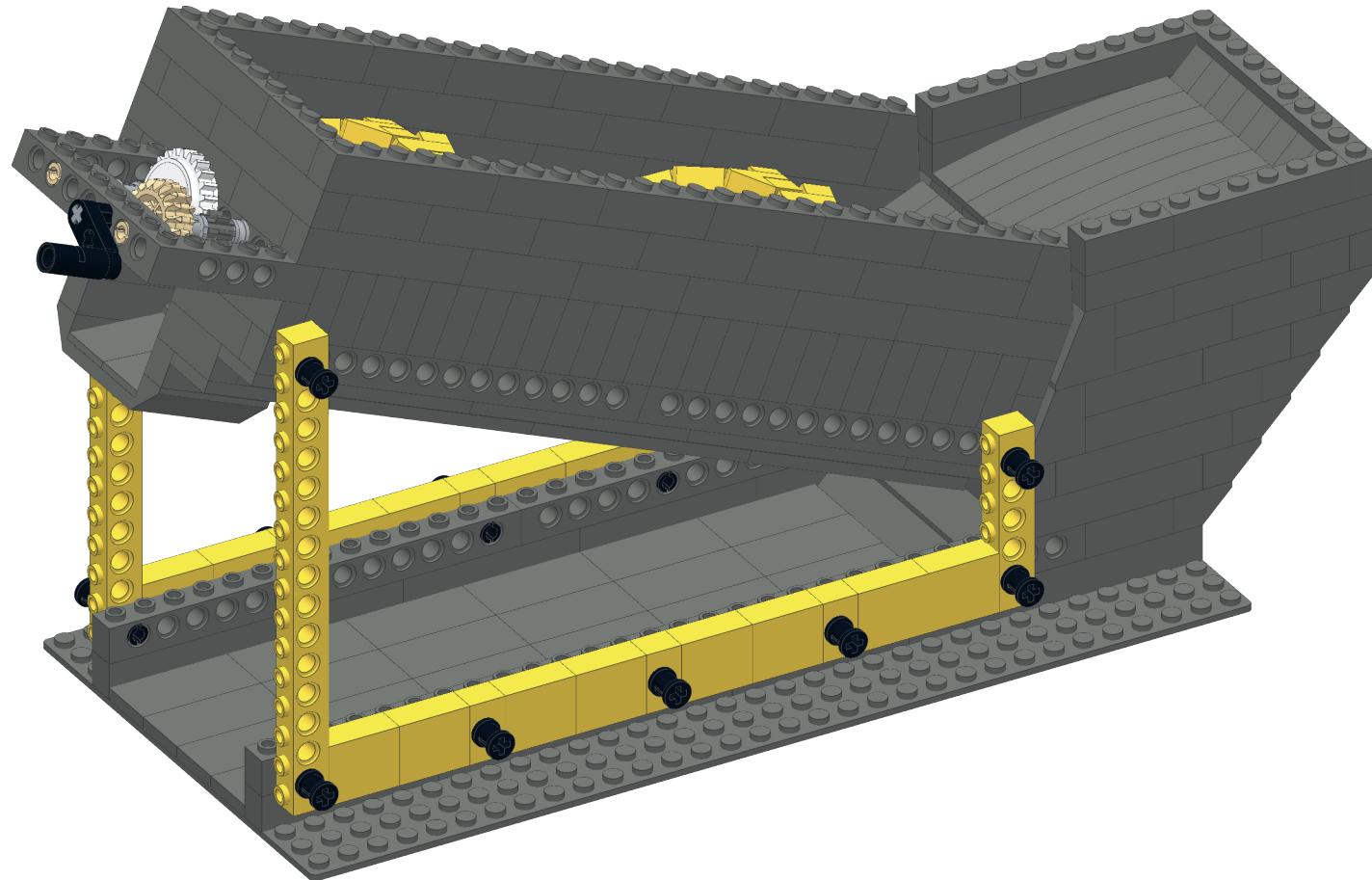


# Great Ball Contraption



Greek screwpump

# The Great Ball Contraption

LEGO® fans throughout the world gather regularly to show their creations to each other and to the public. These events also allow them to put their efforts together to build bigger, communal displays. Among these, the Great Ball Contraption has quickly become a public favourite at a lot of events.

In the first LEGO® exhibitions, most collaborative displays focussed on dioramas for LEGO® minifigures: city, trains, castle or space were common themes. Technic fans were feeling their own theme was under-represented and some of them decided to show a common creation for the BrickFest exposition of 2005.

They quickly settled on a machine similar to the creations of Rube Goldberg: a complex design to achieve a simple task. The task they chose was indeed very simple: move LEGO® balls (soccer or basket) around. They also devised a set of rules which allowed them to work independently of each other and still be sure that their creations could be combined with a minimum of coordination.

The core rules created in 2005 were as follows:

- Each Great Ball Contraption module is an independent unit which has the purpose of transferring LEGO® balls received from the previous module, to the next one.
- Each module has an input box with easy-to-remember fixed dimensions: 10 LEGO® bricks high, deep and wide.
- Each module has to move the balls received in its input box so that they will land in the input box of the next module. This usually involves lifting them up one way or the other, a

task which every participant is free to achieve however he wants - the more convoluted the better!

- Each module should be able to receive and transfer 1 ball per second and should be able to receive a batch of 30 balls at once.

These rules are still in use nowadays, even if the tempo at most exhibitions is usually slower than 1 ball per second. Some flexibility is also allowed: for example, the input box may be bigger or lower than the standard.

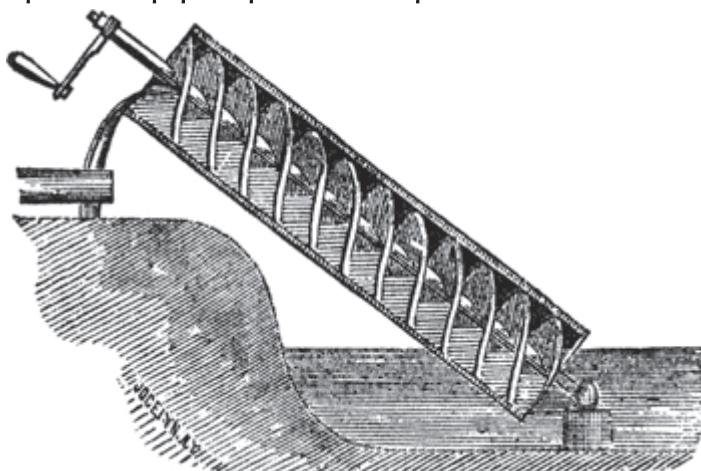
# Archimedes' screw

Lifting water is an age-old agricultural problem : in regions where rainfall is insufficient to support crops, irrigation is required: water has to be transported to the cultures from some other place - possibly a lower one.

The task accomplished by the Great Ball Contraption is very similar to transporting water. As such, a lot of the techniques used for water transport can be used as ideas for new modules.

Of these, one of the oldest techniques is Archimede's screw. Archimedes was a Greek mathematician who lived more than 2200 years ago and is credited for discovering a lot of principles and inventions which are nowadays taken for granted. The screwpump is attributed to him, although it is unsure if he discovered it himself or if it was even older than that.

The design of Archimede's screw is very simple: it consists of an helical screw along a central cylindrical axle, rotating in a hollow pipe. As the axle rotates, the screw forces water to slide up in the pipe up to the top.



Archimedes' screw - early illustration

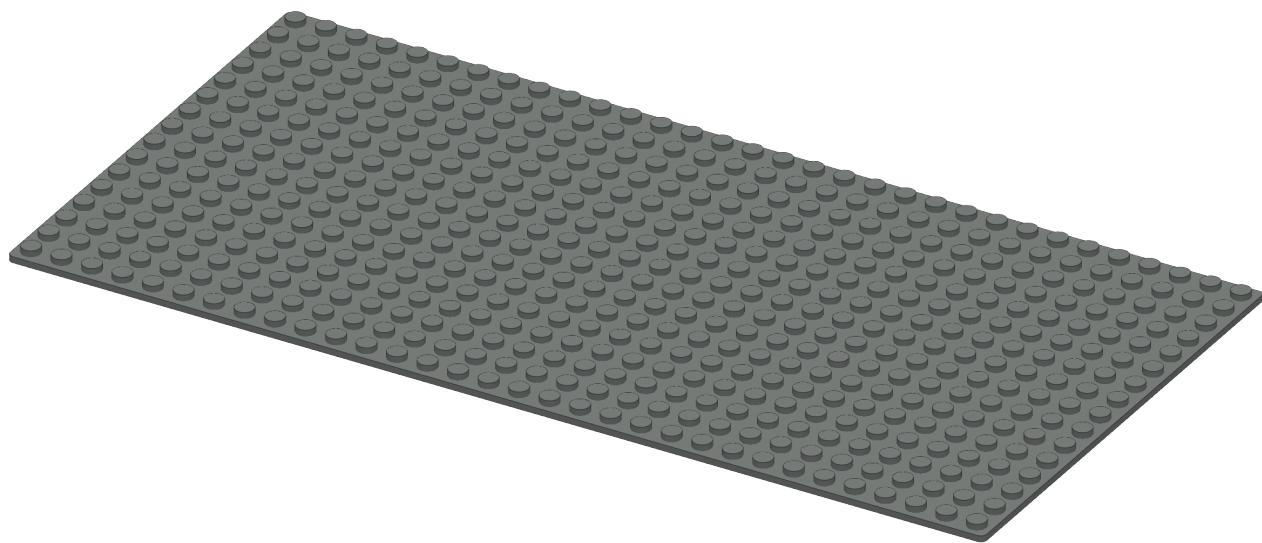
The design is very efficient and a screwpump could be operated manually in the antiquity.



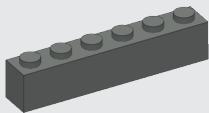
Screwpumps in Kinderdijk, Netherlands

A screwpump can also be used to drain low bodies of water, such as the polders in the Netherlands - tracts of lands which are even below sea level. In the Kinderdijk village, 19 windmills were built around 1740 to provide the required mechanical power. Two steam-powered pumping stations were added in 1868, which were replaced by electrical pumping stations in 1924 in 1953.

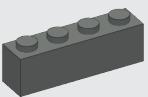
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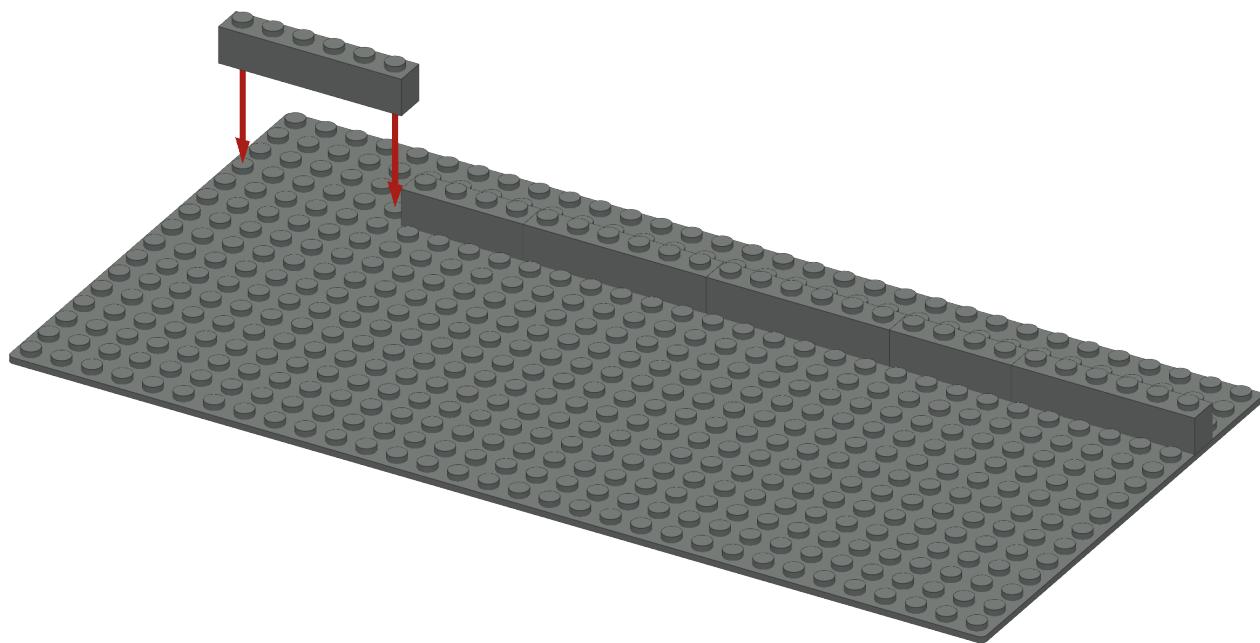


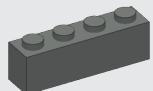
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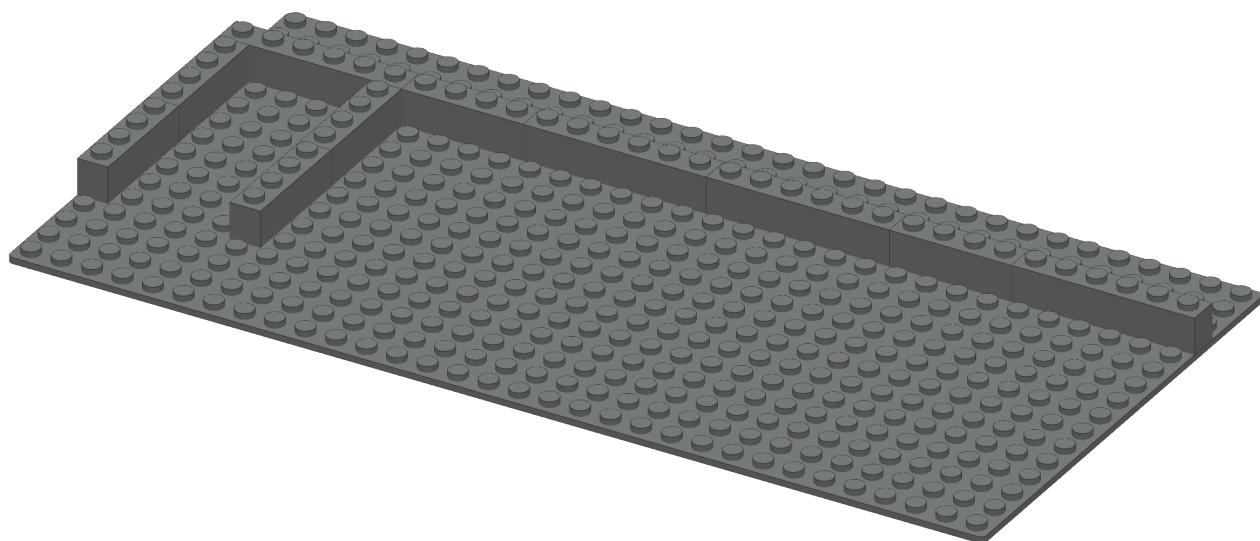
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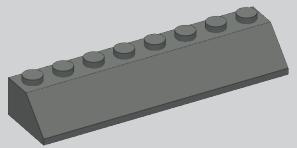




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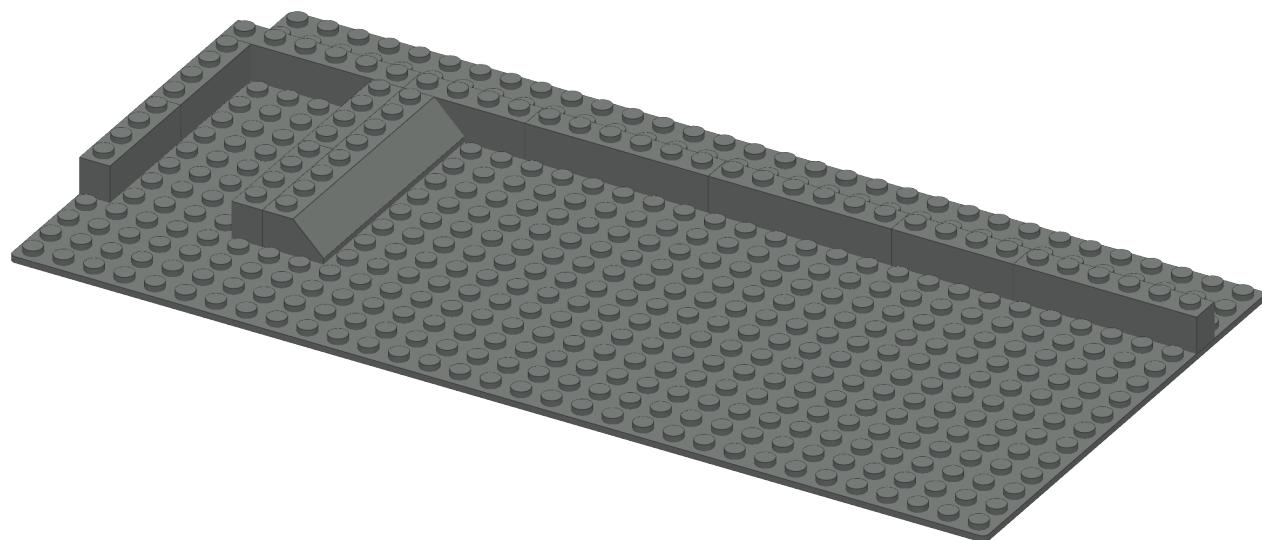
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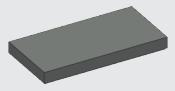




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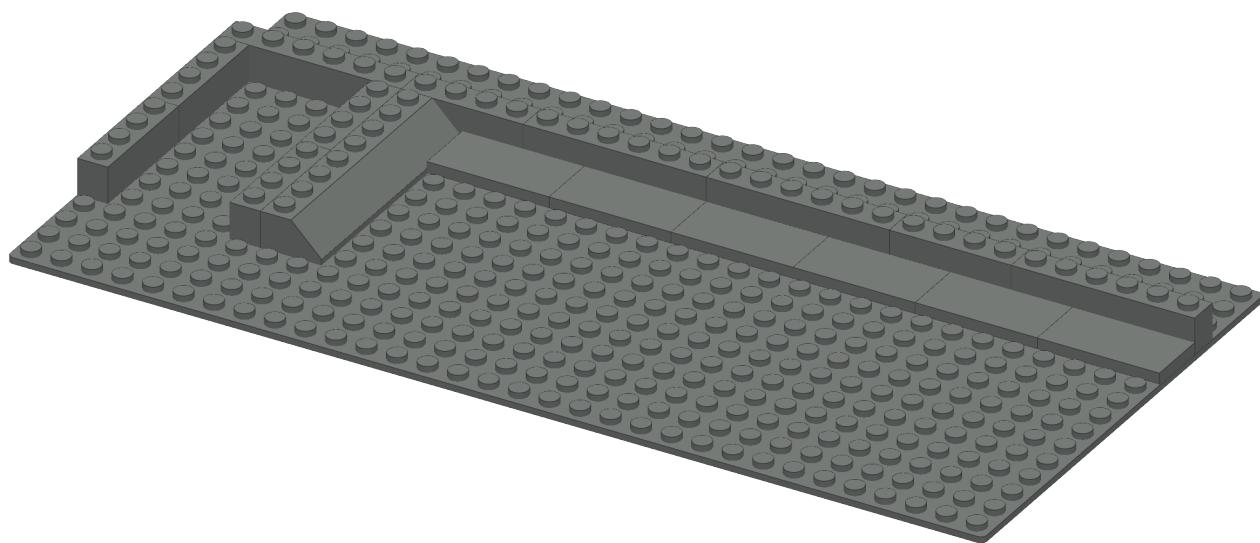
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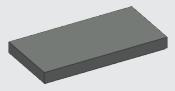




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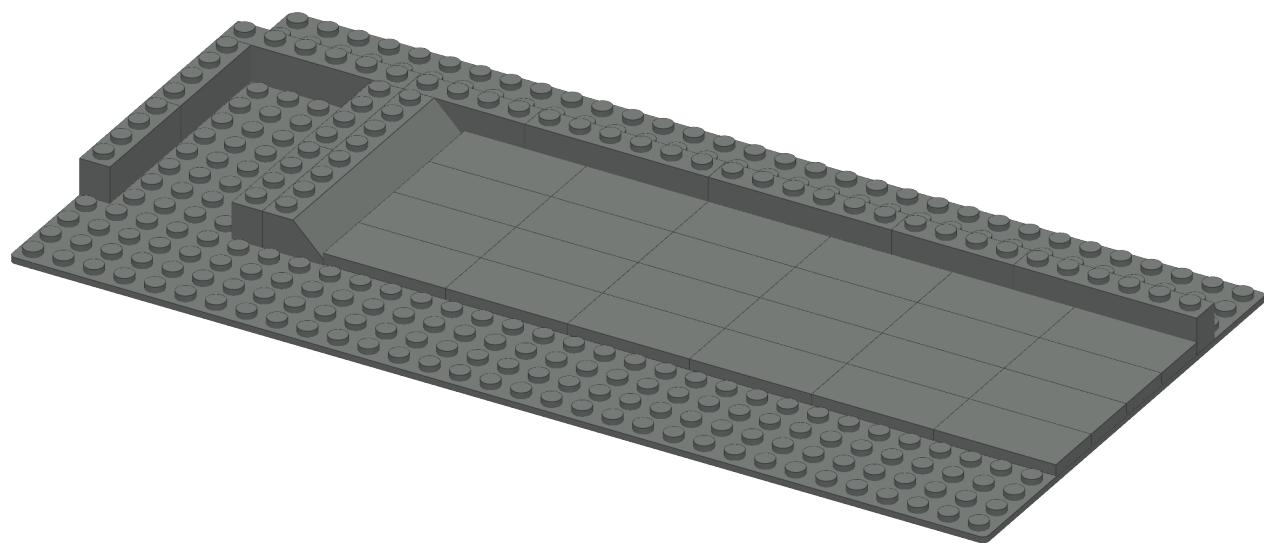
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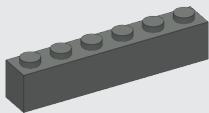




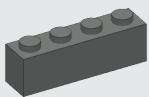
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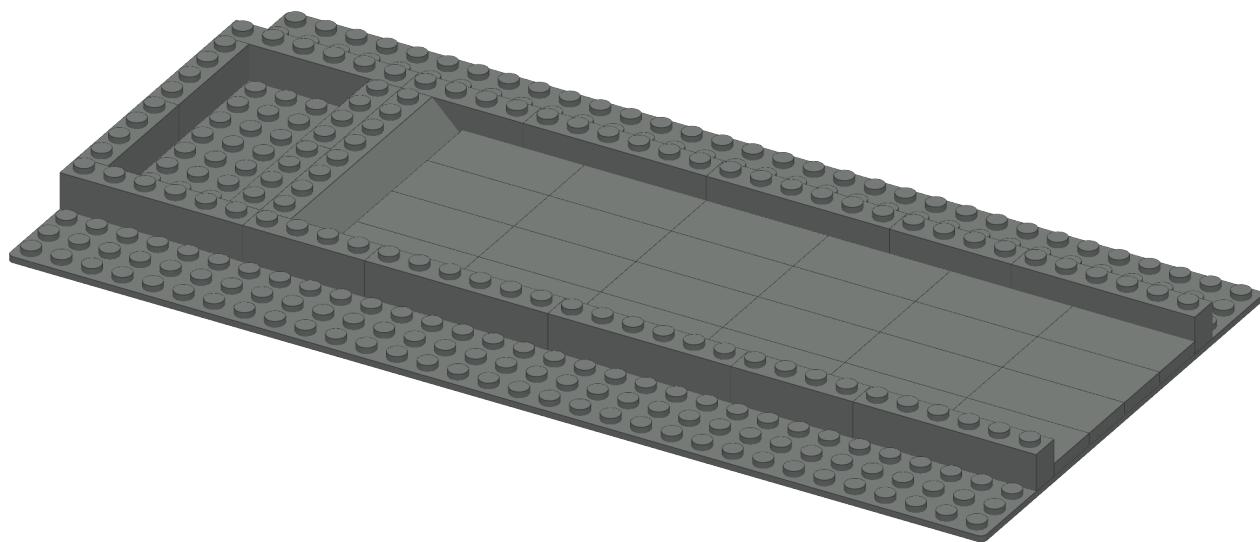


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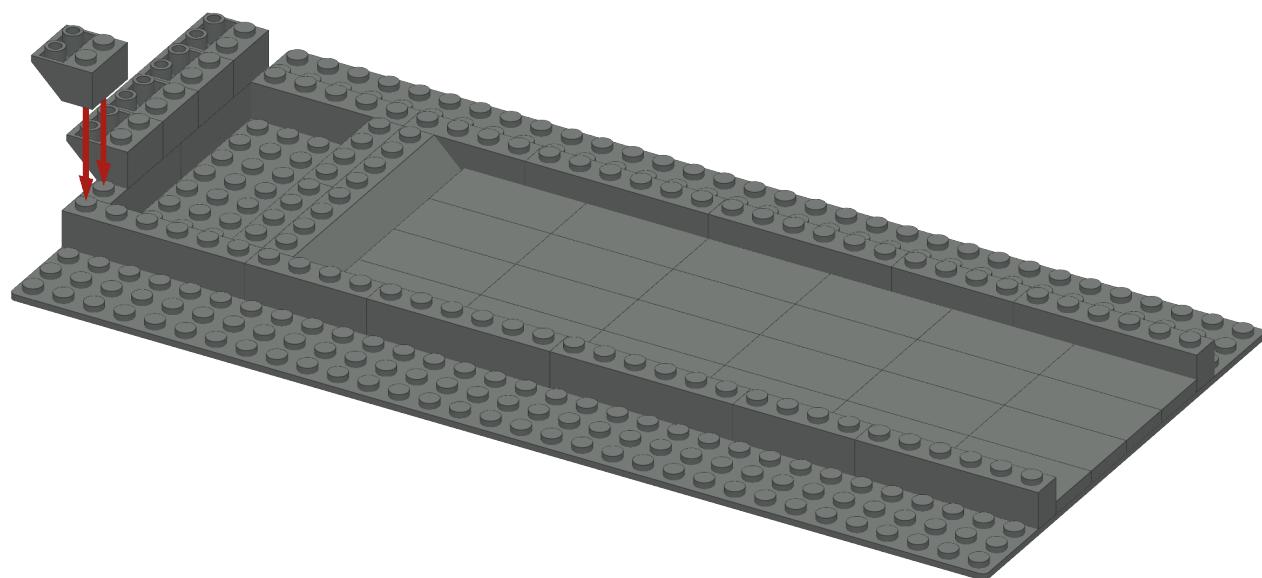
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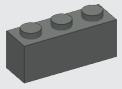




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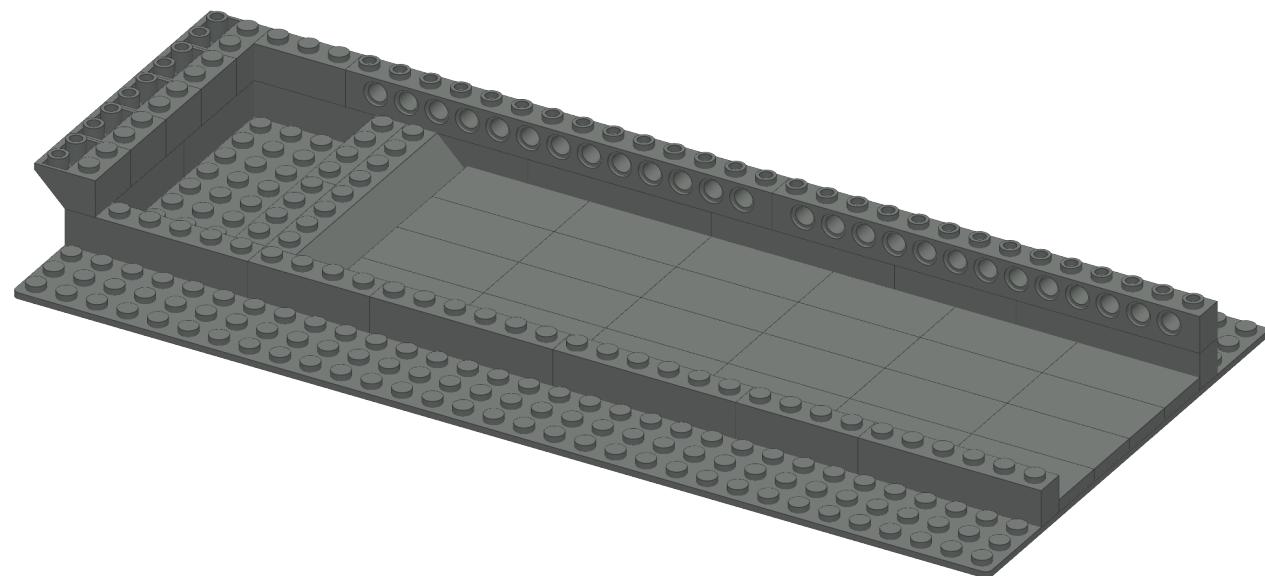


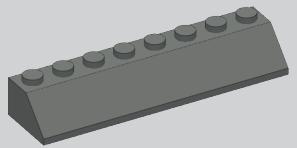
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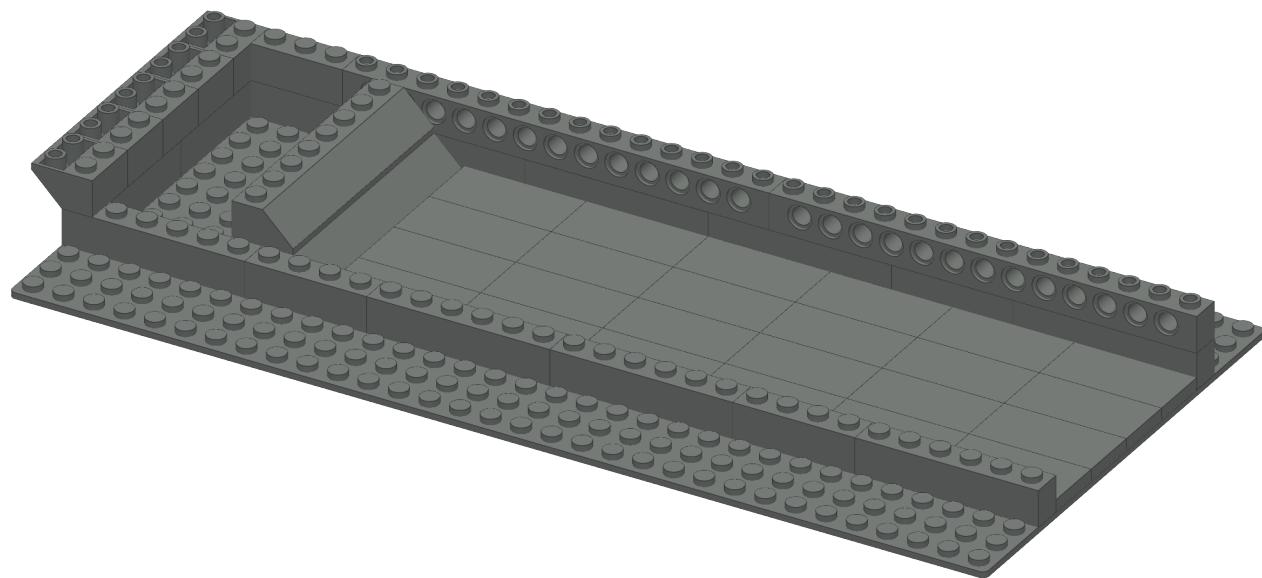
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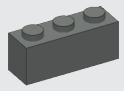




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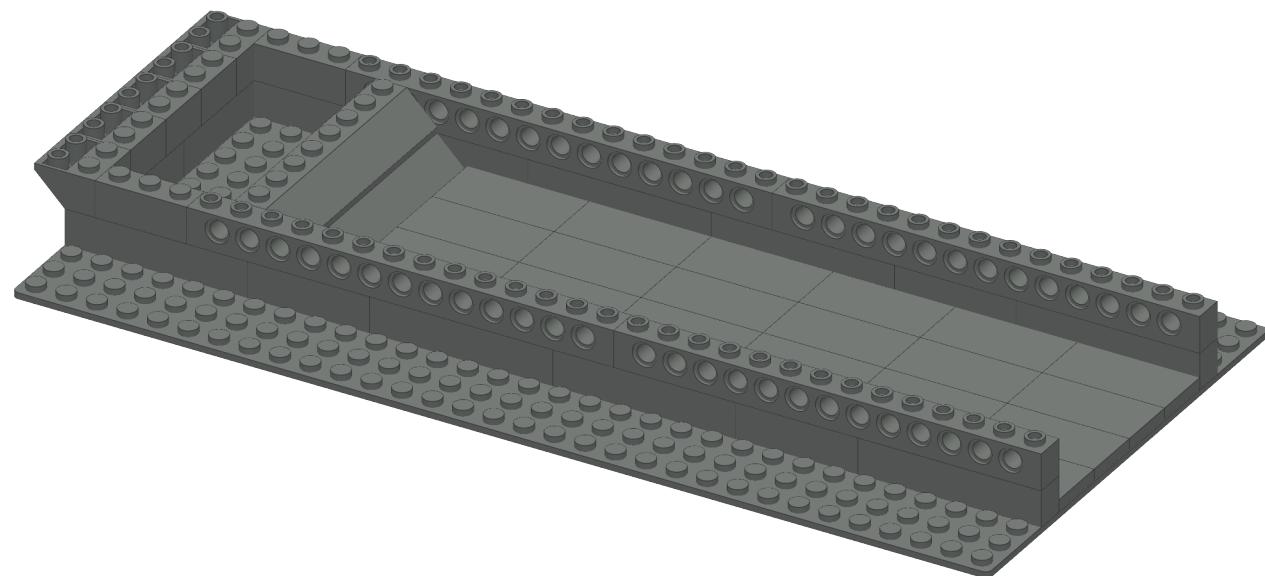


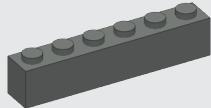
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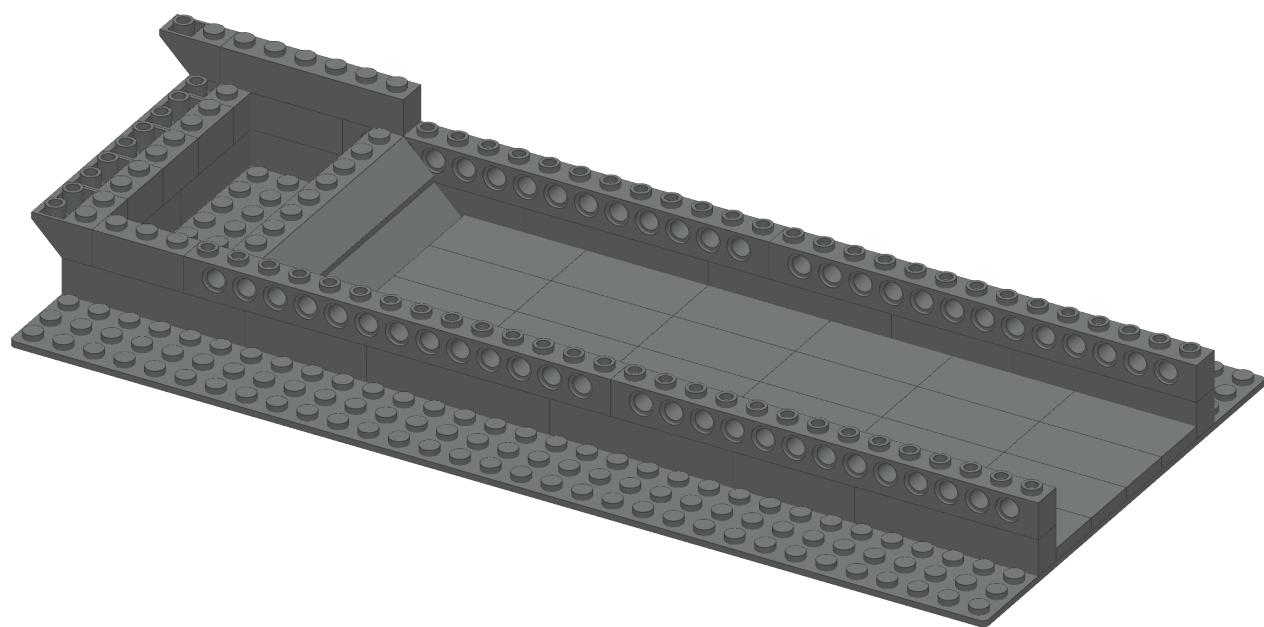


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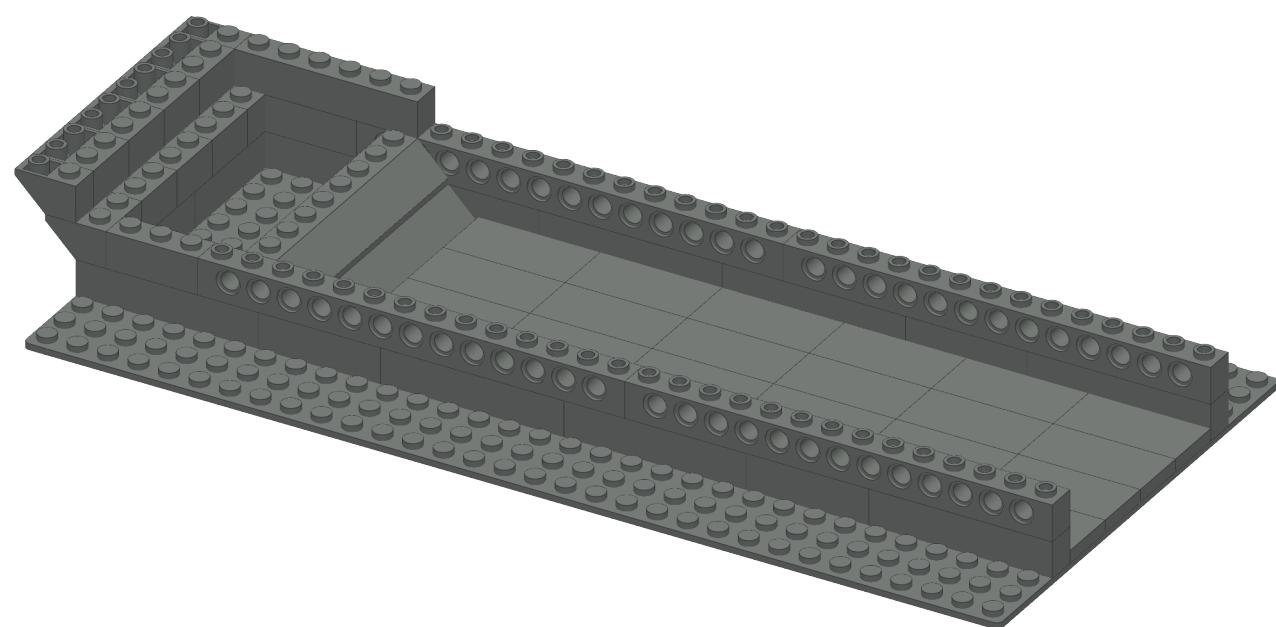


