

EXPERIMENT MANUAL

ENGINEERING MAKERSPACE

GEARED-UP GADGETS



 THAMES & KOSMOS

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>> SAFETY INFORMATION

Warning! Not suitable for children under 3 years. Choking hazard — small parts may be swallowed or inhaled.

Keep the packaging and the instructions as they contain important information.

Store the experiment materials and assembled models out of the reach of small children.

The models are intended for indoor use. Do not use your models in a sandbox. Do not use the hand mixer with food.

Clear sufficient space before launching the models. Keep small children or animals away when launching the models (in order to prevent nearby objects from breaking).

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Dear Parents and Adults,

Before starting the experiments, read through the instruction manual together with your child and discuss the safety information. Check to make sure the models have been assembled correctly, and assist your child with the experiments.

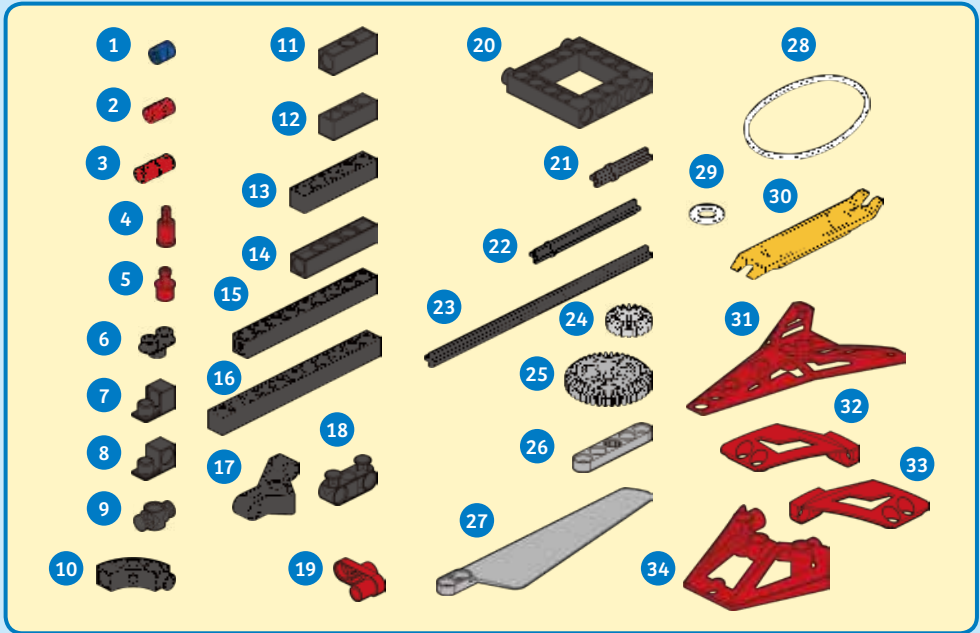
We hope you and your child have a lot of fun with the experiments!



Kosmos Quality and Safety

More than one hundred years of expertise in publishing science experiment kits stand behind every product that bears the Kosmos name. Kosmos experiment kits are designed by an experienced team of specialists and tested with the utmost care during development and production. With regard to product safety, these experiment kits follow European and US safety standards, as well as our own refined proprietary safety guidelines. By working closely with our manufacturing partners and safety testing labs, we are able to control all stages of production. While the majority of our products are made in Germany, all of our products, regardless of origin, follow the same rigid quality standards.

>>> KIT CONTENTS



Checklist: Find – Inspect – Check off

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<input type="radio"/>	1	Short anchor pin	30	717767
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<input type="radio"/>	3	Joint pin	3	702524
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<input type="radio"/>	9	1-hole connector	6	719233
<input type="radio"/>	10	Curved rod	2	716310
<input type="radio"/>	11	3-hole cross rod	4	717899
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<input type="radio"/>	15	9 hole rod	1	717806
<input type="radio"/>	16	11-hole rod	2	716304
<input type="radio"/>	17	Angled arm	4	720731

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<input type="radio"/>	19	3-hole crank	2	720730
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<input type="radio"/>	24	Small gear	5	716885
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<input type="radio"/>	26	5-hole axle rod	2	720737
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<input type="radio"/>	28	Rubber band, small	2	702596
<input type="radio"/>	29	Washer	1	703242
<input type="radio"/>	30	Anchor pin lever	1	702590
<input type="radio"/>	31	Large body piece A	2	720732
<input type="radio"/>	32	Small body piece left	1	720733
<input type="radio"/>	33	Small body piece right	1	720734
<input type="radio"/>	34	Large body piece B	3	720735



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On page 4 you can see all the models at a glance.



Learn amazing information about gears pages 3 and 25.



TIPS FOR ASSEMBLY THE ANCHOR PIN LEVER

Side A of the lever can be used to easily remove anchor pins.

Side B can be used to loosen firmly inserted parts, such as axle plugs.



>>> CHECK IT OUT

Before building any of the models, you should carry out the following little experiment.

>>> Hold two of the gear wheels together, so that the cogs on the edges (the “teeth”) interlock. Turn one of the wheels. The other wheel will turn as well, automatically moving along with the first gear. This demonstrates that interlocking gear wheels can transmit a rotational movement.

Pay close attention to the direction of rotation: The second wheel turns differently than the first one.



When the gear wheels have different diameters and, as a result, a different number of teeth, their rotational

speeds will also be different. The larger wheel turns slower than the smaller one.

This shows that gear wheels can be used to convert a slow rotational movement into a faster rotational movement and vice versa. For example, if the larger gear wheel has 40 teeth and the smaller wheel has 10, the smaller wheel will complete 4 rotations in the time it takes the larger wheel to do one rotation. This relationship between the input speed and the output speed is known as the gear ratio. In this case, the ratio is 1:4.

>>> Use your other hand to slow down the second gear wheel while you turn the first wheel. You will notice that you need to apply a lot of force. This shows that interlocking gear wheels also transmit force.

>>> In the field of engineering, two or more interconnected gear wheels are called a gear train, or transmission. They come in many different shapes and sizes.

Two gear wheels on parallel shafts are known as spur gears. If you want to transmit a rotational movement to an axle standing perpendicular to the gear wheel, you can use a bevel gear (you’ll use two of those for your helicopter model). It’s also possible to arrange multiple

gear wheels one after the other to convert a slow rotational movement into one or multiple very quick rotational movements — as you’ll see when making the hand mixer model.



>>> Bicycles generally have a chain drive, in which gear wheels of various sizes are connected by a chain.

Gear trains can be found inside many machines and devices. For example, in mechanical clocks, the kind you might see in a museum, gear wheels enable the movement of a gear wheel propelled by a spring or weights to be transmitted to the hands of the clock. Thanks to the different gear ratios, the hands can move quickly (the second hand), slowly (the minute hand), or even slower (the hour hand).

This means that you can usually choose between multiple “gears,” that is, you can switch between various different gear ratios.

This has a significant advantage, as gear trains don’t just transmit rotational speeds, they also transmit force. Cycling is easiest when you can keep pedaling at the same speed. If you want to cycle over flat terrain or downhill, you can switch into a high gear in the rear. This connects the crankset with a much smaller gear on the rear wheel. The force from the pedals is converted into a much greater driving force making the bike move faster.

If you’re cycling uphill, you can switch to a large gear in the rear and a small gear in front. This allows you to apply a smaller force on the pedals and turn them at a faster rate but the rear wheel will rotate a larger amount.

