EXPERIMENT MANUAL

ENGINEERING MAKERSPACE

KINETIC MACHINES

THAMES & KOSMOS

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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.

Warning! Do not aim at eyes or face.

Do not aim the projectiles toward other people or animals. Make sure people and animals are well out of the potential path of the projectiles.

Warning! The catapult model is able to discharge objects other than the suggested projectiles.

Do not use with any other objects than the ones suggested (especially not heavy or sharp-pointed ones). There is a risk of injury. For use under adult supervision.

Please make sure that the catapult is stored uncharged.

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

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!

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.

TIPS AND TRICKS

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.

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.

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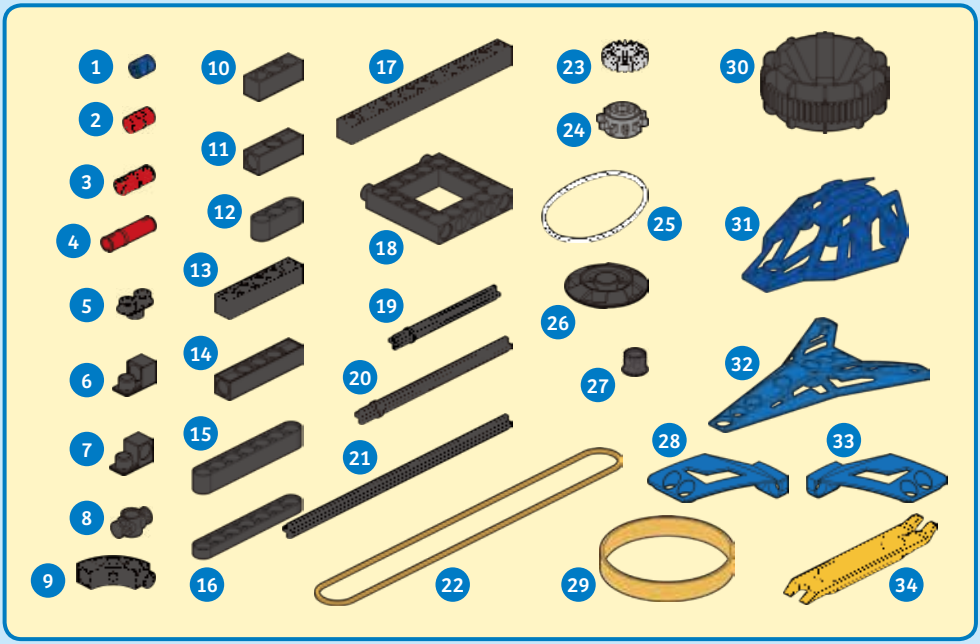
››› KIT CONTENTS



Checklist: Find - Inspect - Check off

✔	No.	Description	Qty.	Item No.
◯	1	Short anchor pin, blue	30	717767
◯	2	Anchor pin	10	702527
◯	3	Joint pin	4	702524
◯	4	Long joint pin	1	720757
◯	5	Two-to-one converter	4	716889
◯	6	90-degree converter - Y	2	716884
◯	7	90-degree converter - X	3	716682
◯	8	1-hole connector	4	719233
◯	9	Curved rod	2	716310
◯	10	3-hole rod	2	719234
◯	11	3-hole cross rod	4	717899
◯	12	3-hole wide rounded rod	2	716872
◯	13	5-hole rod	2	716876
◯	14	5-hole cross rod	4	716677
◯	15	7-hole wide rounded rod	2	716878
◯	16	7-hole flat rounded rod	2	716879
◯	17	11-hole rod	2	716304

✔	No.	Description	Qty.	Item No.
◯	18	Square frame	2	718936
◯	19	Axle, 70 mm	1	713490
◯	20	Axle, 100 mm	1	716901
◯	21	Axle, 150 mm	1	703518
◯	22	Rubber band, large	2	716689
◯	23	Small gear	2	716885
◯	24	Small sprocket	1	720232
◯	25	Rubber band, small	2	702596
◯	26	Disk wheel	2	720760
◯	27	Disk wheel pin	2	720761
◯	28	Small body piece left	2	720763
◯	29	Rubber band, small thick	2	720759
◯	30	Wheel frame	2	720762
◯	31	Main body piece	1	720766
◯	32	Large body piece A	2	720765
◯	33	Small body piece right	2	720764
◯	34	Anchor pin lever	1	702590

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The Physics of Cars

POWER

Why is it harder to carry a heavy box while you are running up a flight of stairs than it is while you are walking up the same flight of stairs? It is because it requires more power to move the box when you are running. Power in physics means the amount of work that is done over time.

You may have heard the term horsepower used to describe a car. In the late 1700s, the Scottish engineer James Watt wanted a way to compare the amount of power that a steam engine could produce with that of a draft horse. Watt found that a horse could lift about 33,000 pounds of coal a distance of one foot in one minute. Thus, Watt set one horsepower equal to 33,000 foot-pounds per minute. An average person can produce about 0.1 horsepower, while a car can produce 120 or more horsepower.

VELOCITY AND SPEED

Speed and **velocity** are often used interchangeably, but in physics they mean different things. Speed is just how fast something is going, while velocity is both how fast and in what direction.

For example, if you are moving 30 miles per hour, then that is your speed. But, if you are moving 30 miles per hour north, then that is your velocity. The speed of a car is shown by the speedometer in miles per hour or kilometers per hour.

ACCELERATION

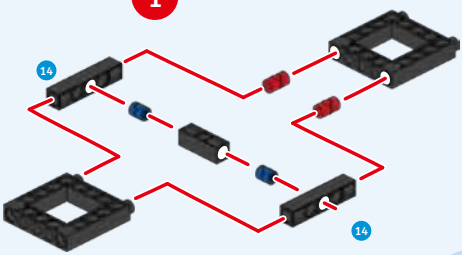
Acceleration is a change in the velocity of an object. That means that the object could be speeding up, slowing down, or changing direction and it would be accelerating. The time it takes for a car to go from 0 to 60 miles per hour is a common measure of a car's ability to accelerate.

WORK

The way that physicists define work is different from the common usage of the word. Work is when a force causes a displacement in the same direction as the motion of an object. For example, if you were walking around at a steady velocity with a box in your arms you would not be performing work. This is because the force required to hold up the box points in the upward direction, while the displacement from your walking around is in the horizontal direction. However, if you were to push a box along the floor or lift a box up, you would be performing work.

