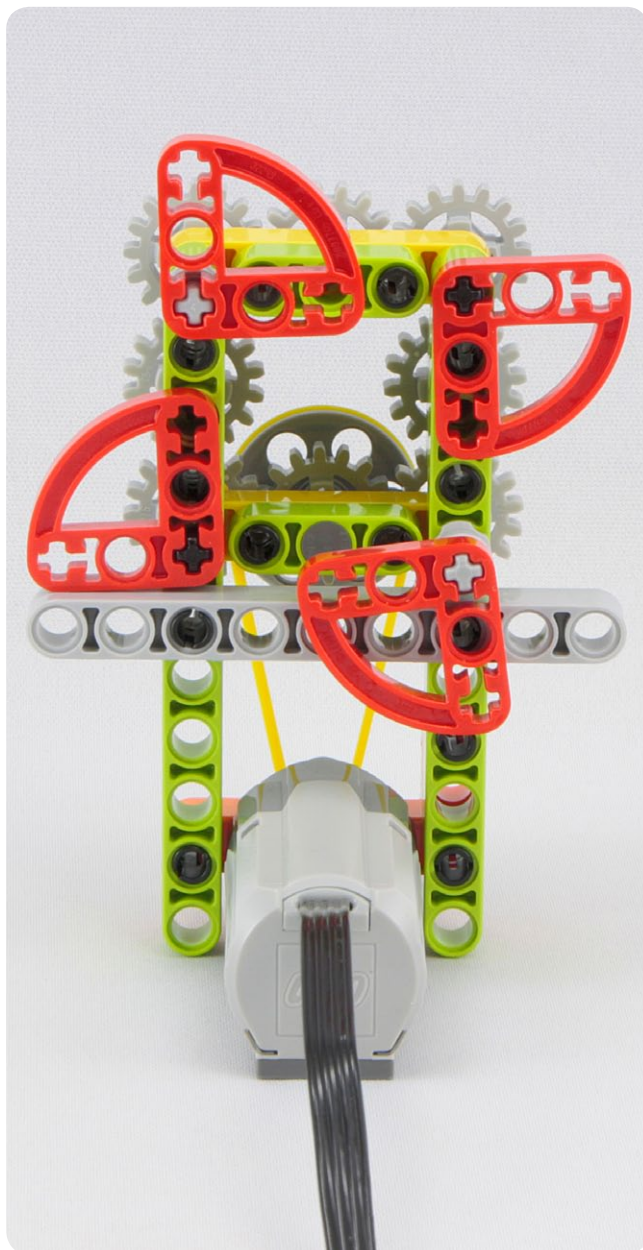
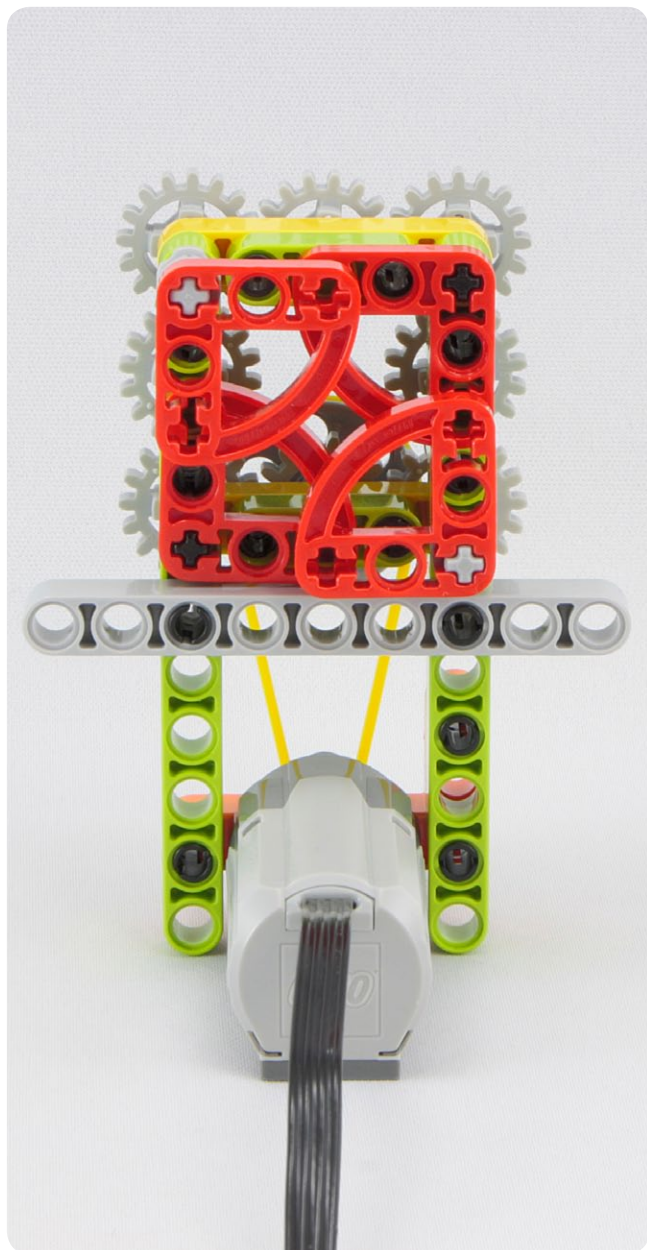
1 yellow 1x2 Technic pin

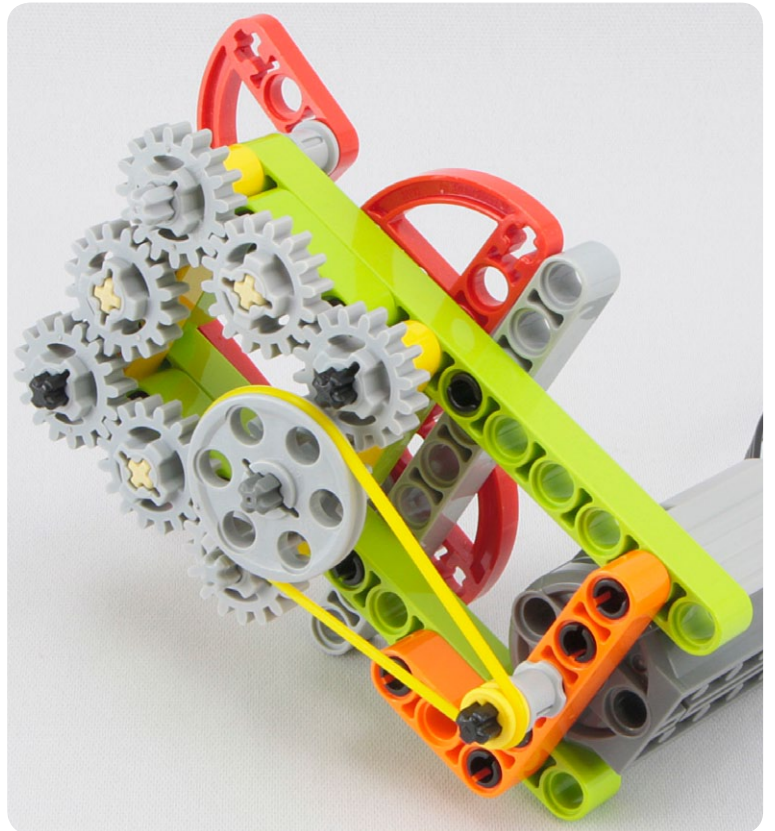
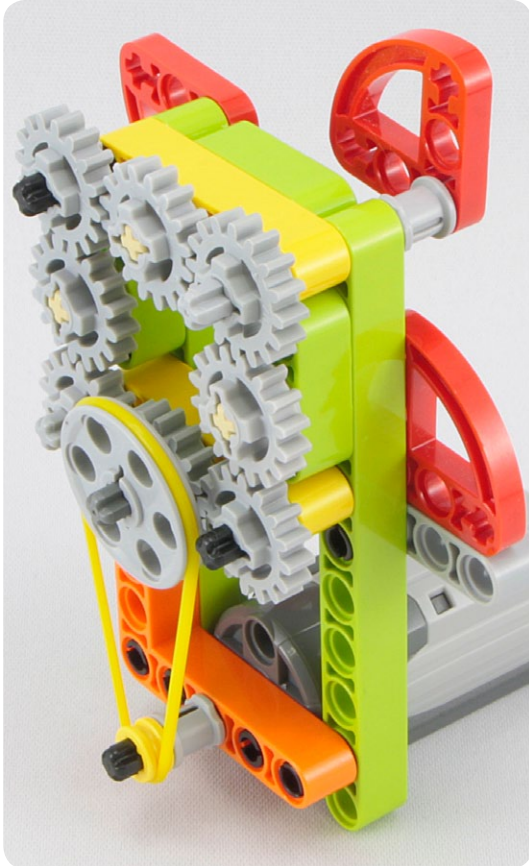
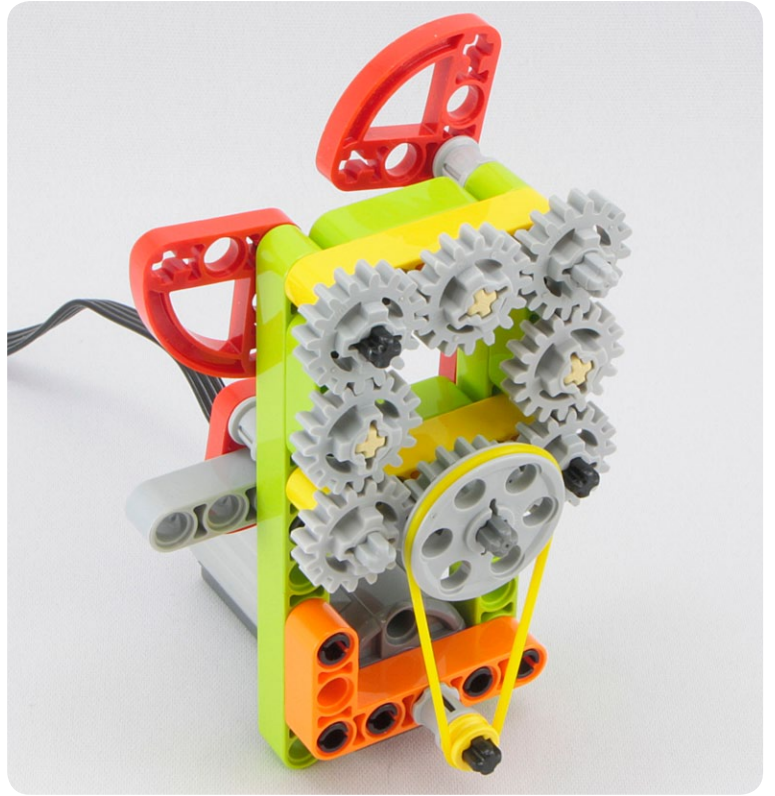
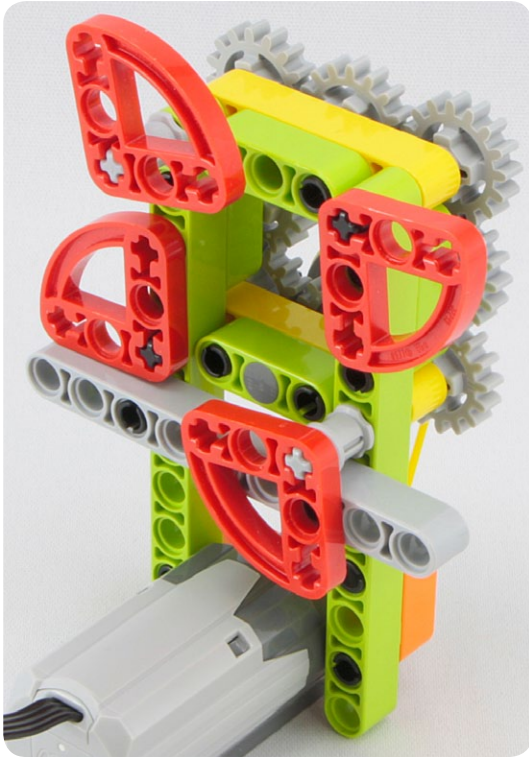
3 grey 1x2 Technic pins

3 tan 1x2 Technic pins

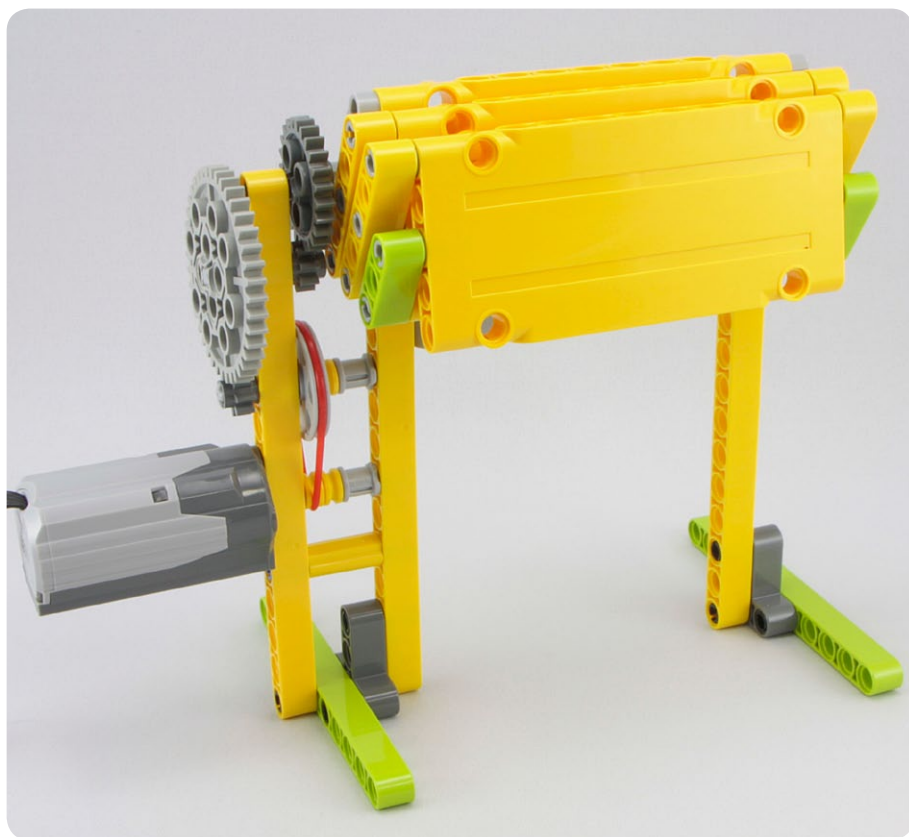
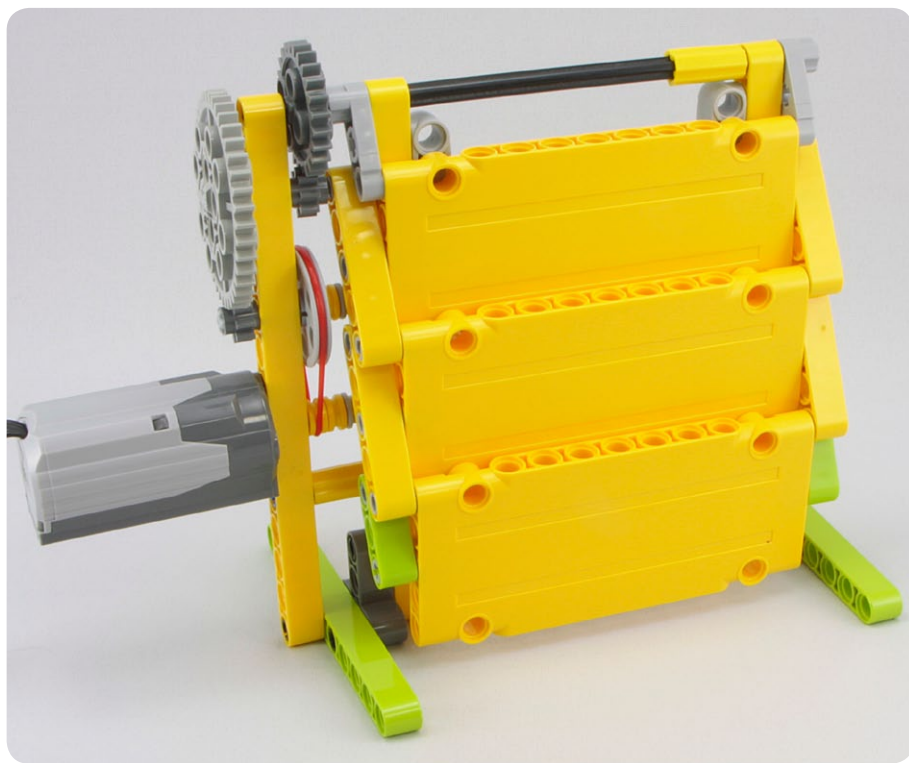
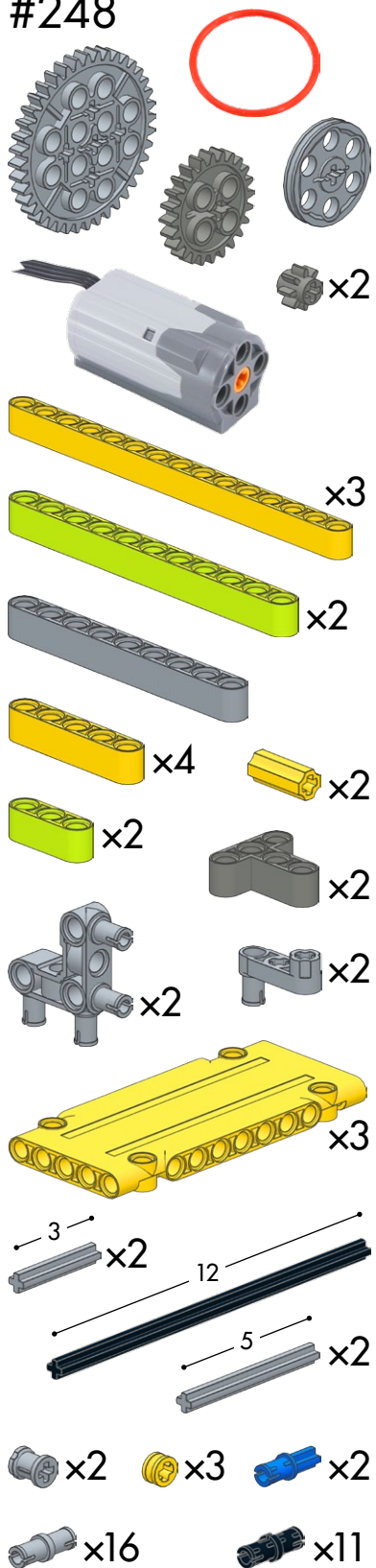
3 grey 1x2 Technic pins

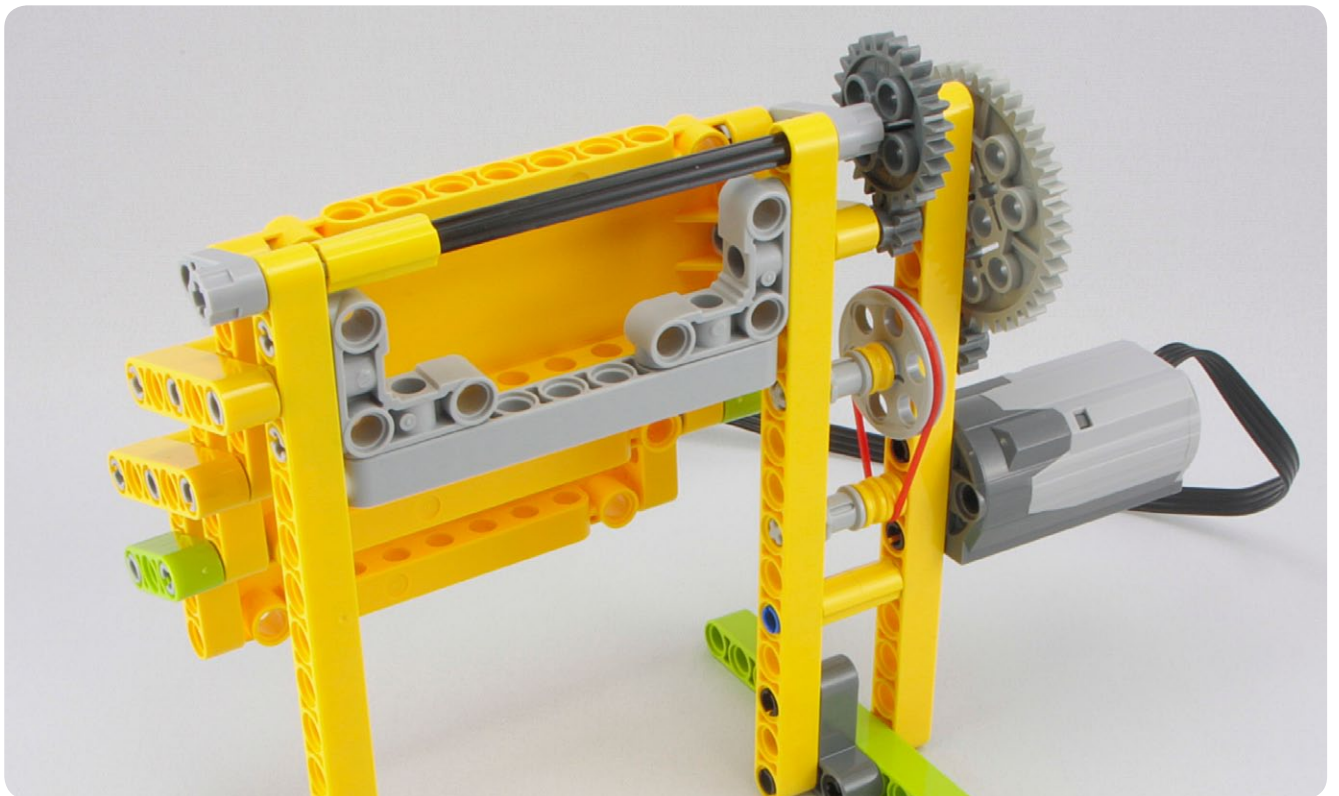
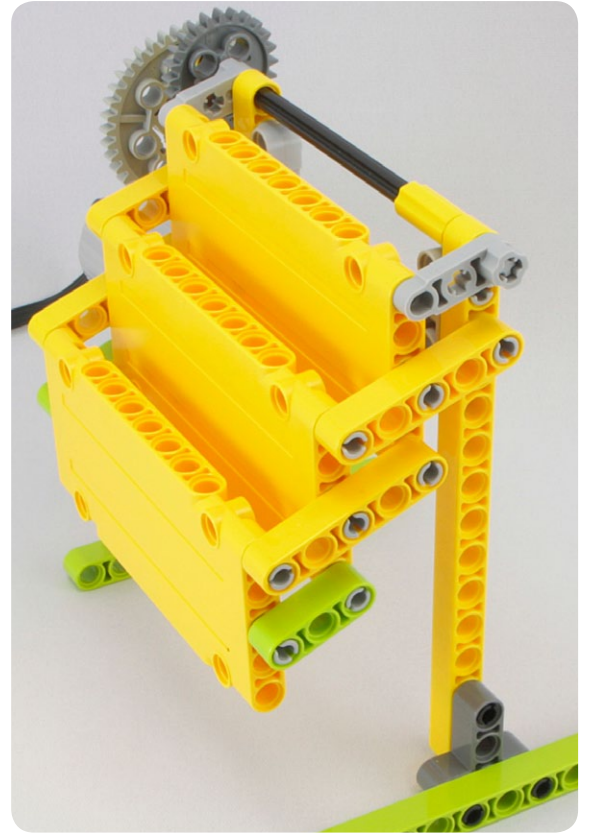
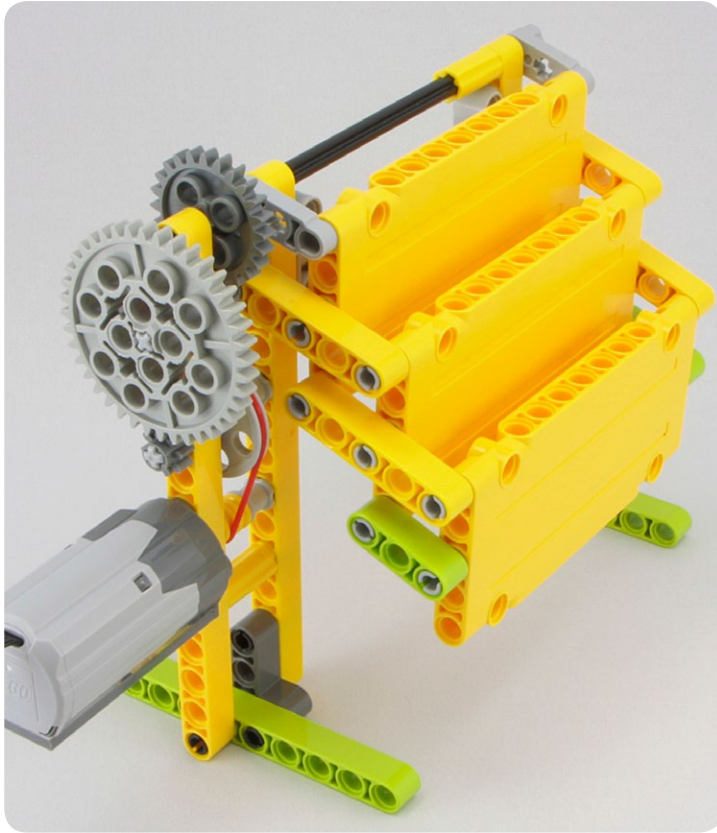
15 black 1x2 Technic pins

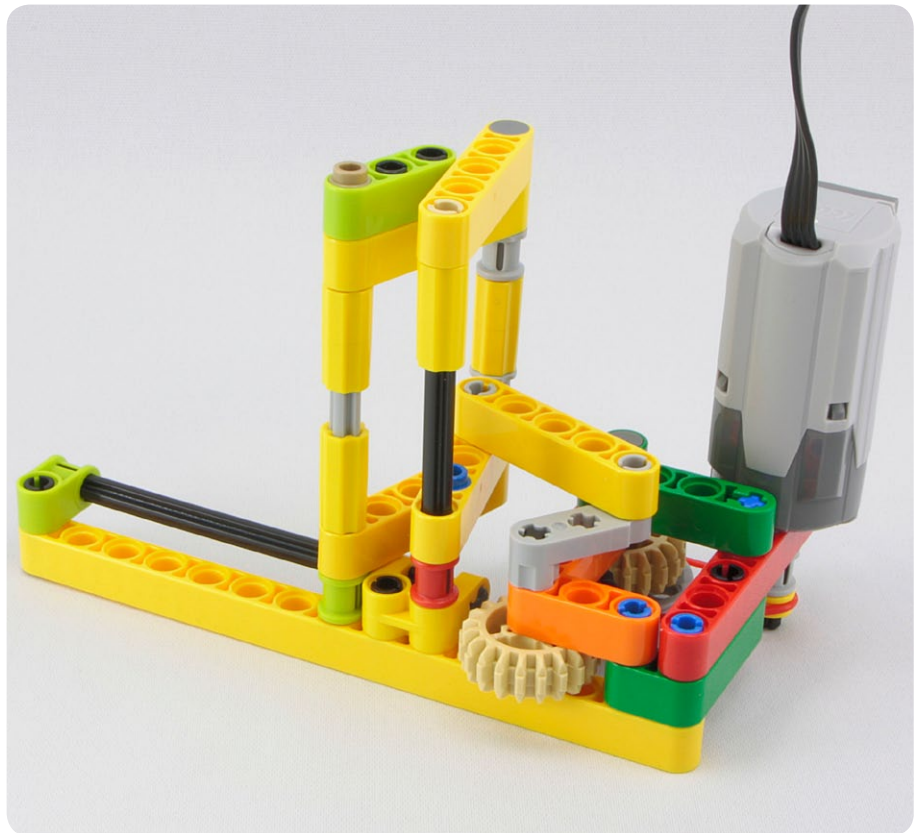
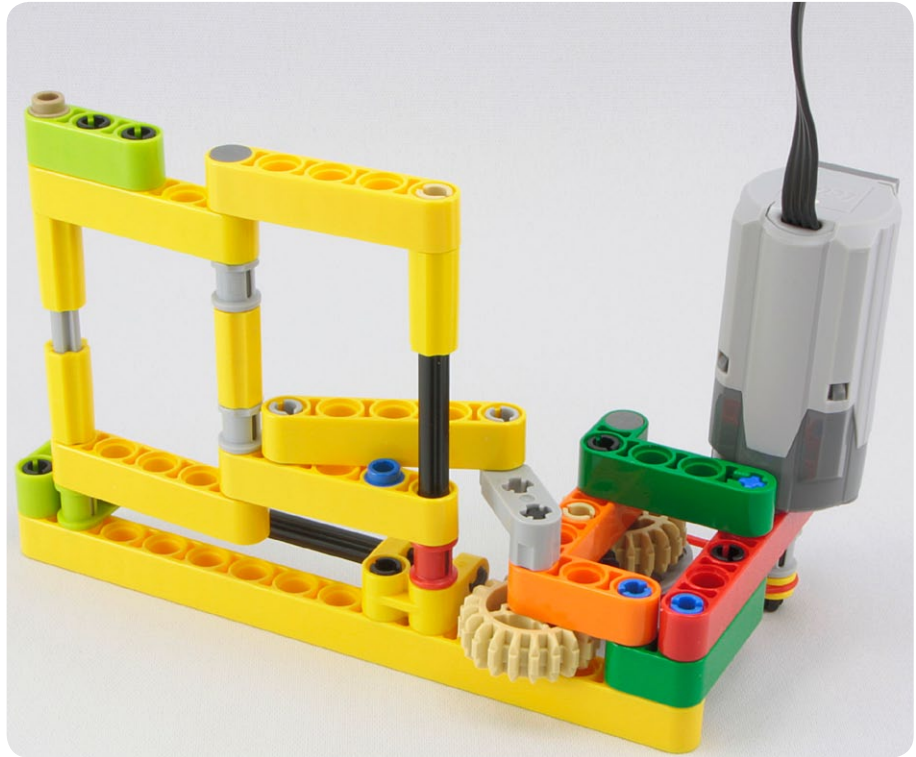


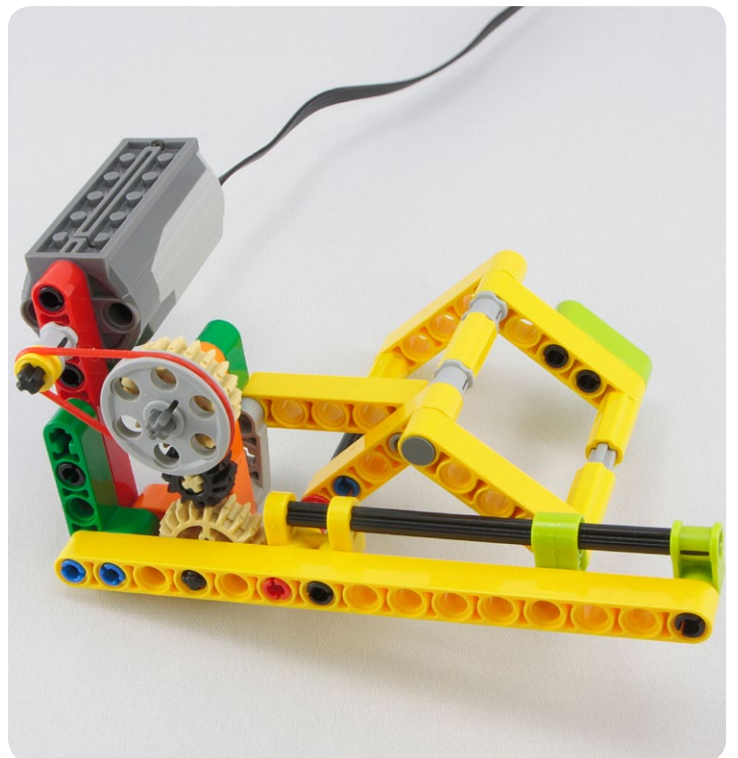
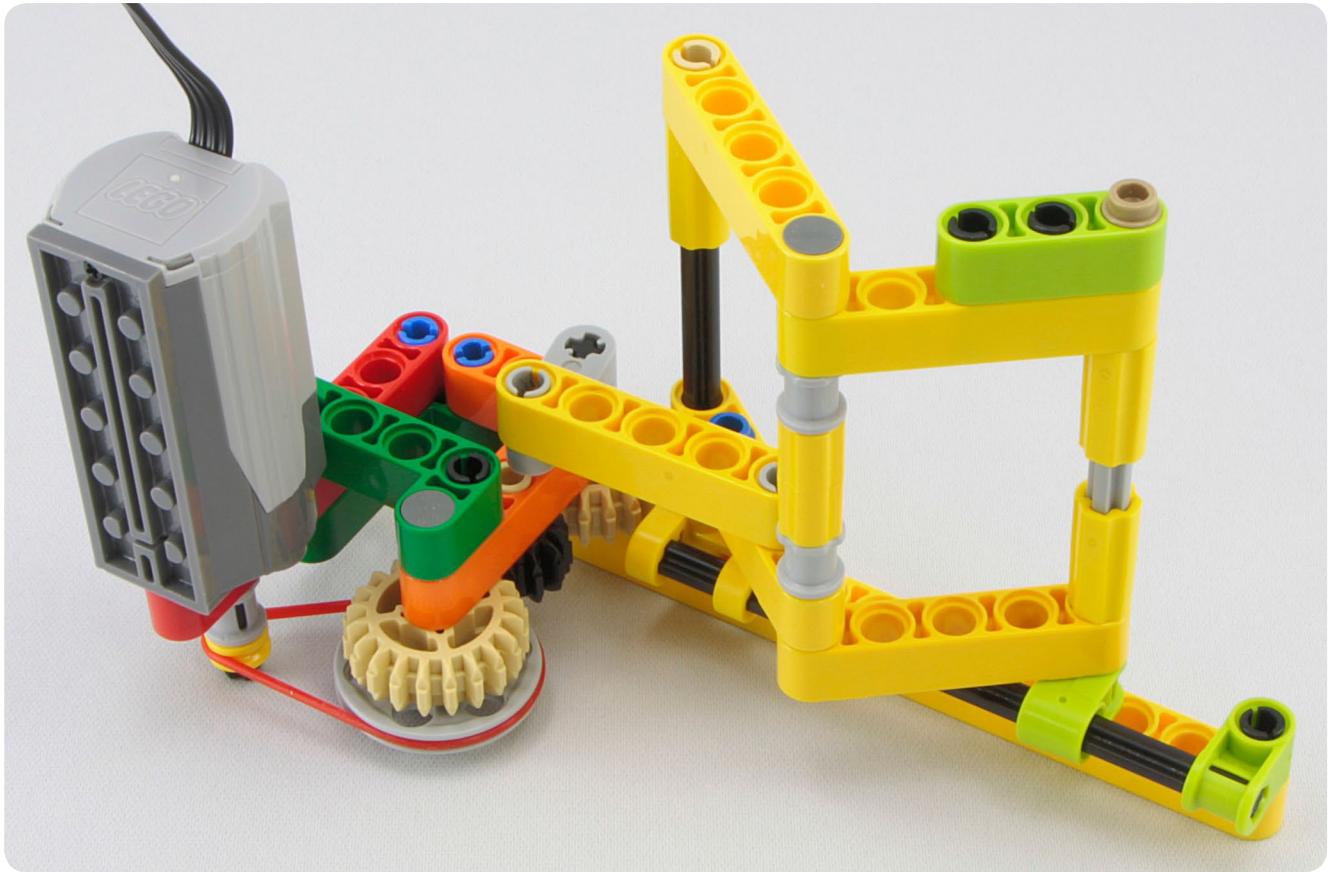


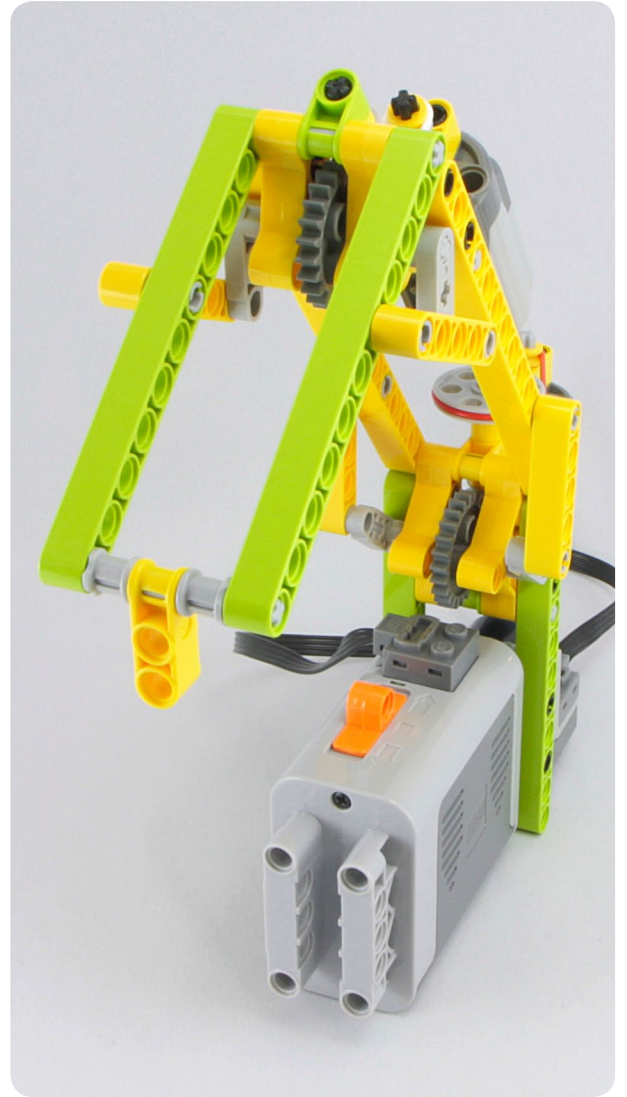
#248

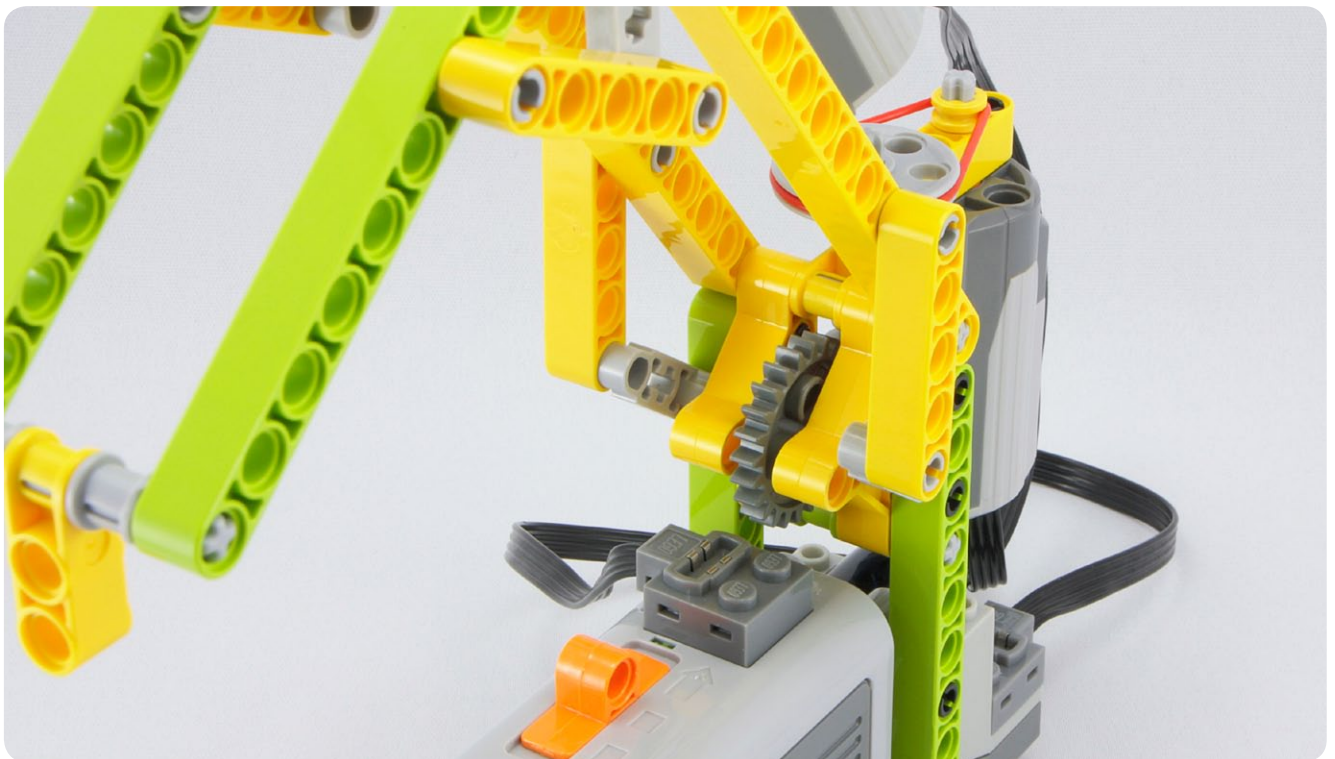
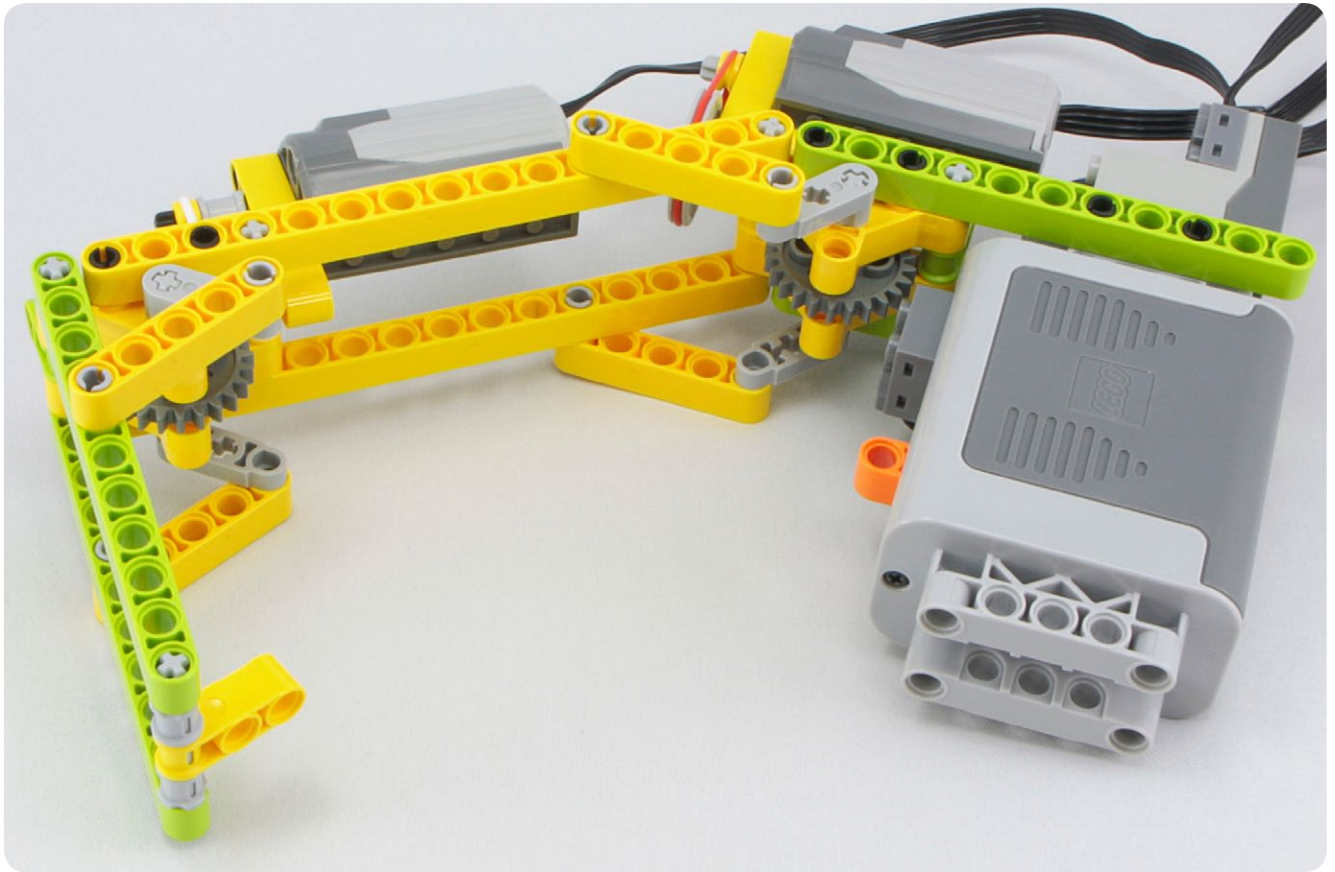


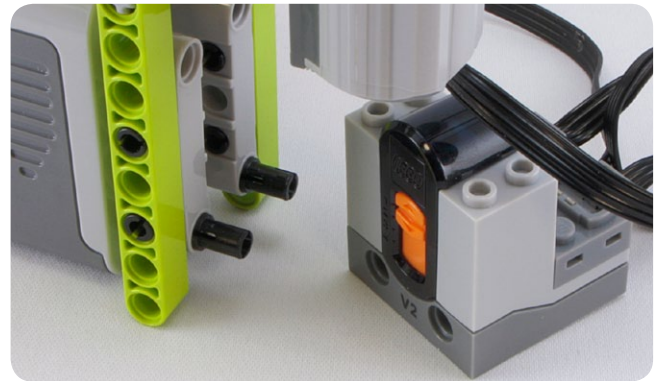
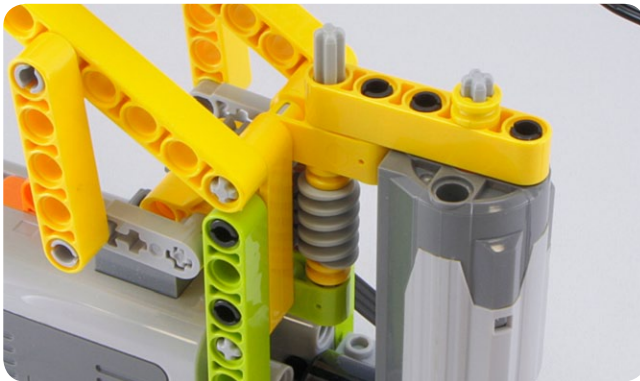
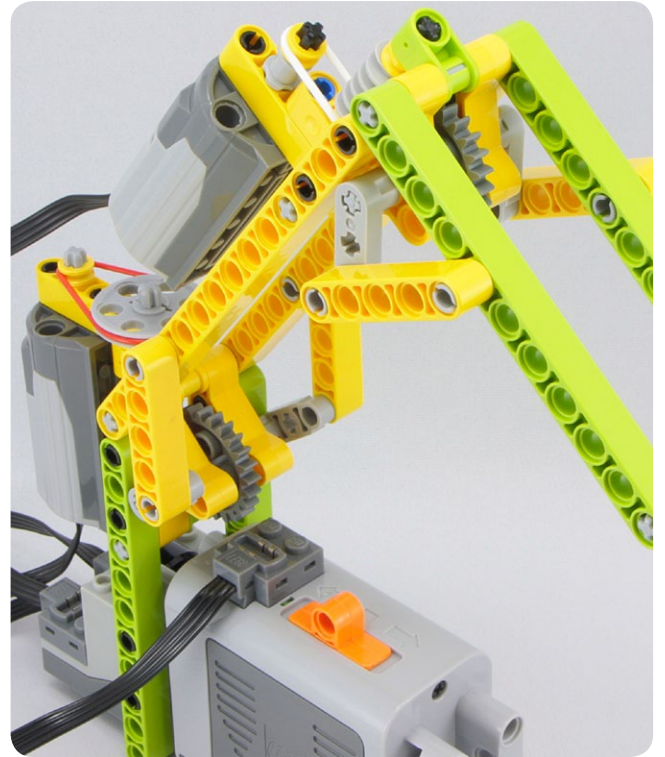


