

MECHANICS Laboratory

Constructions **40** to **50**

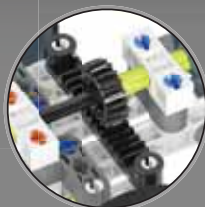
SC
NCE
EU
EU
APPROVED

- 40 - The first car in the world
- 41 - A vintage car with four seats
- 42 - Build a gear rack
- 43 - Assemble a manual gearbox
- 44 - Car with gearbox and electric motor
- 45 - Lunar buggy
- 46 - Assemble a scooter
- 47 - Build a motorbike
- 48 - Dragster with electric motor
- 49 - Livestock lorry
- 50 - Play music with a Celtic harp

2-speed
GEARBOX



Gear
RACK



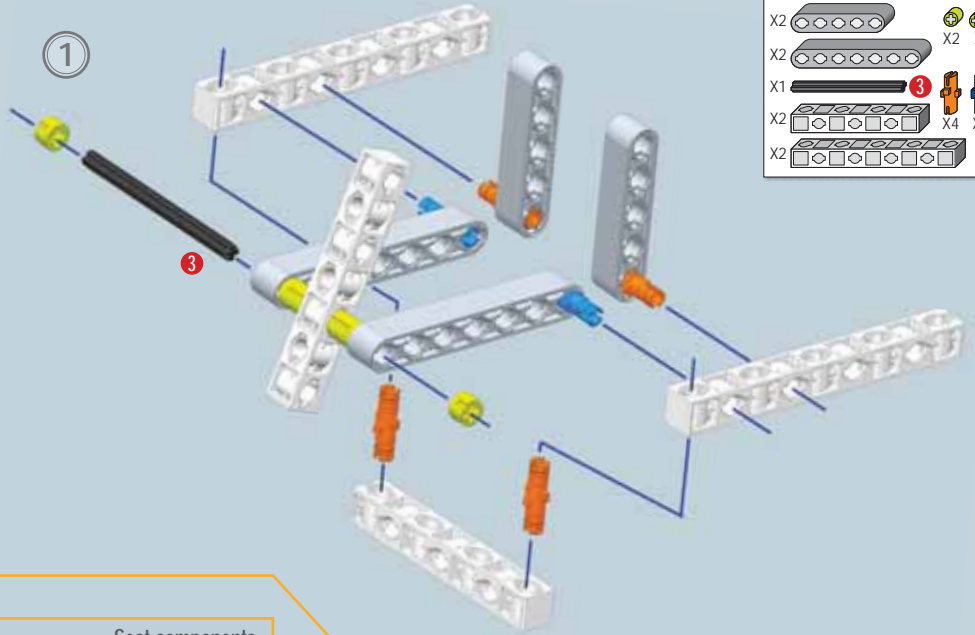
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TECHNOLOGIC

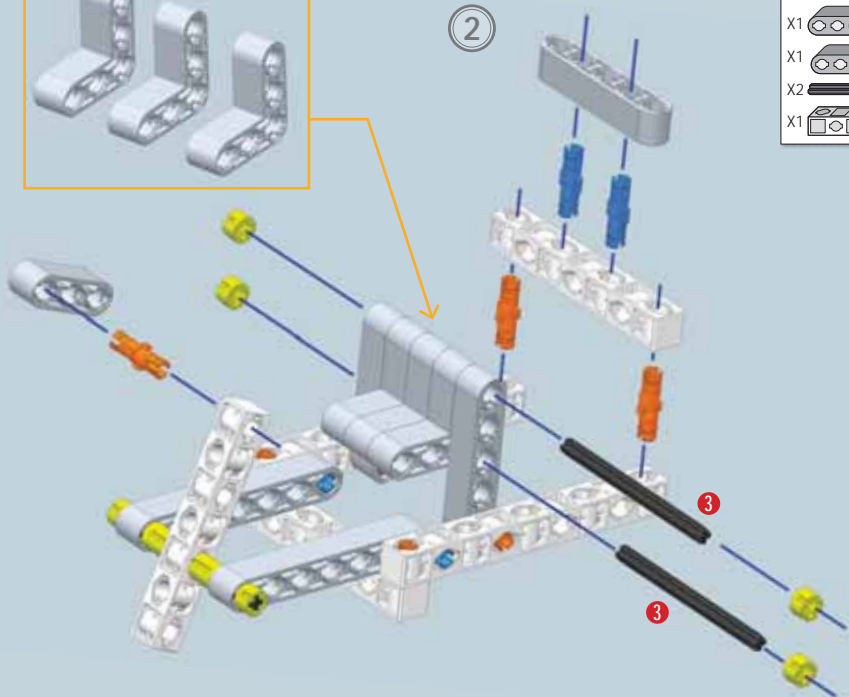
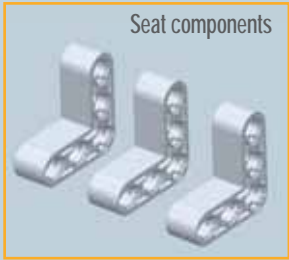
Made in Italy

Read and keep this booklet for future reference.

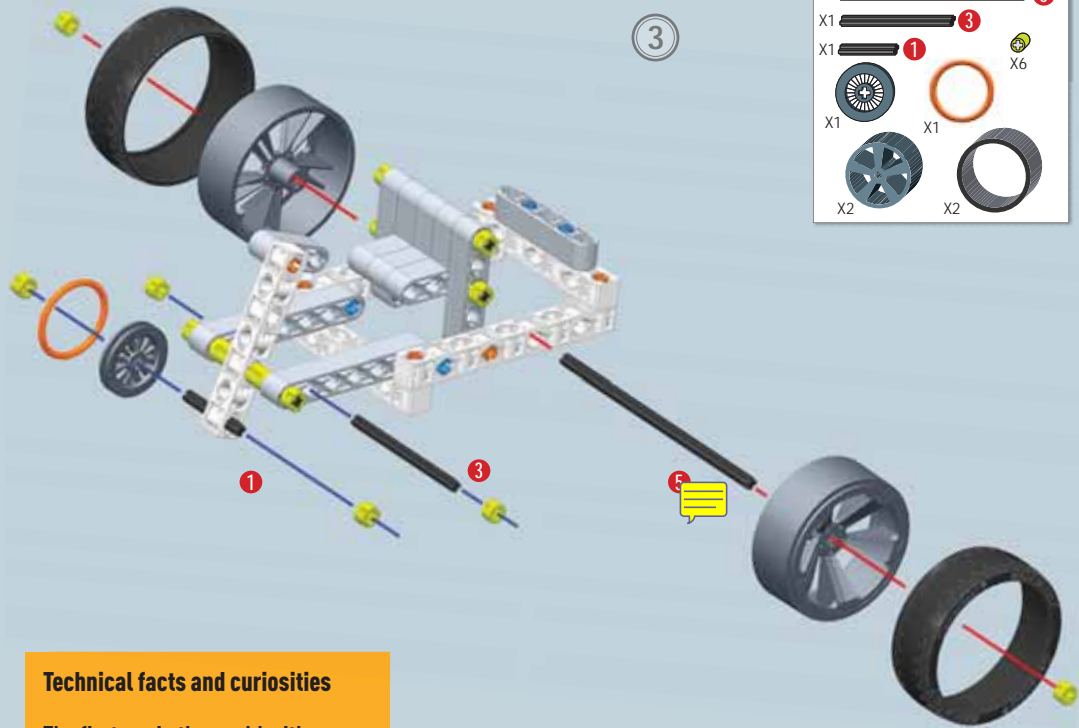




X2			
X2		X2	X2
X1			
X2		X4	X2
X2			



X1		X3			X4
X1					
X2					
X1		X3	X2		



Technical facts and curiosities

The first car in the world with a combustion engine was built in Germany by K. Benz in 1876. It was just under three metres long, weighed about 250 kg and could carry two people. It had a single wheel at the front, like a tricycle, and a bar for steering, since a viable solution for moving two front wheels at the same time had not yet been devised.

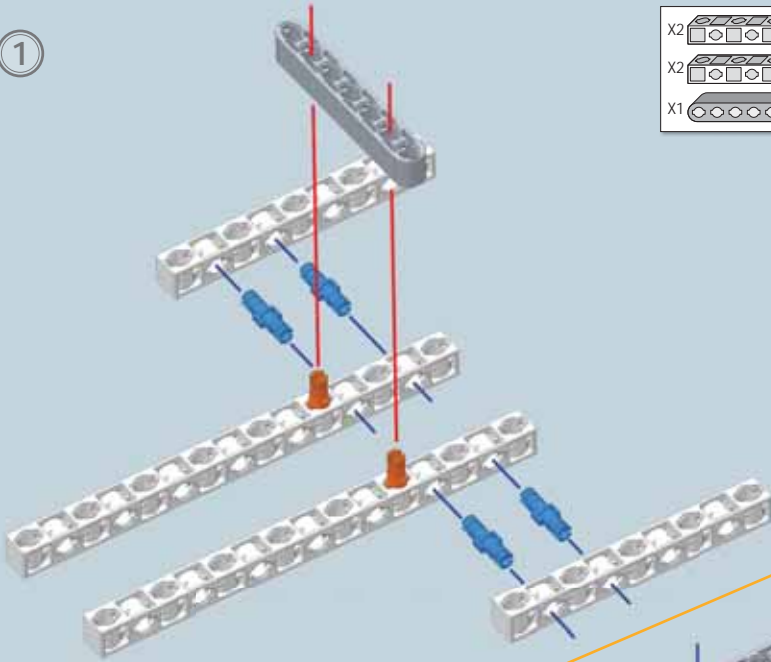


Final assembled model



41 A vintage car with four seats

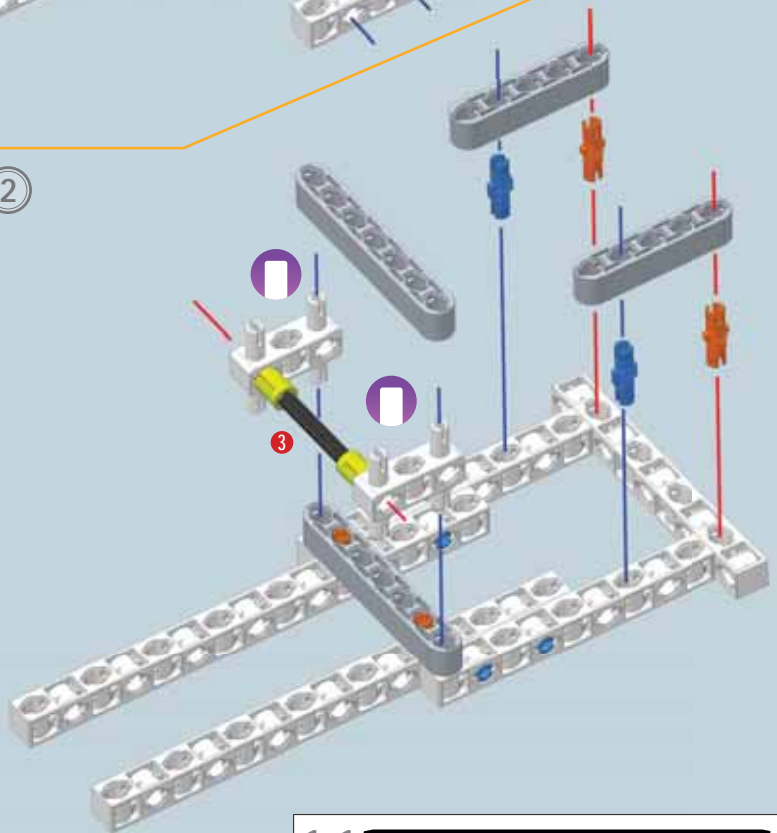
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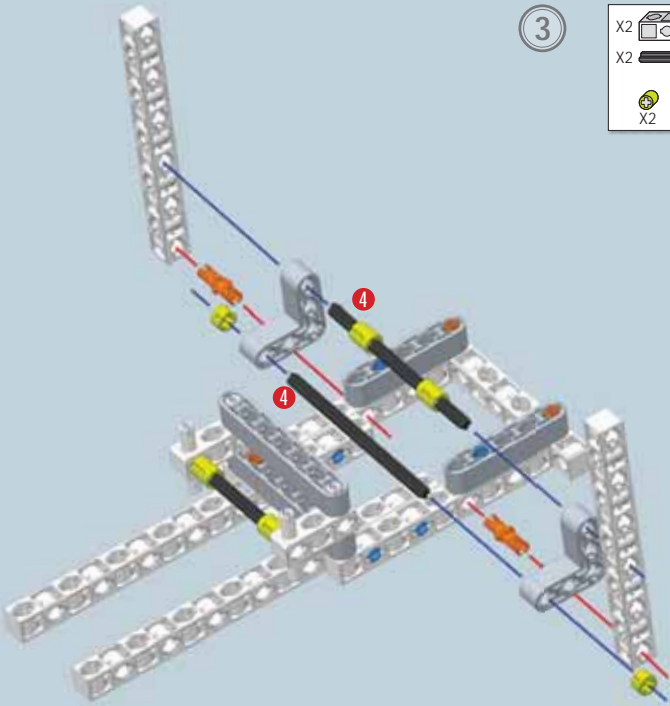
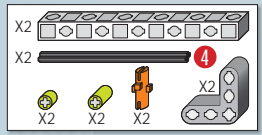
X2		
X2		
X1		

2

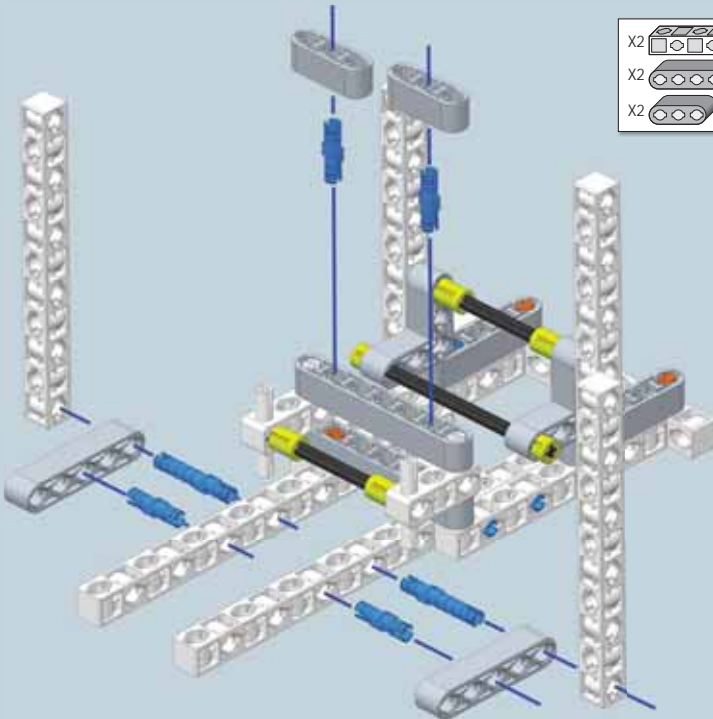
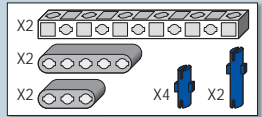
X2			
X1			
X1			
X2			
X1			