DESERT RACER

1



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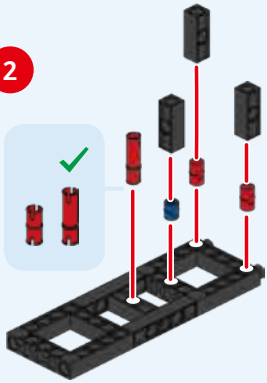

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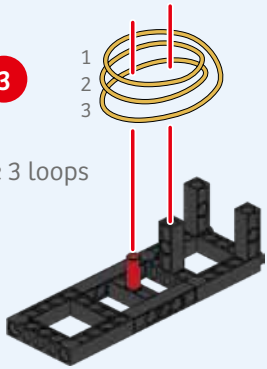

Make 3 loops

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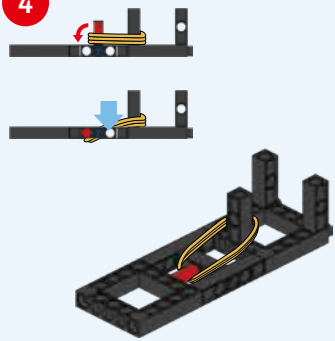

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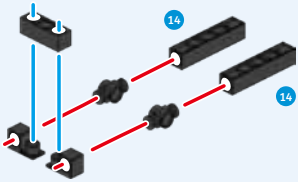

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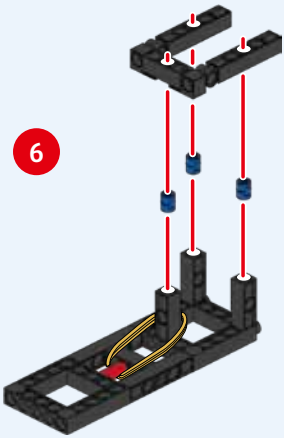

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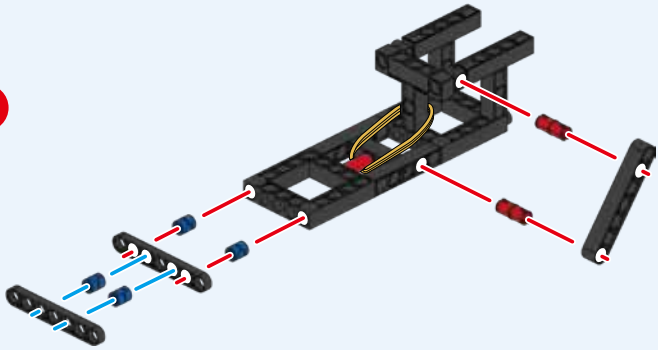

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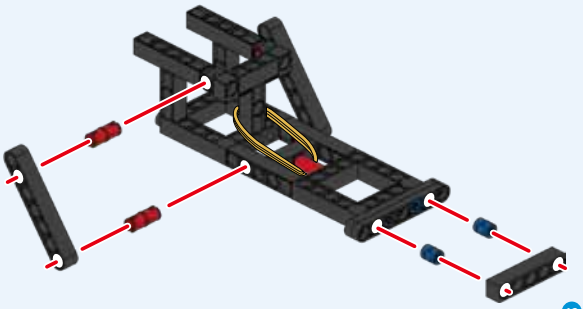

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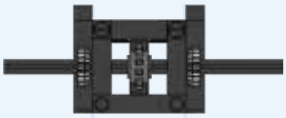
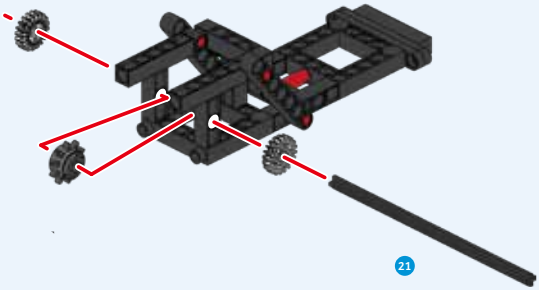


Keep a 1-mm gap on each side



DESERT RACER

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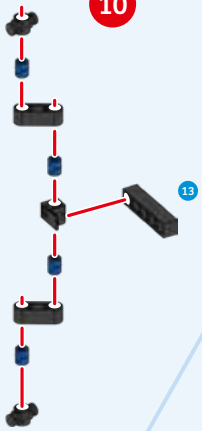

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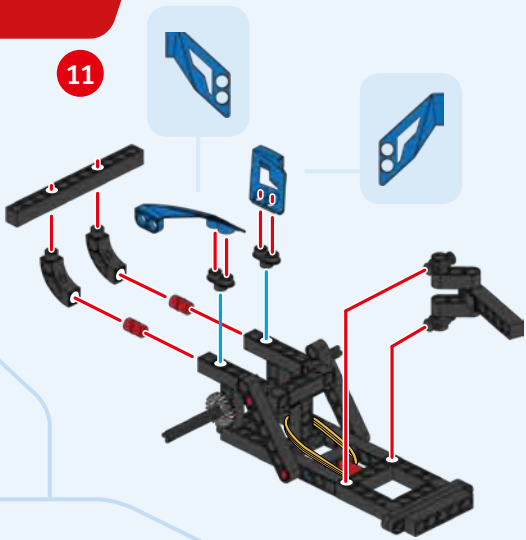

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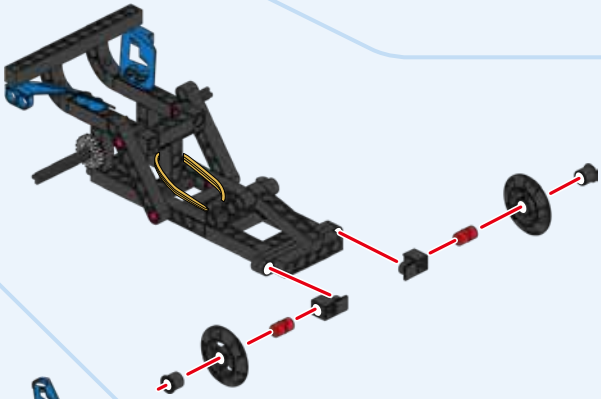