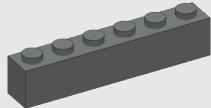
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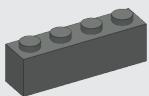
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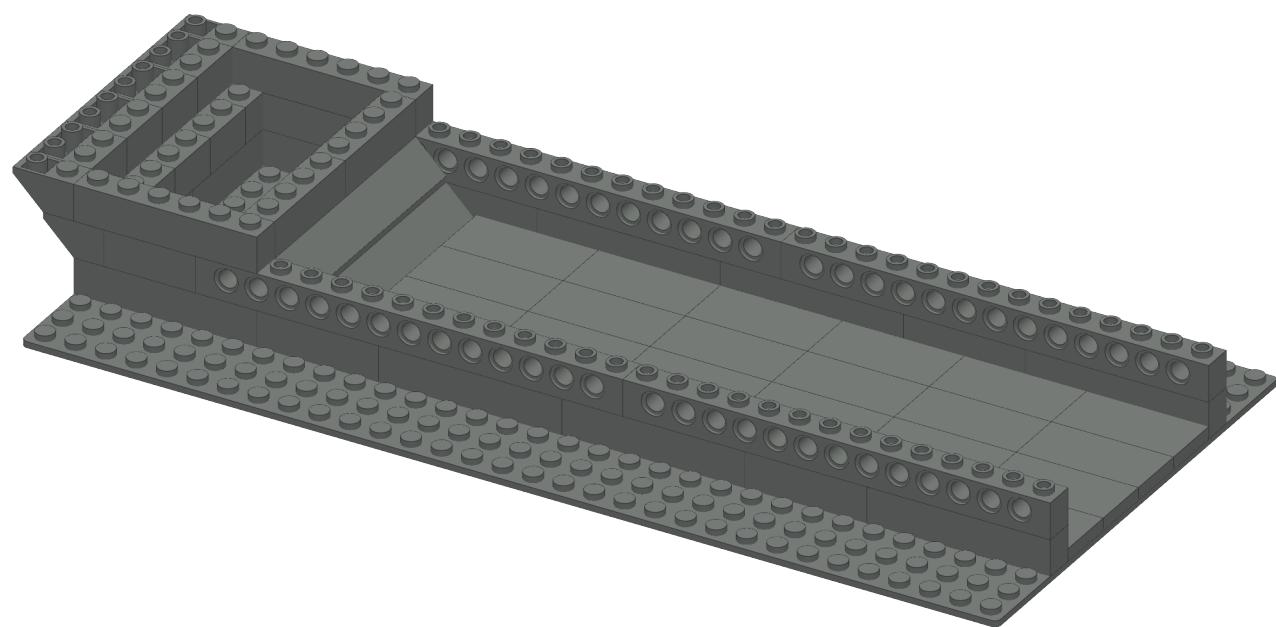


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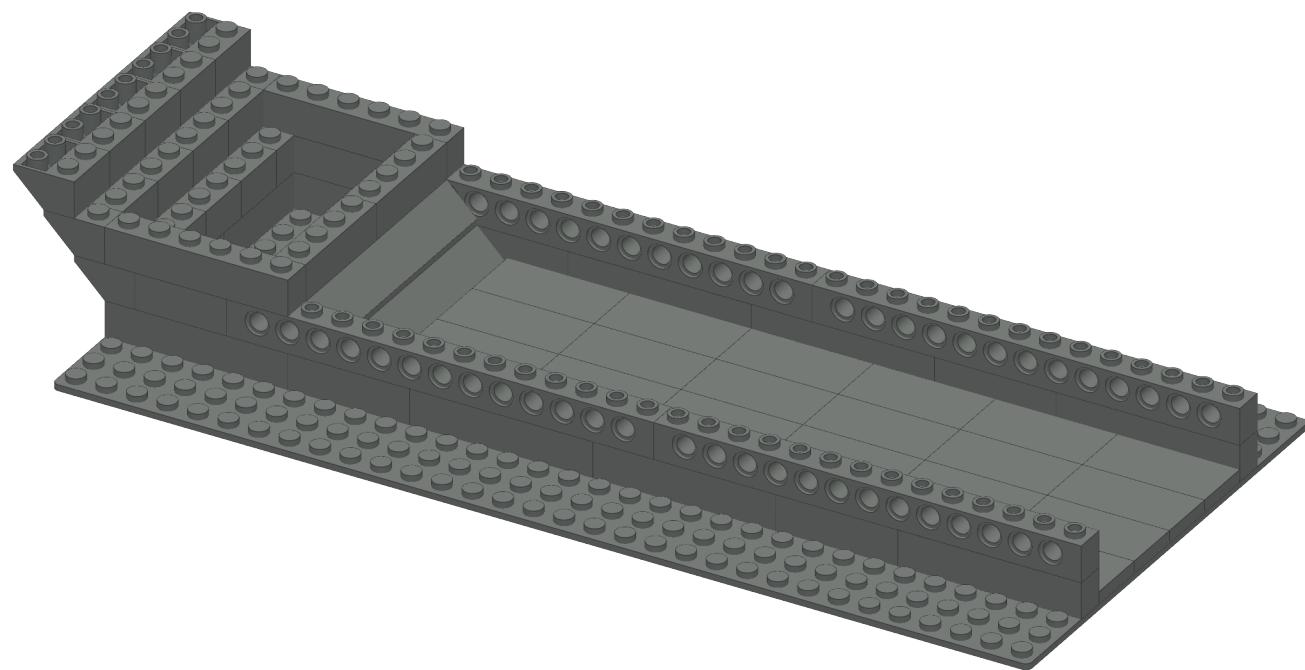
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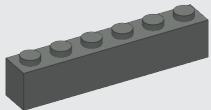


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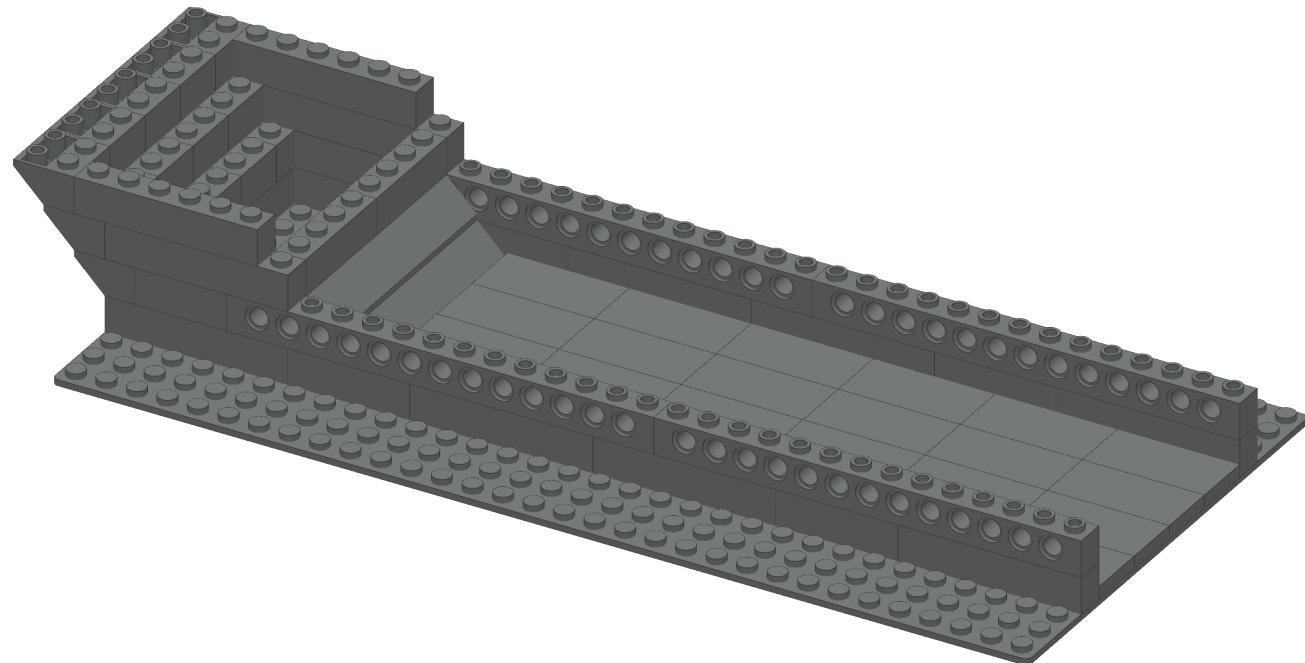


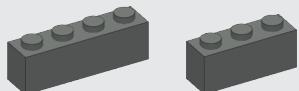
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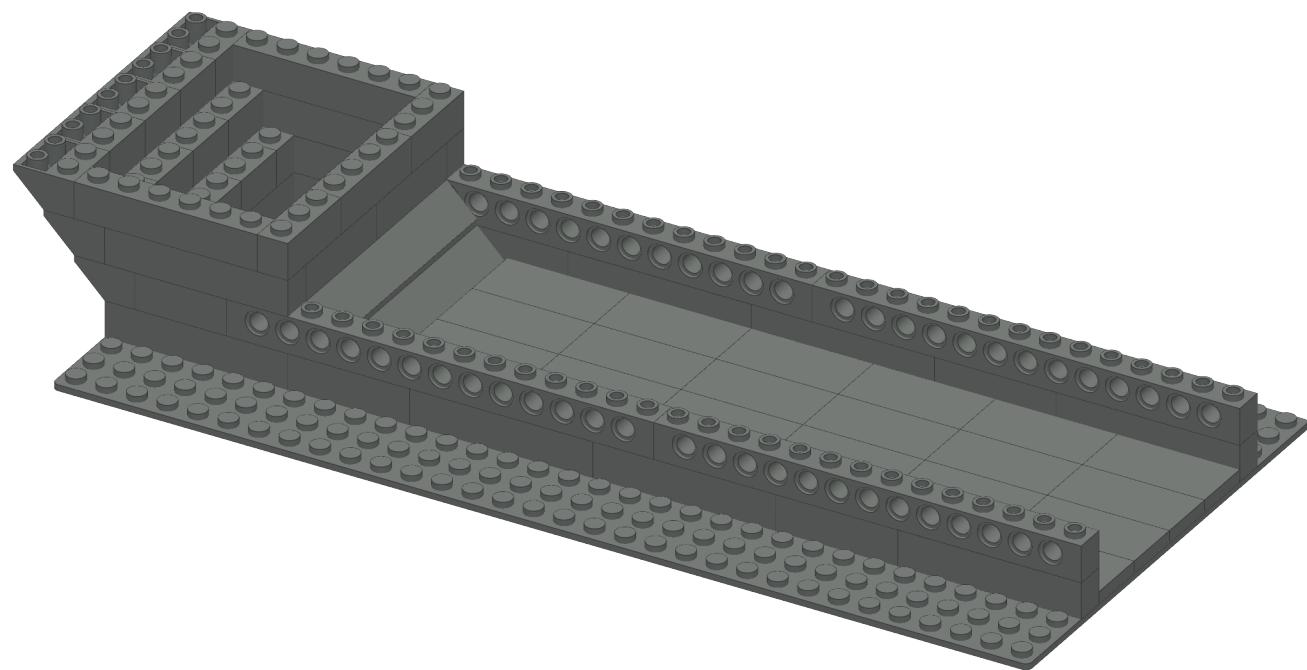
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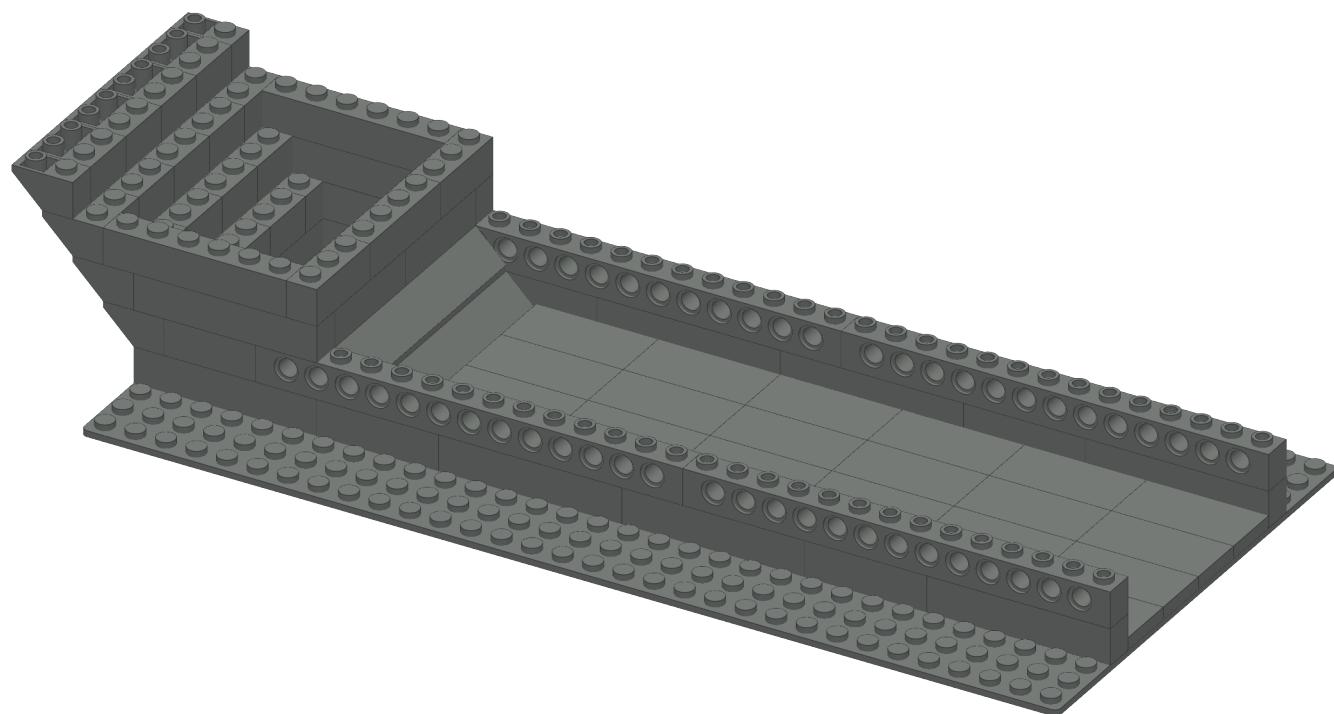


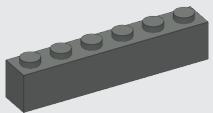
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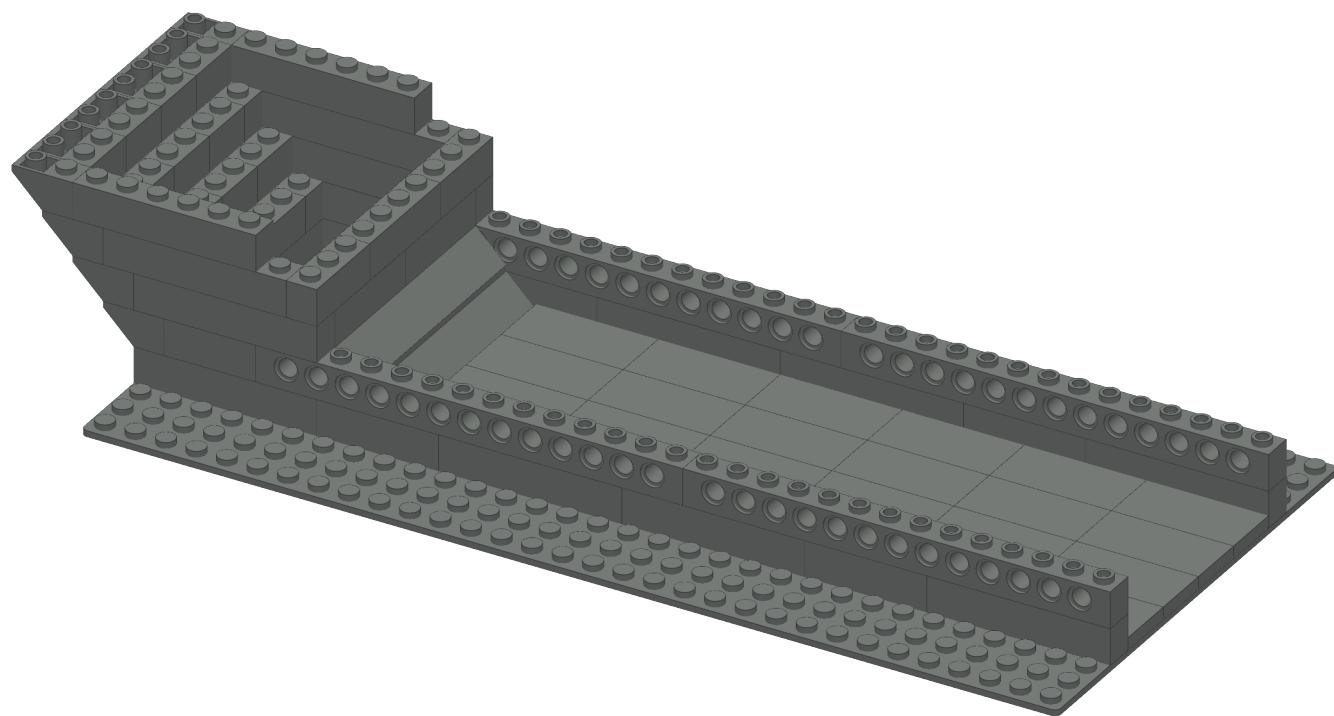
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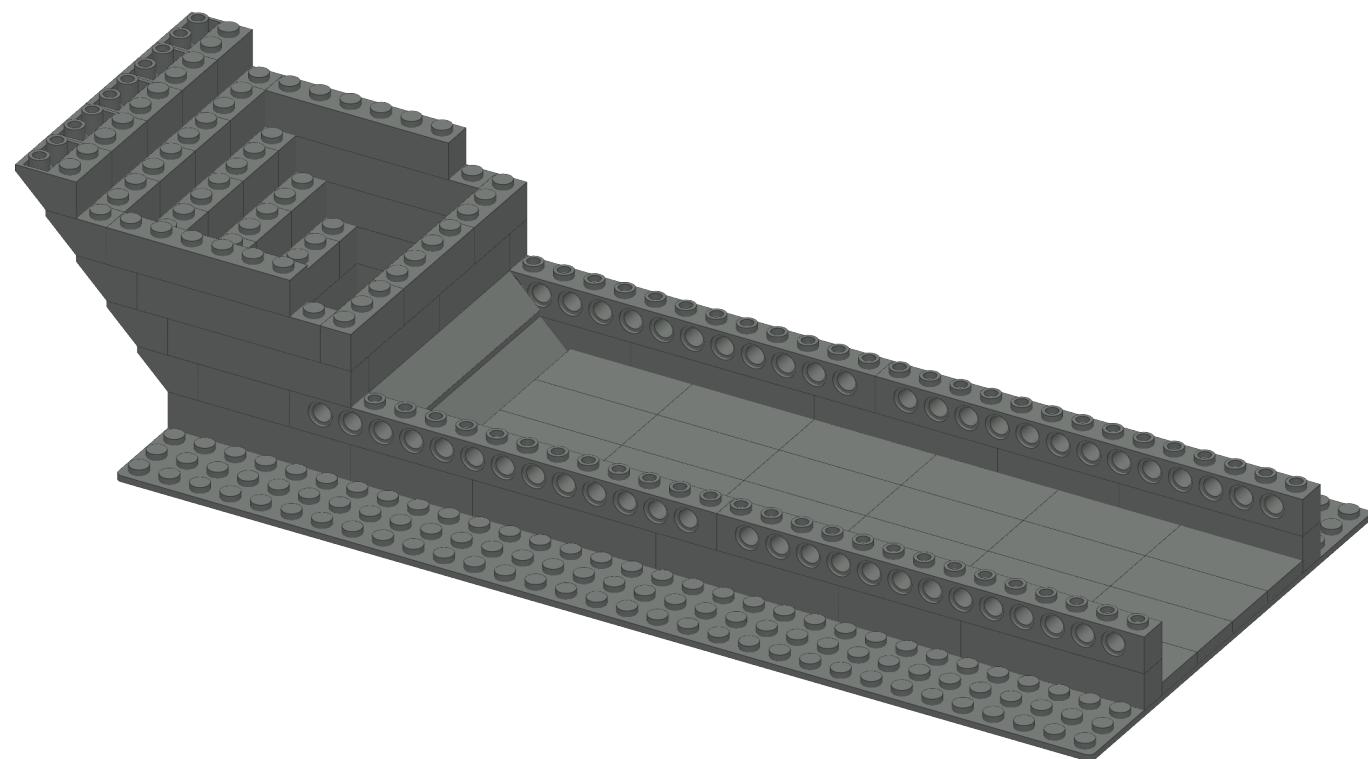
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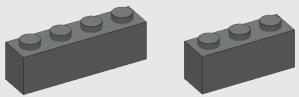




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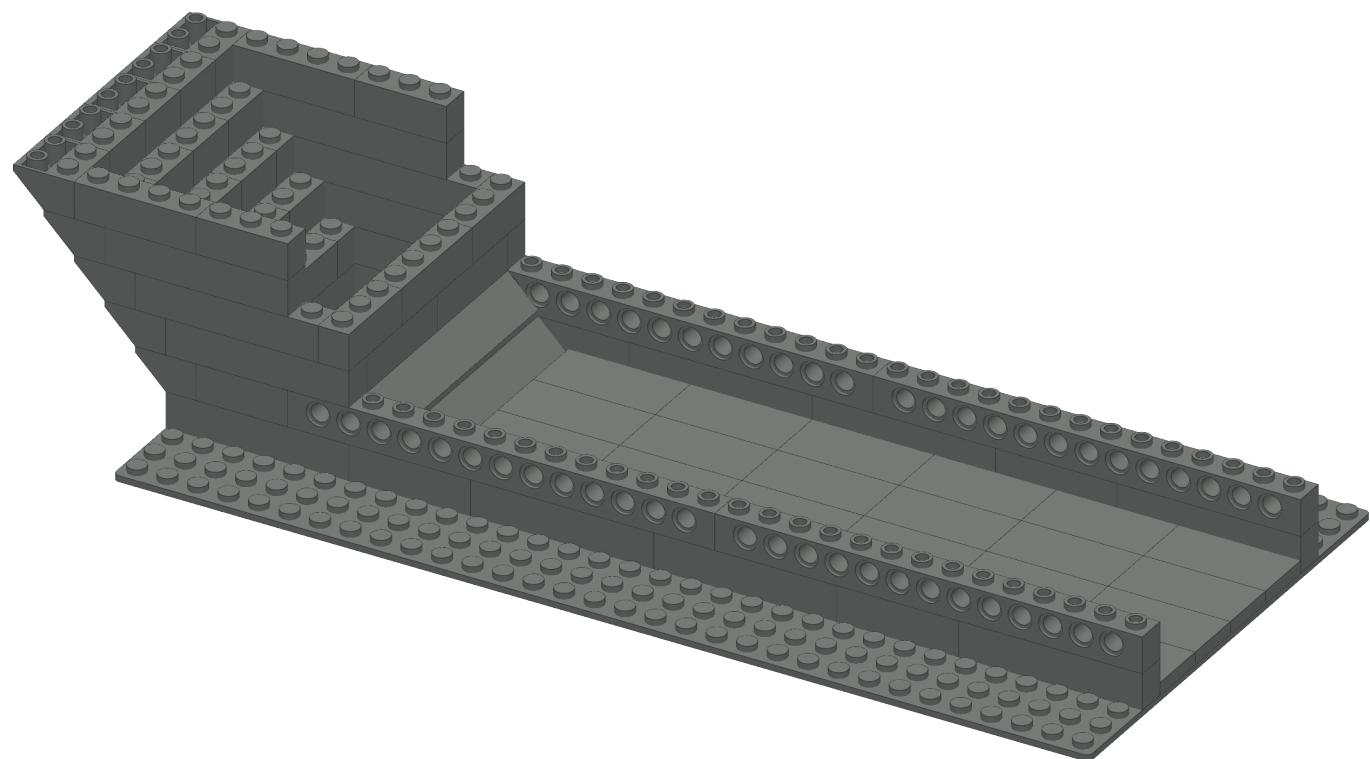




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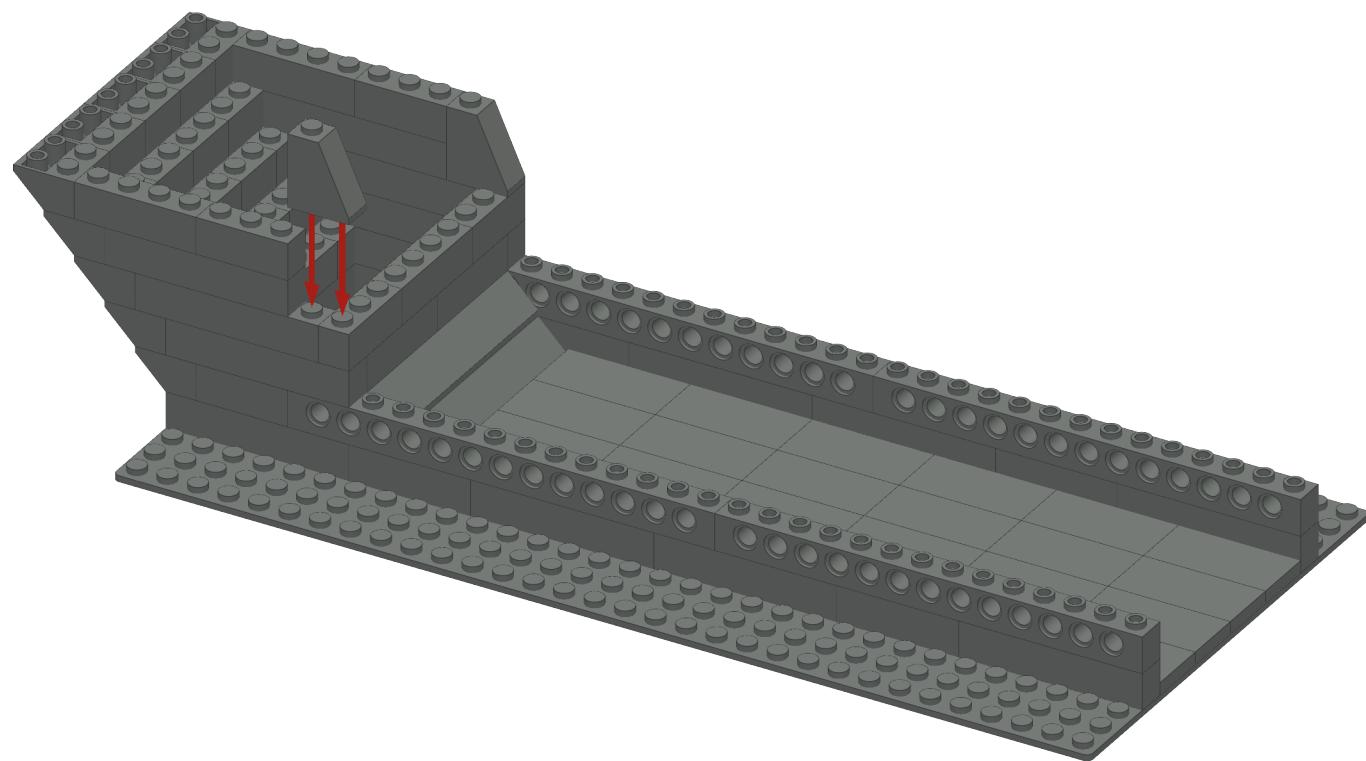
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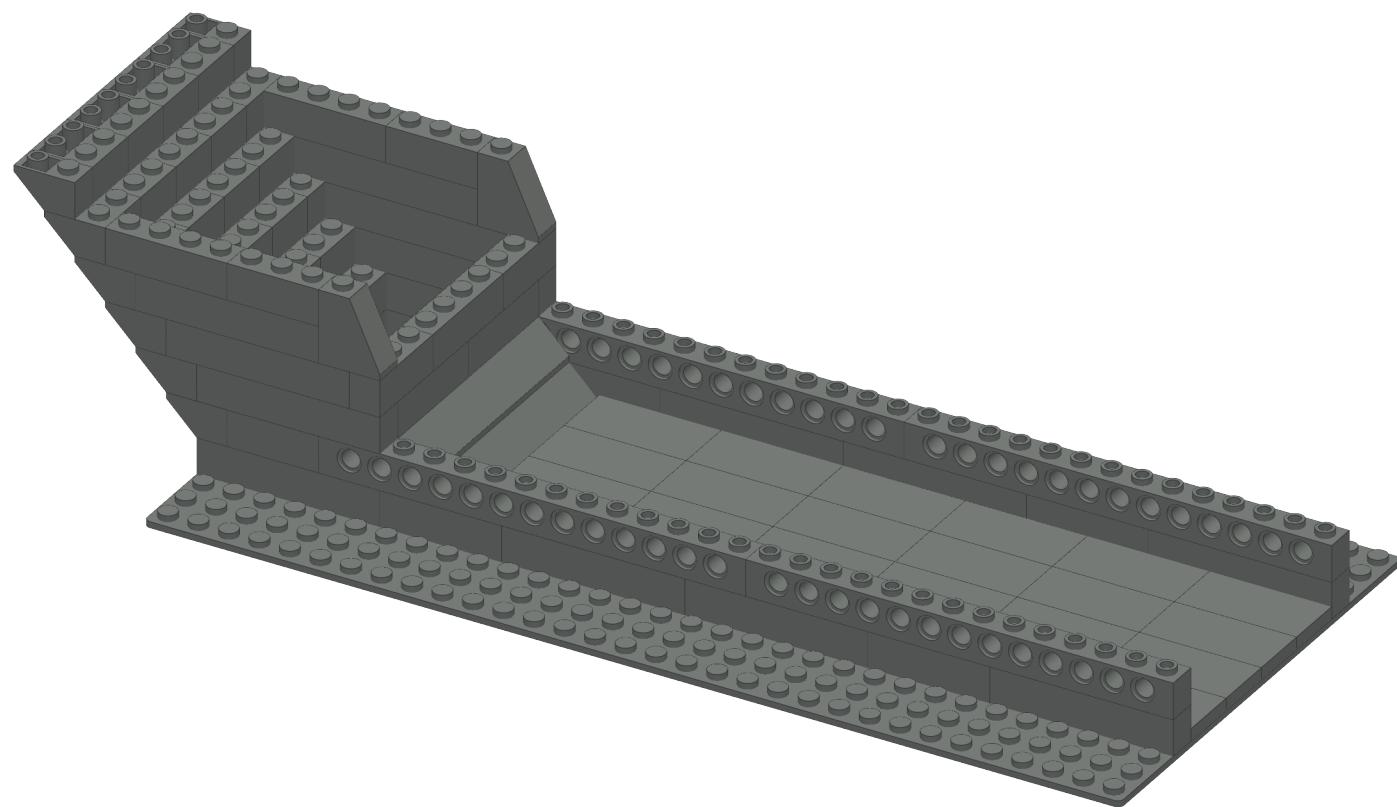
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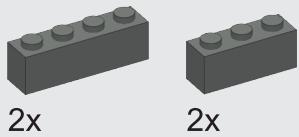




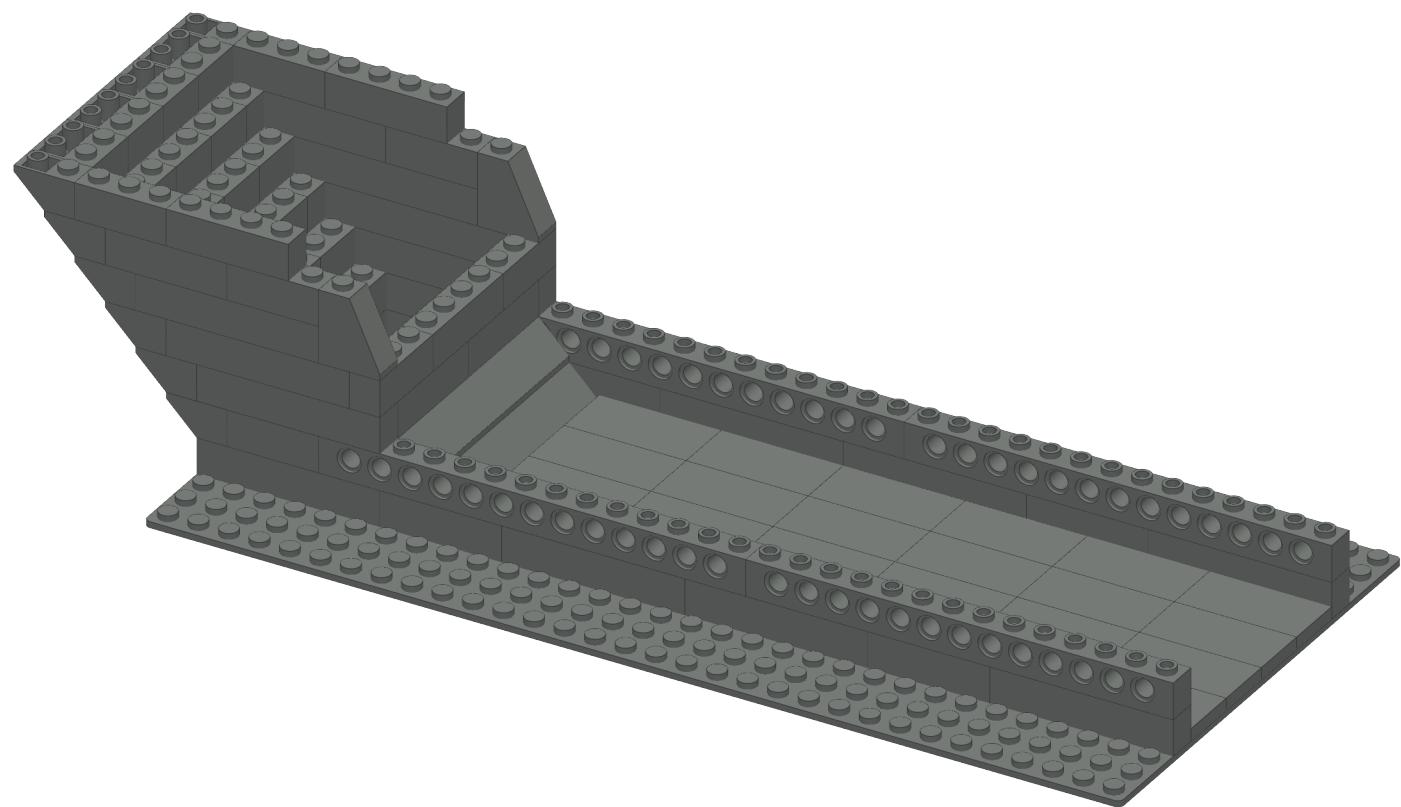
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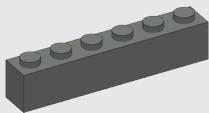
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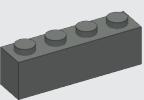


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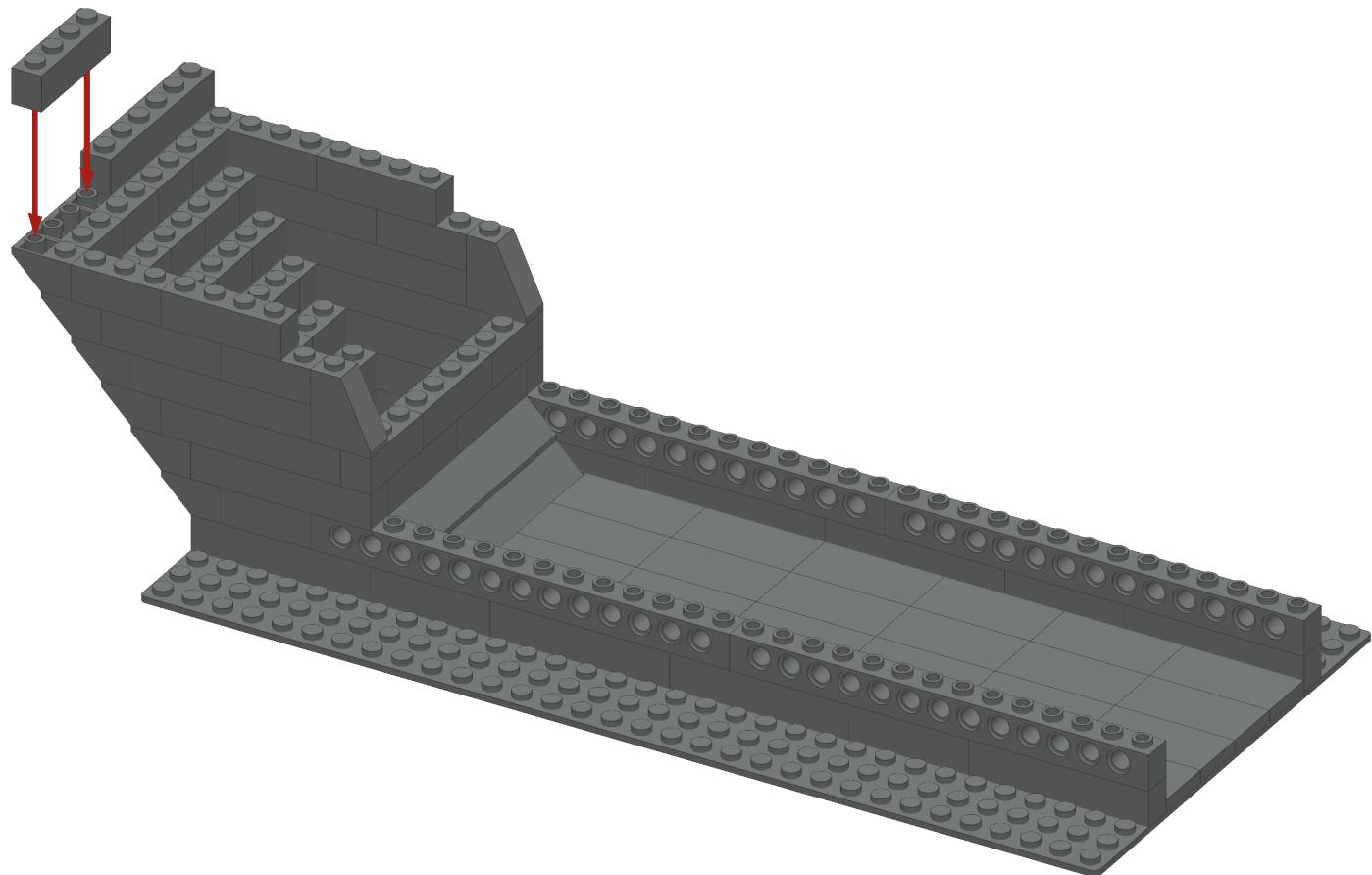