3

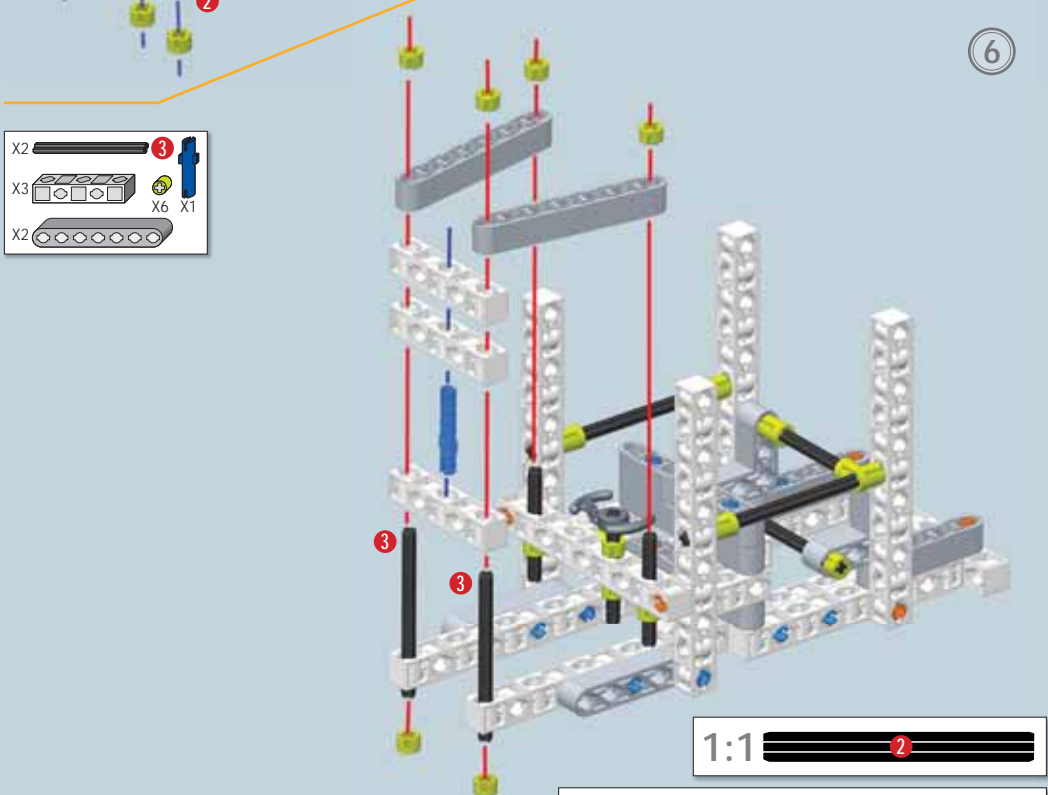
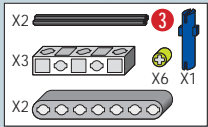
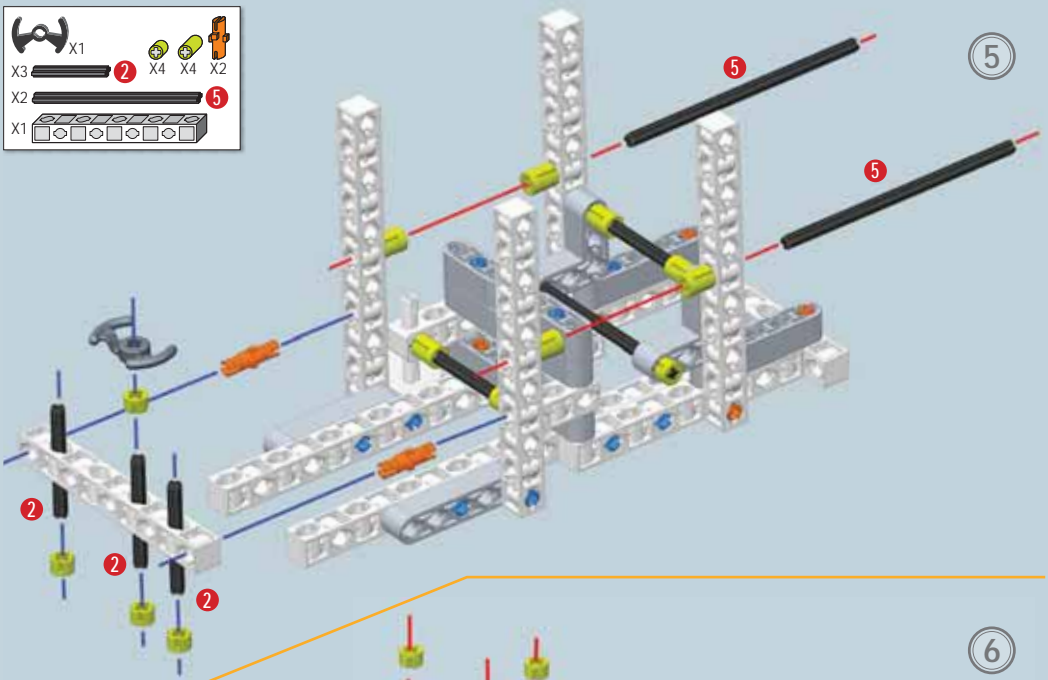
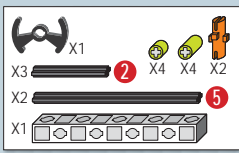


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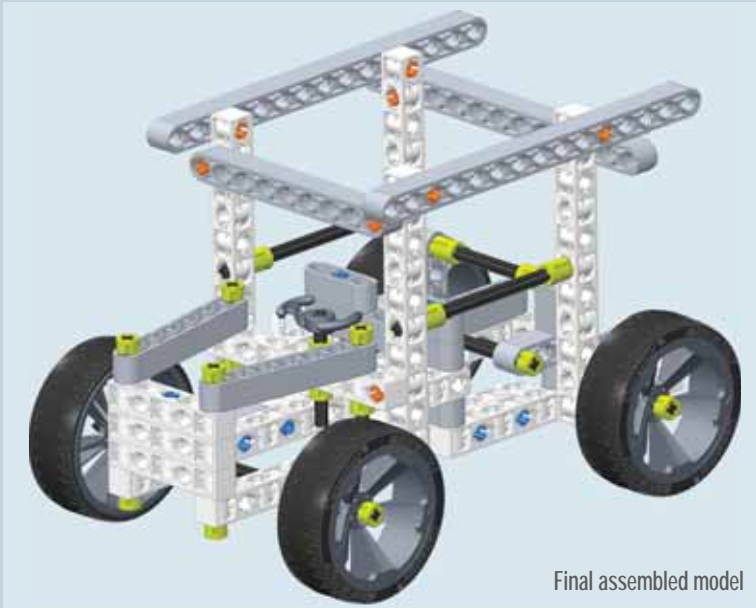
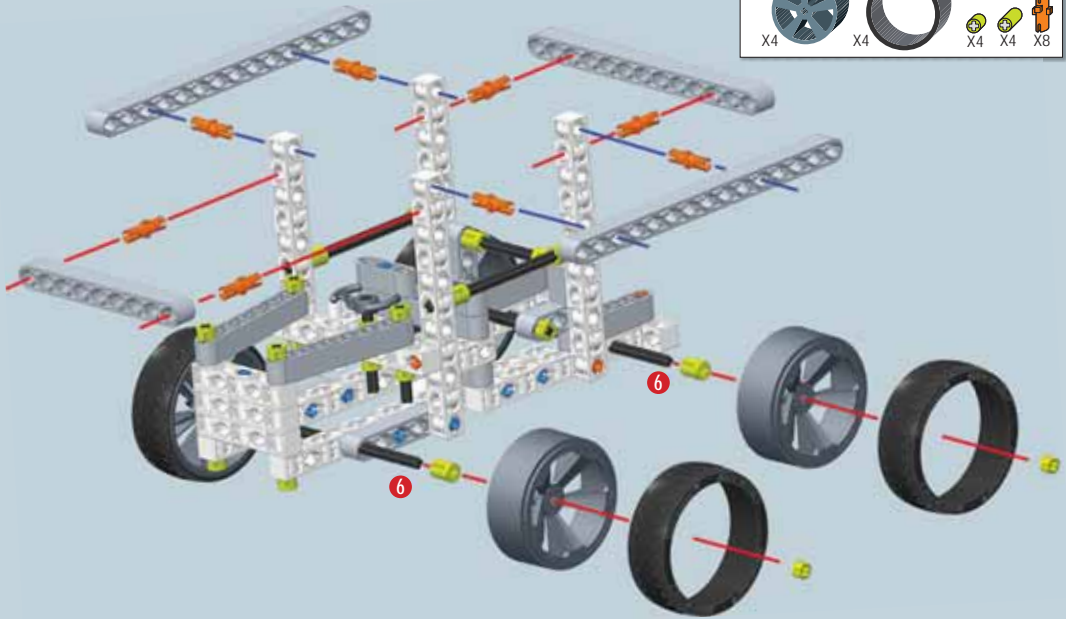
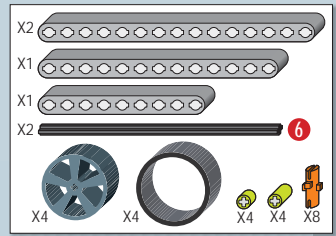


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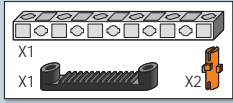


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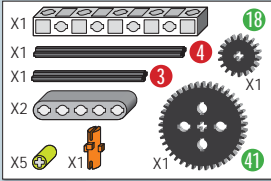
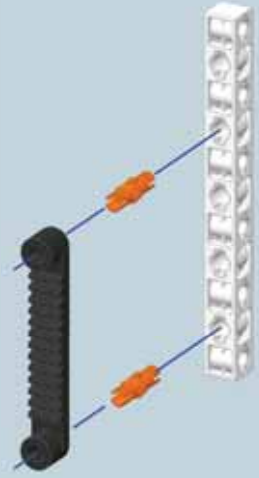


Final assembled model

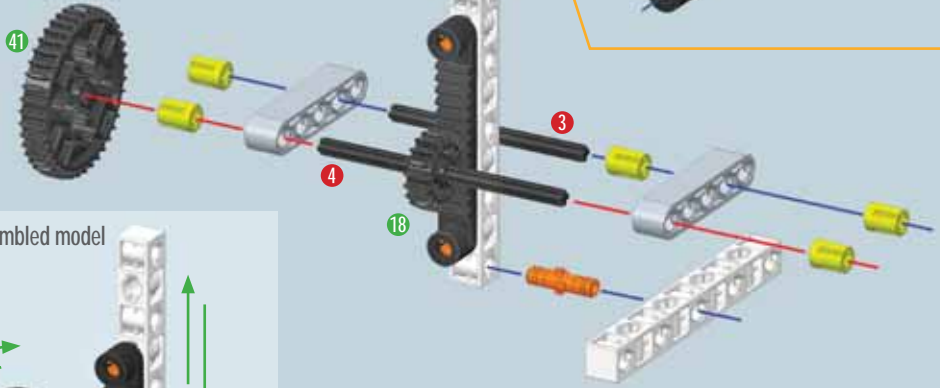
42 Build a gear rack



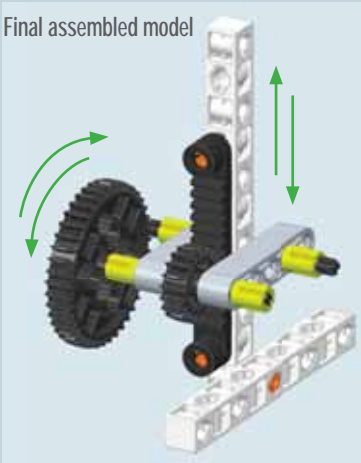
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2

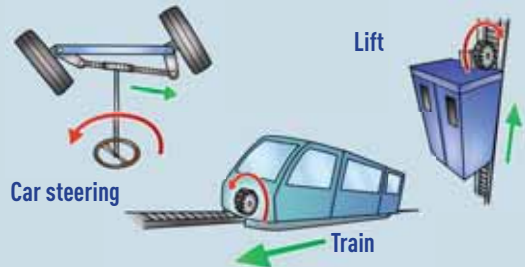


Final assembled model

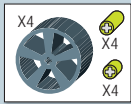
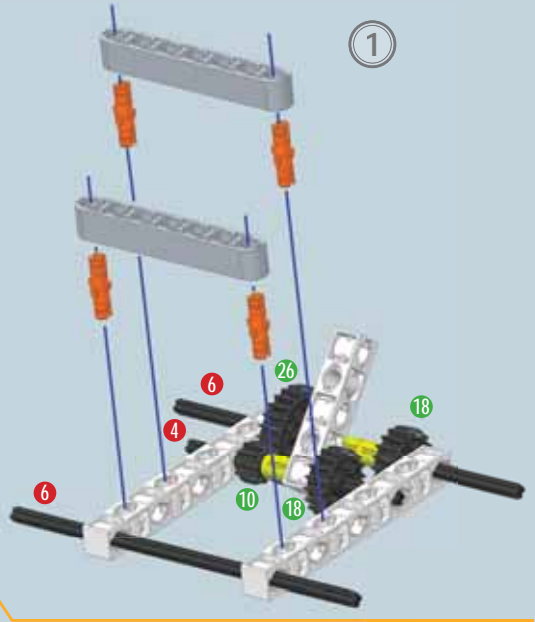
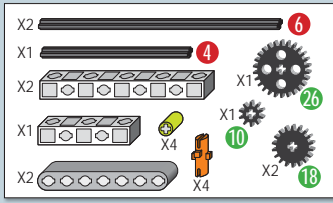


Technical facts about gear racks

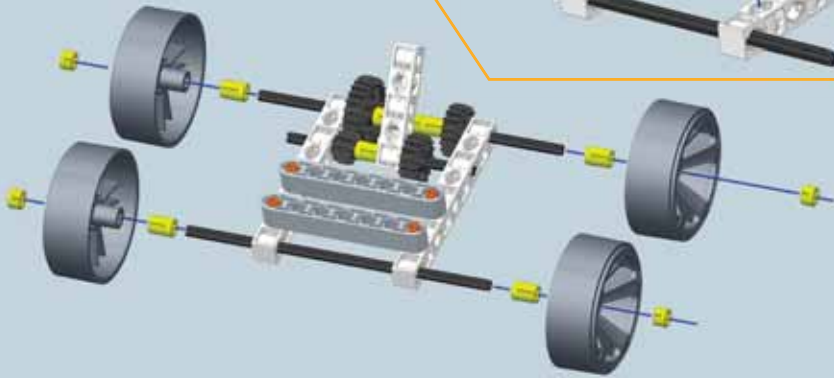
A gear rack, together with a pinion, converts rotational motion into linear motion. In a car's steering system, the rotational motion of the steering wheel is converted into the linear motion of the wheels' tie rods, thus steering the car.