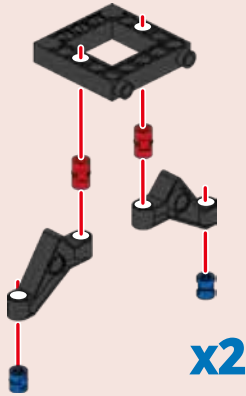


>>> OVERVIEW

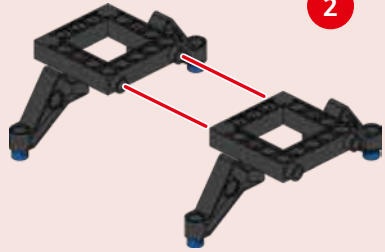


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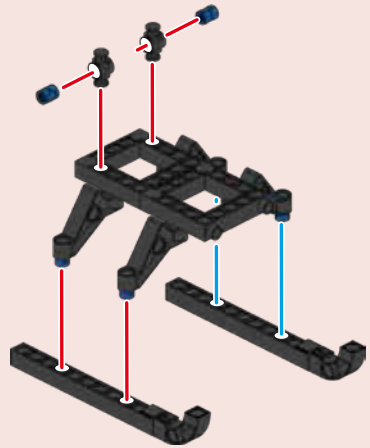
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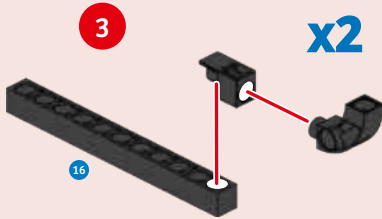
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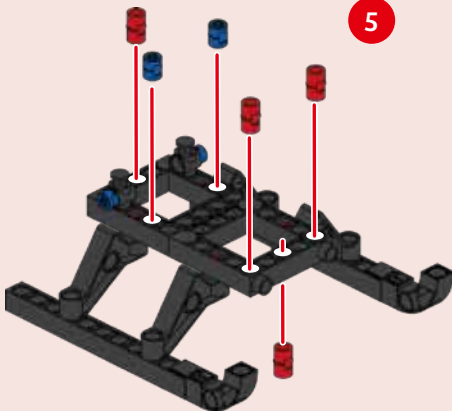
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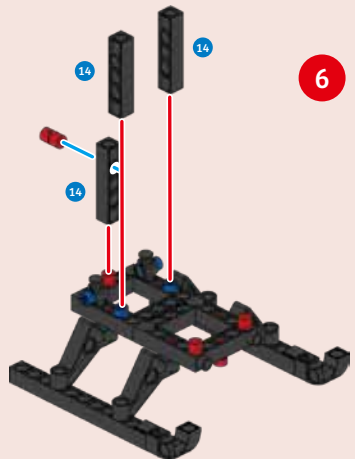
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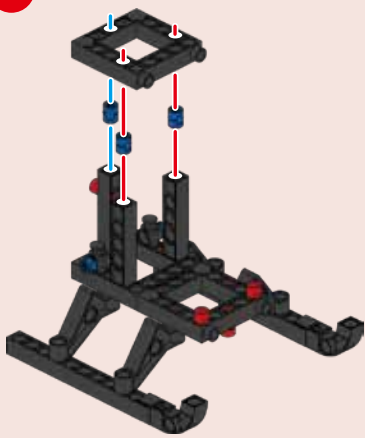
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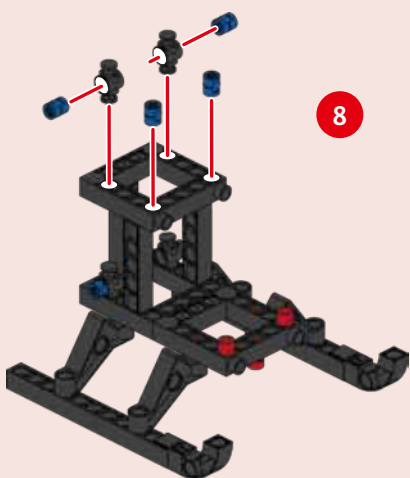


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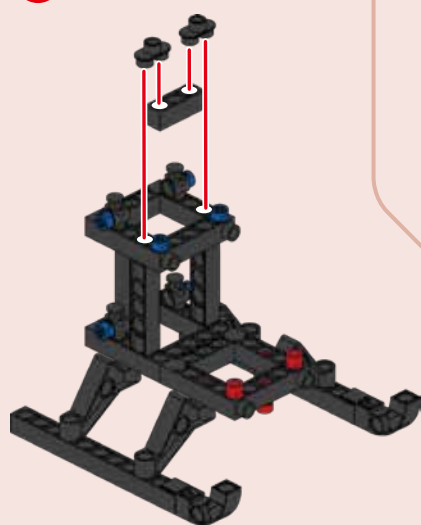
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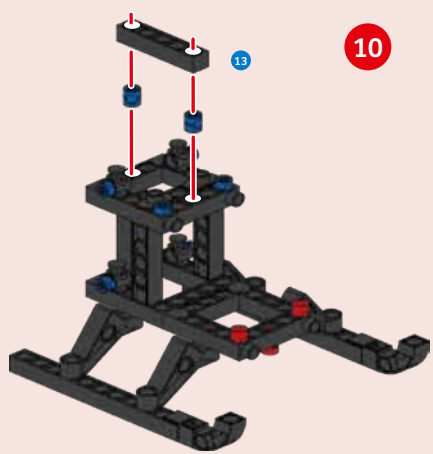
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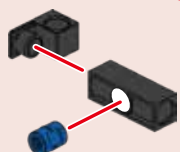


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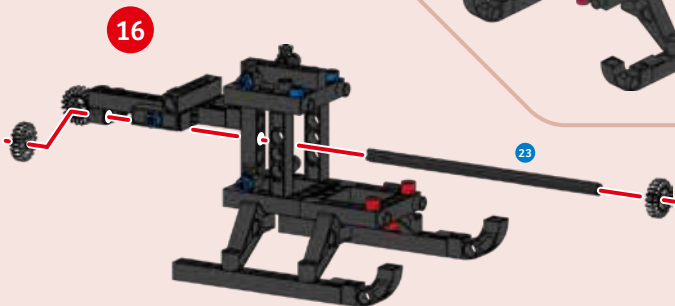
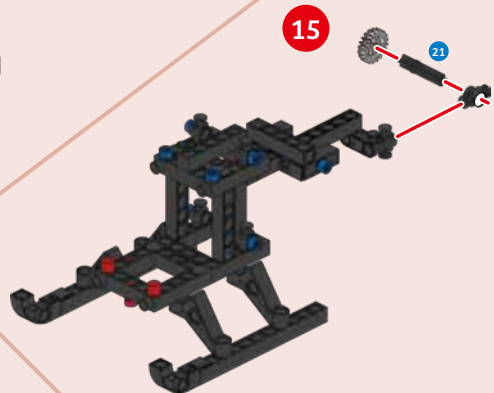
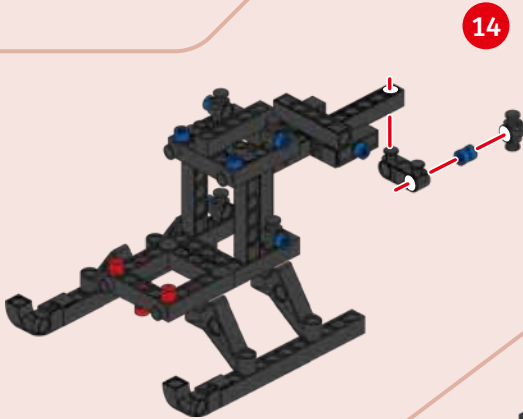
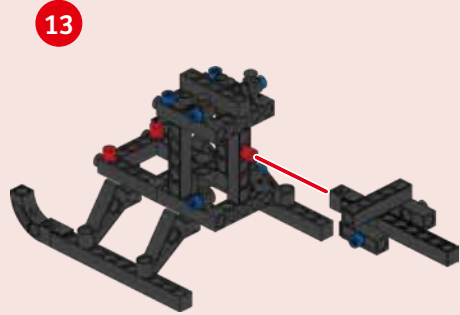
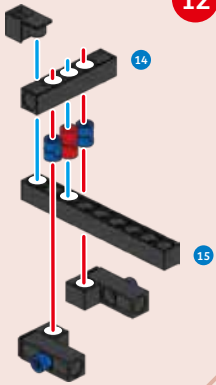