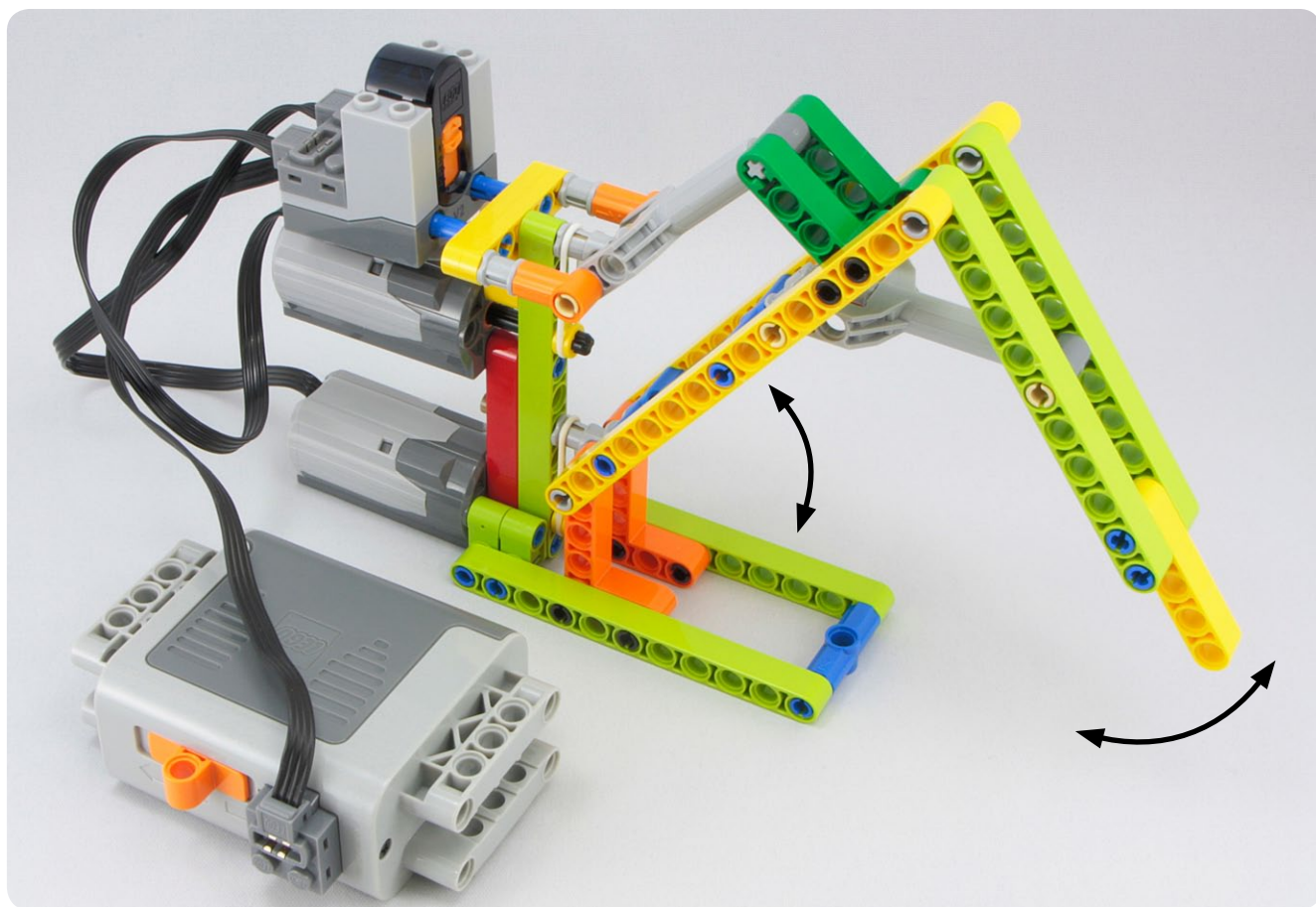


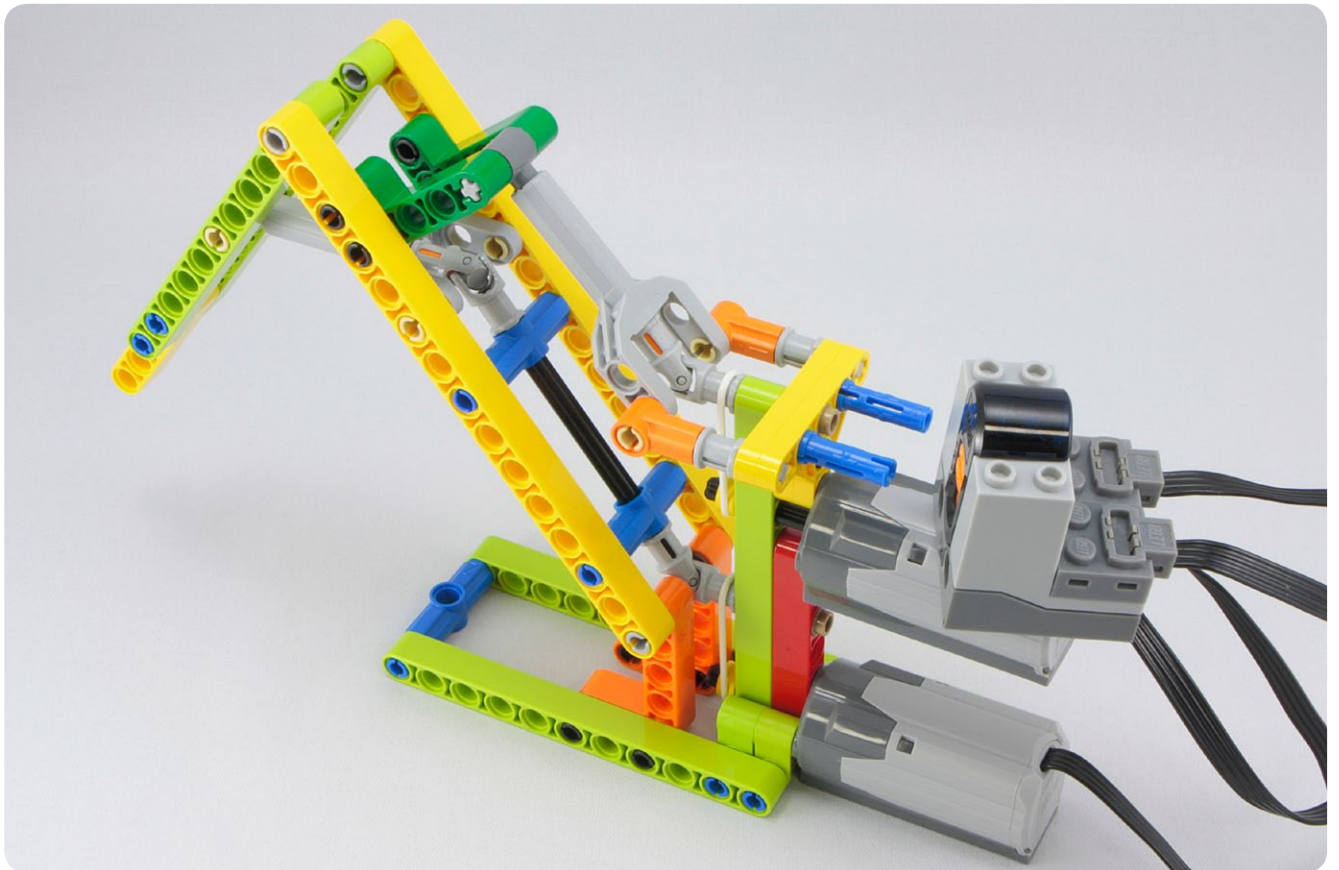
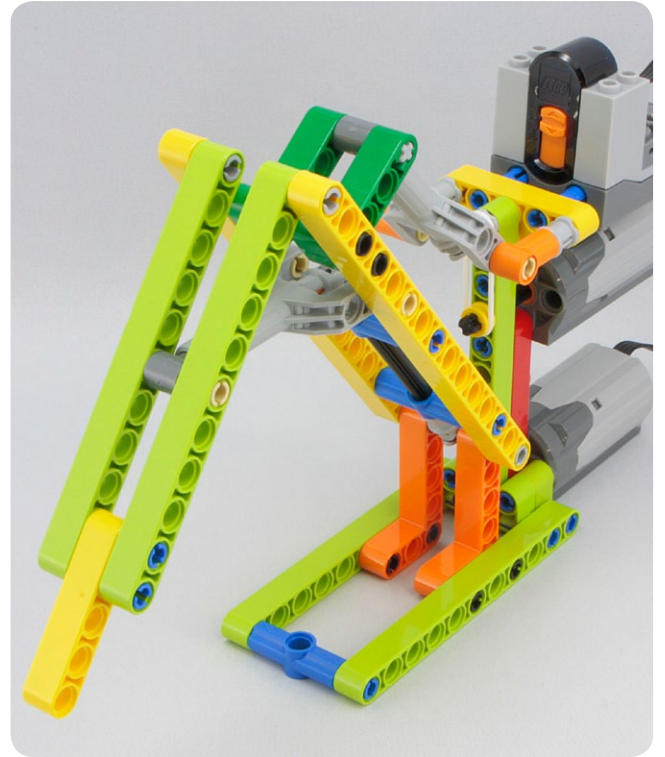
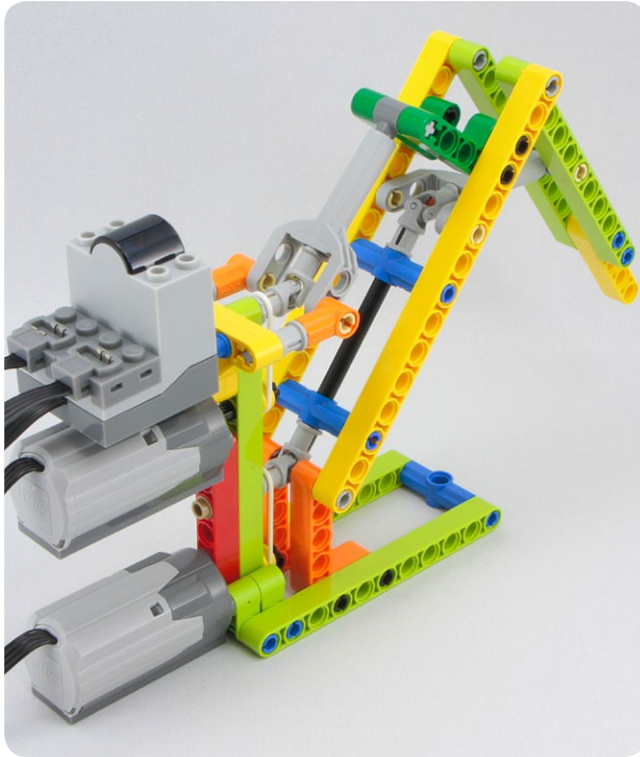


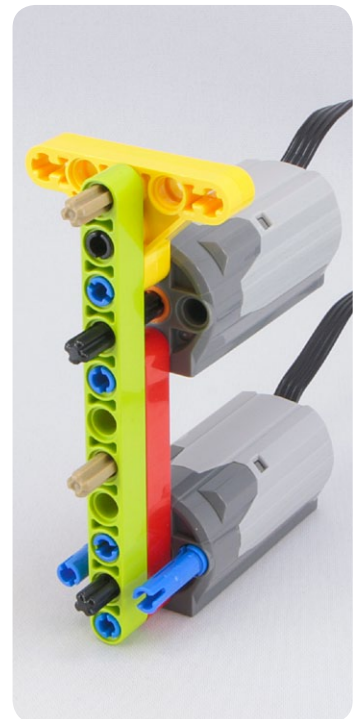
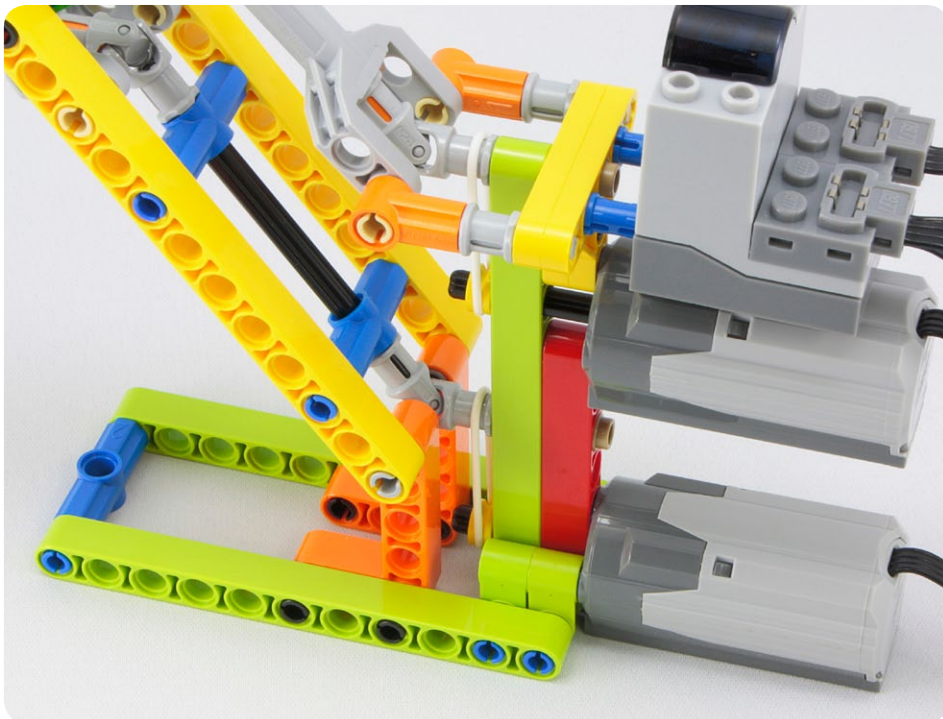
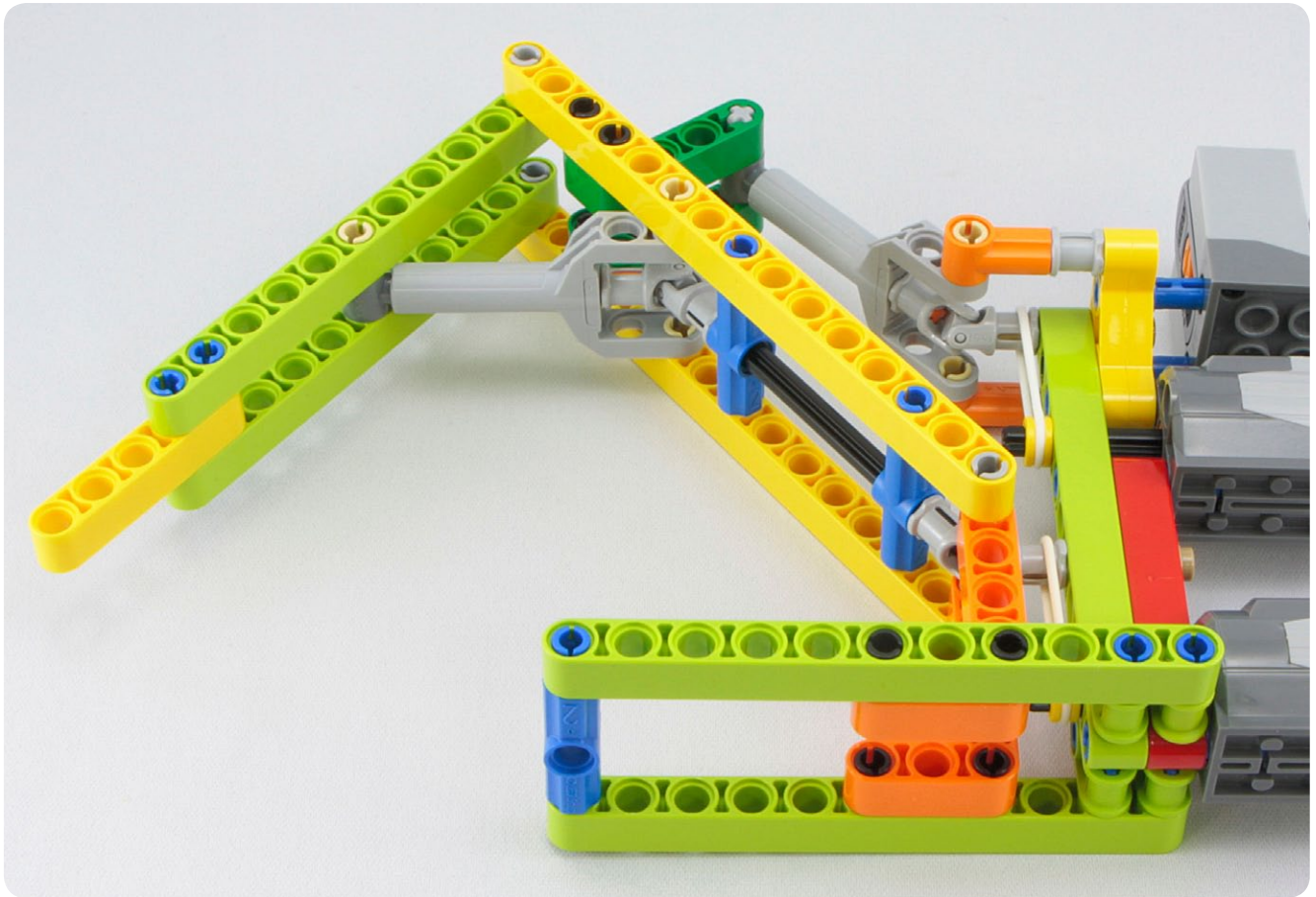


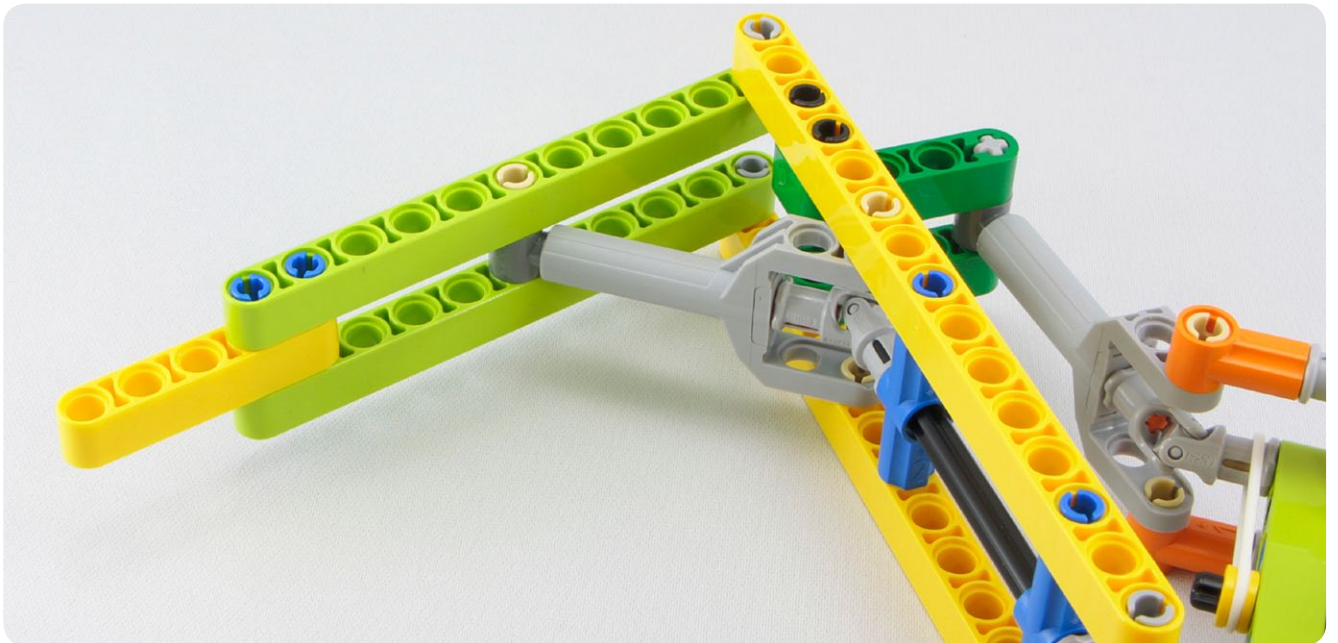


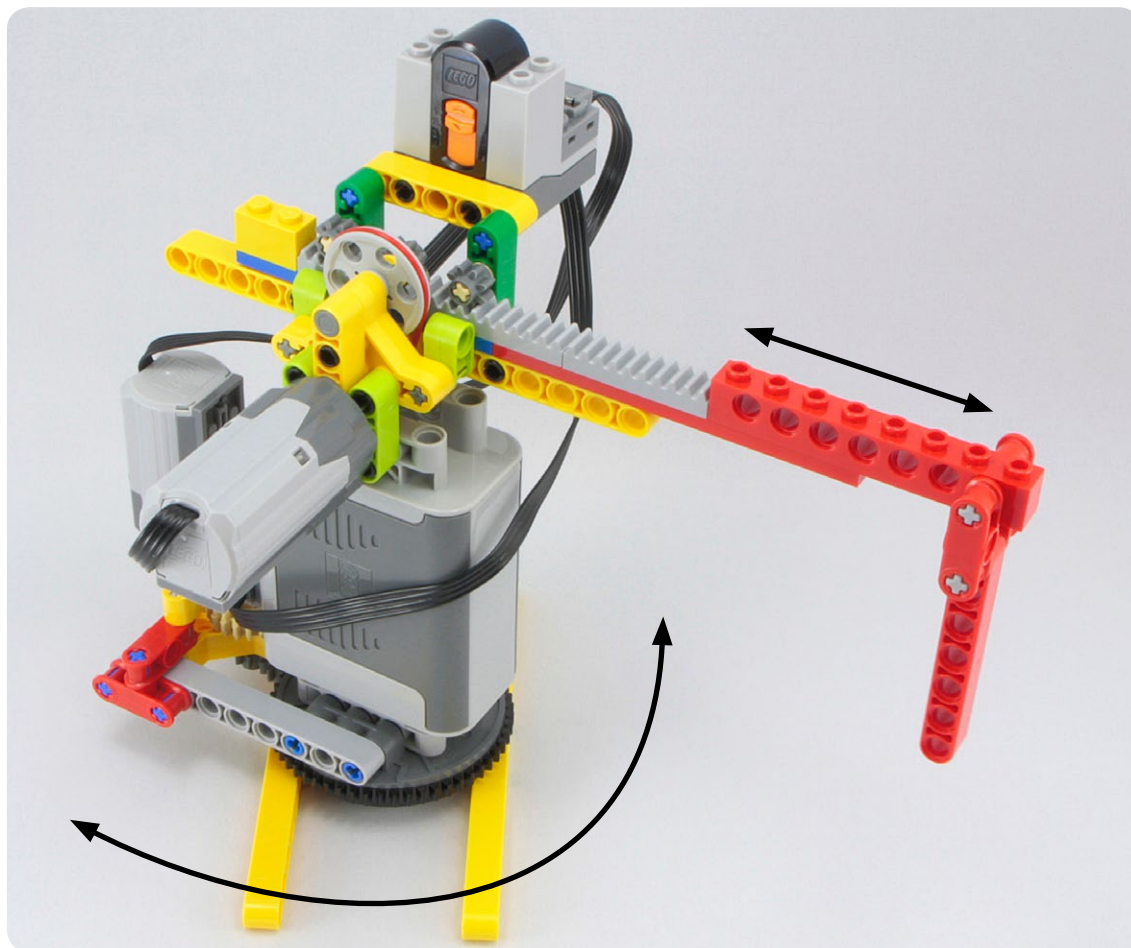











[illegible]

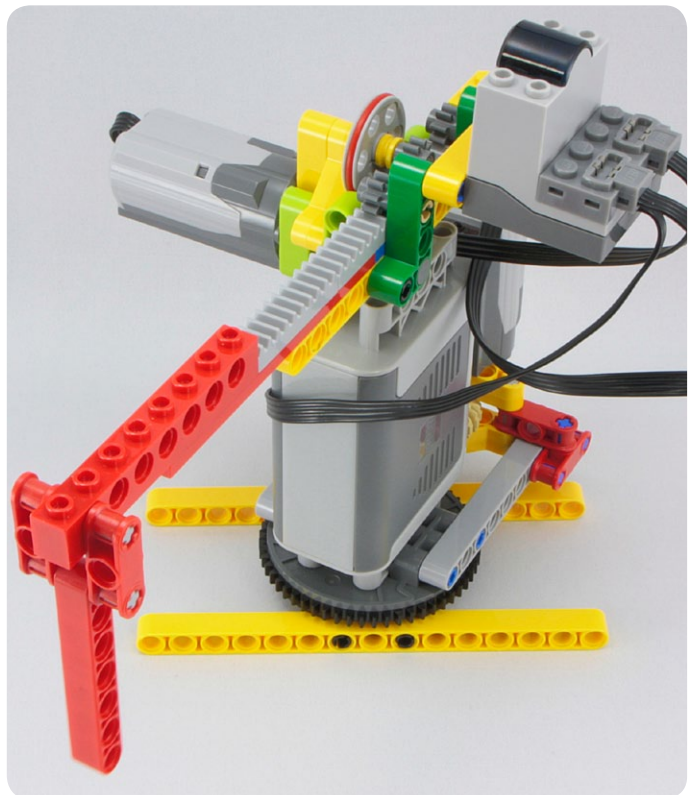
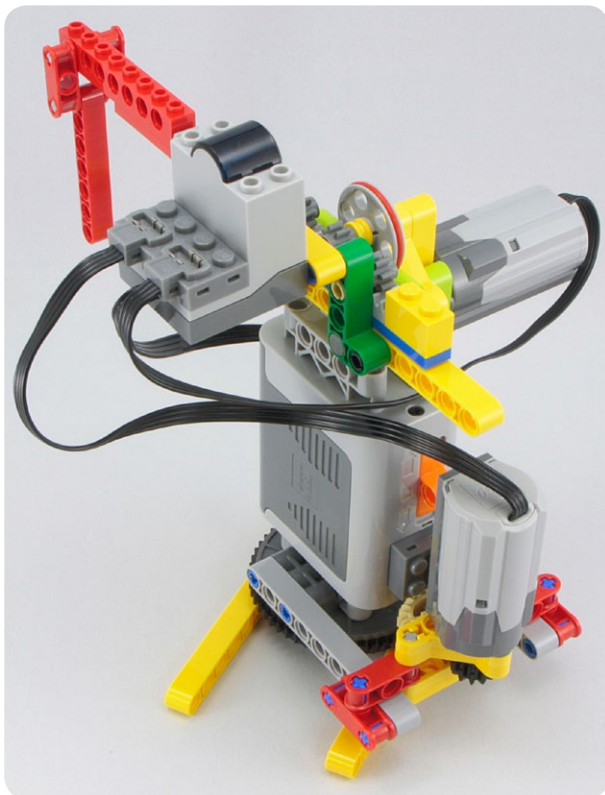


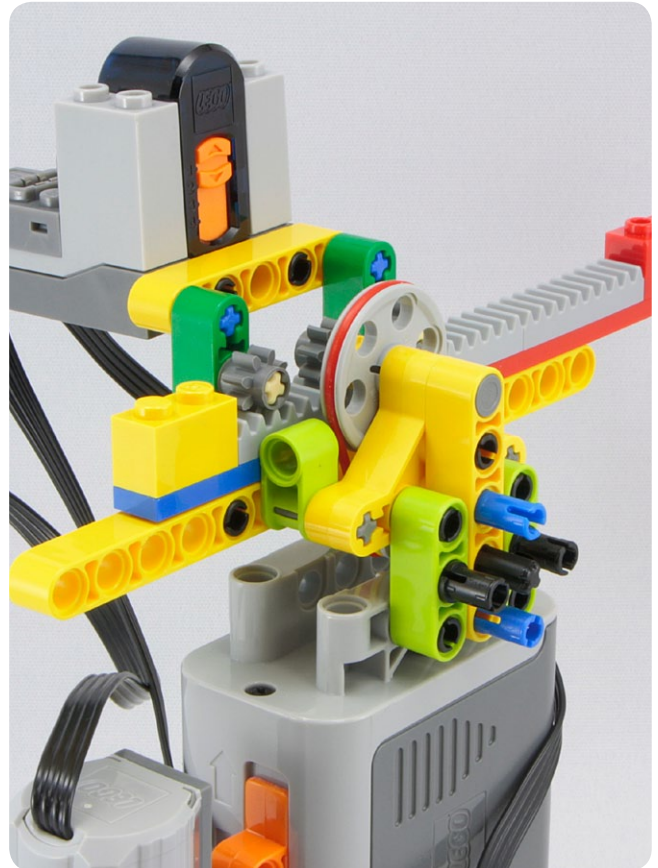
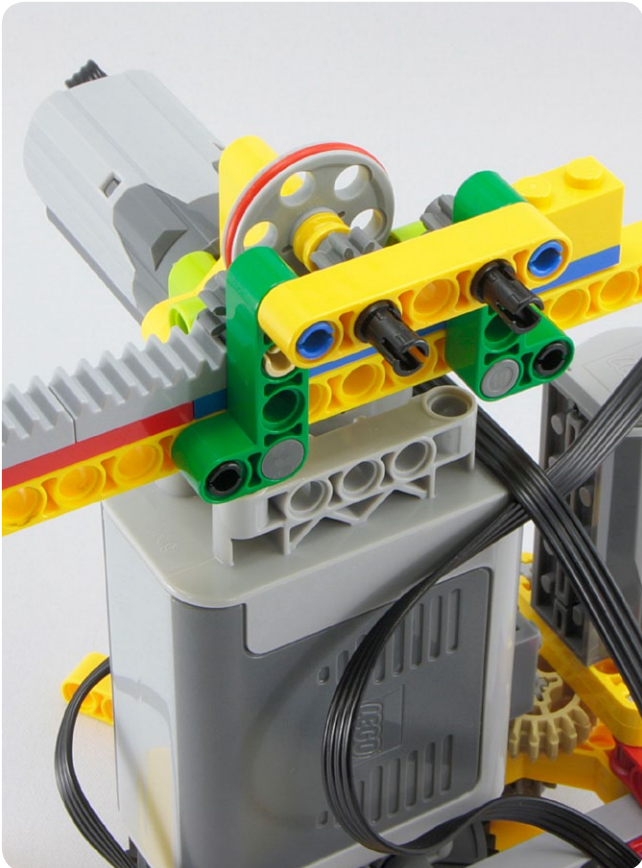
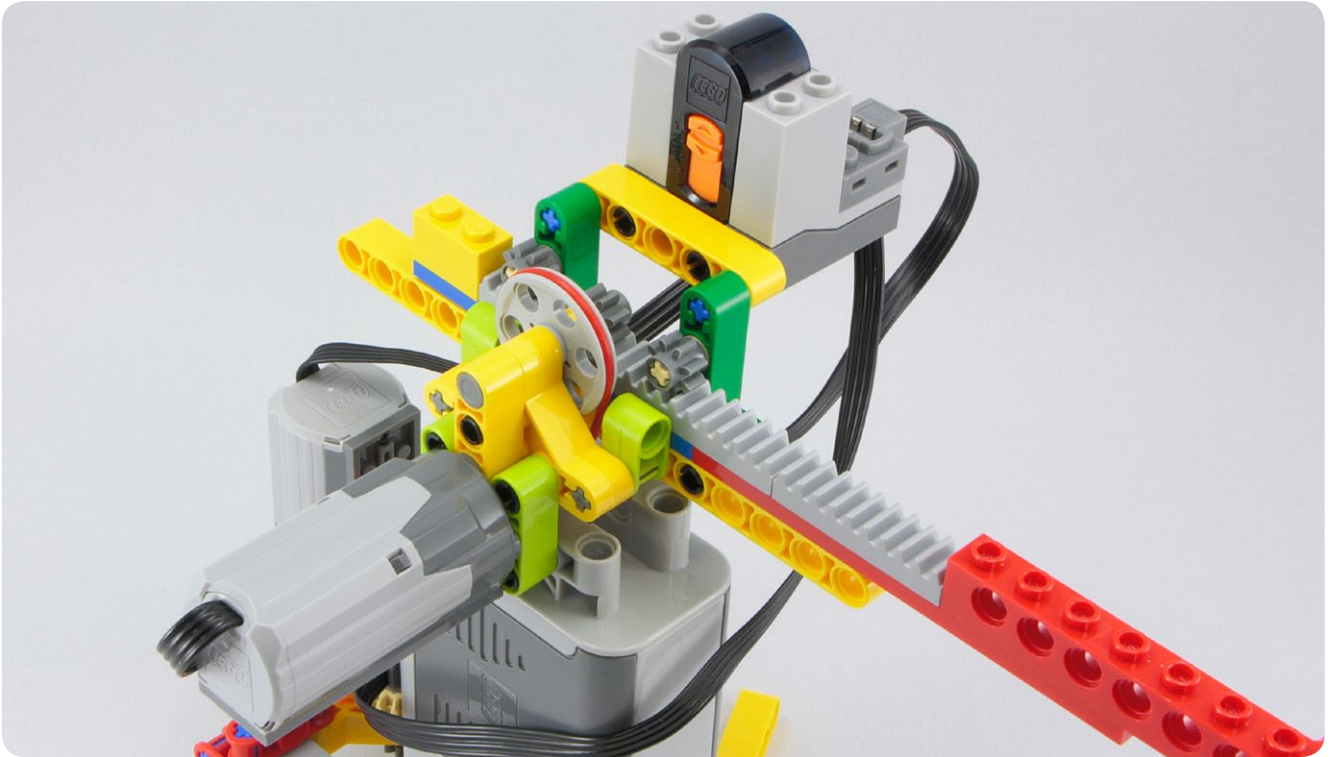


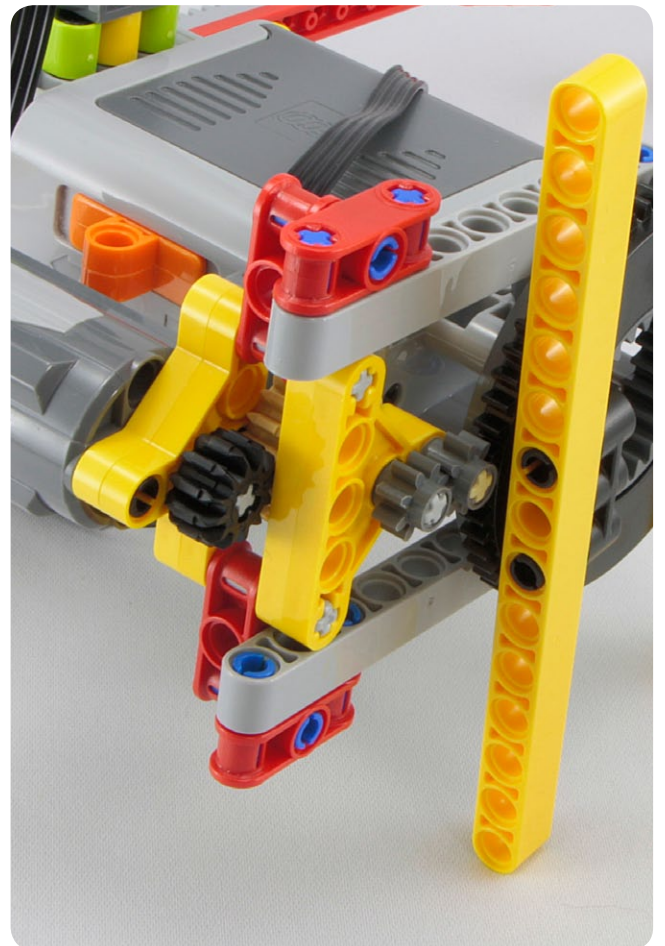
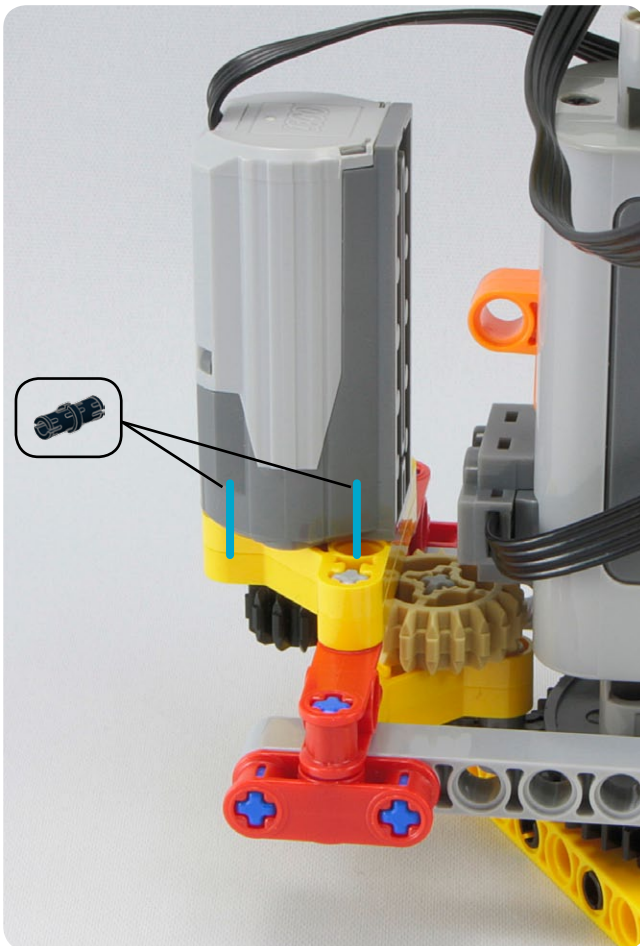
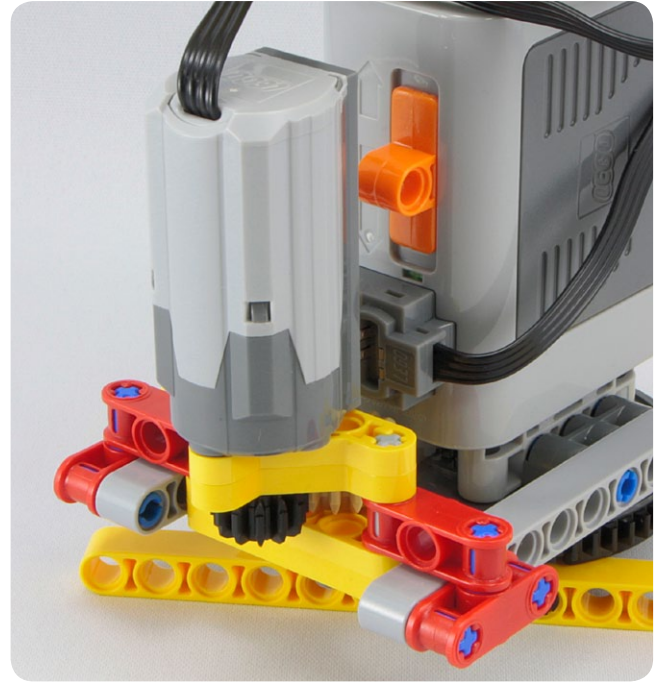
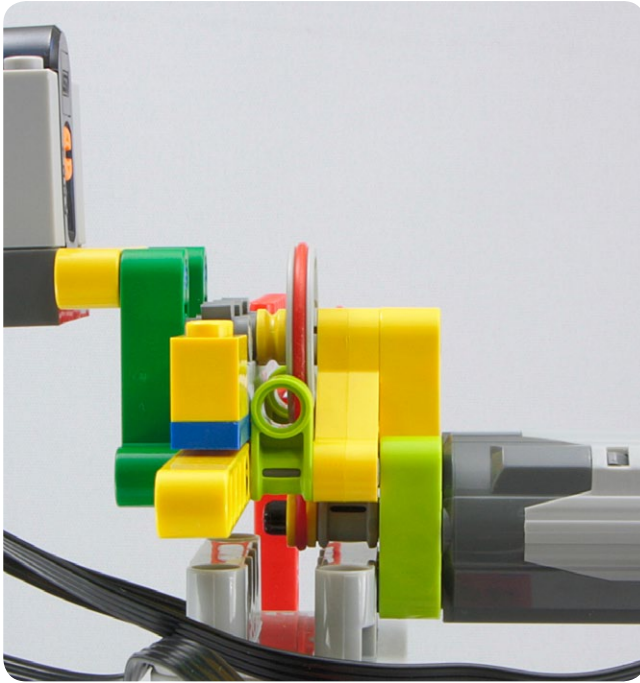


[illegible]

-  x6
 x4
 x3
 x2

 x6
 x3
 x8
 x17







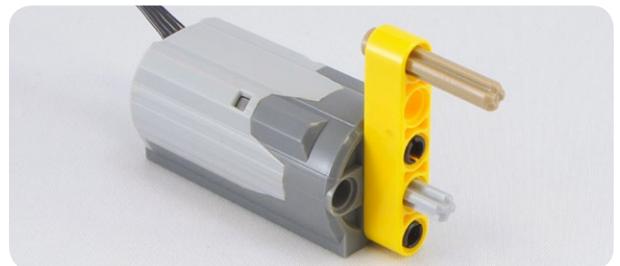
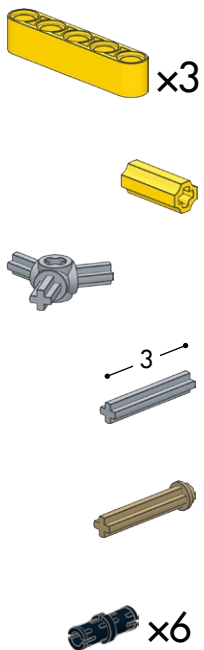
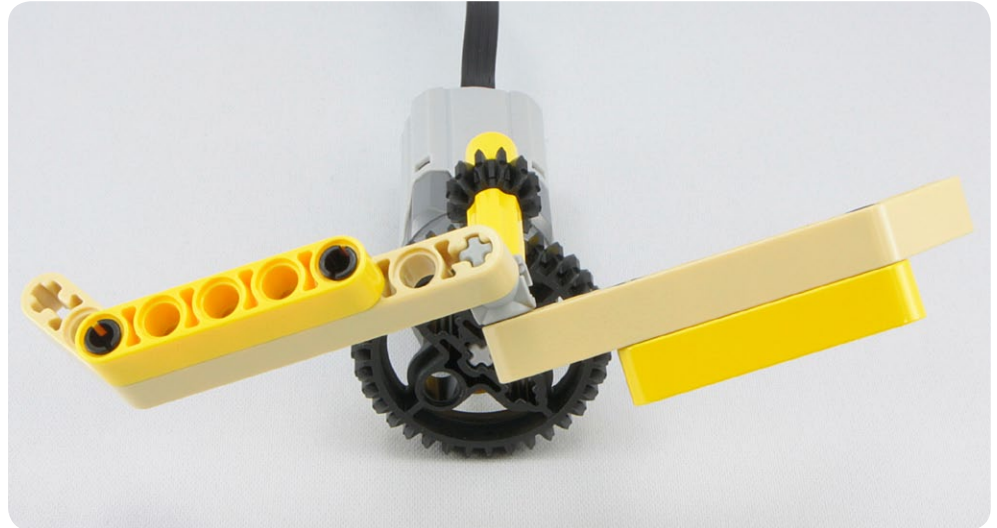


Caution!
These models spin.
Protect your eyes.