43 Assemble a manual gearbox



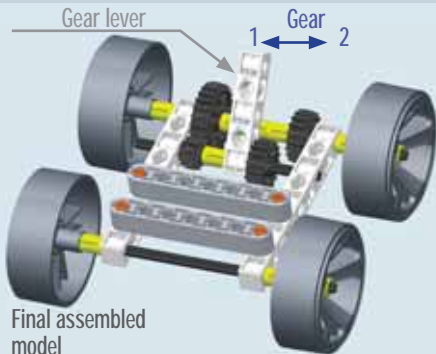
2



1:1



1:1



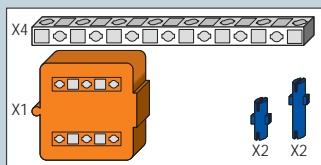
Technical facts on manual gearboxes

In a real car the gears are sealed inside a box, called the gearbox, which is positioned between the engine axle and the wheel axles.

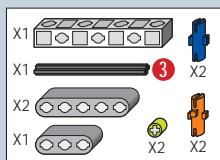
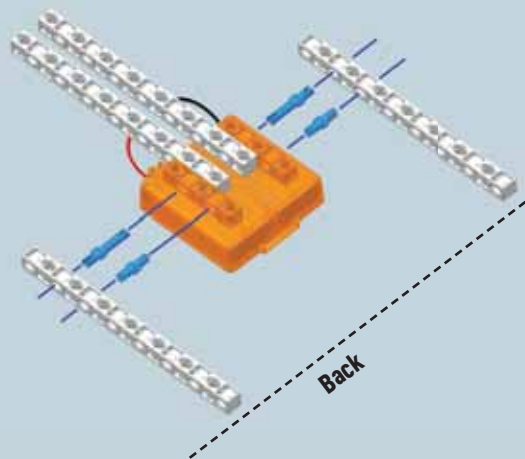
Ways of changing gear

The lever (see figure) can be used to move the various-sized cogwheels horizontally on the transmission axle to make them engage with the cogwheels on the wheel axles, which, depending on the driving wheel, causes a change in the rotation of the wheels and a change in the speed of the car.

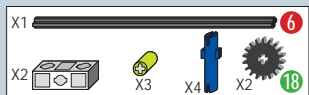
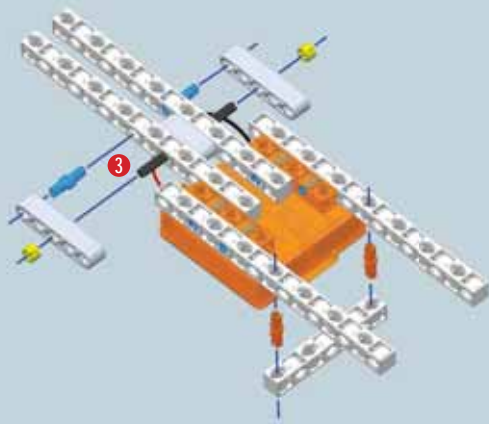
44 Car with gearbox and electric motor



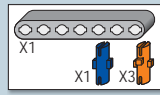
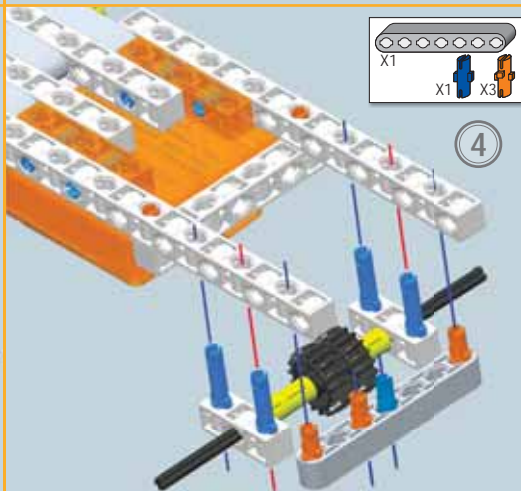
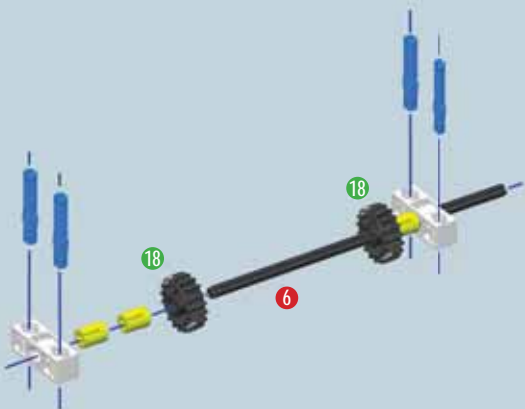
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2

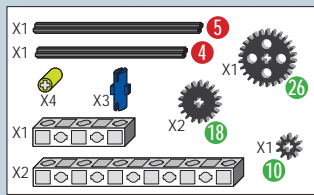
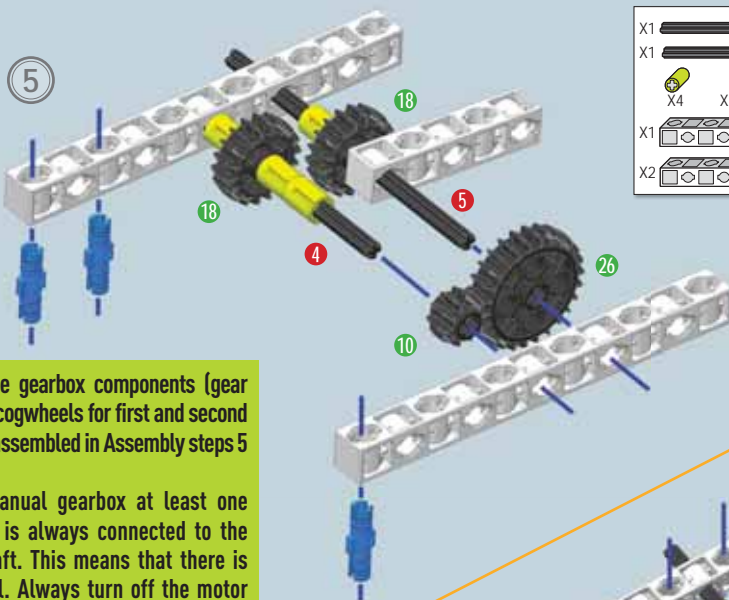


3



4

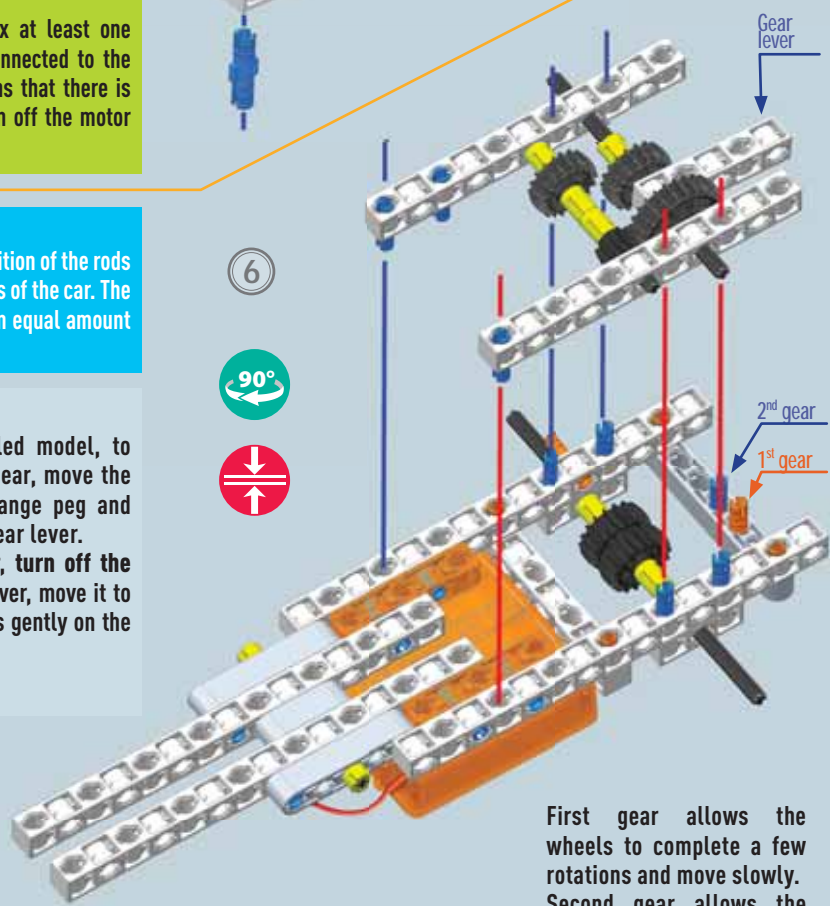




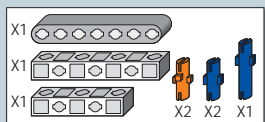
Note - The gearbox components (gear lever and cogwheels for first and second gear) are assembled in Assembly steps 5 and 6. In this manual gearbox at least one cogwheel is always connected to the motor shaft. This means that there is no neutral. Always turn off the motor to change gear.

Warning! Carefully check the position of the rods with respect to the sides of the car. The rods should stick out an equal amount on both sides.

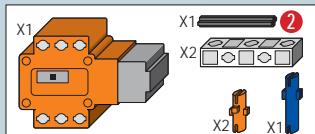
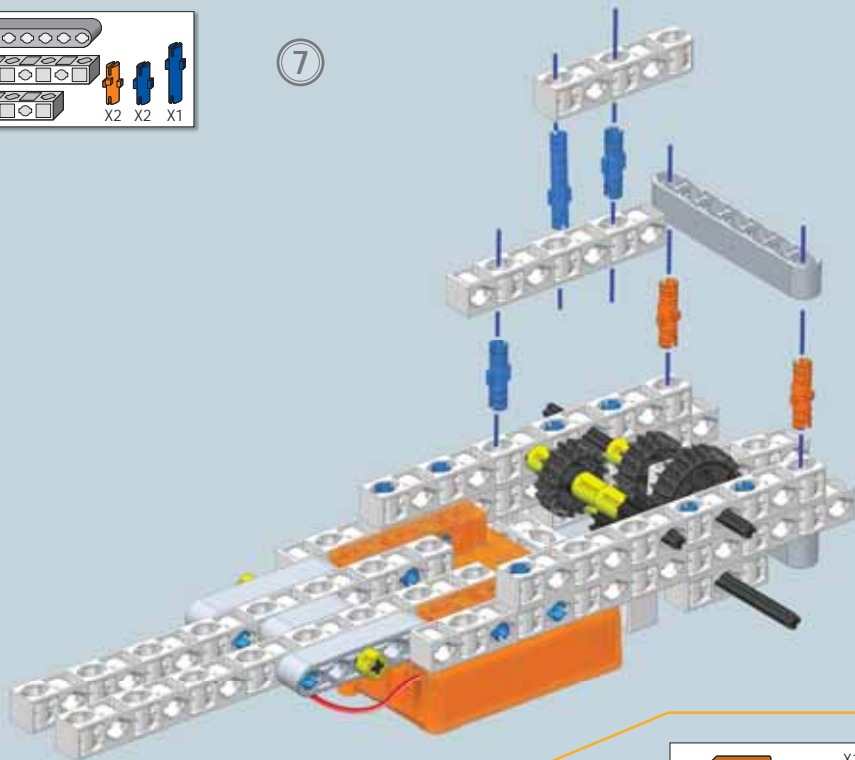
Engaging the gears
 In the final assembled model, to engage and lock 1st gear, move the gear lever to the orange peg and press gently on the gear lever. To move into 2nd gear, turn off the motor, lift the gear lever, move it to the blue peg and press gently on the gear lever. Restart the motor.



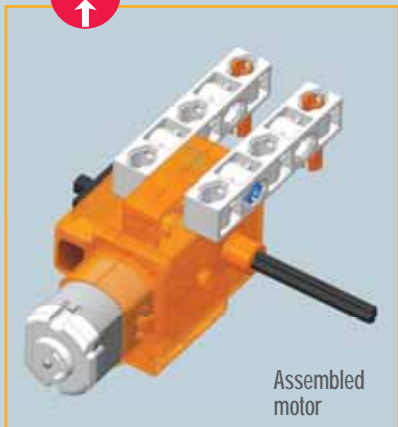
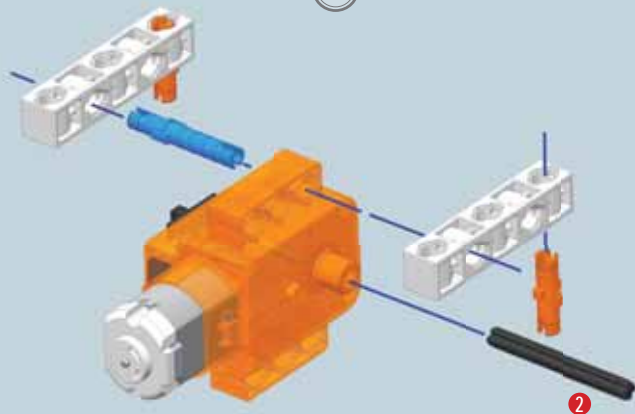
First gear allows the wheels to complete a few rotations and move slowly. Second gear allows the wheels to increase the number of rotations and therefore move faster.