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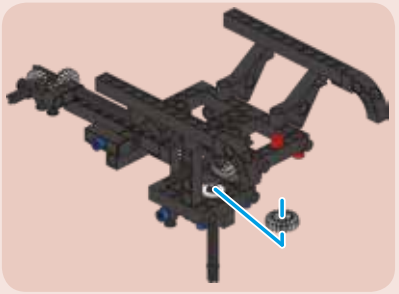
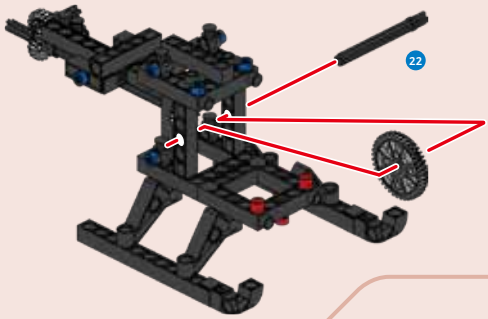
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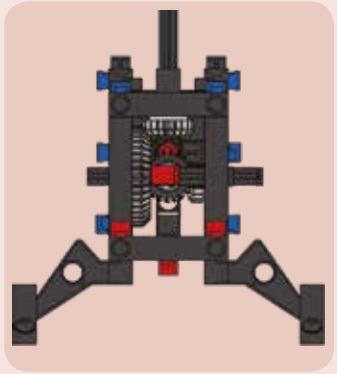
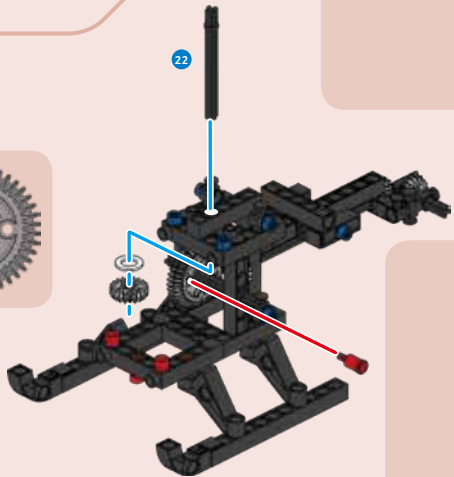
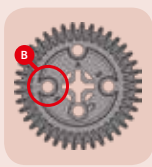


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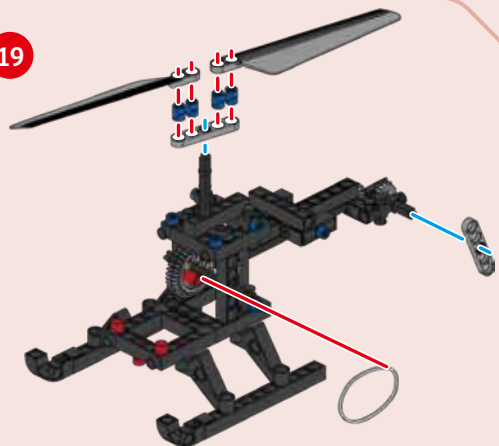
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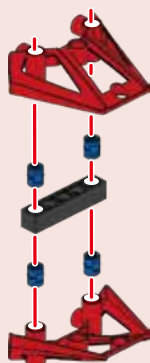


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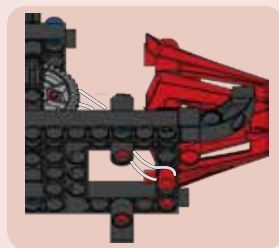
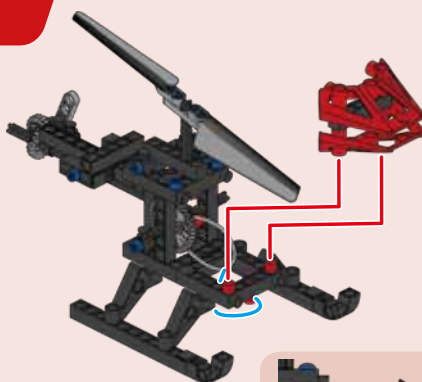


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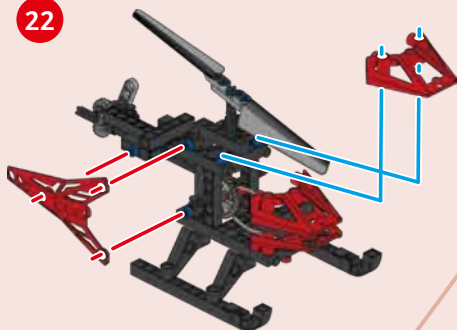
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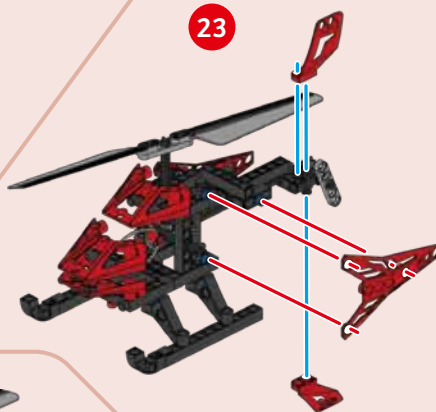
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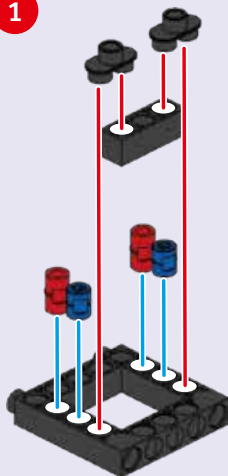


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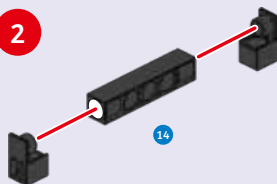


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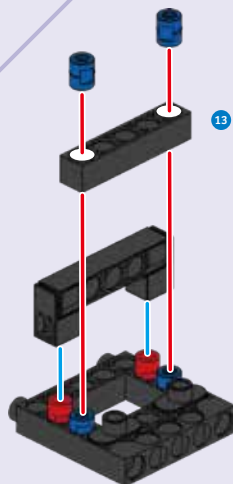
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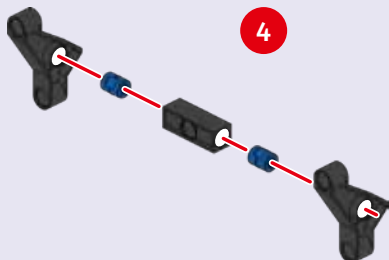
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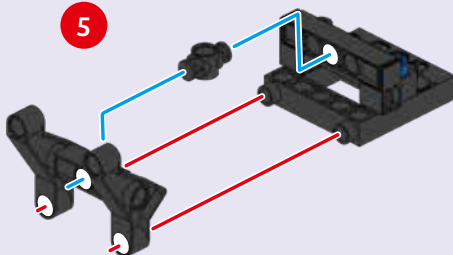
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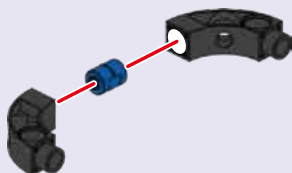
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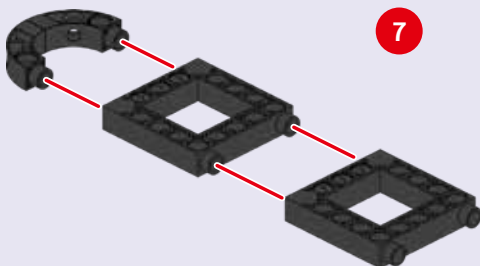
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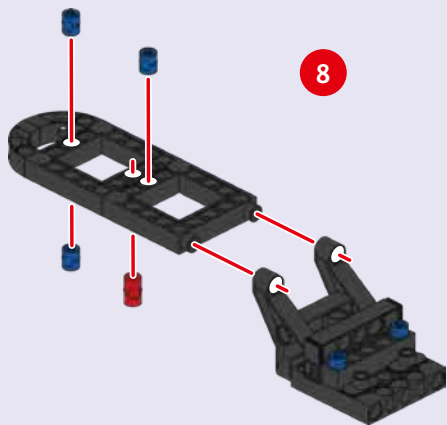