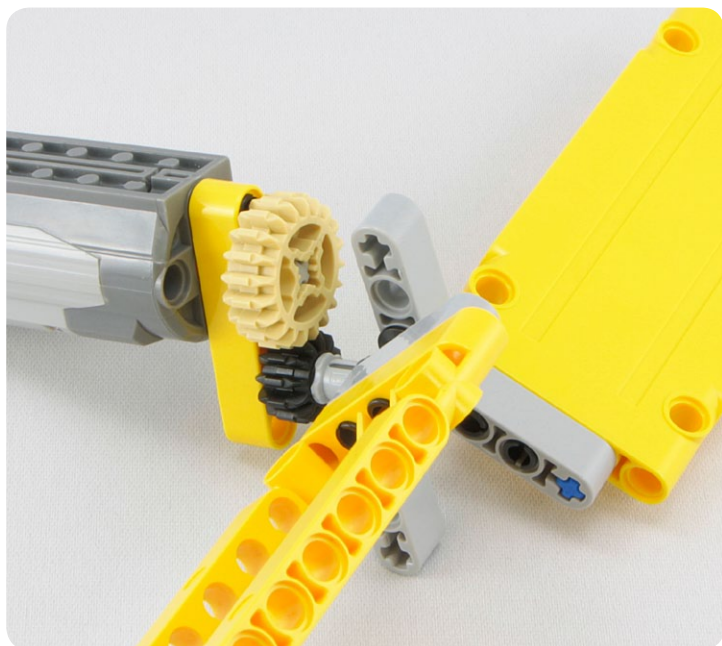
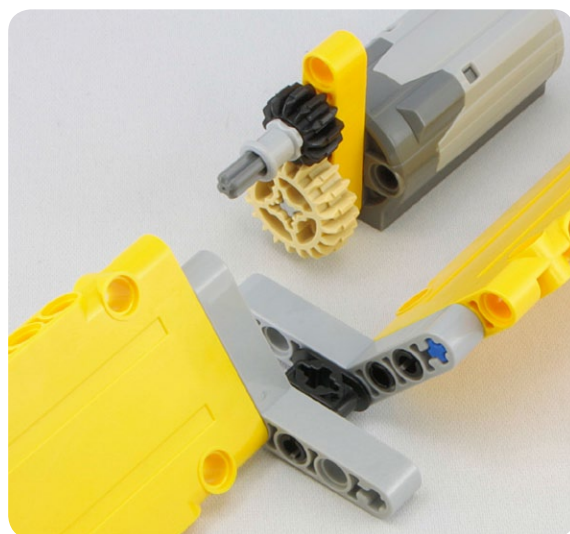
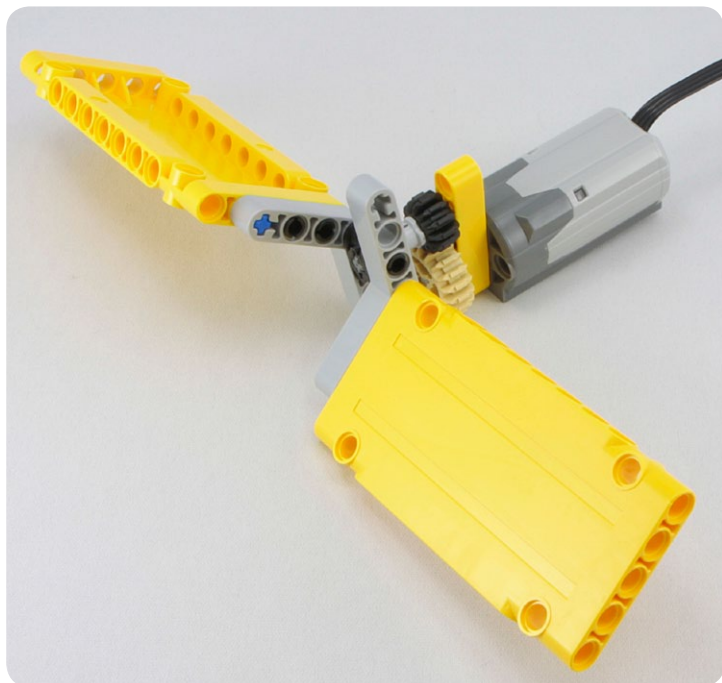
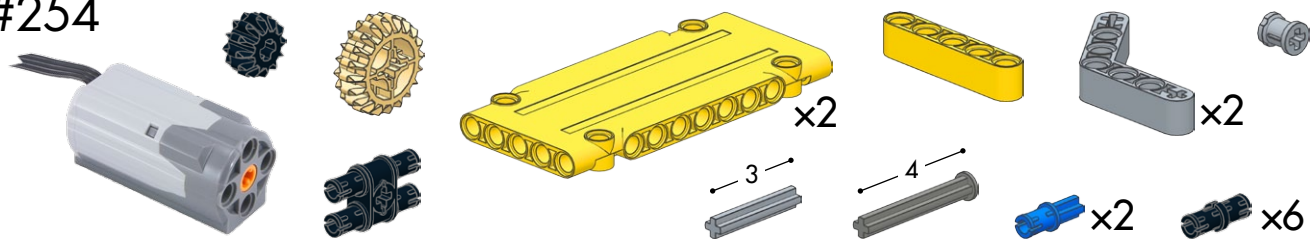


Spinning fans

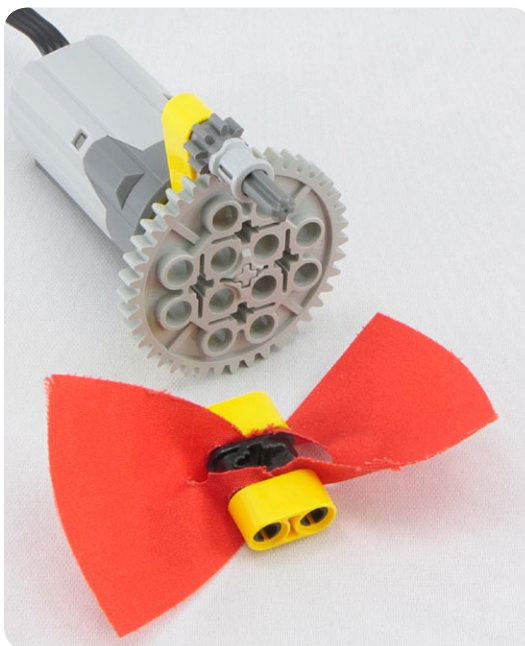
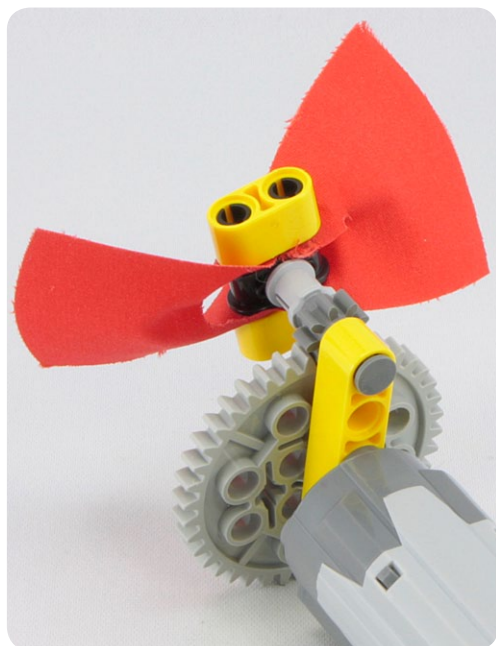
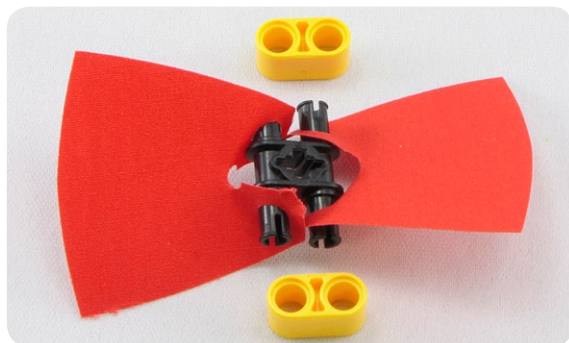
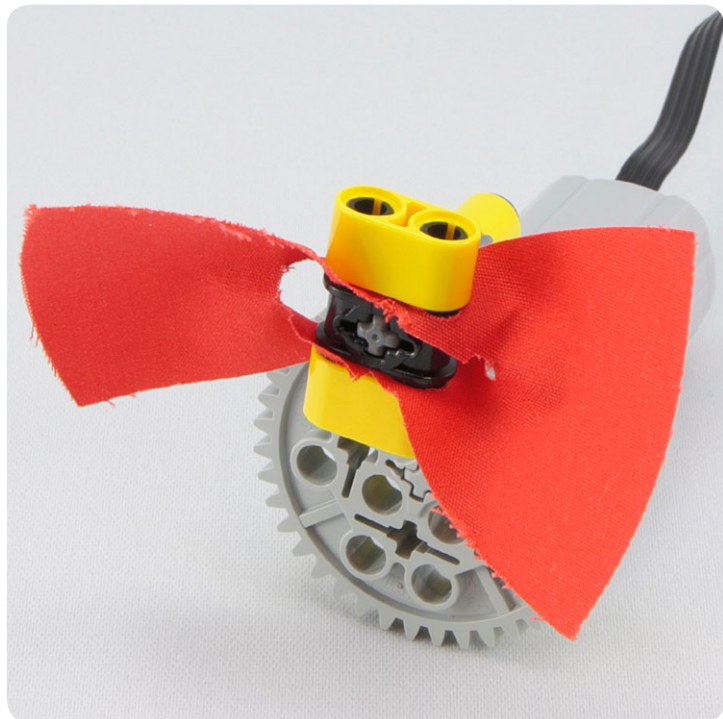
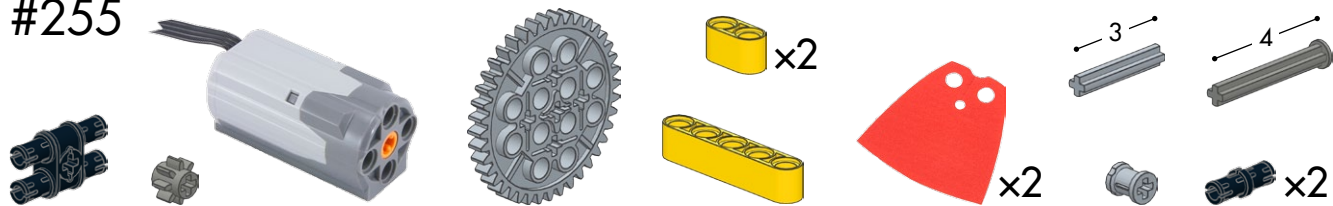
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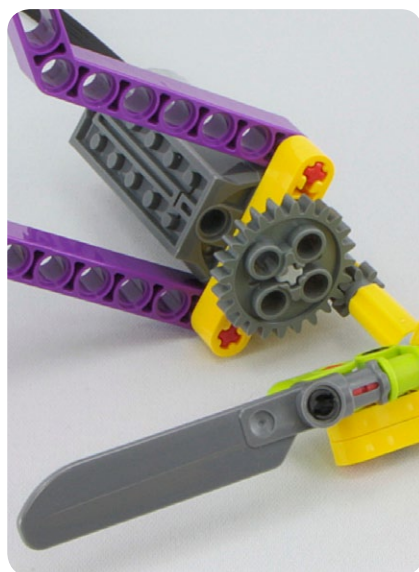
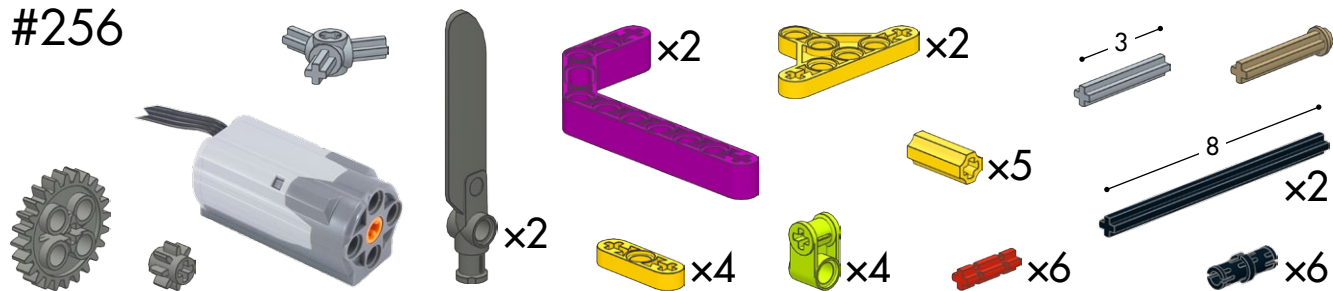
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#255



#256

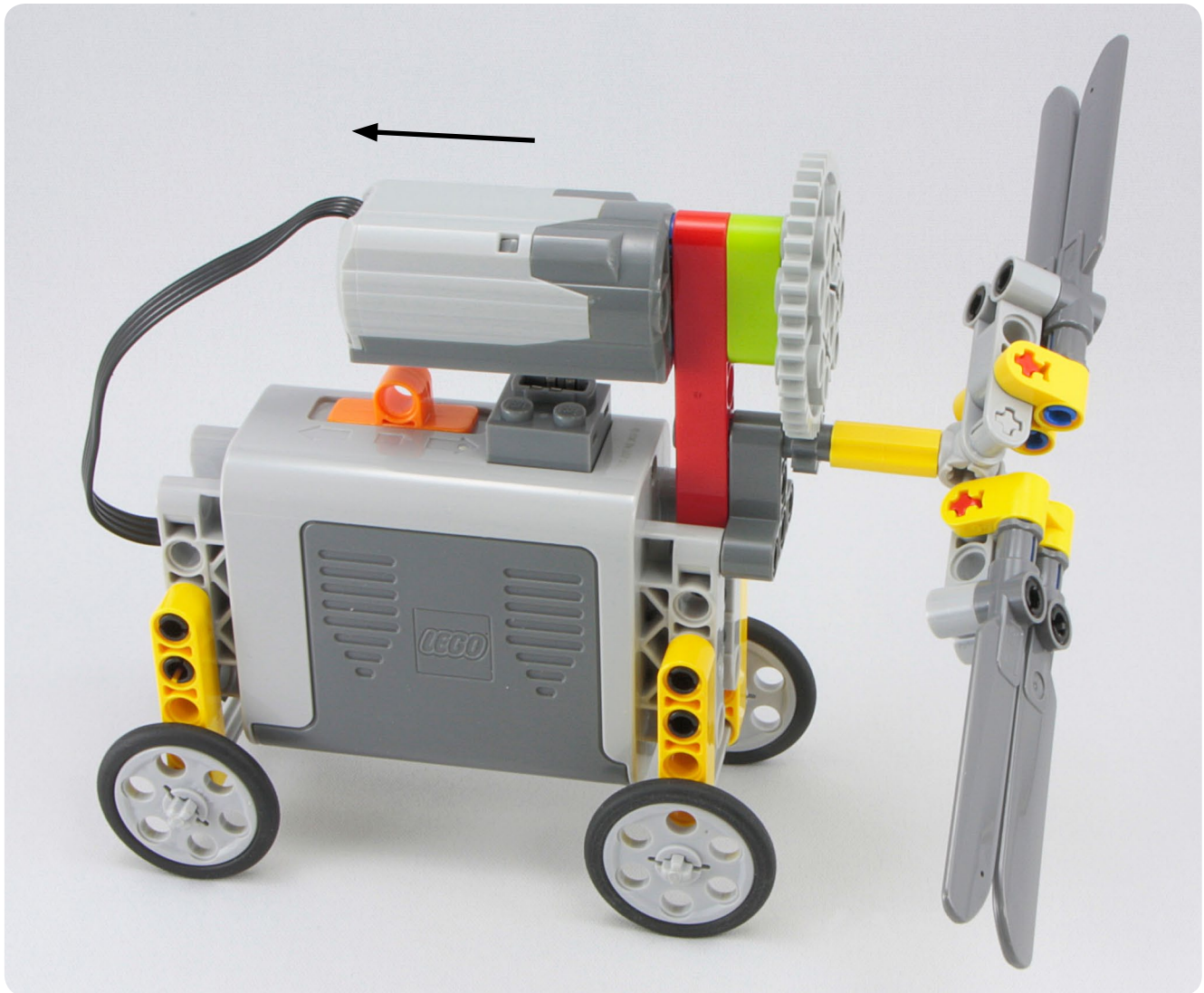


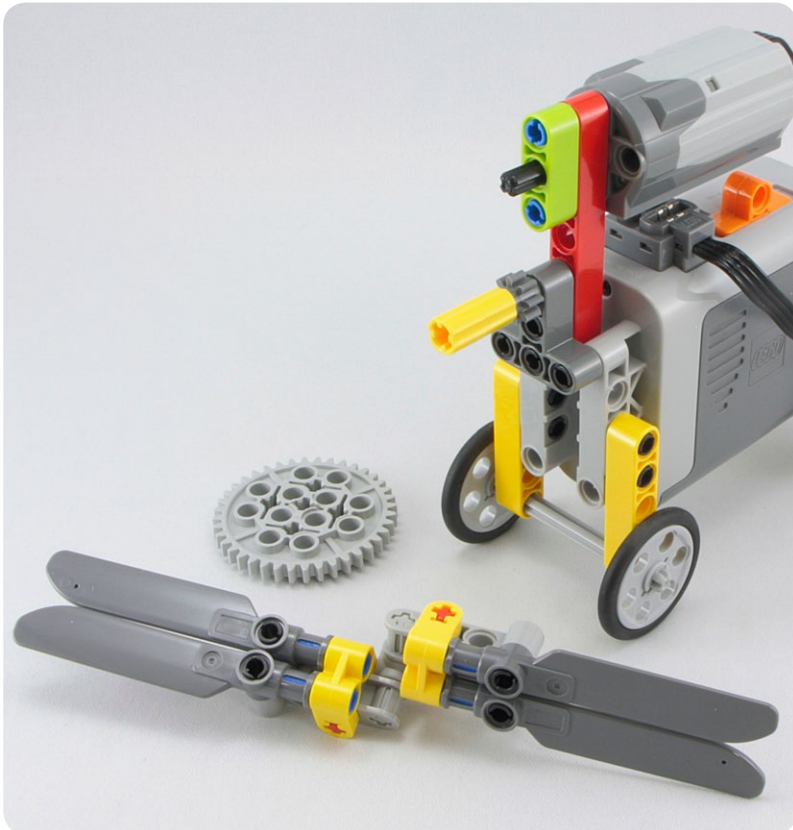
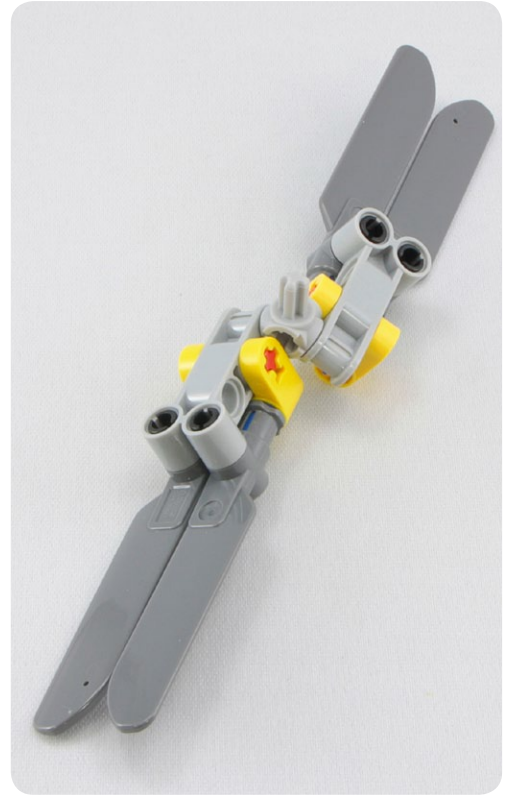
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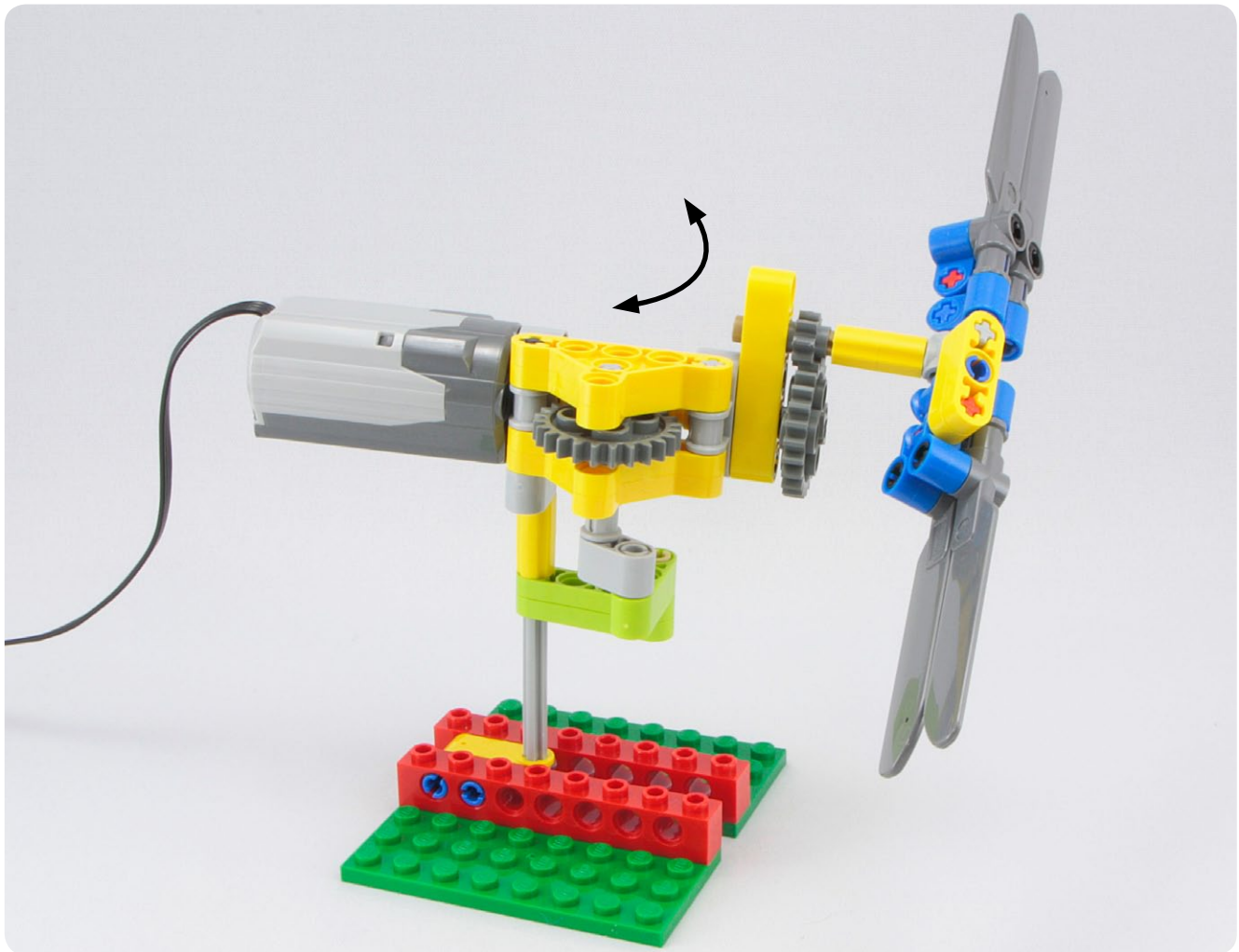


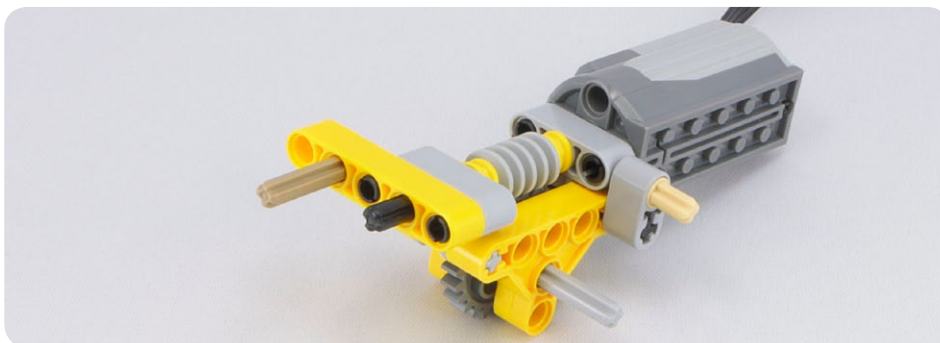
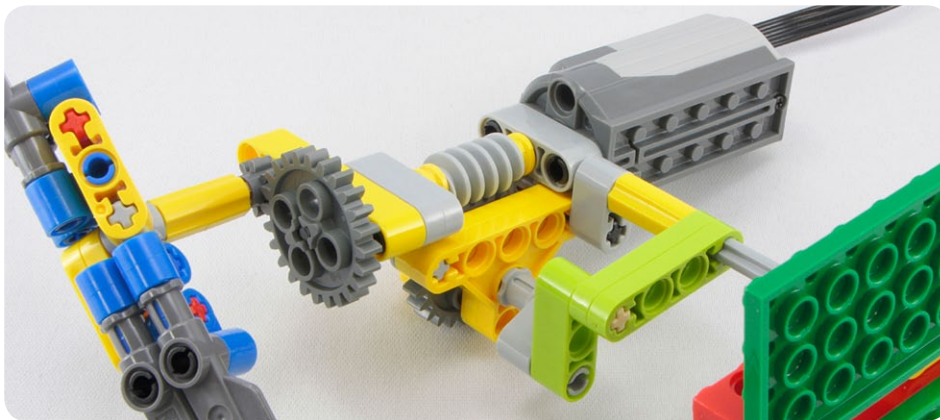
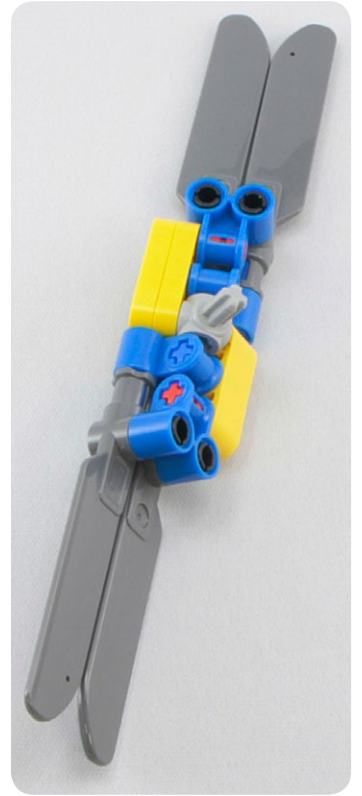
This image displays the parts required for step 257 of a LEGO Technic build. The parts are arranged in a grid-like fashion, with their quantities indicated by 'x' followed by a number. The parts include:

- 1x Large grey motor (LEGO 8850)
- 1x Grey motor connector (LEGO 8851)
- 1x Red 1x5 Technic beam (LEGO 1121)
- 4x Yellow 1x5 Technic beam (LEGO 1122)
- 1x Green 1x5 Technic beam (LEGO 1123)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1124)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1125)
- 1x Grey 1x2 Technic L-shaped connector (LEGO 1126)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1127)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1128)
- 1x Grey 1x2 Technic L-shaped connector (LEGO 1129)
- 1x Blue 1x2 Technic L-shaped connector (LEGO 1130)
- 4x Blue 1x2 Technic L-shaped connector (LEGO 1131)
- 1x Blue 1x2 Technic L-shaped connector (LEGO 1132)
- 16x Black 1x2 Technic L-shaped connector (LEGO 1133)
- 1x Large grey gear (LEGO 1134)
- 1x Small grey gear (LEGO 1135)
- 4x Black O-ring (LEGO 1136)
- 4x Small grey gear (LEGO 1137)
- 4x Grey 1x2 Technic L-shaped connector (LEGO 1138)
- 2x Red 1x2 Technic L-shaped connector (LEGO 1139)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1140)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1141)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1142)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1143)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1144)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1145)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1146)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1147)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1148)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1149)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1150)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1151)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1152)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1153)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1154)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1155)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1156)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1157)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1158)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1159)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1160)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1161)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1162)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1163)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1164)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1165)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1166)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1167)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1168)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1169)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1170)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1171)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1172)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1173)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1174)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1175)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1176)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1177)
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- 2x Grey 1x2 Technic L-shaped connector (LEGO 1191)
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- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1194)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1195)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1196)
- 2x Grey 1x2 Technic L-shaped connector (LEGO 1197)
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- 2x Grey 1x2 Technic L-shaped connector (LEGO 1199)
- 2x Yellow 1x2 Technic L-shaped connector (LEGO 1200)

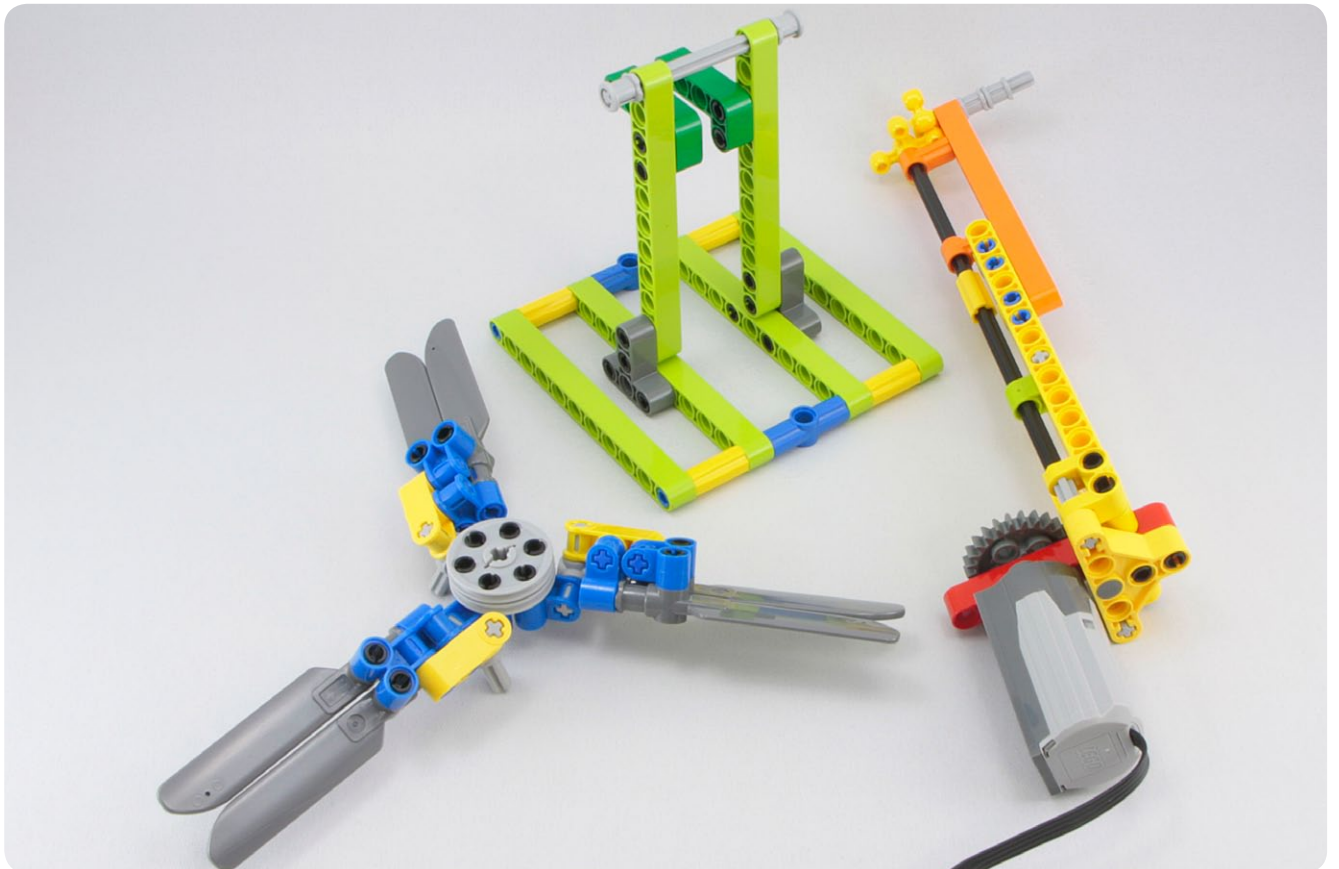


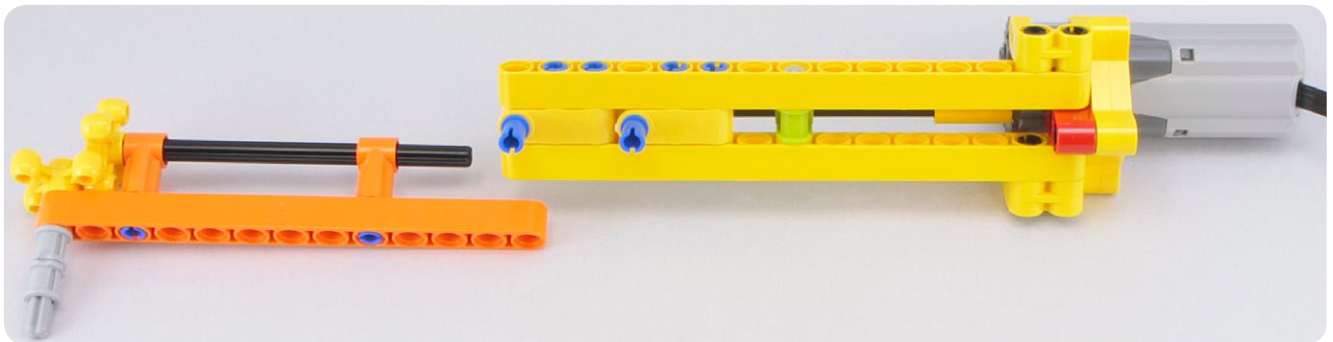
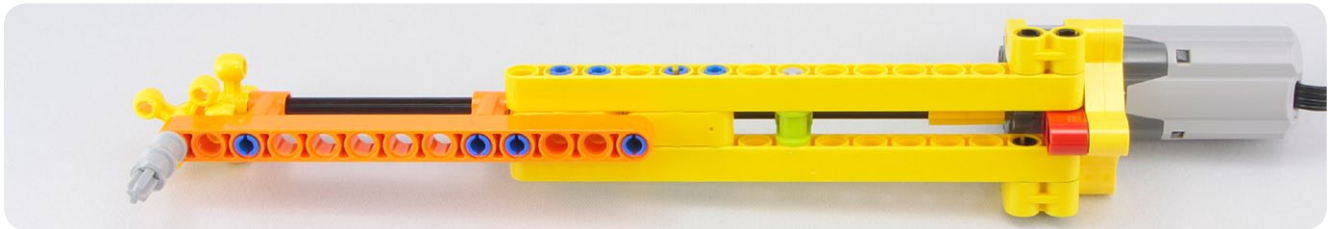
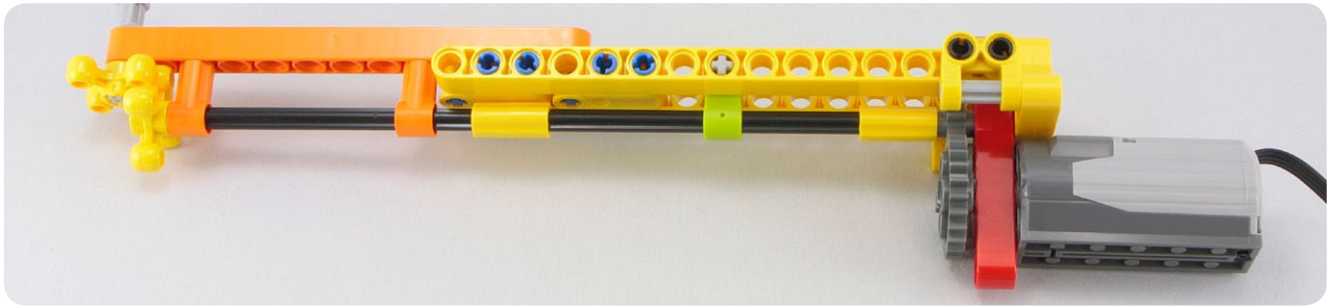
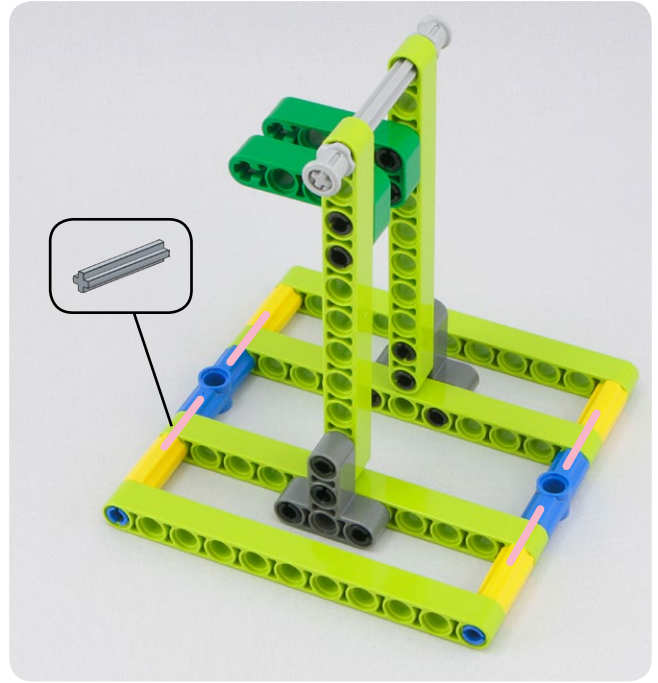
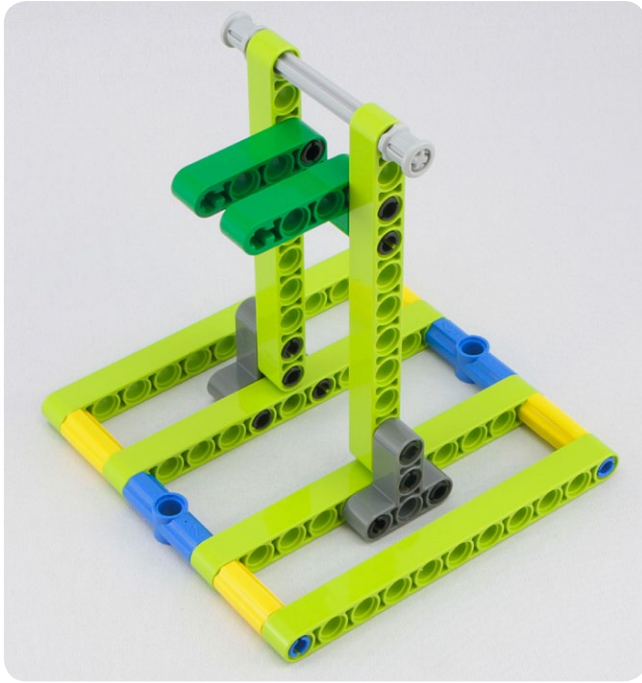


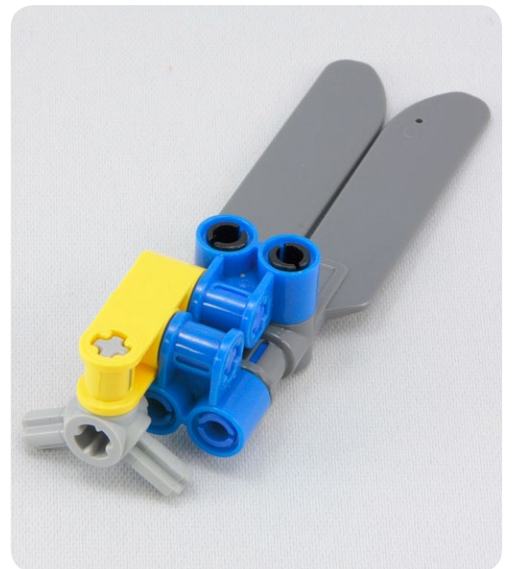
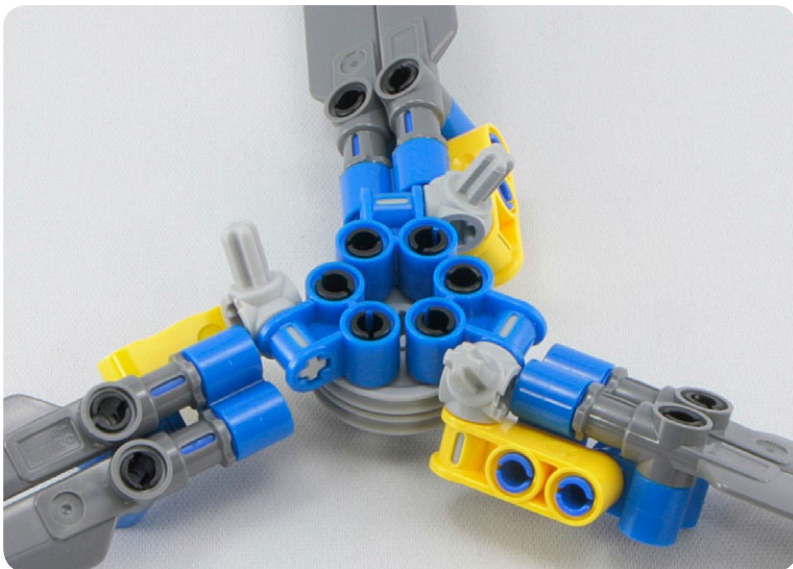
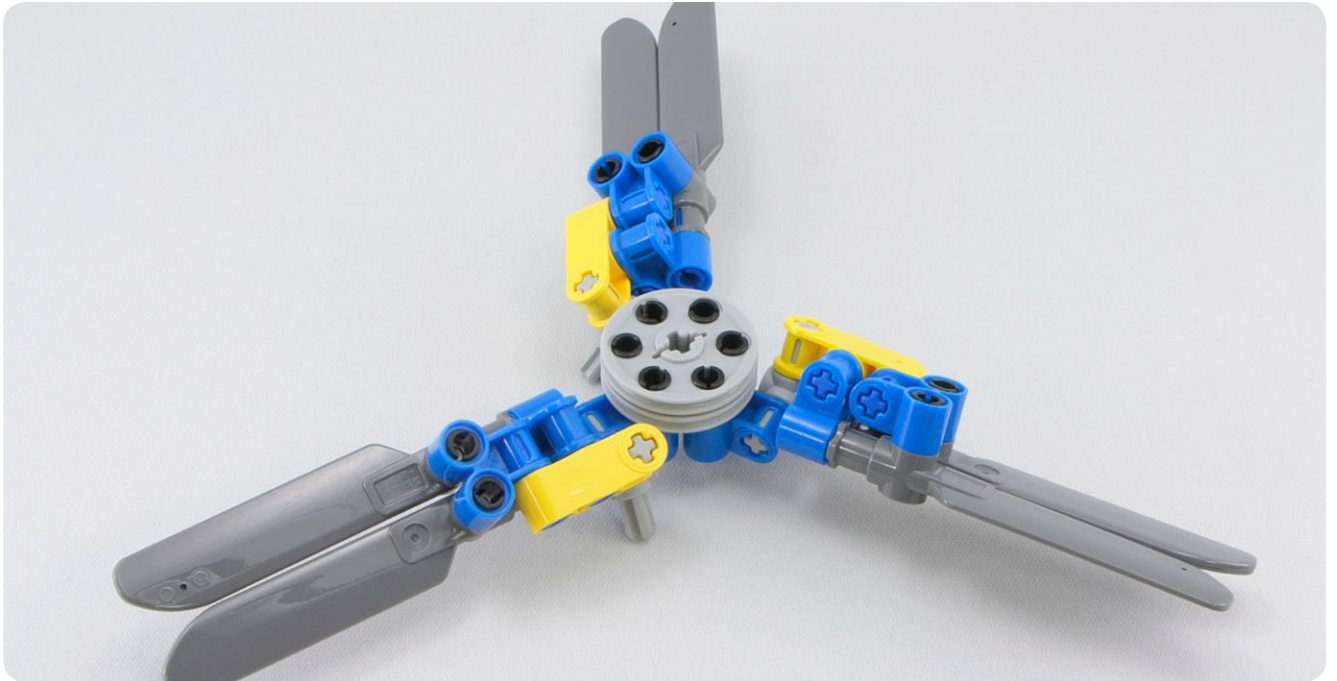
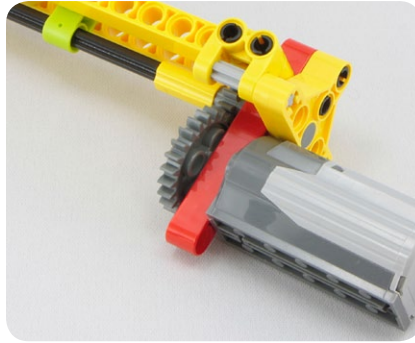
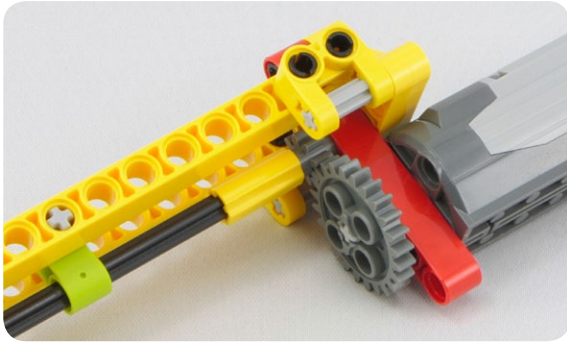
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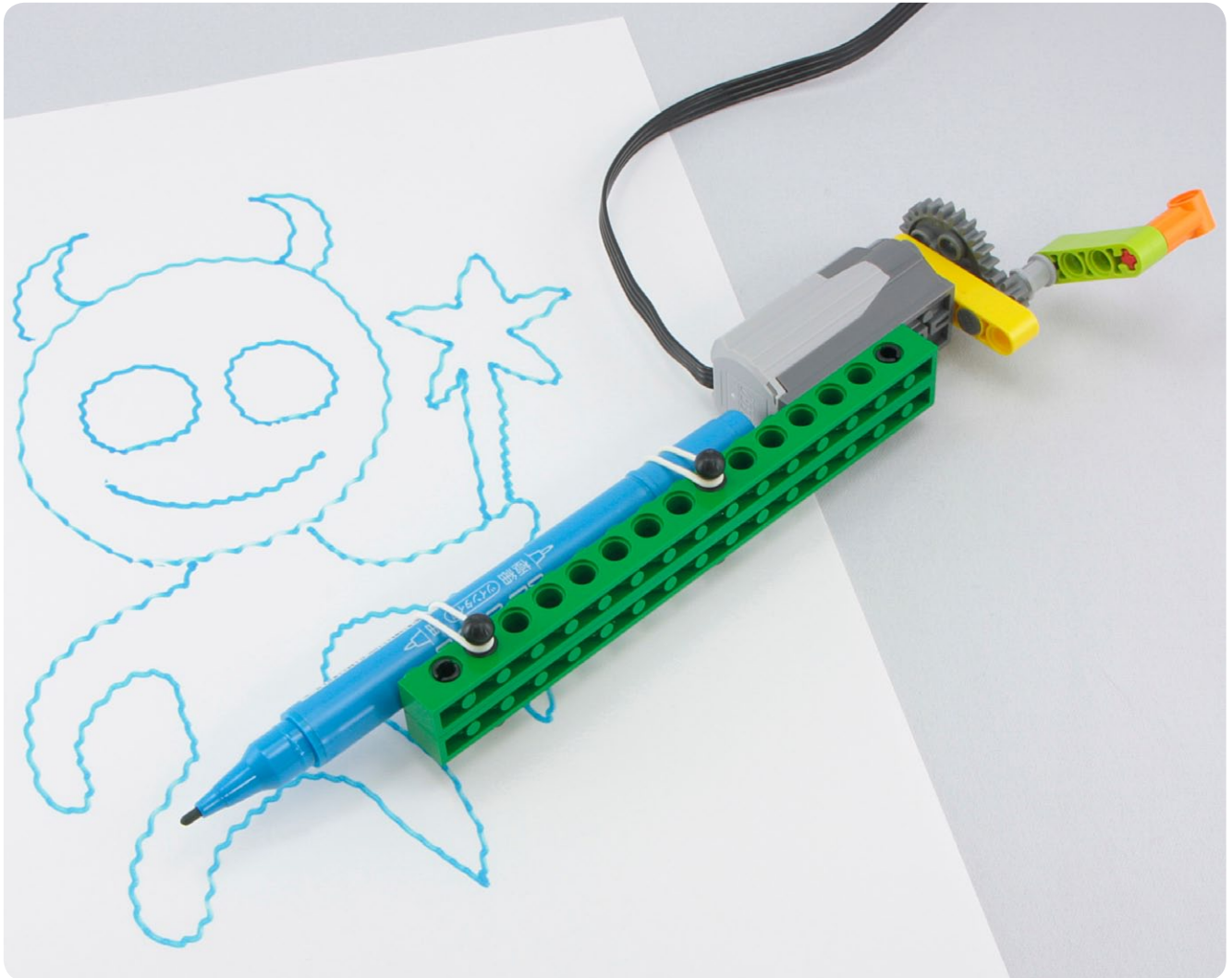
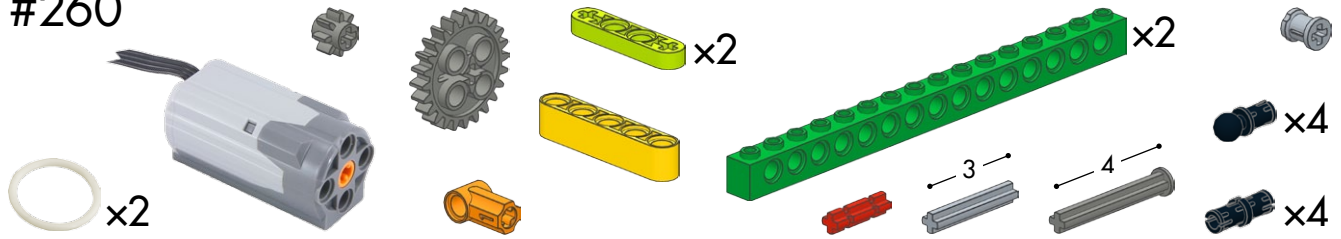