7



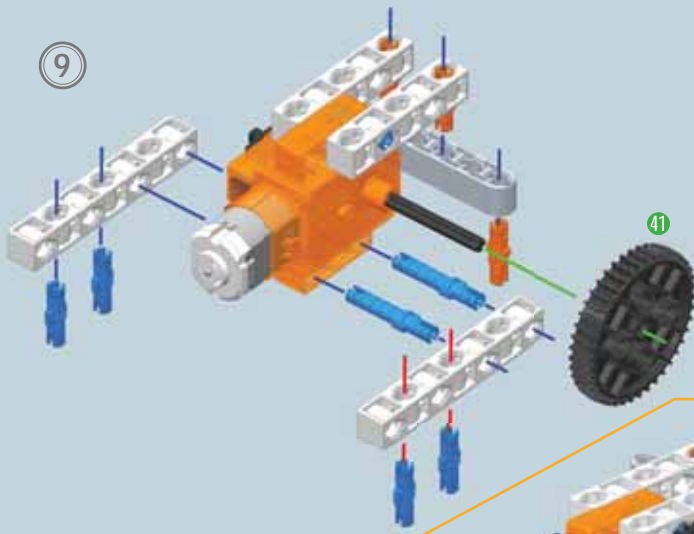
8



Assembled motor



9



X1

X2

X1

X2

X4

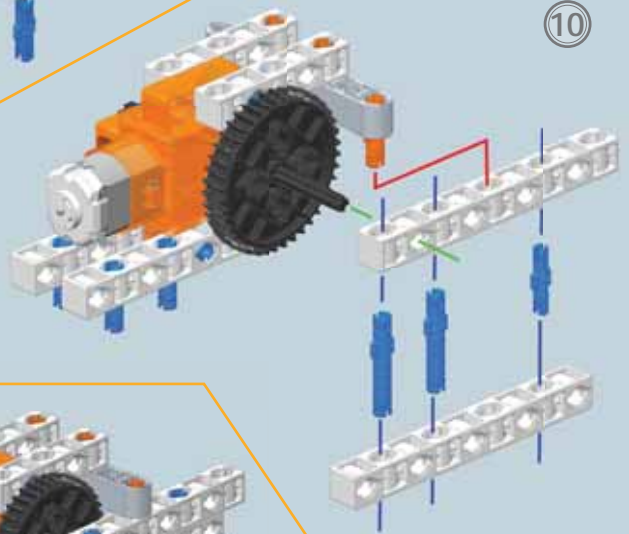
X1

X2

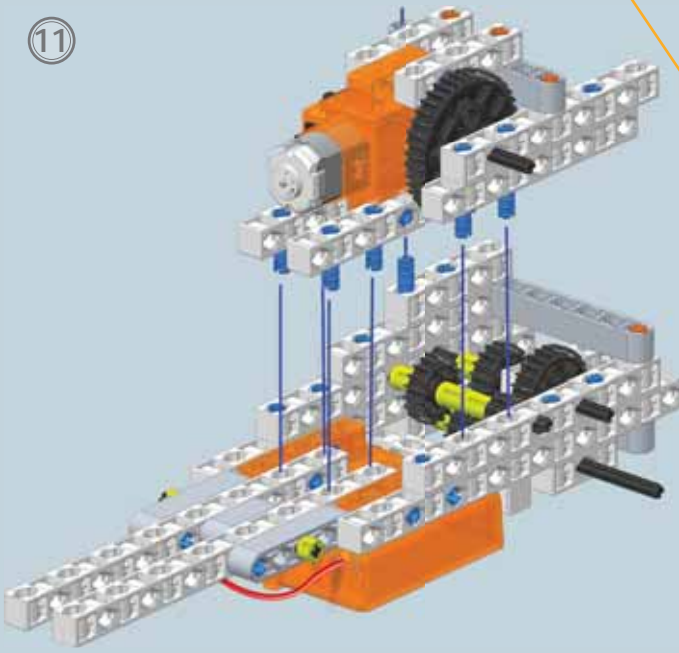
X1

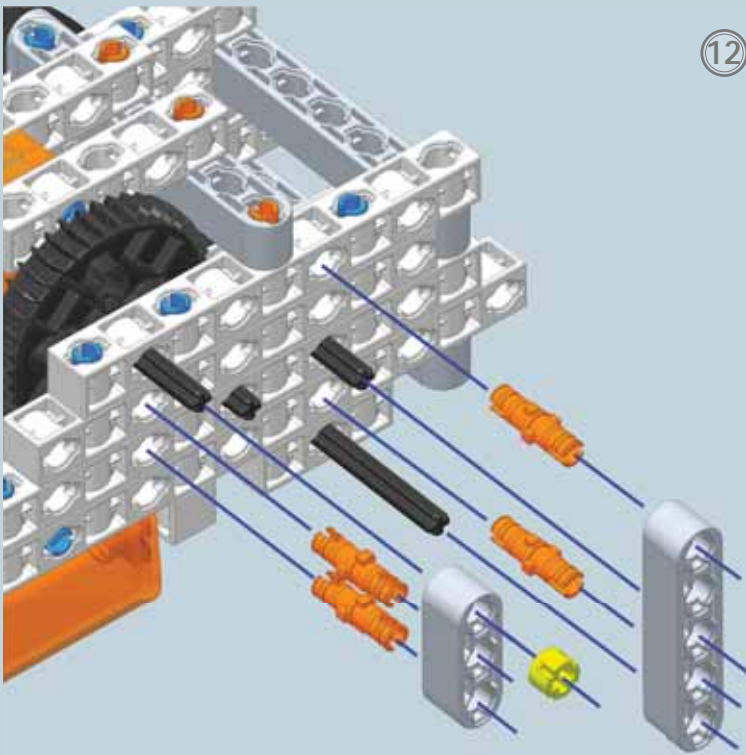
X2

10



11

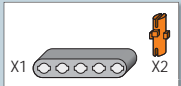




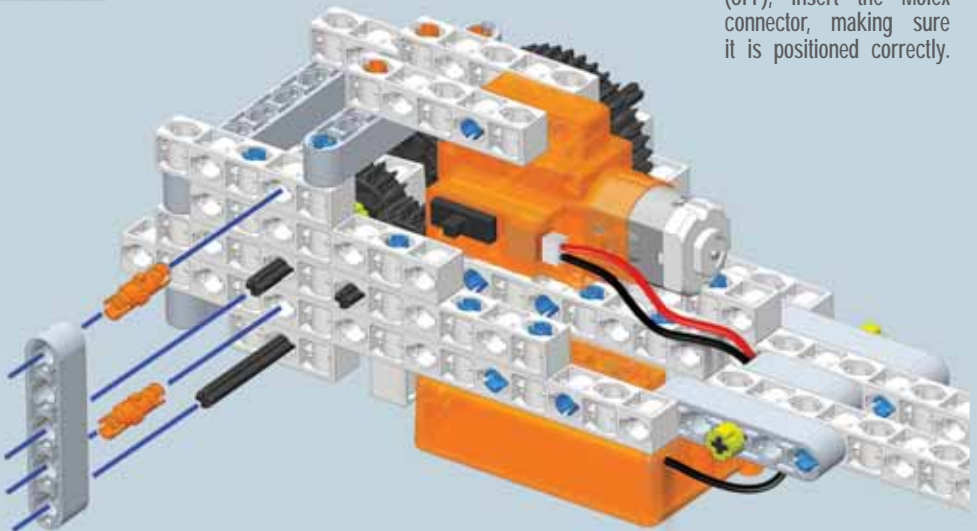
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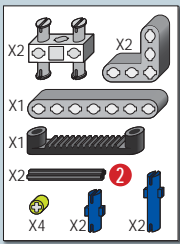


13



- With the motor switch in the central position (OFF), insert the Molex connector, making sure it is positioned correctly.





14

Assembled
RHS steering
components



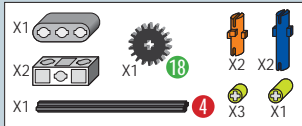
RHS

LHS

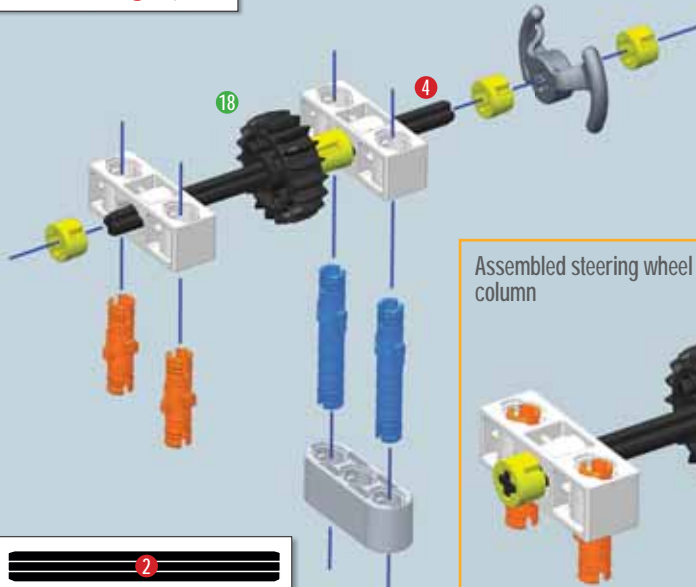
Note - The steering components (rods and collars) must be securely tightened.



Unassembled LHS steering components



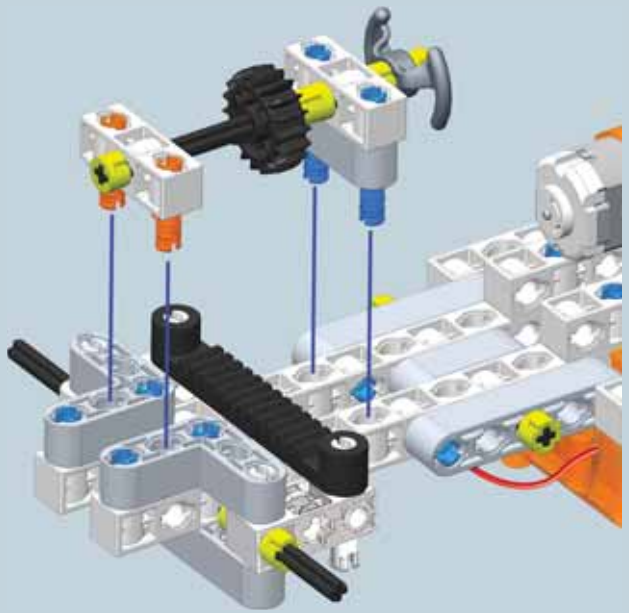
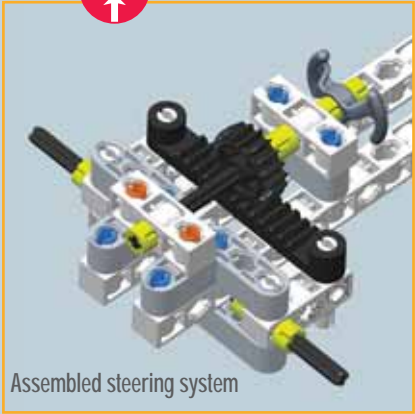
15