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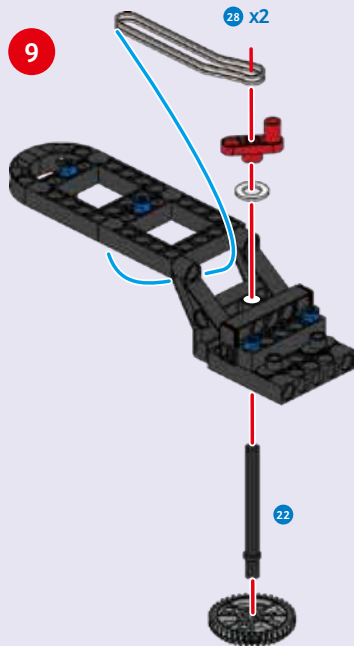


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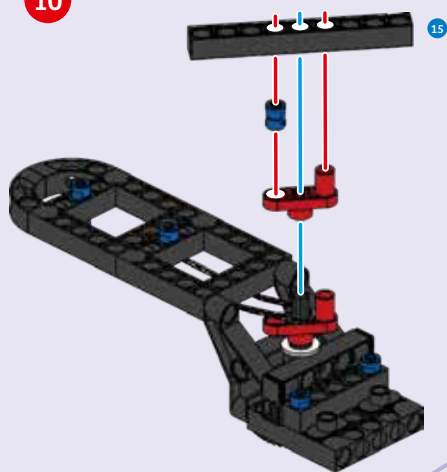
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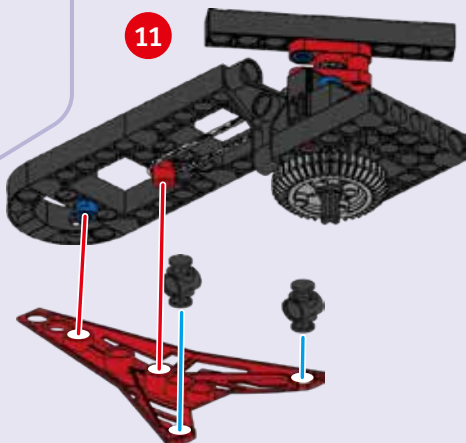
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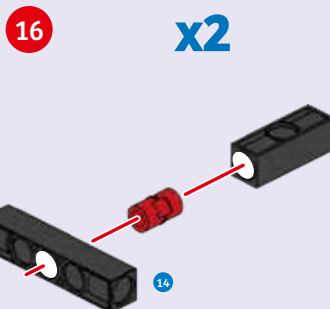
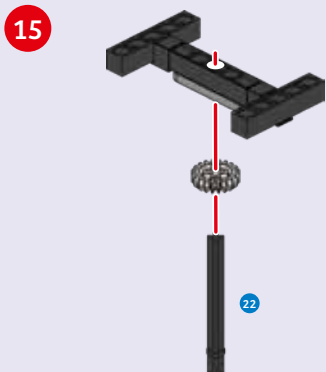
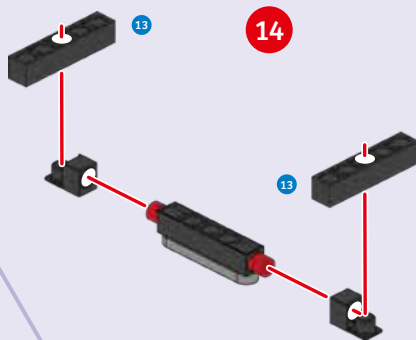
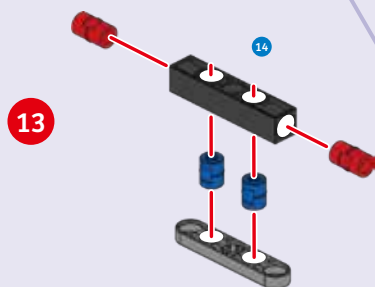
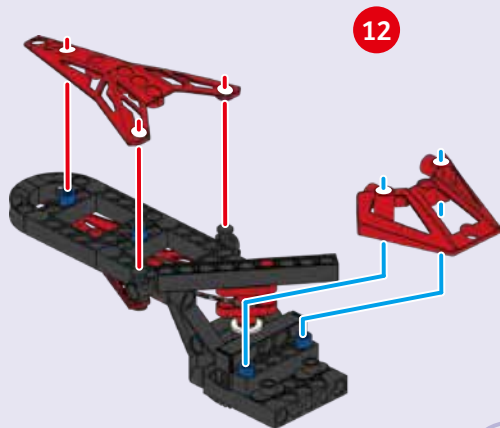


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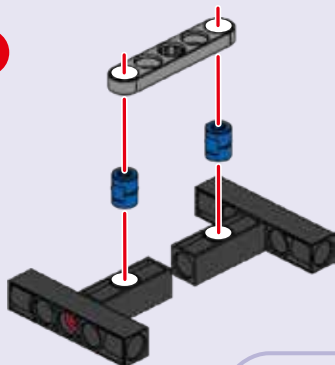


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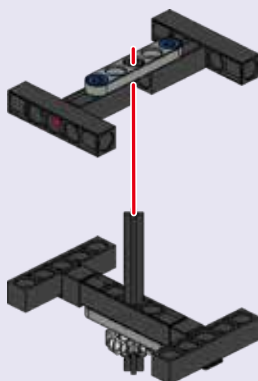


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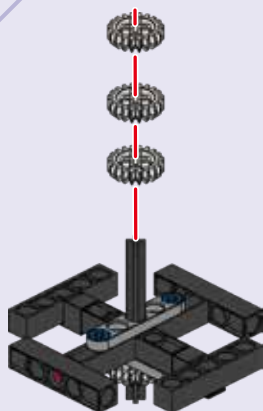
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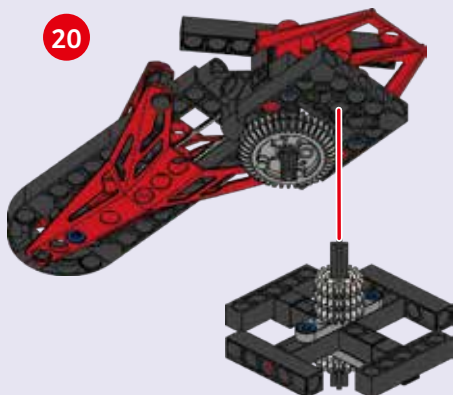
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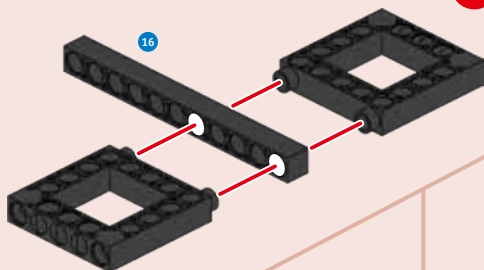
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Spin the top and then let go!