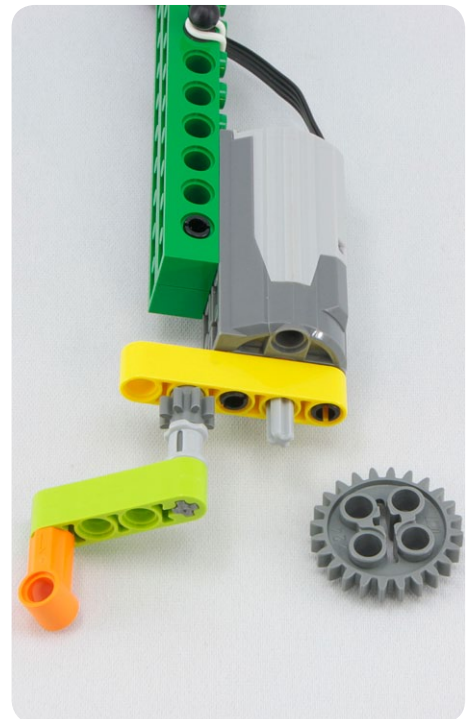
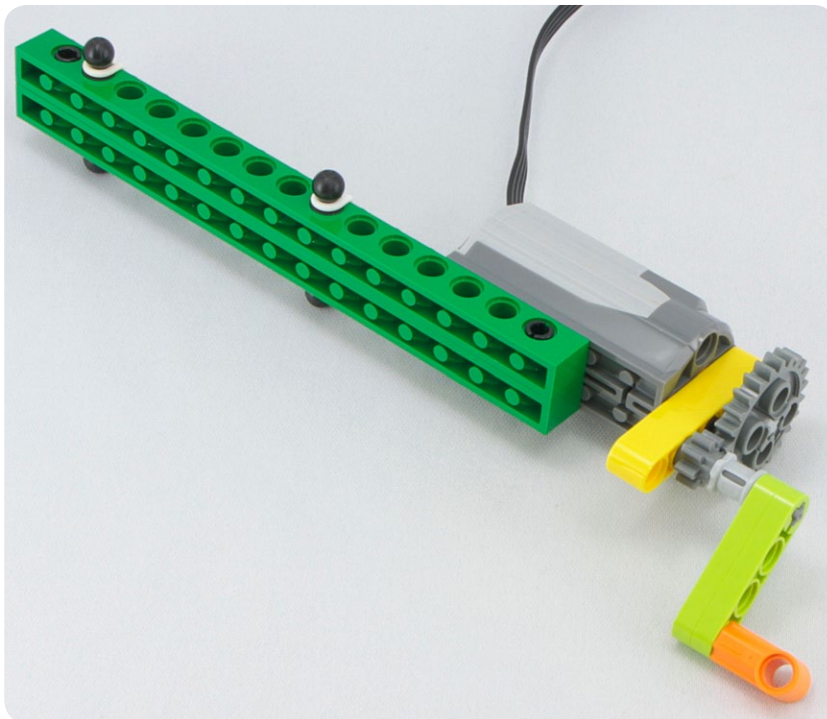
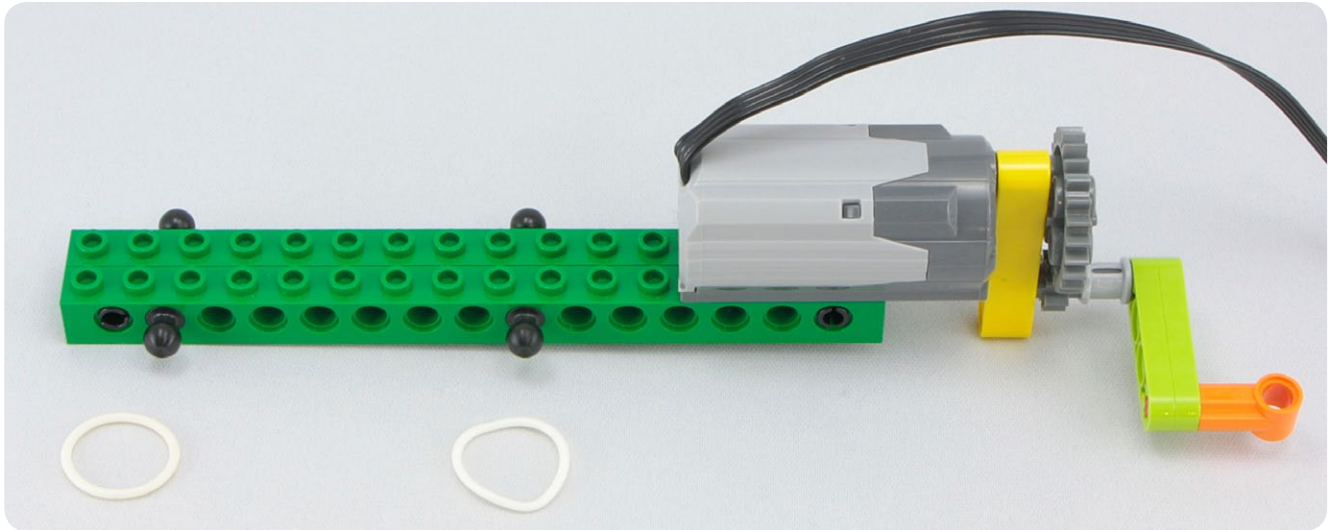
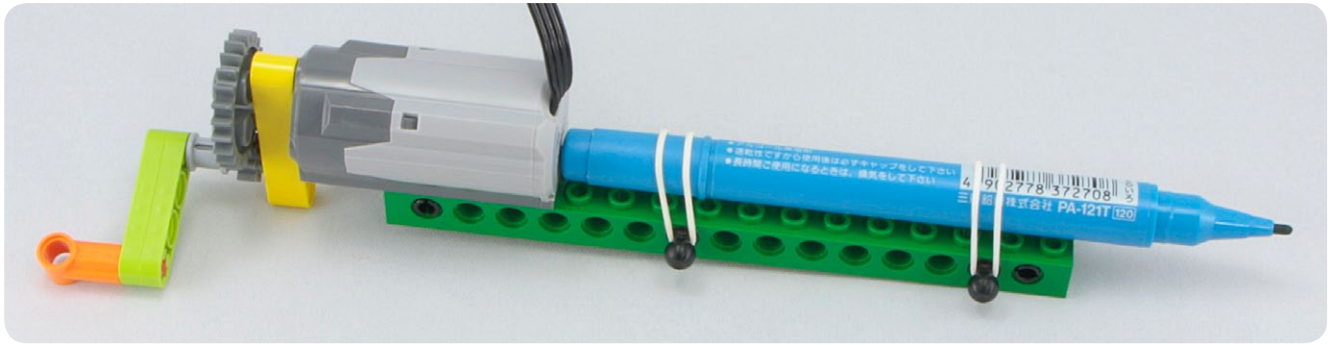


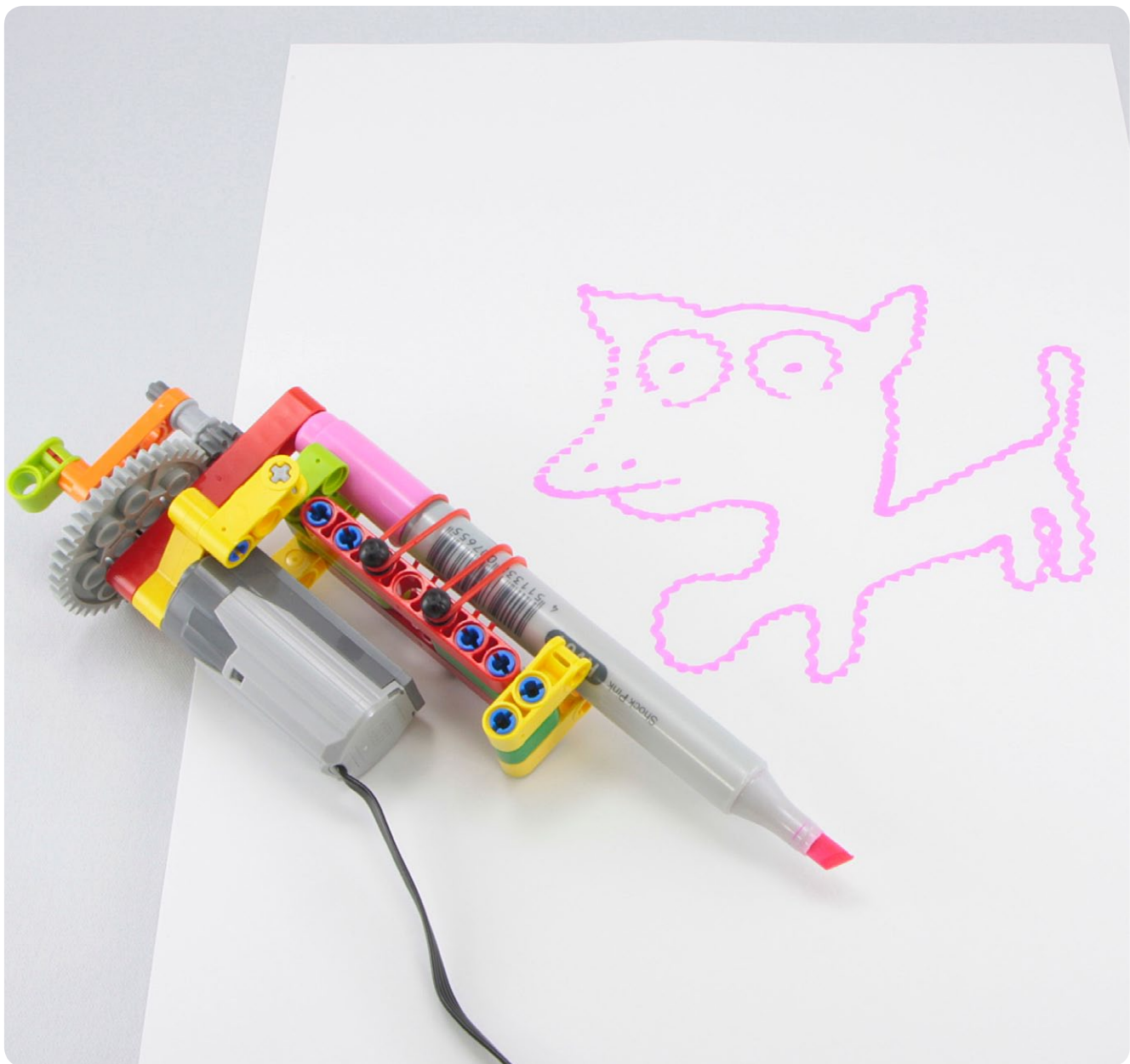


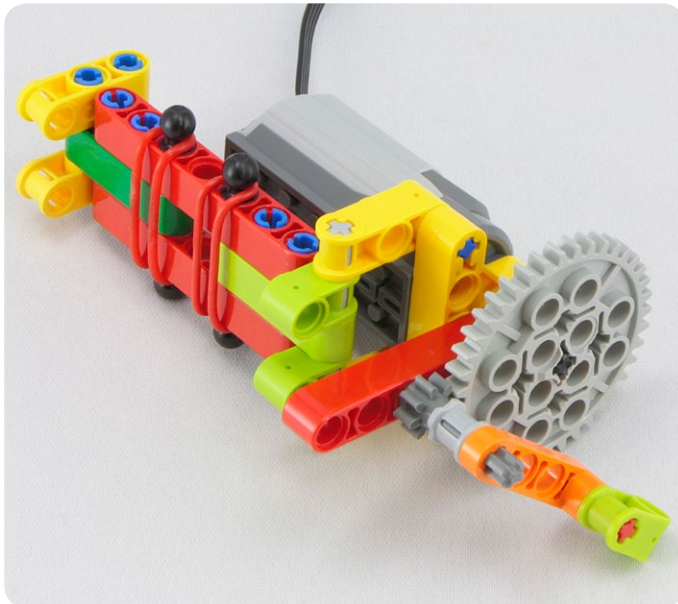
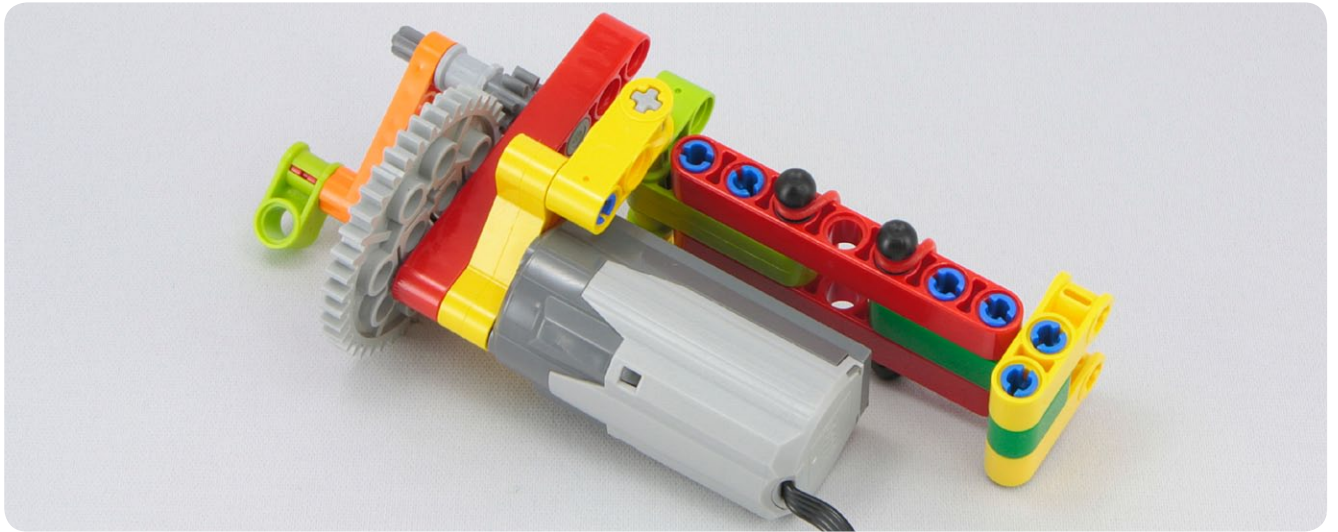
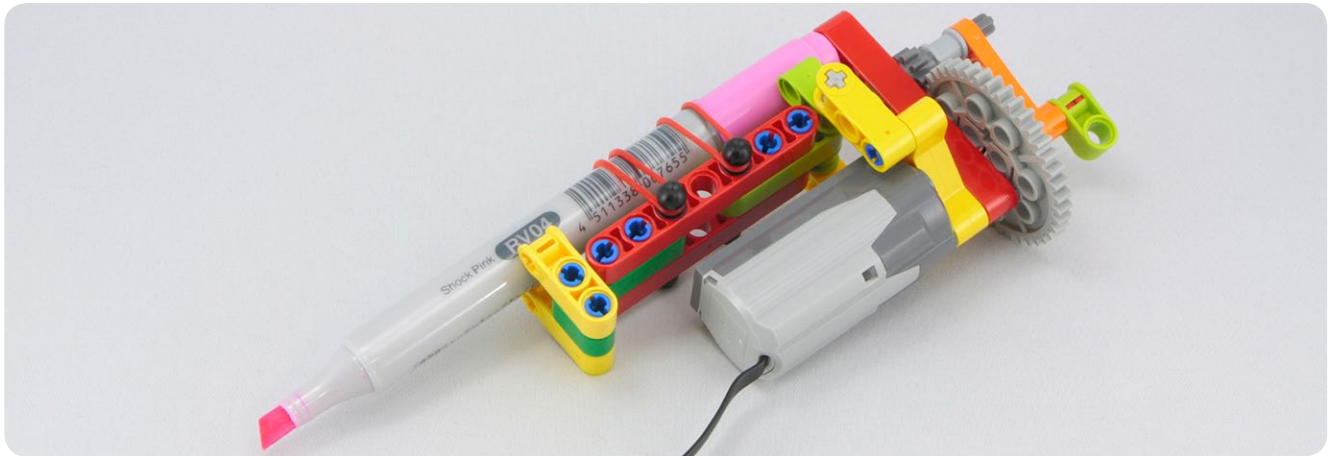
Drawing pictures

#260

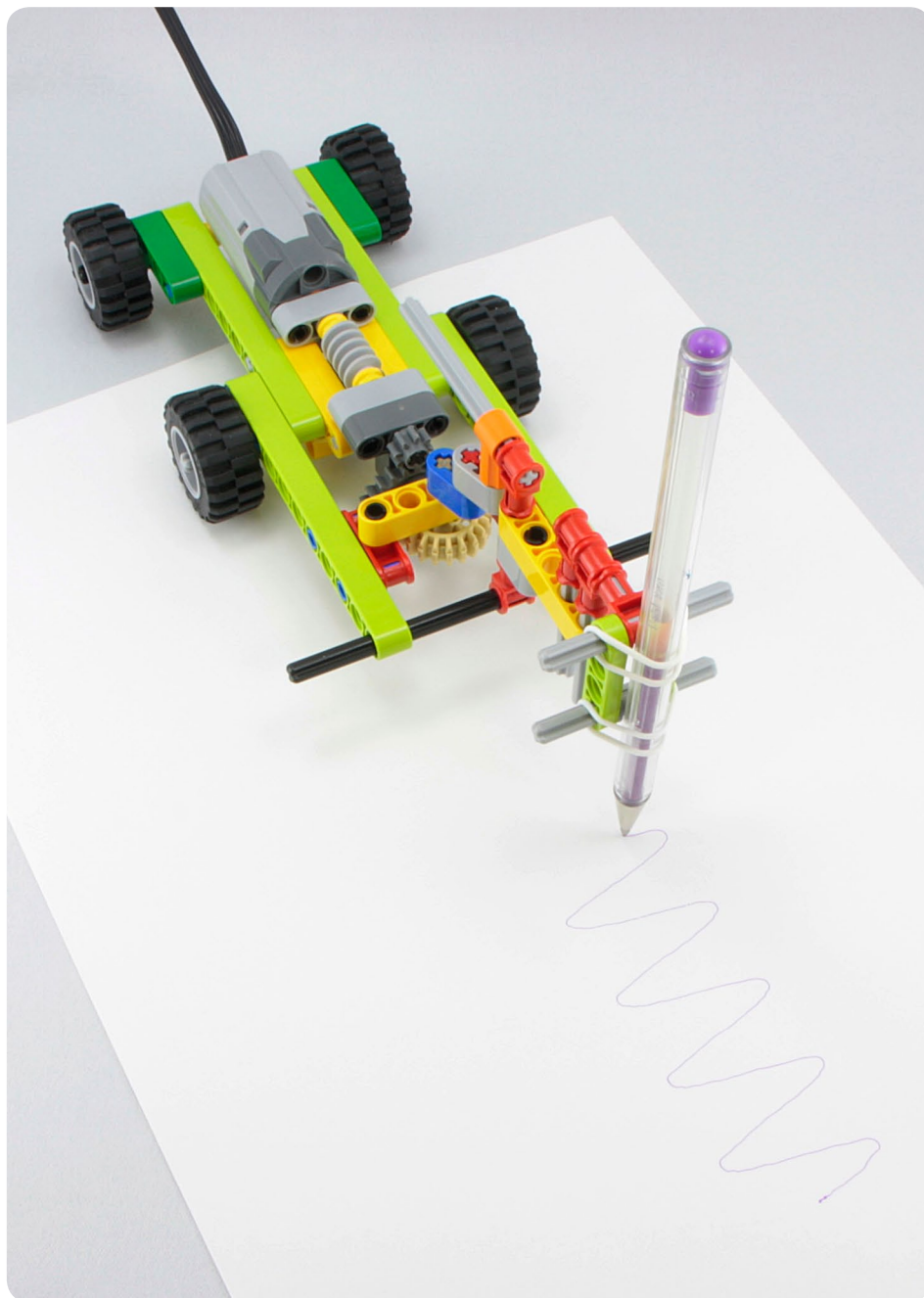
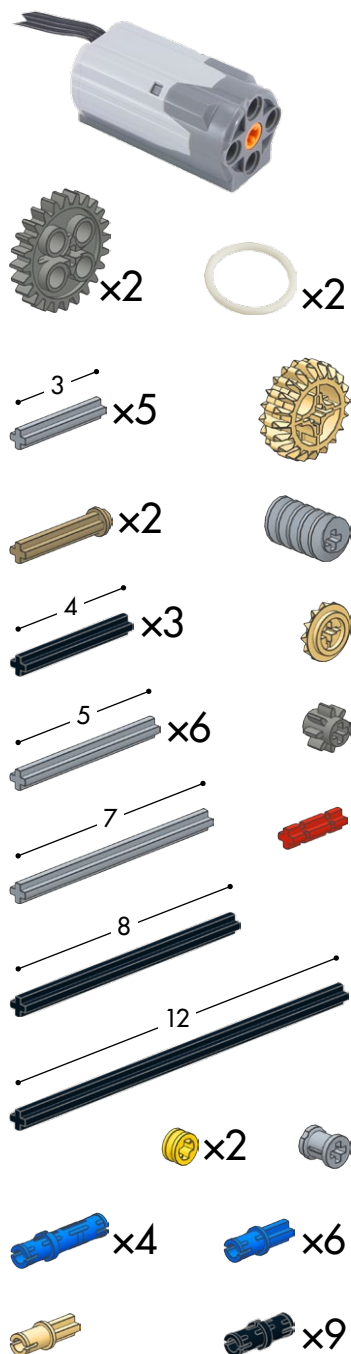
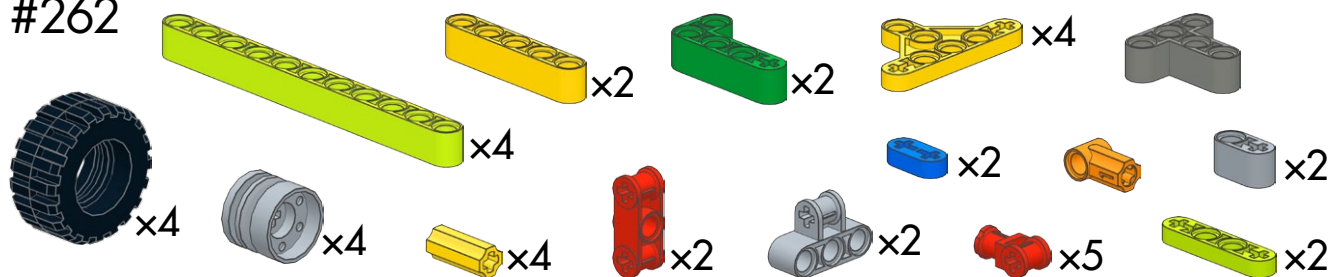


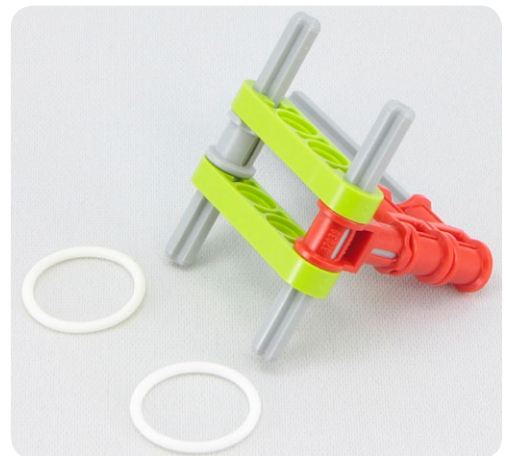
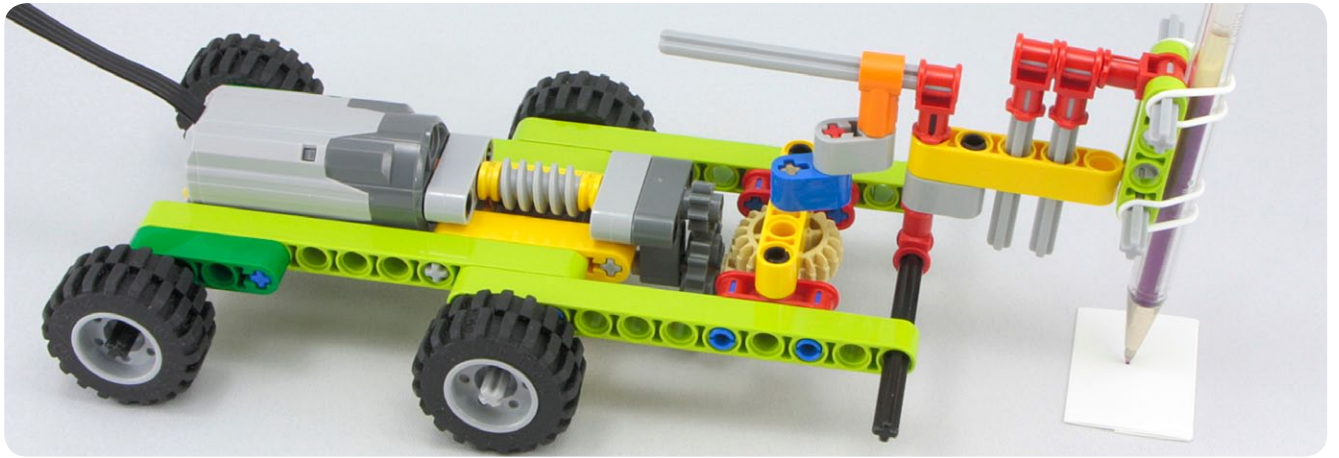


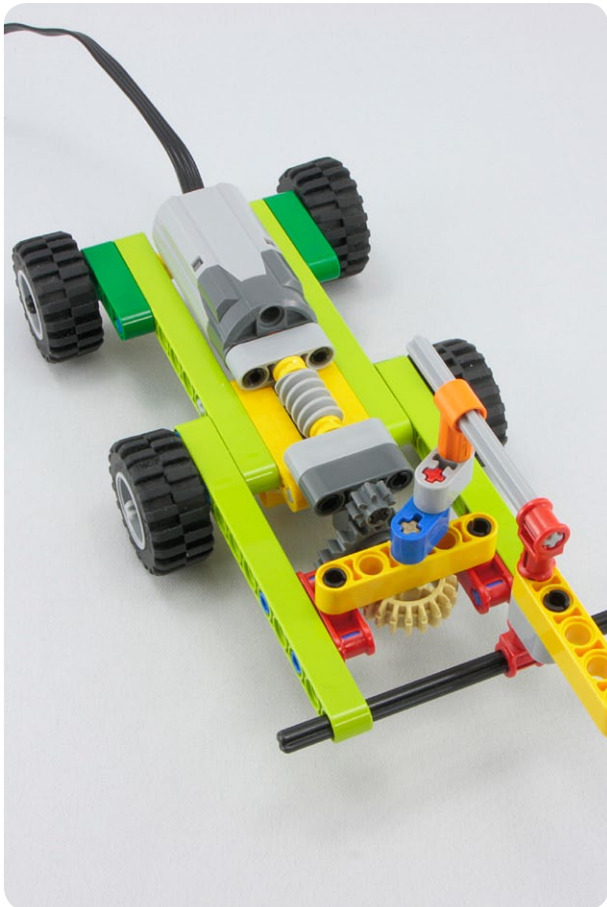
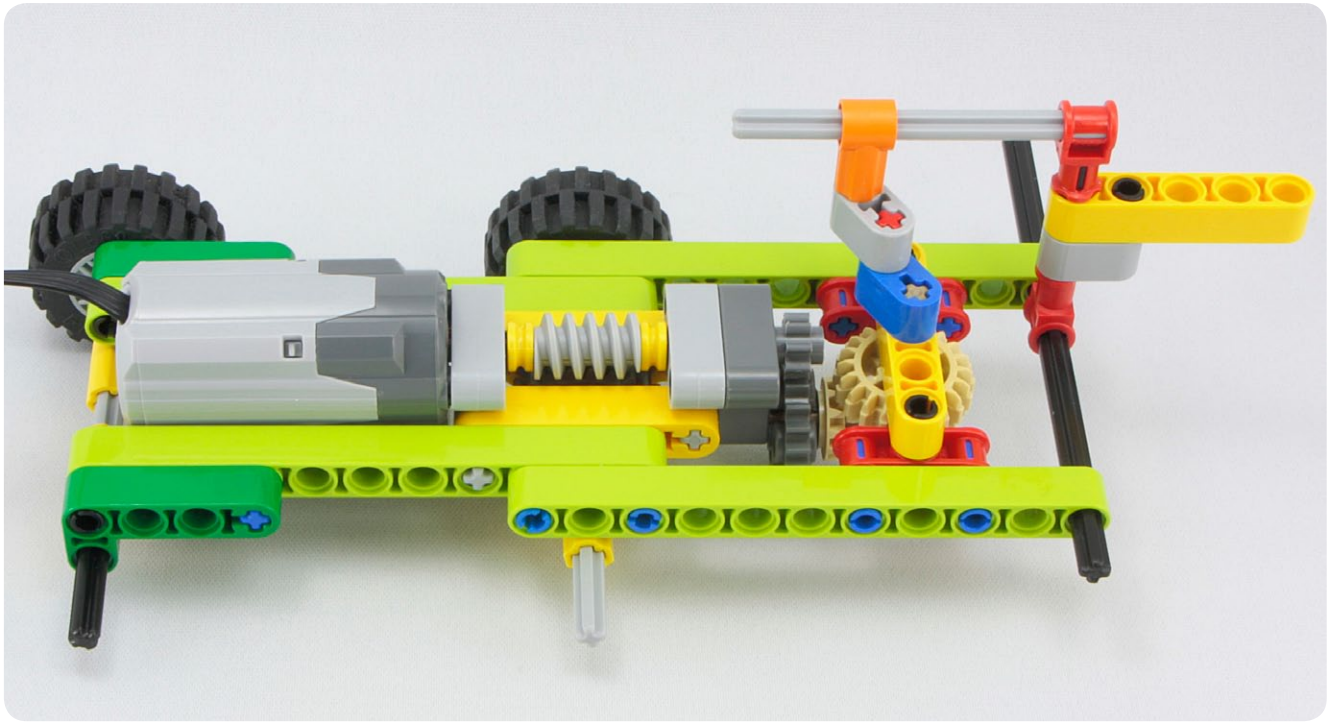
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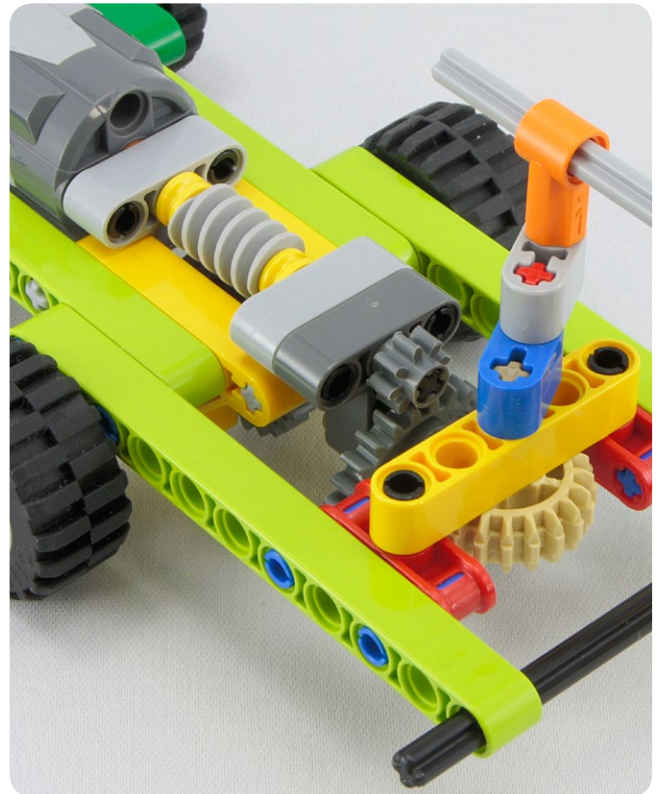


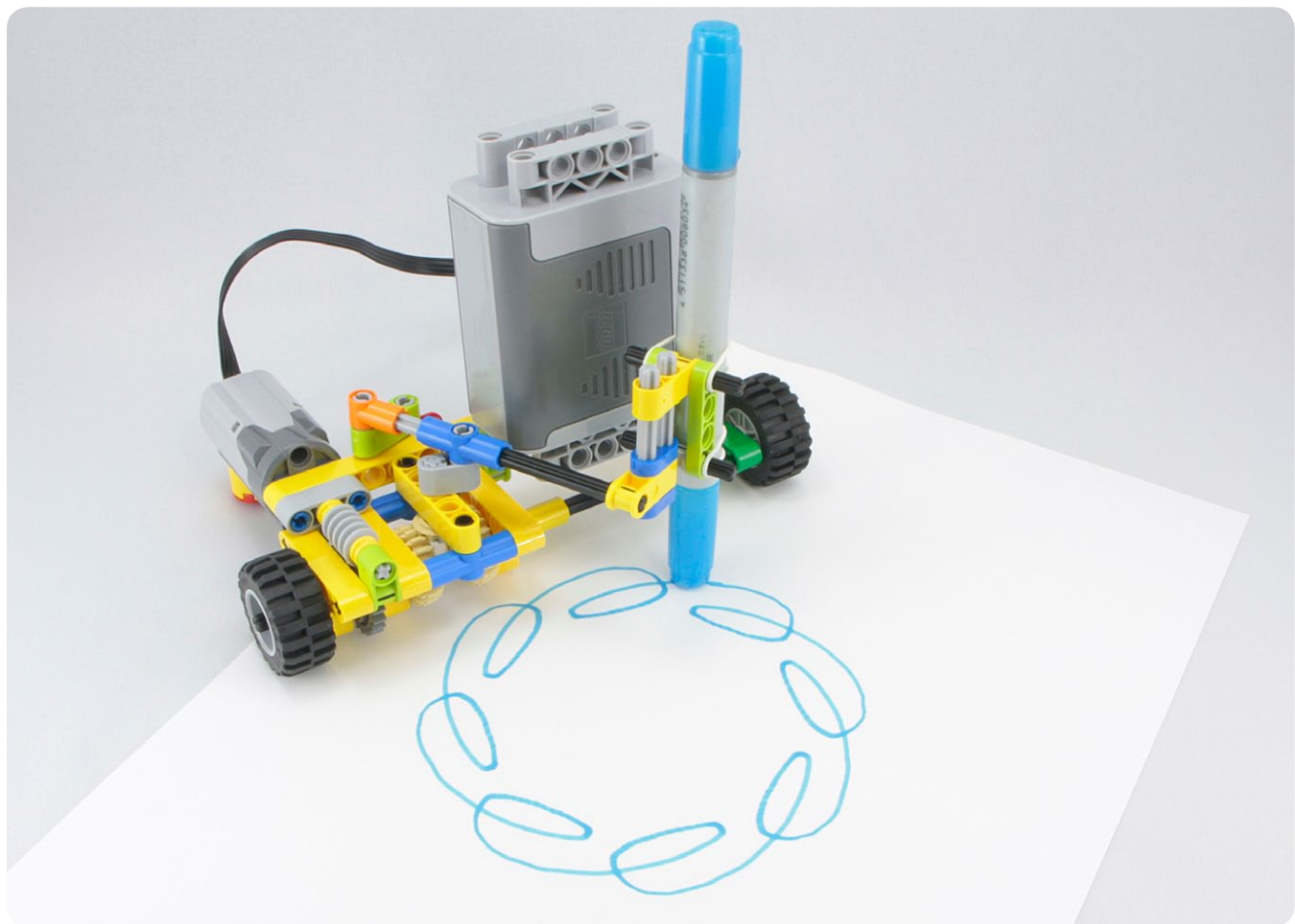
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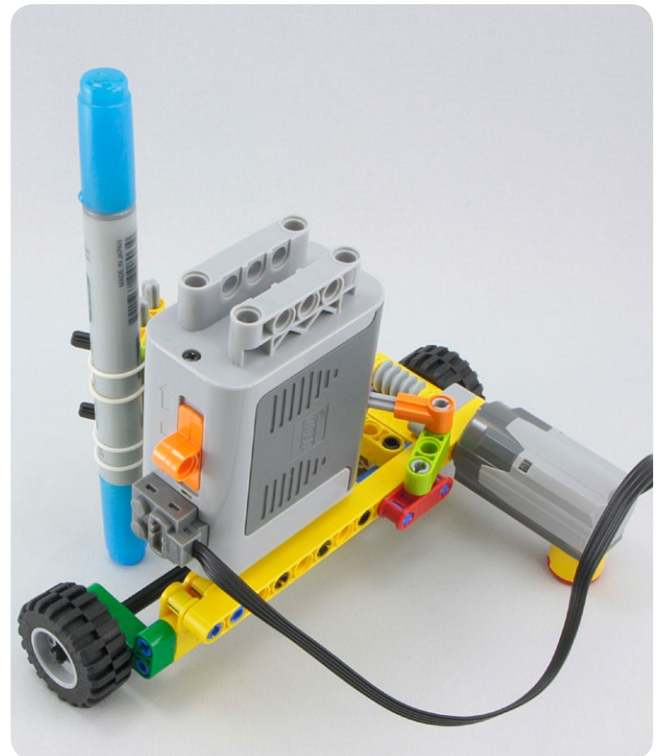
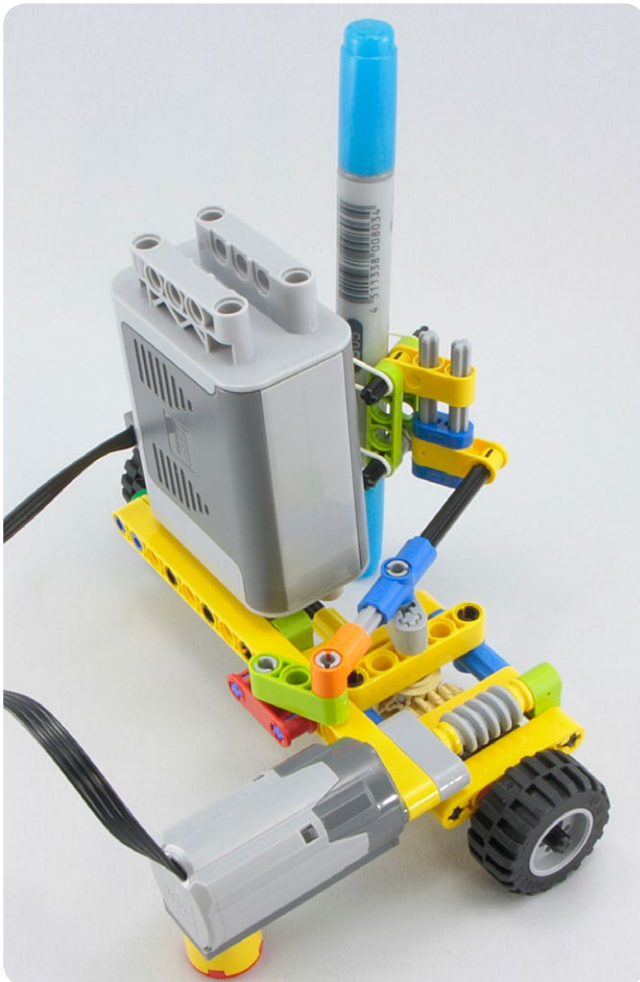
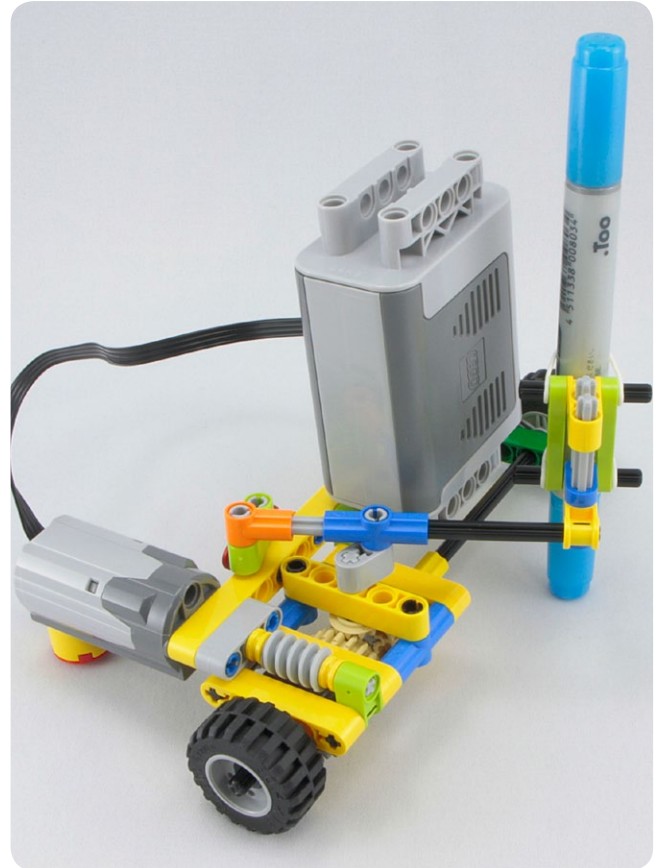


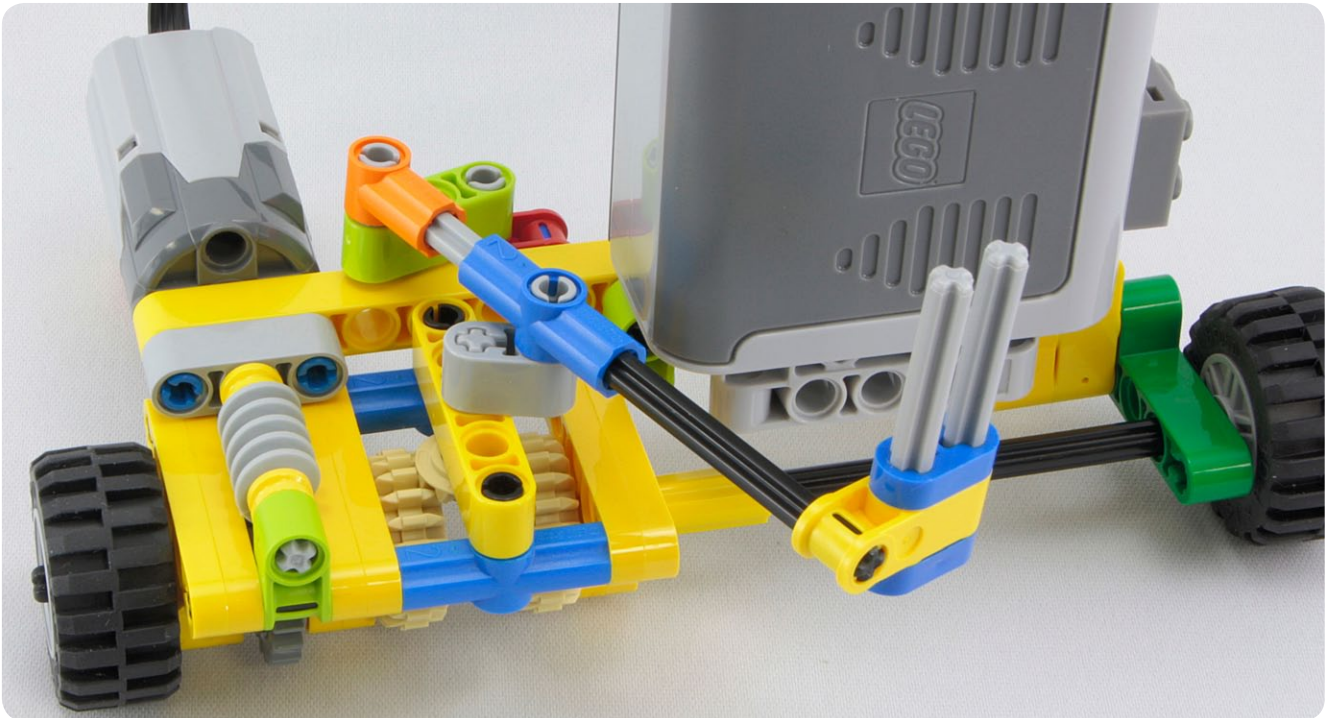
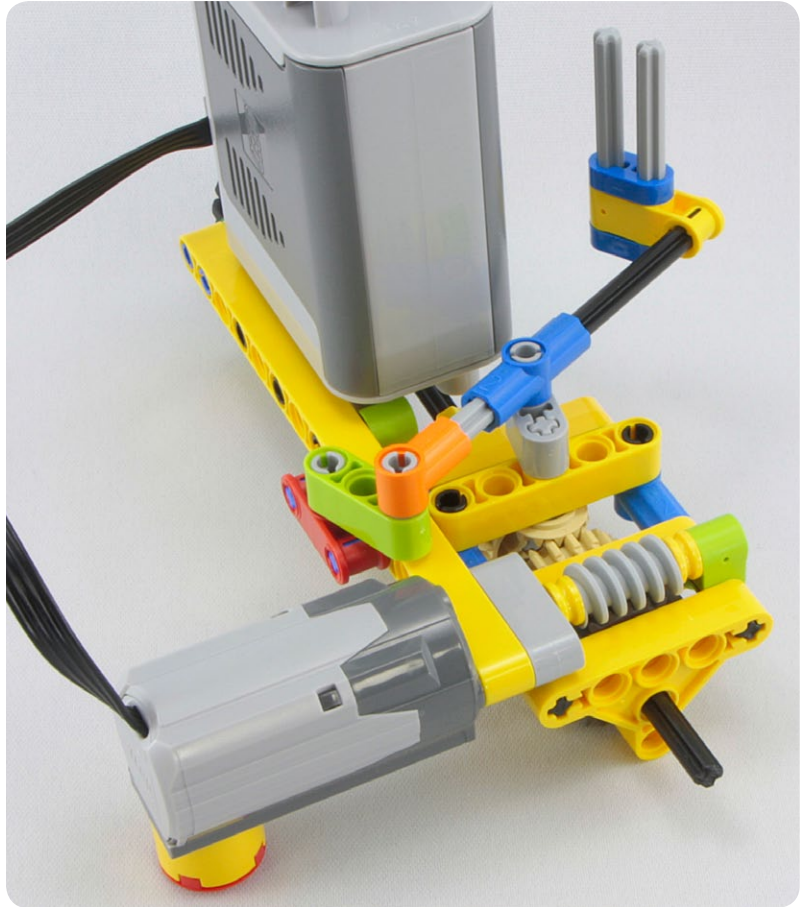