Assembled steering wheel and steering column

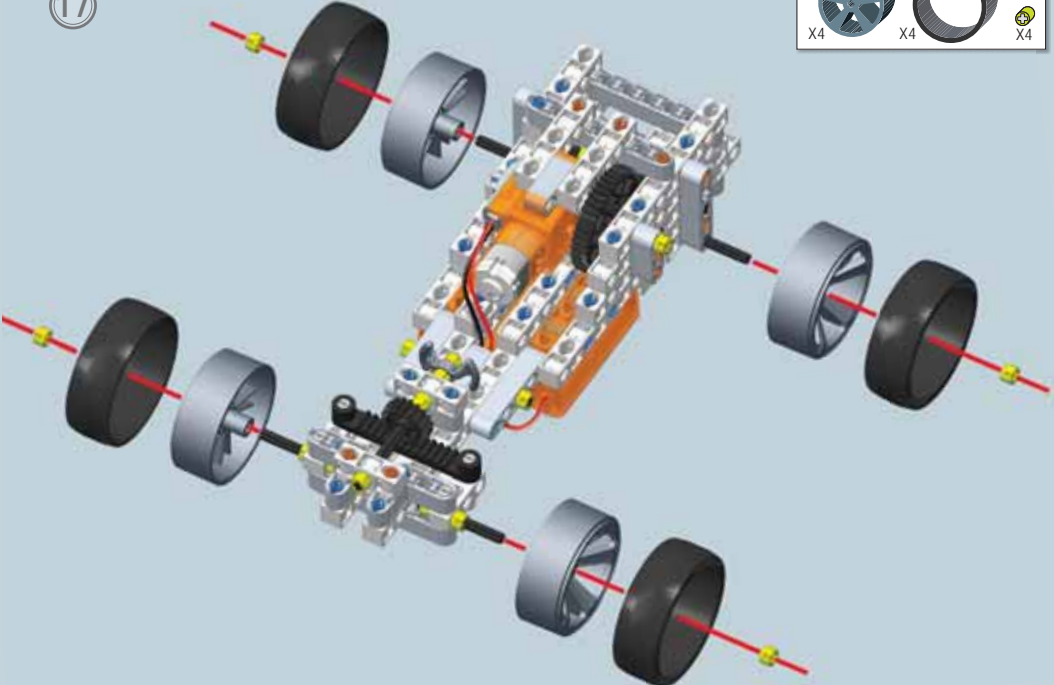


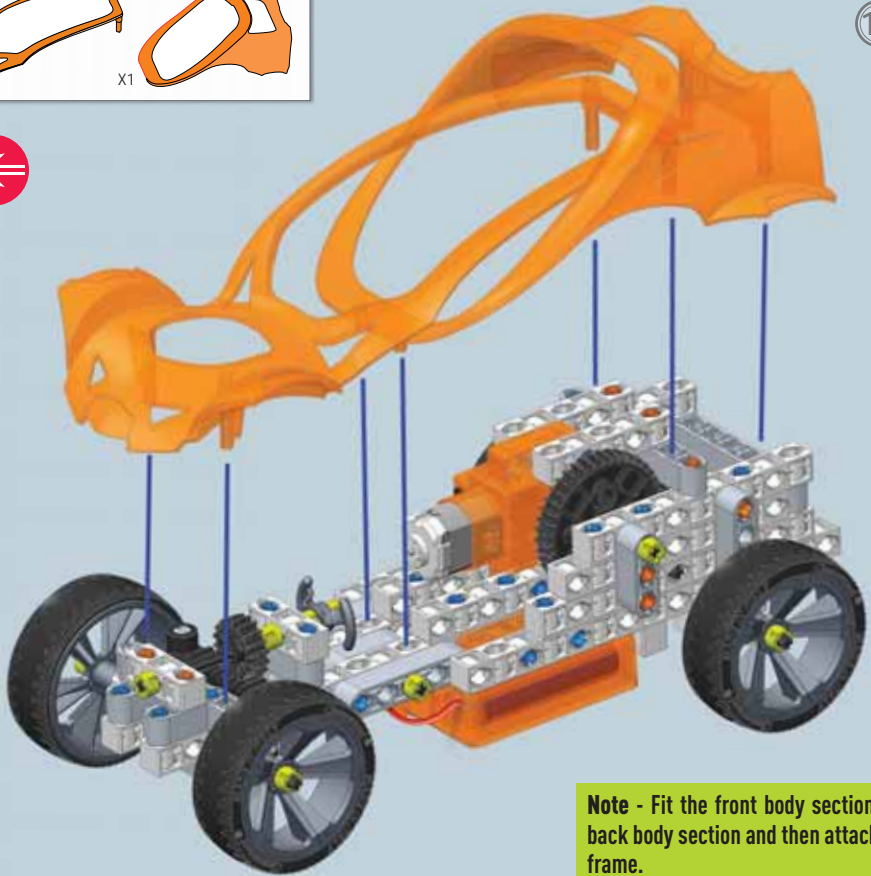
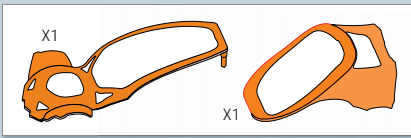
16



Assembled steering system

17





Note - Fit the front body section to the back body section and then attach to the frame.

IMPORTANT! Always turn off the motor to change gear.

- Electric motor switch**
 Sliding the switch to the **central** position turns the motor **OFF**
 Sliding the switch to the **side** positions turns the motor **ON**

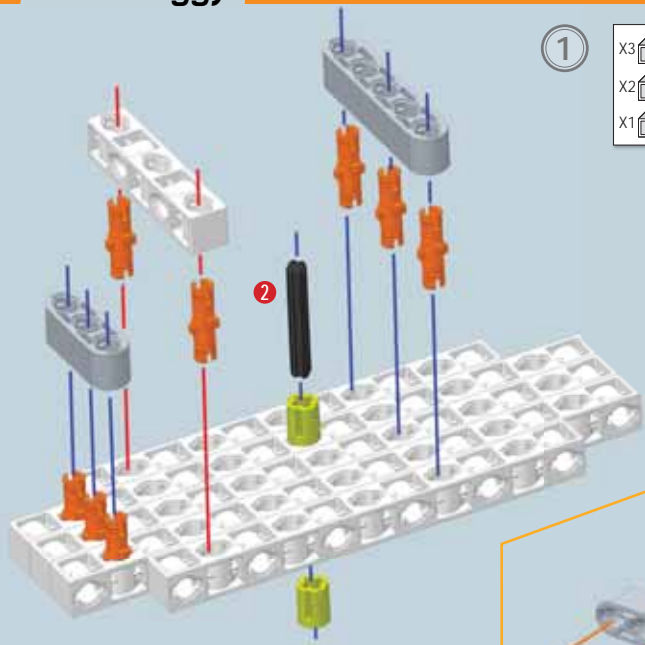


Final assembled model

Note - The car has a reverse gear, which can be accessed by operating the motor switch, and a two-speed gearbox.

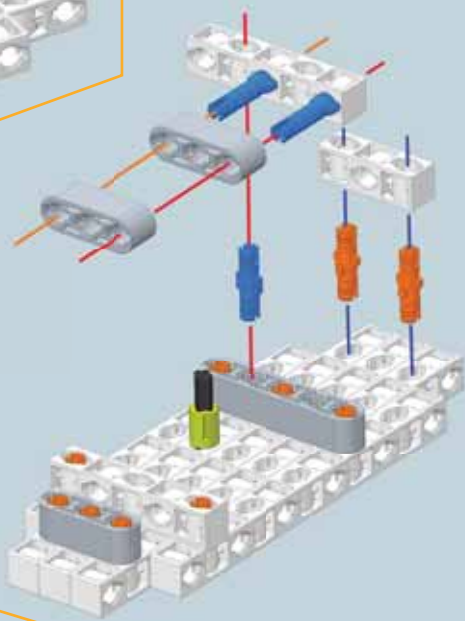
1

X3		X2		
X2		X1		X8
X1		X1		X1



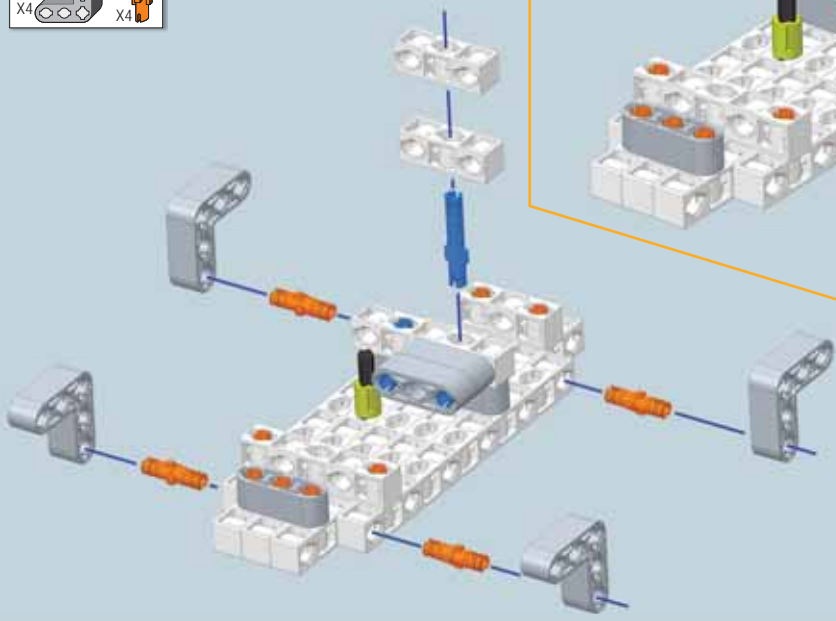
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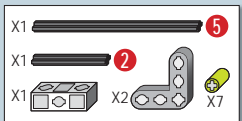
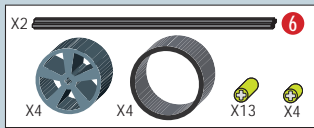
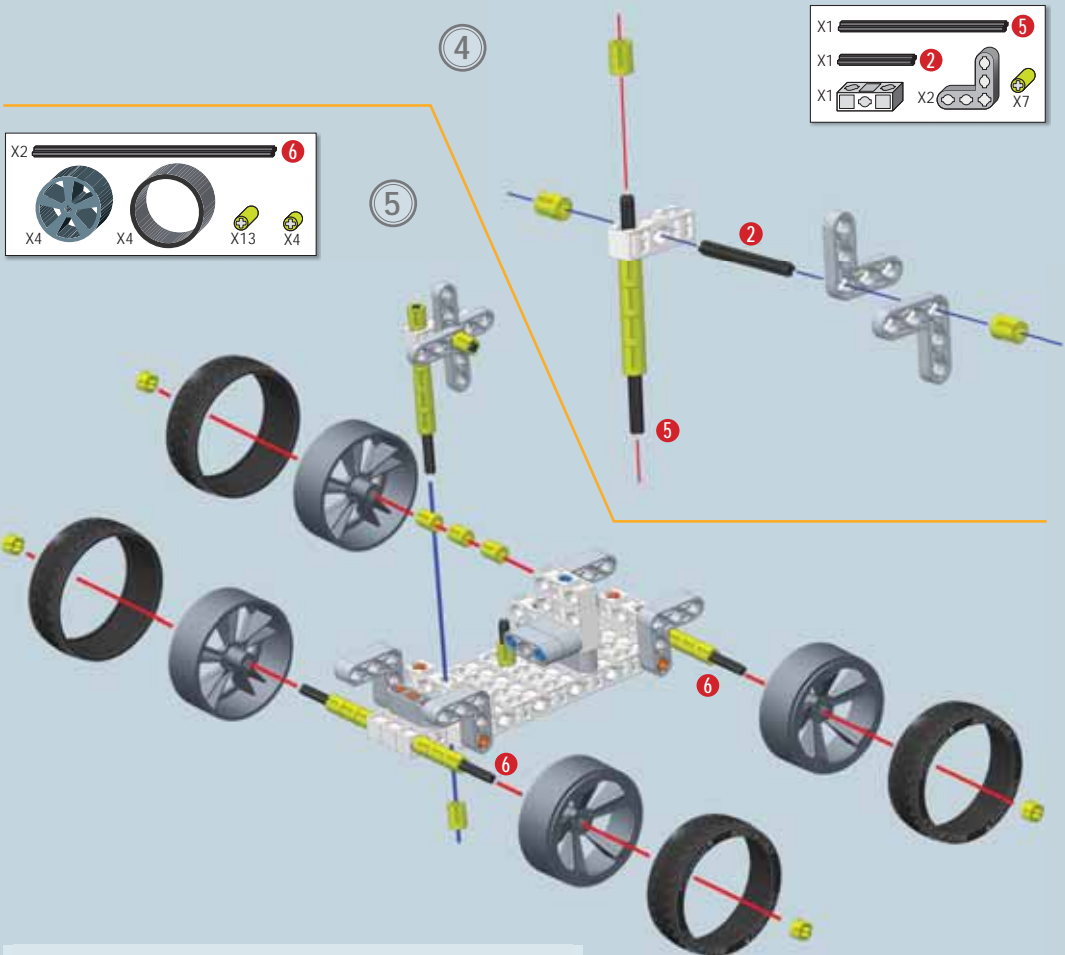
X2			X1
X1		X2	
X1		X2	



3

X2		
X4		X4





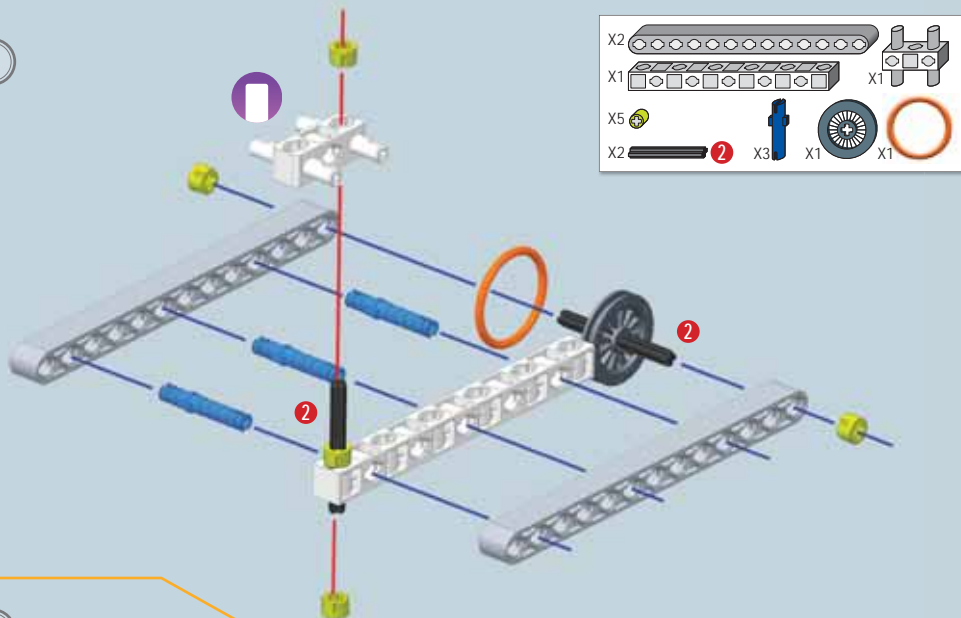
Final assembled model

Technical facts and curiosities
1971 In the **Apollo 15** moon mission, **NASA**, the US space agency, used the first car with an electric motor on the surface of the moon. It weighed 200 kg, had non-rechargeable chemical batteries and went about 5 km an hour. The buggy was abandoned on the moon.