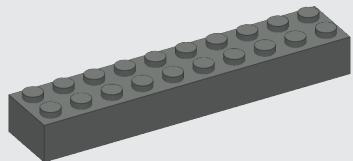
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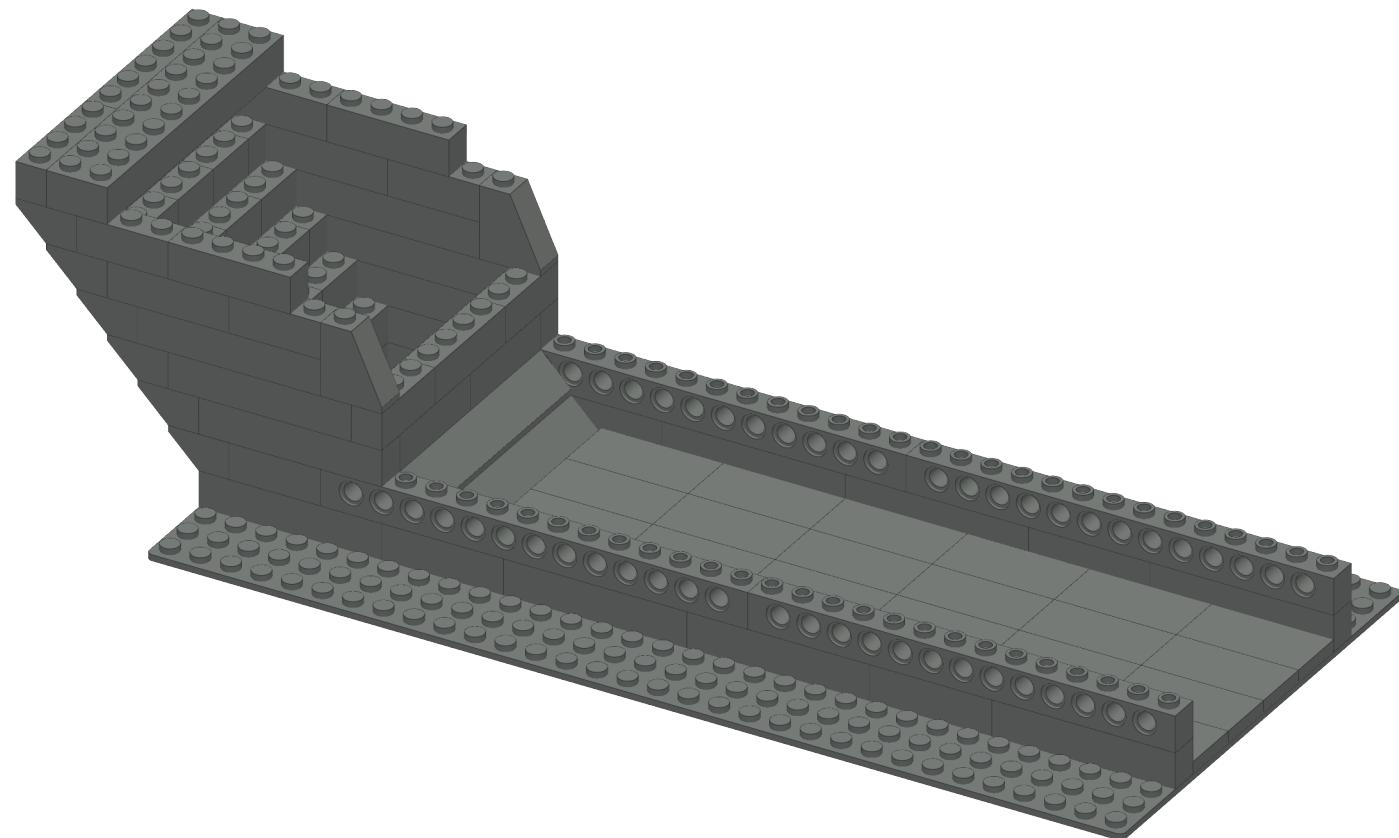
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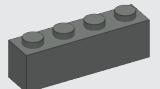




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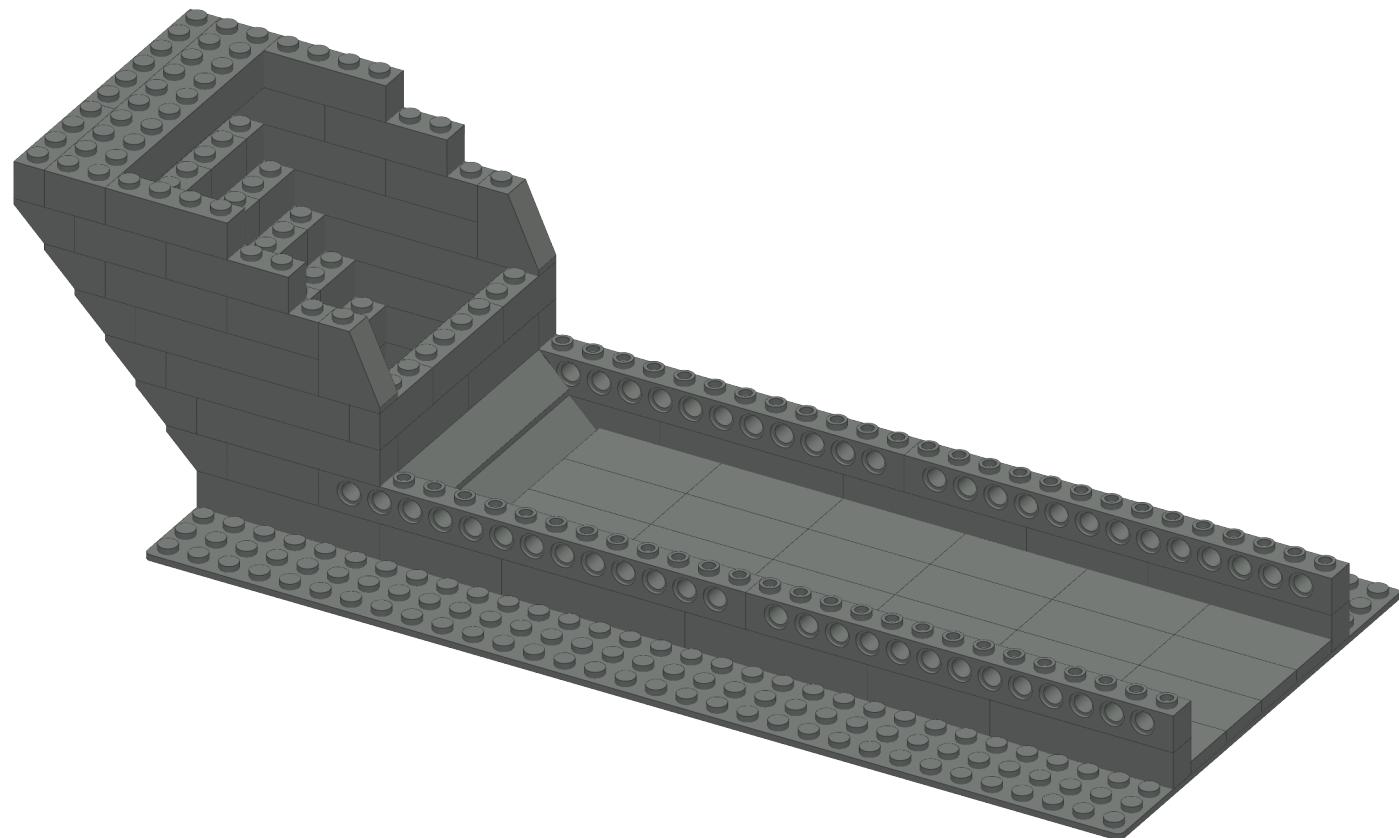
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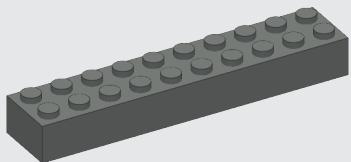




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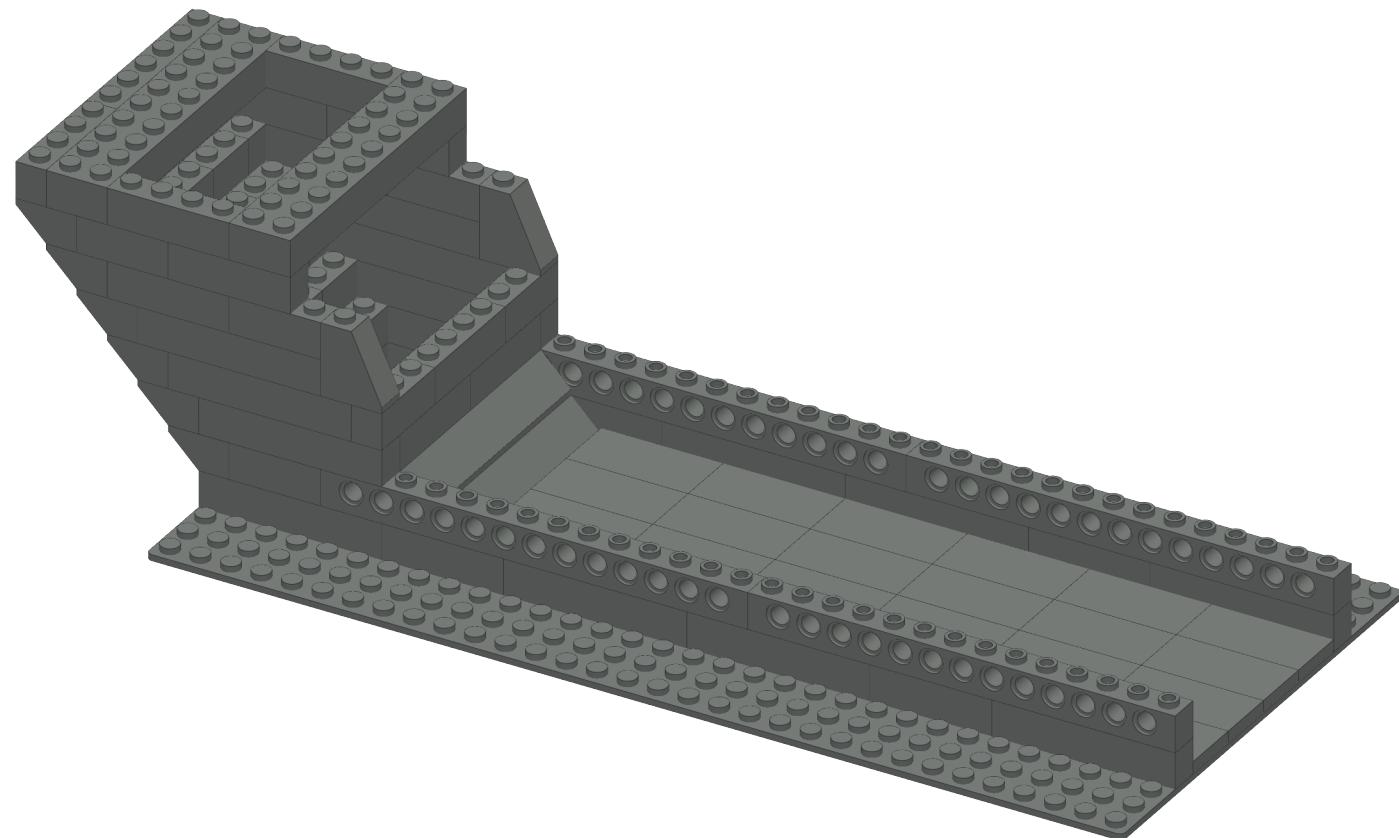
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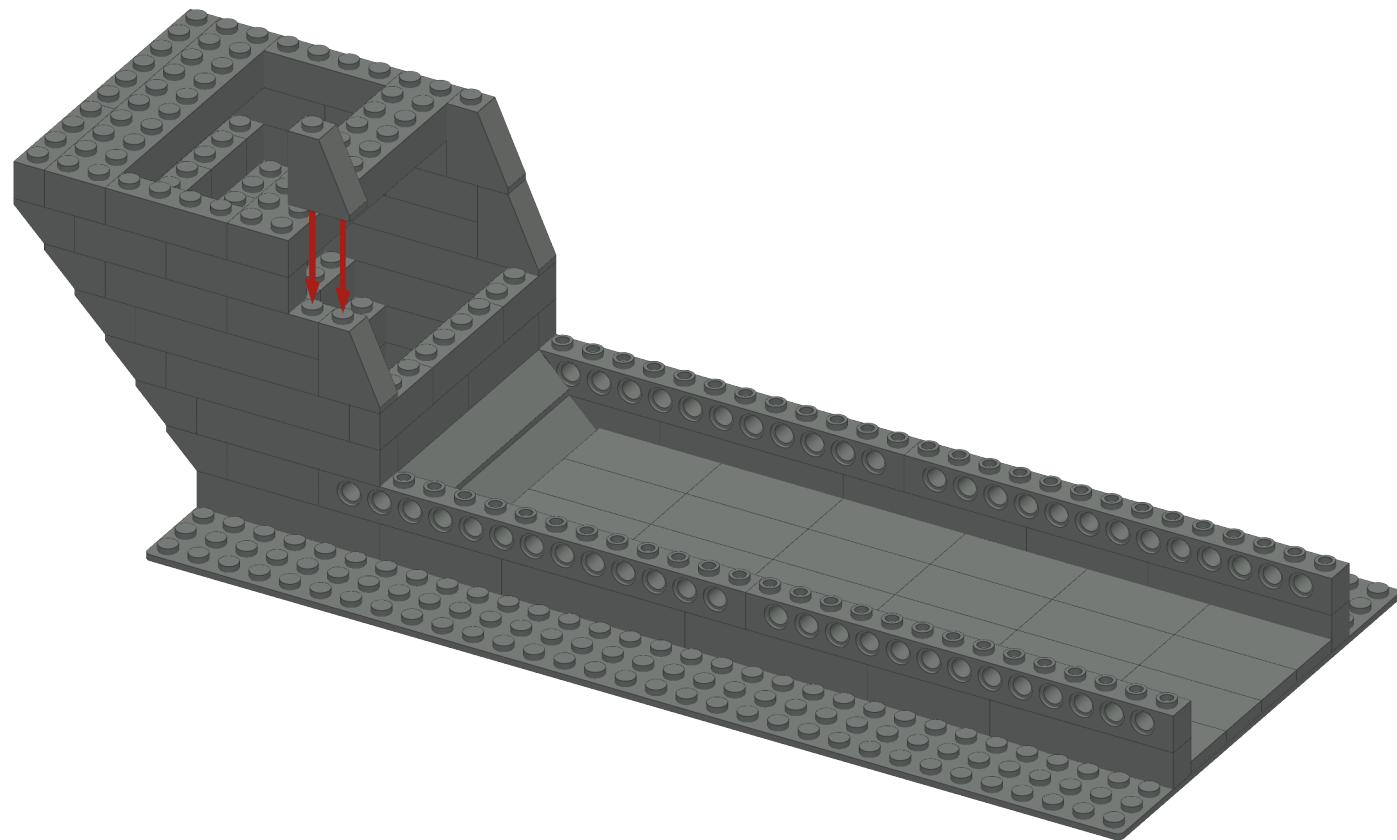
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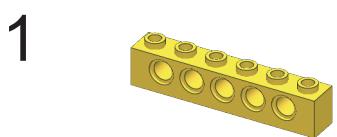
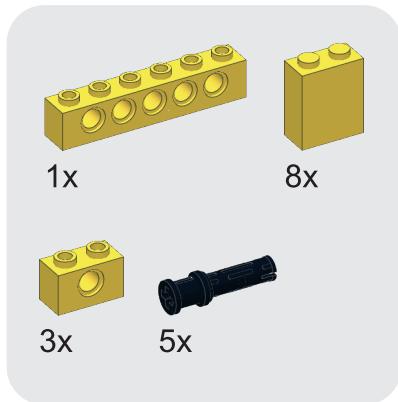
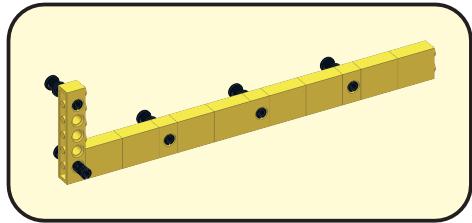




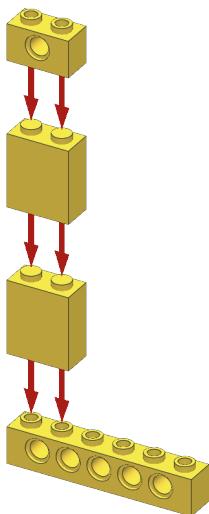
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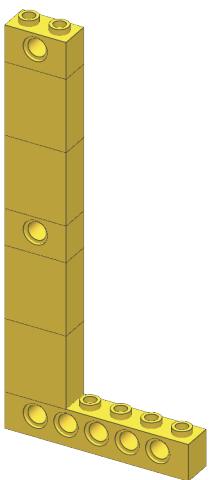




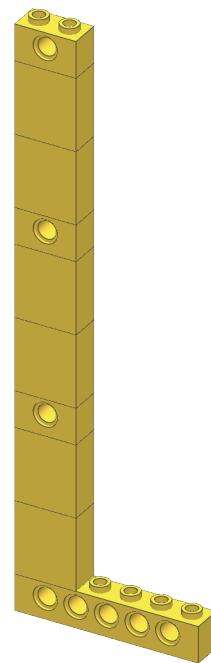
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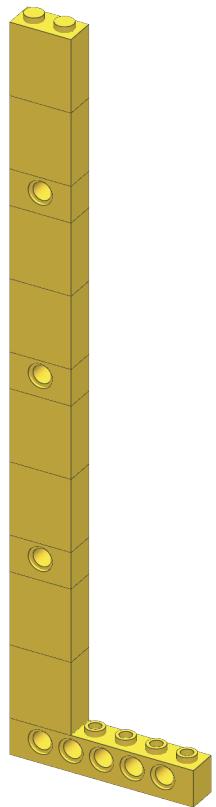
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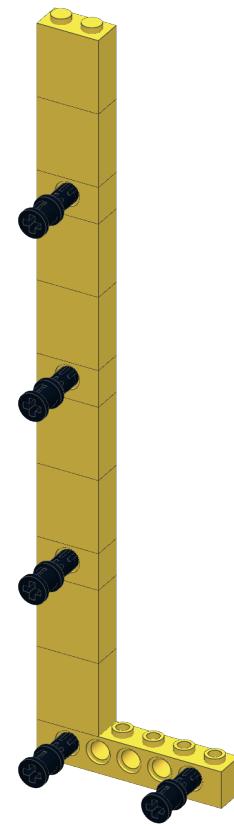
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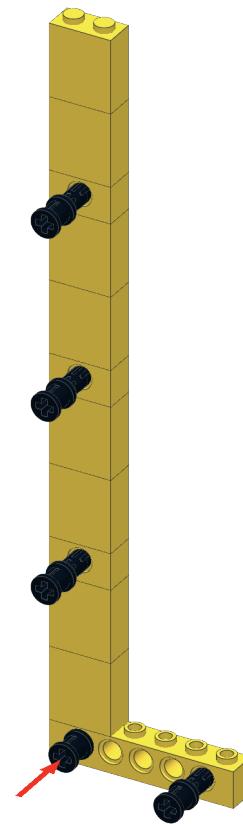
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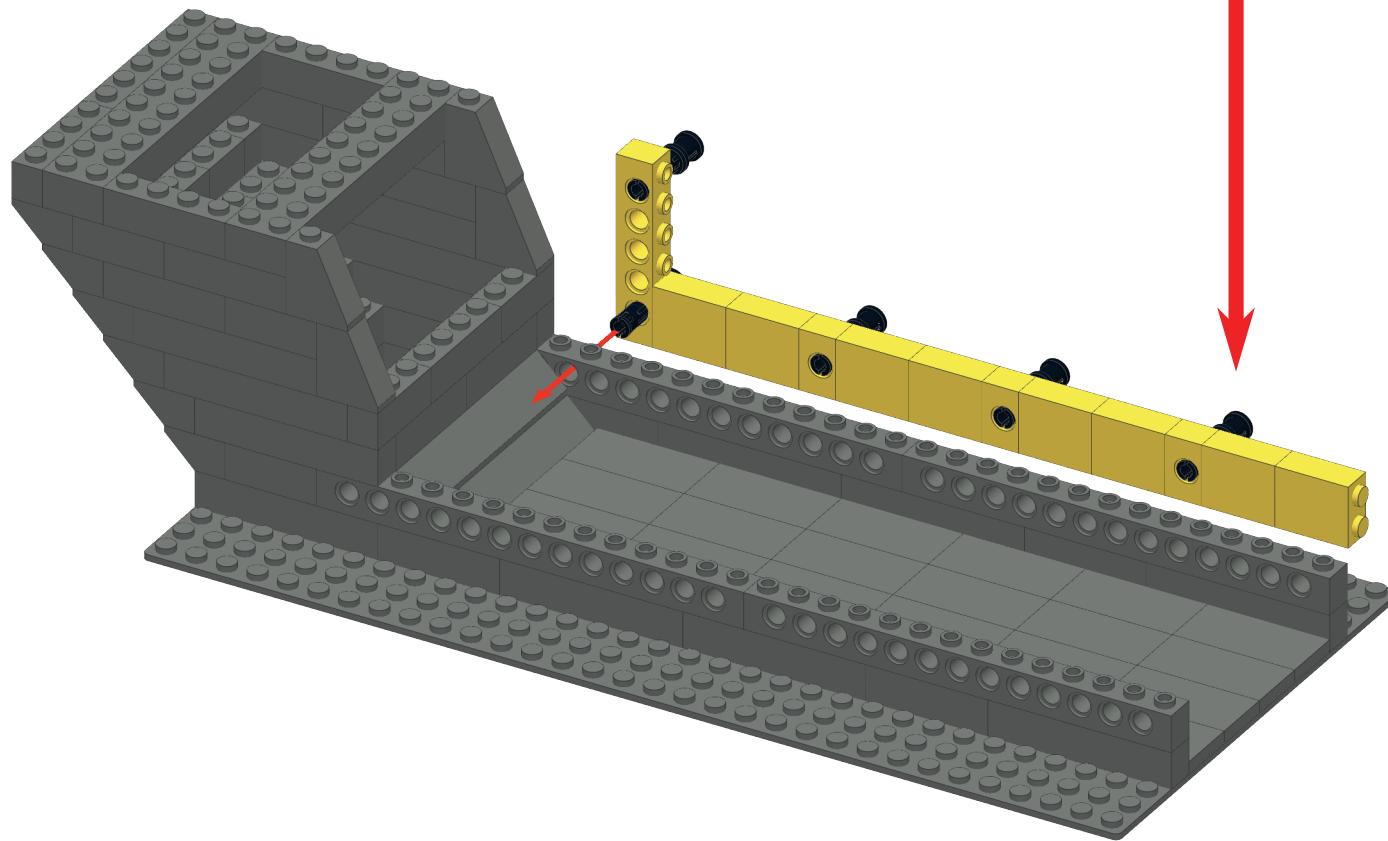
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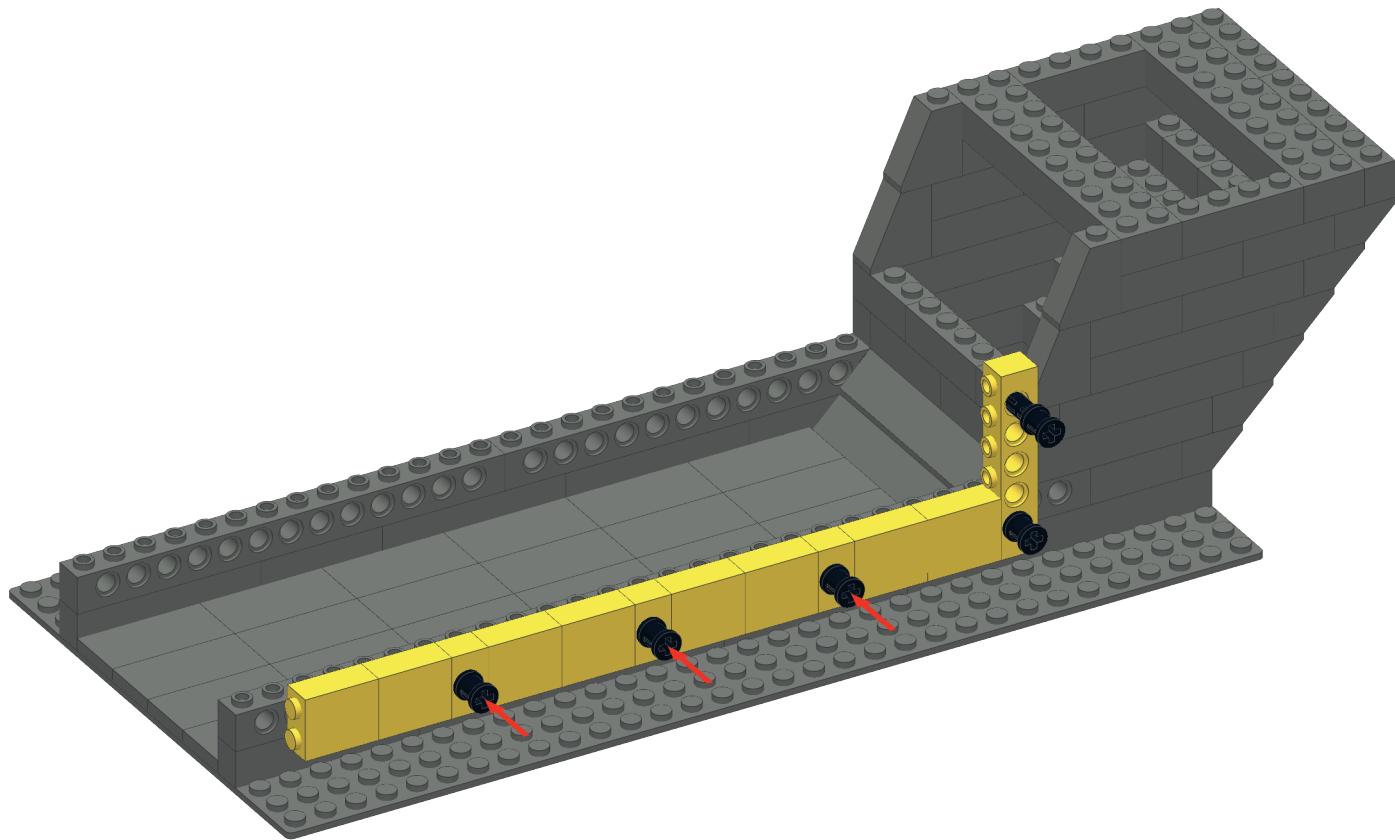
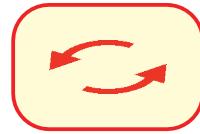
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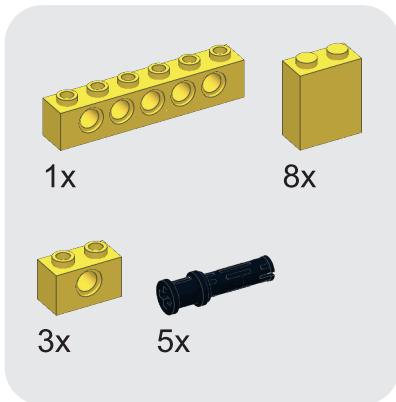
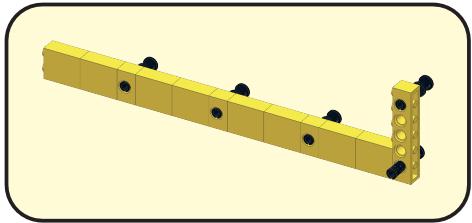


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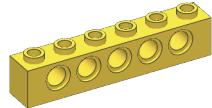


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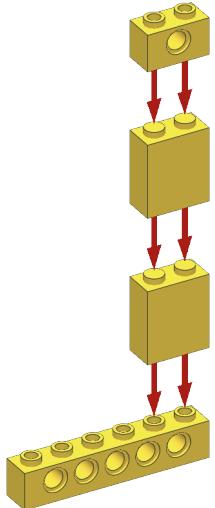




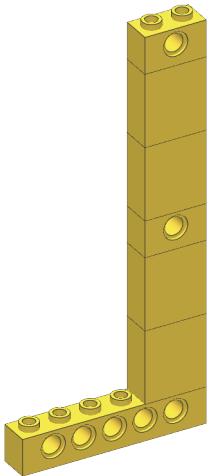
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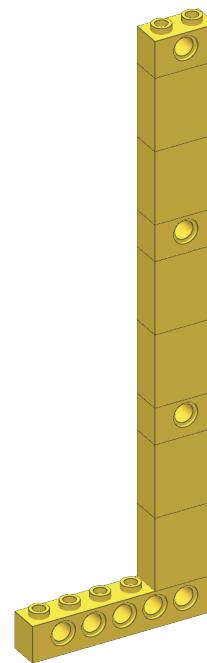
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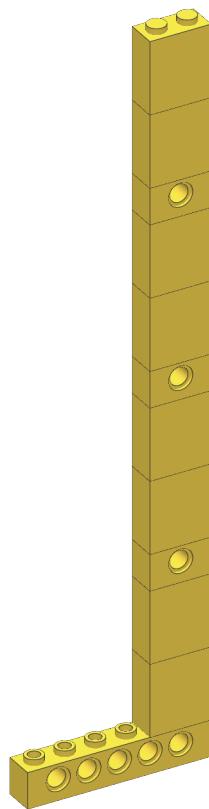
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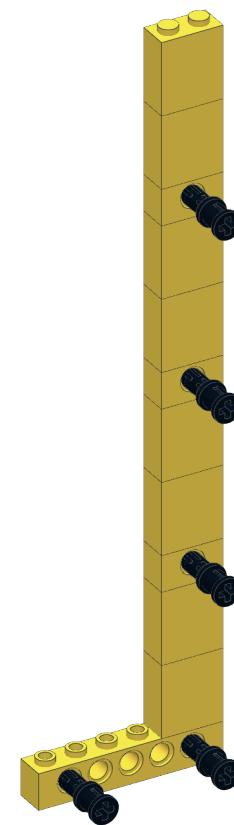
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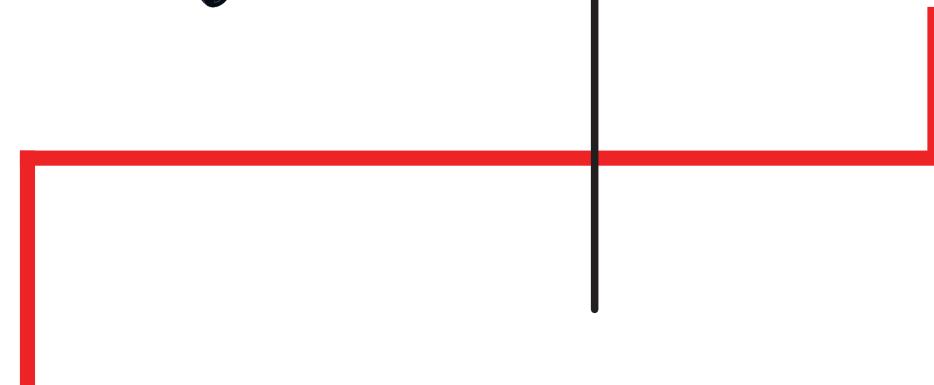
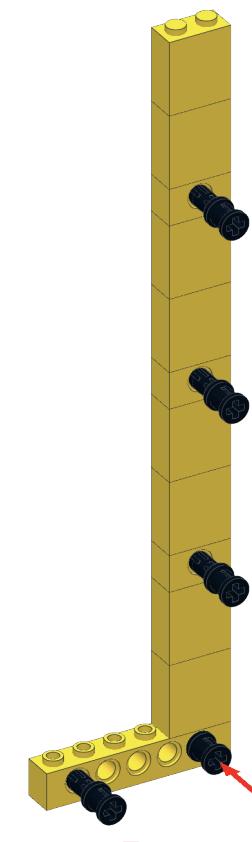
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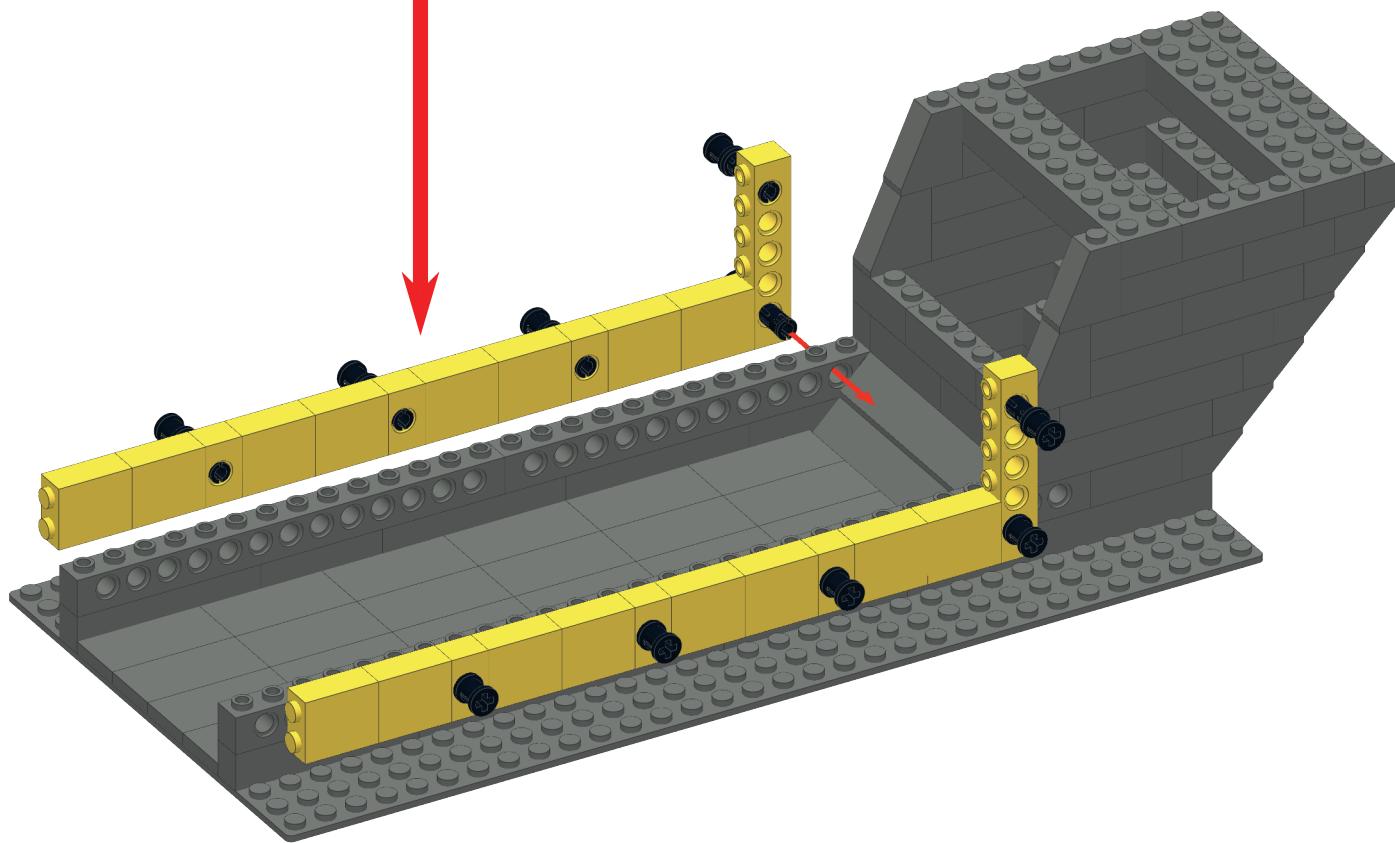
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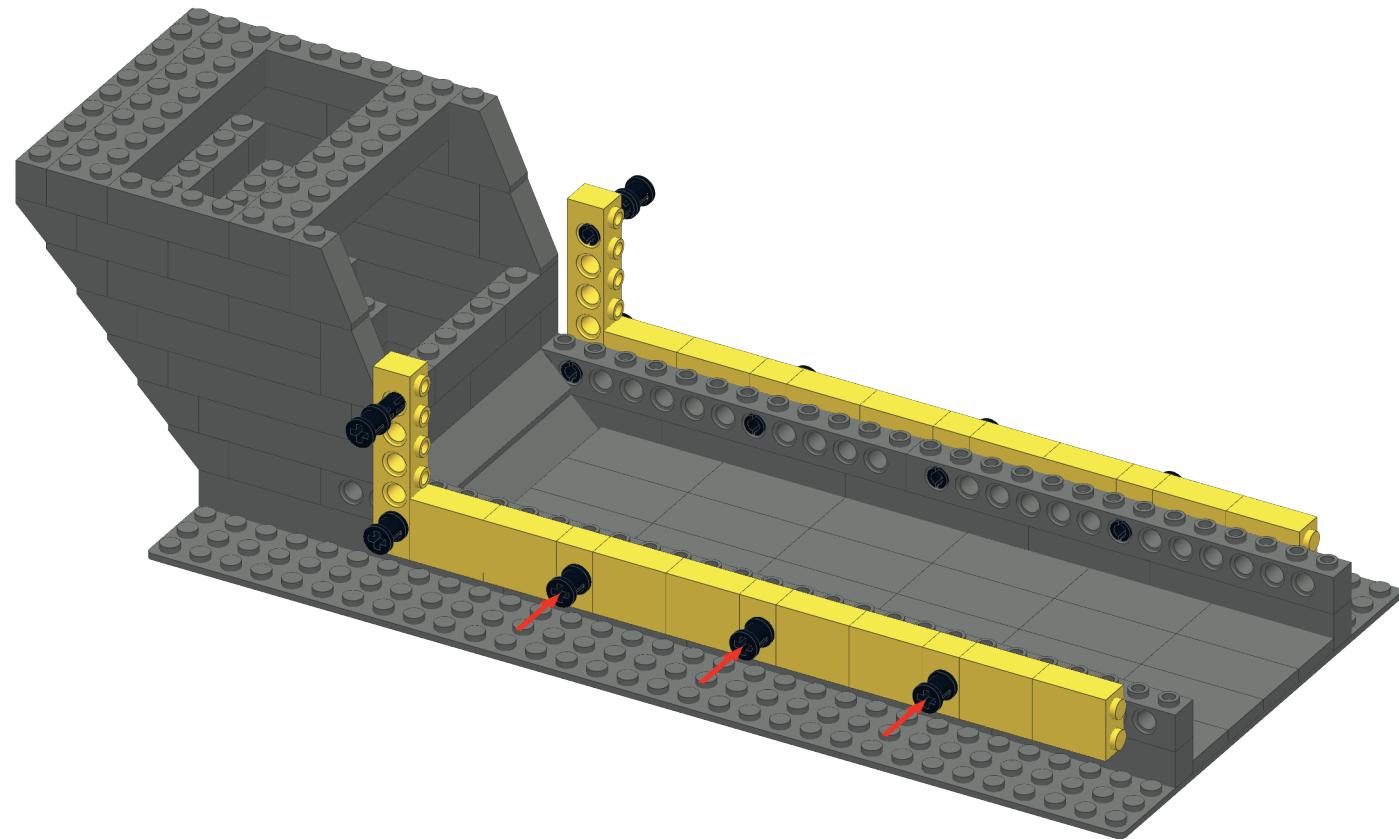
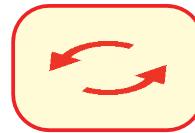
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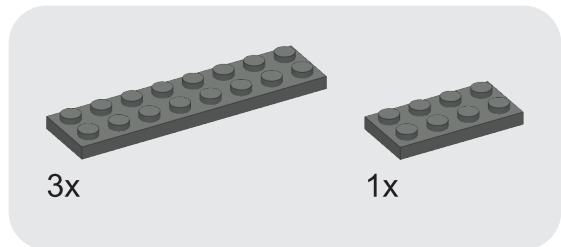
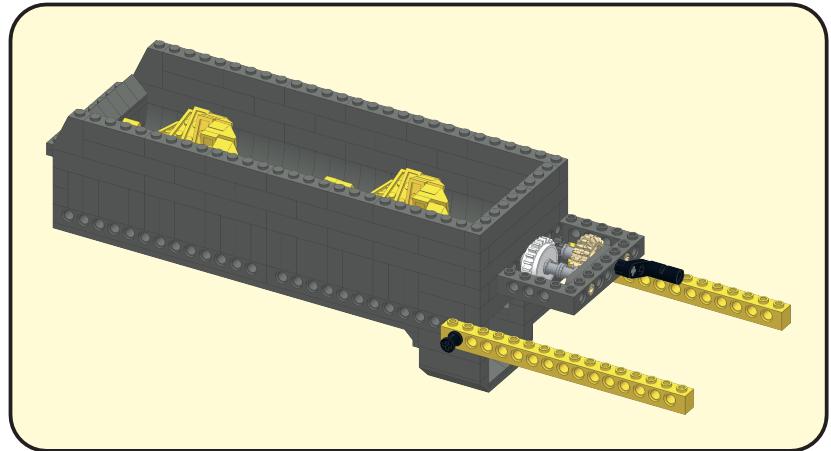