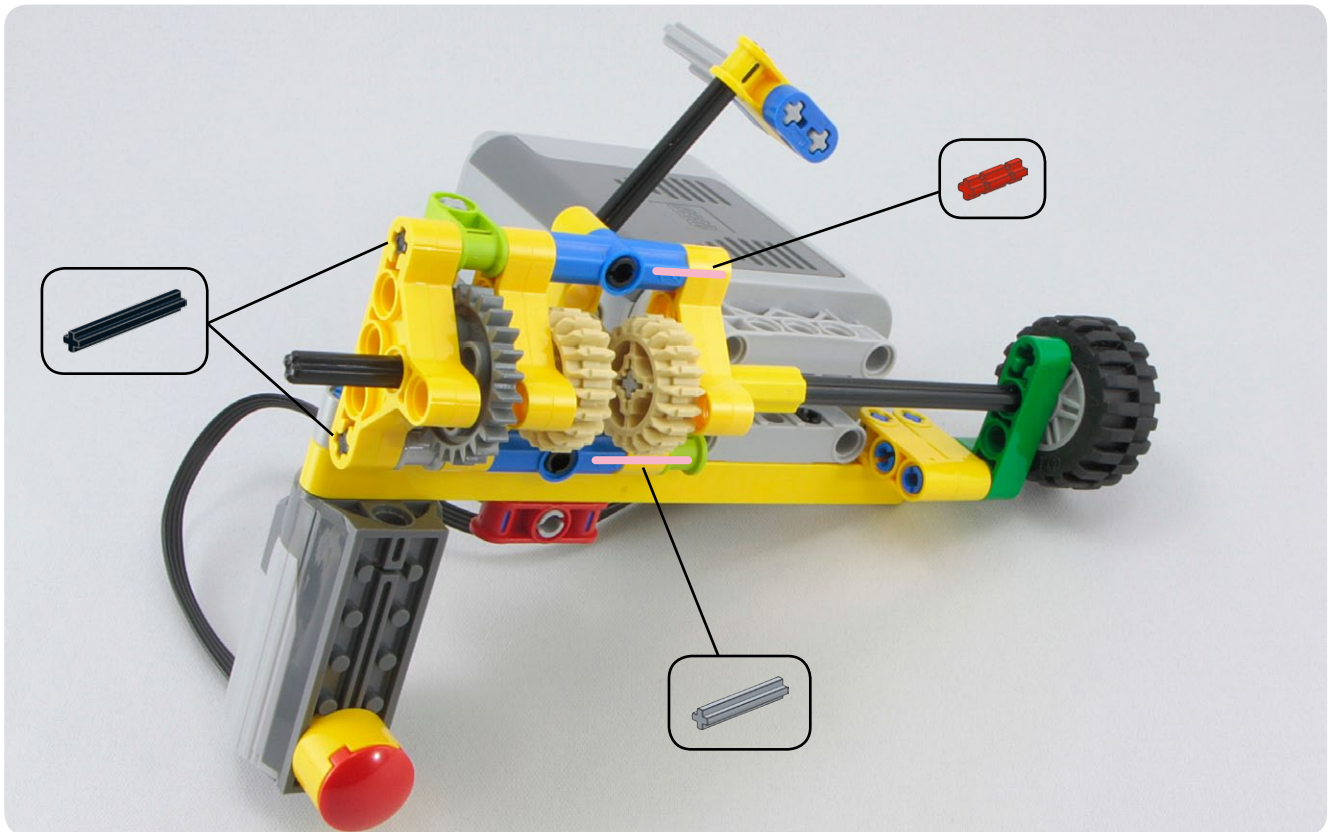
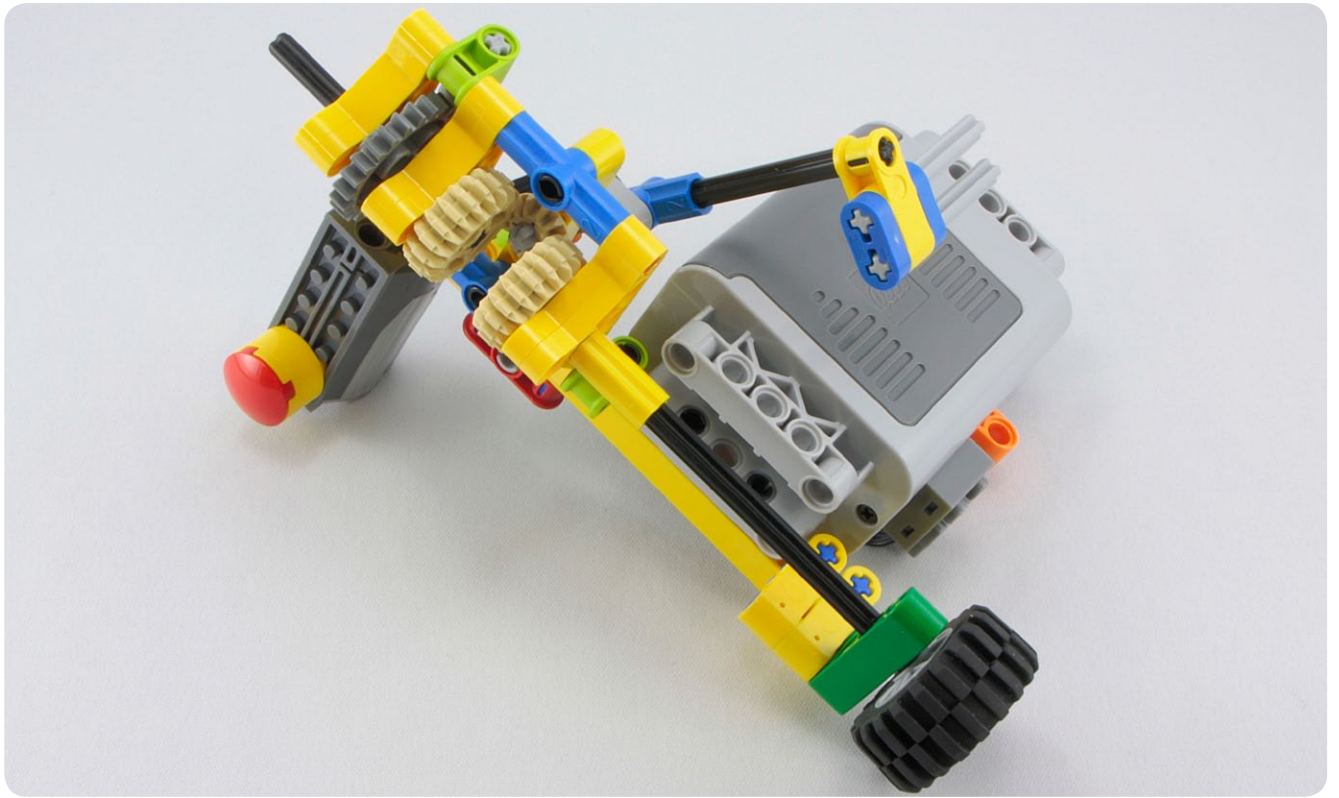




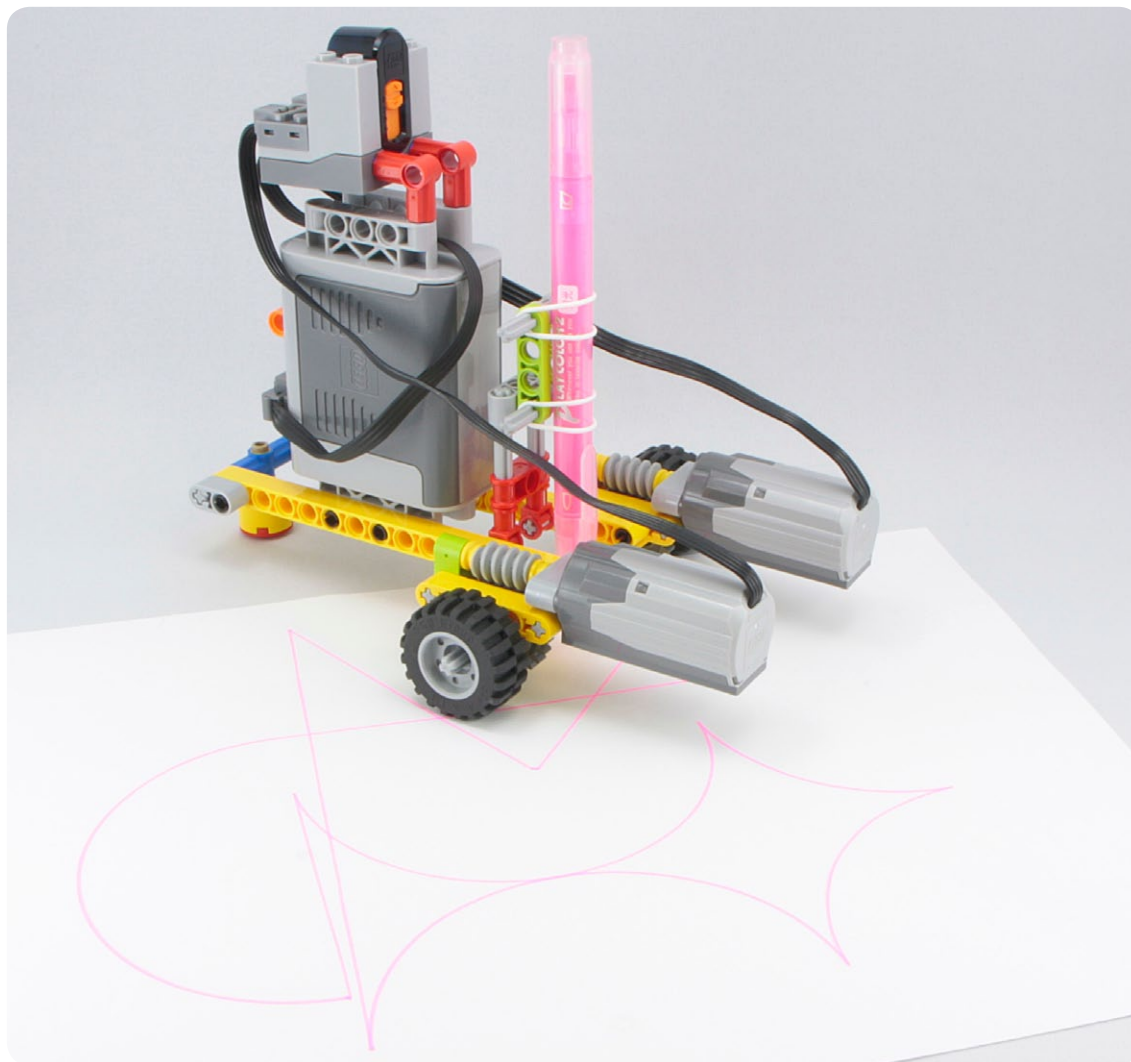
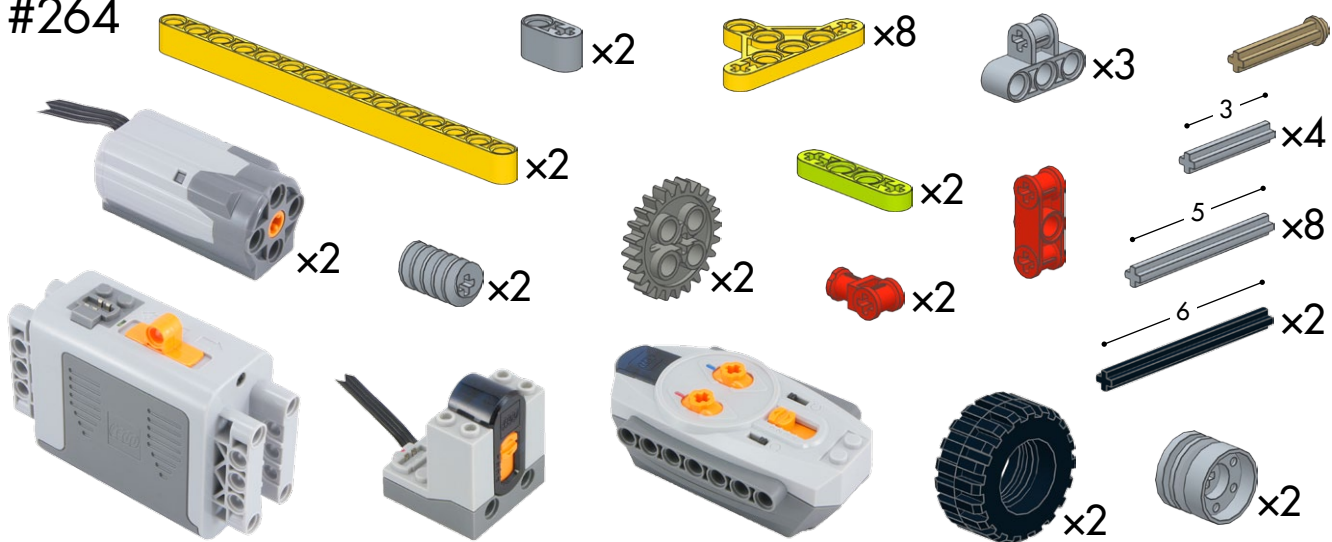
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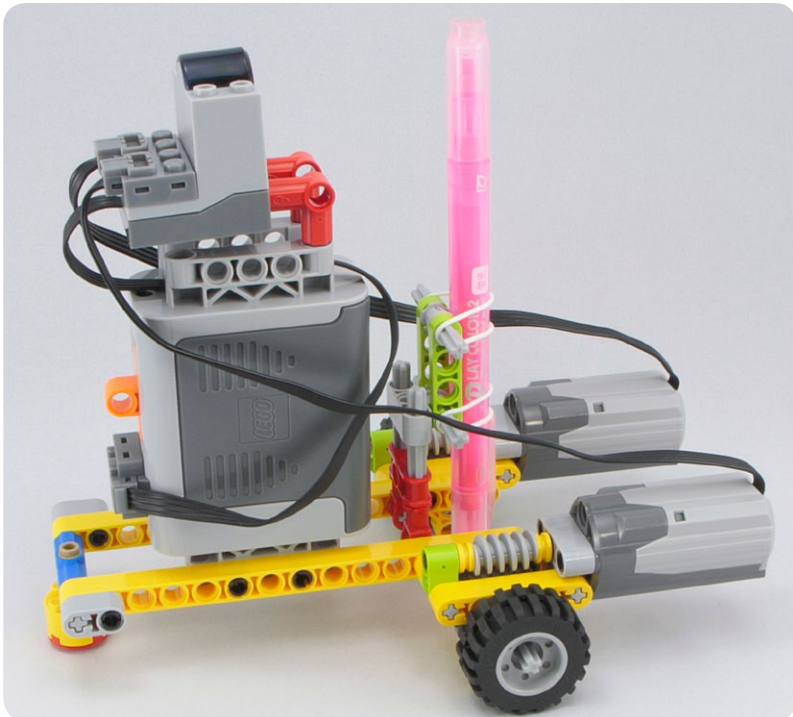
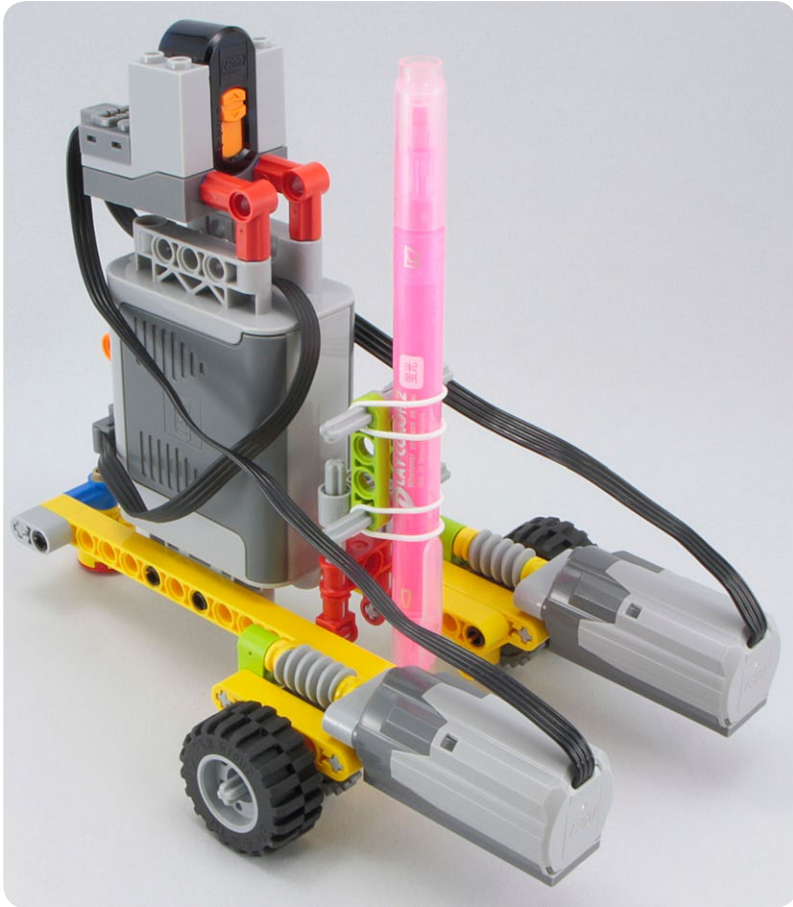


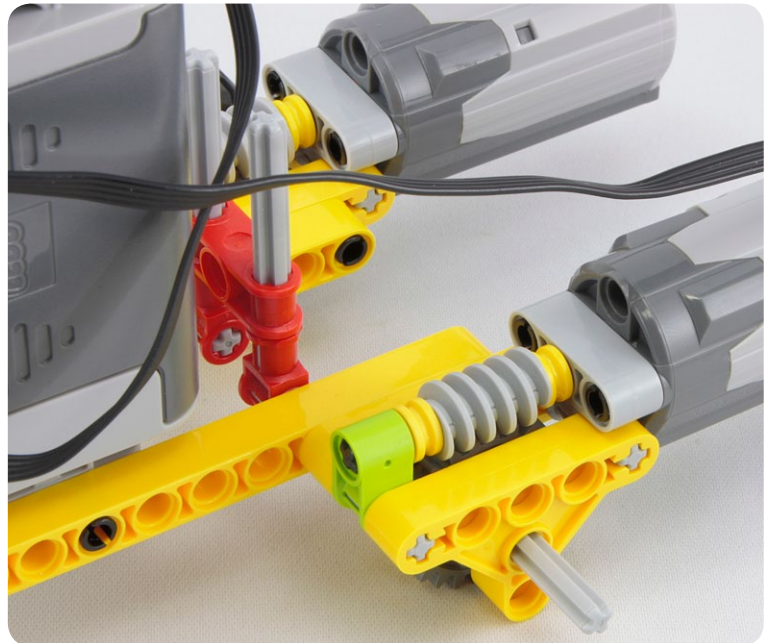
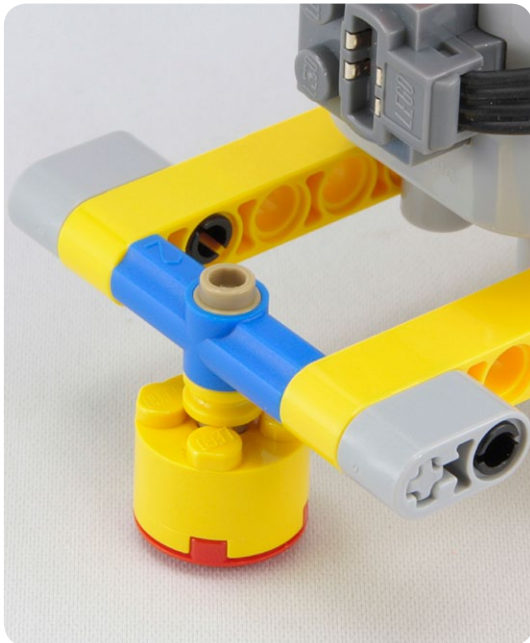
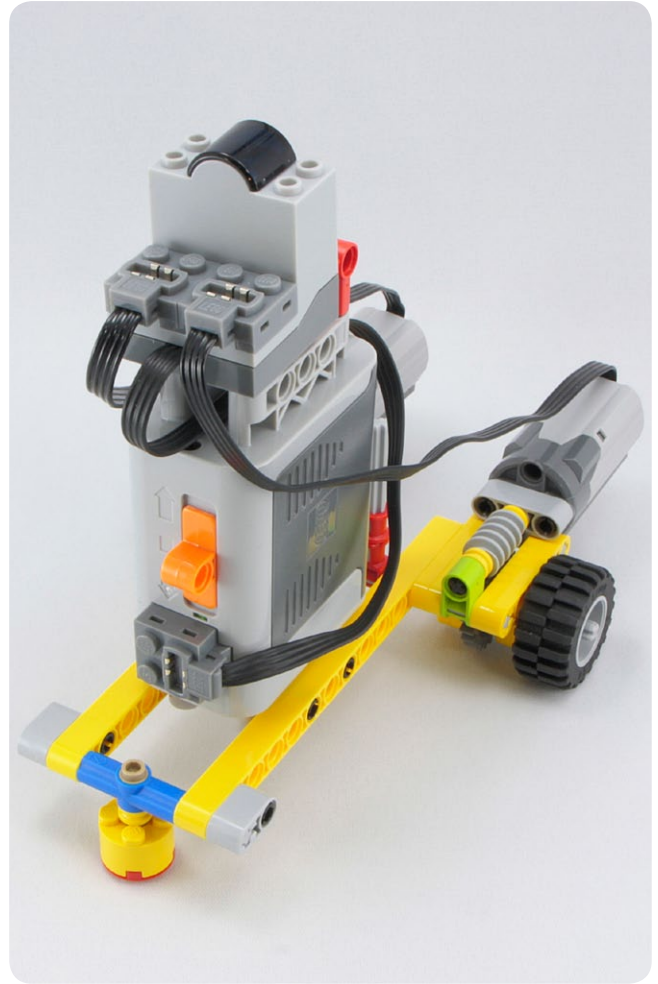
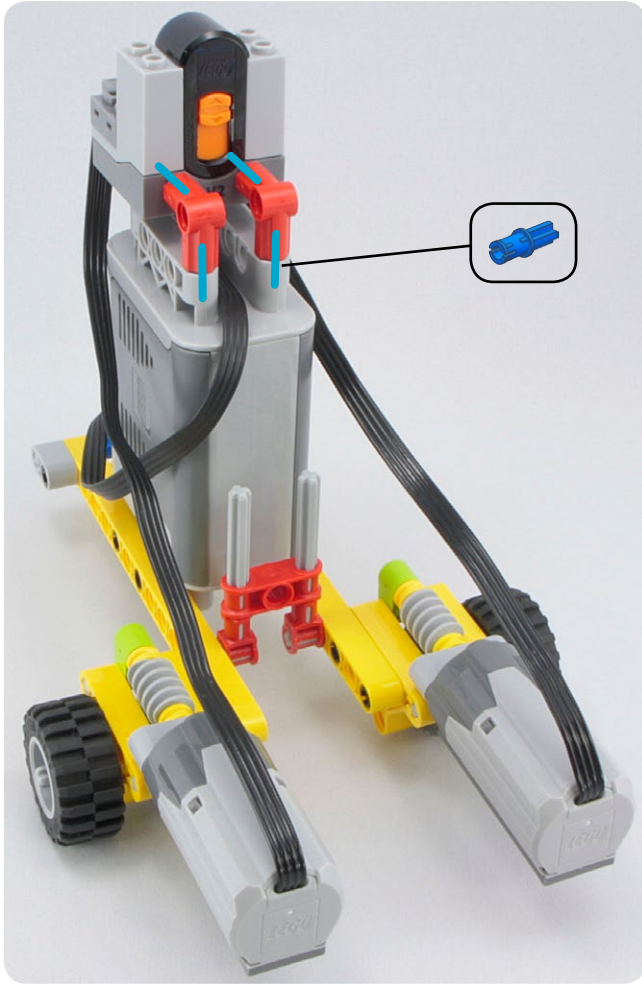


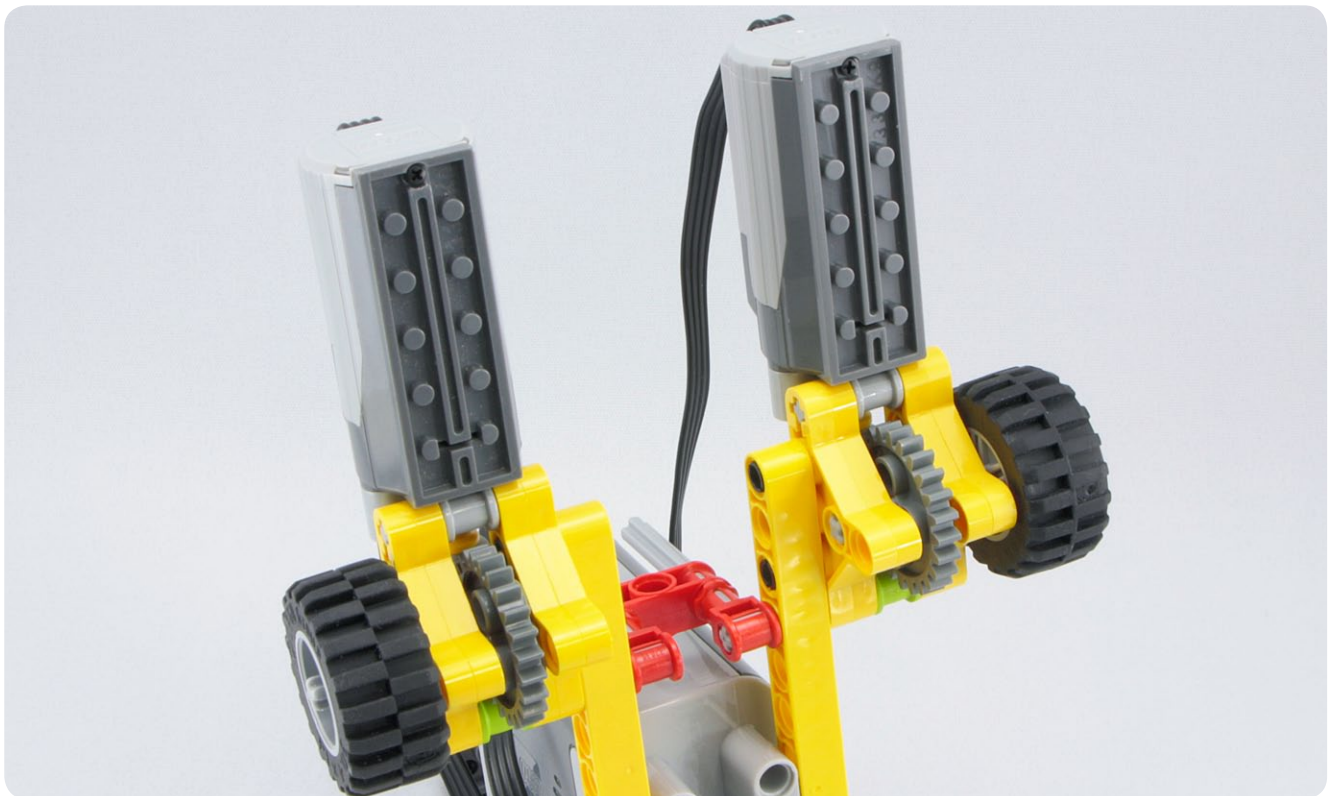
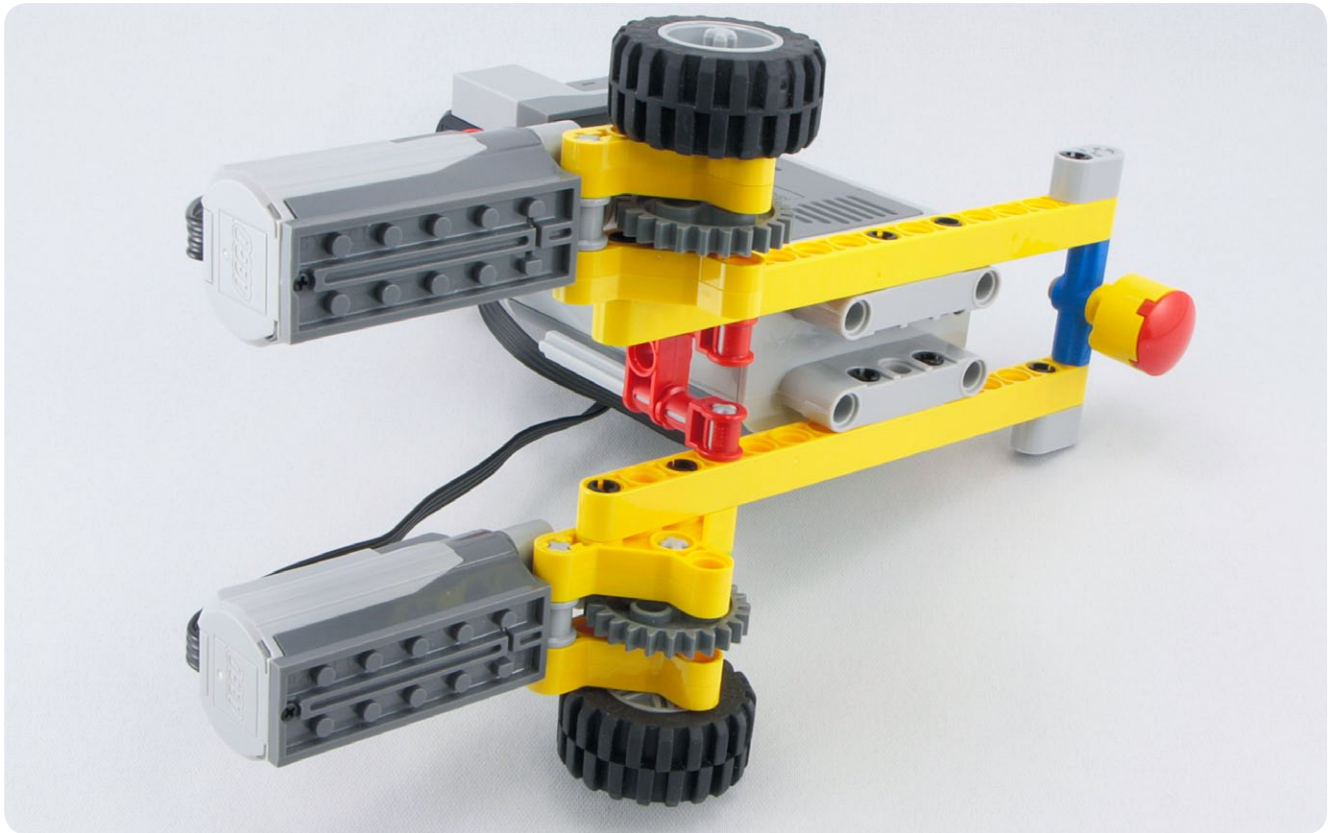


#264

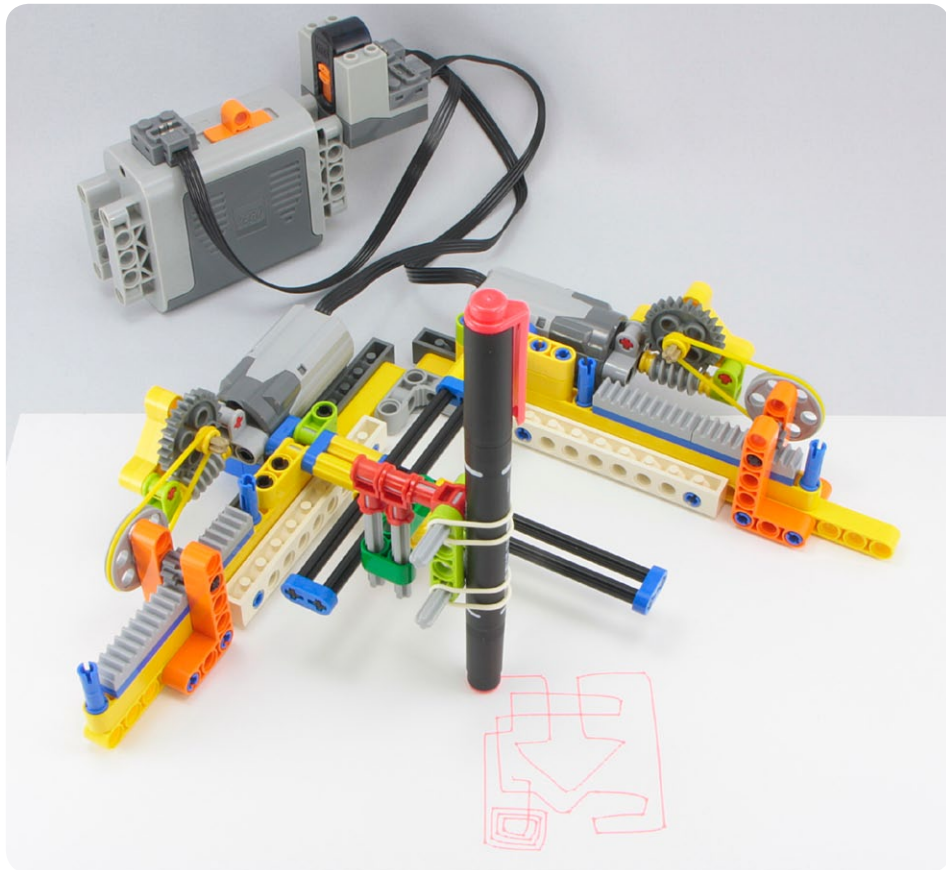
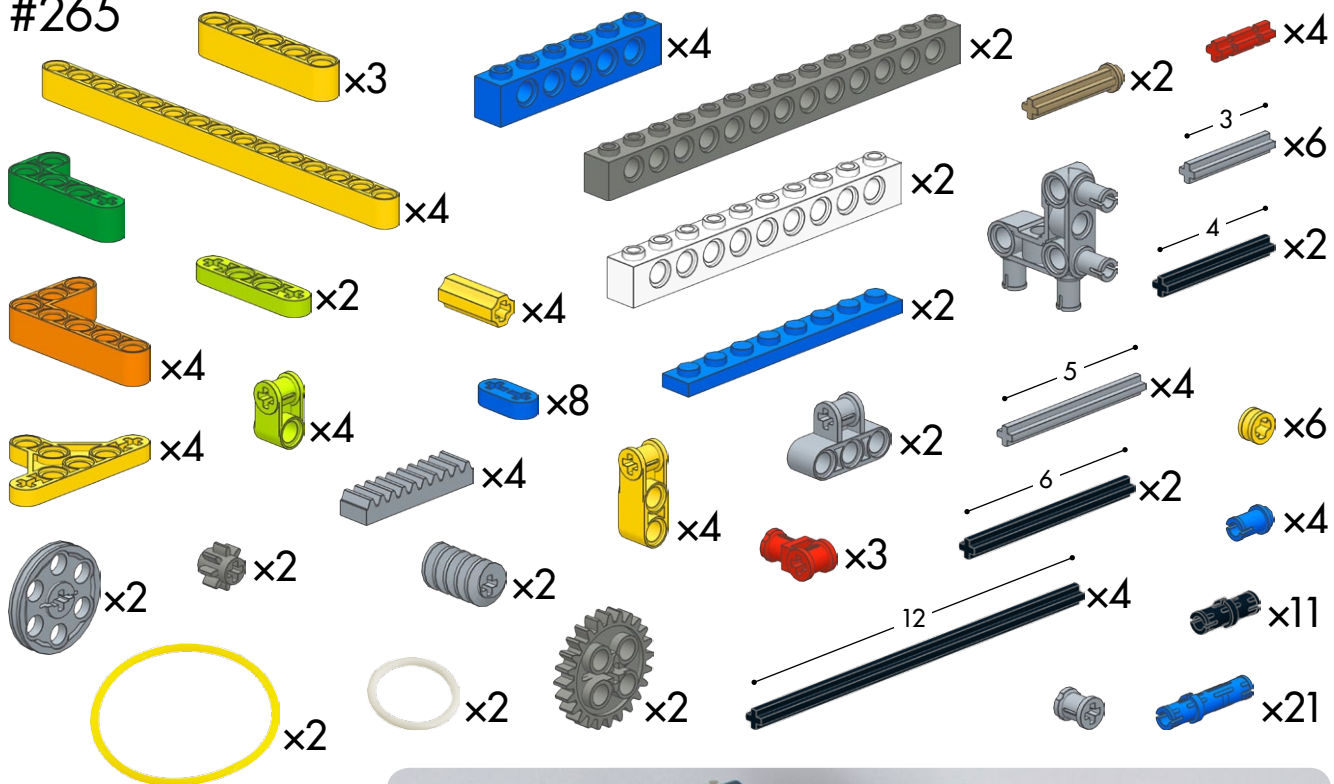


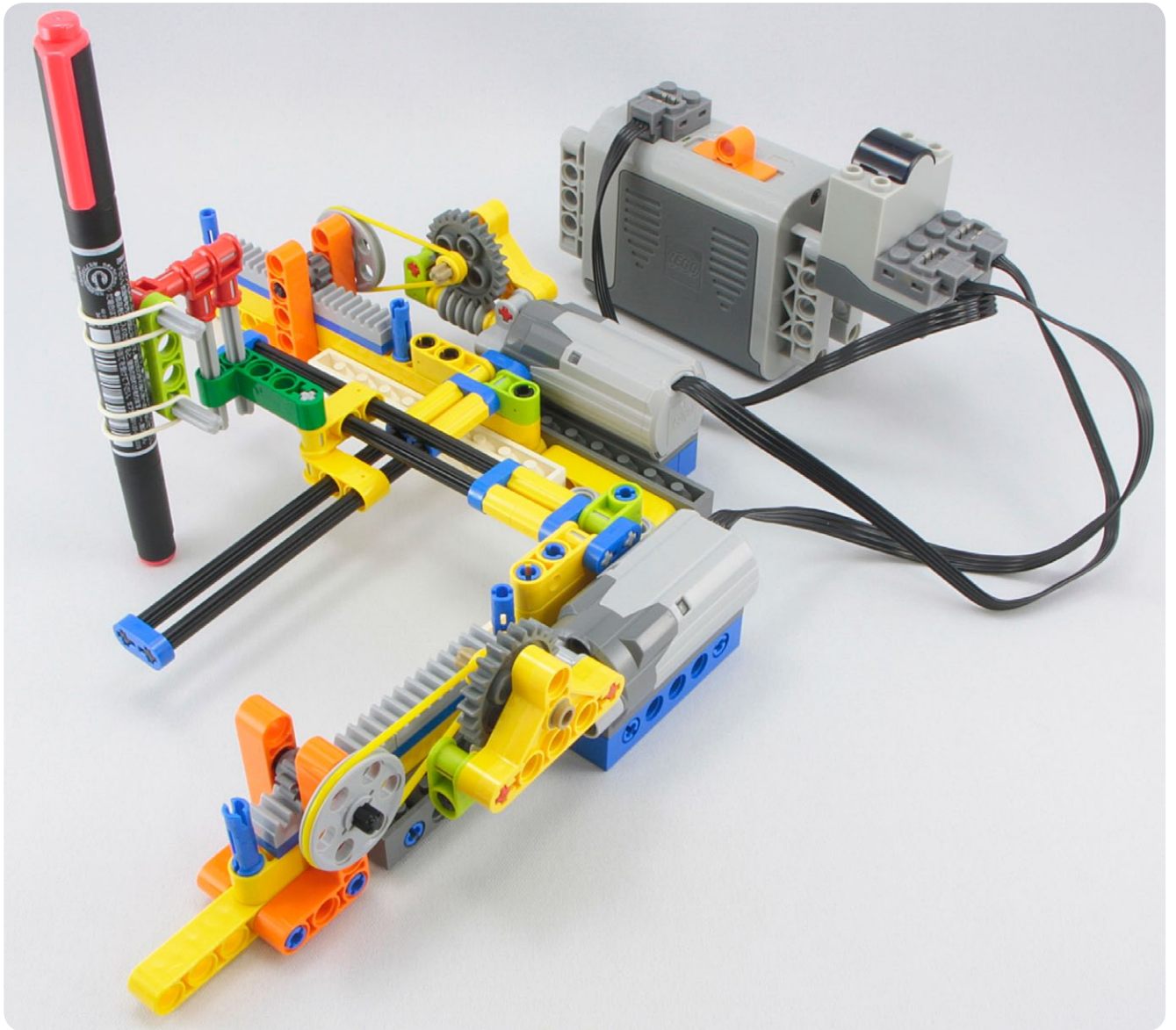


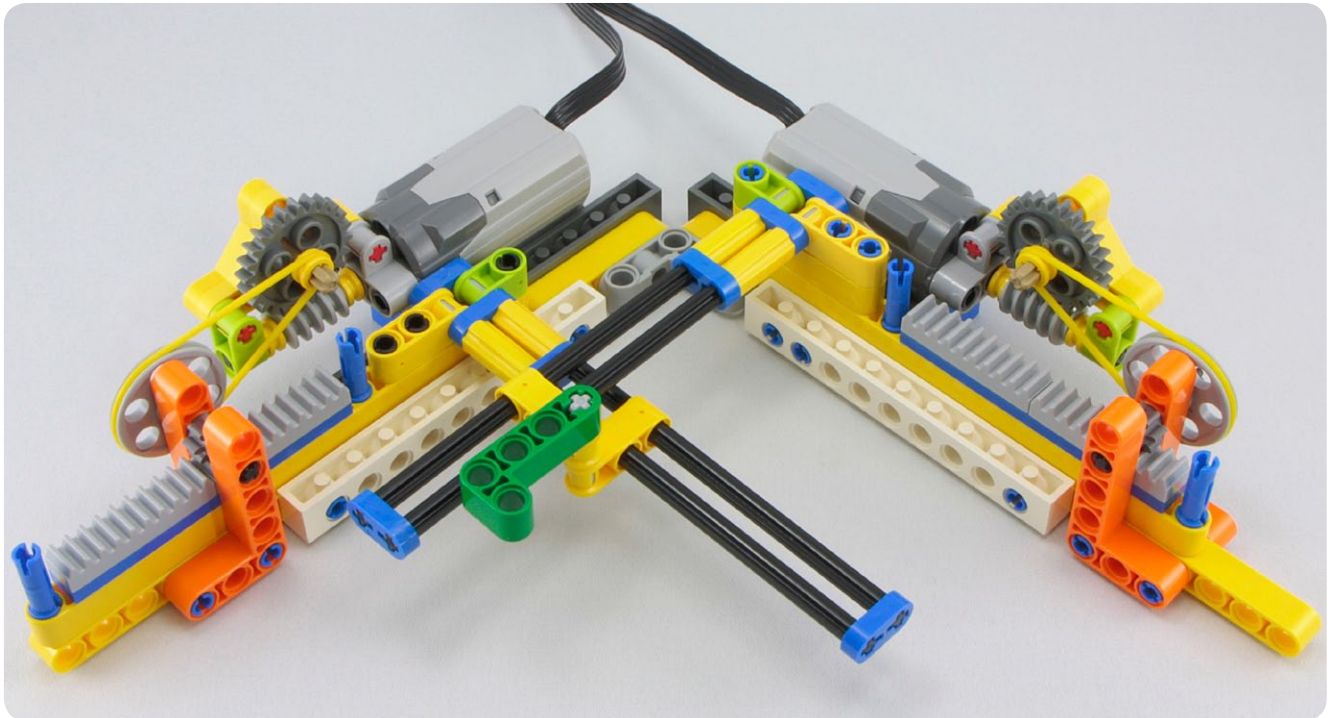
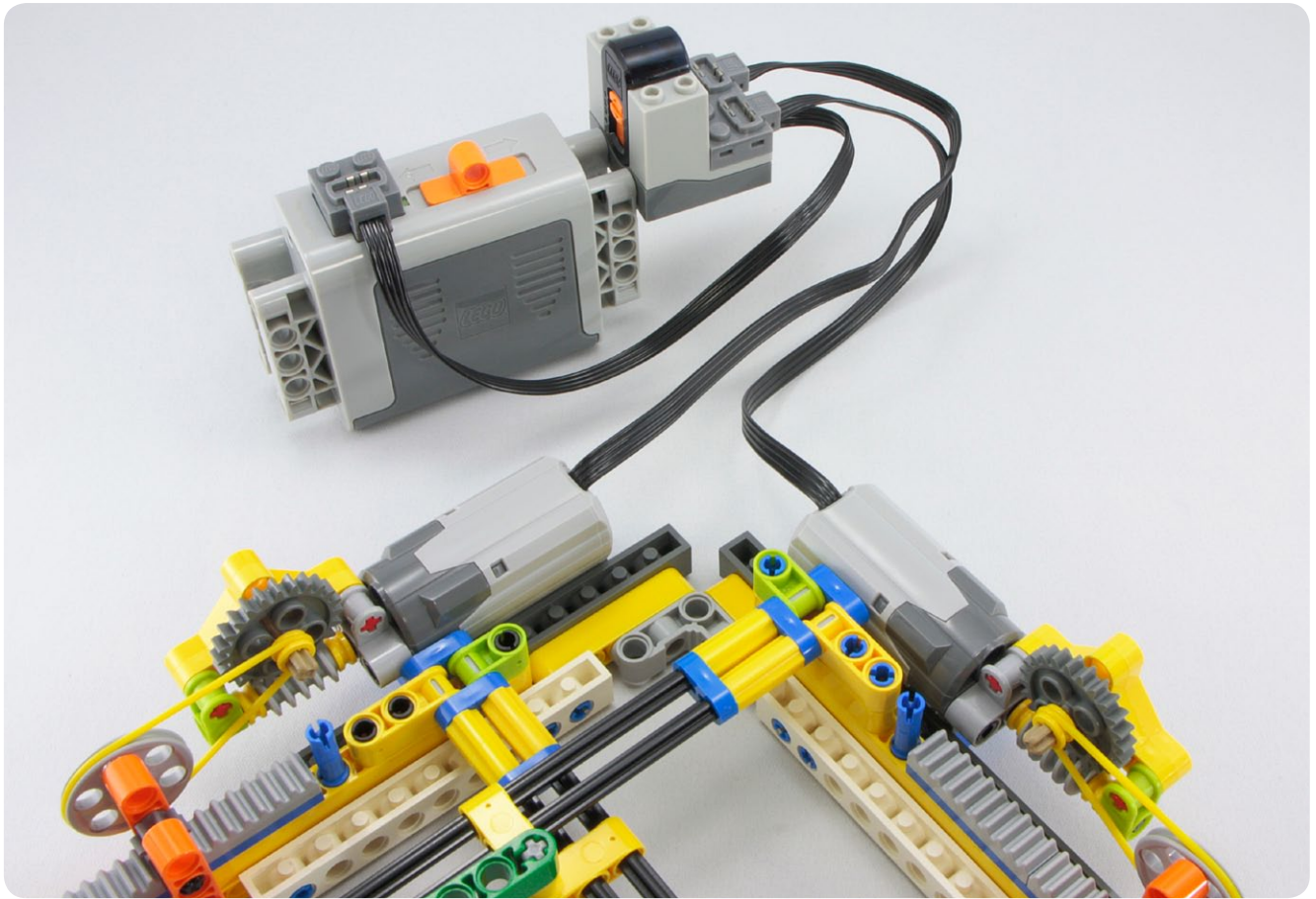