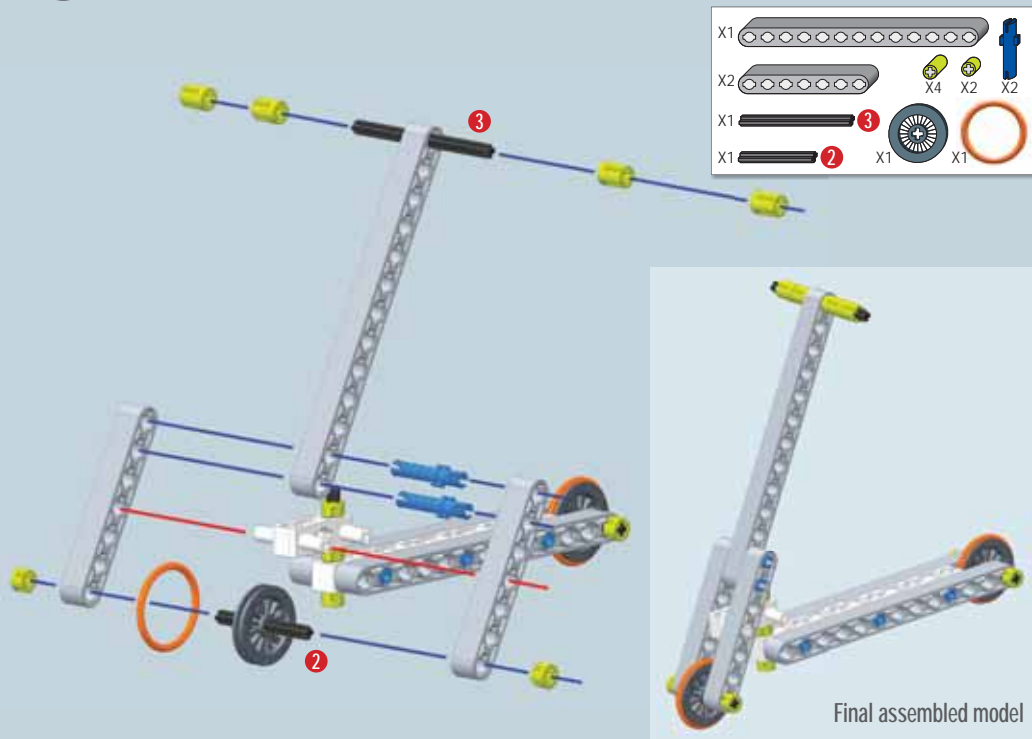
46 Assemble a scooter

1



X2		
X1		
X5		
X2		X3
		X1
		X1

2

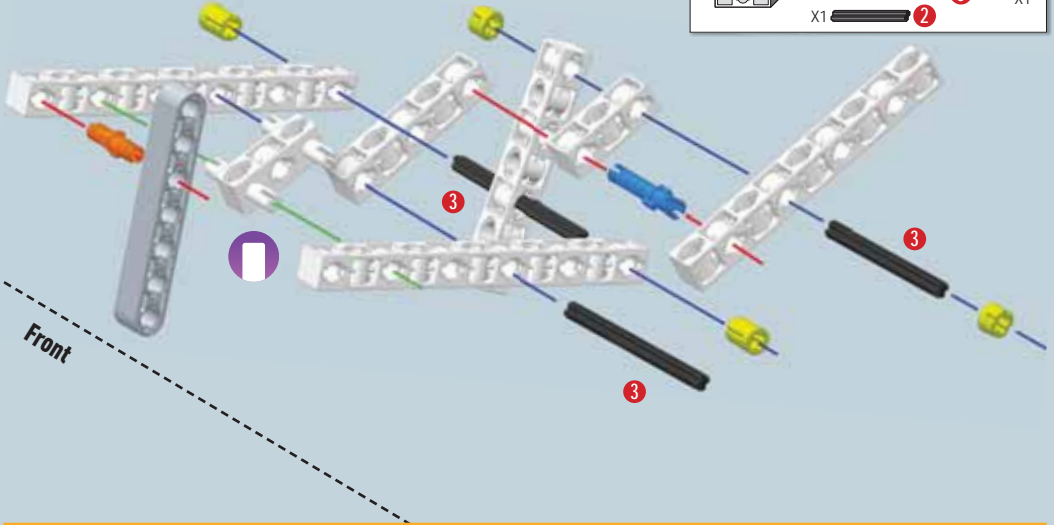
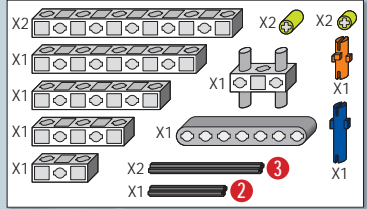


X1		
X2		X4
		X2
X1		X2
X1		X1
		X1

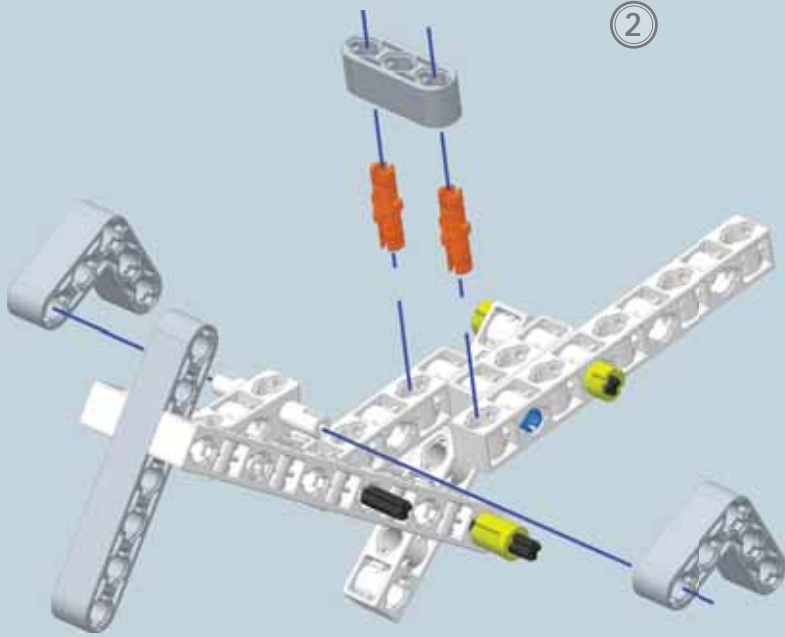
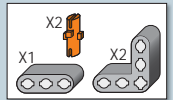


47 Build a motorbike

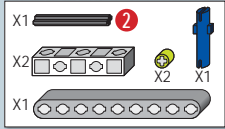
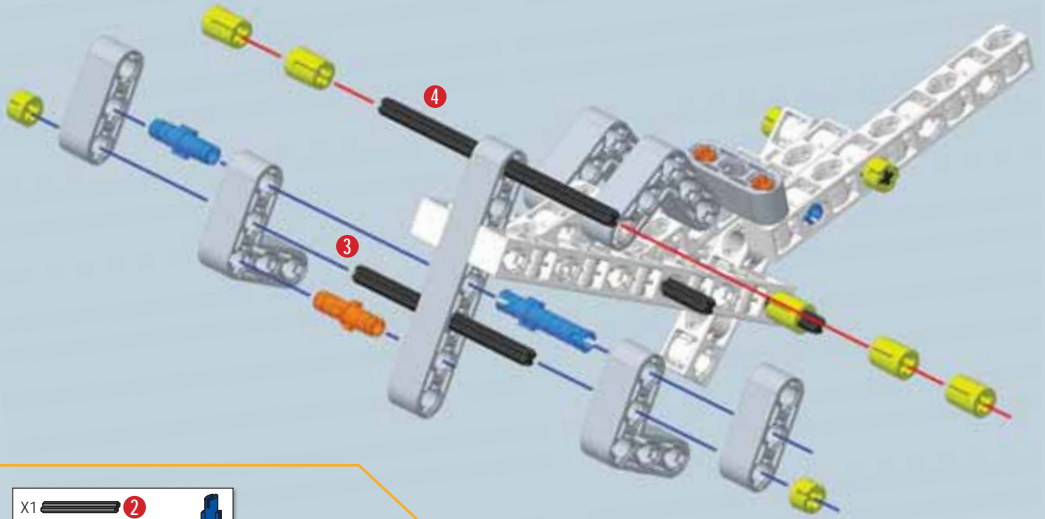
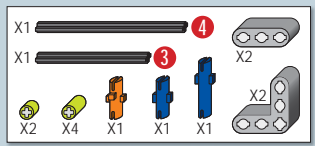
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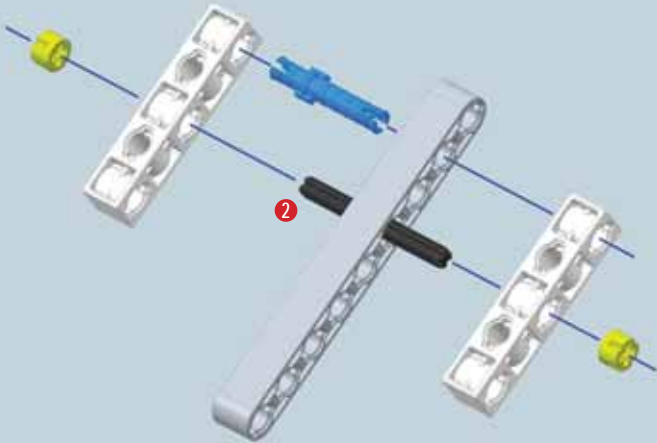
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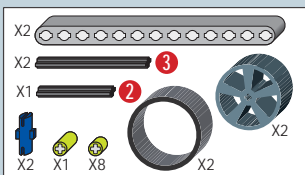


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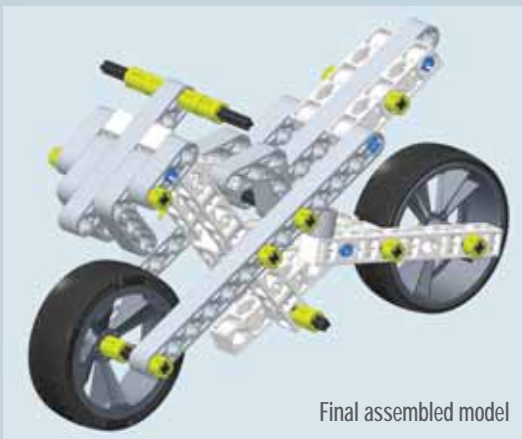
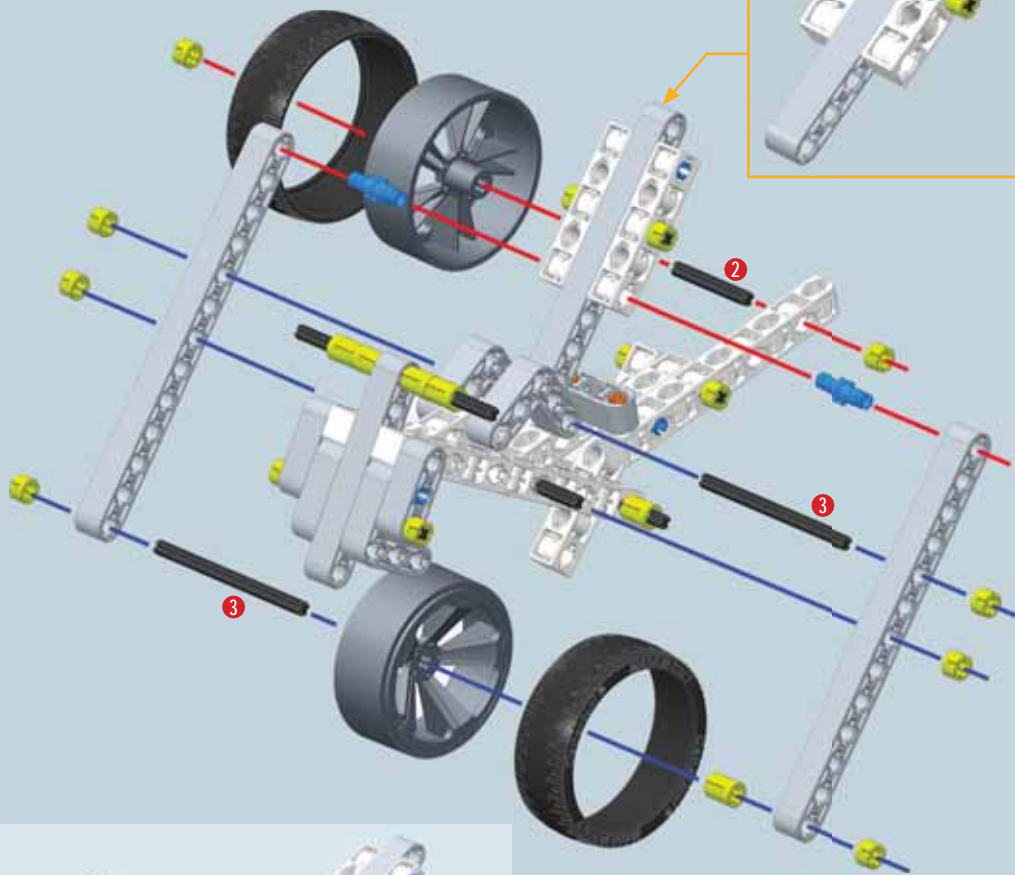


4





5



Final assembled model

Technical facts and curiosities

1869 French engineer **L. G. Perreaux** filed a patent for a motorbike and built a two-wheeled vehicle with a steam engine, based on the bicycle.

1885 German engineers **G. Daimler** and **W. Maybach** built the first motorbike with a combustion engine. It had a wooden frame and wheels.