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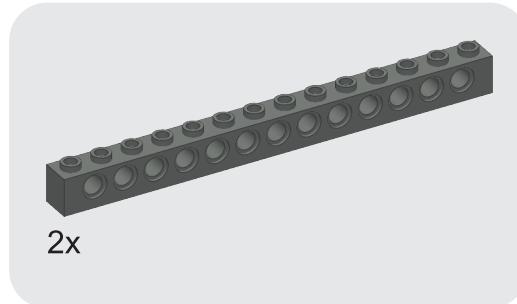
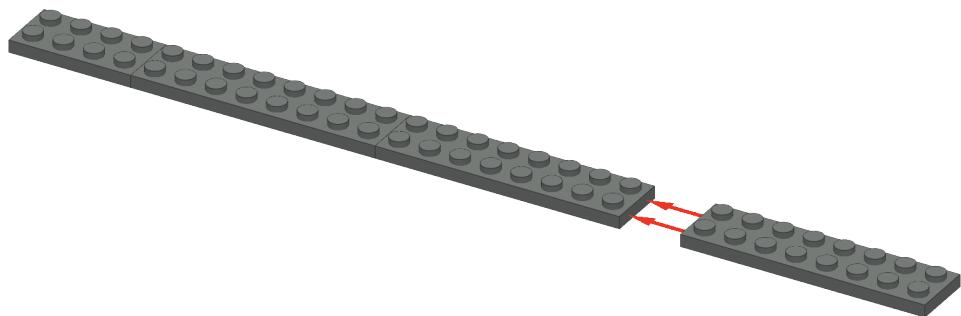


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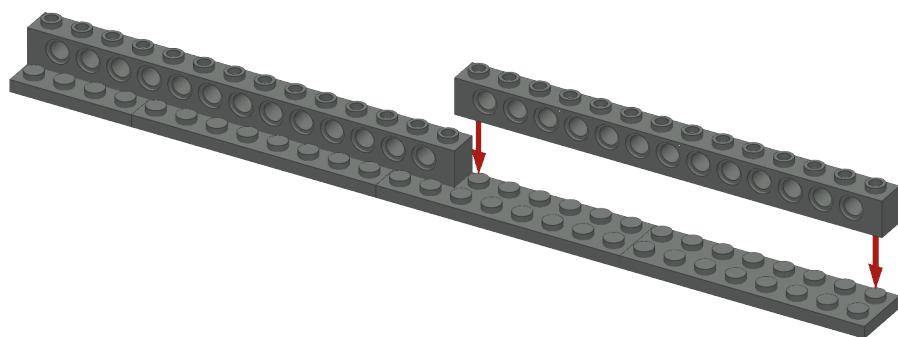


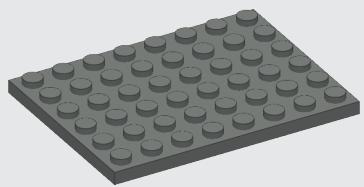


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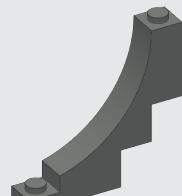


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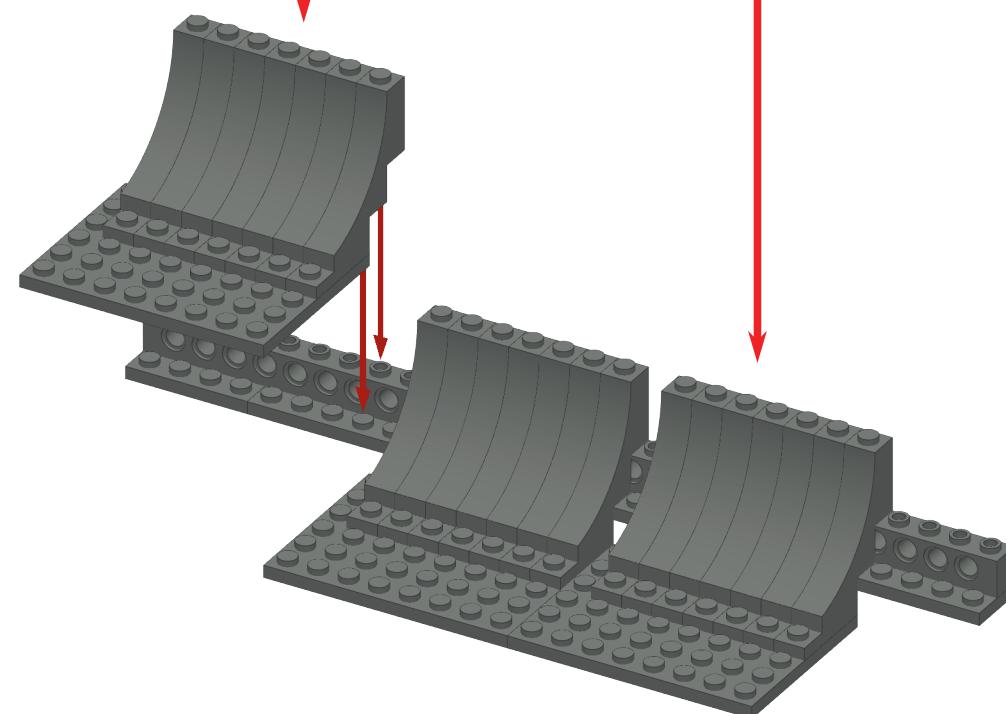


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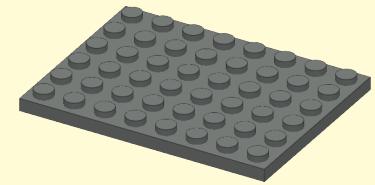


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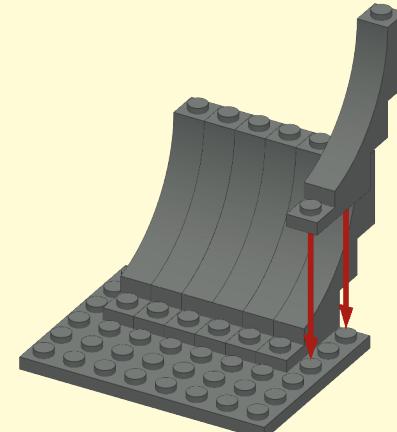
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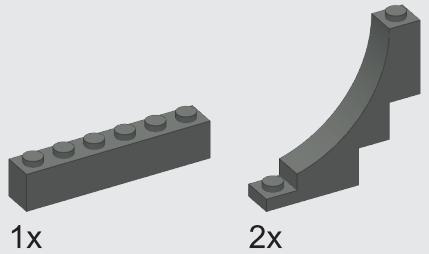
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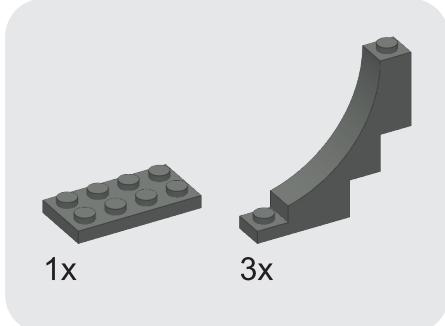
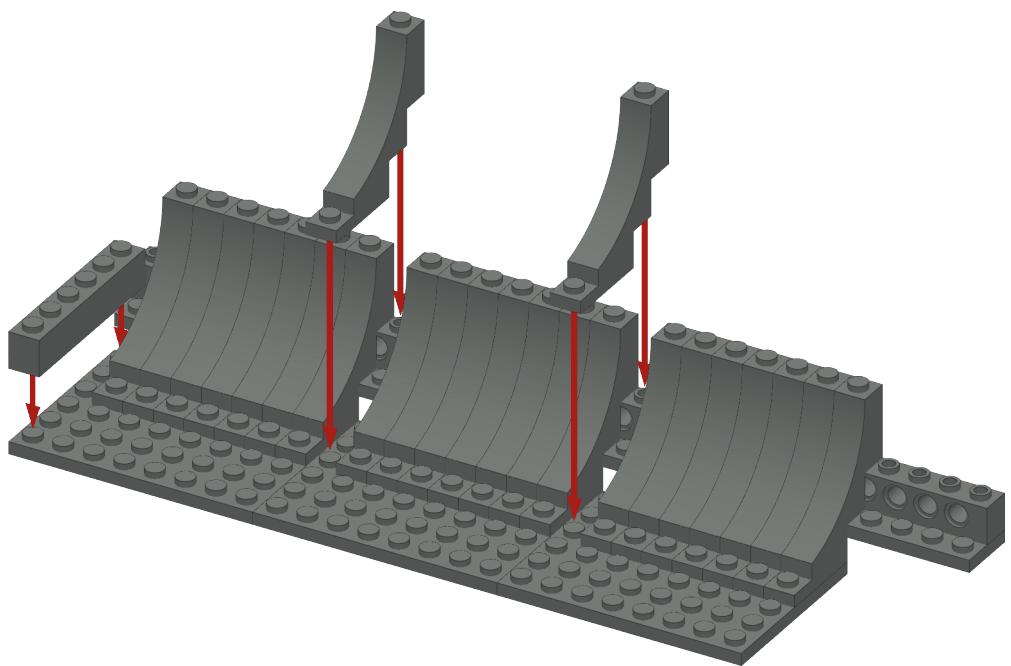
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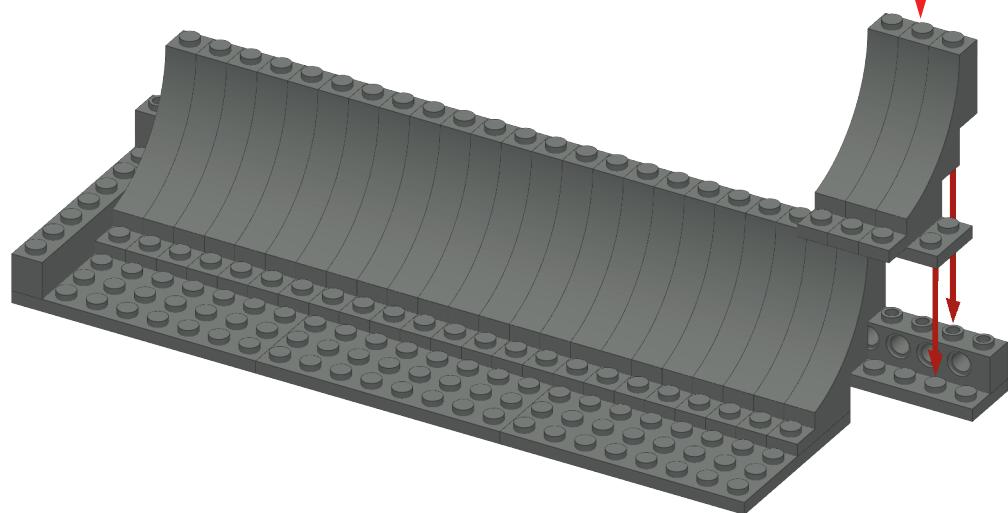
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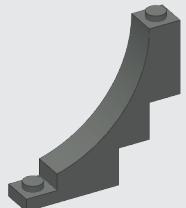


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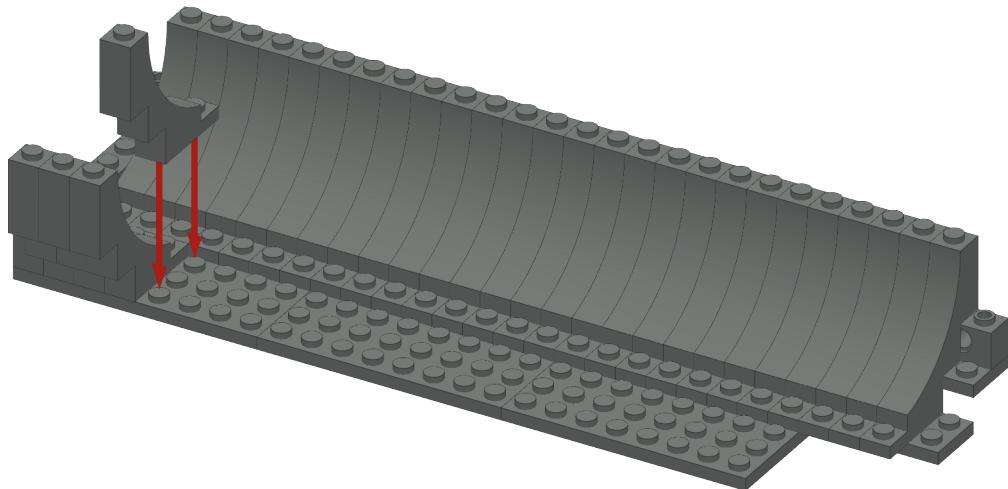
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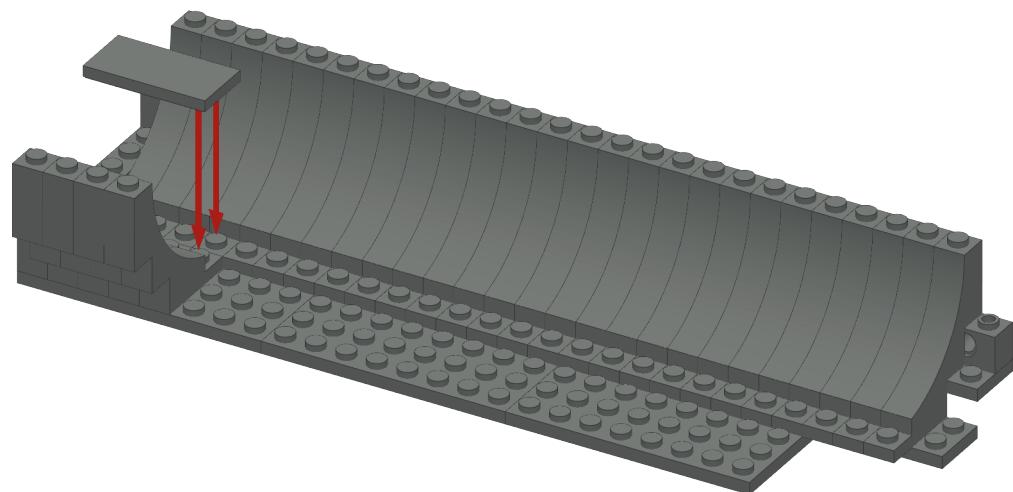
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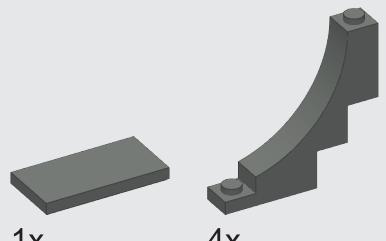
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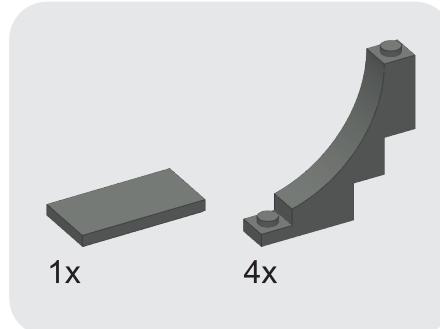
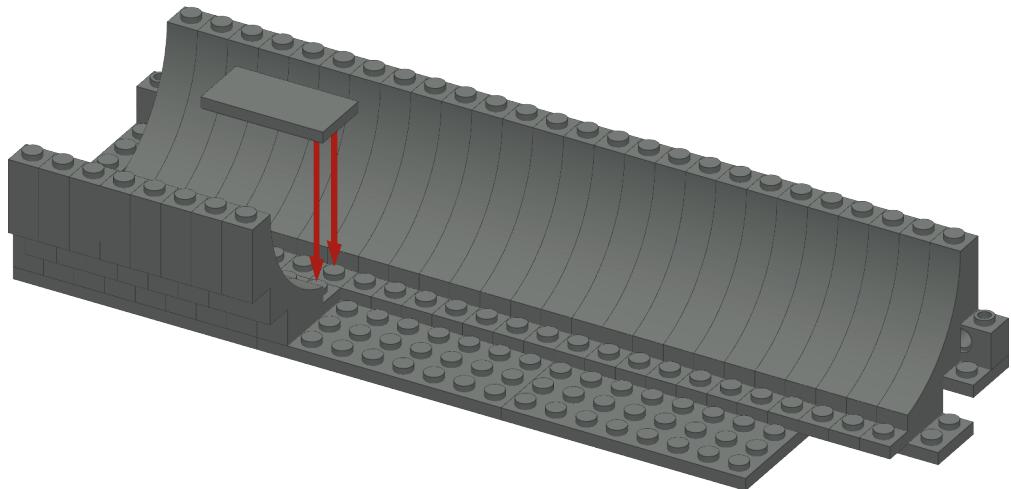
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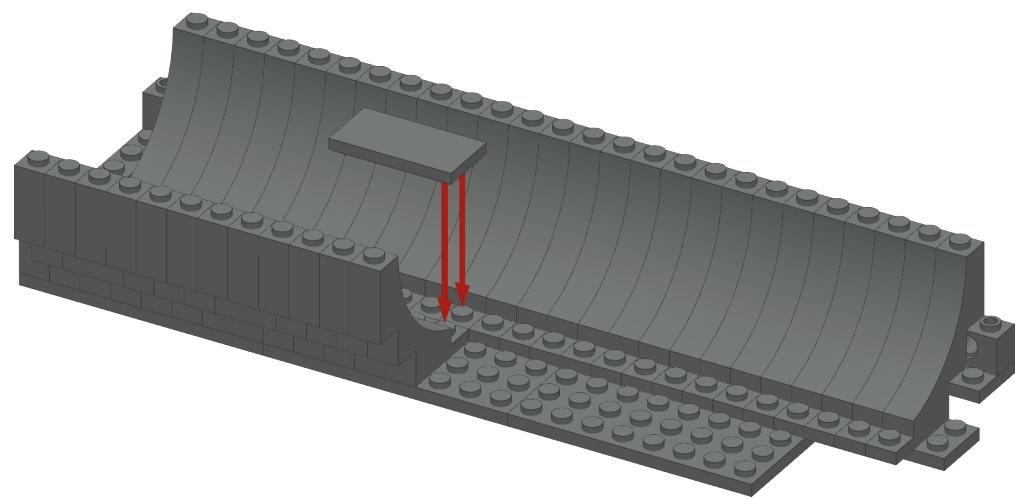


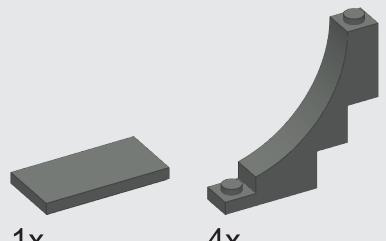


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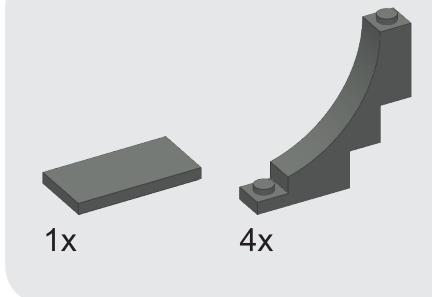
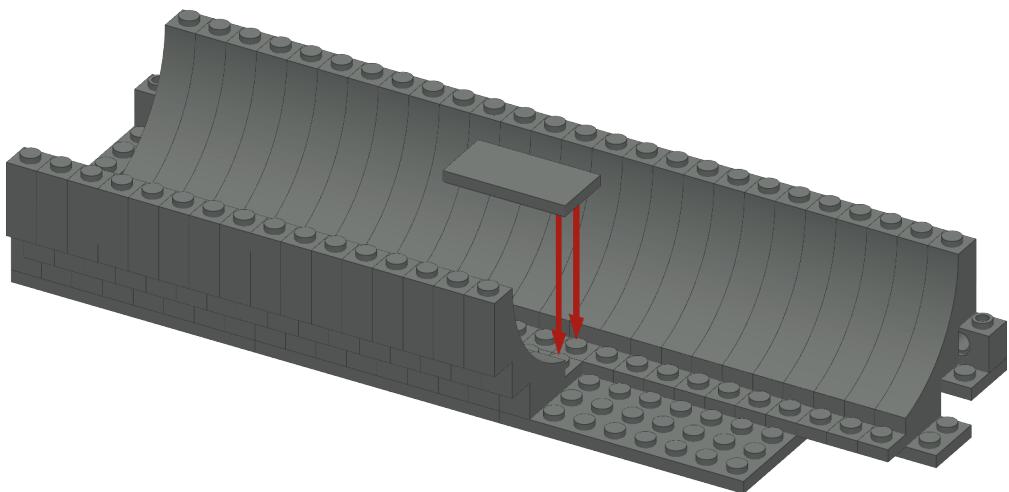


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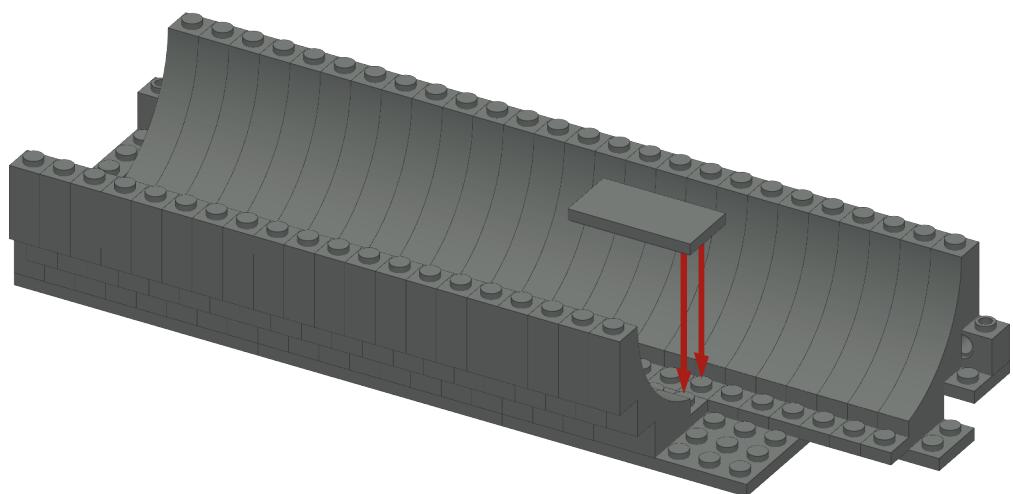


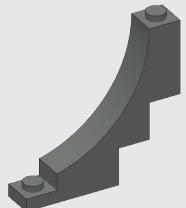


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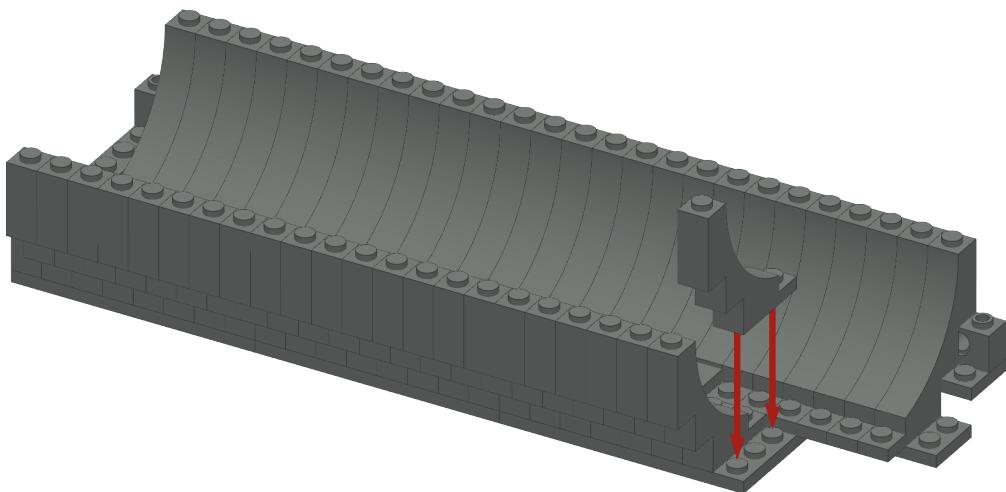
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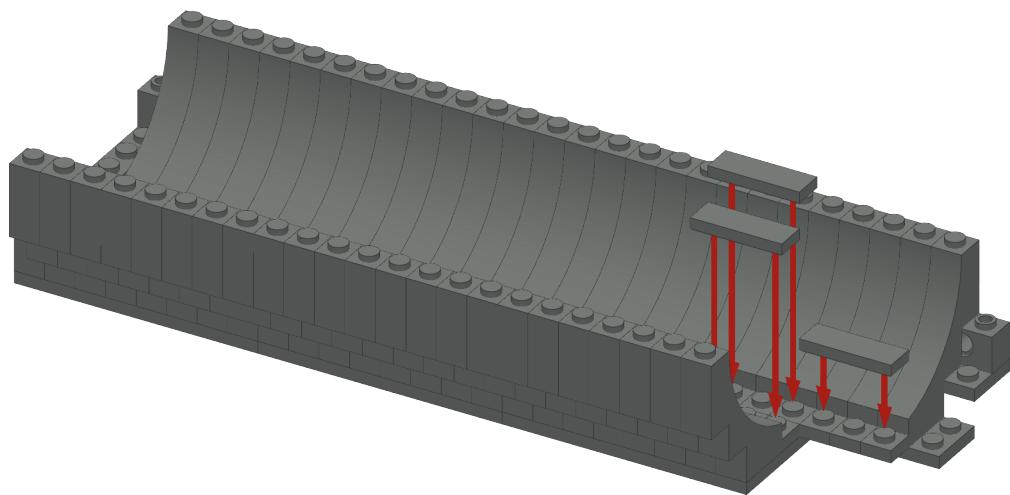
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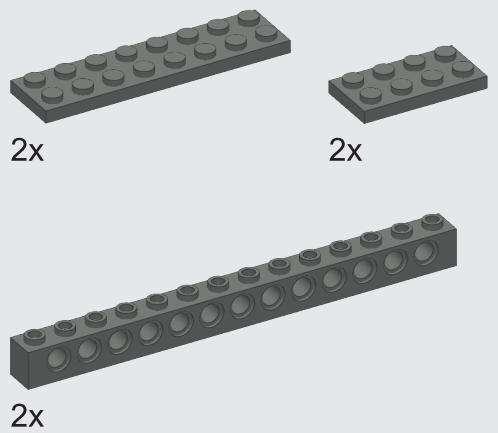
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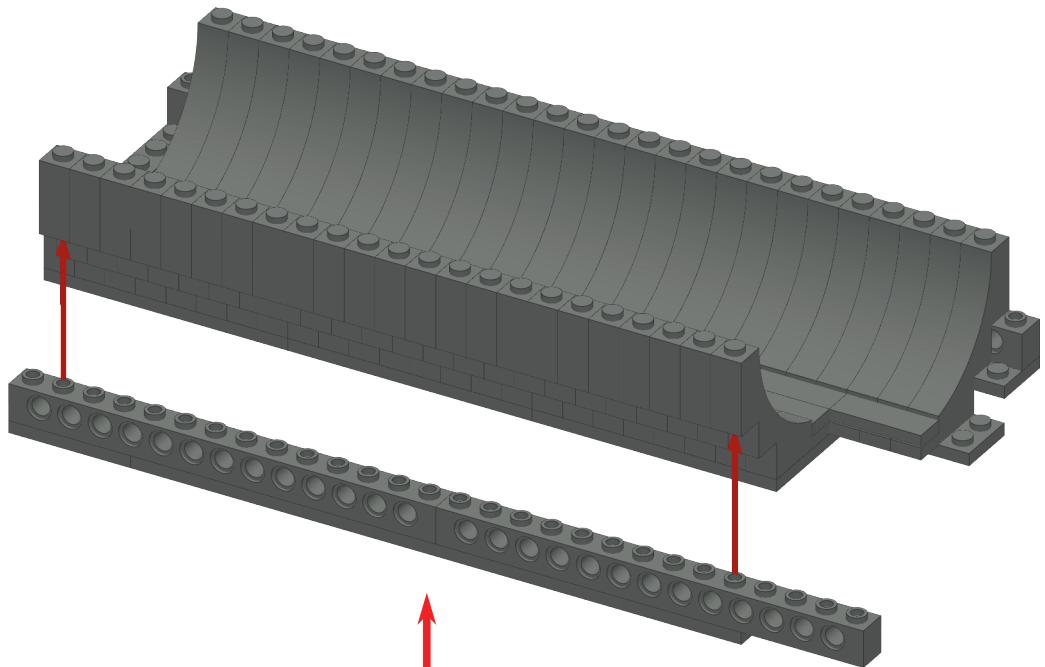
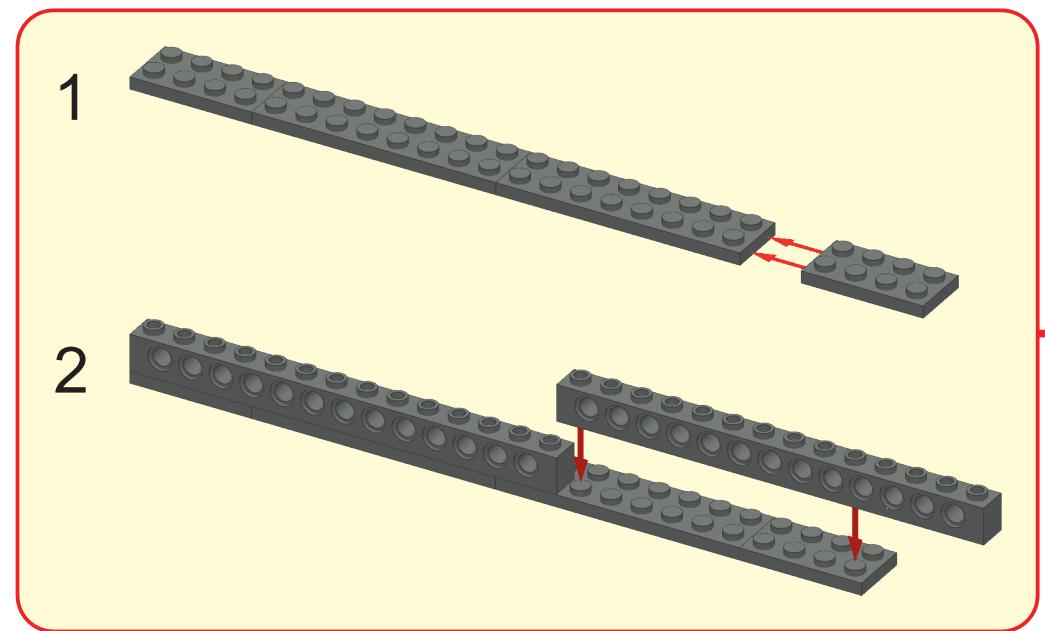
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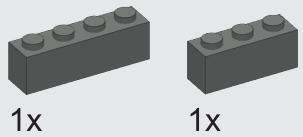
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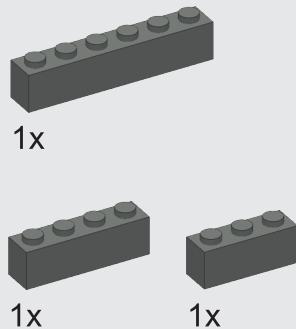
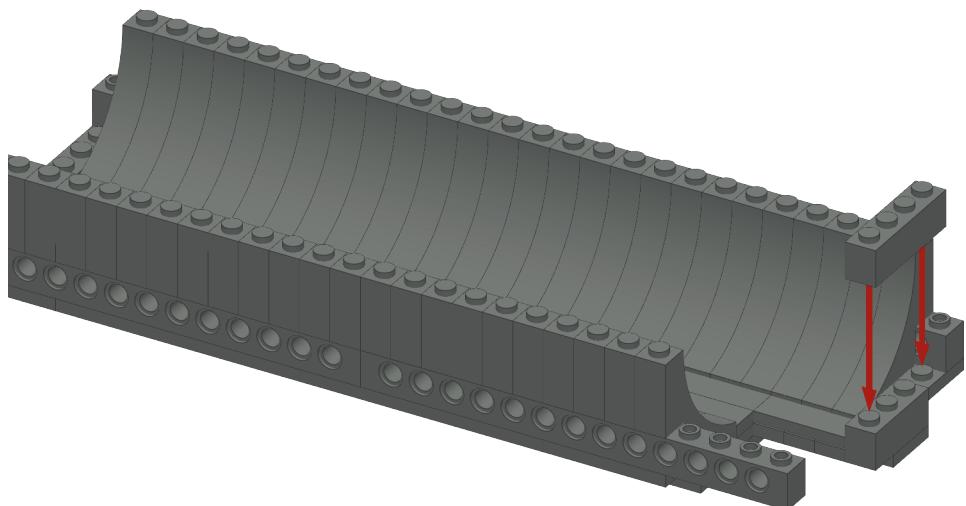