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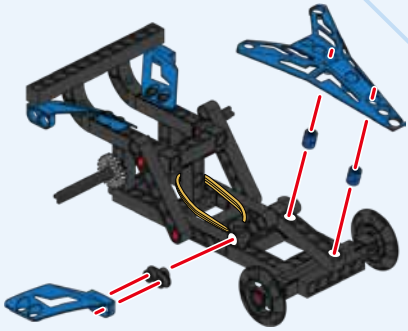

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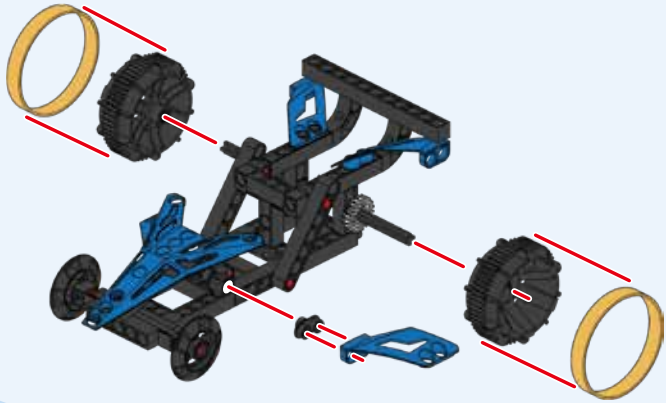

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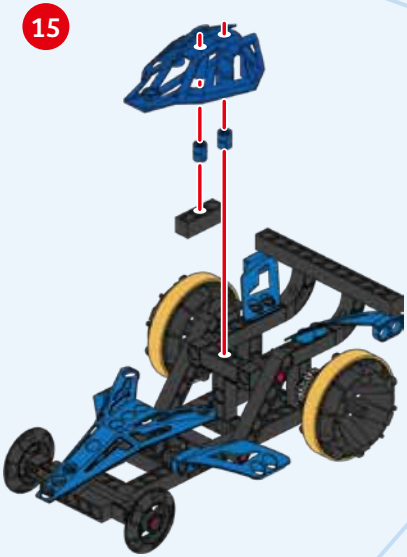

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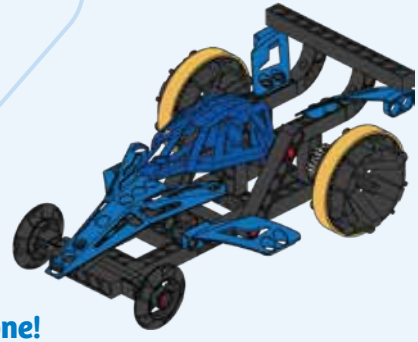
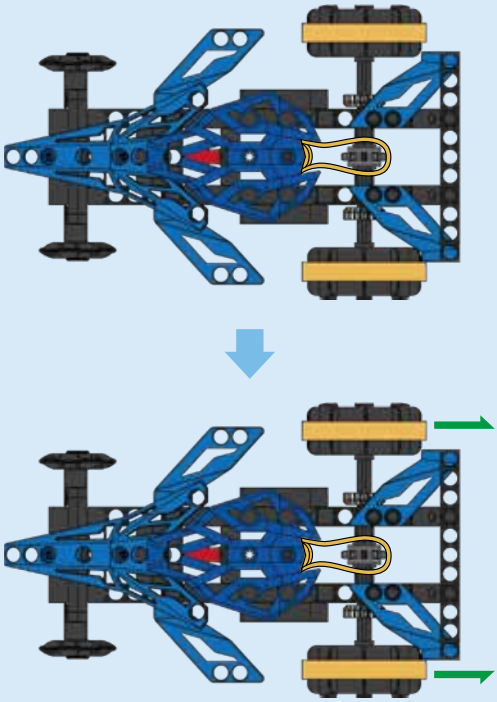


Done!

DESERT RACER



1. Place the car on a smooth, flat floor.

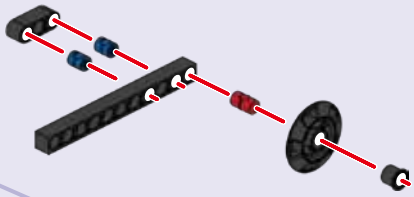
2. Pick one loop of the rubber band and hook it onto the small sprocket.

3. Pull the race car backwards. The small sprocket will wind up the rubber band.

4. Release the car and watch it go!

MOTORCYCLE LAUNCHER

1 x2



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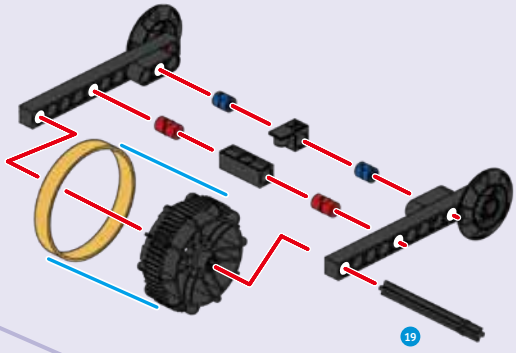

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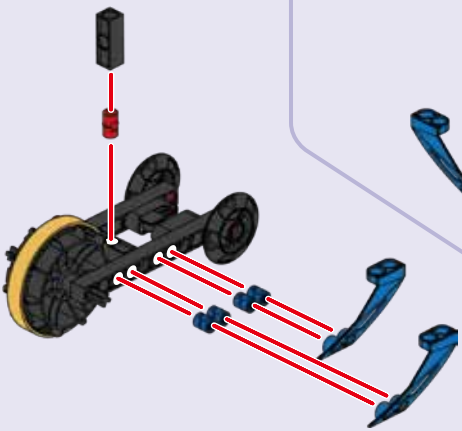

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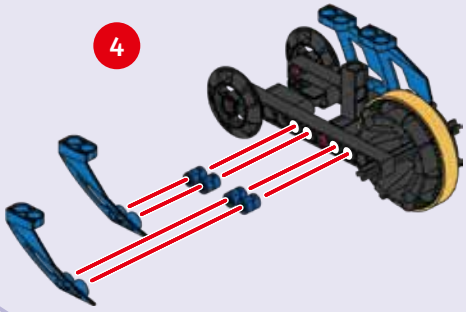