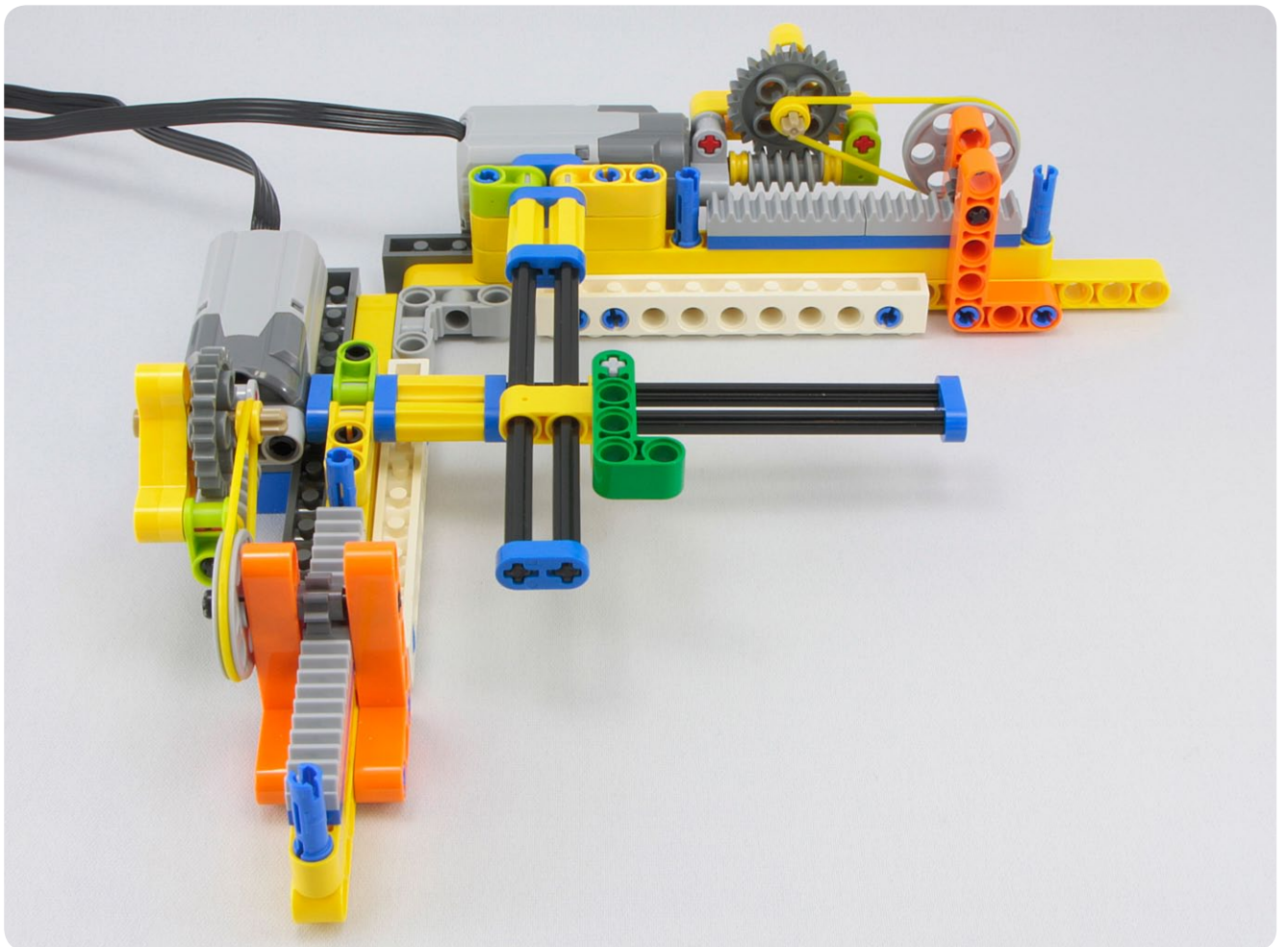
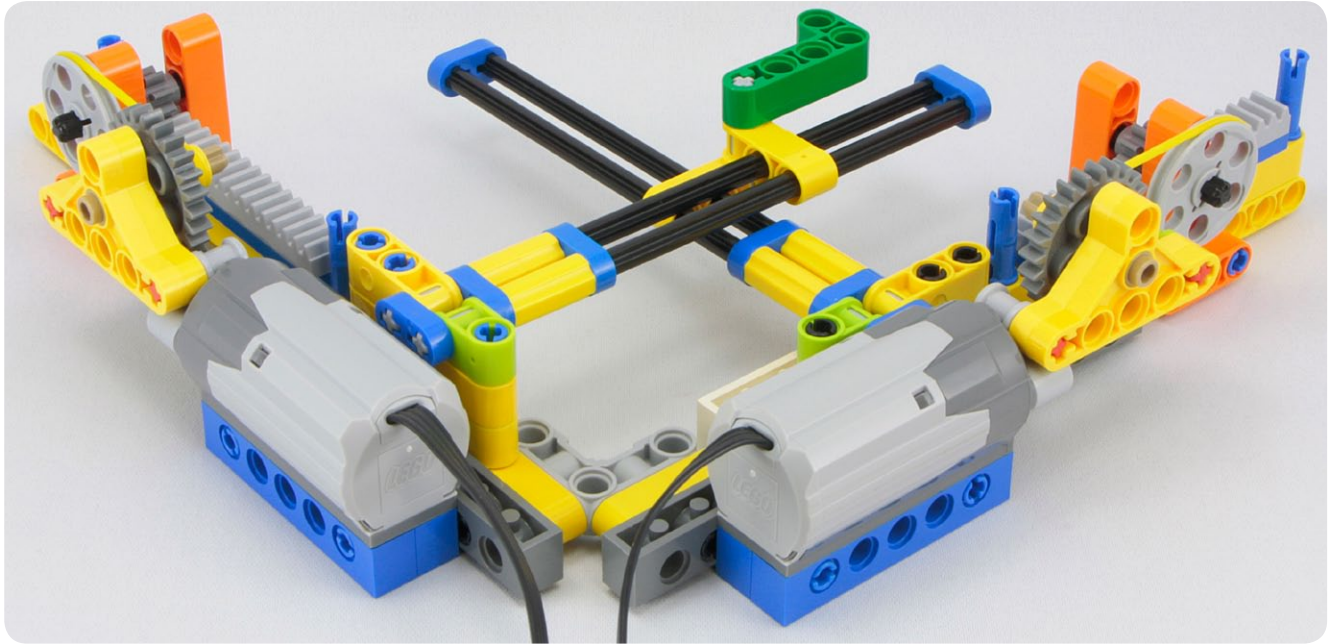


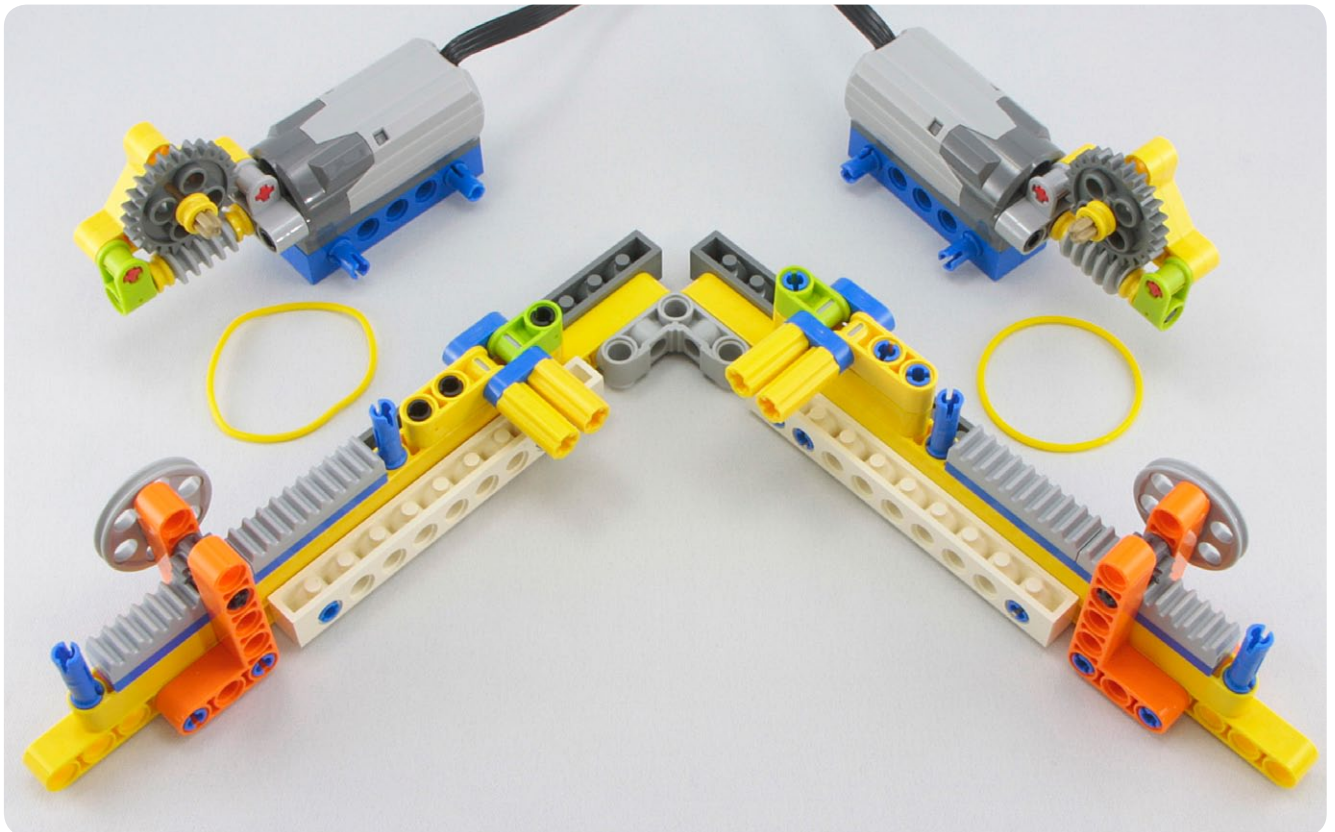
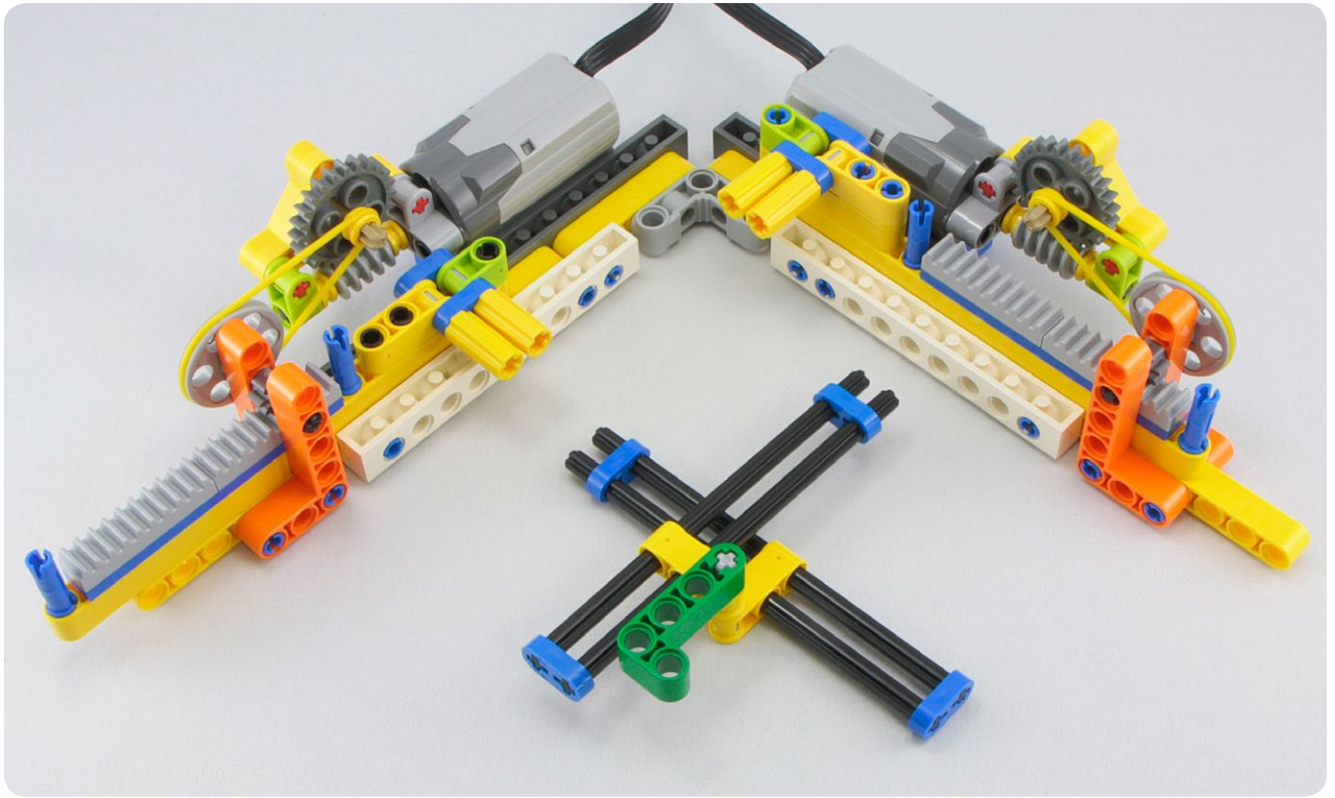
#265

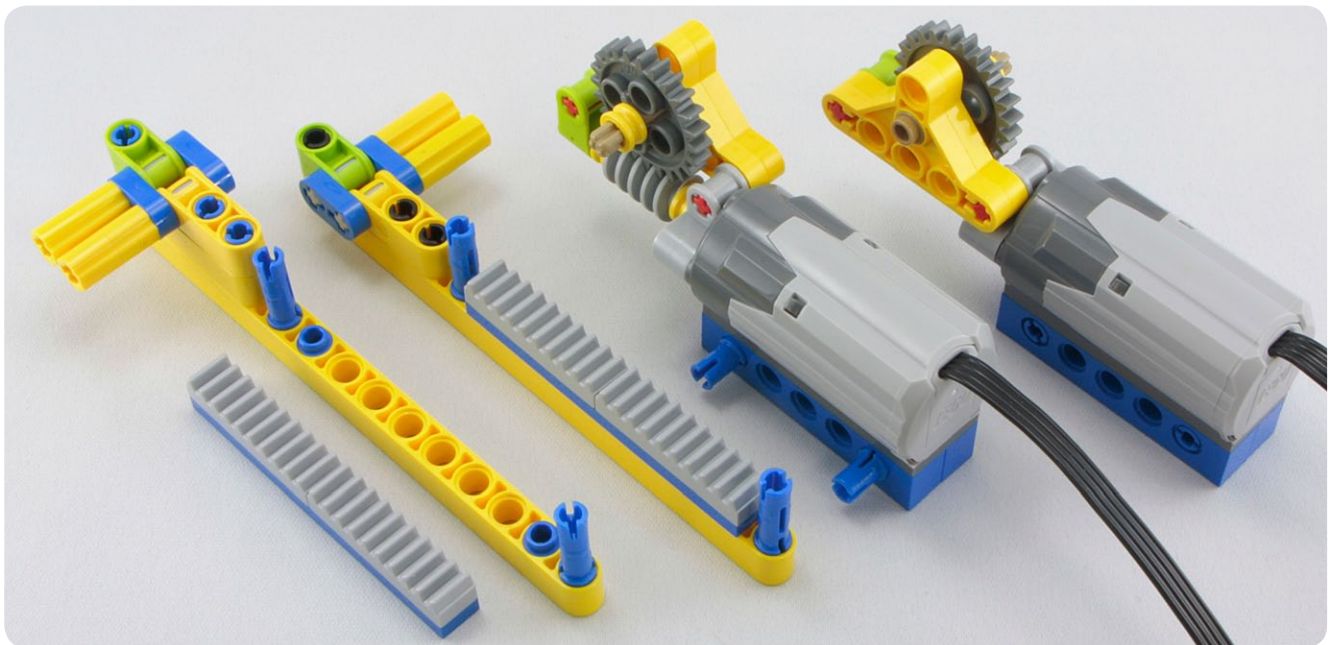
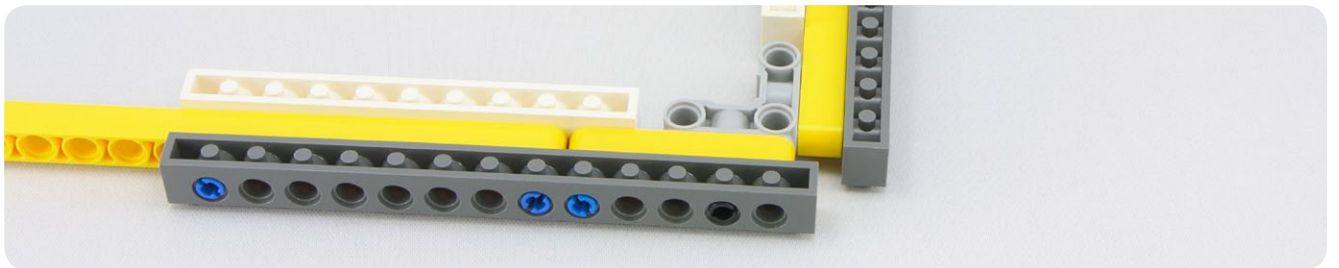
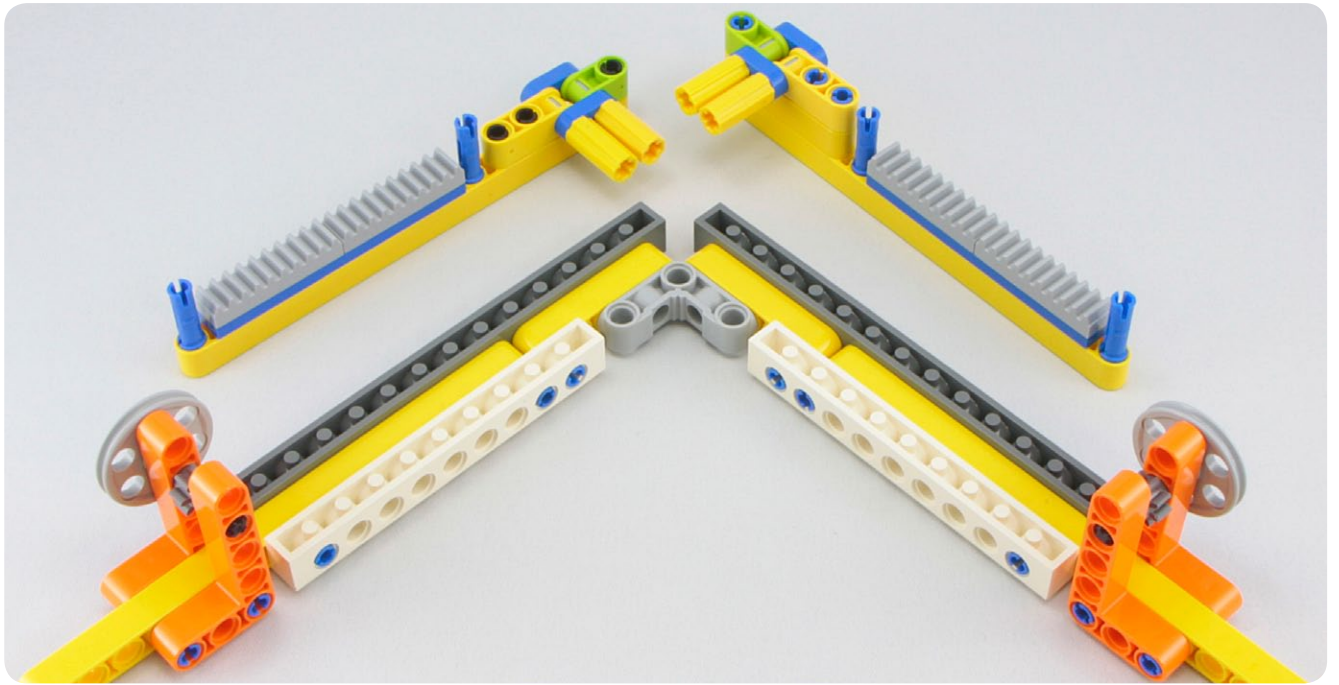


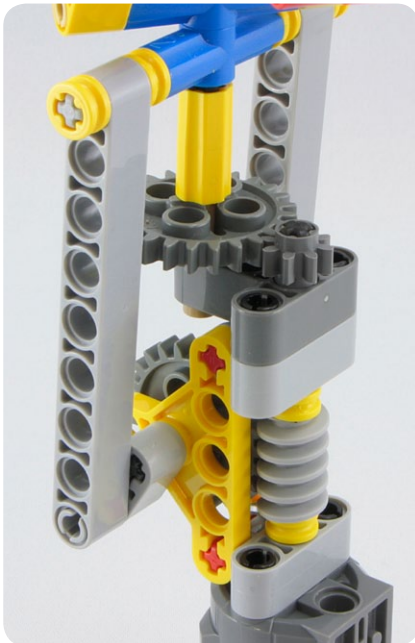
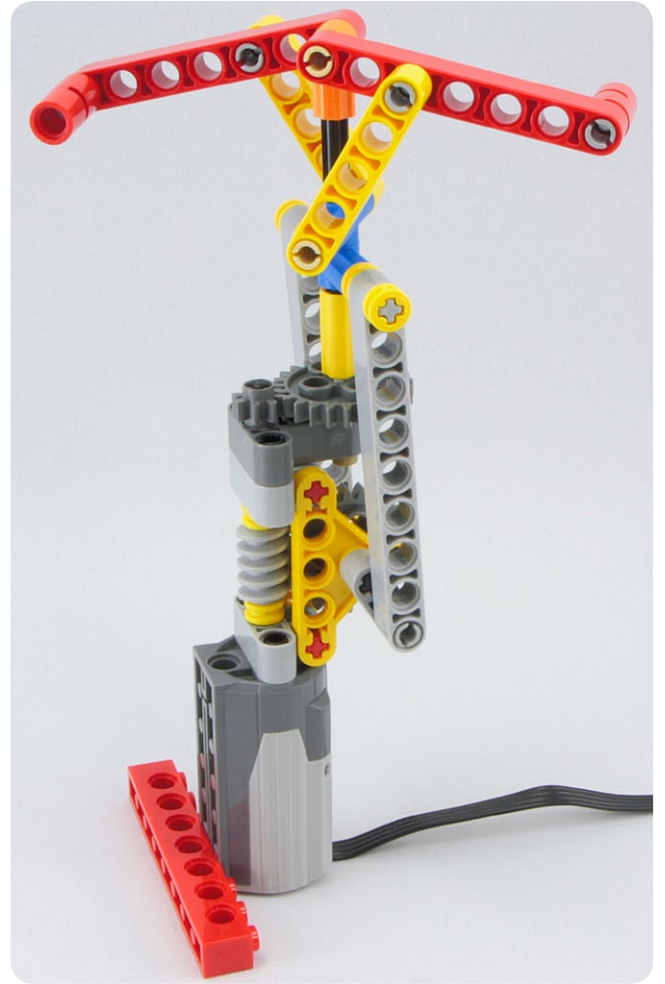






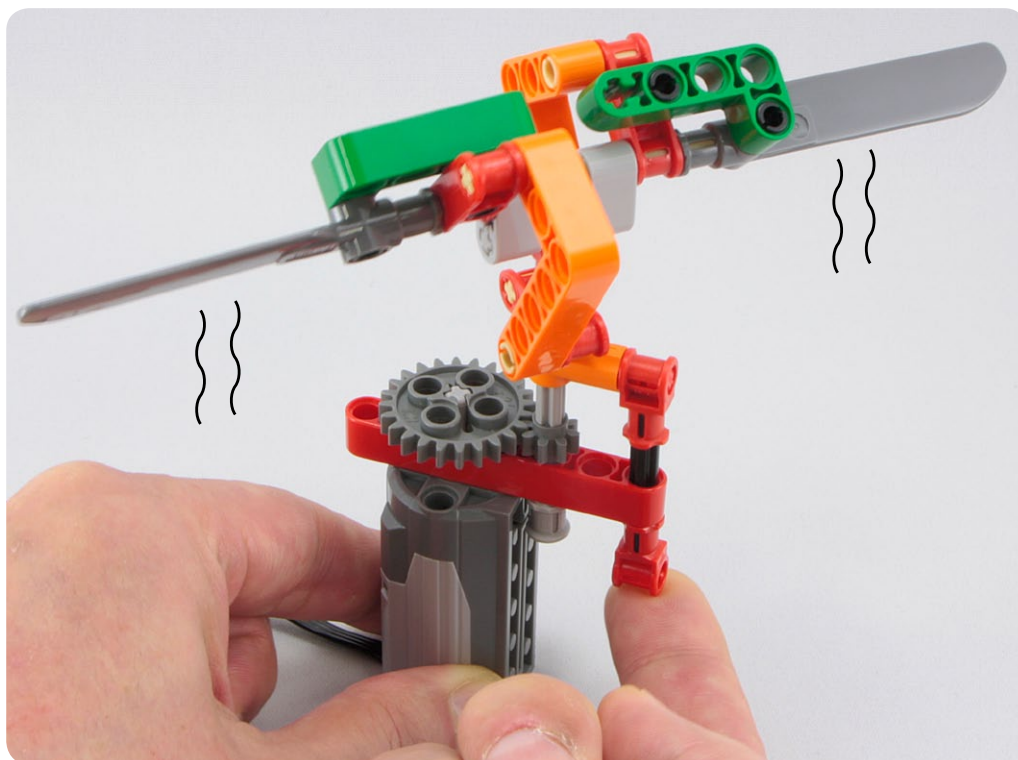


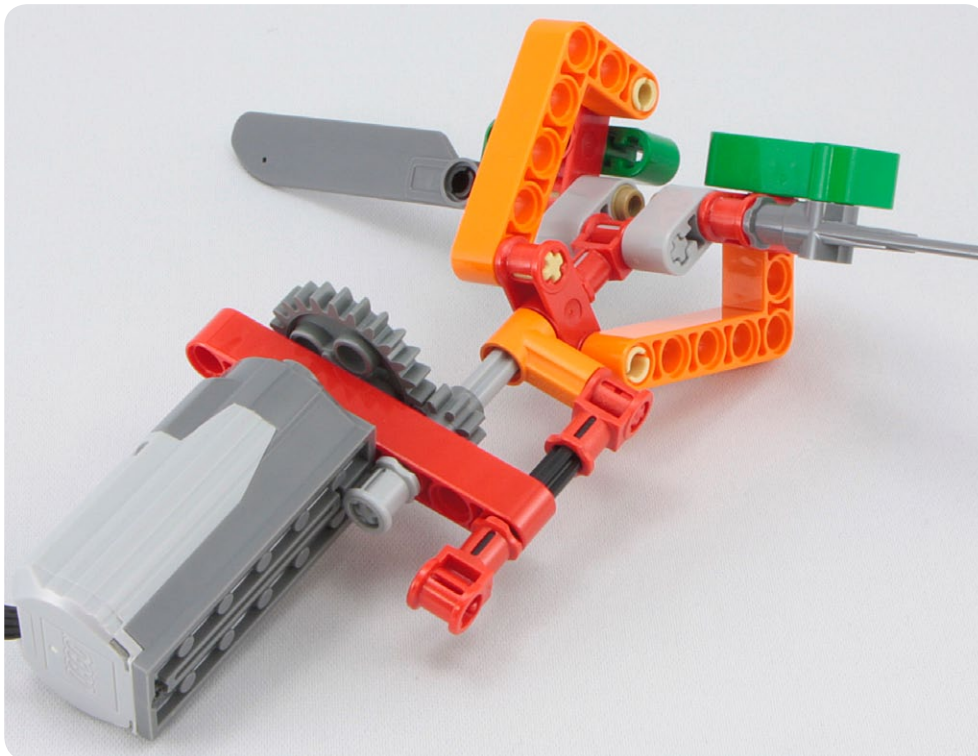
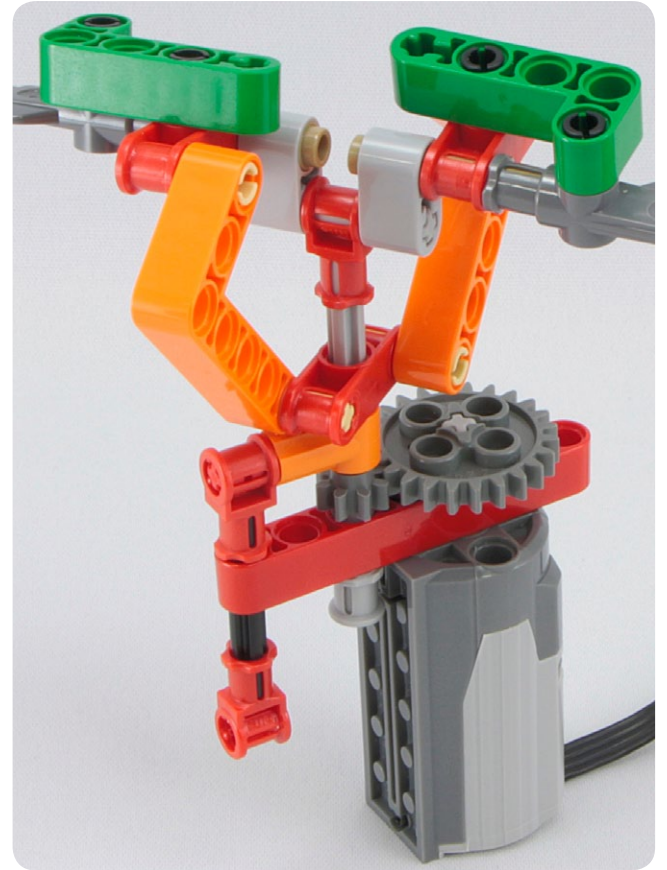
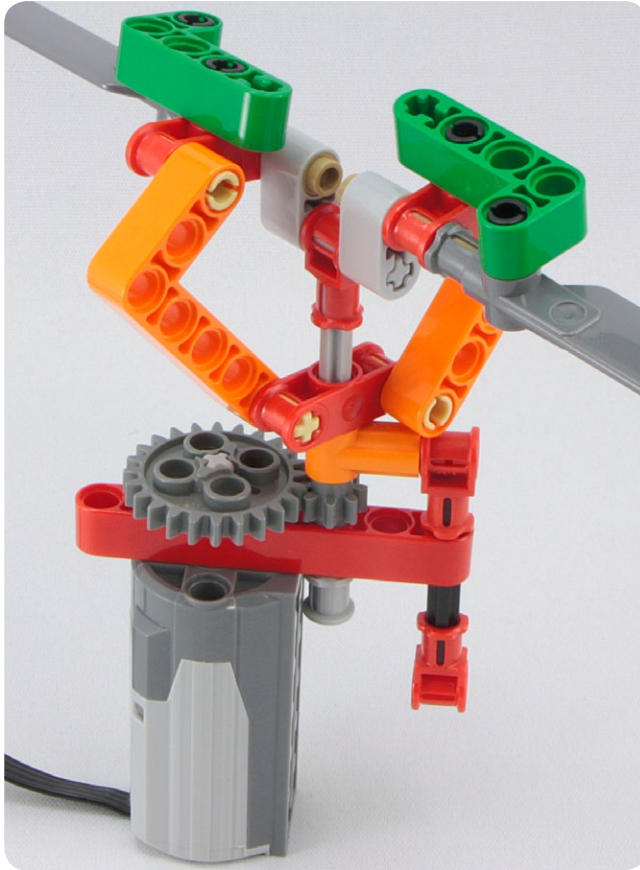




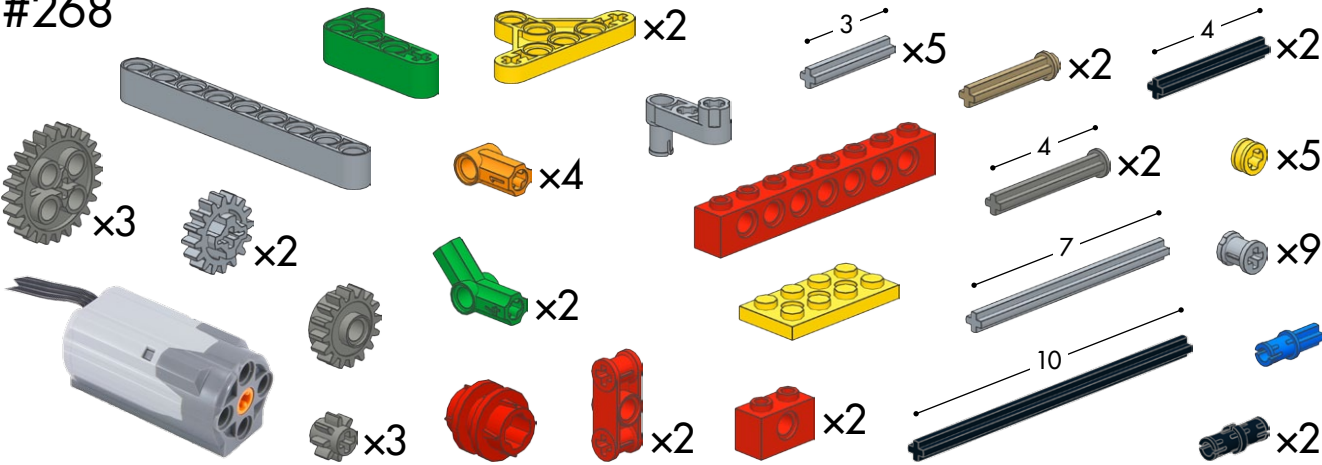
LEGO parts list for step 10:

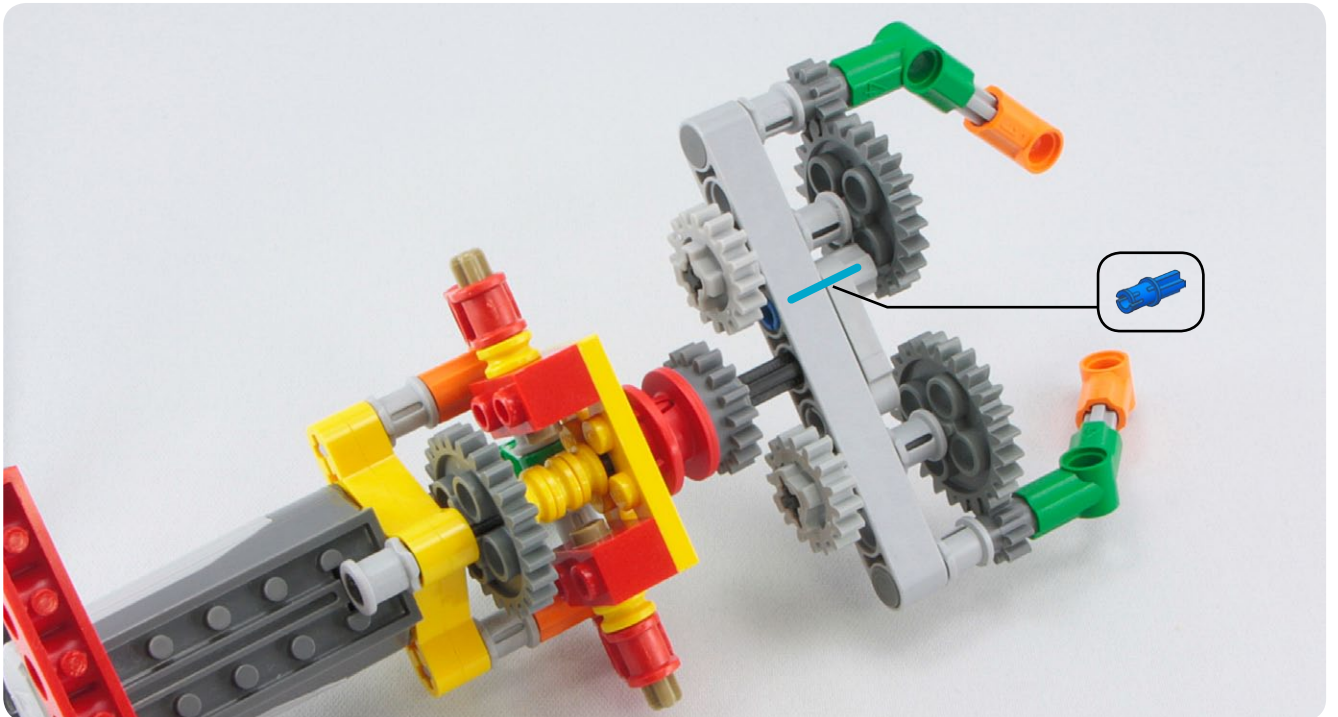
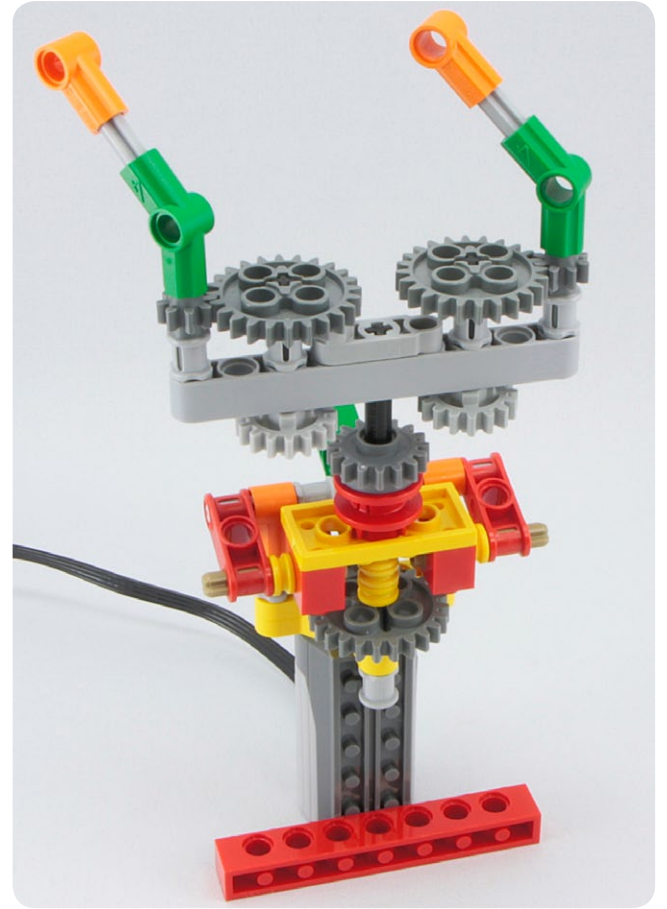
- 1x Small grey gear
- 1x Large grey gear
- 1x Grey motor
- 1x Red 1x6 Technic beam
- 2x Orange 1x3 Technic beam
- 2x Green 1x3 Technic beam
- 1x Orange 1x2 Technic connector
- 2x Grey 1x2 Technic connector
- 2x Grey 1x2 Technic arm
- 3x Red 1x2 Technic connector
- 3x Red 1x2 Technic connector
- 2x Grey 1x3 Technic beam (length 3)
- 1x Red 1x2 Technic connector
- 2x Tan 1x2 Technic connector
- 1x Black 1x4 Technic beam (length 4)
- 1x Grey 1x7 Technic beam (length 7)
- 4x Tan 1x2 Technic connector
- 1x Small grey gear
- 6x Black 1x2 Technic connector



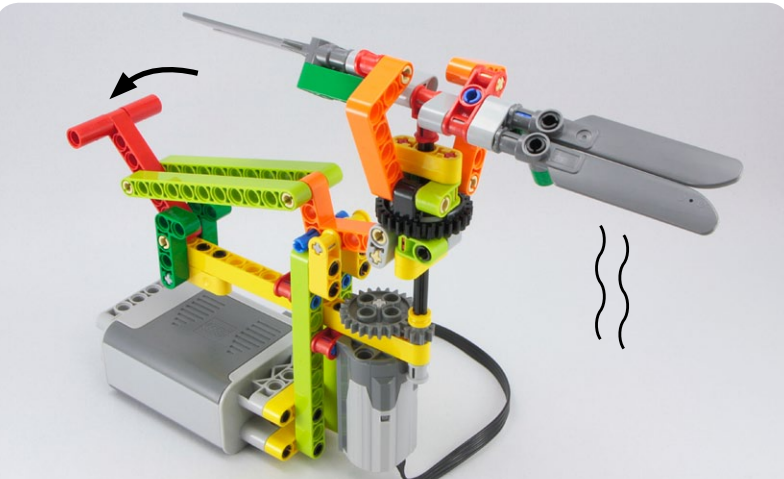
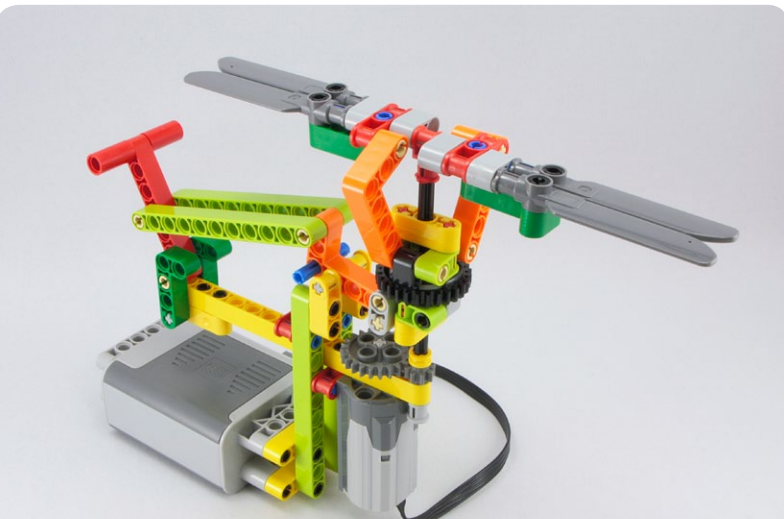
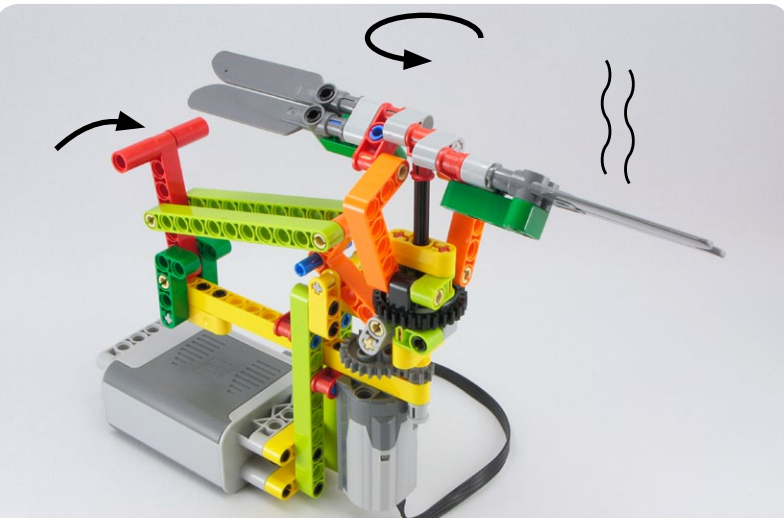
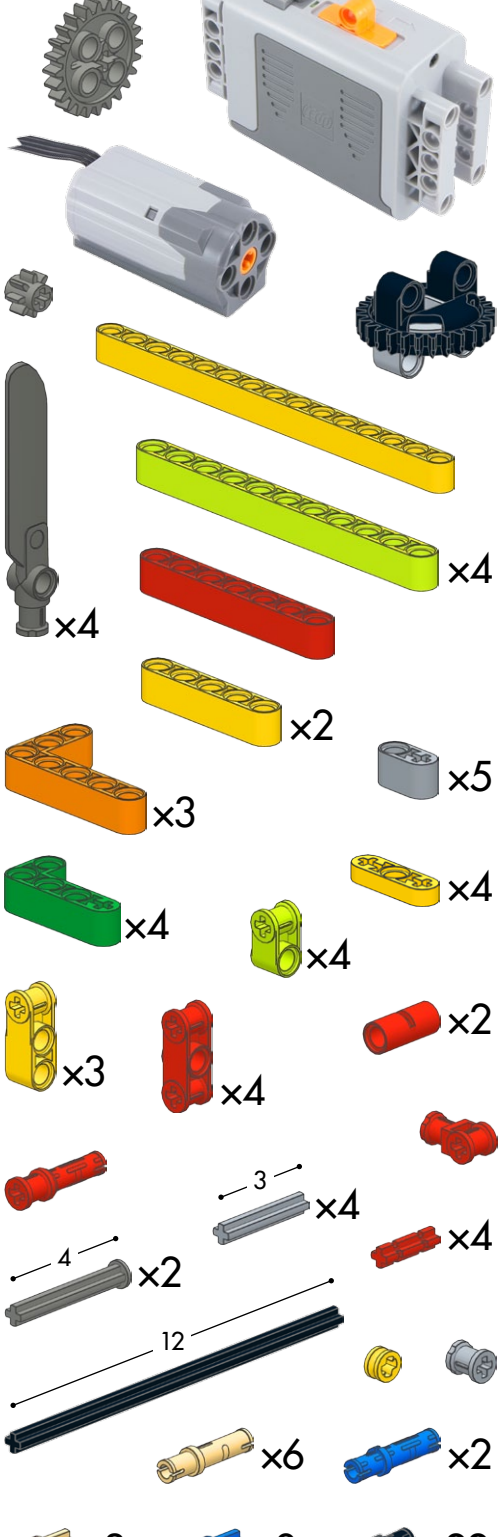