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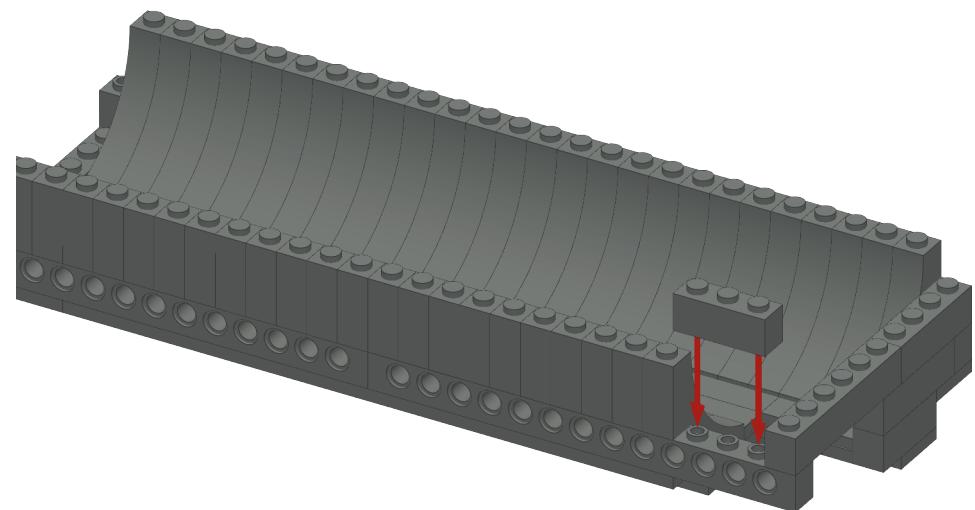


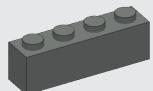


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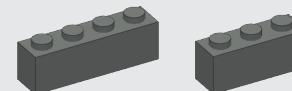
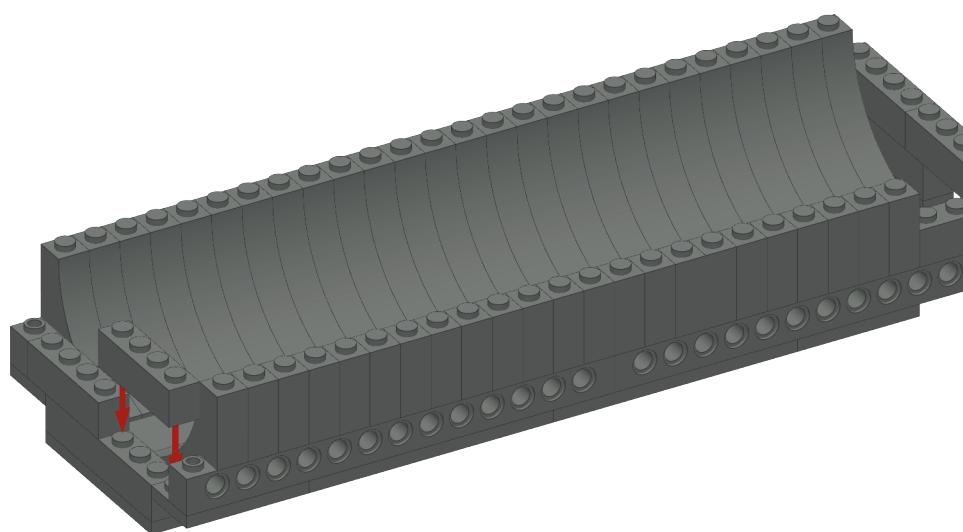
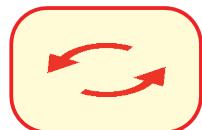
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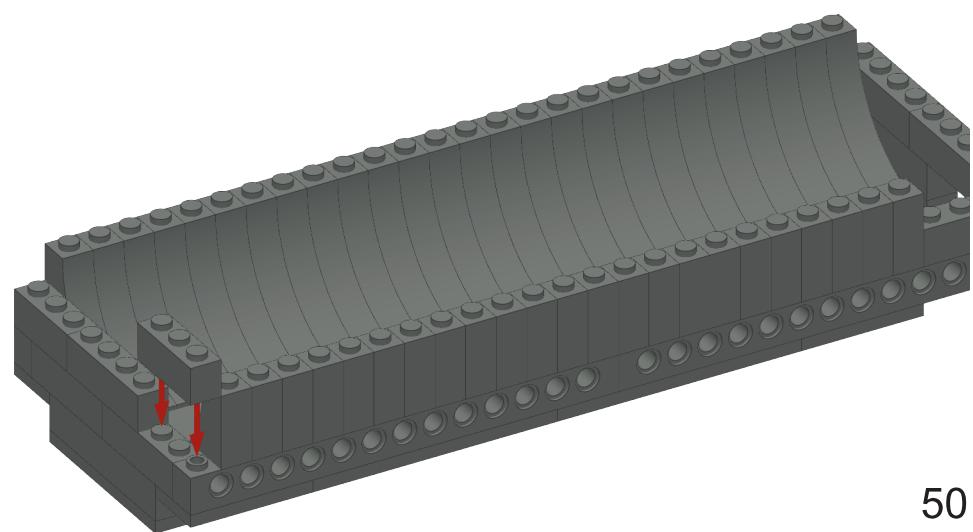
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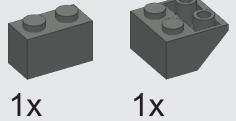


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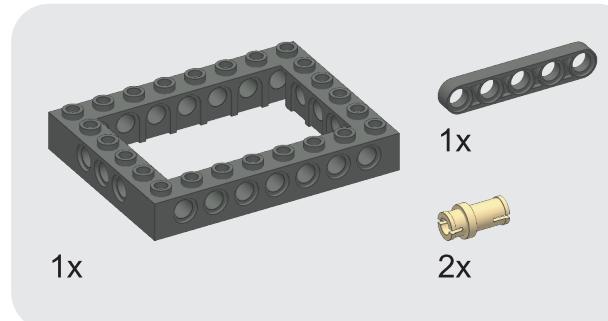
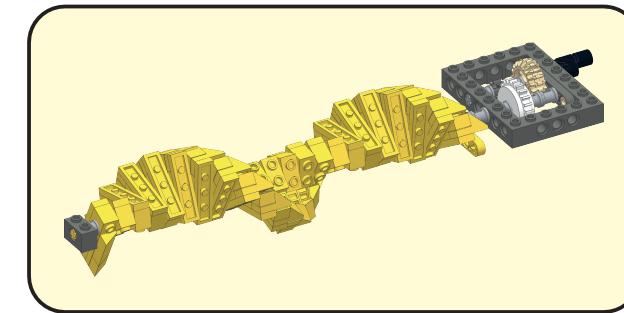
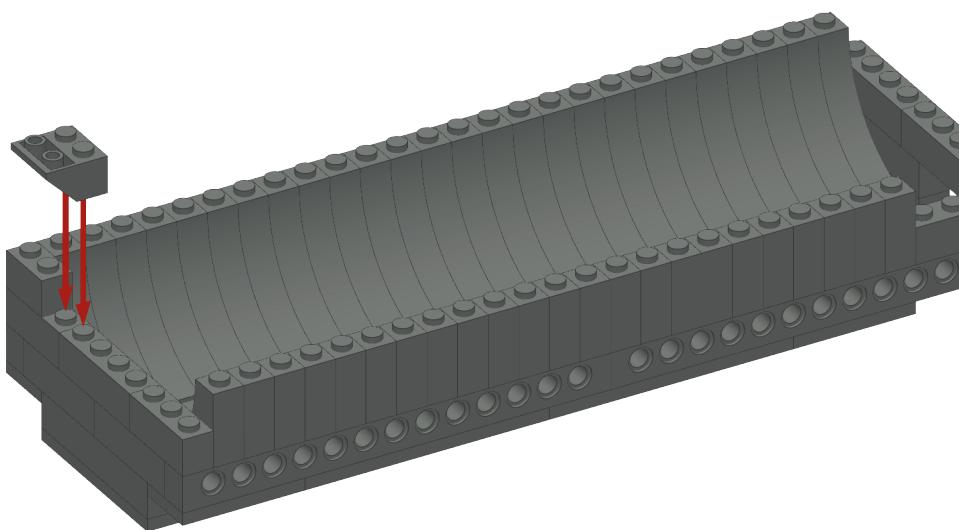
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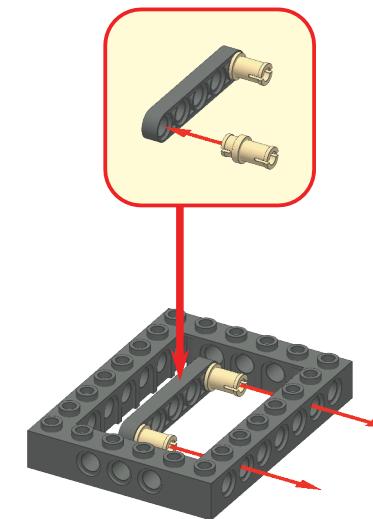


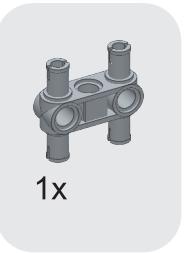


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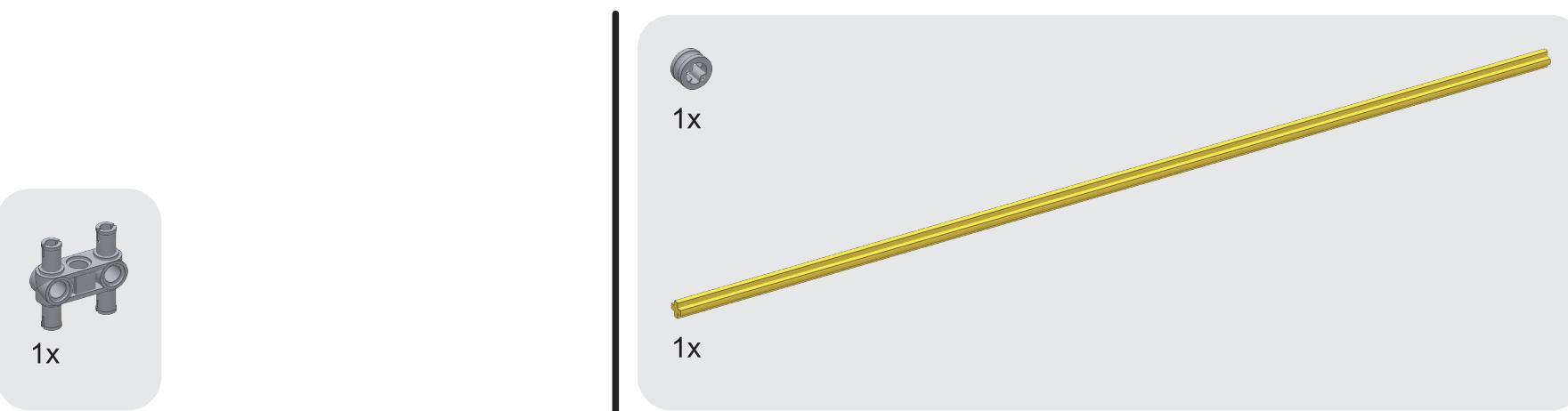


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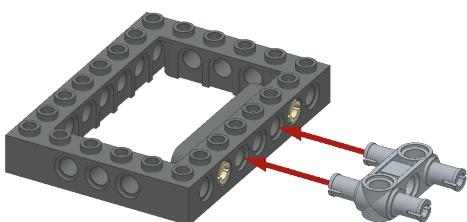


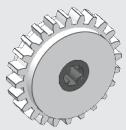


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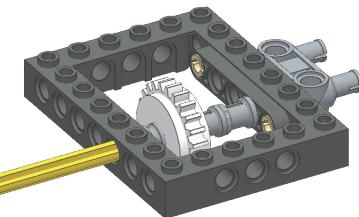
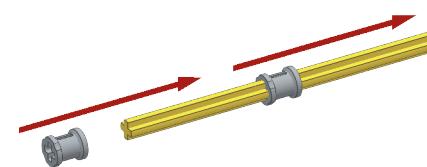
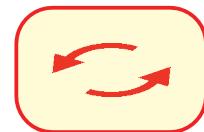
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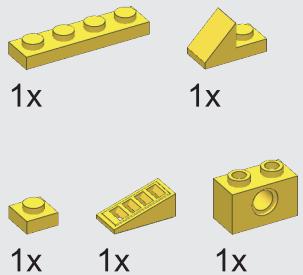
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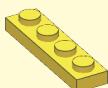
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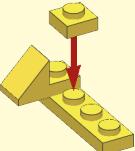




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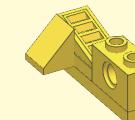
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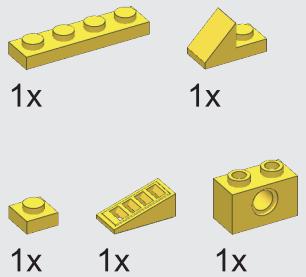


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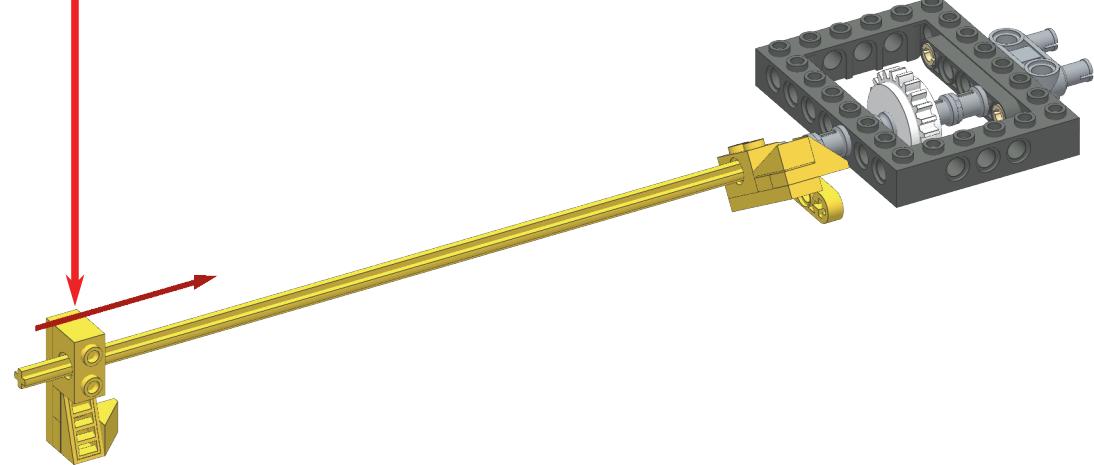
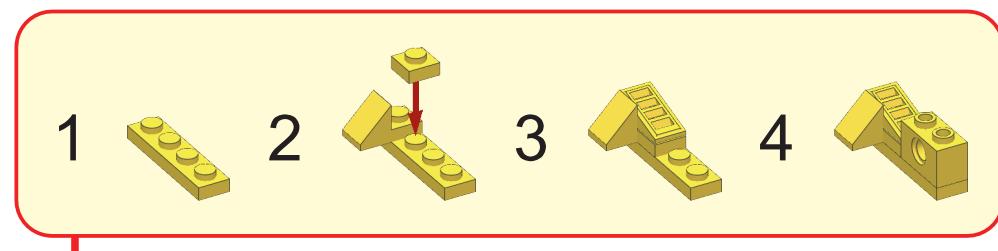


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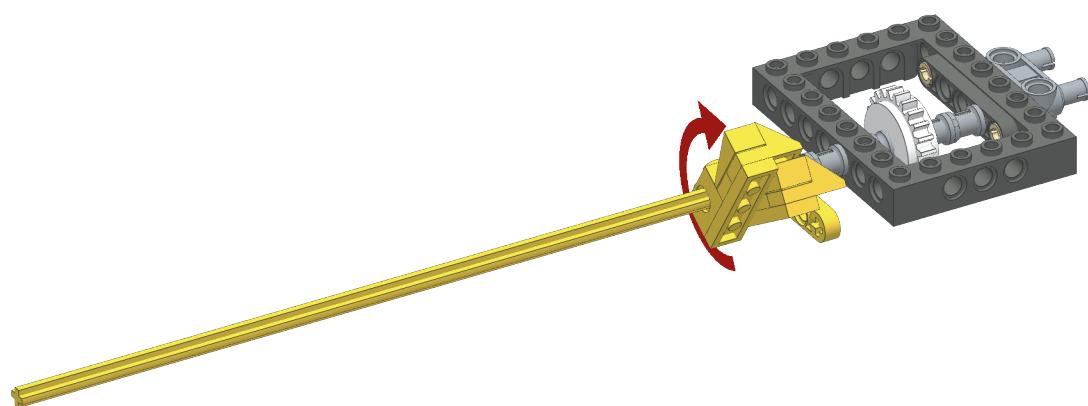




10



11





20x



20x



20x



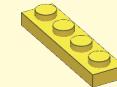
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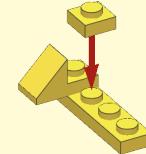
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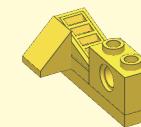
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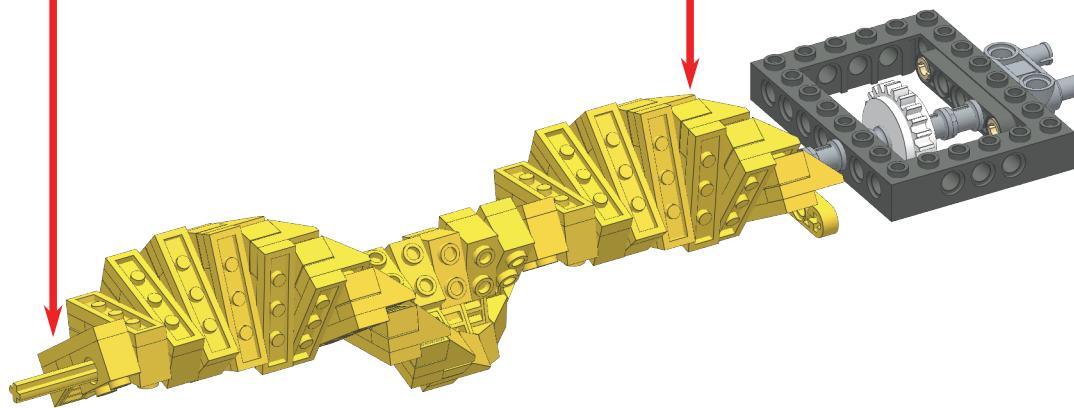
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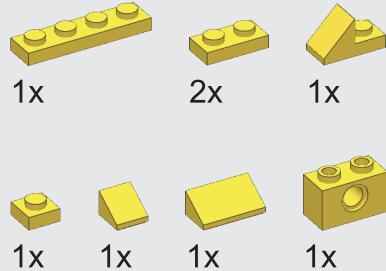


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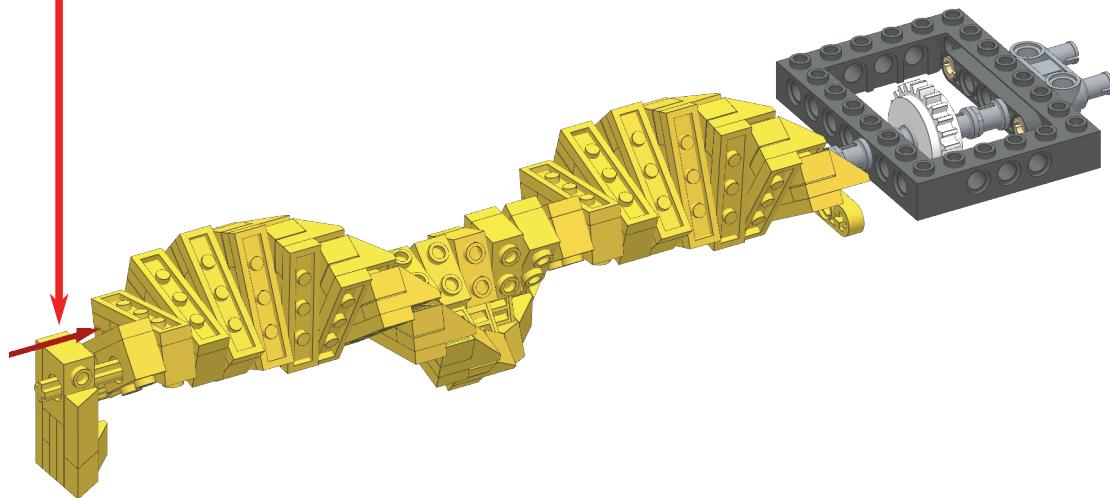
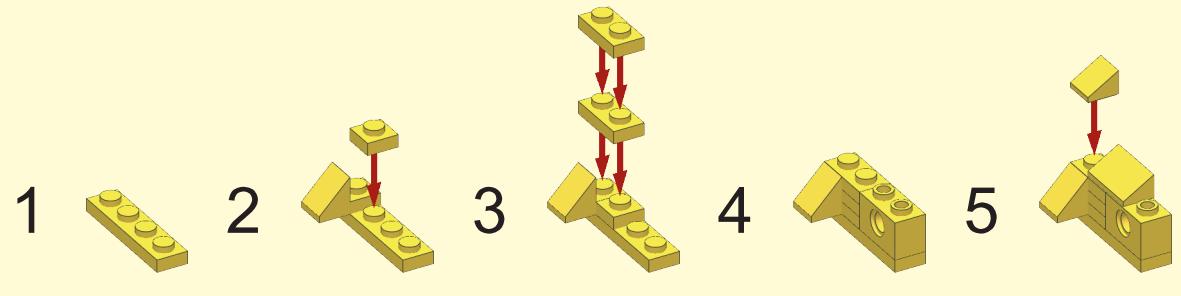


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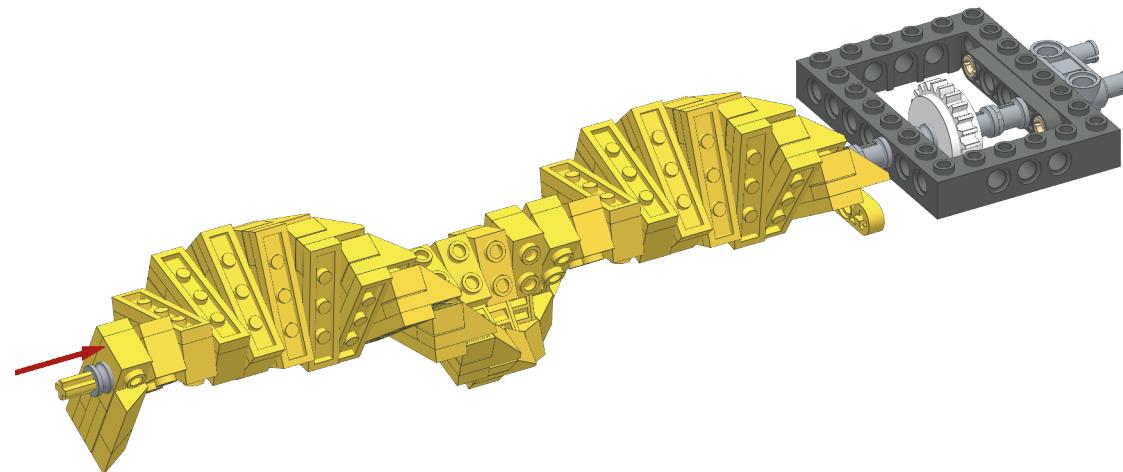
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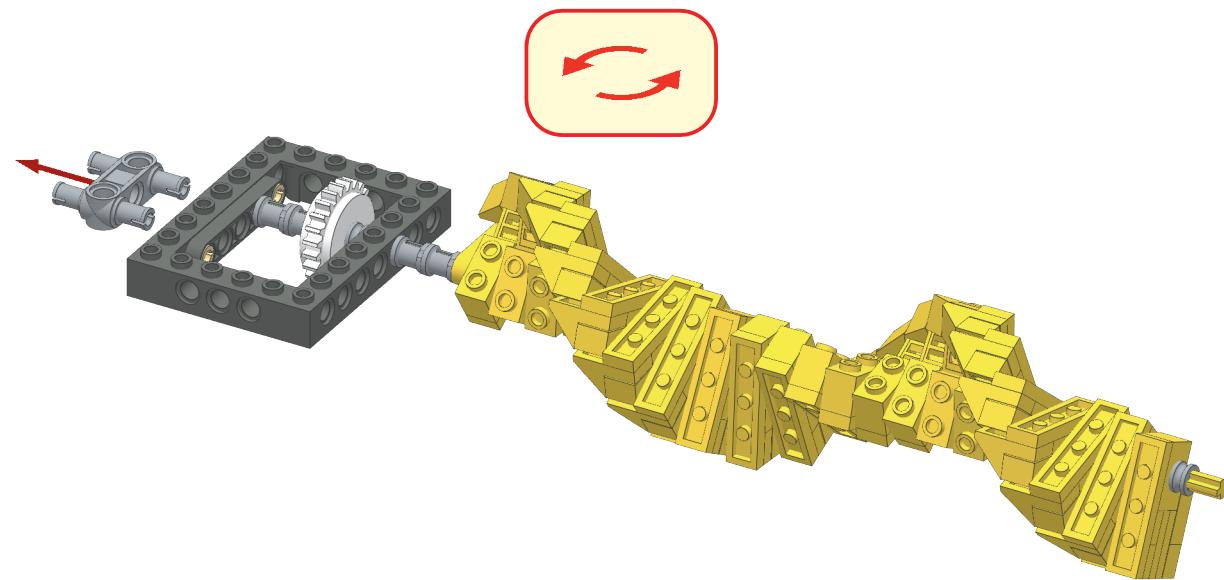


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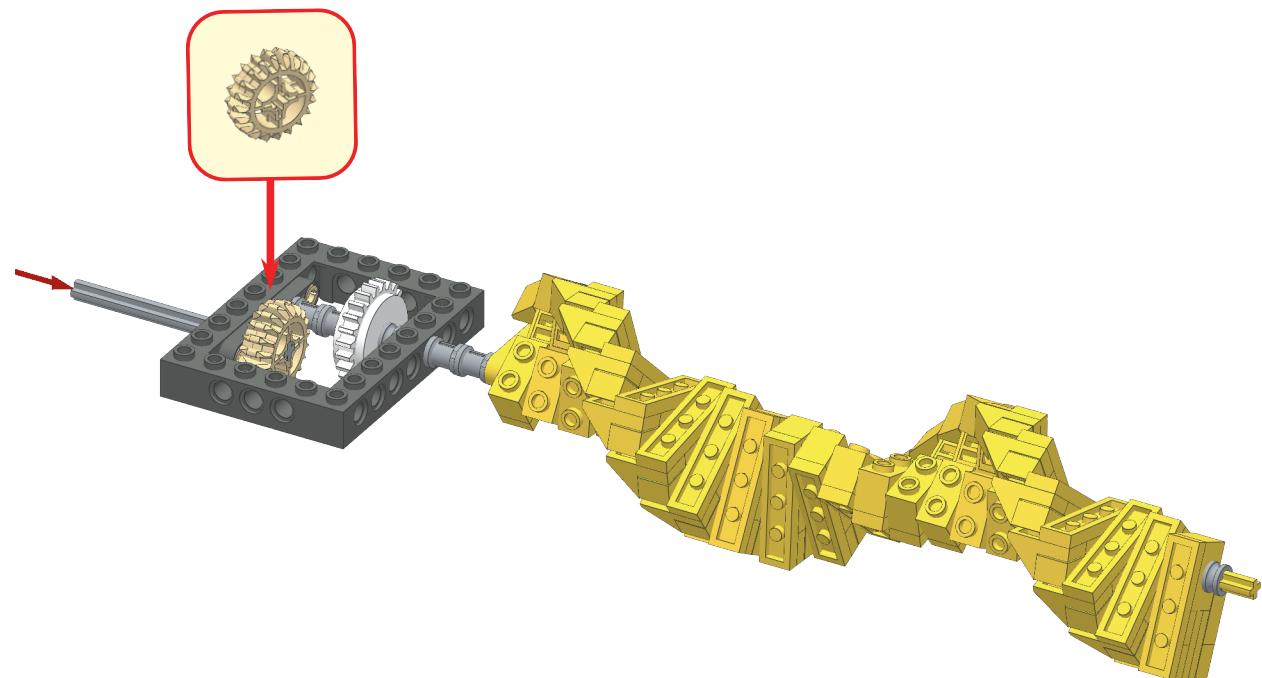
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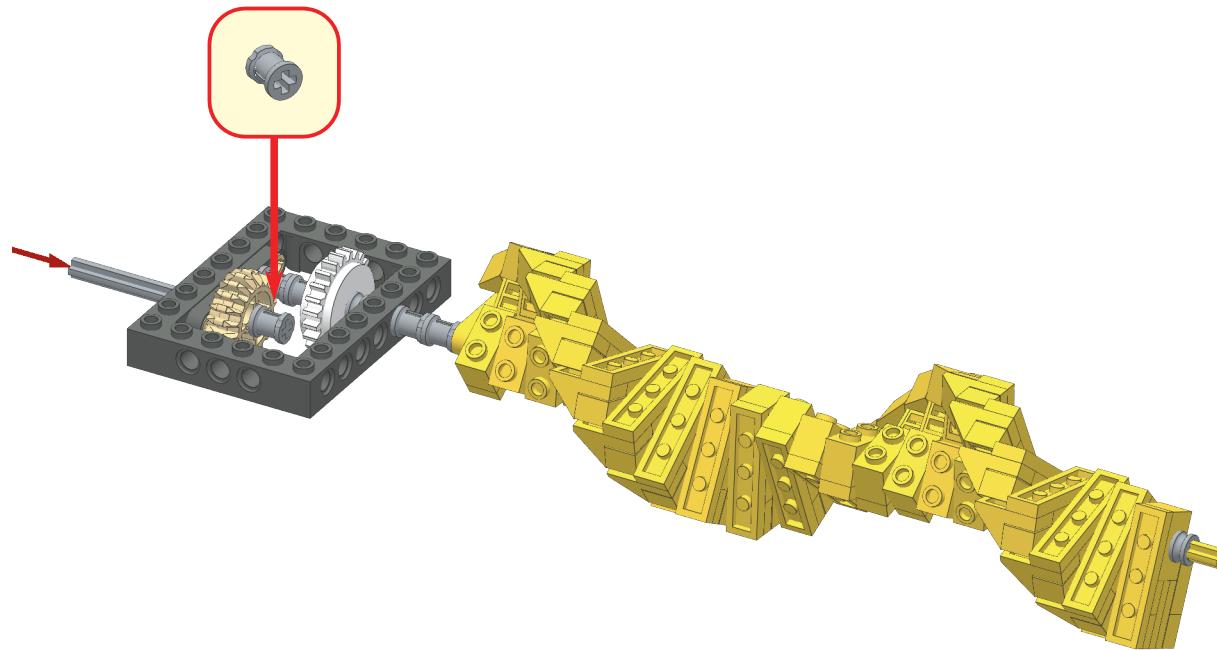
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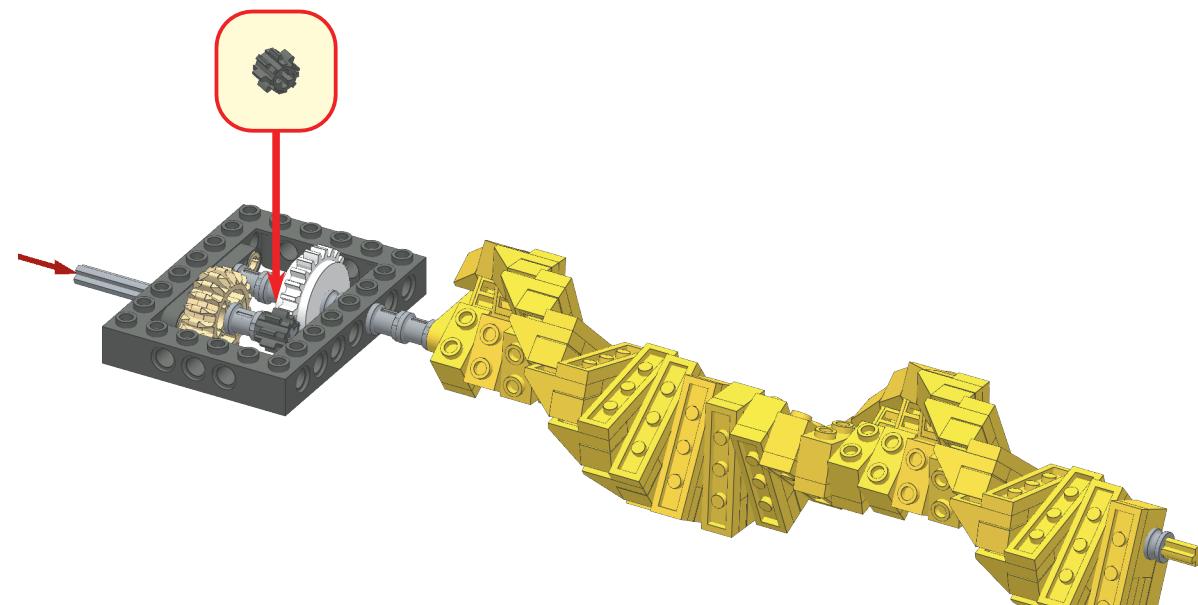
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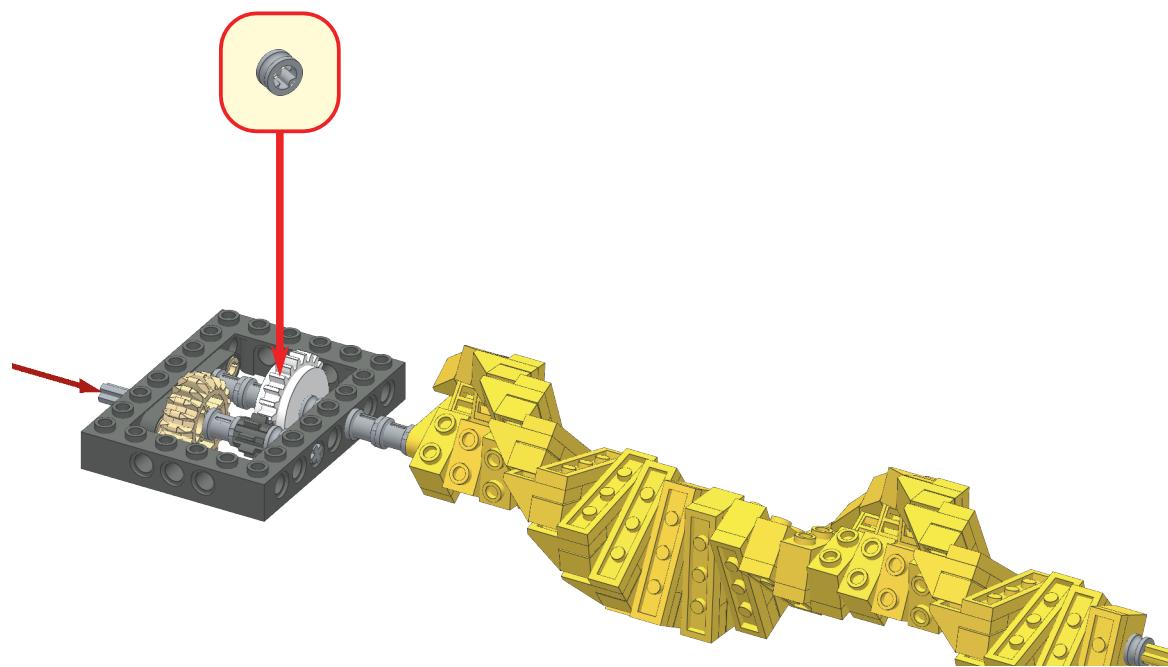
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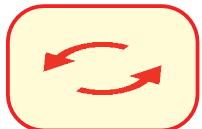
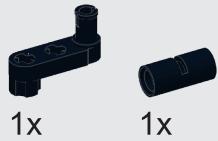
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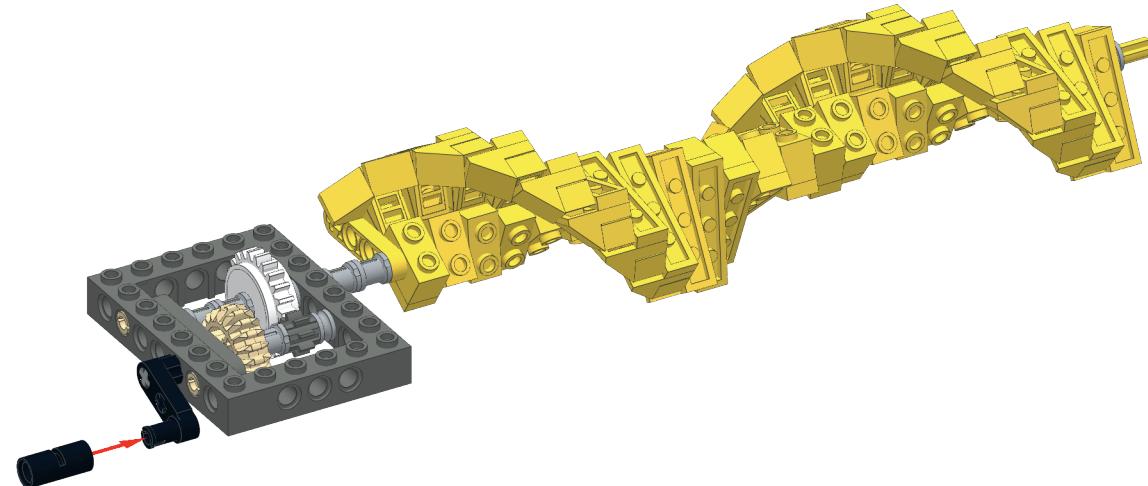
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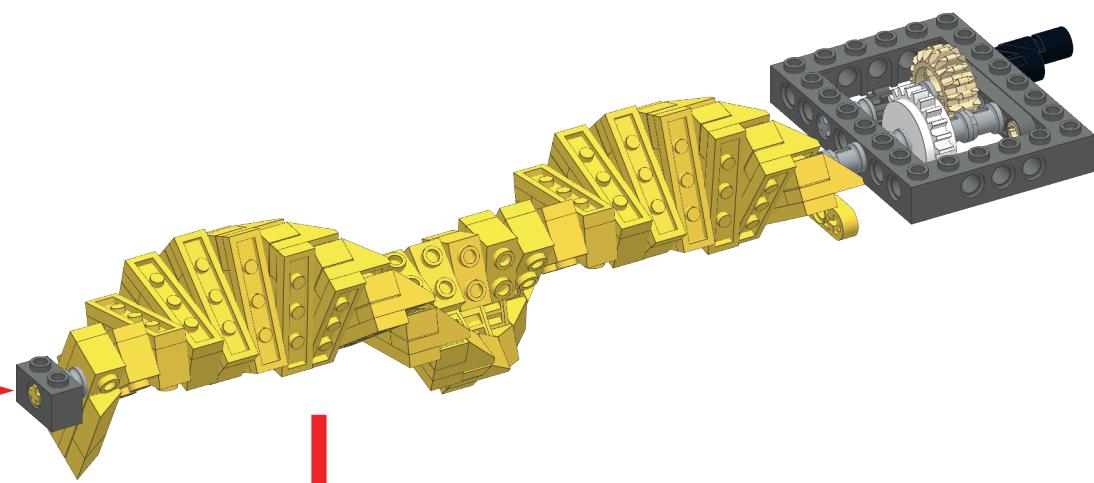
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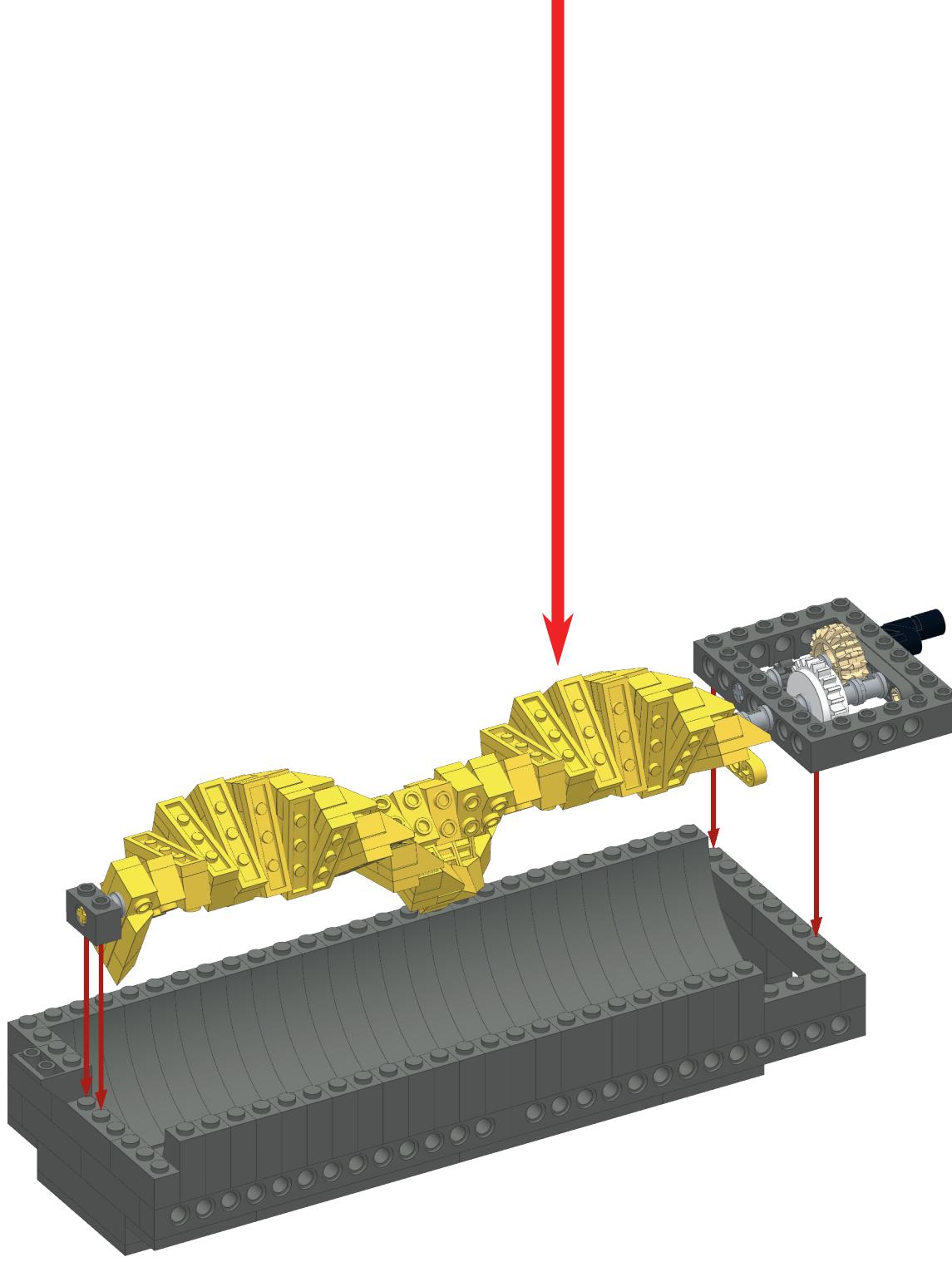