MOTORCYCLE LAUNCHER

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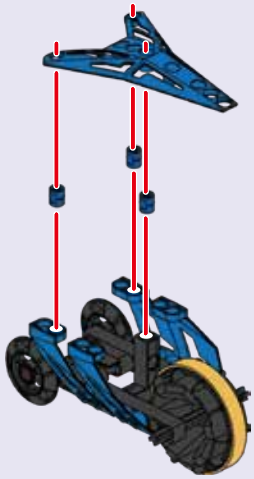

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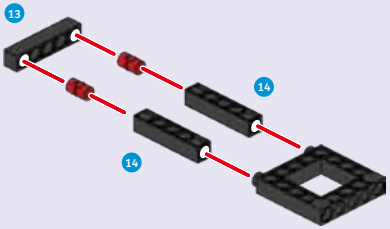

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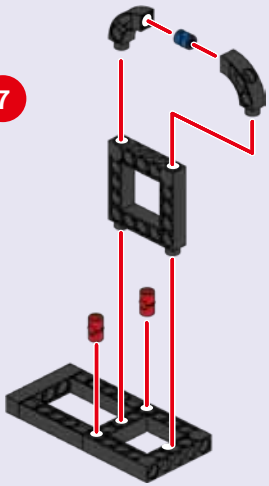

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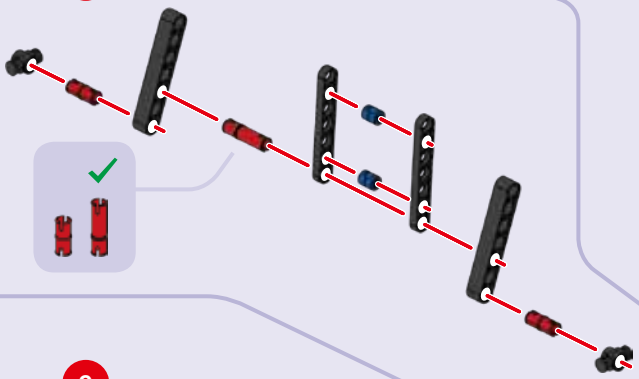

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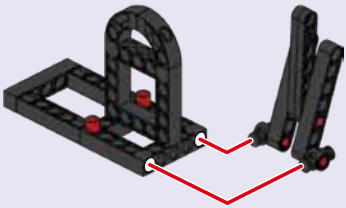

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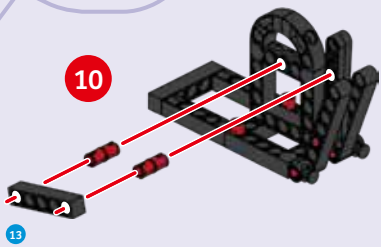

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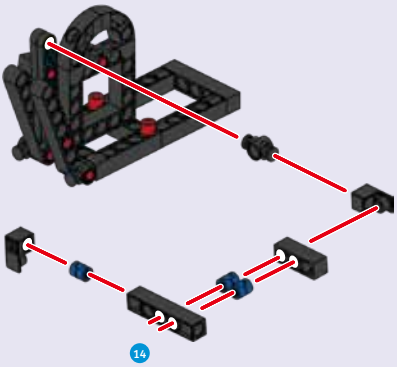

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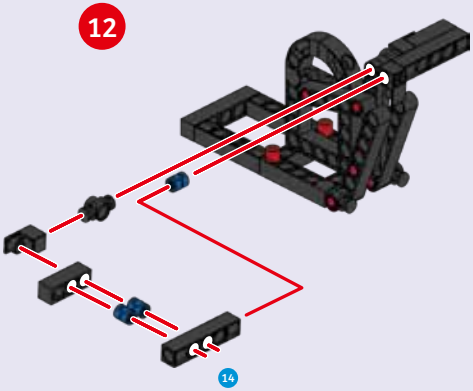

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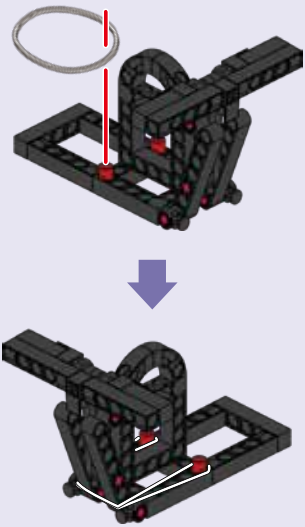

Done!

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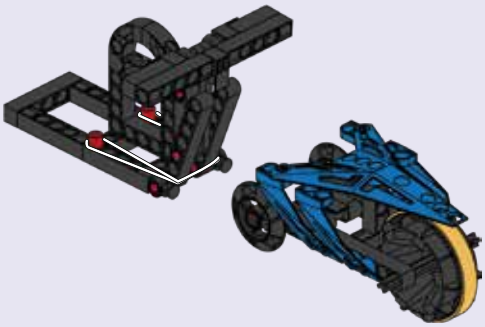
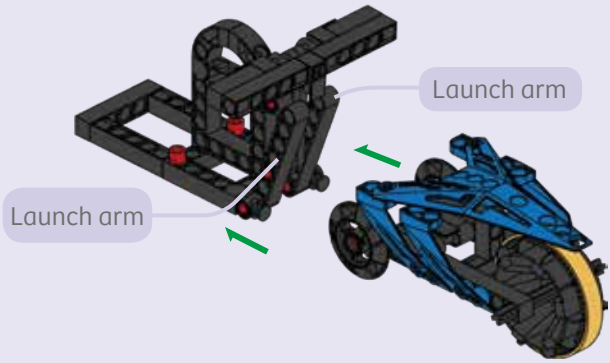
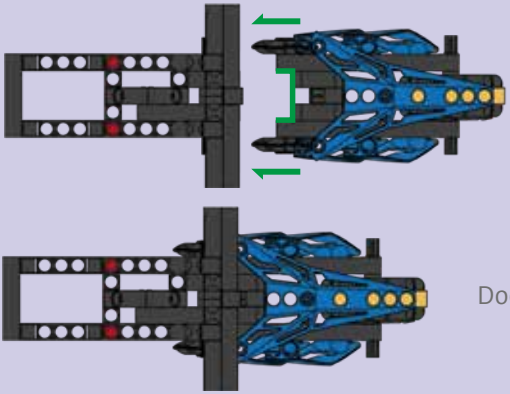