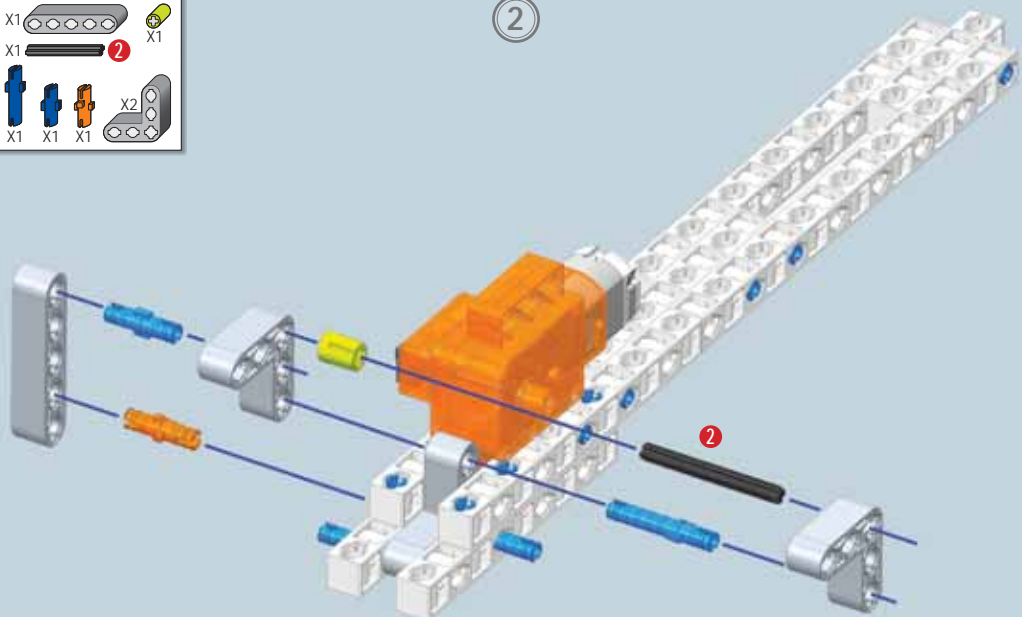
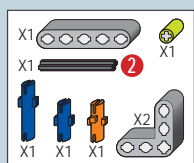
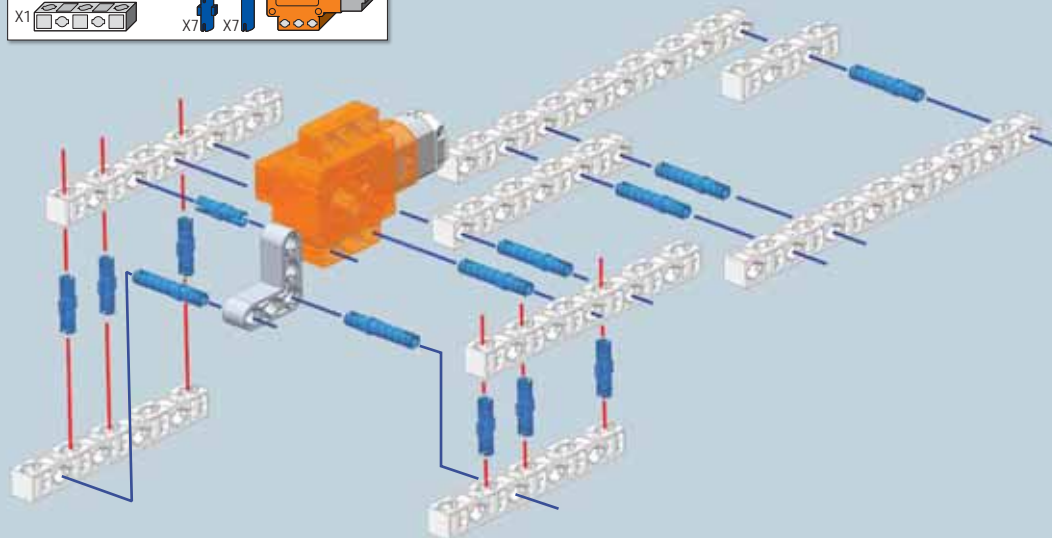
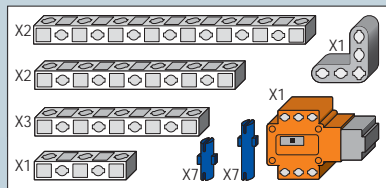
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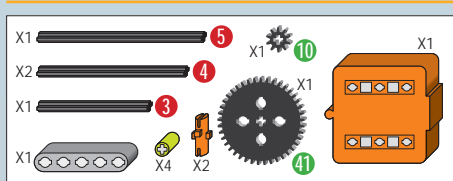
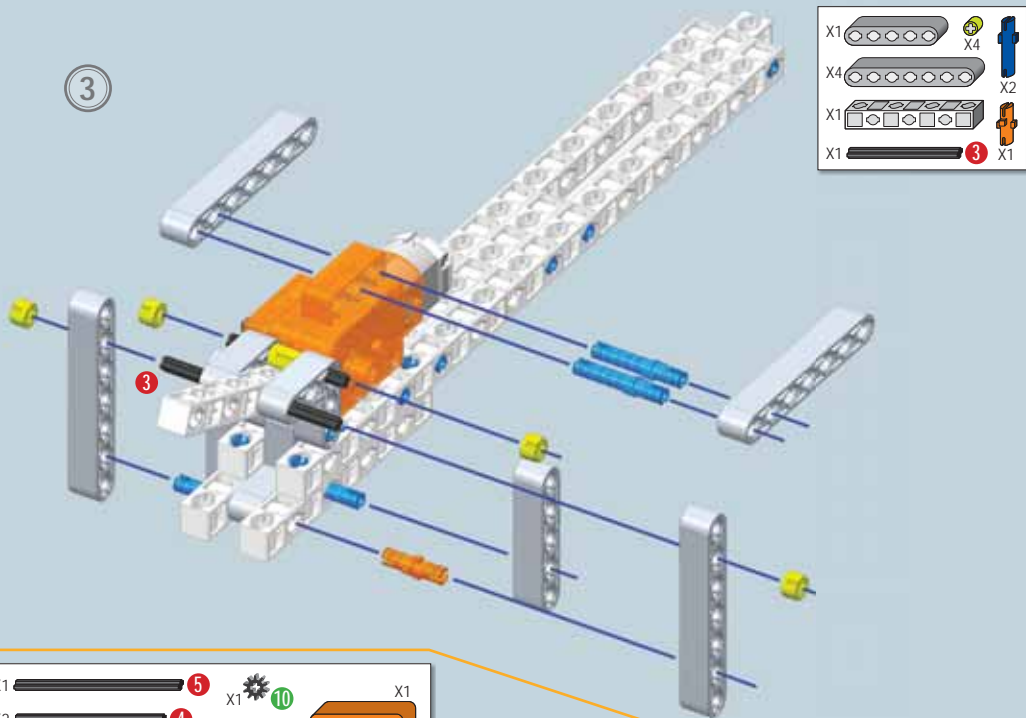
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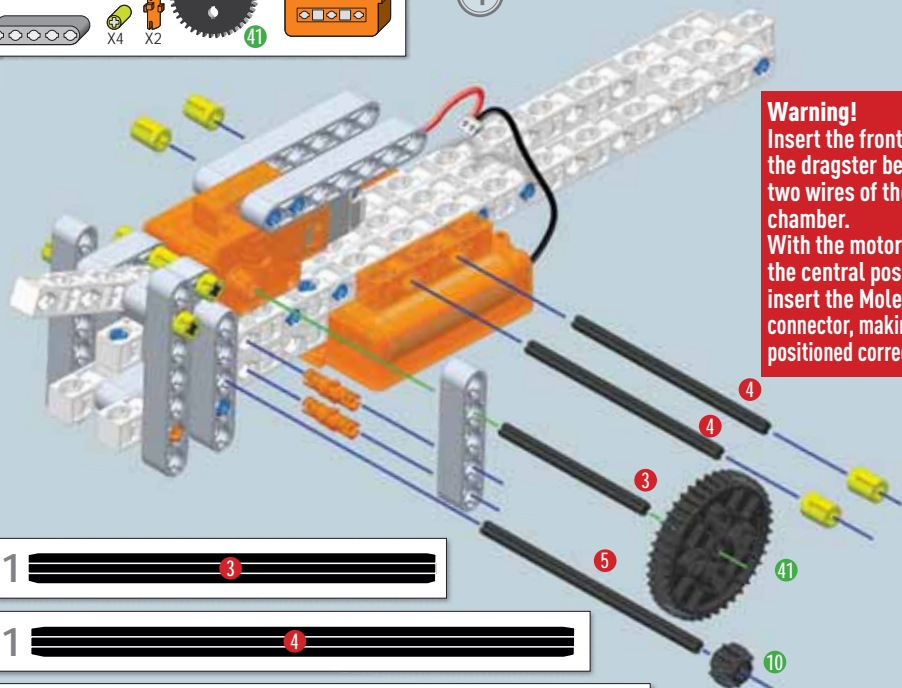
48 Dragster with electric motor



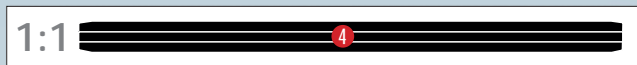
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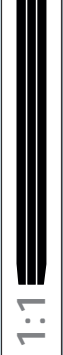
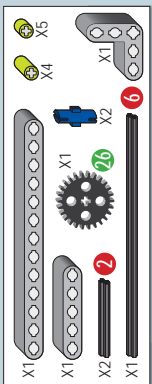
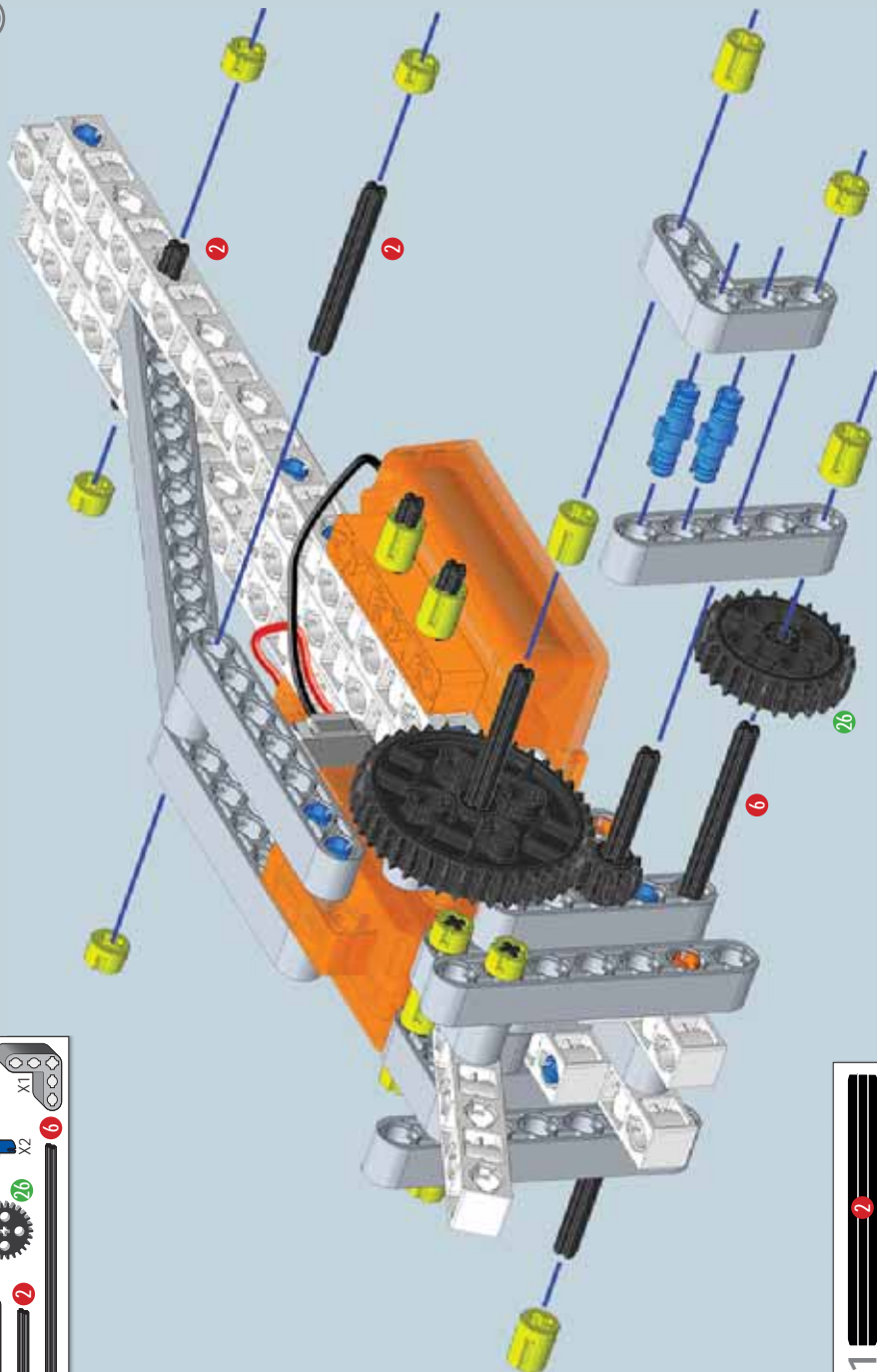
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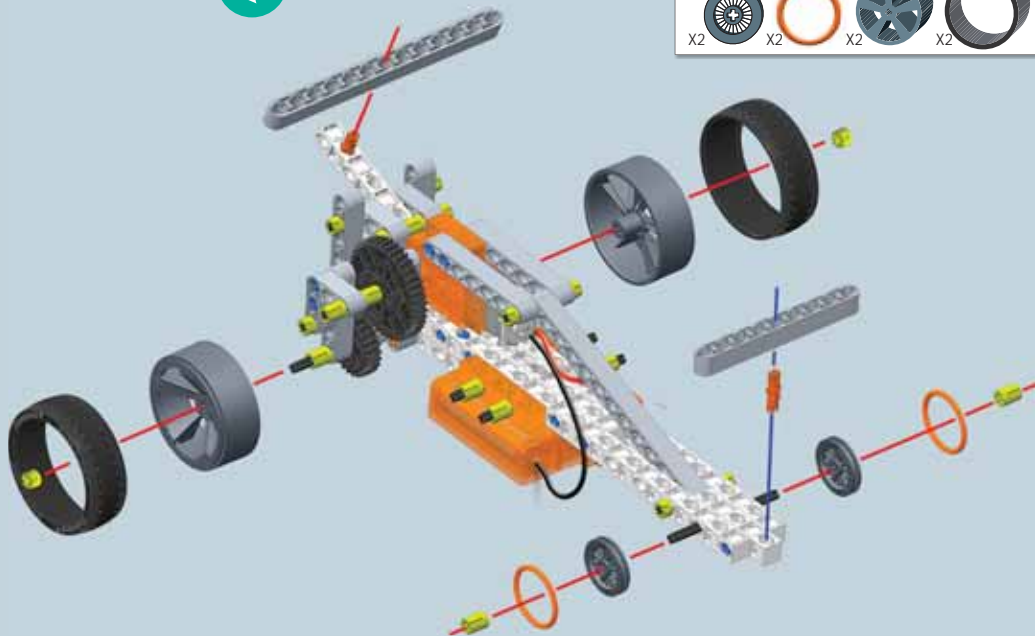
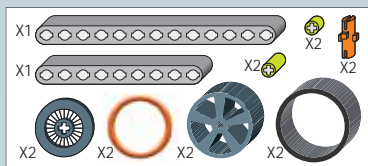
Warning!
 Insert the front base of the dragster between the two wires of the battery chamber.
 With the motor switch in the central position (OFF), insert the Molex connector, making sure it is positioned correctly.