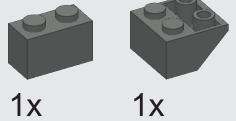
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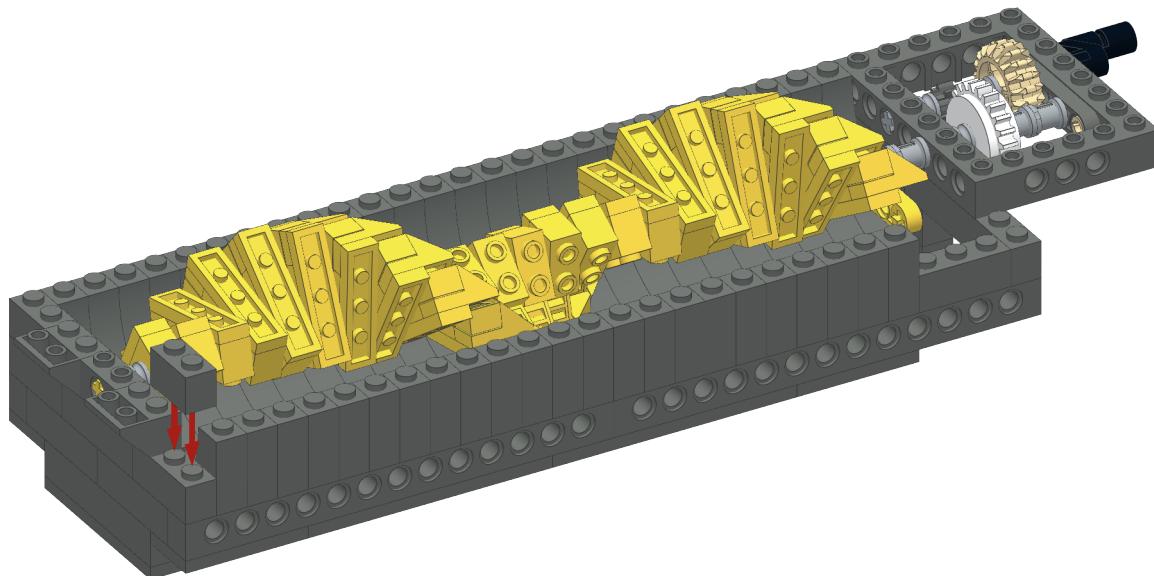
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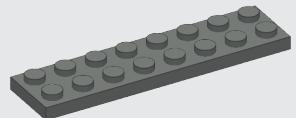
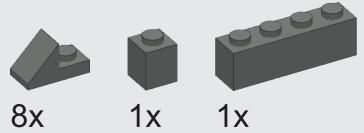
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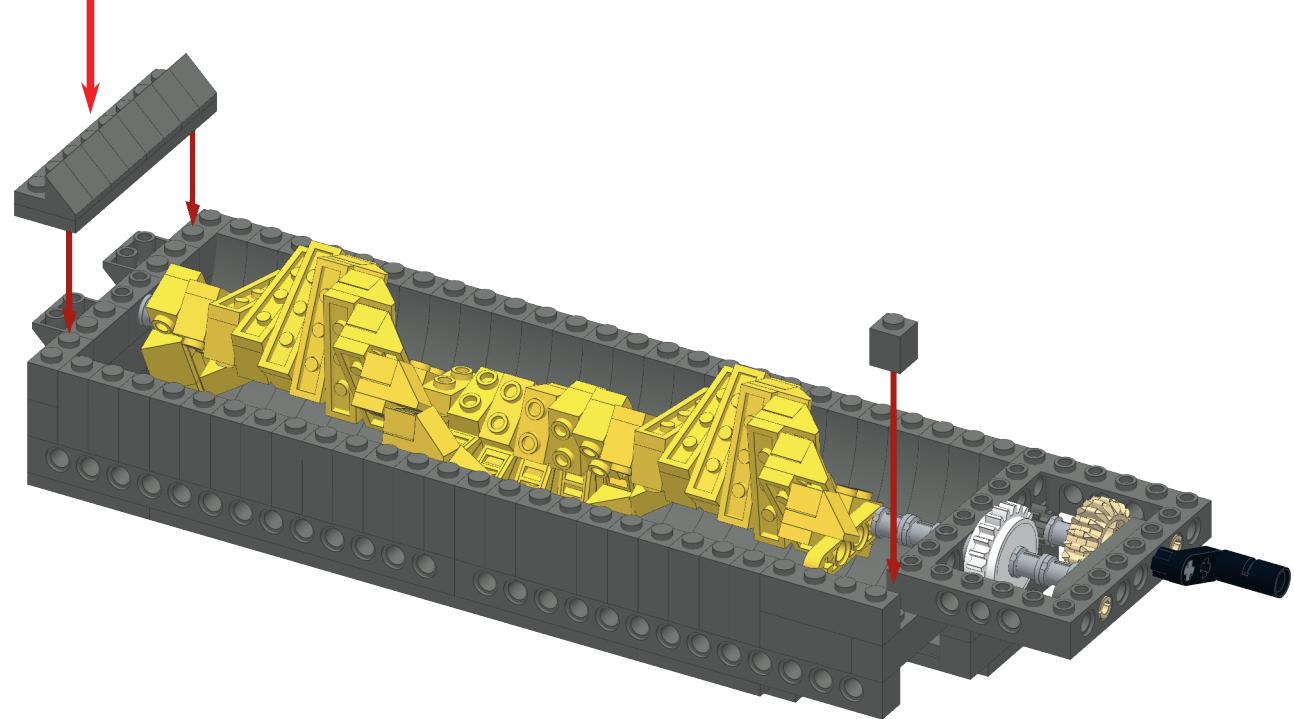
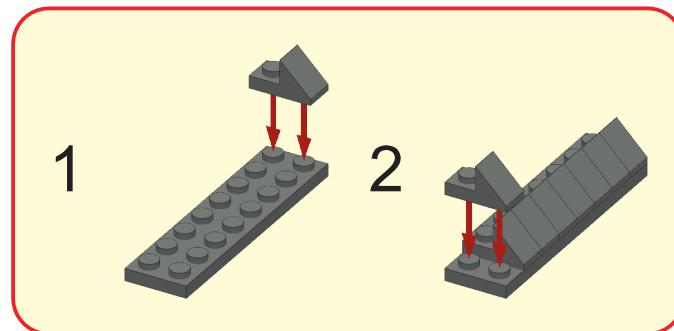


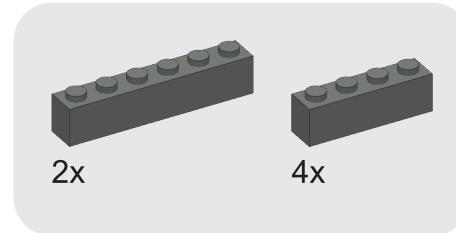
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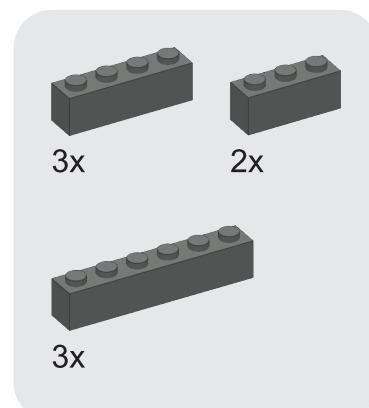
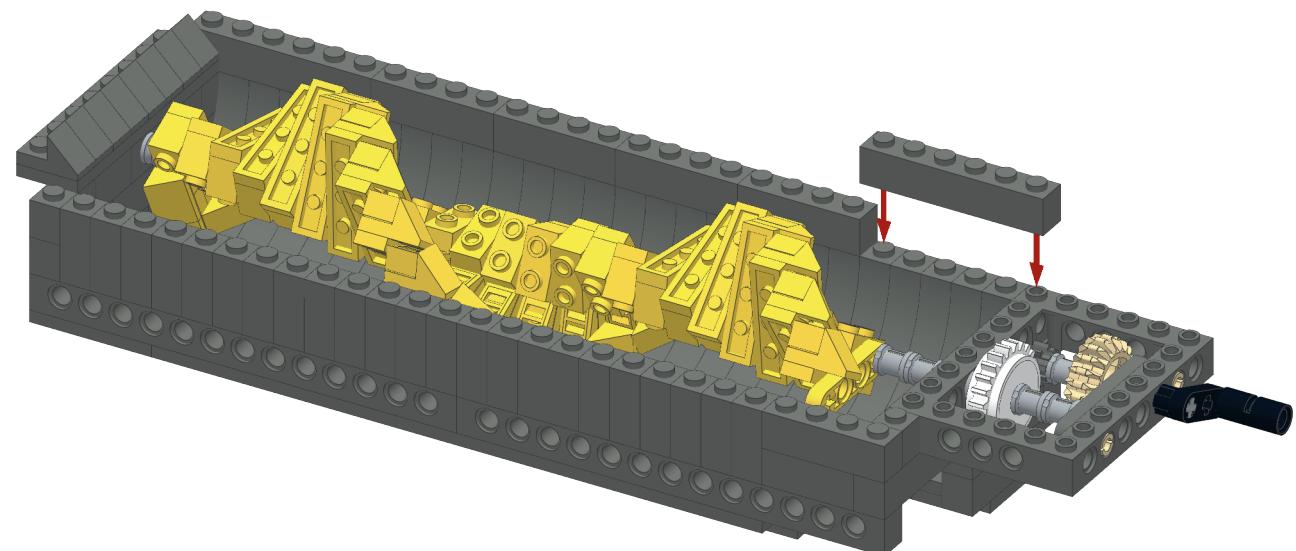


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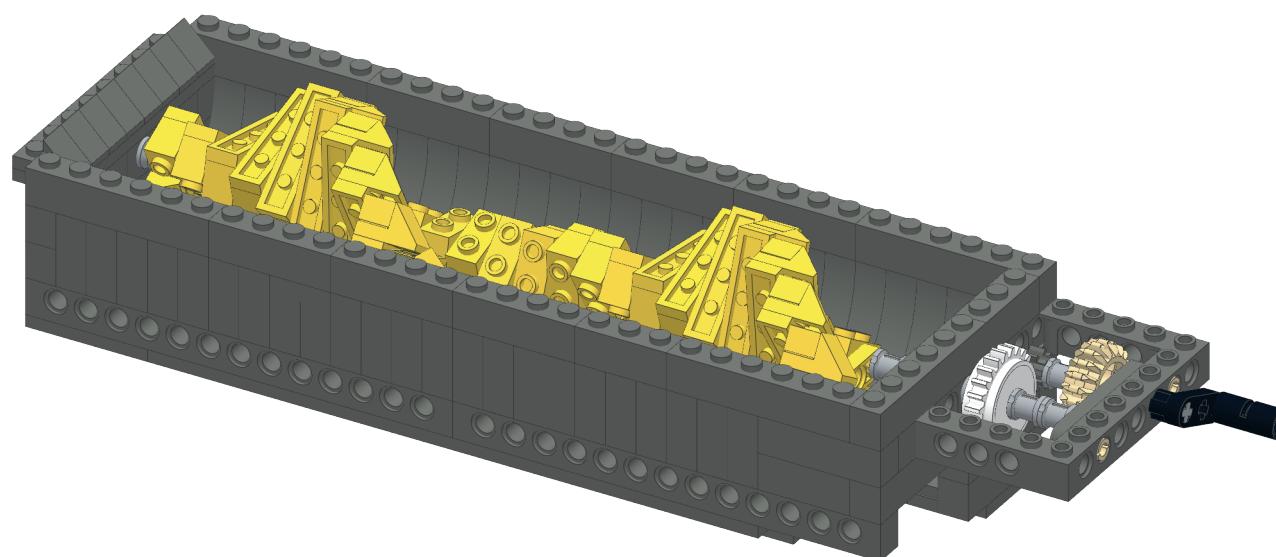


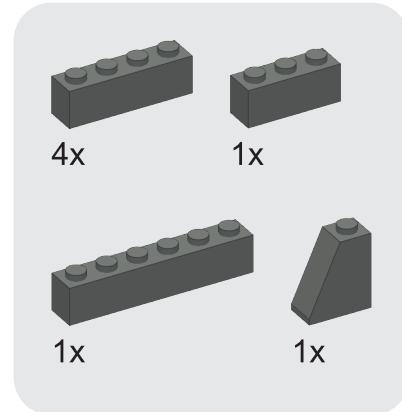


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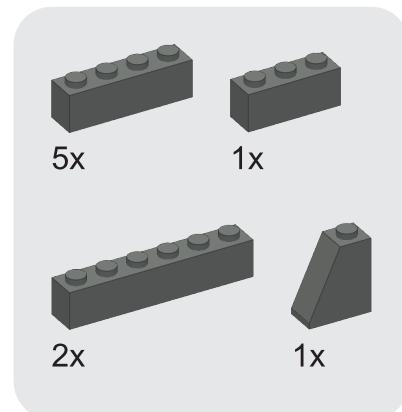
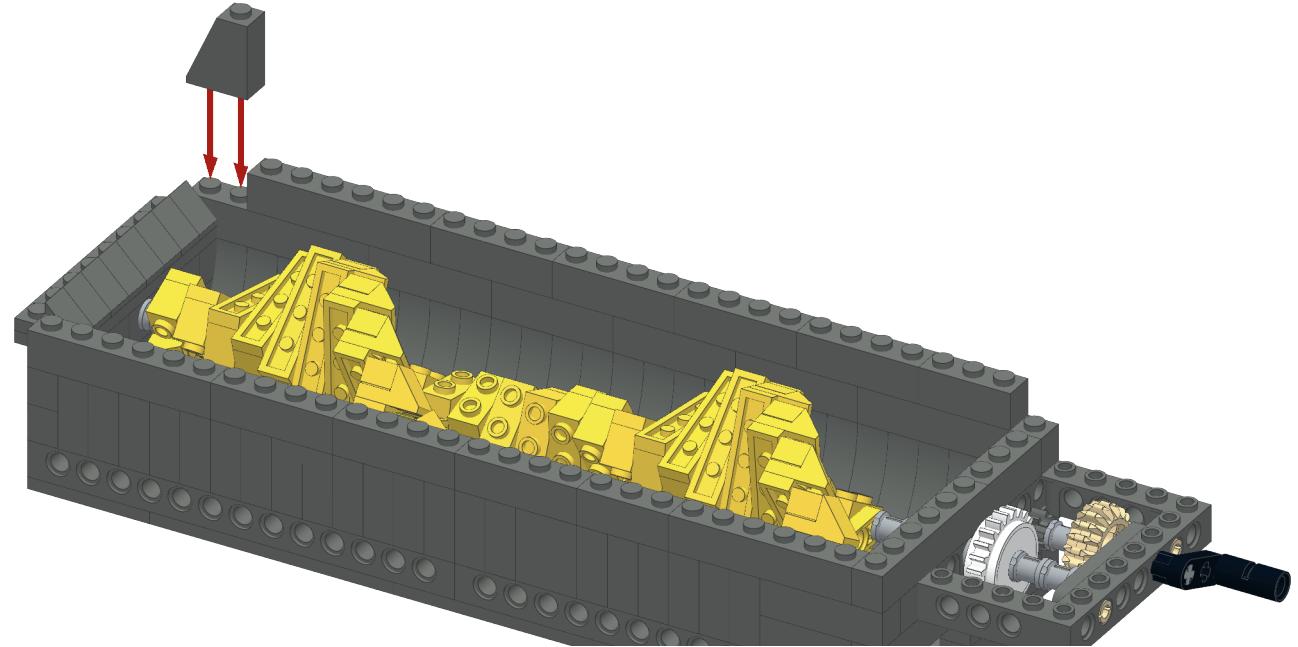


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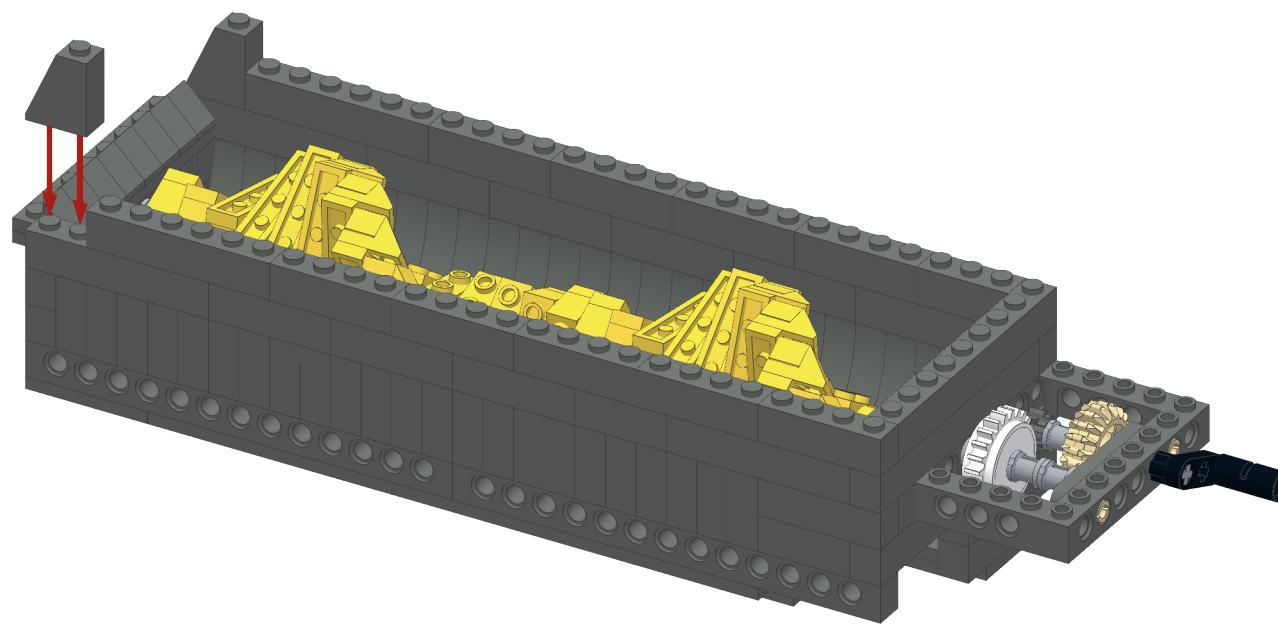


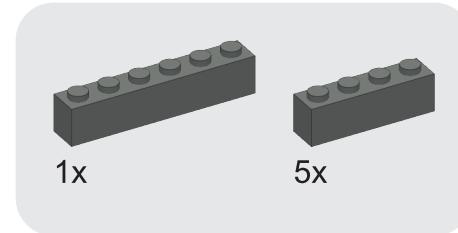


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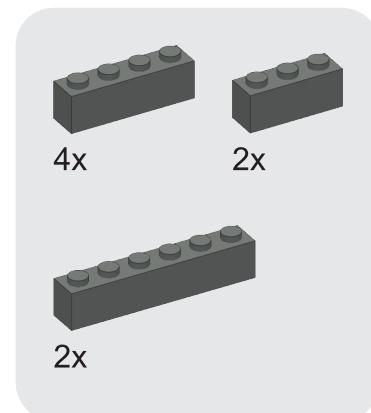
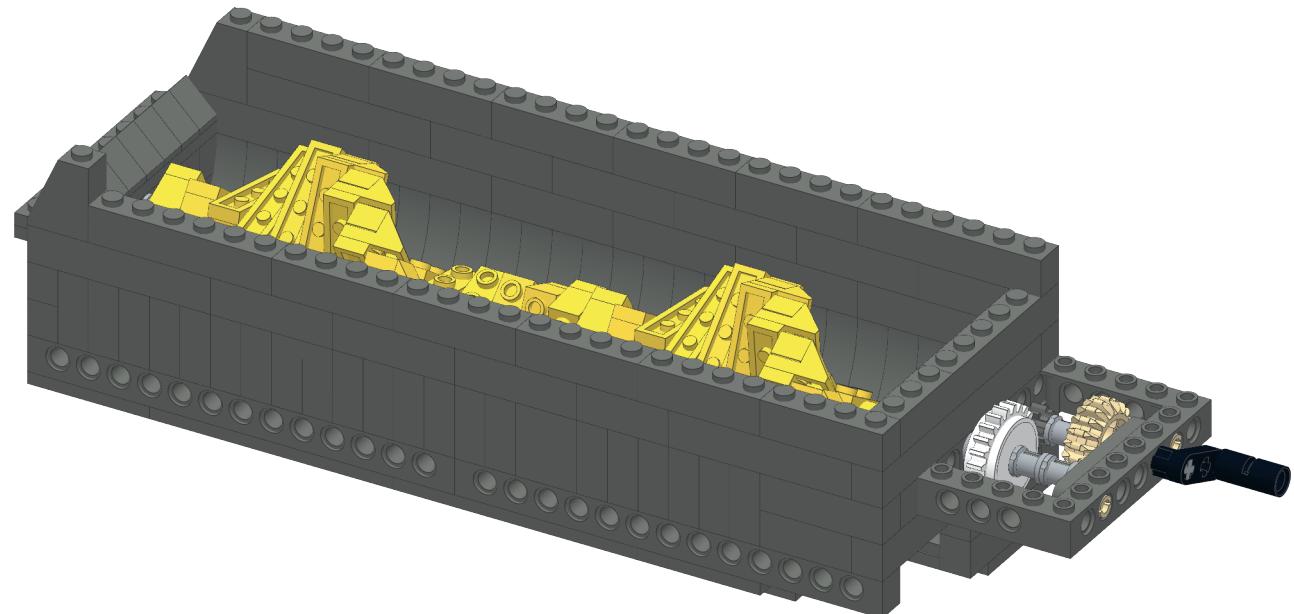


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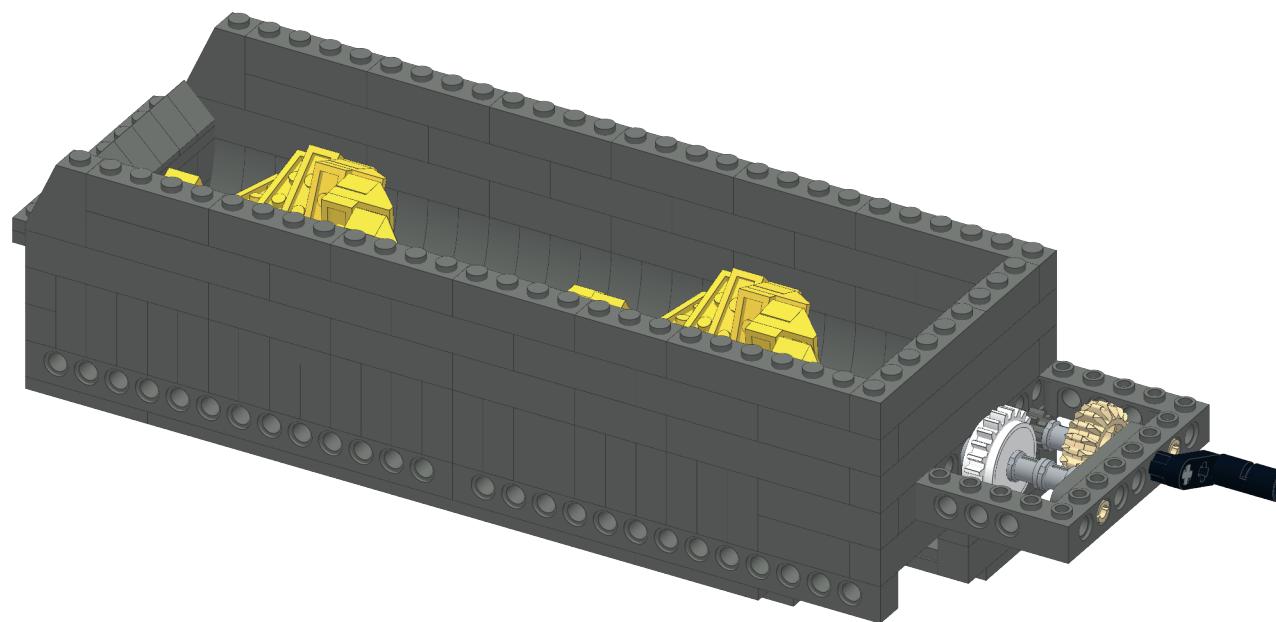


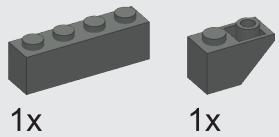


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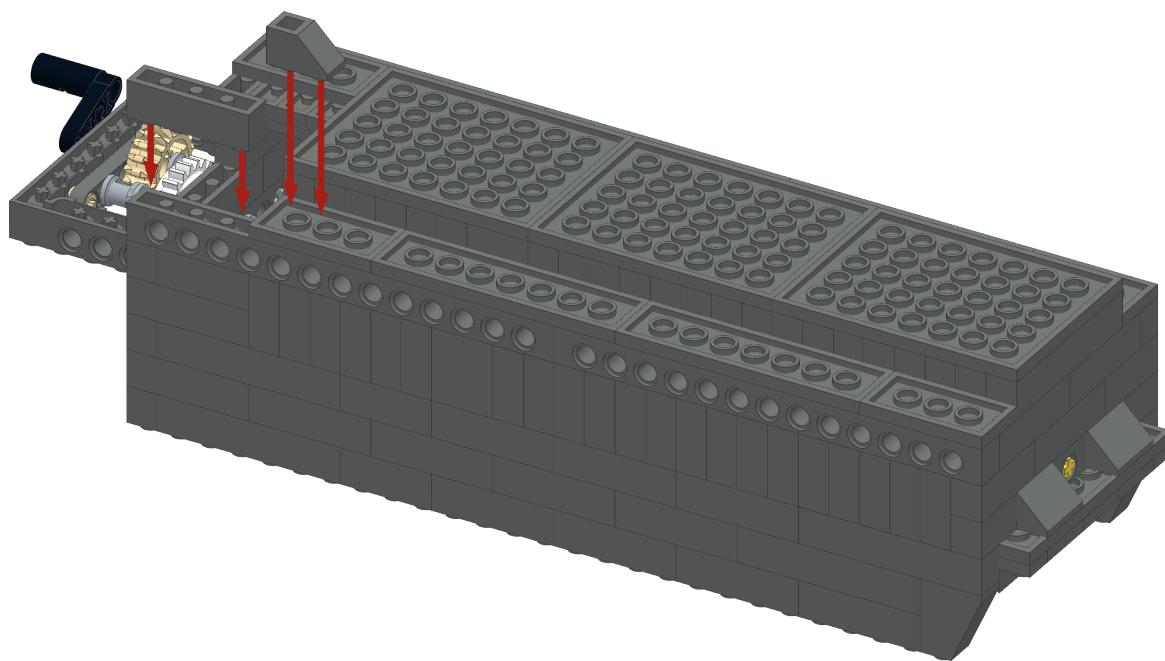


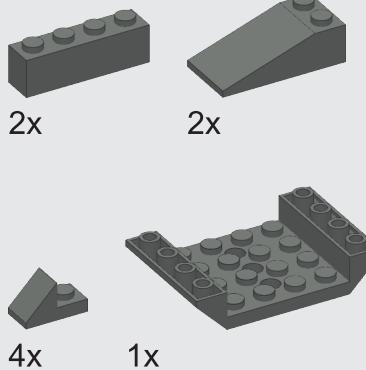
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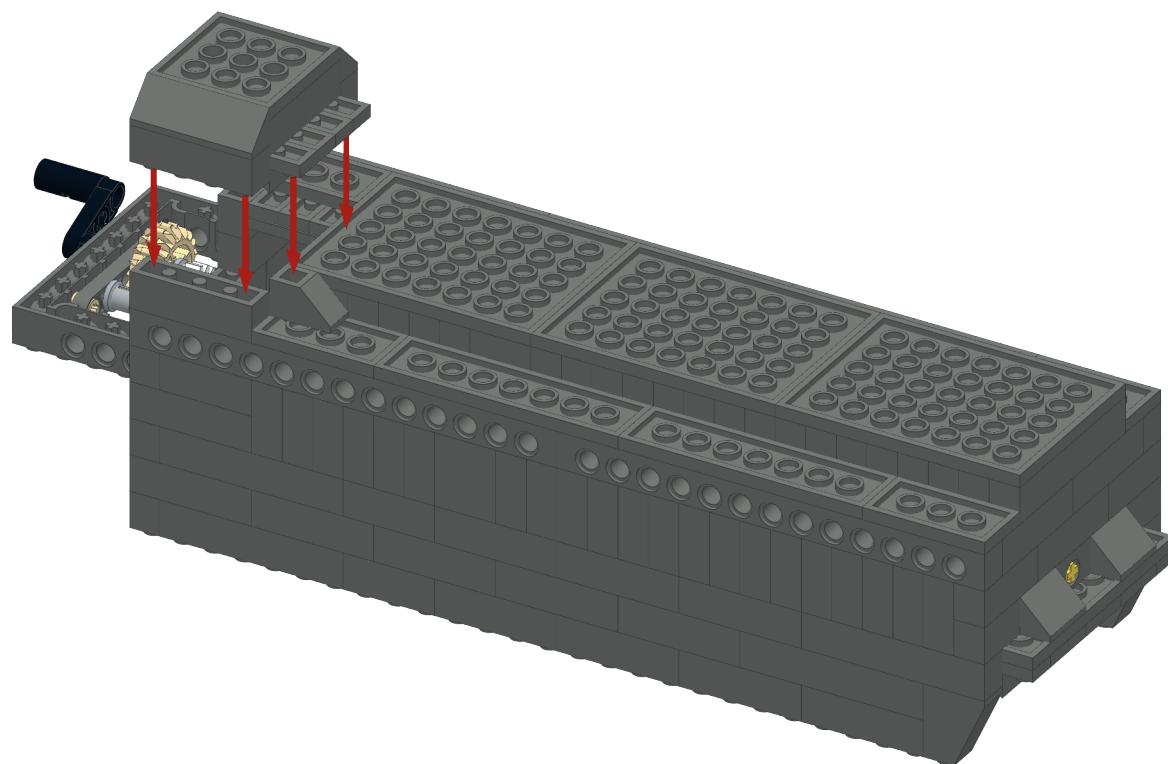
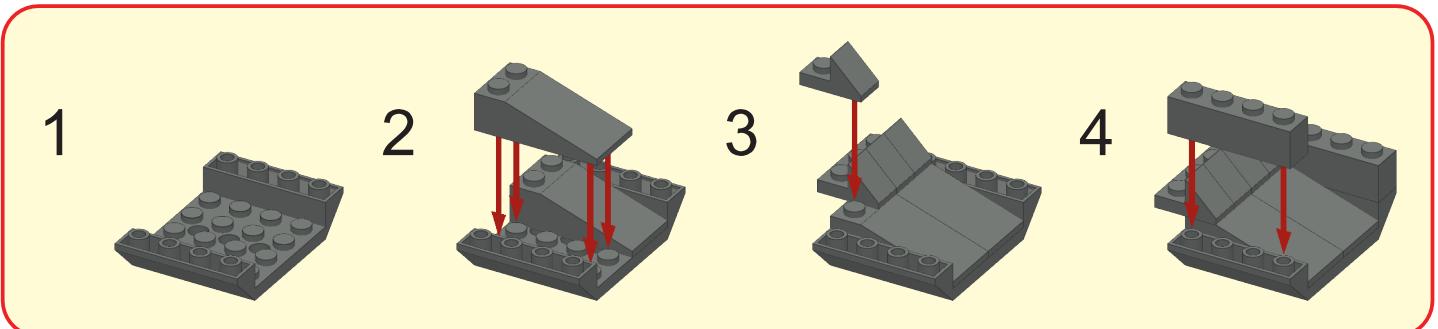


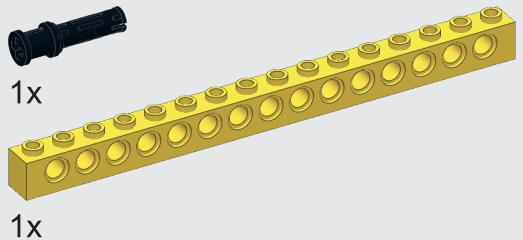
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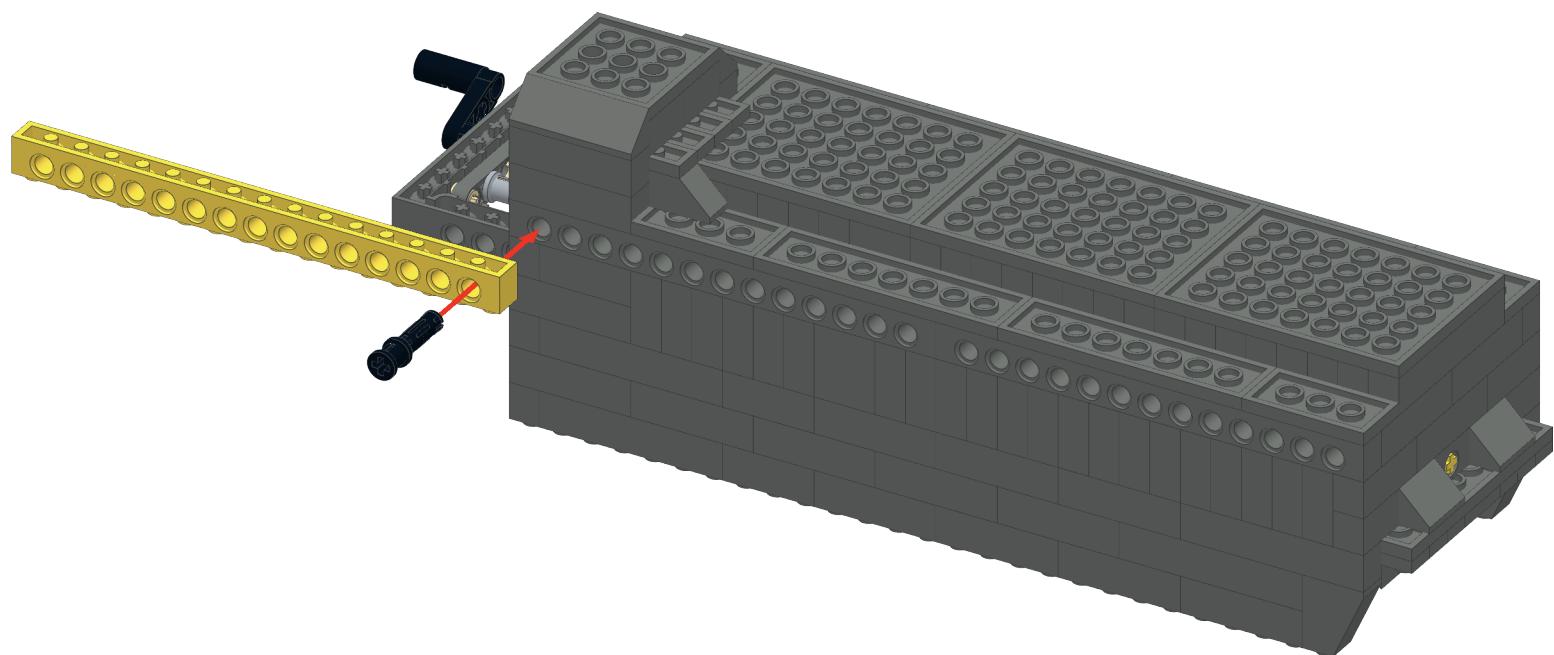