MOTORCYCLE LAUNCHER

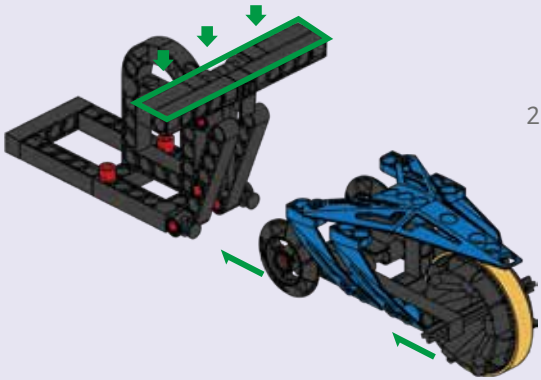


1. Roll the motorcycle backward to dock it onto the launch arm.

Top View



Docking complete

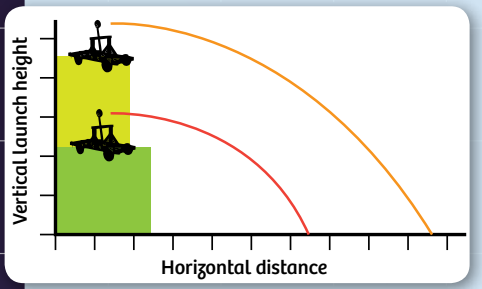


2. Press down on the bar to launch the motorcycle.

Catapults

The term "catapult" comes from the Ancient Greek word "*Katapeltes.*" The Ancient Greek Dionysius the Elder of Syracuse invented the catapult around 400 BCE. Early catapults were larger versions of crossbows.

Pictured here is a mangonel. The mangonel is often what people think of when they think of a catapult. Historically, the mangonel was not able to throw projectiles as far or with as great of a velocity as other types of catapults, such as the trebuchet. This is because a lot of the energy goes into accelerating the arm itself which means less energy goes into the projectile.



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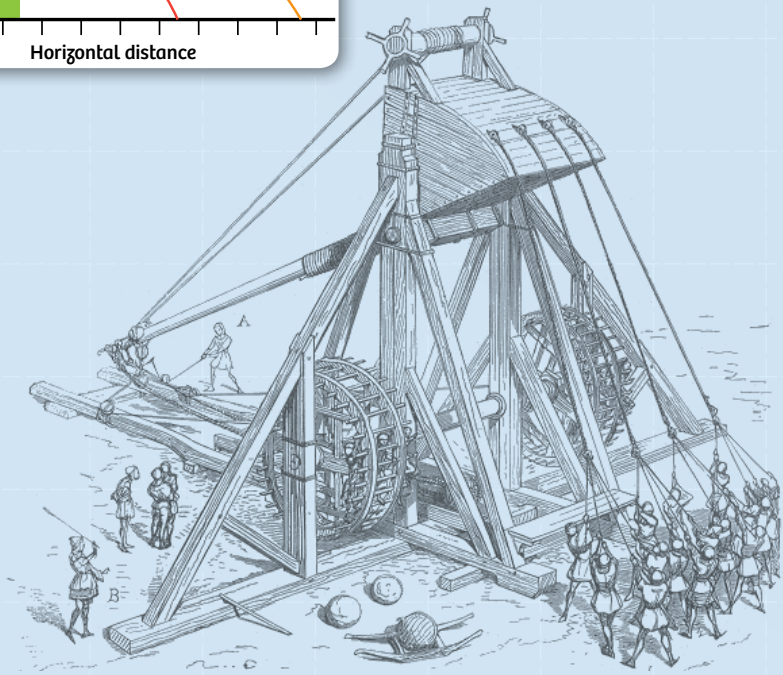

CATAPULT

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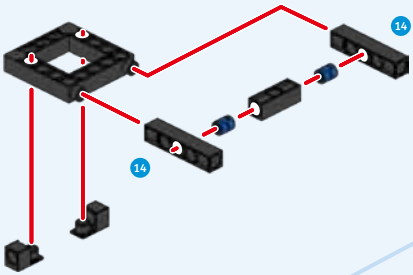

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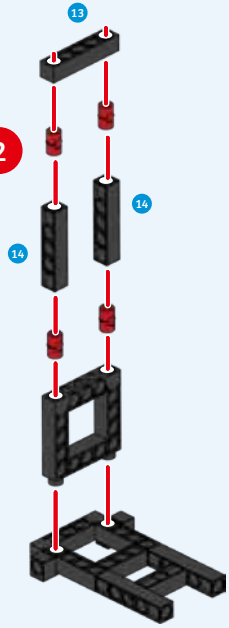

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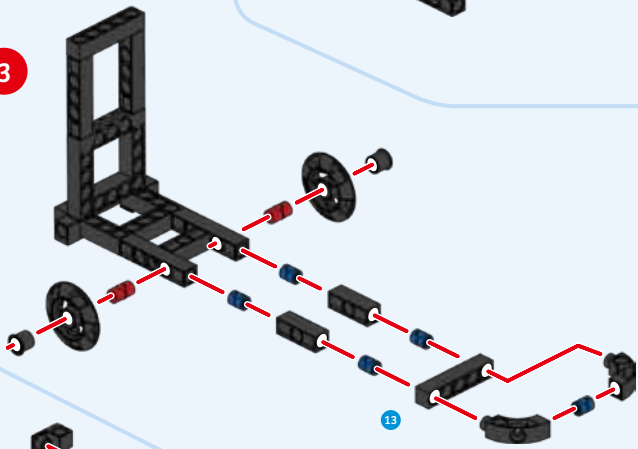

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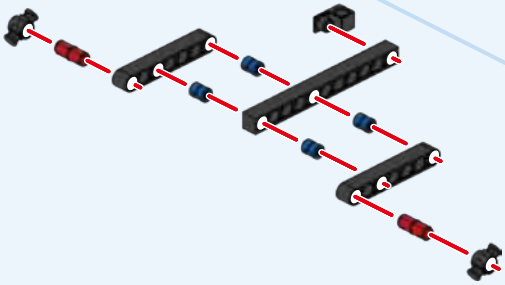
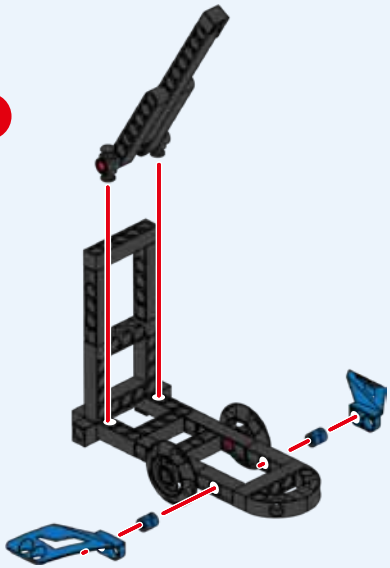