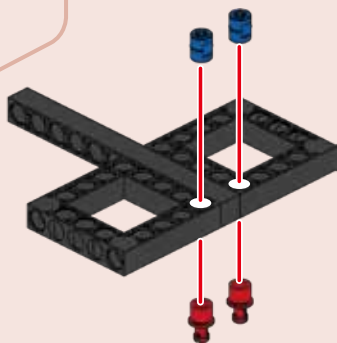


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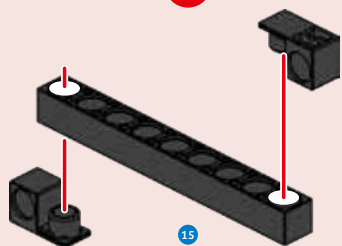
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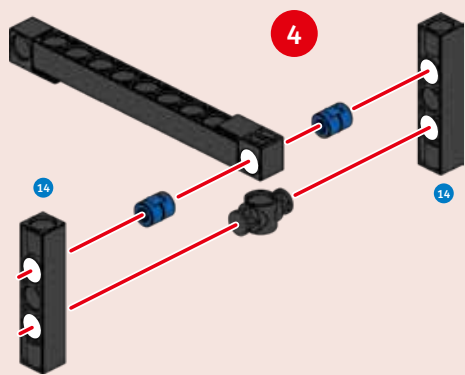
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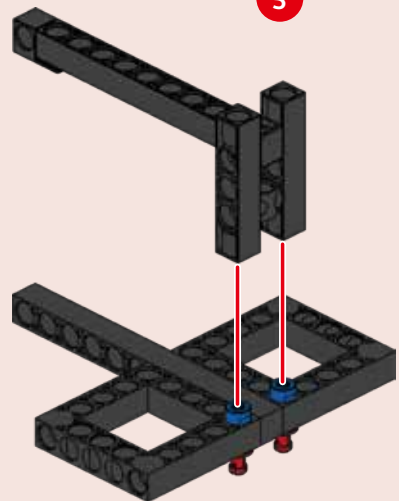
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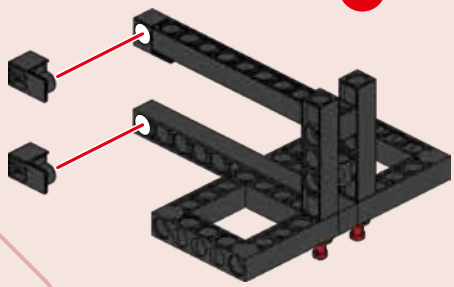
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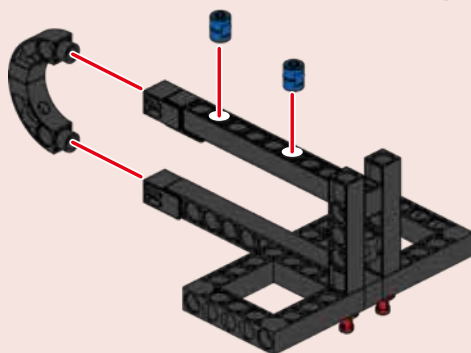


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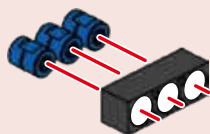
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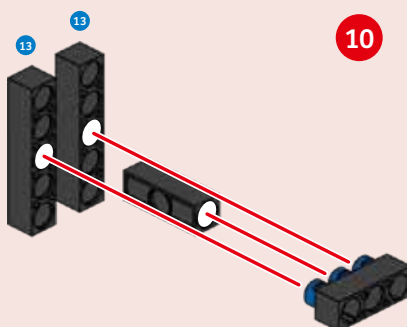
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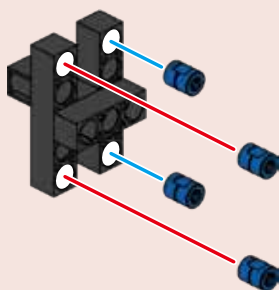
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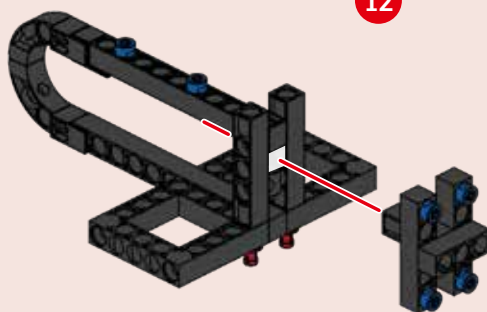
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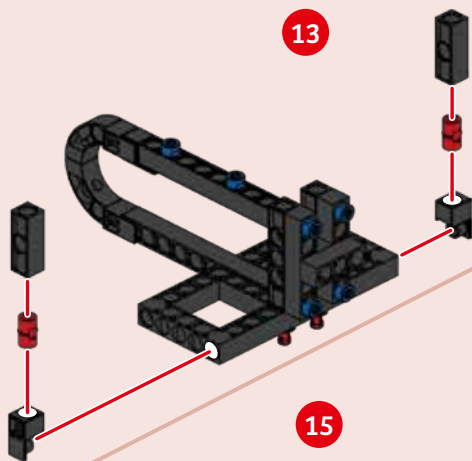
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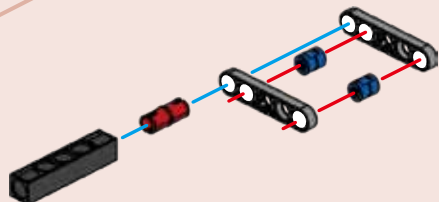


HAND MIXER

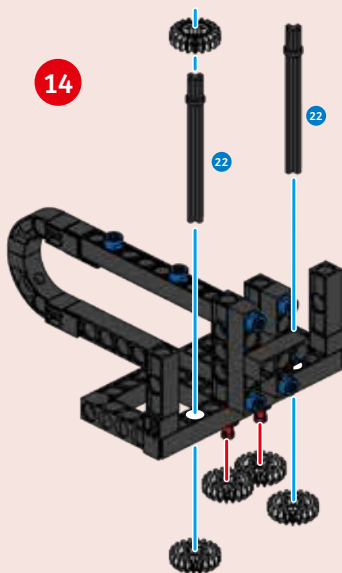
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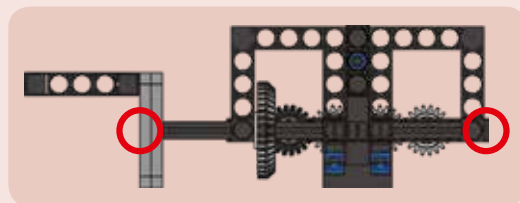
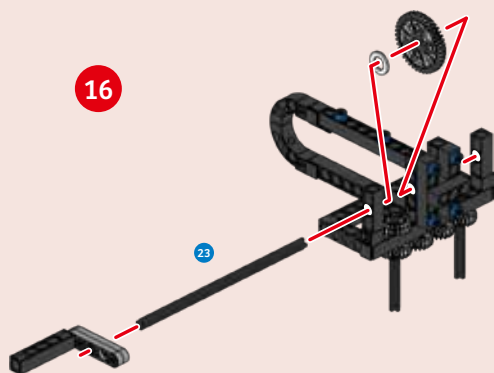
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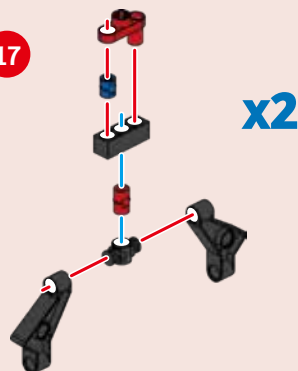
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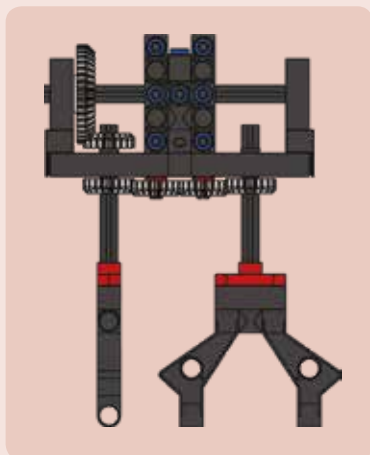
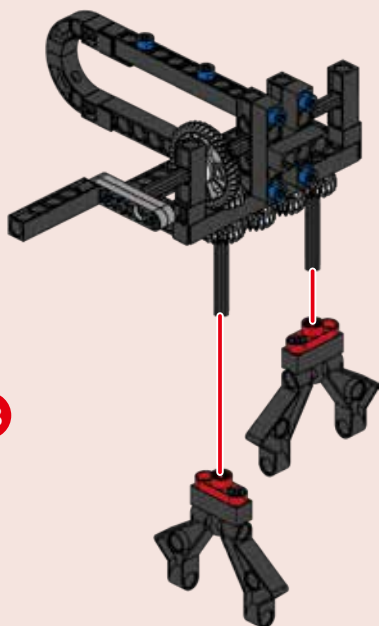