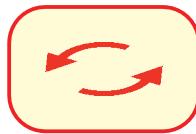
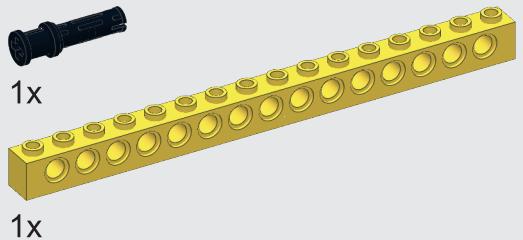
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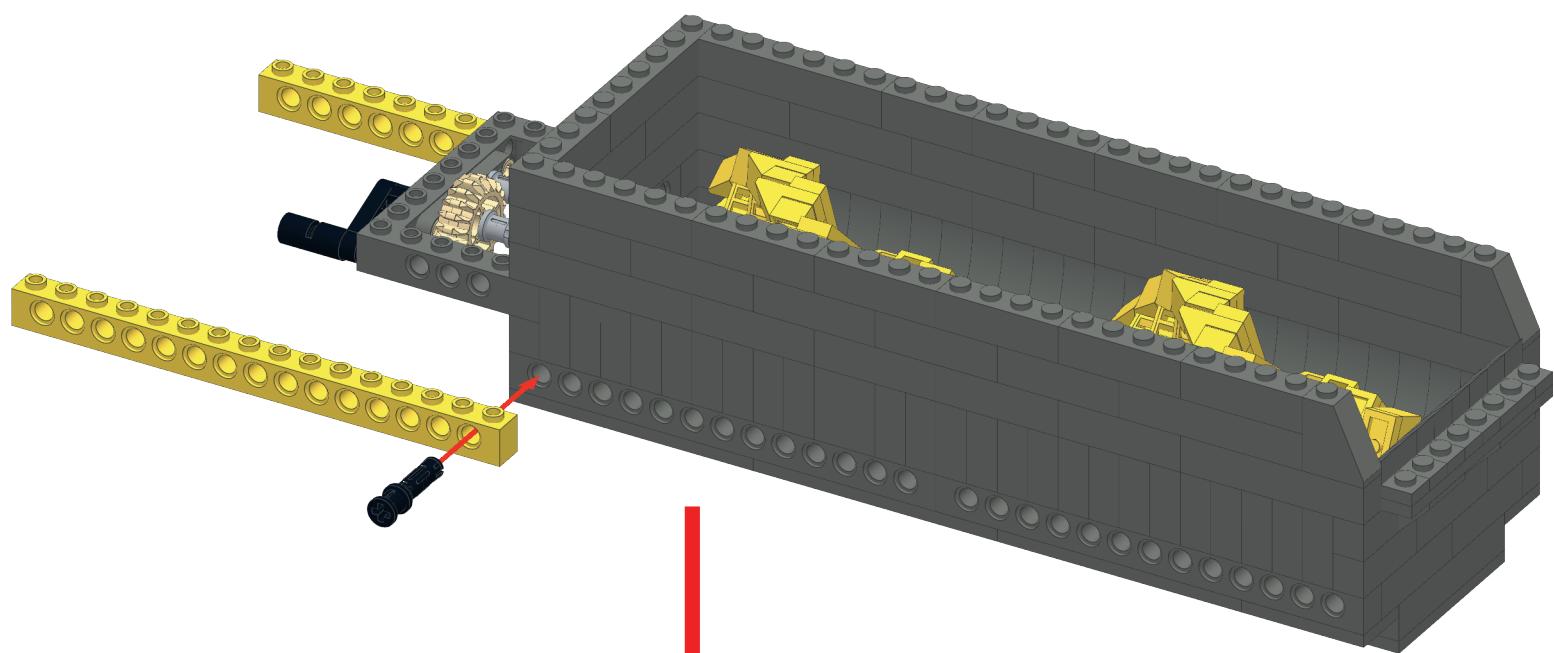


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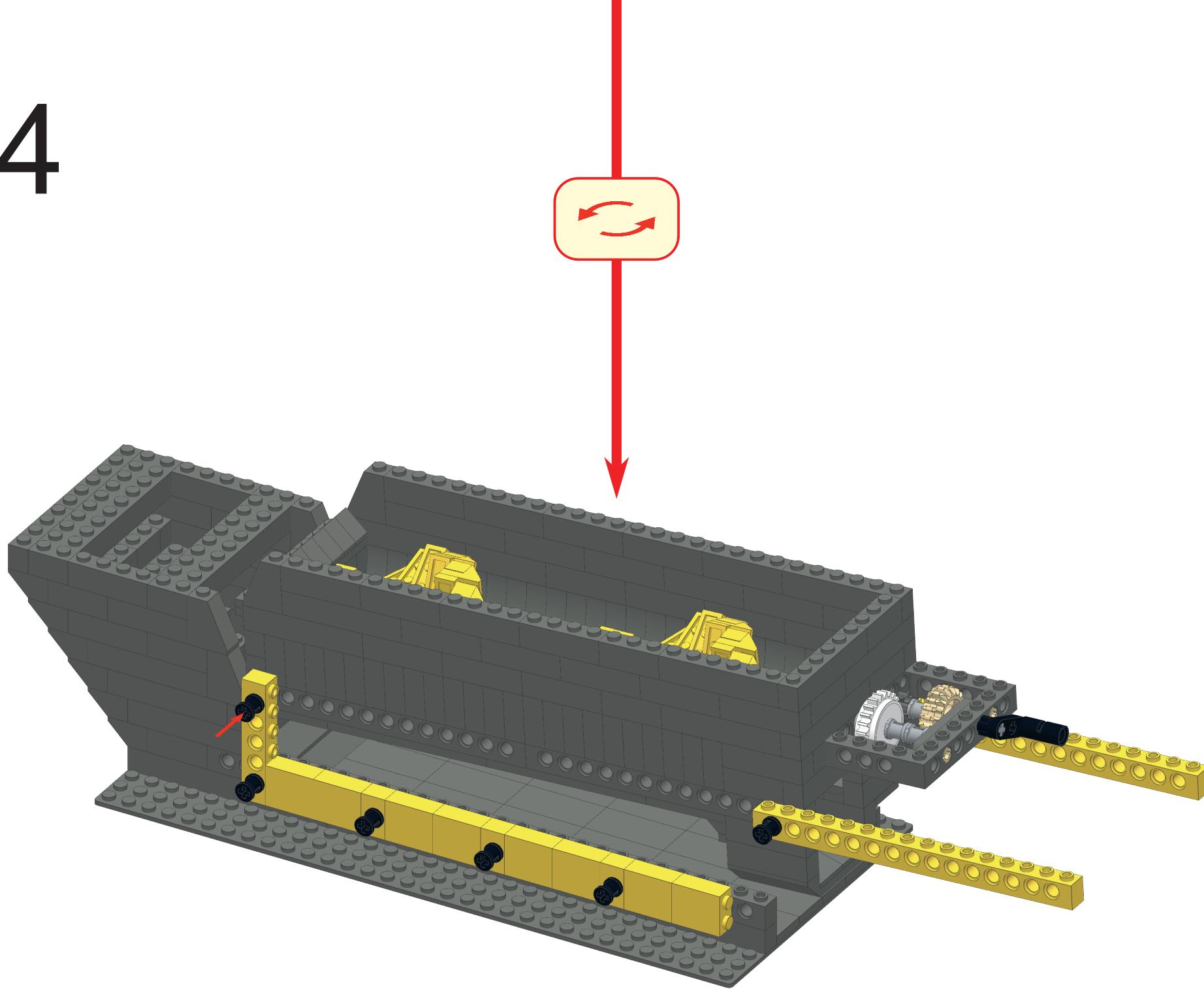




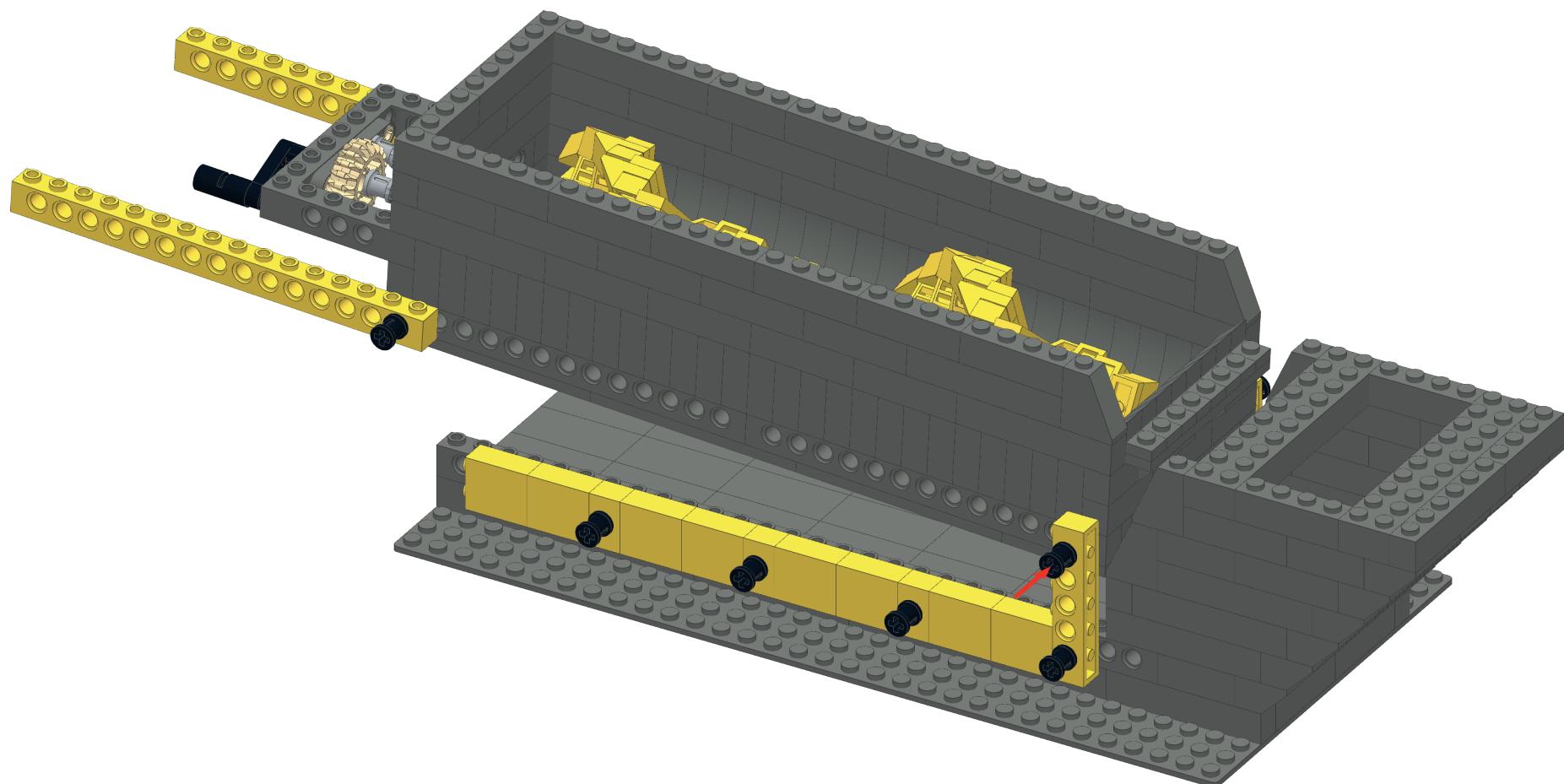
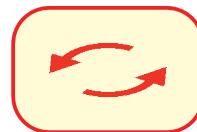
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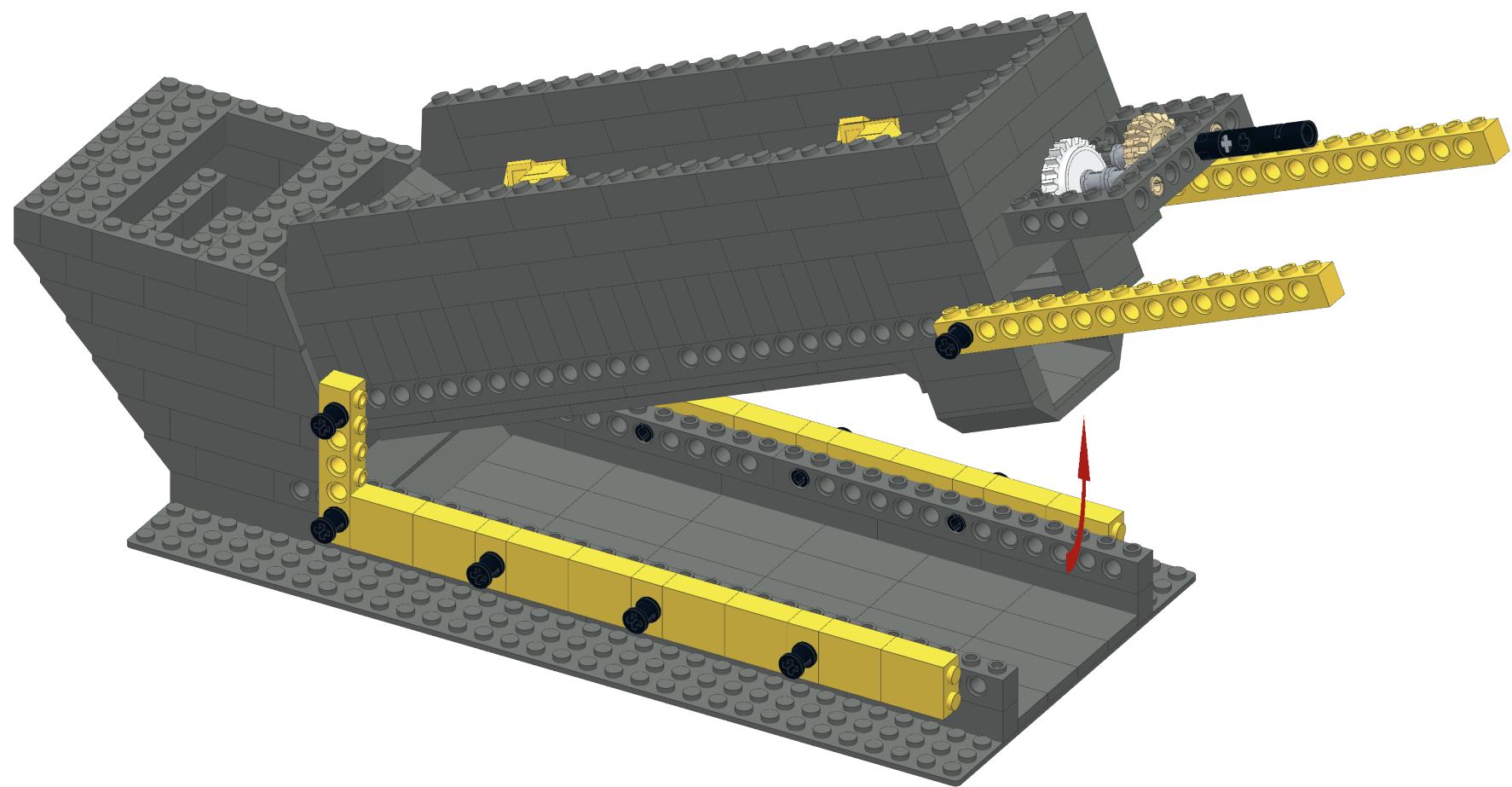
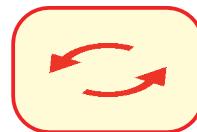
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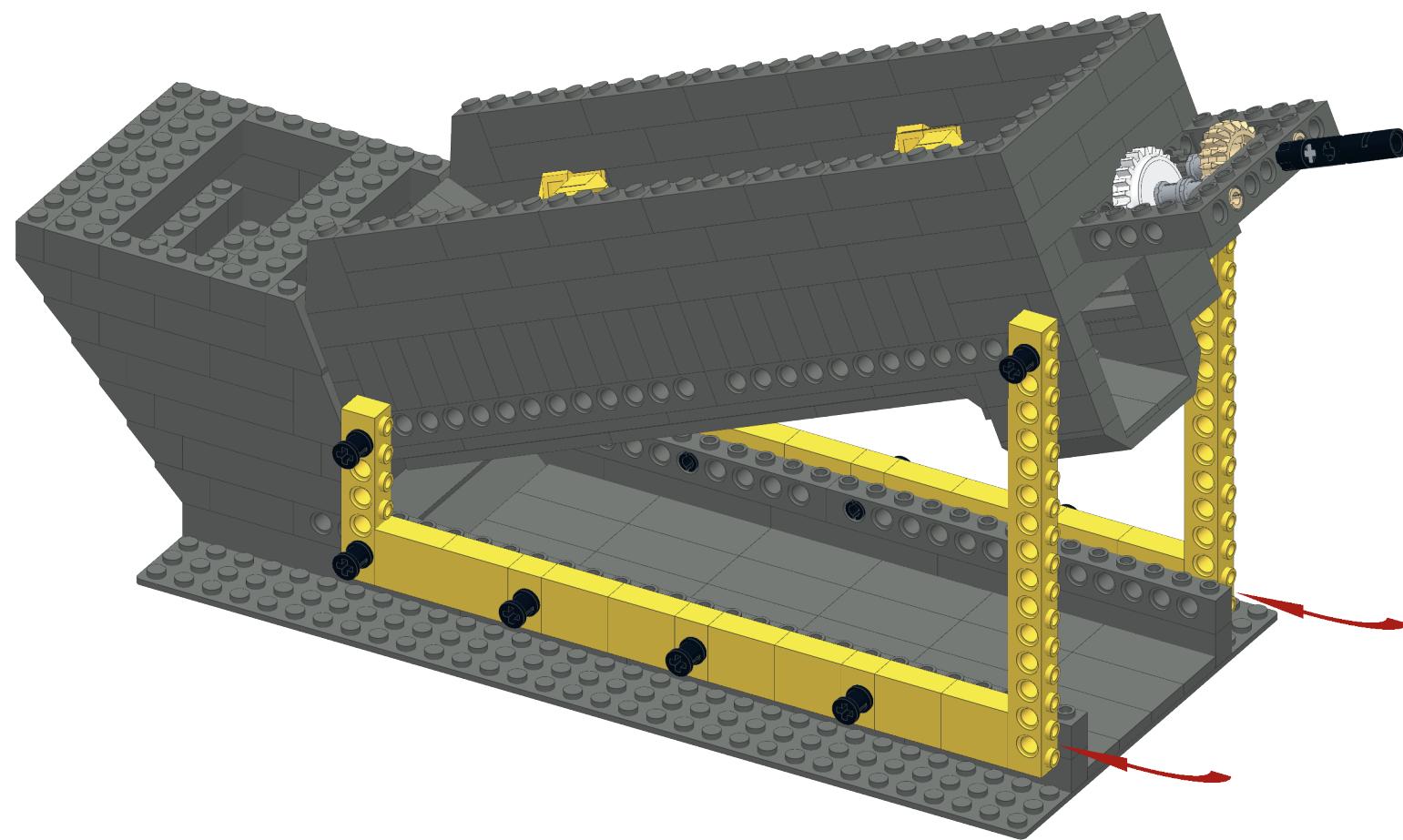
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# 36



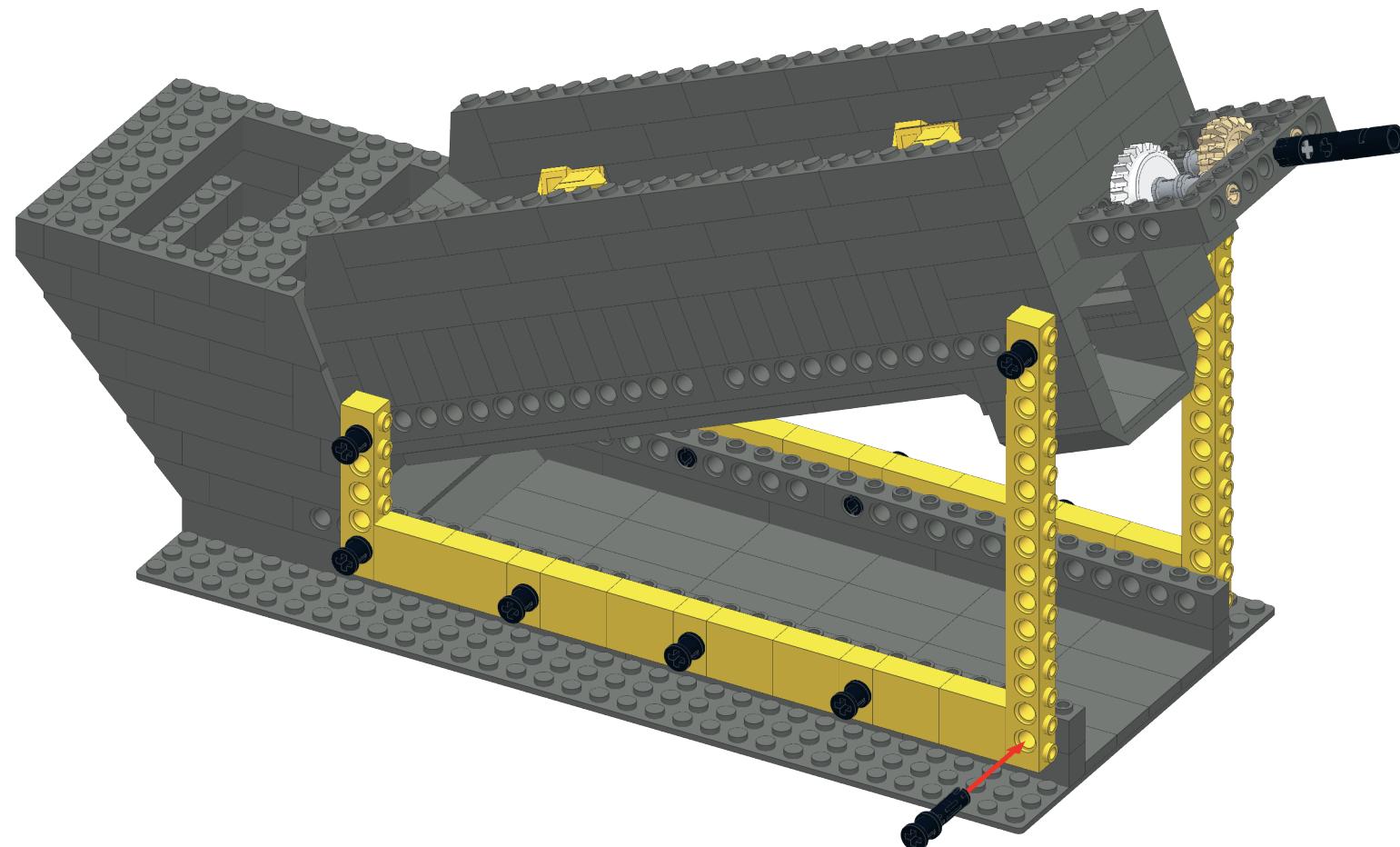
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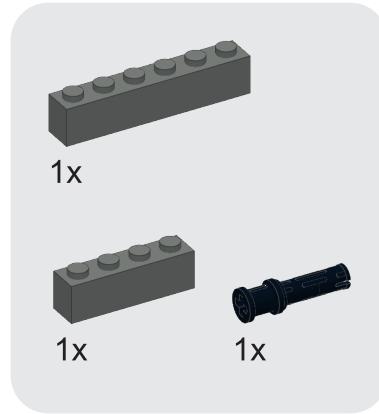




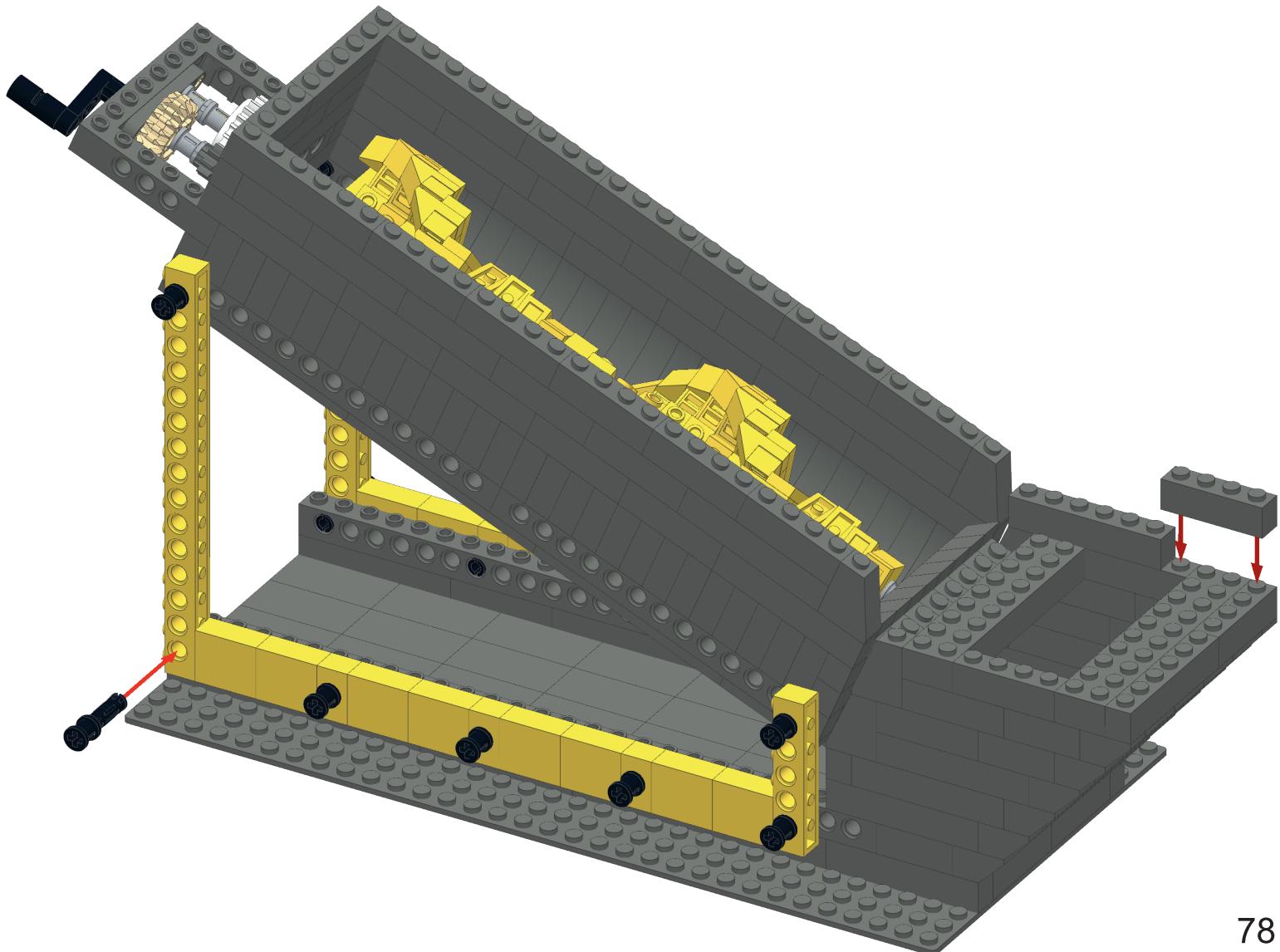
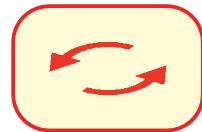
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38





39

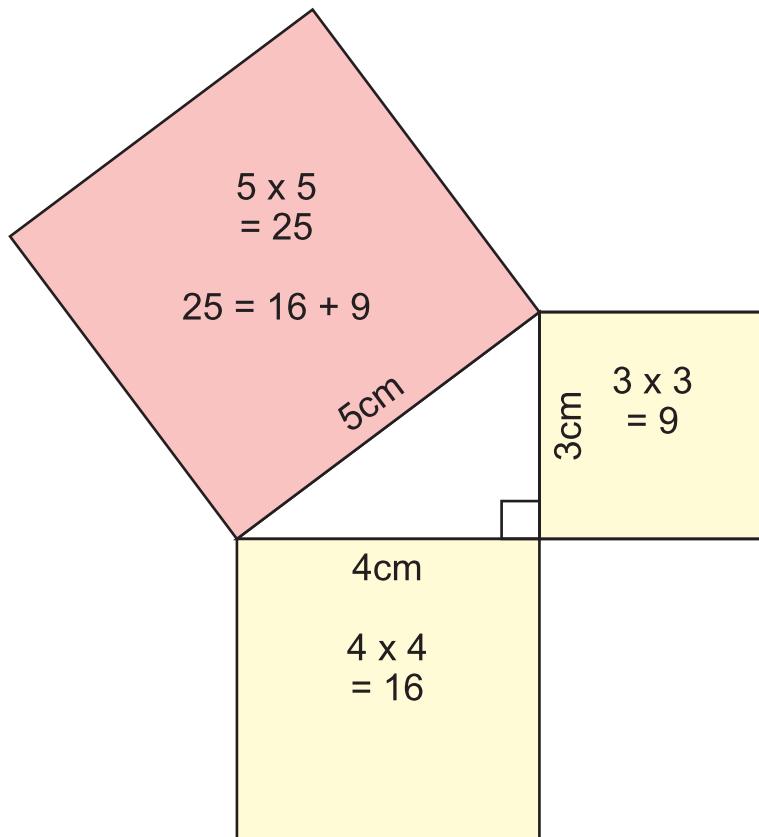


# Pythagoras' theorem

Pythagoras, another greek mathematician, lived 300 years before Archimedes - or 2500 years ago!

Among other discoveries, he proved an interesting relation between the sides of a right triangle (one which has a 90° angle). In such a triangle, the sum of the squares of the small sides is the same as the square of the larger side (called the hypotenuse).

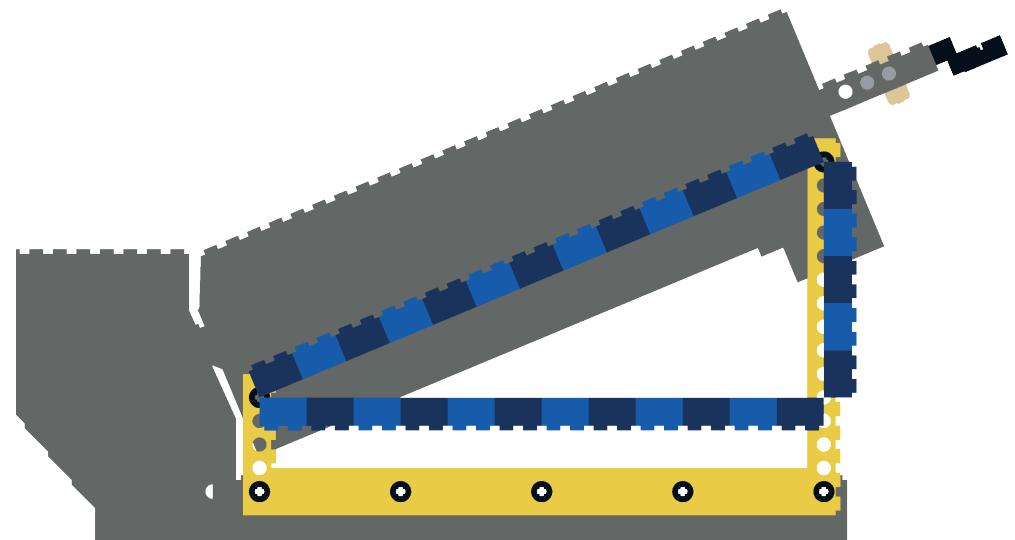
If that sounds complicated, just have a look at the following picture:



The small sizes measure 3cm and 4cm. The square of 3 is 9, the square of 4 is 16, and the sum of 9 and 16 is 25.

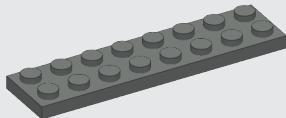
The hypotenuse measures 5cm. The square of 5 is also 25.

Pythagoras' Theorem is also useful with LEGO® creations as it allows model designers to attach parts at various angles easily, without putting unnecessary stress on them.



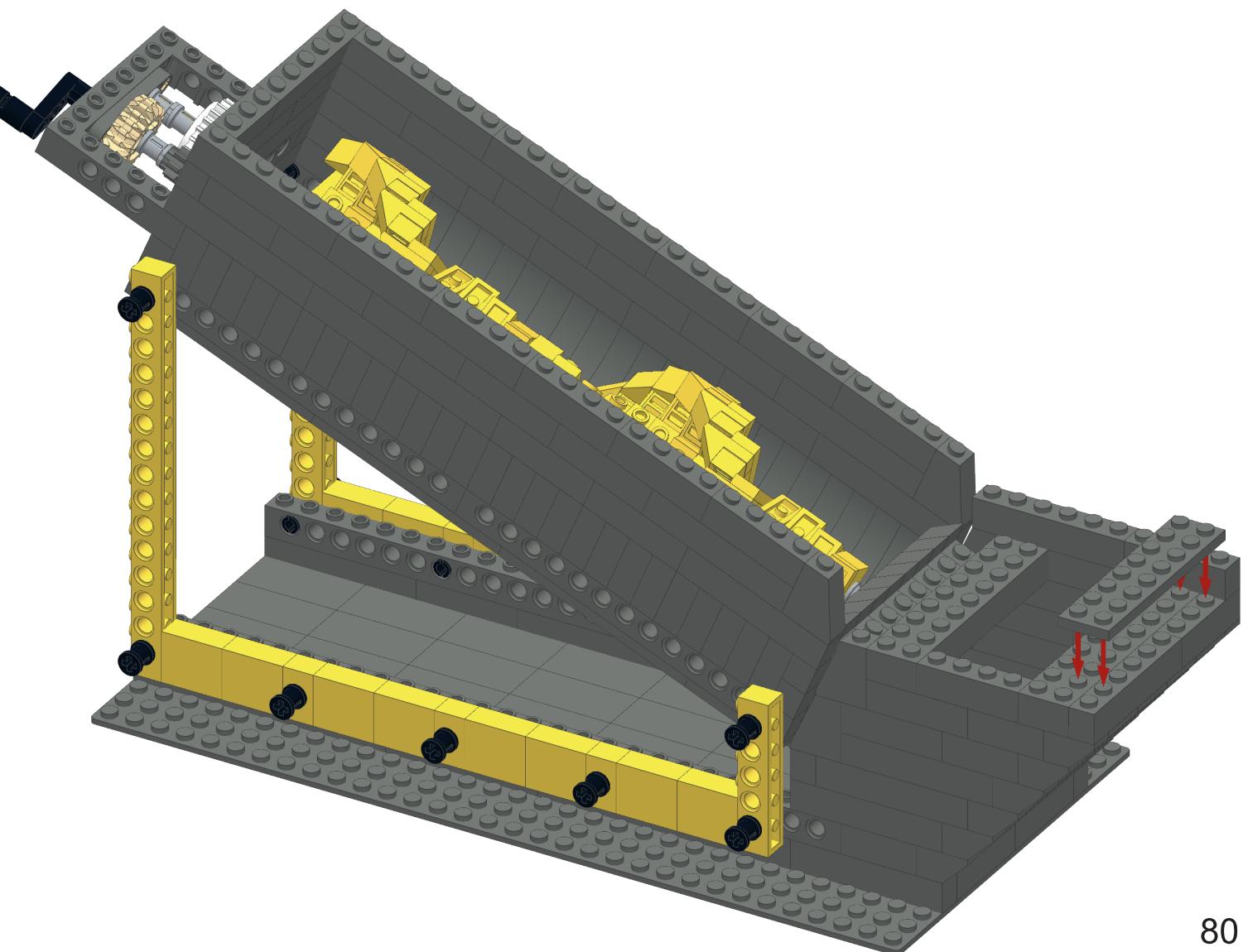
In this model of Archimede's screw, the pipe is placed using this technique as well. The dimensions are slightly more complicated, however: 24 bricks (192mm) at the base, 10 bricks (80mm) on the side and 26 bricks (208mm) on the pipe, which forms the hypotenuse.

Can you verify Pythagoras' theorem with these numbers?