CATAPULT

5



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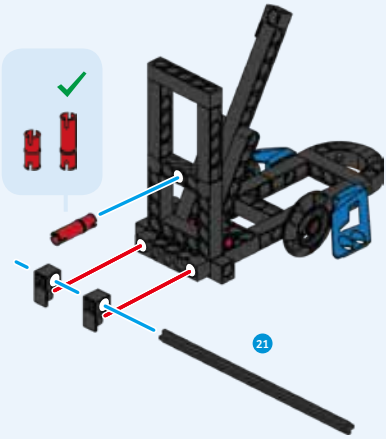

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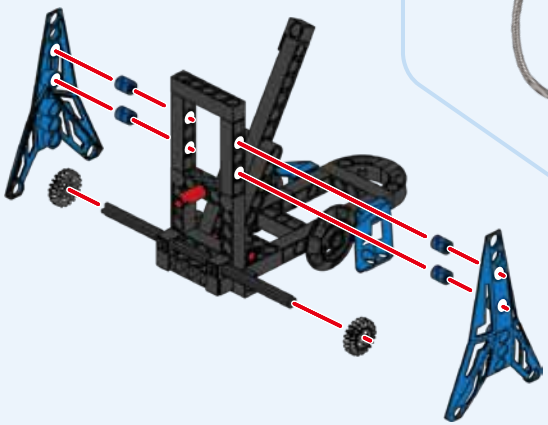

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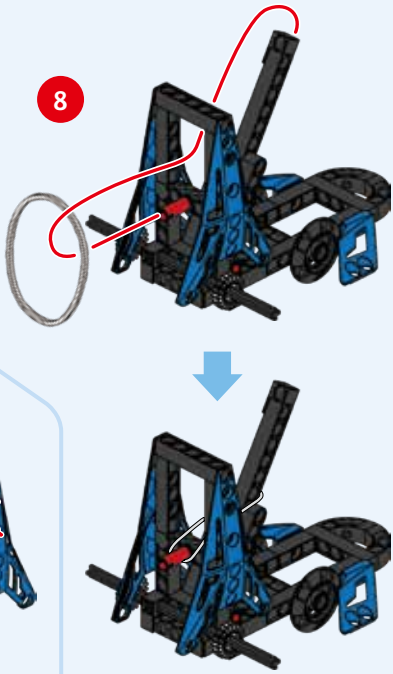
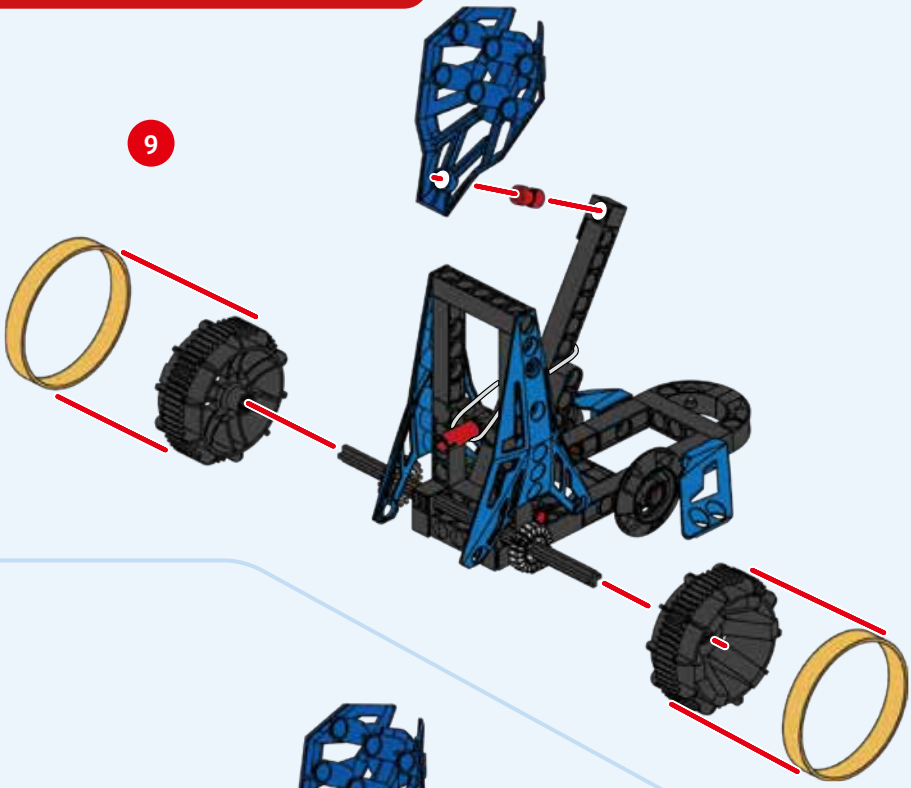


CATAPULT

9



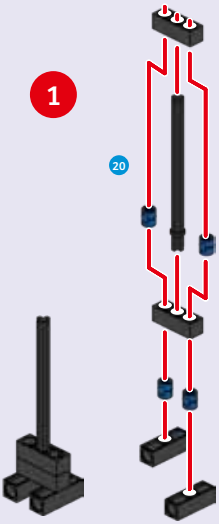
Done!

Important! Use balls of crumpled up paper to shoot out of your catapult. Do not use any other objects.

WARNING. Do not aim at eyes or face. Never launch heavy, sharp-pointed, or sharp-edged objects.