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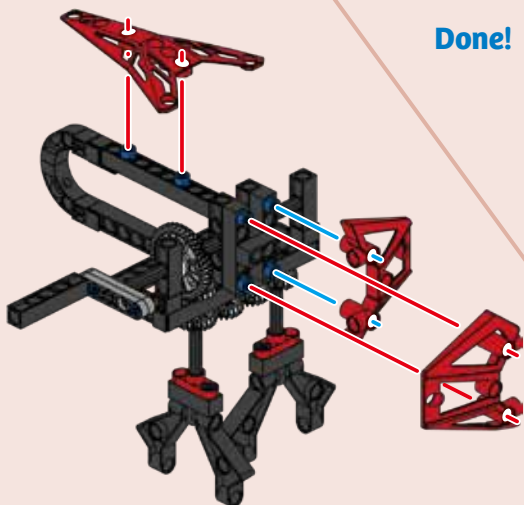


HAND MIXER

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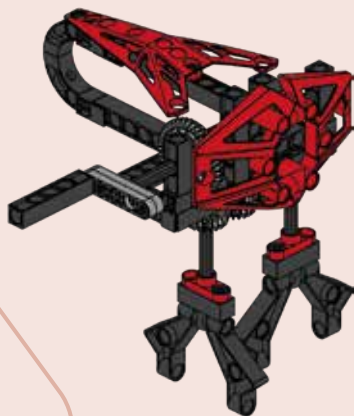


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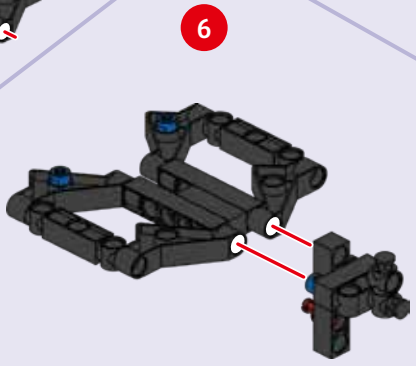
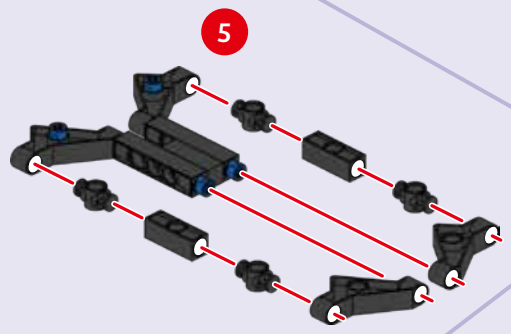
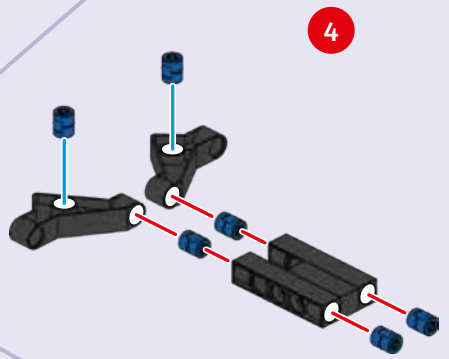
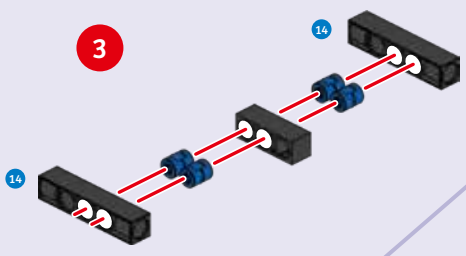
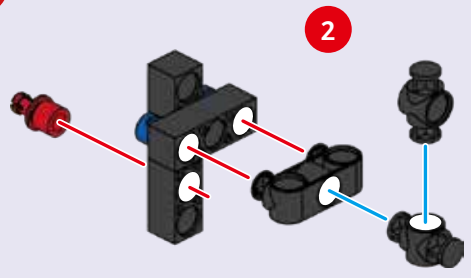
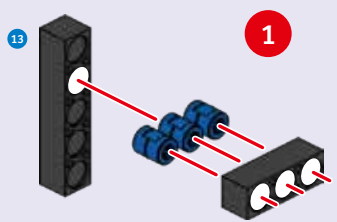
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Done!



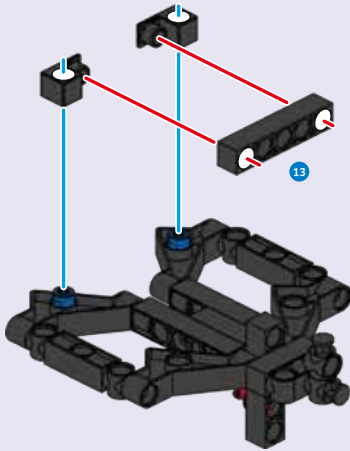


AIRCRAFT LAUNCHER

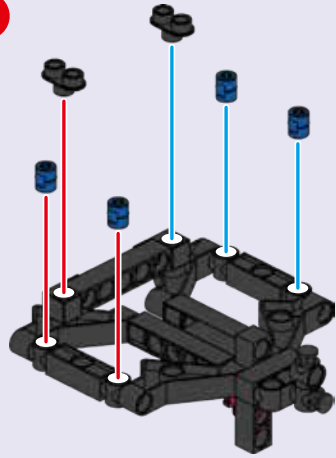


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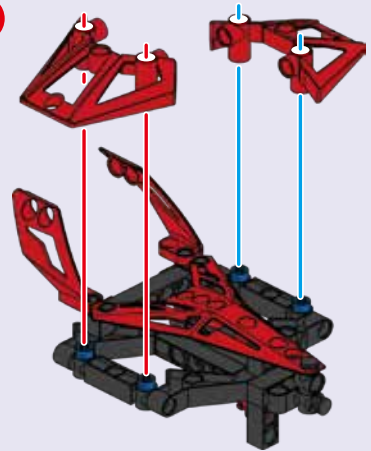
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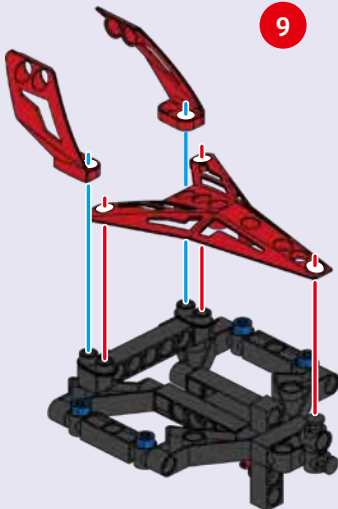
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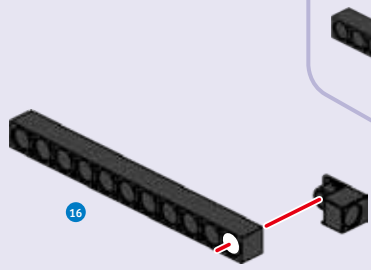
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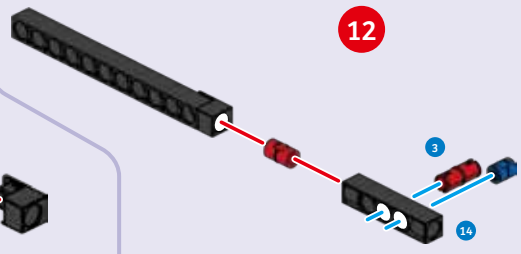