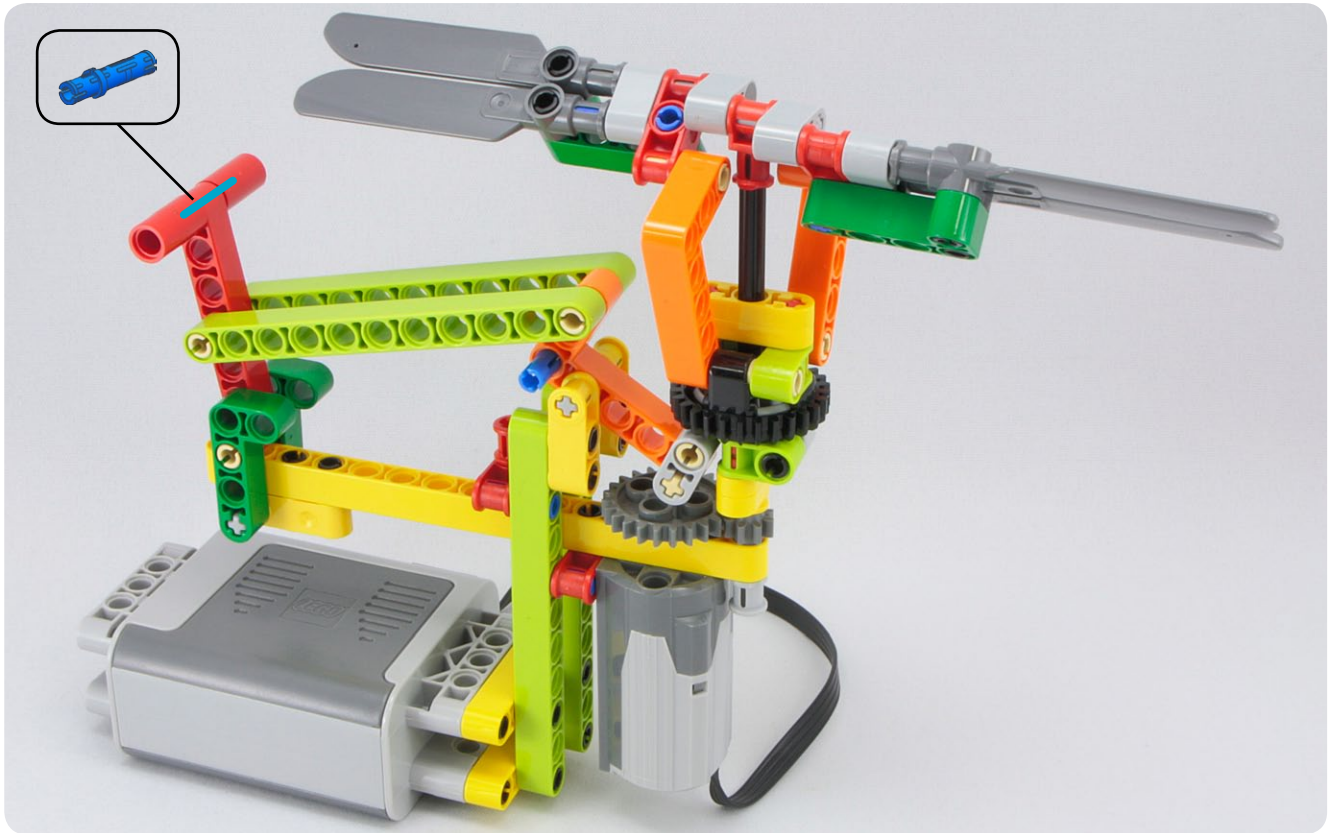
#268

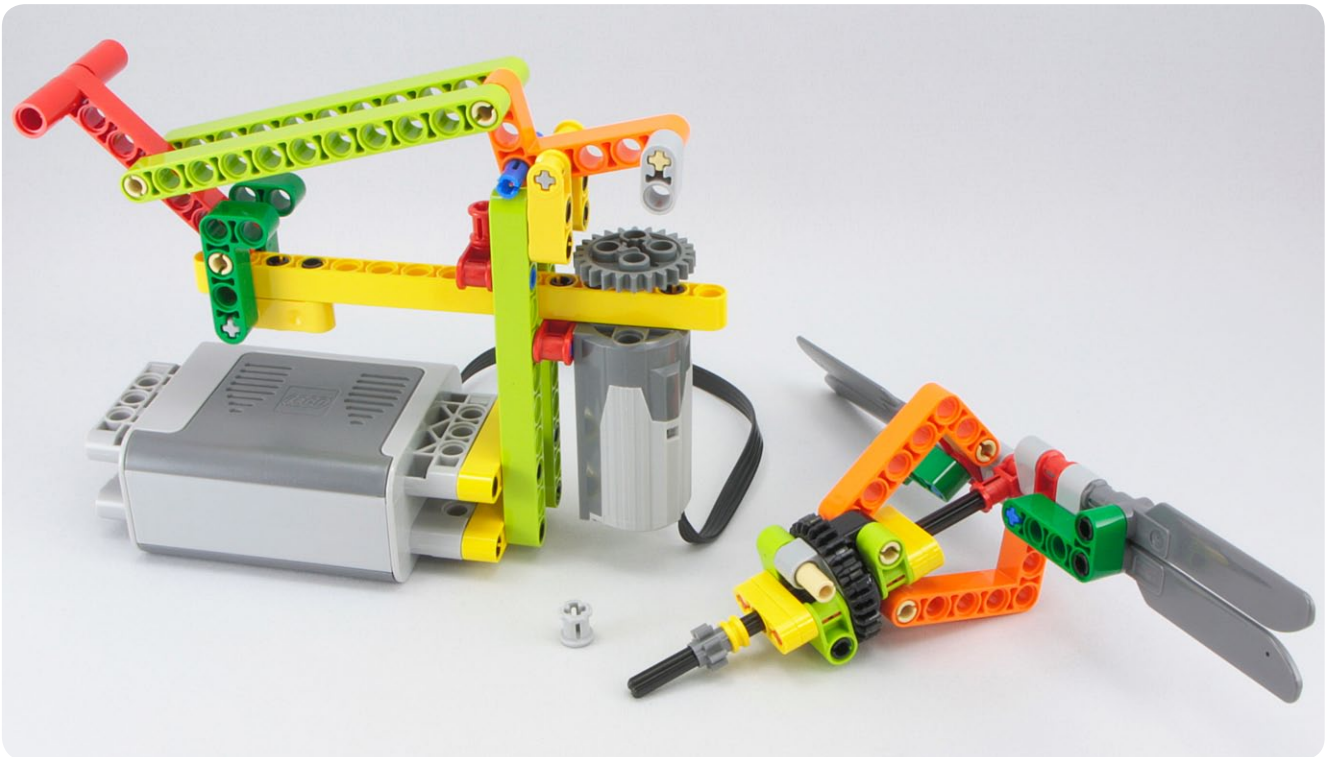
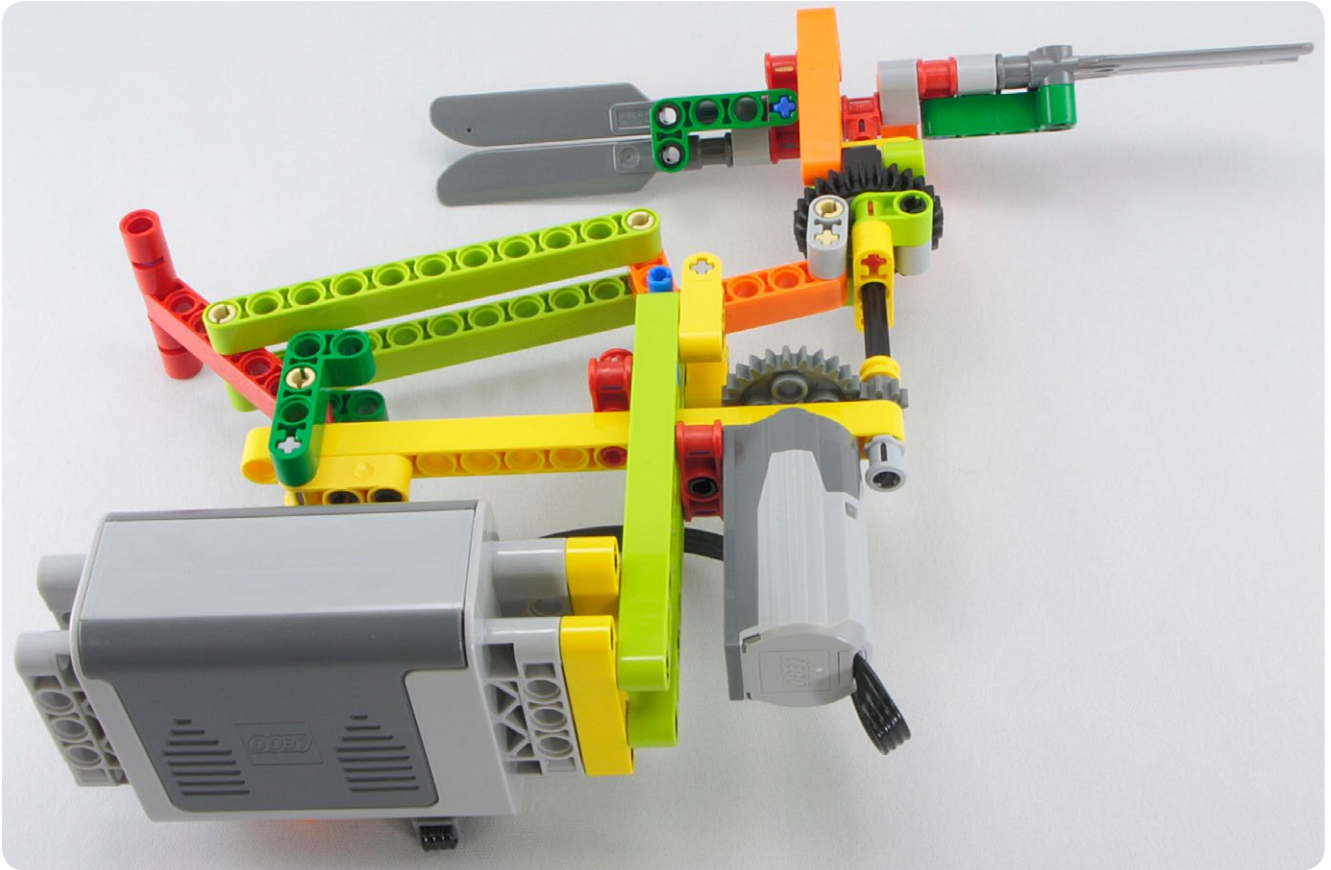


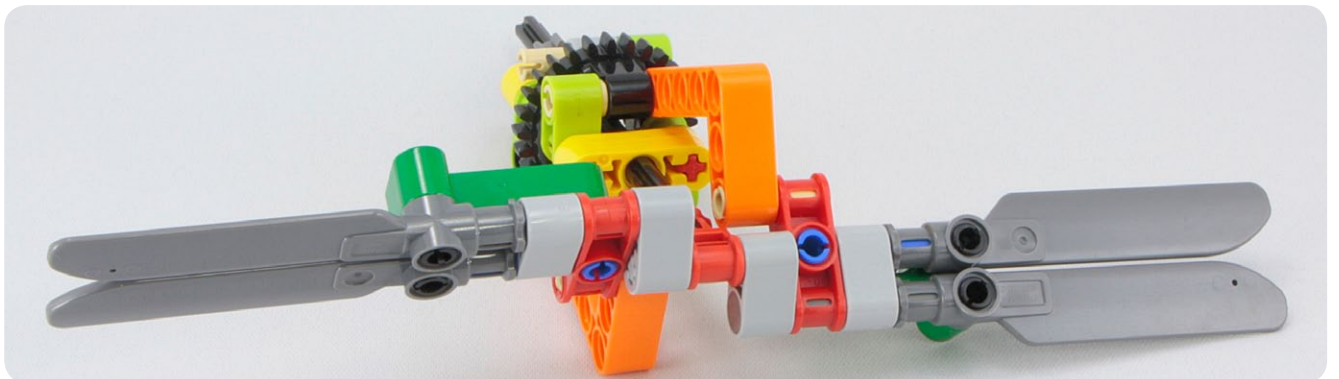
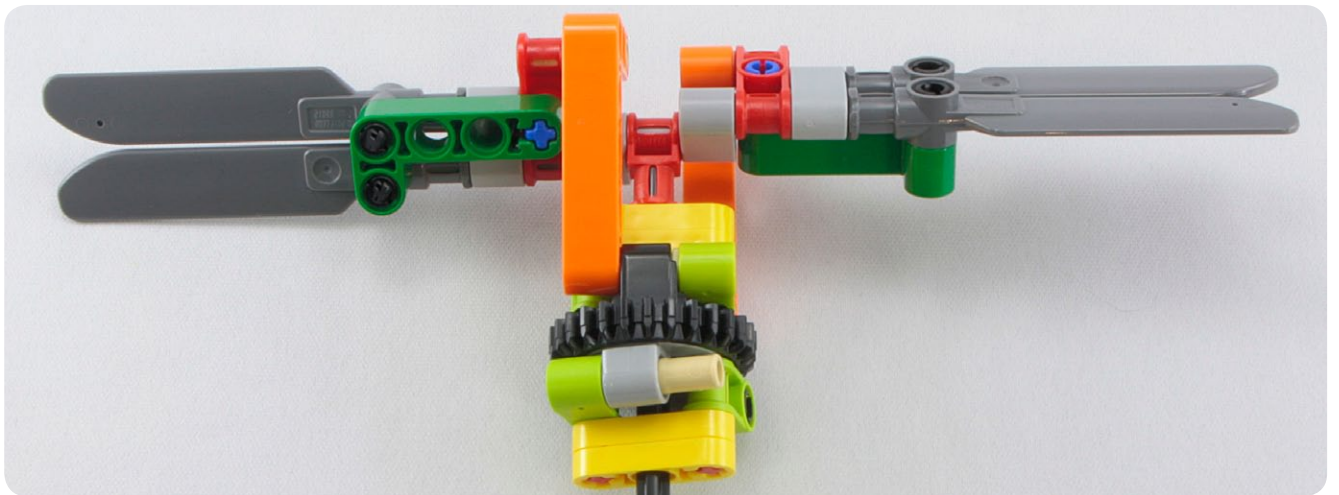
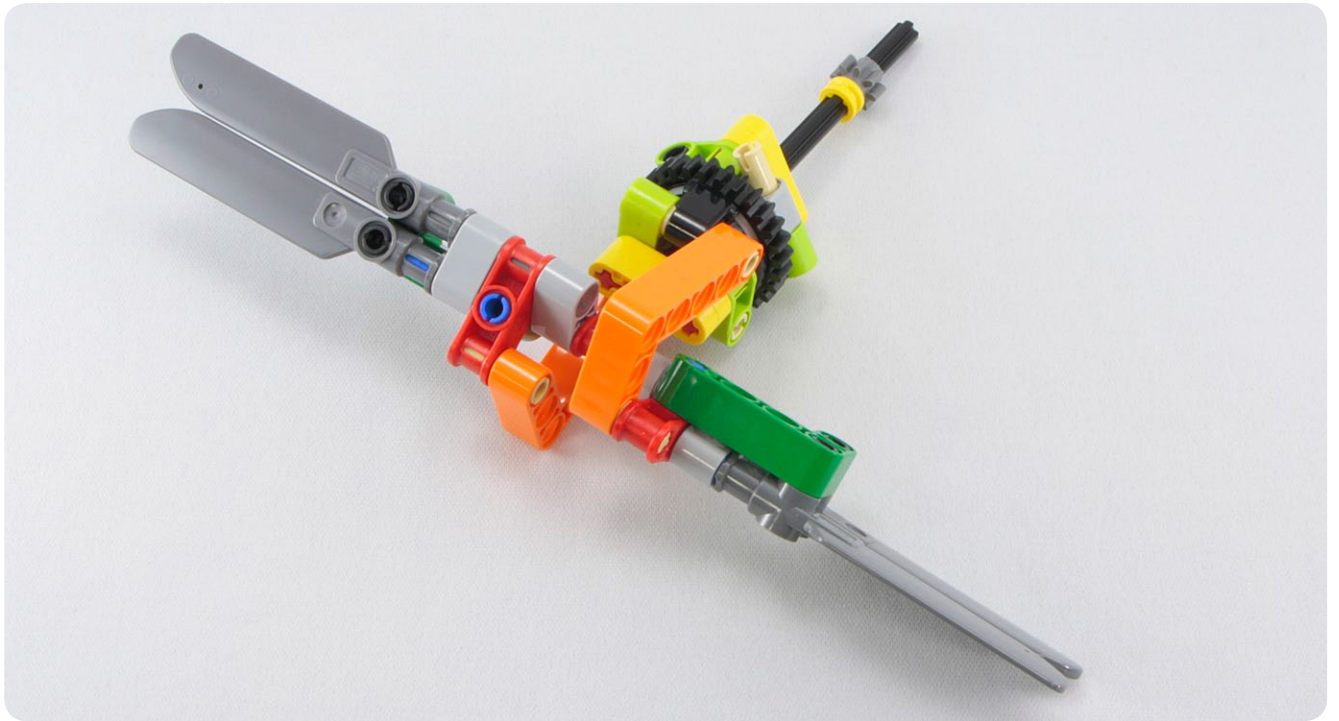


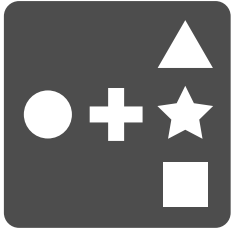
#269











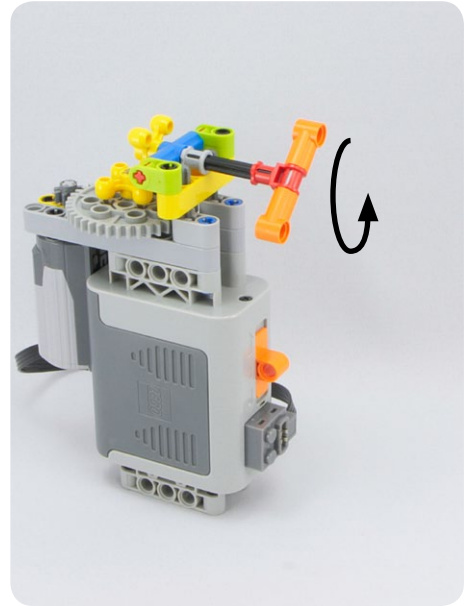
Using attachments to change motion



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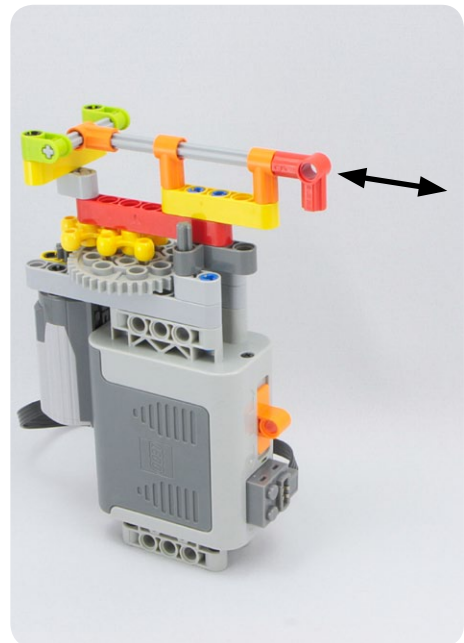
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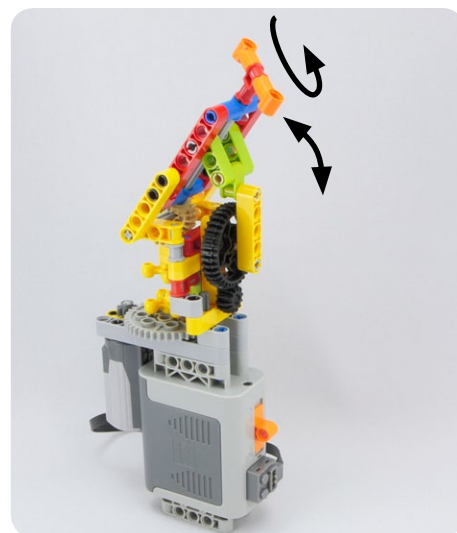
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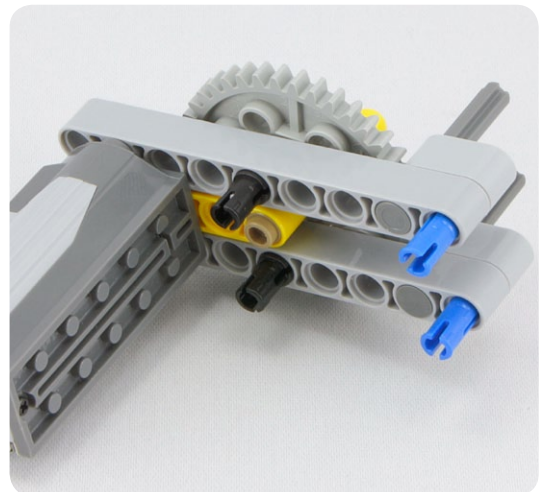
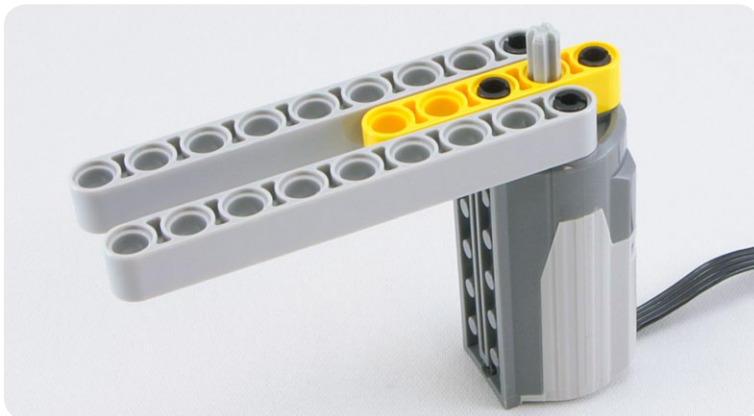


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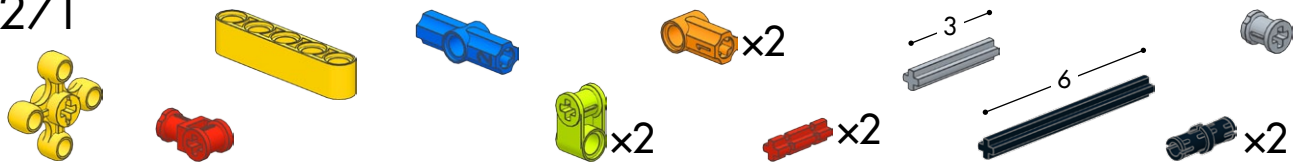


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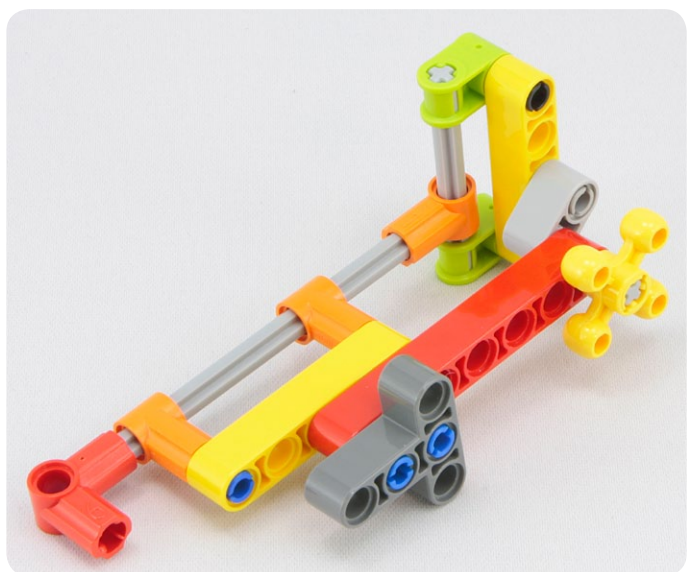
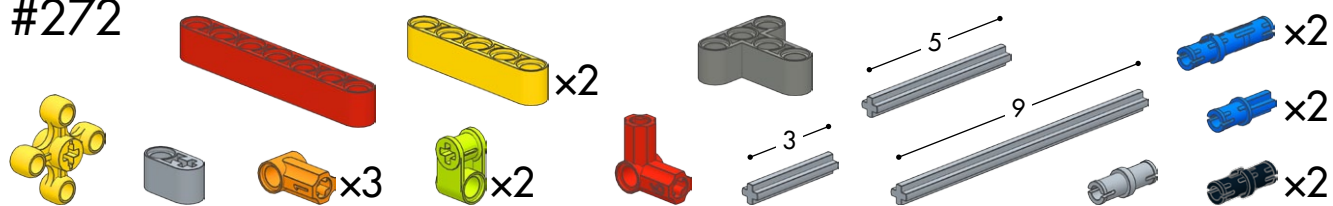


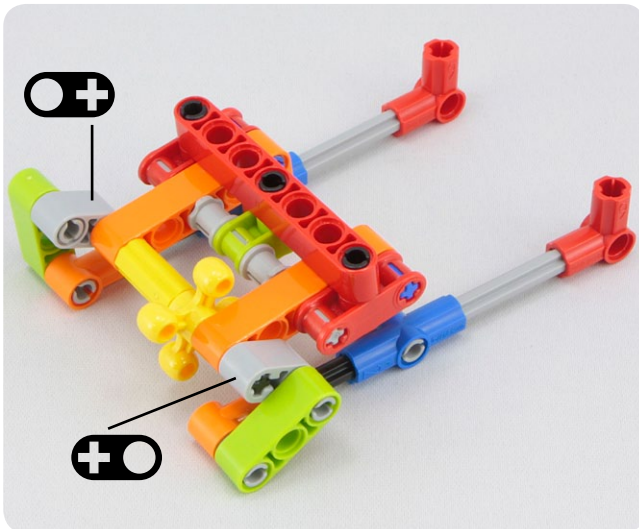
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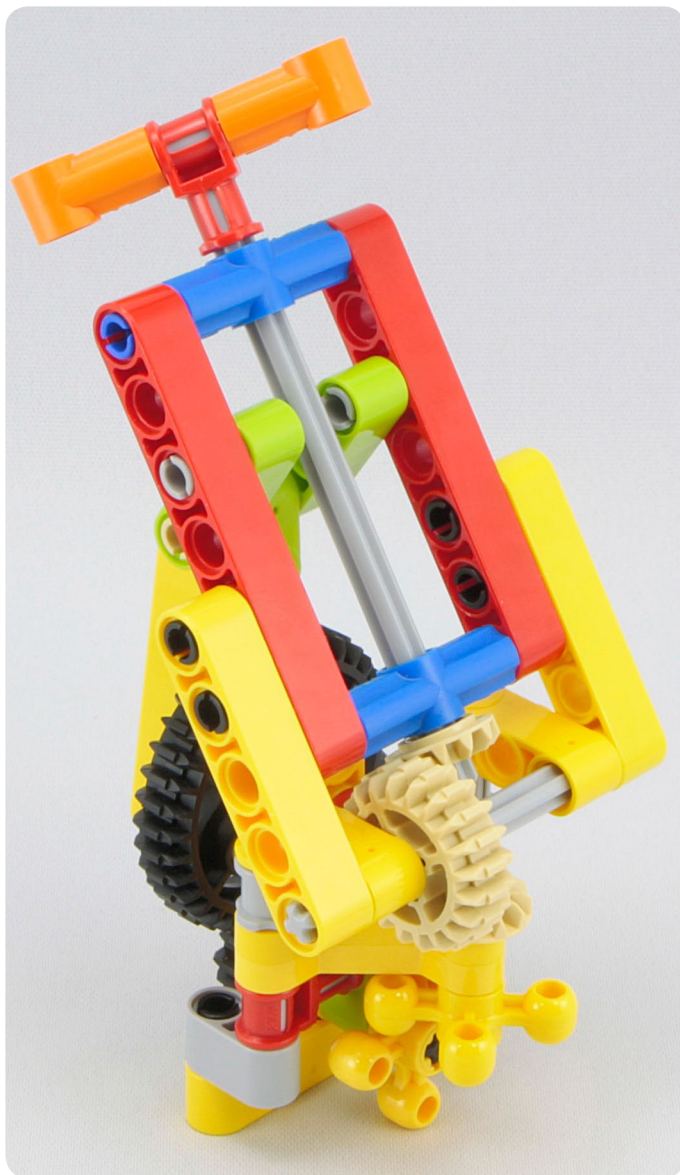
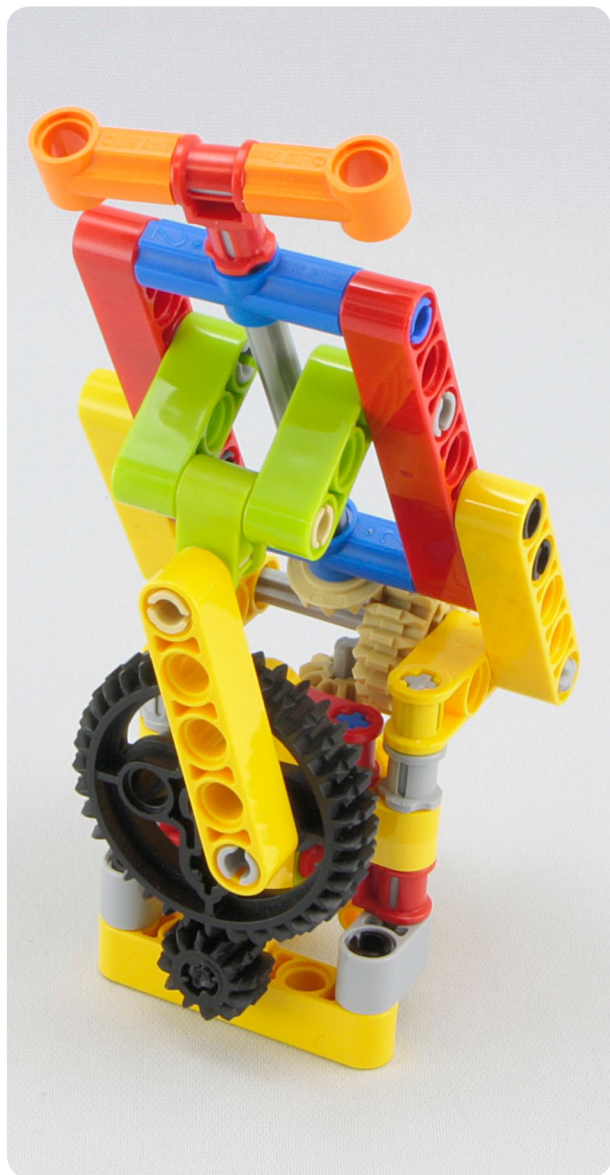
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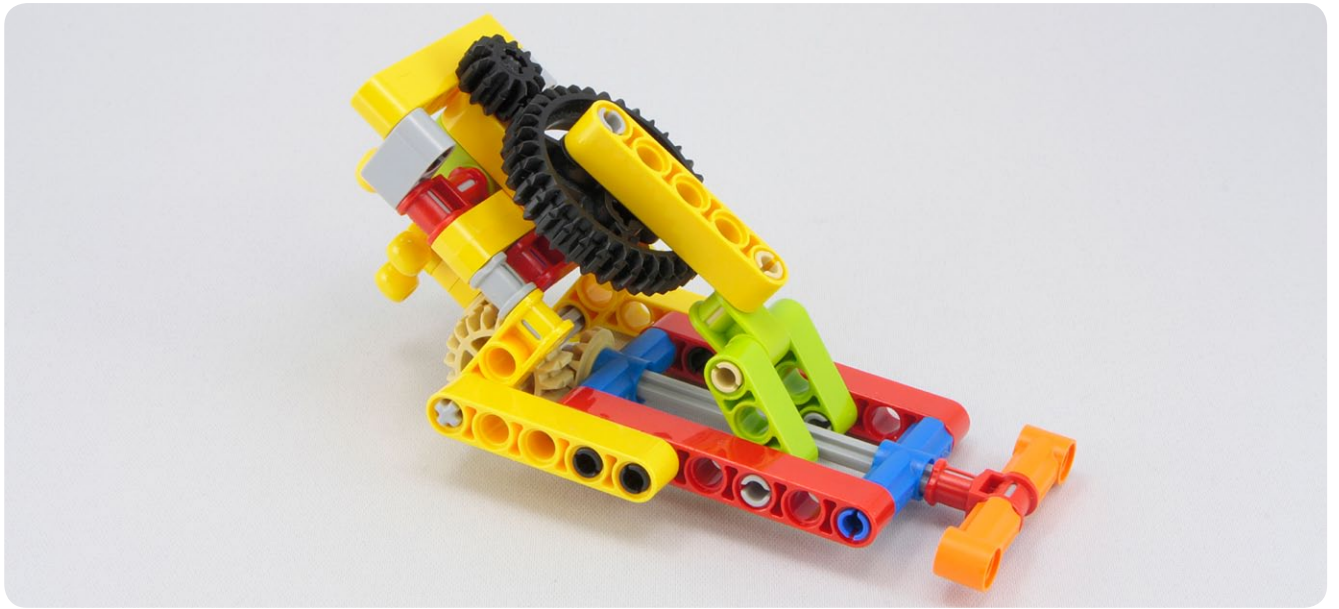


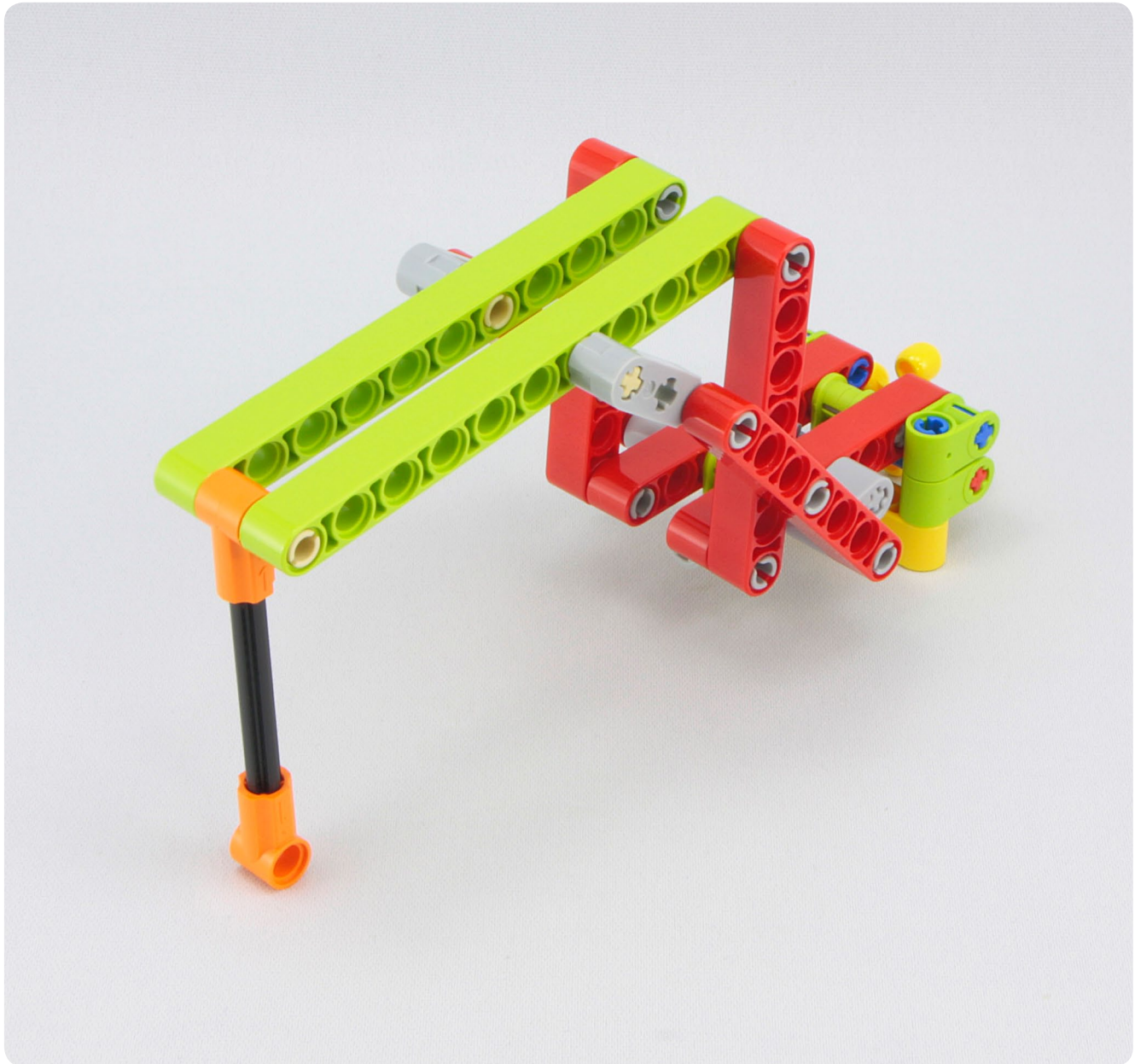
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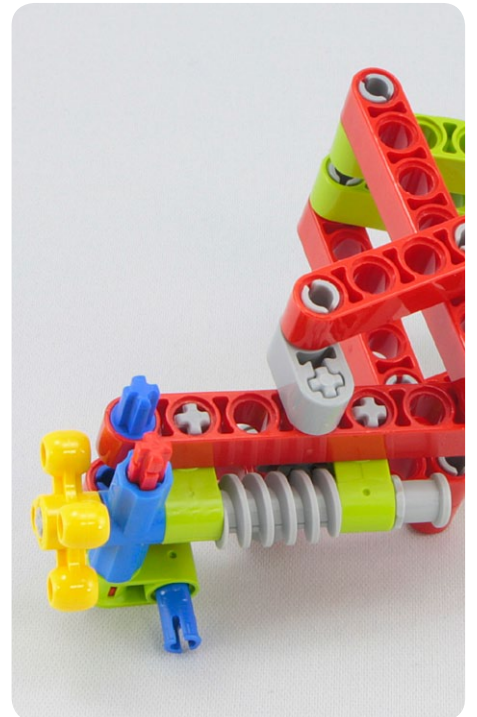
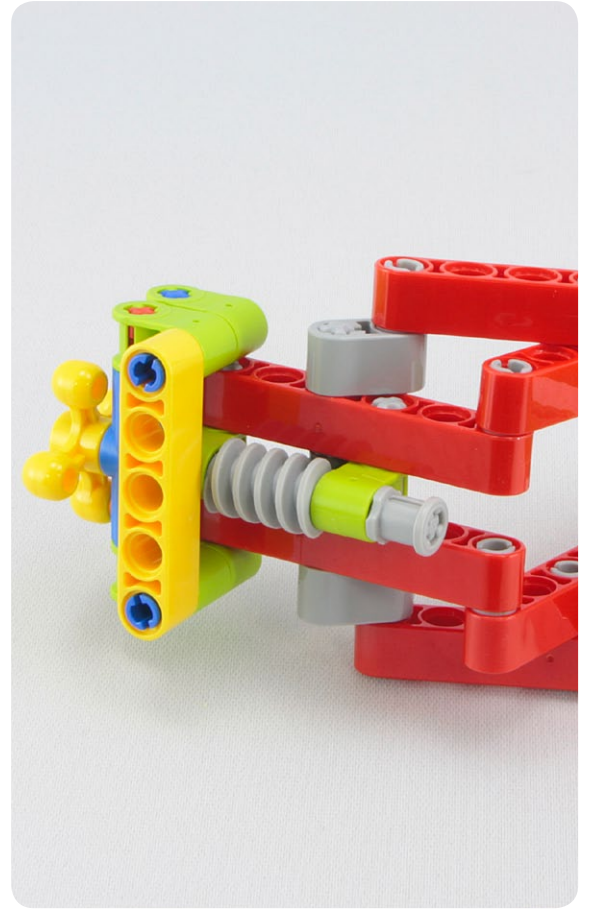
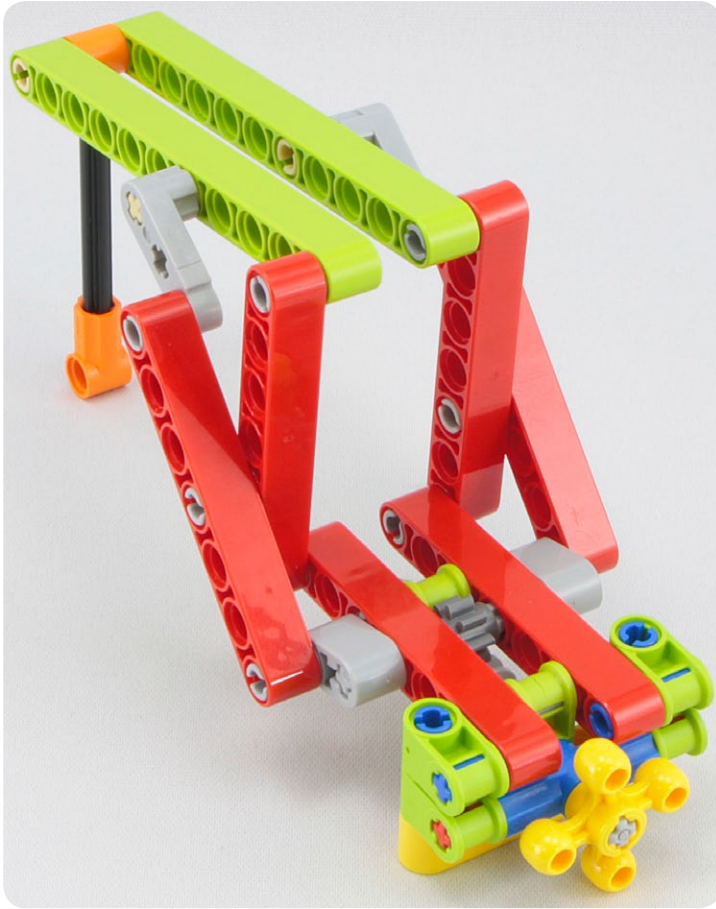


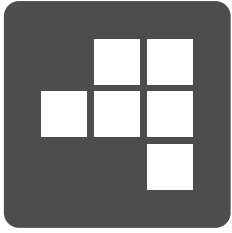
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[illegible]



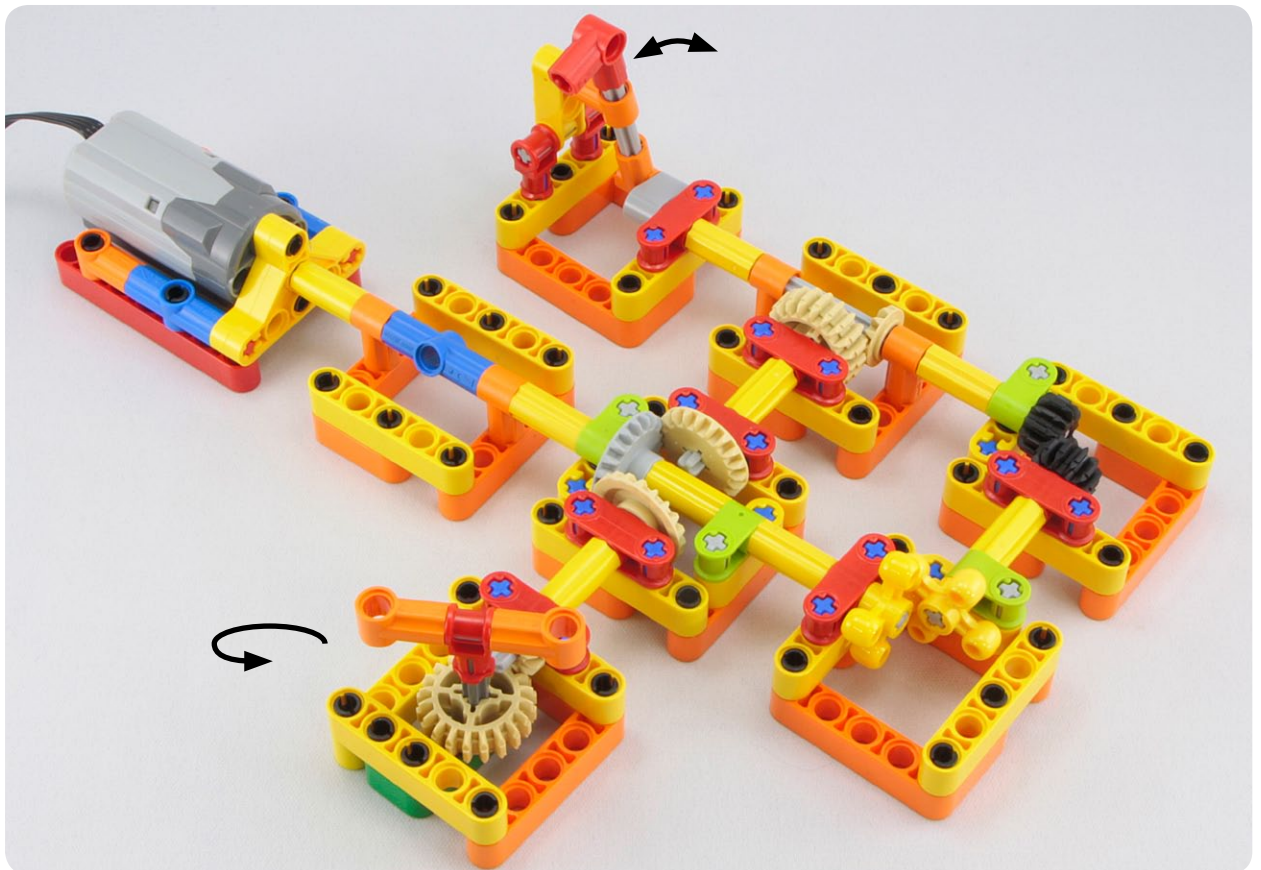
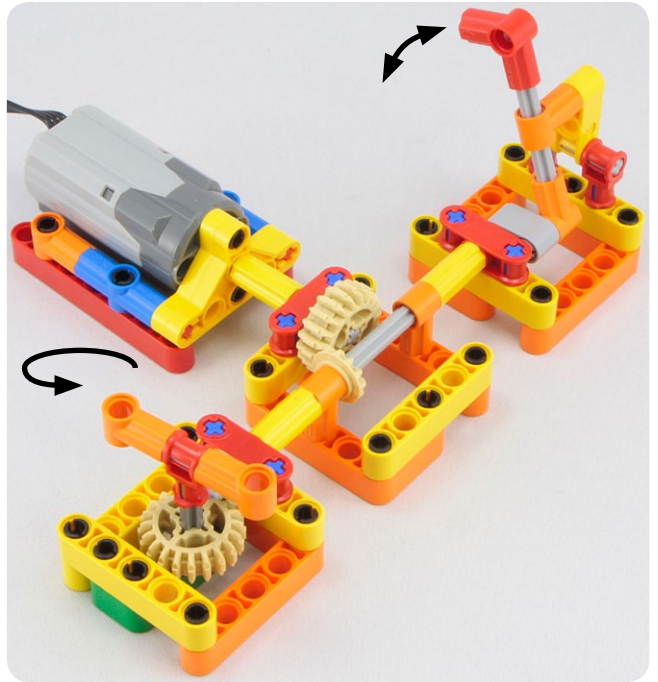
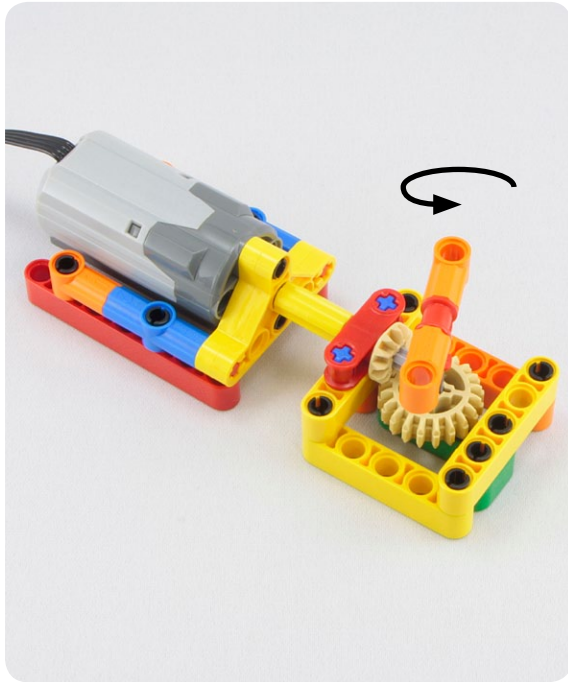
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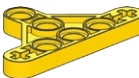