DRAGONFLY

1



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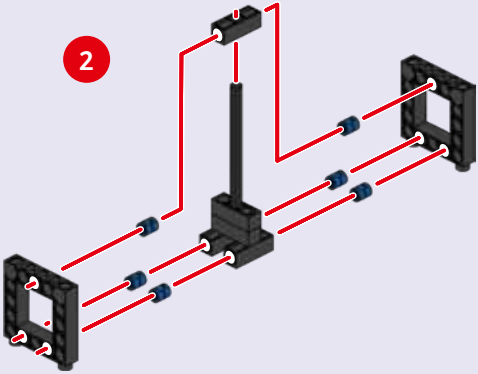

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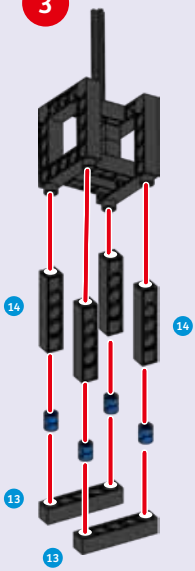

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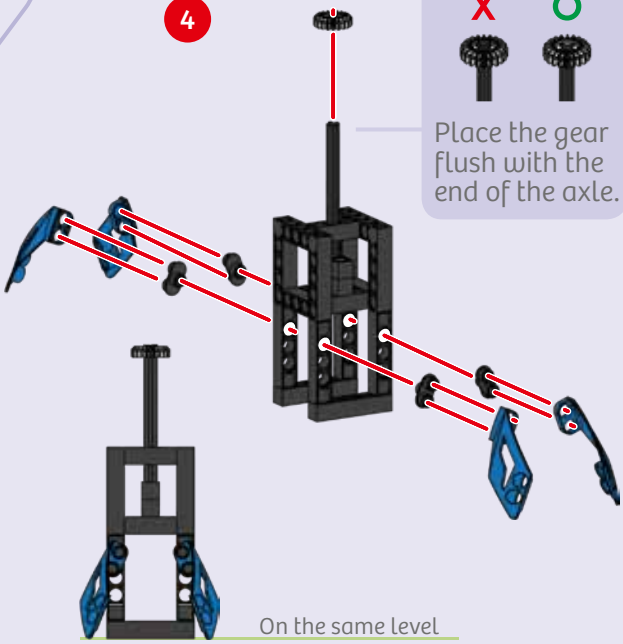
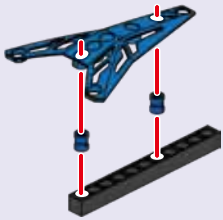


DRAGONFLY

5 x2



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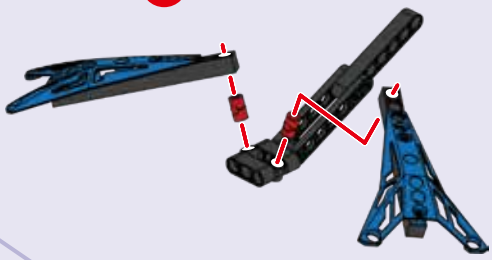

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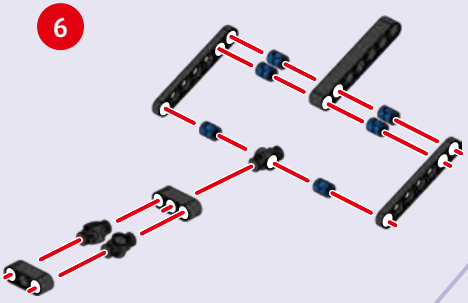

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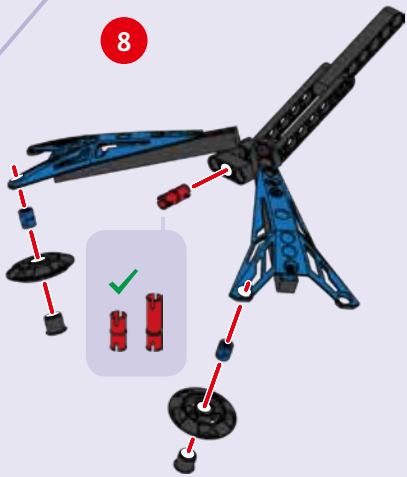

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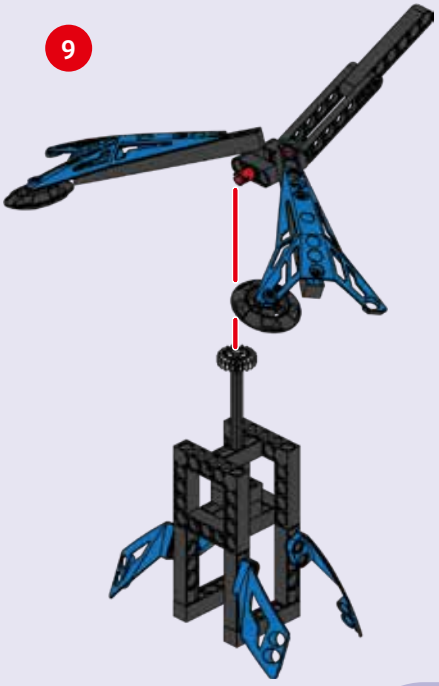
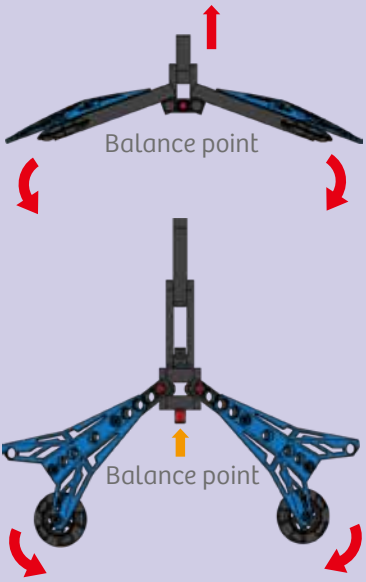
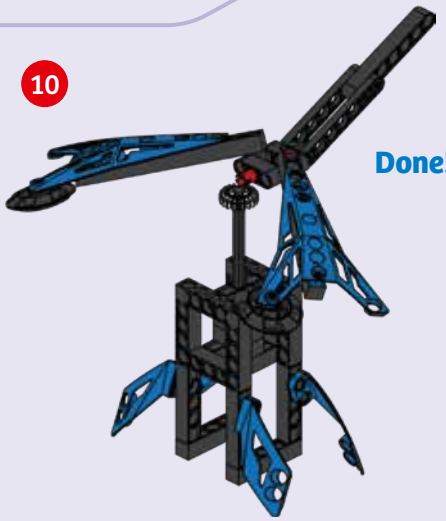




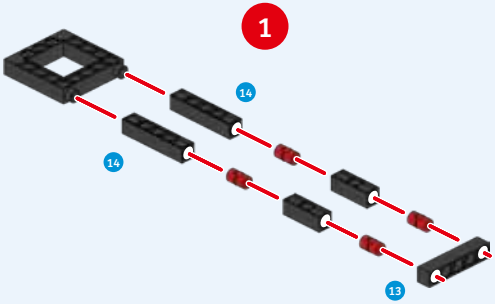
Adjust the wings into the correct position so the dragonfly is balanced.