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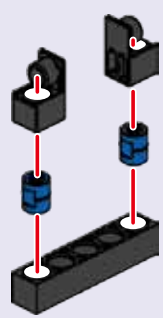
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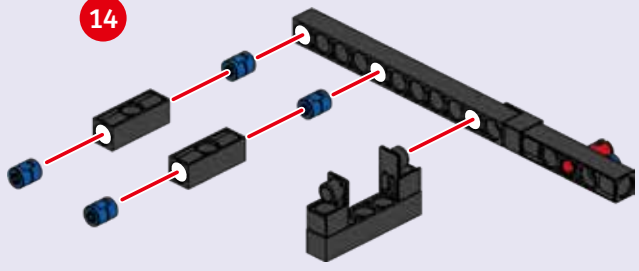
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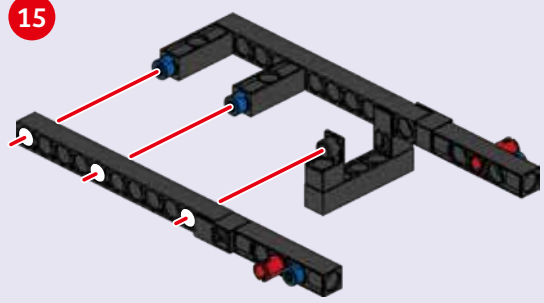
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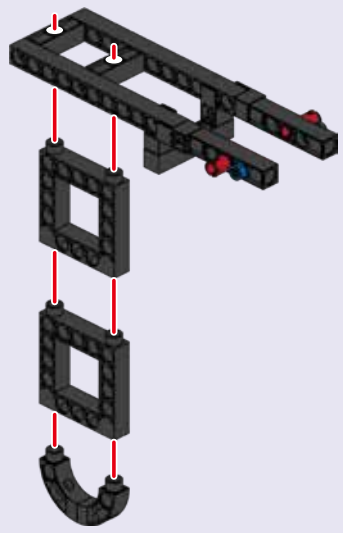
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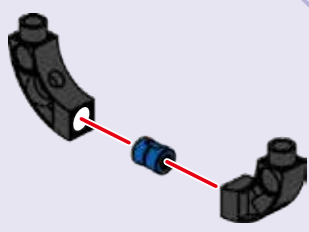
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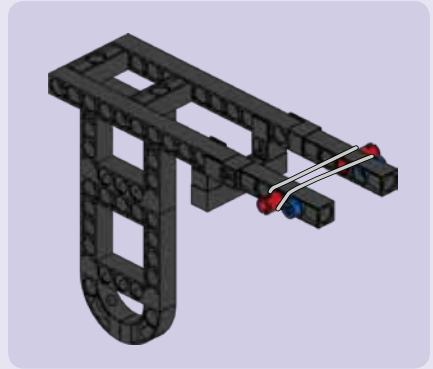
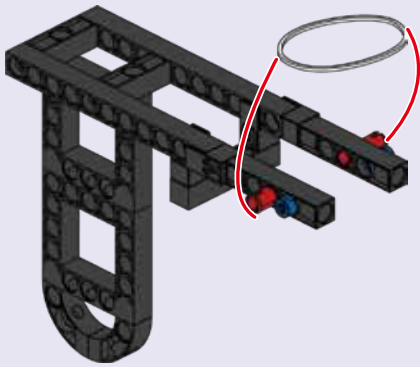


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AIRCRAFT LAUNCHER

18



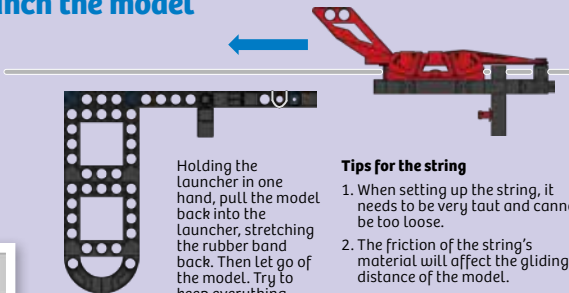
19 Done!



IMPORTANT: Only use with the model on the string!

Guide a thick string (not included) through the model and then stretch the string between two fixed points.

How to launch the model



Holding the launcher in one hand, pull the model back into the launcher, stretching the rubber band back. Then let go of the model. Try to keep everything lined up on the same plane such that the string is level and straight.

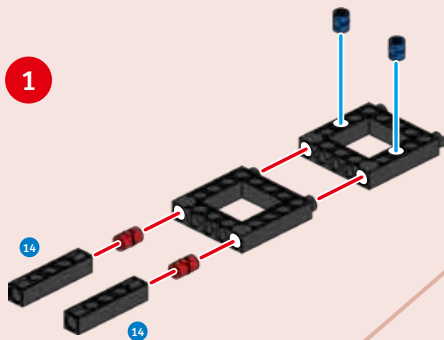
Tips for the string

1. When setting up the string, it needs to be very taut and cannot be too loose.
2. The friction of the string's material will affect the gliding distance of the model.
3. The number of rubber bands will also affect the gliding distance of the model.
4. If you have wax at home, you can apply some on the rope to reduce the friction from the rope.