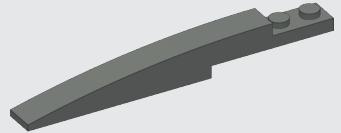


1x

40

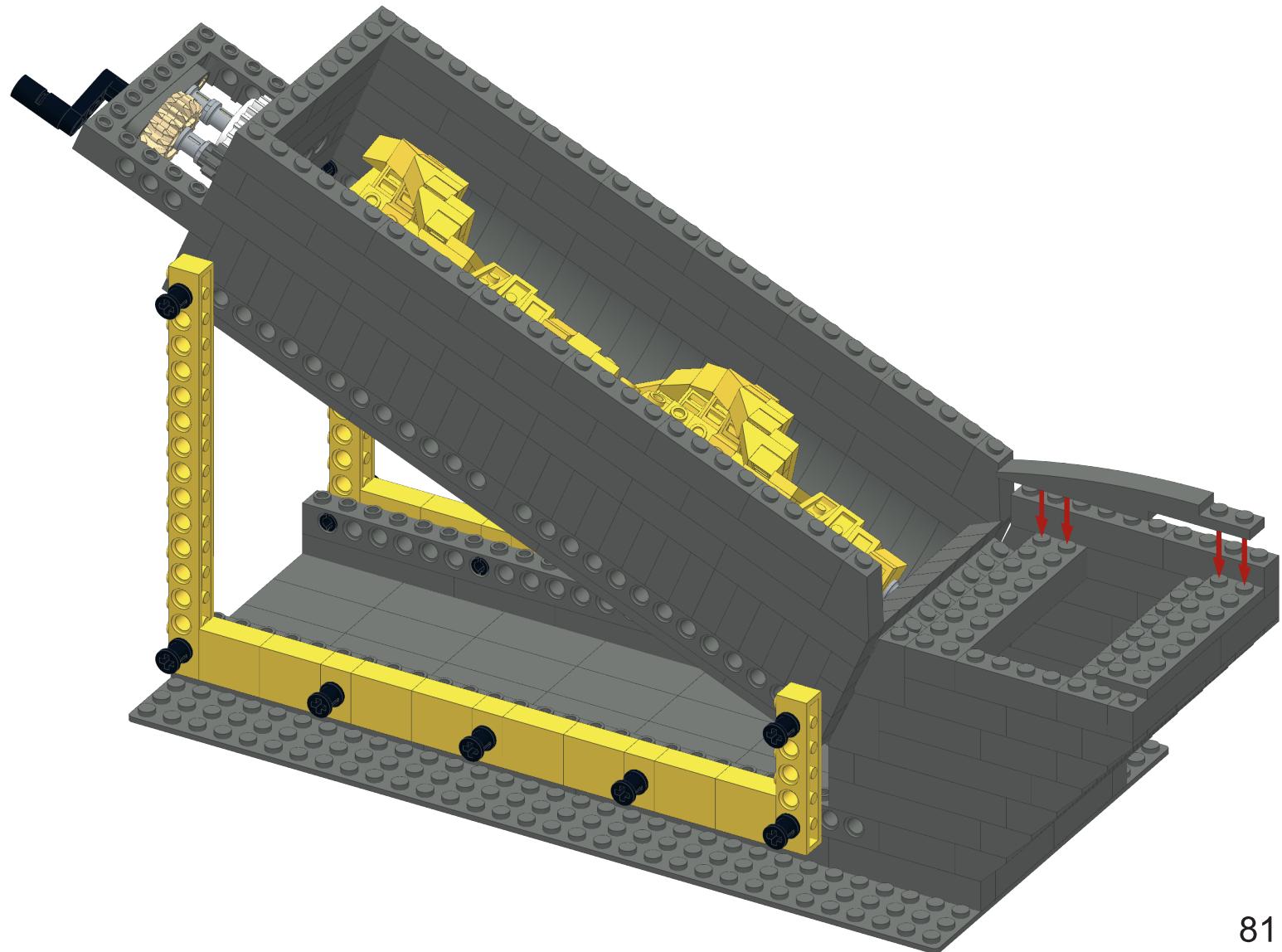


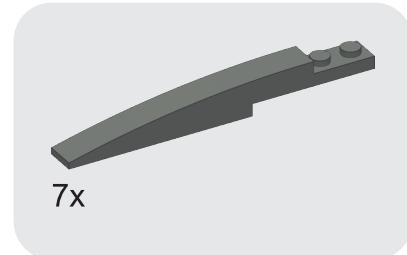
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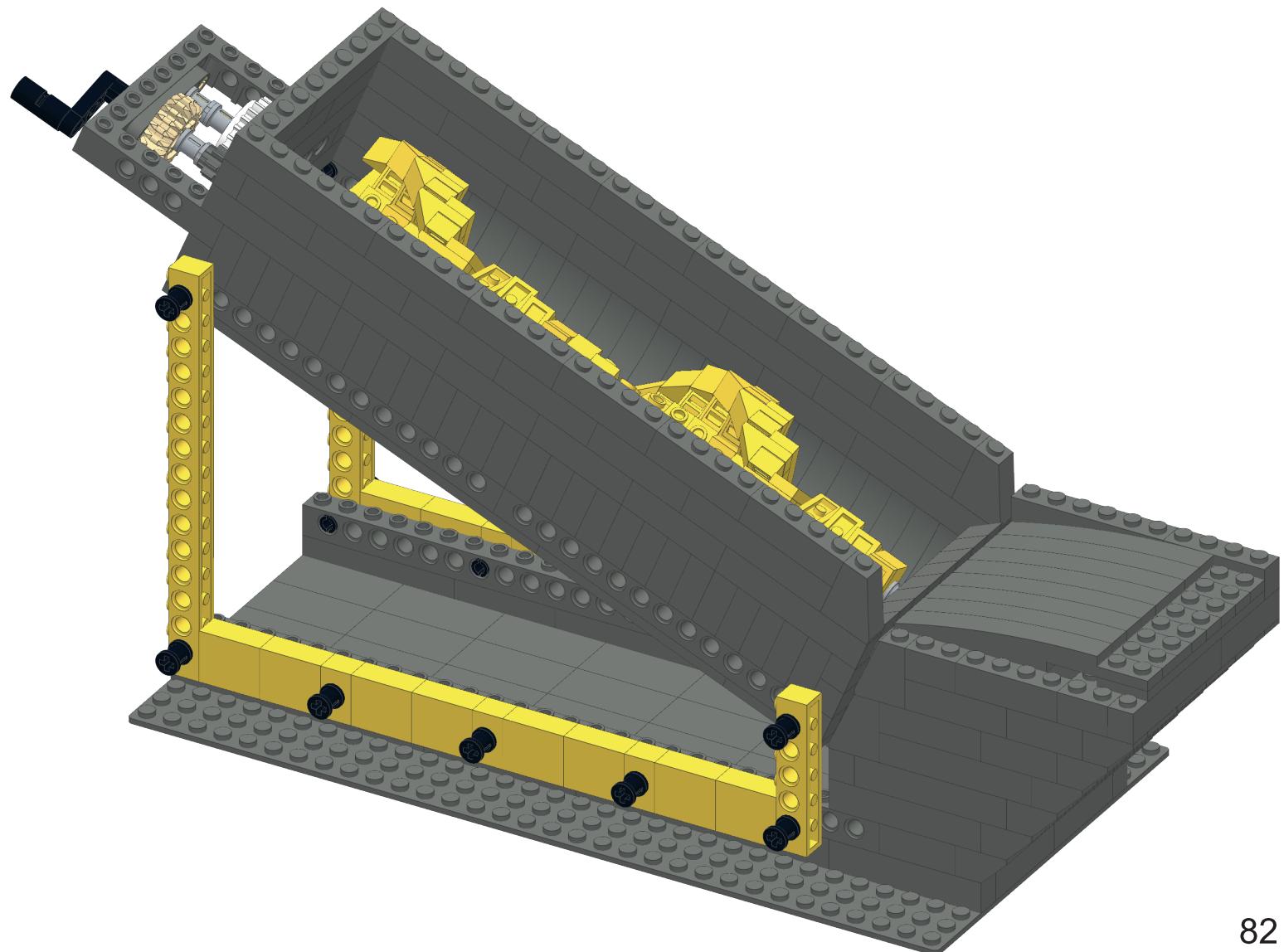
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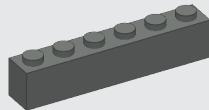


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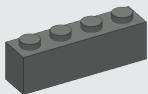
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82

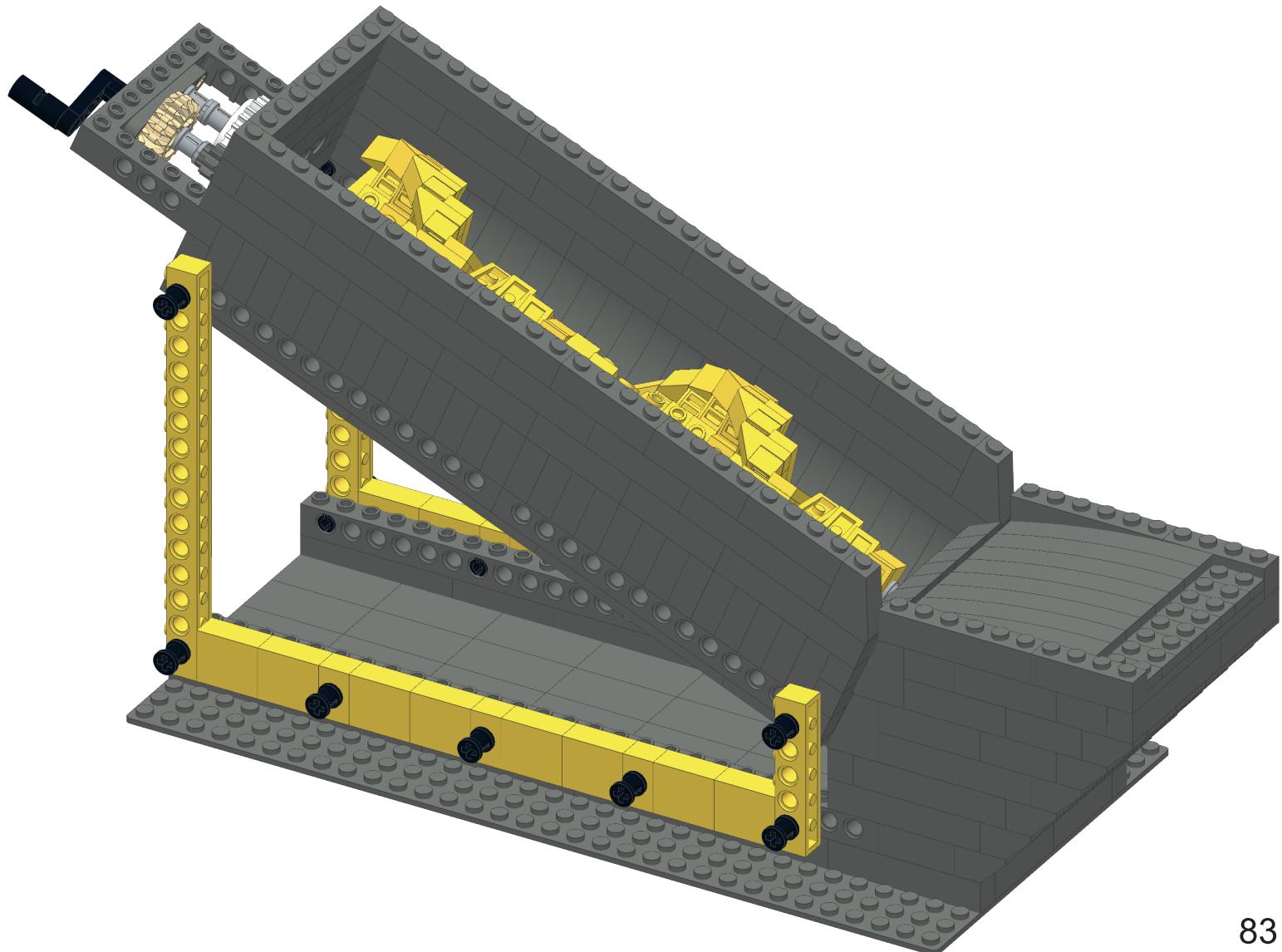


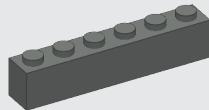
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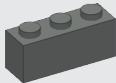
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43



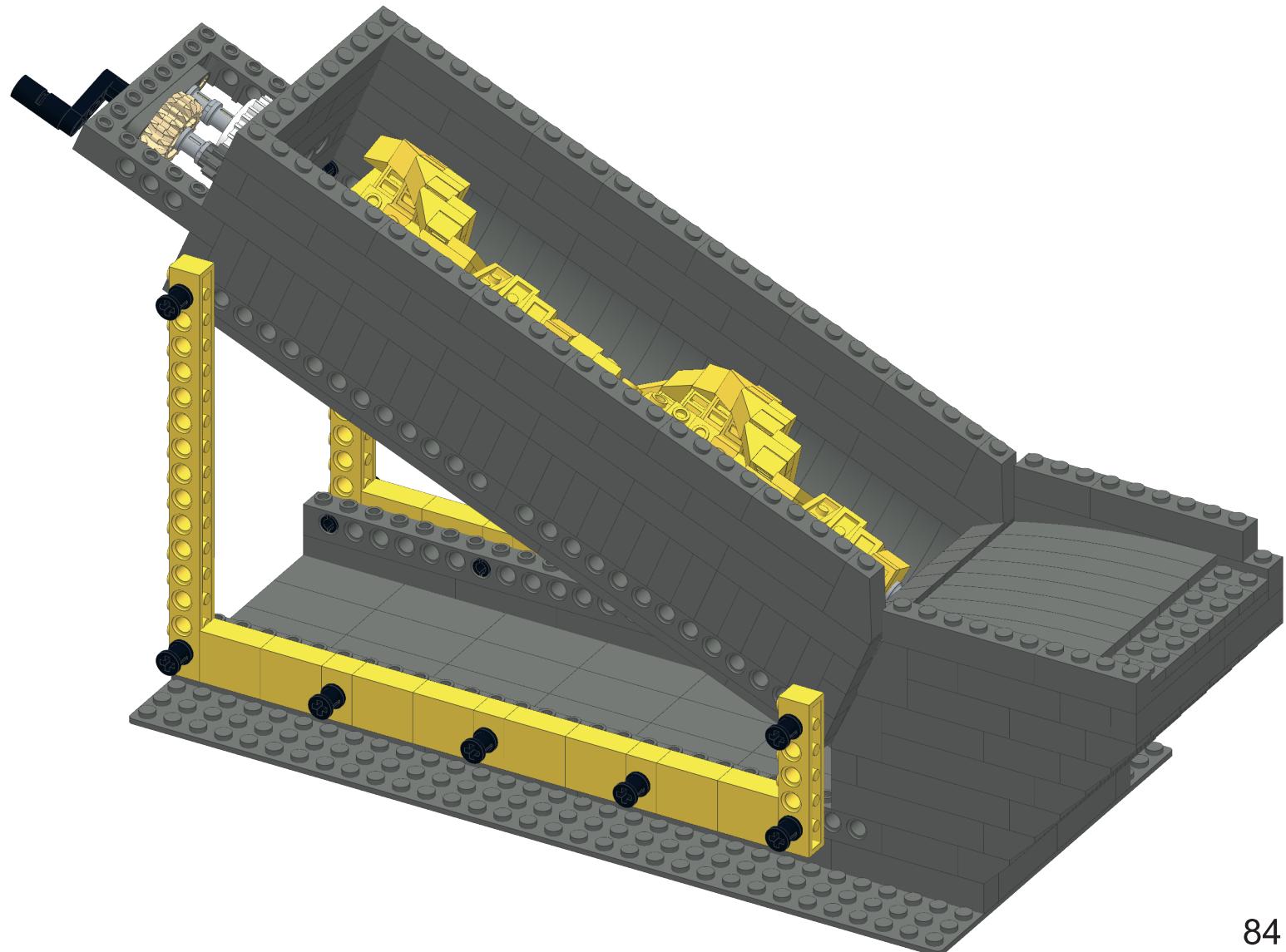


1x



1x

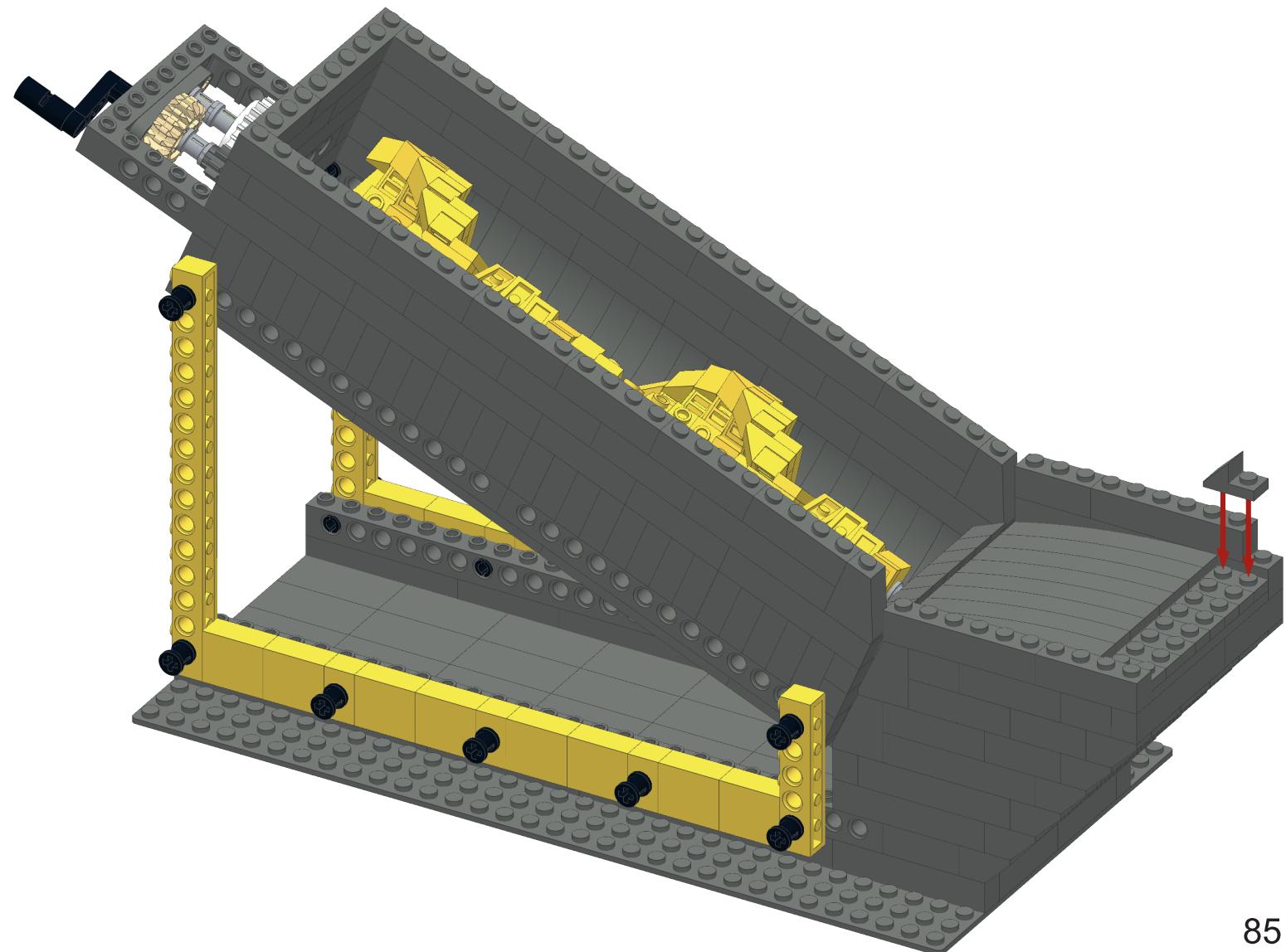
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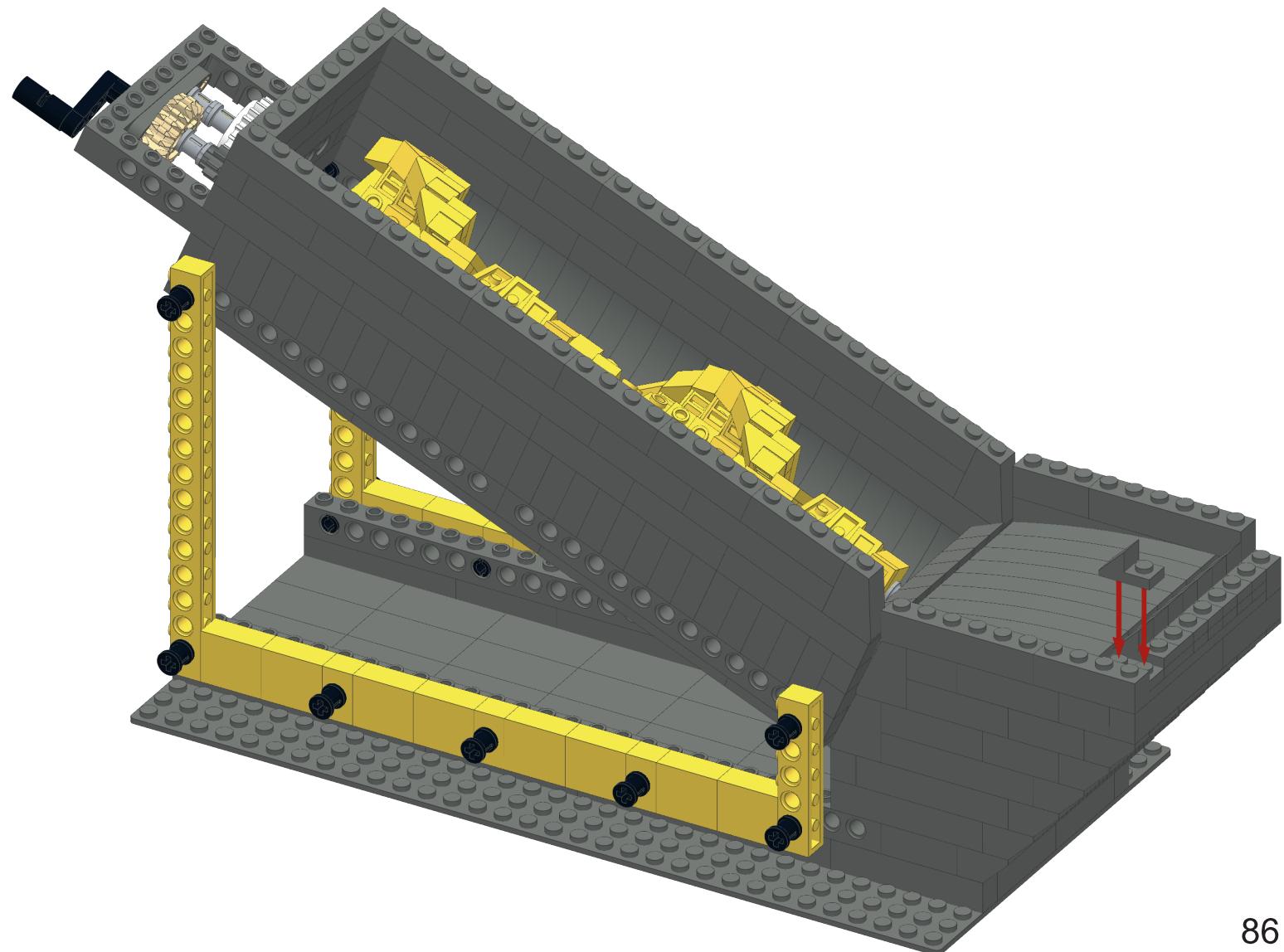
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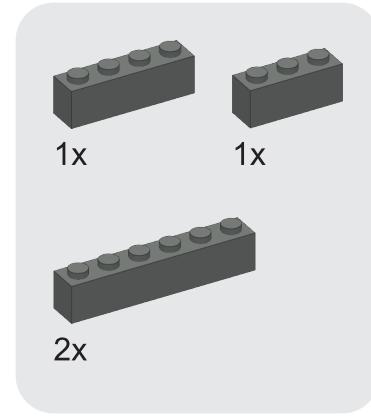




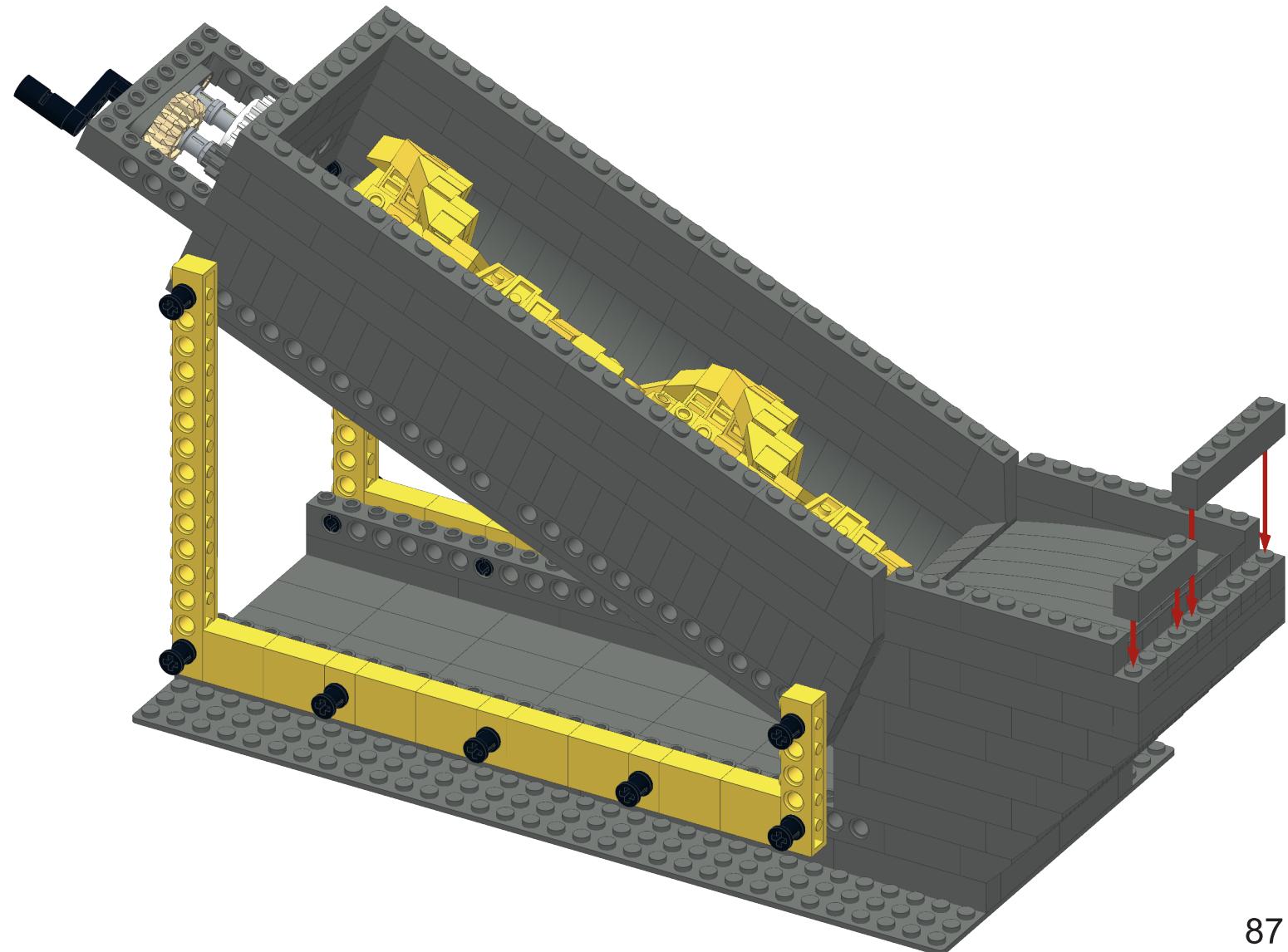
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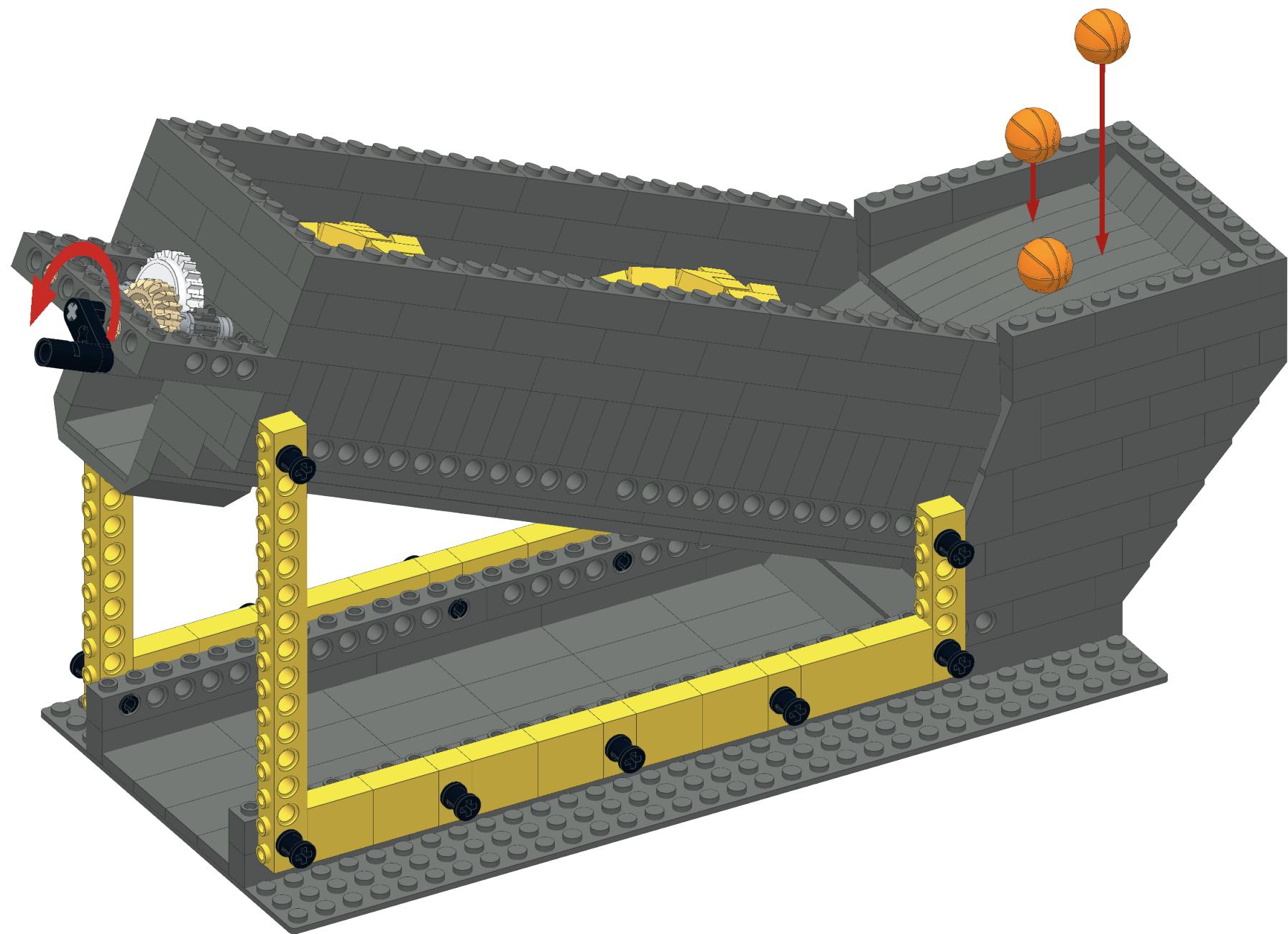
46





47







**1x**  
6036892



**2x**  
6013938



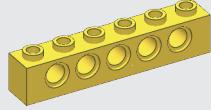
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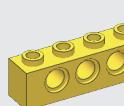
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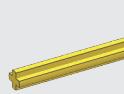
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370024



**2x**  
389424



**2x**  
370324<sup>(1)</sup>



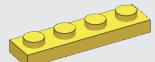
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**23x**  
302424



**2x**  
302324



**23x**  
371024



**1x**  
4504381



**1x**  
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**22x**  
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**23x**  
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**1x**  
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**1x**  
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**14x**  
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**1x**  
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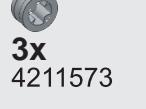
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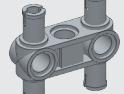
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**3x**  
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**5x**  
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**1x**  
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**1x**  
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**1x**  
4211098



**2x**  
4211088



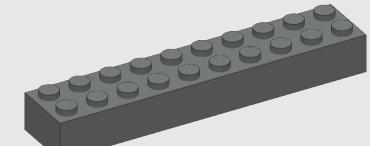
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**55x**  
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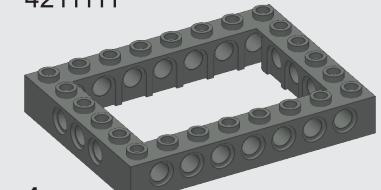
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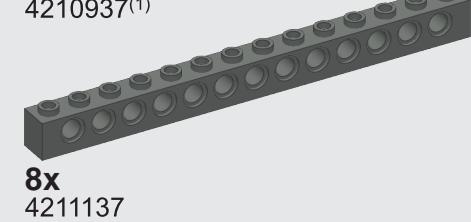
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**1x**  
4211111



**1x**  
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**8x**  
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**7x**  
4211096



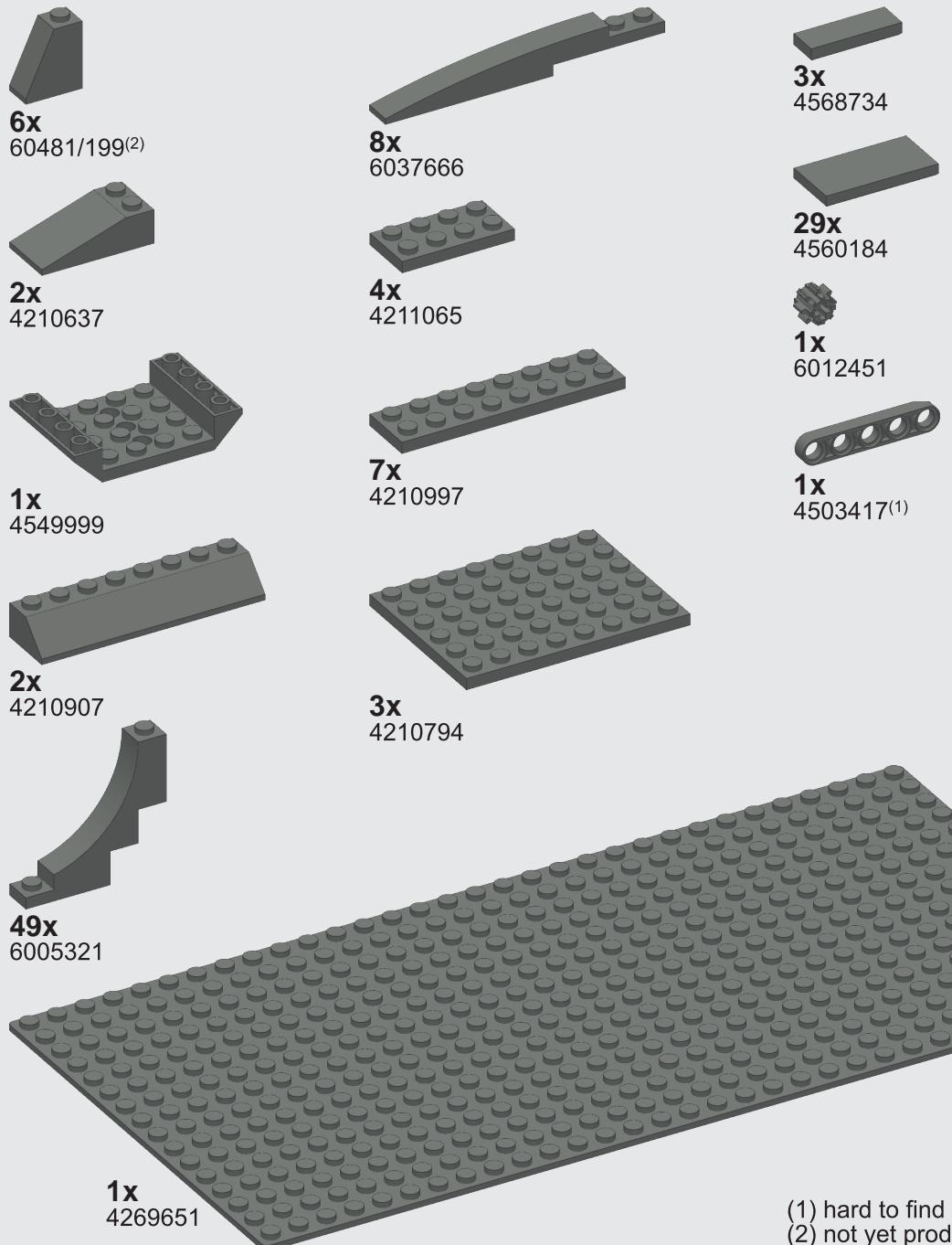
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4211000



**20x**  
4621917

(1) hard to find in that colour

# Links



- Great Ball Contraption:  
<http://www.greatballcontraption.com>
- Archimedes' screw:  
[http://en.wikipedia.org/wiki/Archimedes\\_screw](http://en.wikipedia.org/wiki/Archimedes_screw)  
<http://en.wikipedia.org/wiki/Screwpump>  
<http://www.kinderdijk.com>
- Pythagoras' theorem:  
[http://en.wikipedia.org/wiki/Pythagoras'\\_theorem](http://en.wikipedia.org/wiki/Pythagoras'_theorem)  
[http://en.wikipedia.org/wiki/Pythagorean\\_theorem](http://en.wikipedia.org/wiki/Pythagorean_theorem)
- LEGO® elements:  
<http://shop.lego.com/en-US/Pick-A-Brick-ByTheme>  
<http://shop.lego.com/en-US/LEGO-Power-Functions-M-Motor-8883>  
<http://shop.lego.com/en-US/LEGO-Power-Functions-Battery-Box-8881>
- LEGO® modelling:  
<http://www.Idraw.org>