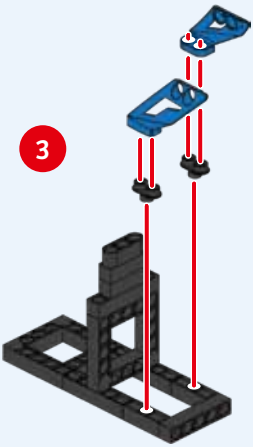
10

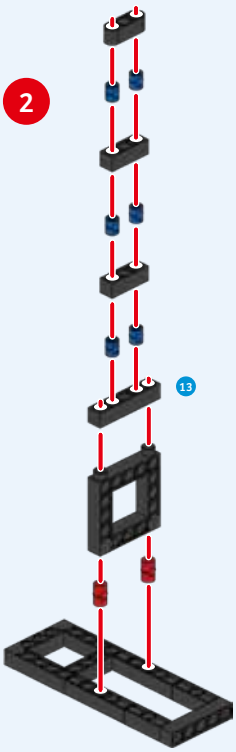


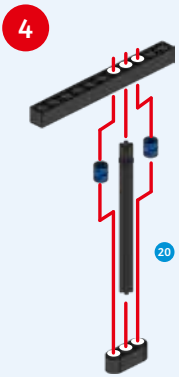
Done!

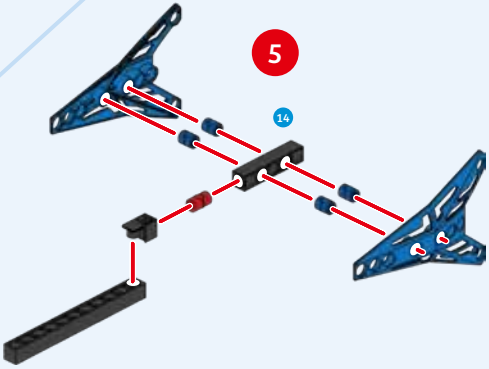
WIND MOBILE











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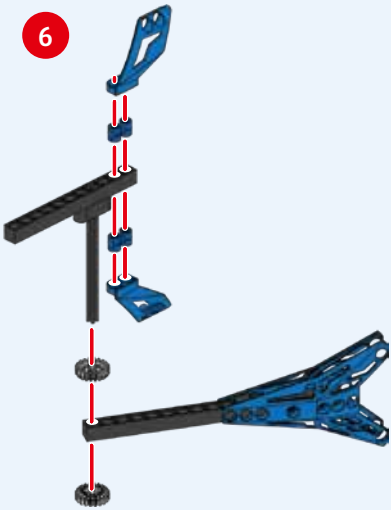

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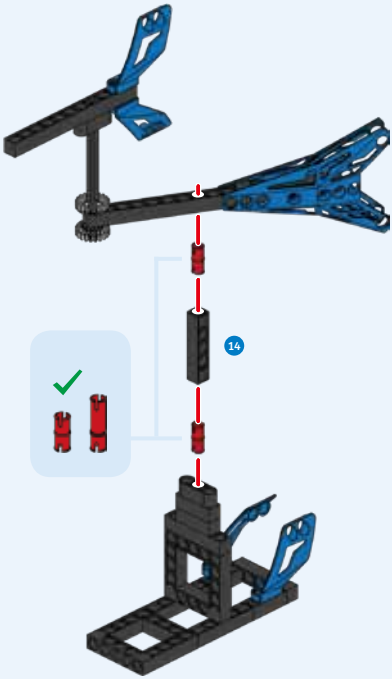

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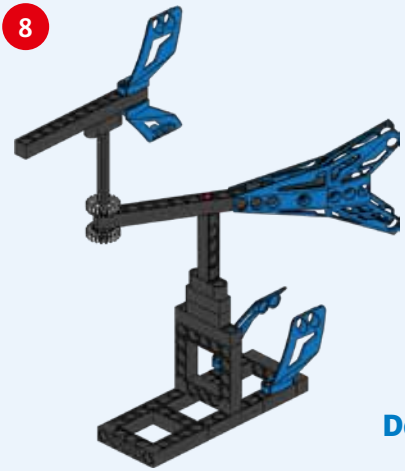

Done!

››› CHECK IT OUT

Your will also have to put energy into your rubber band.

You can do this thanks to your muscles. When you stretch the band, you're storing mechanical energy in it. Because the band is elastic, it instantly tries to revert to its previous shape. In doing so, it releases the energy it had stored, again in the form of mechanical energy. This gives your model the push that it needs.

In terms of physics, winding up a rubber band is work that you perform. Therefore, the energy that is stored in the rubber band is stored work. Your model can then use this energy to perform other work, such as rolling forward or catapulting a ball, for example.

Dragonfly

This trick is also used by tight-rope walkers at the circus:

The dragonfly's center of gravity is located beneath its support point. This is due to the downward angle of the "wings." These are comparatively heavy. This means that the dragonfly is not really balancing — it only looks as if it is — instead, it is essentially hanging from the point. However, this actually makes it far more stable, and prevents it from toppling over if you give it a little nudge.

The models that you built in this experiment kit move because of the energy that is stored in them.

The chemical energy found in gasoline is converted into mechanical energy, namely motion.

The same applies to cars. The only difference is that cars store their energy in their gas tanks while your models use a rubber band for energy storage.

Cars must be fueled up so that they can drive. This means that the chemical energy is found in the gasoline — when the gasoline is burned in the engine, the energy is released as heat. The pressure of the resulting hot combustion gases is what sets the engine in motion.

CONSERVATION OF ENERGY

An important law of physics is that energy remains constant. This means that energy cannot be created or destroyed or used up. When we talk about energy being "used up" we are actually describing energy being converted from one form to another.

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