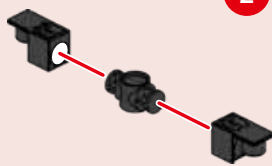


FLYING SCOOTERS

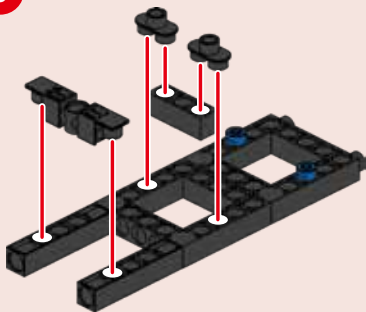
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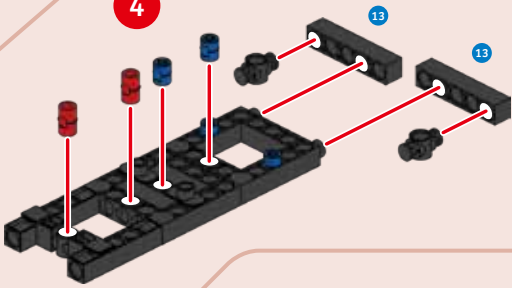
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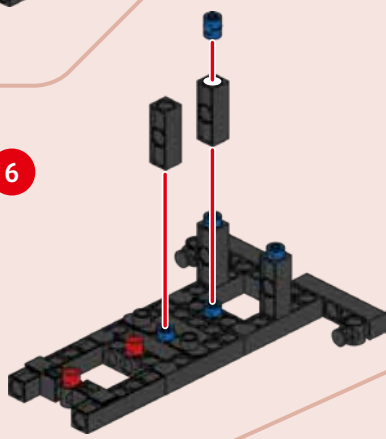
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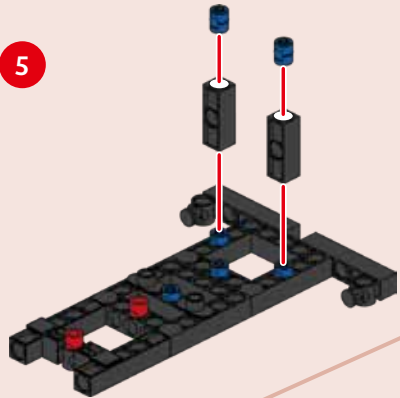
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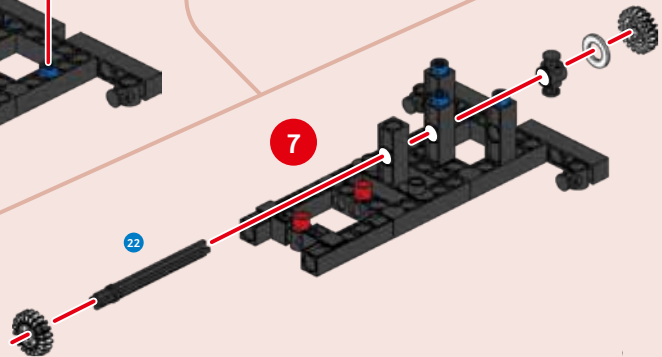
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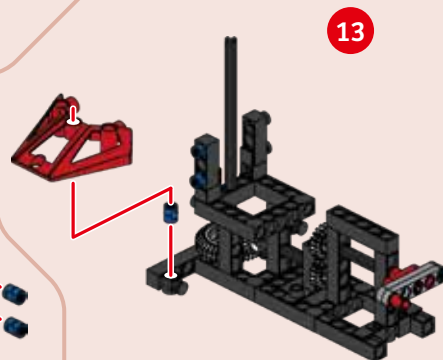
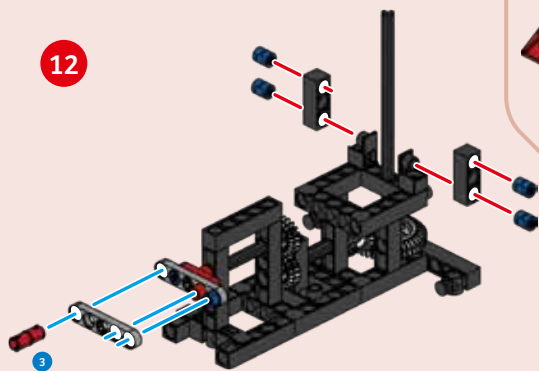
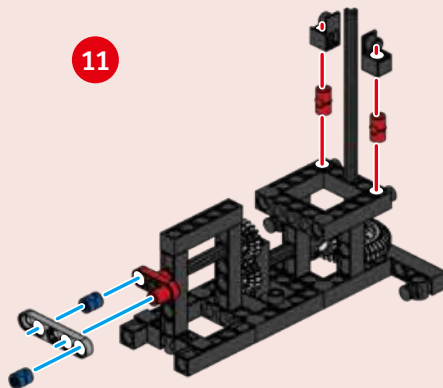
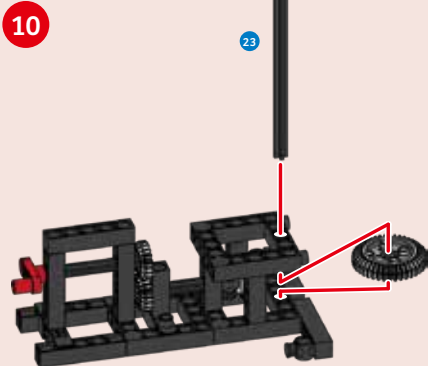
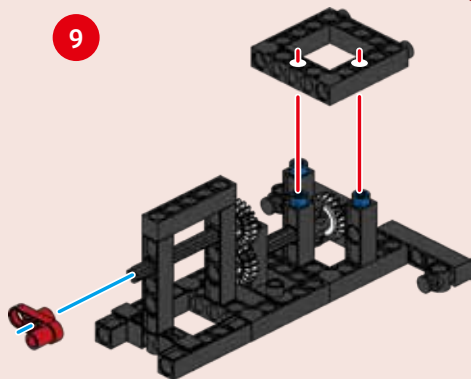
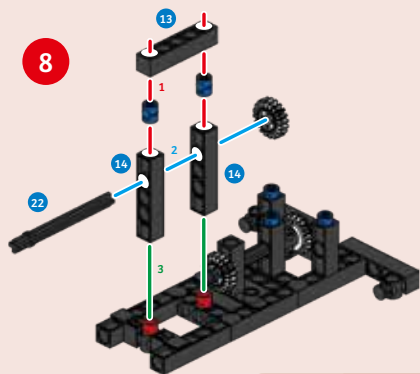
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7



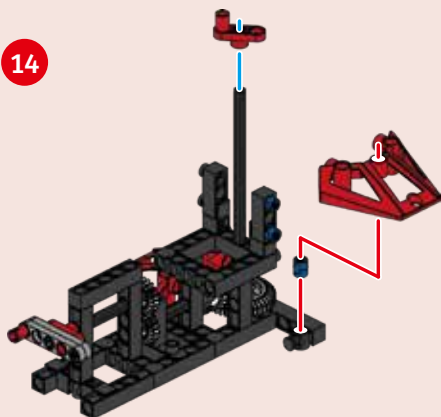
FLYING SCOOTERS



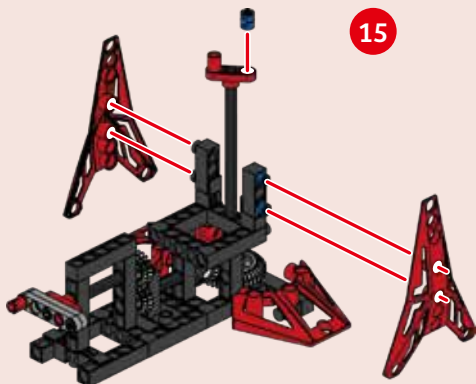


FLYING SCOOTERS

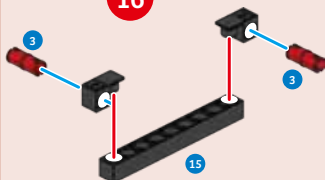
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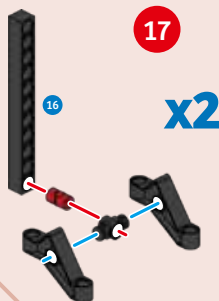
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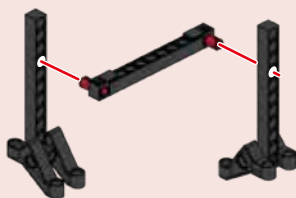
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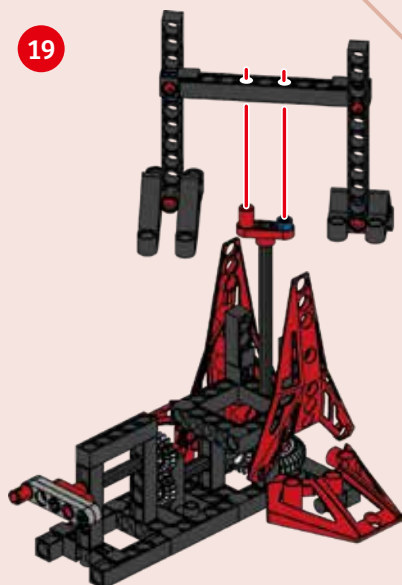
17



18



19



Done!

20



>>> CHECK IT OUT

AMAZING FACTS!

For a long time, gear systems were considered to be an exclusively human invention. So when a group of British biologists discovered an insect with its very own gear system some years ago, their finding was all the more astonishing. The insect in question was the larva of the *Issid Planthopper* (scientific name *Issus coleoptratus*), a tiny creature just a few millimeters in size.

Of course, they can only take off cleanly if both hind legs move at the exact same time and push off with the exact same force. Otherwise, the little

>>> **These insects tend to get around by jumping: if disturbed, they use their powerful hind legs to send themselves shooting upward.**

creature will find itself hurtling off into a spiral, possibly lurching and making for easy prey. This synchronized movement is ensured by a minuscule gear system, consisting of two interlocking structures attached to the insect's legs

This means that the real inventor of the gear wheel is in fact Mother Nature, and she was using it millions of years before humans even existed!