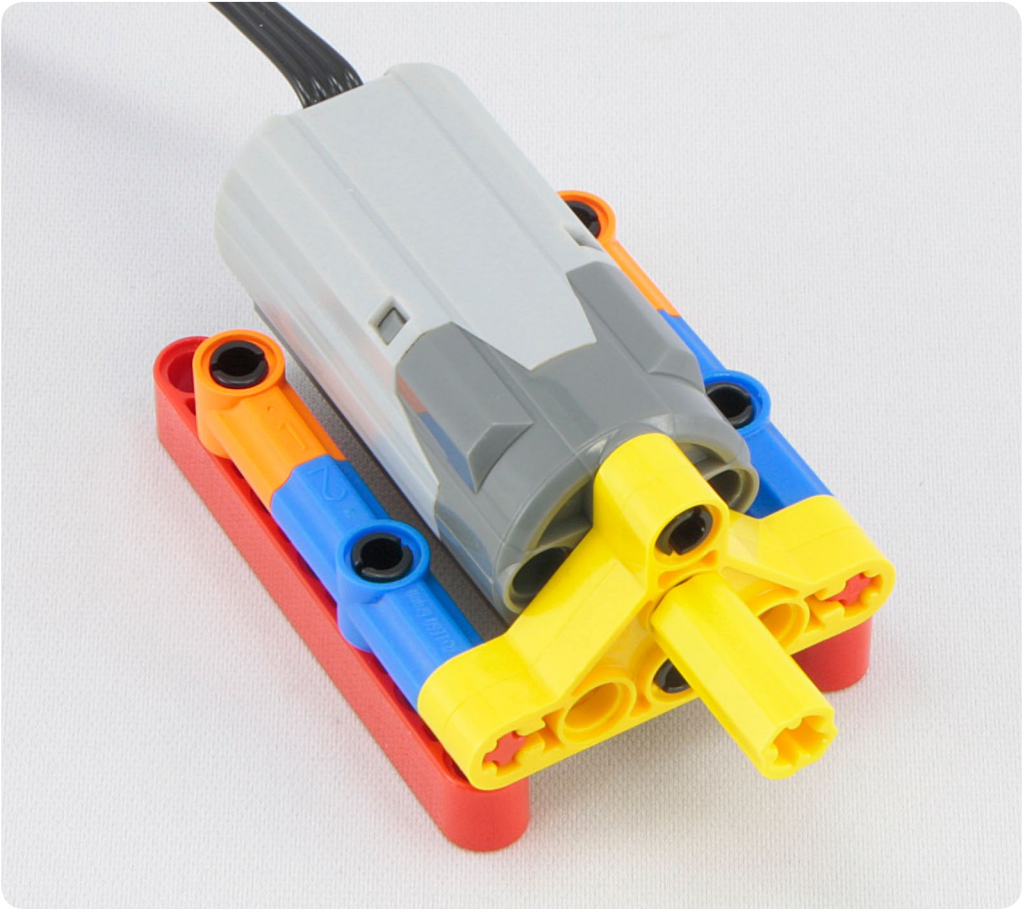
Combining modules



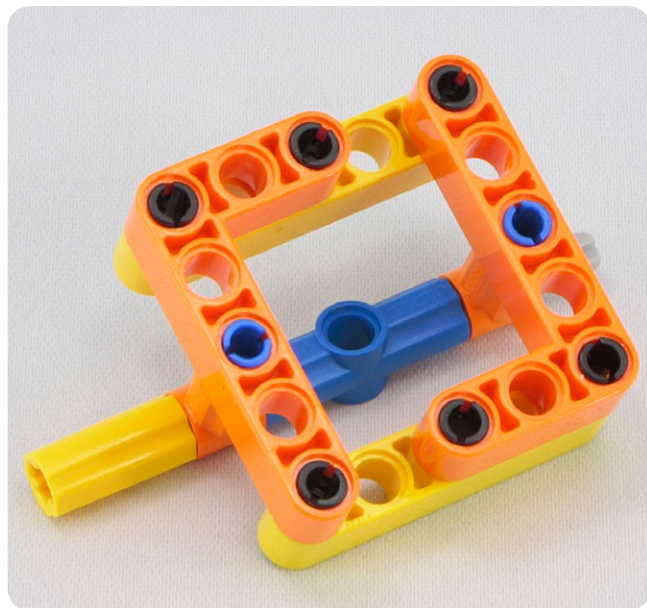
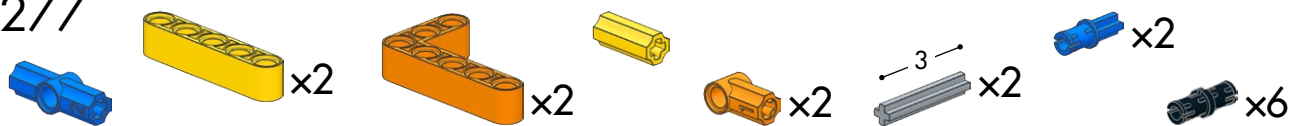


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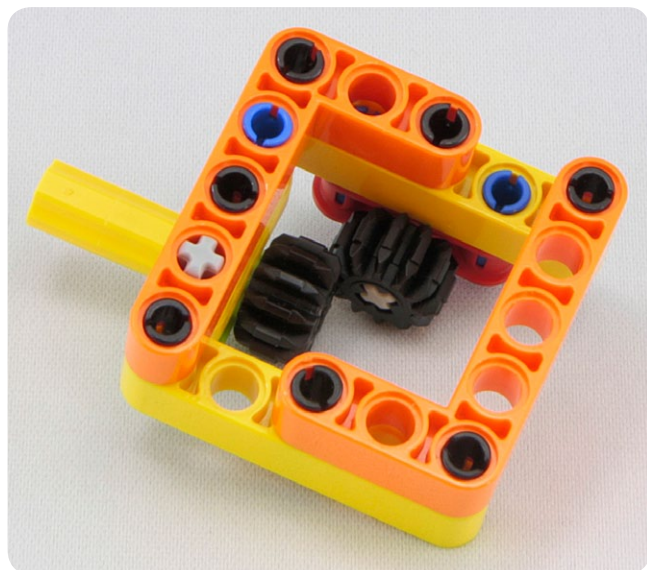
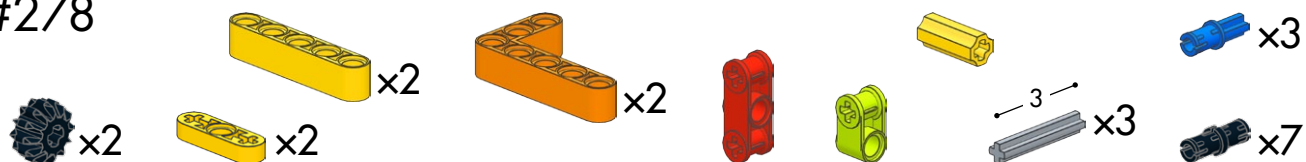
-  x2
- 
-  x2
-  x2
-  x2
- 
-  x4
-  3
-  x6



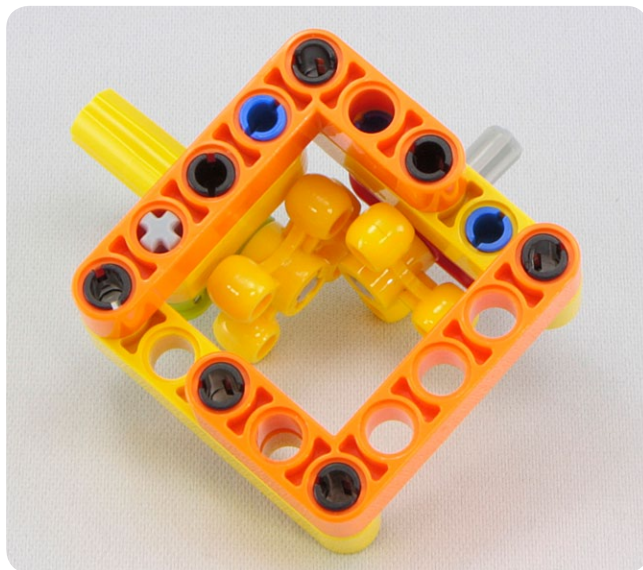
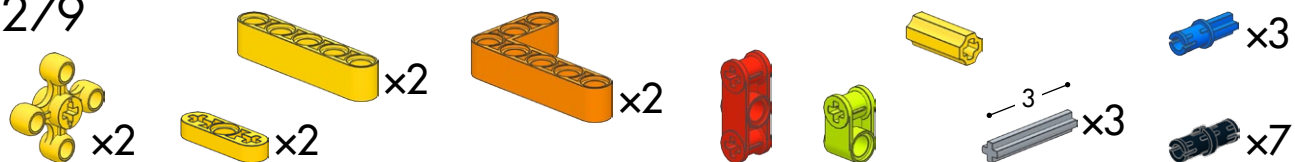
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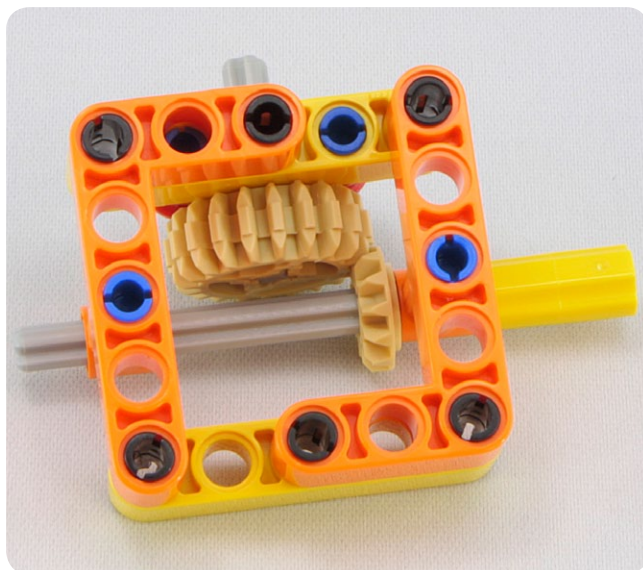
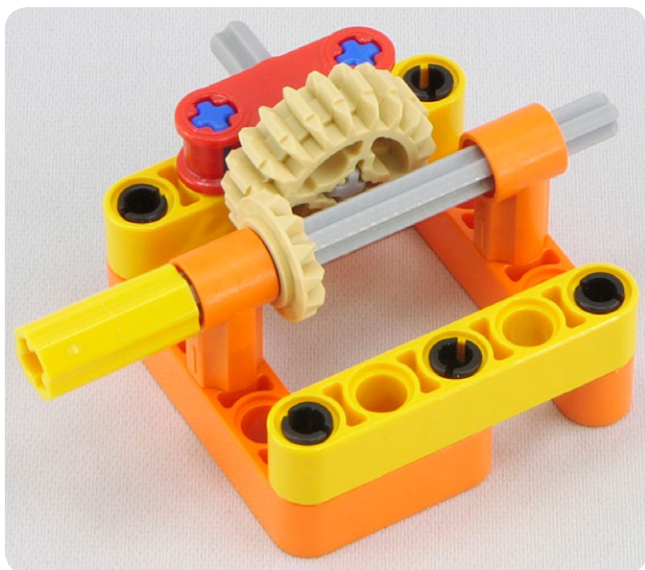
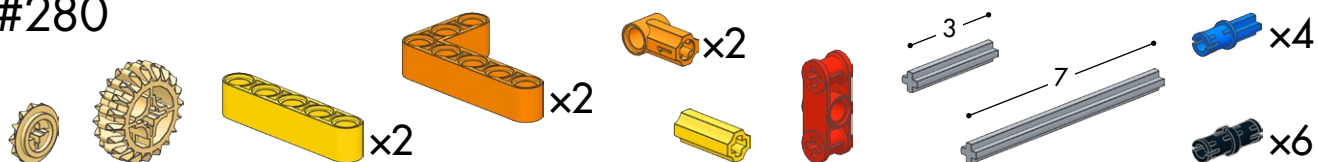
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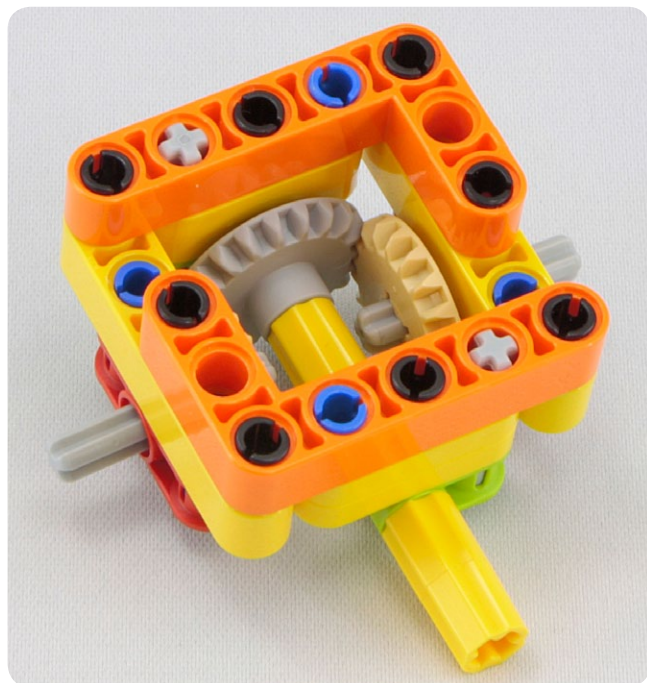
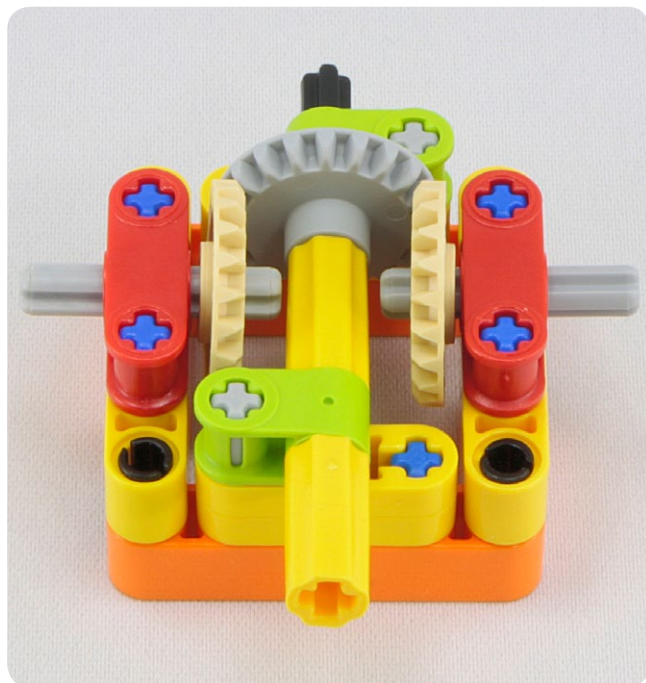
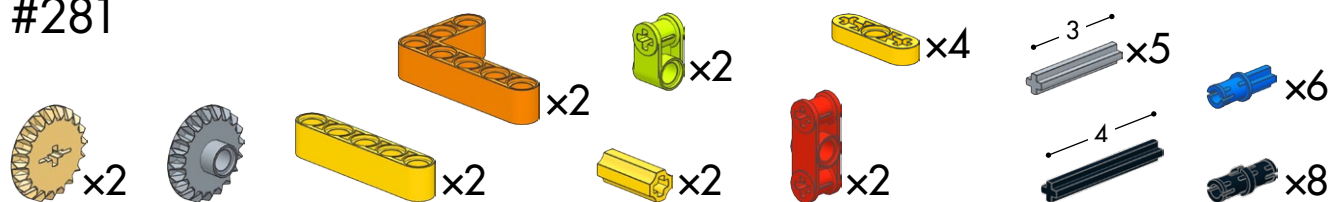
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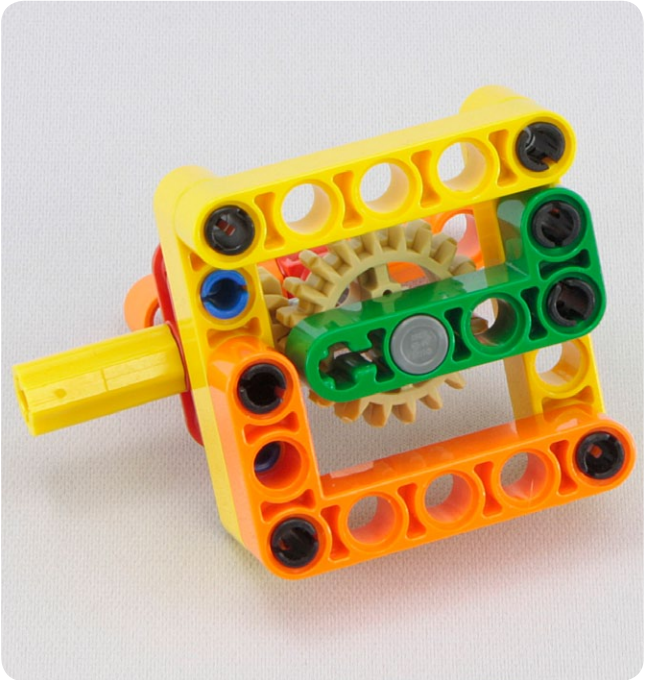
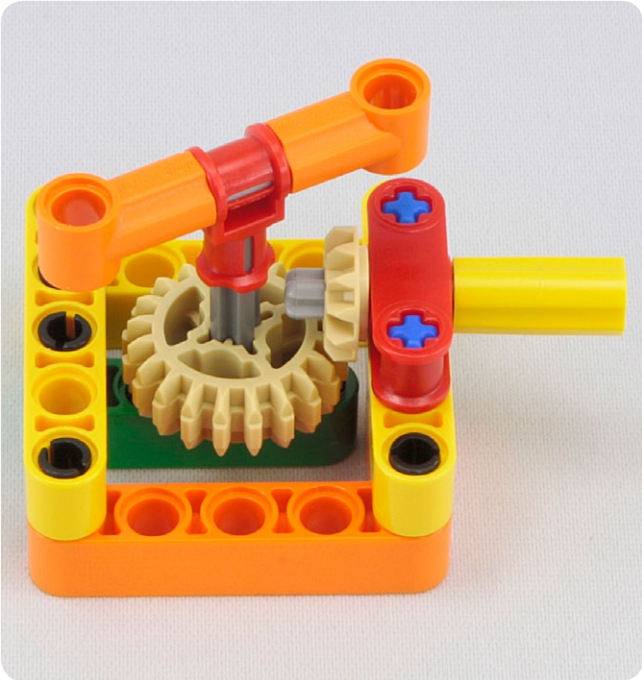
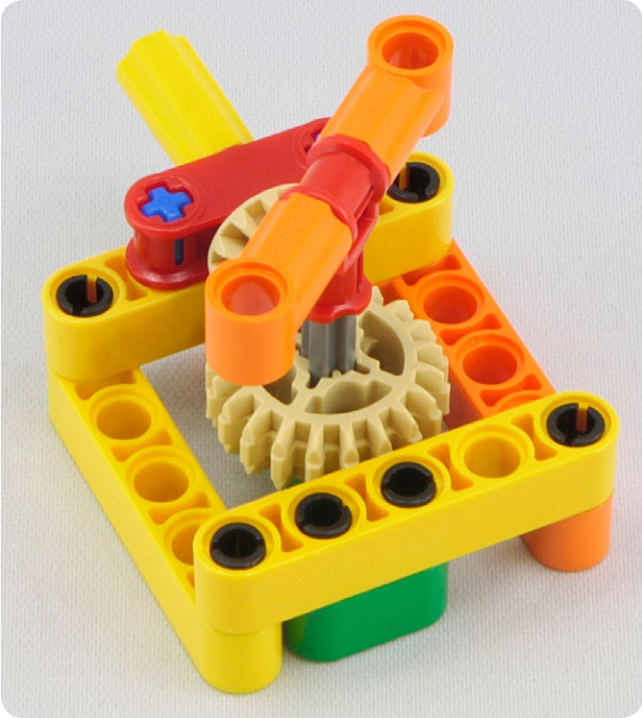
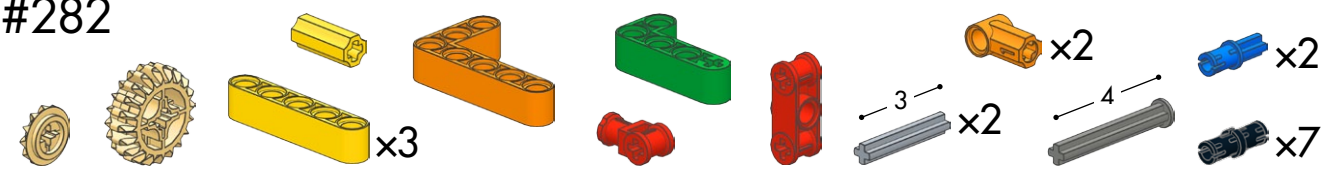
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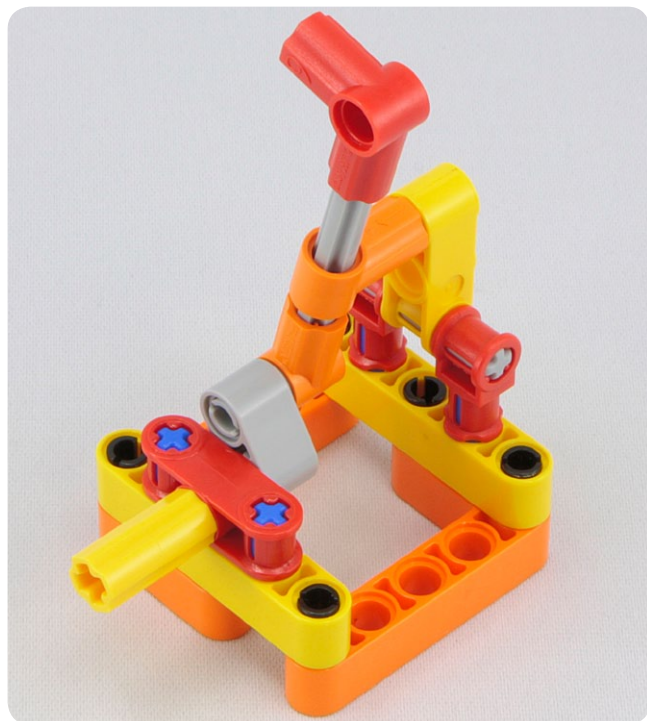
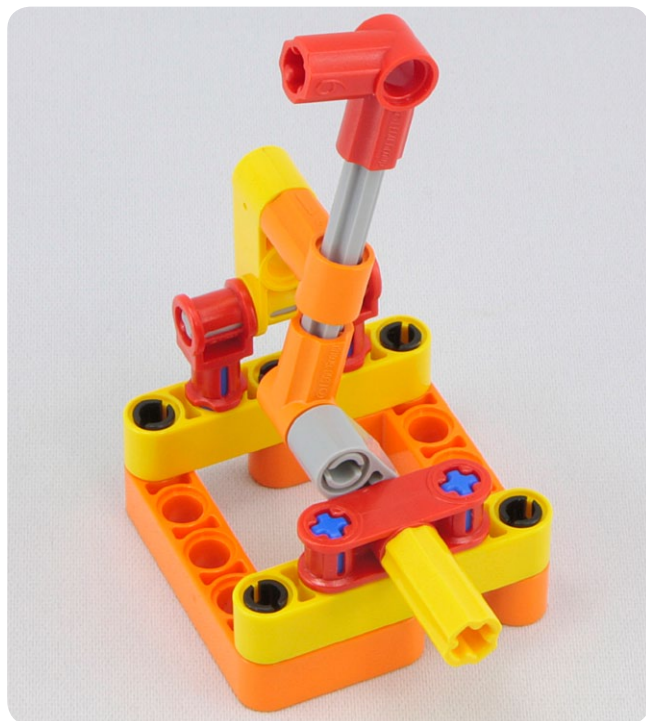
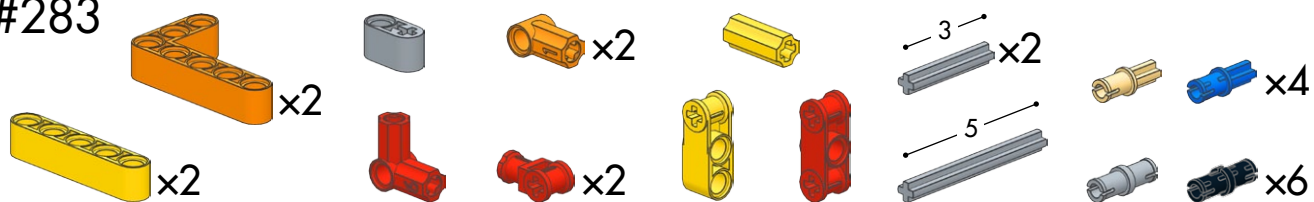
#281



#282



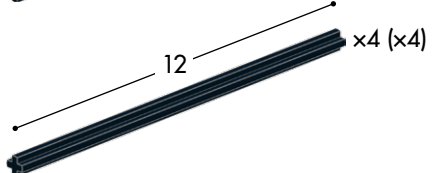
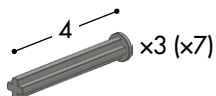
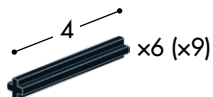
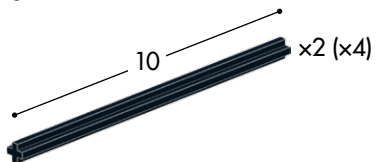
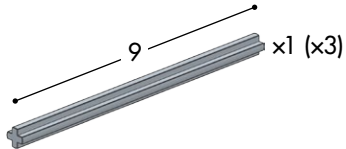
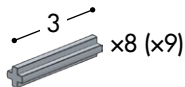
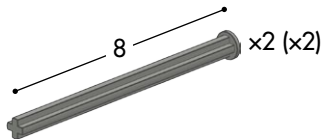
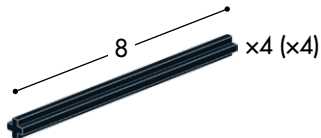
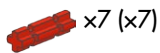
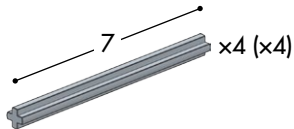
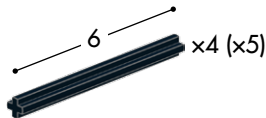
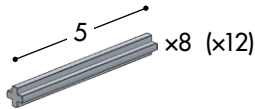
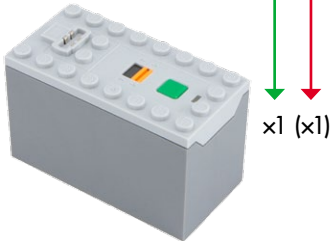
#283

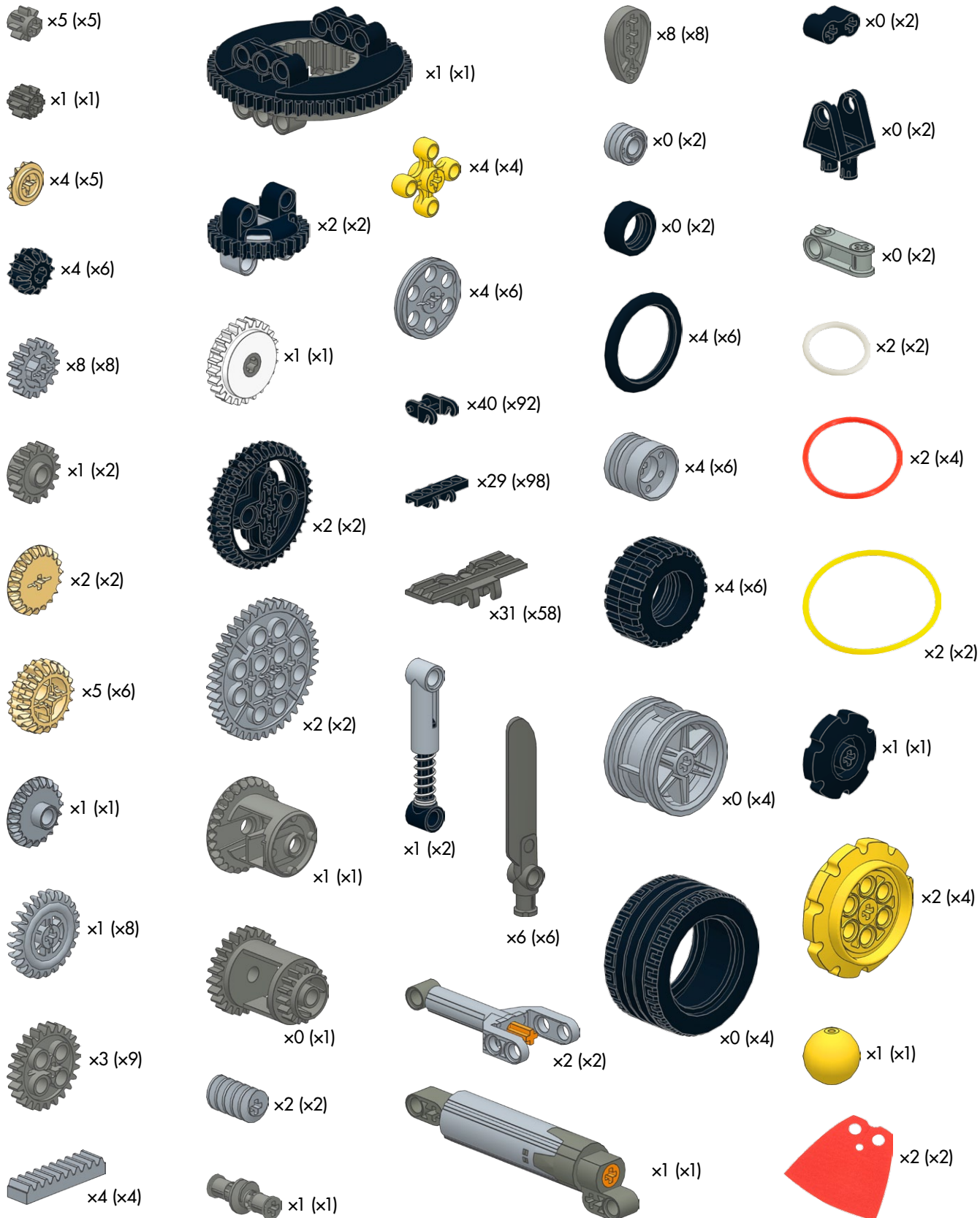


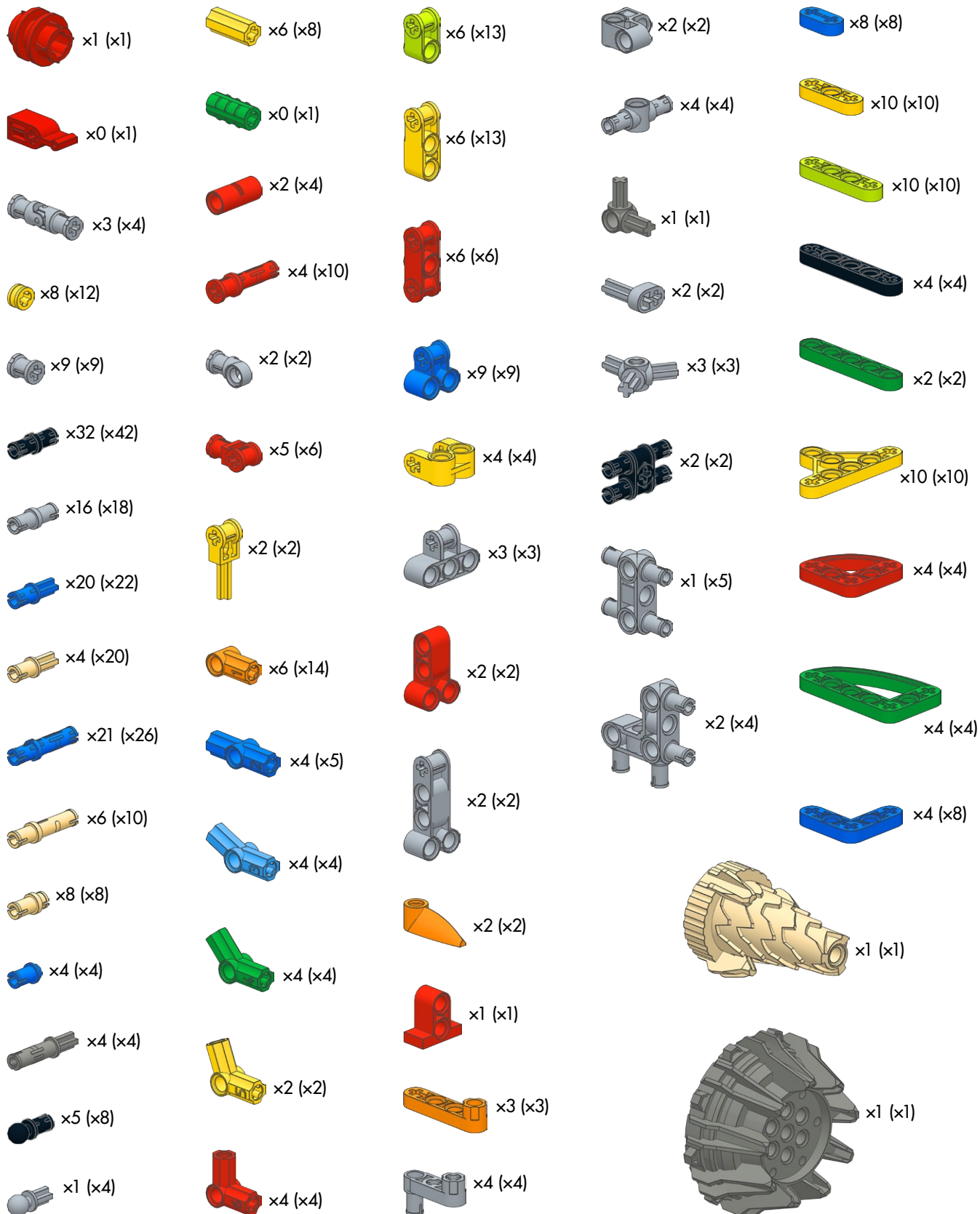
Parts list

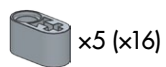
This is the maximum number of this part needed to build any single model in this book.

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*).





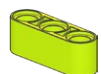




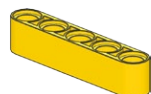
x5 (x16)



x2 (x2)



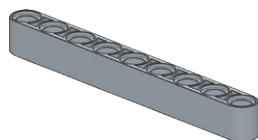
x6 (x6)



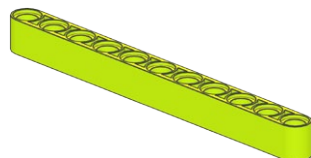
x6 (x10)



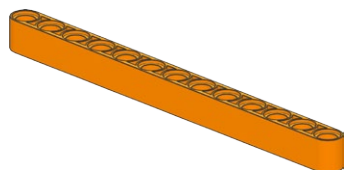
x7 (x7)



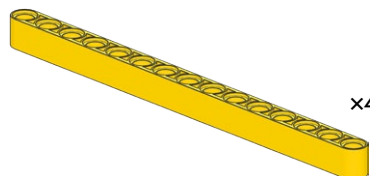
x3 (x6)



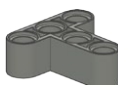
x6 (x6)



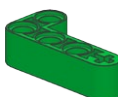
x2 (x2)



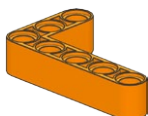
x4 (x4)



x3 (x4)



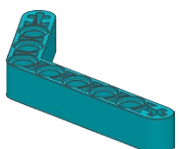
x6 (x10)



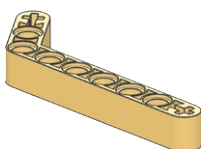
x8 (x8)



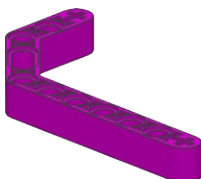
x4 (x4)



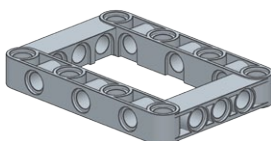
x4 (x4)



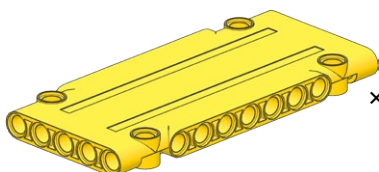
x4 (x4)



x2 (x2)



x1 (x1)



x3 (x3)



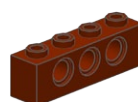
x2 (x2)



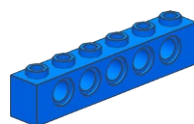
x0 (x2)



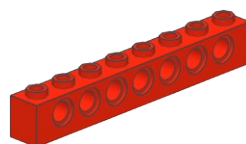
x2 (x2)



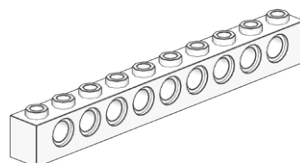
x5 (x5)



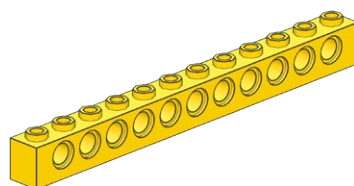
x4 (x4)



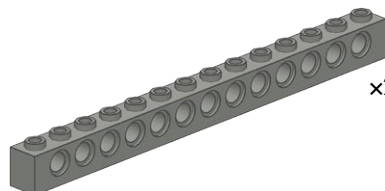
x2 (x4)



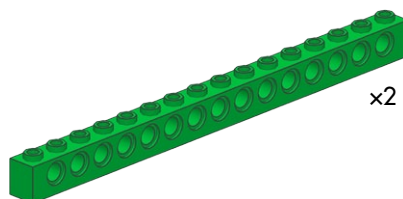
x2 (x2)



x2 (x2)



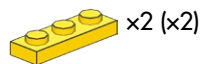
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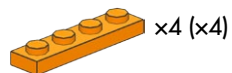
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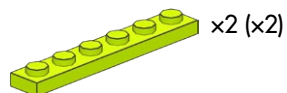
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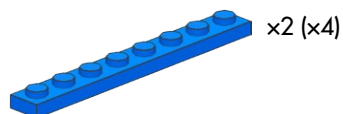
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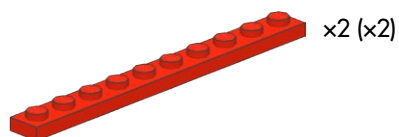
x4 (x4)



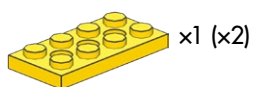
x2 (x2)



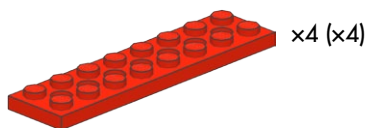
x2 (x4)



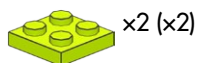
x2 (x2)



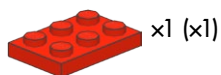
x1 (x2)



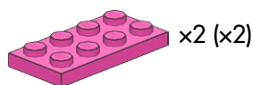
x4 (x4)



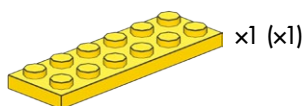
x2 (x2)



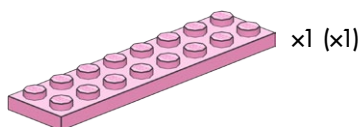
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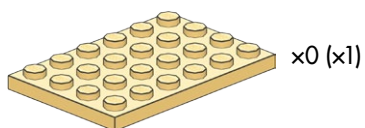
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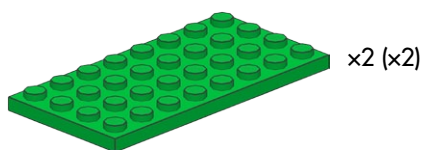
x1 (x1)



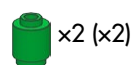
x1 (x1)



x0 (x1)



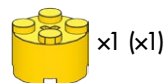
x2 (x2)



x2 (x2)



x1 (x1)



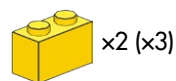
x1 (x1)



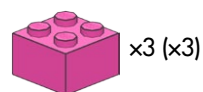
x1 (x1)



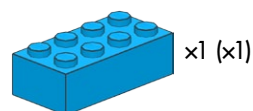
x2 (x2)



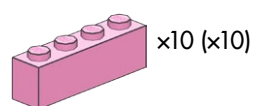
x2 (x3)



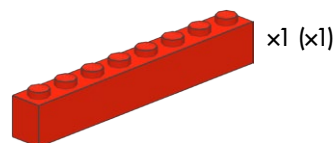
x3 (x3)



x1 (x1)



x10 (x10)



x1 (x1)

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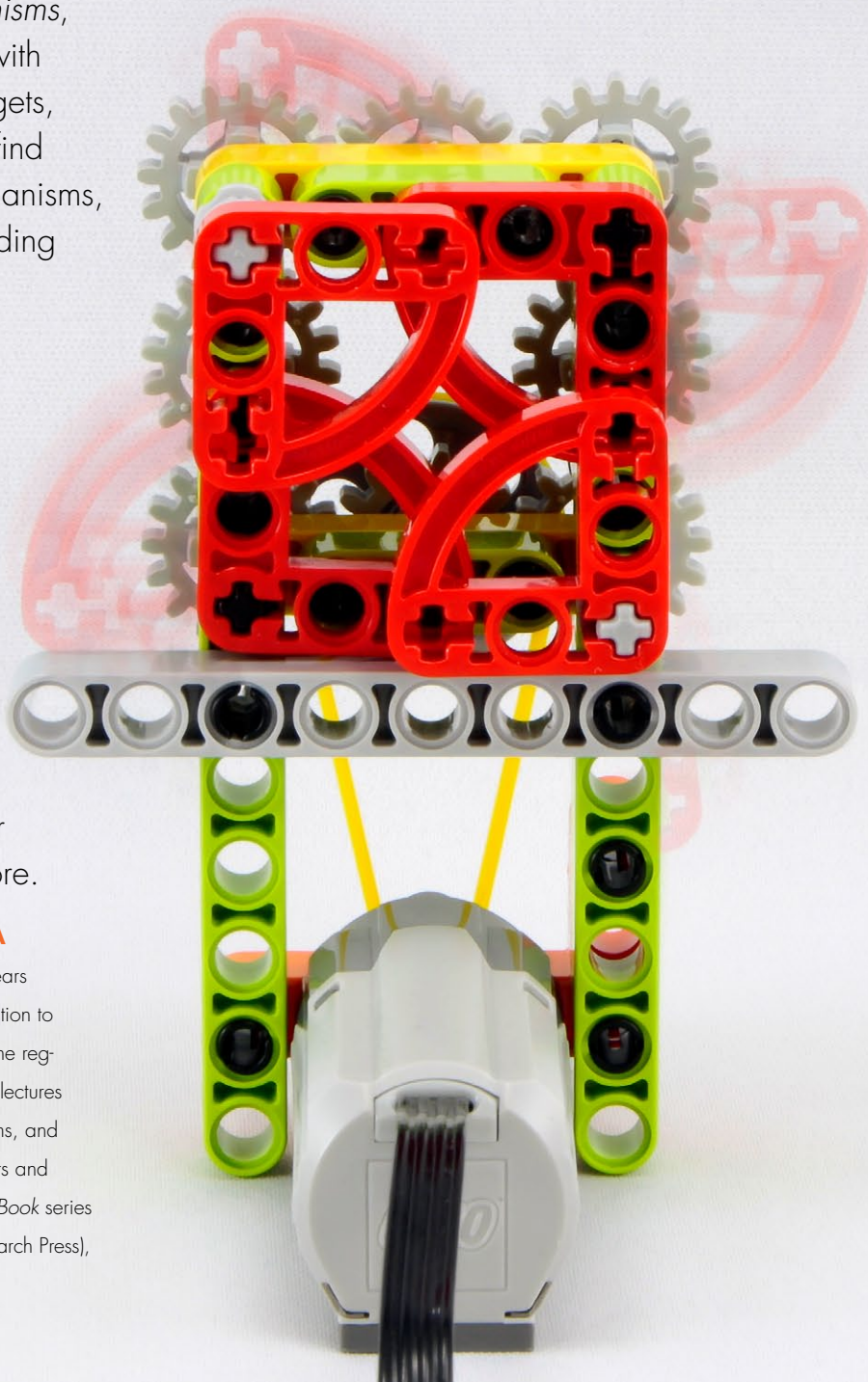
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