5



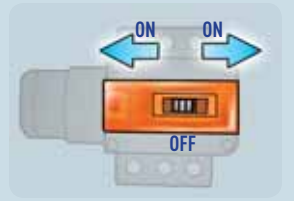
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Technical facts and curiosities

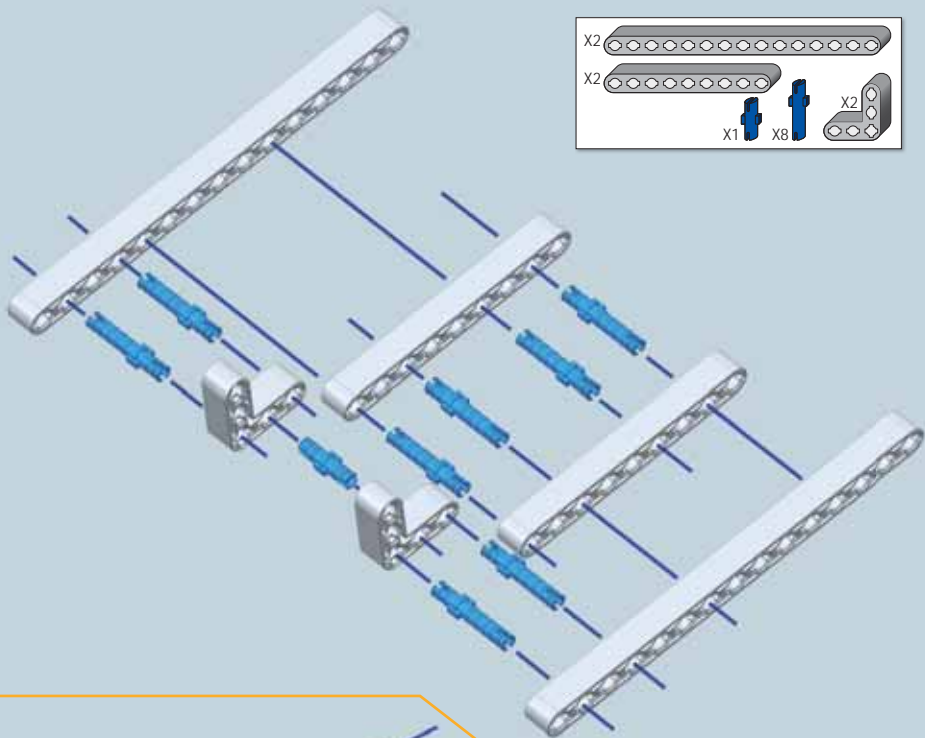
A dragster is a vehicle used in straight-line speed racing. It goes from 0 to 100 km/h in less than half a second. The motion is transmitted directly from the engine to the wheels without the use of a transmission. It has an extremely powerful engine (ten times more powerful than a Formula 1 car) but can only work for short periods of time, consuming hundreds of litres of fuel in just a few seconds.

- **Electric motor switch**
Sliding the switch to the **central position** turns the motor **OFF**
Sliding the switch to the **side positions** turns the motor **ON**

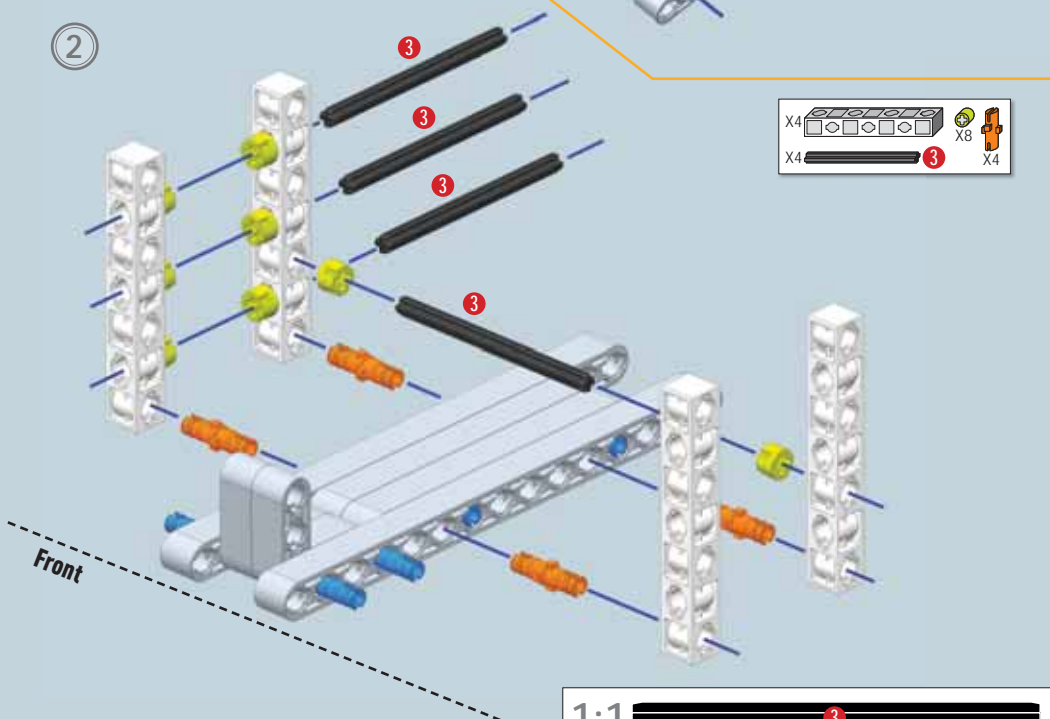


Final assembled model

1

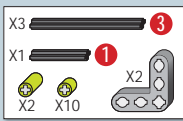


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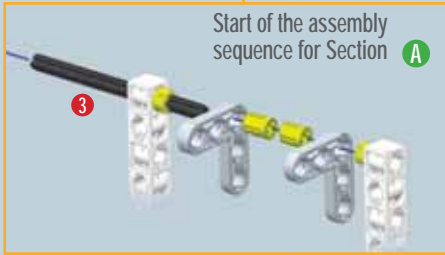
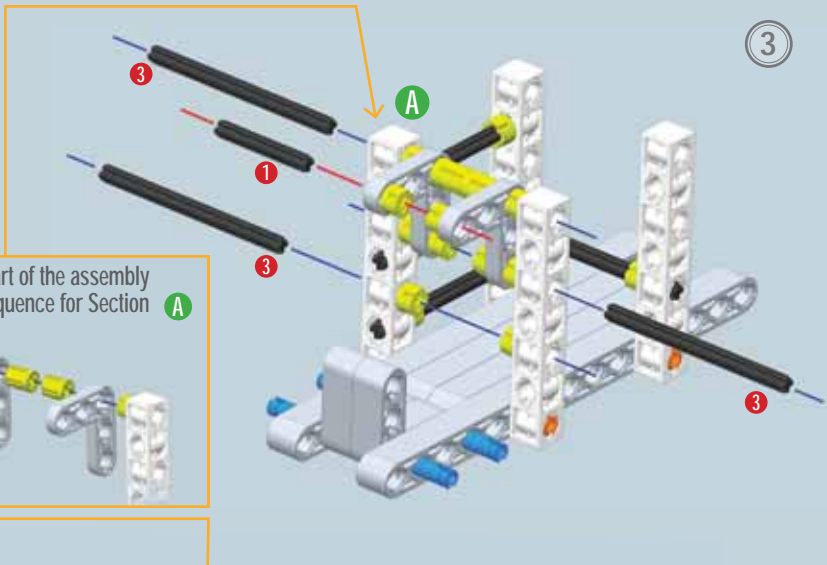


Front

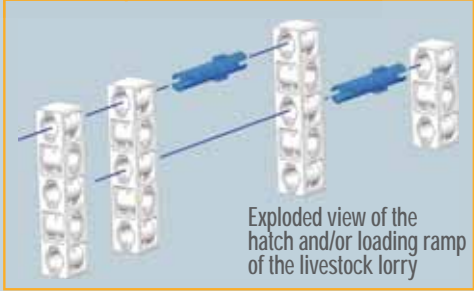
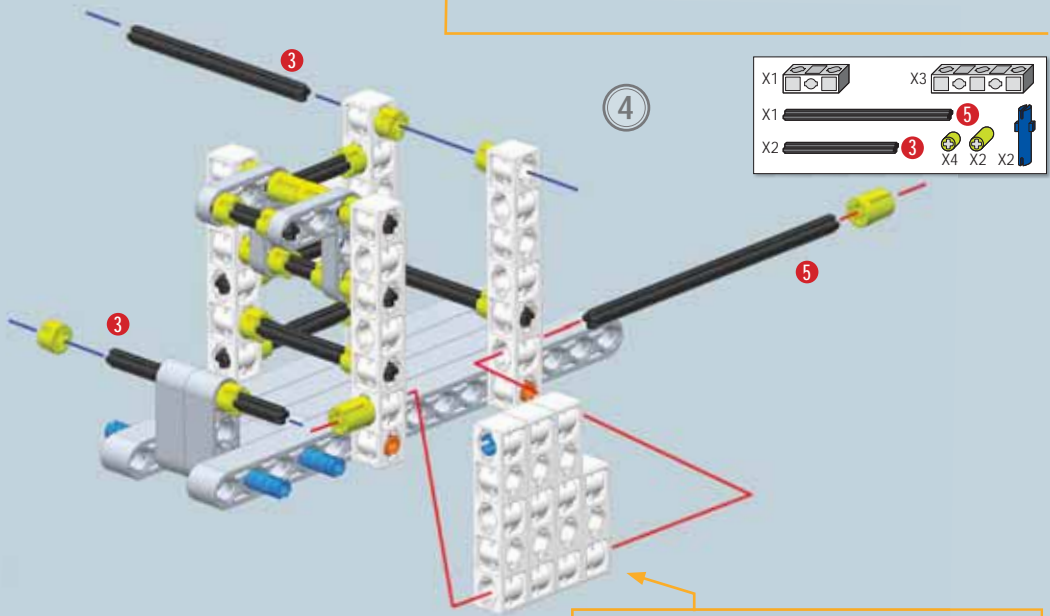
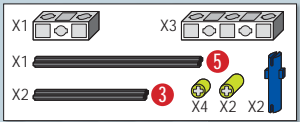




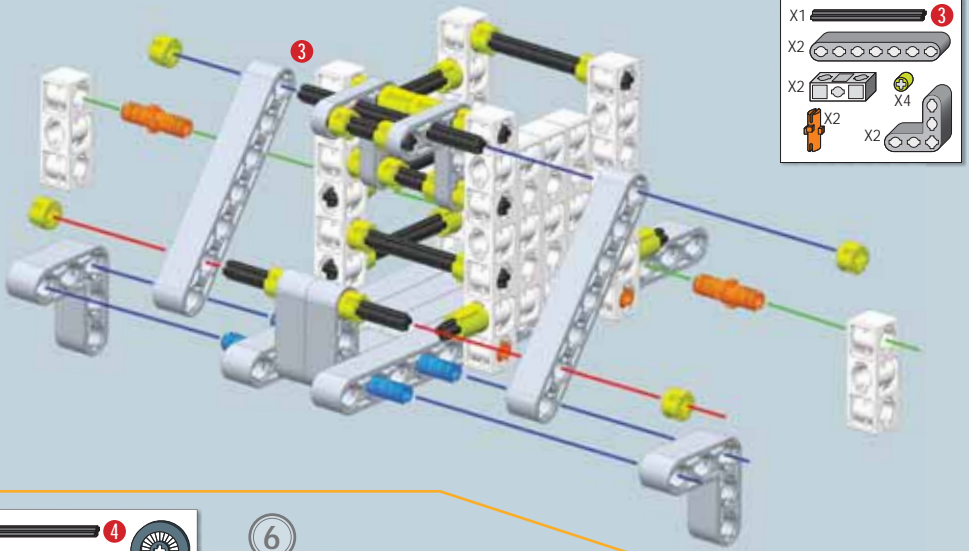
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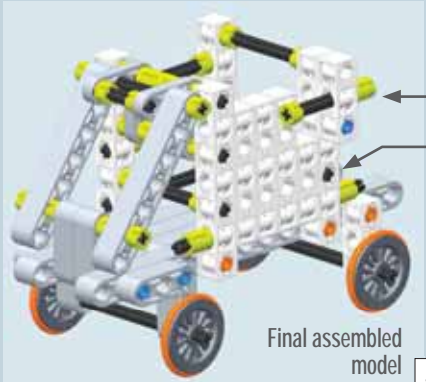
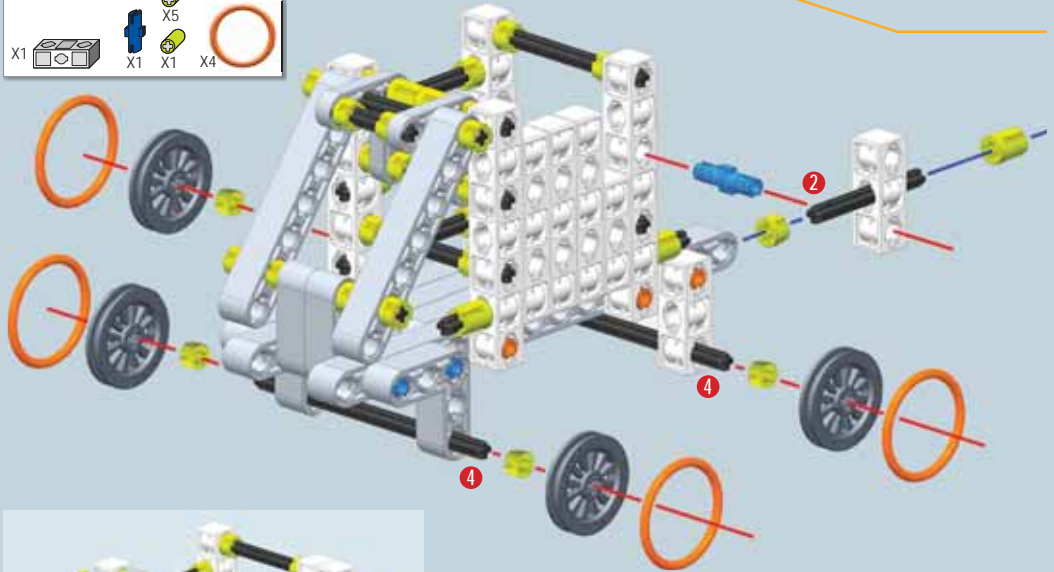
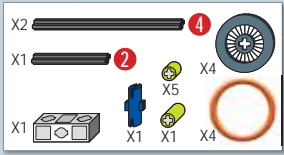
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5



6



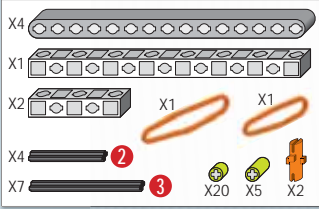
Final assembled model

← Rod for securing the hatch

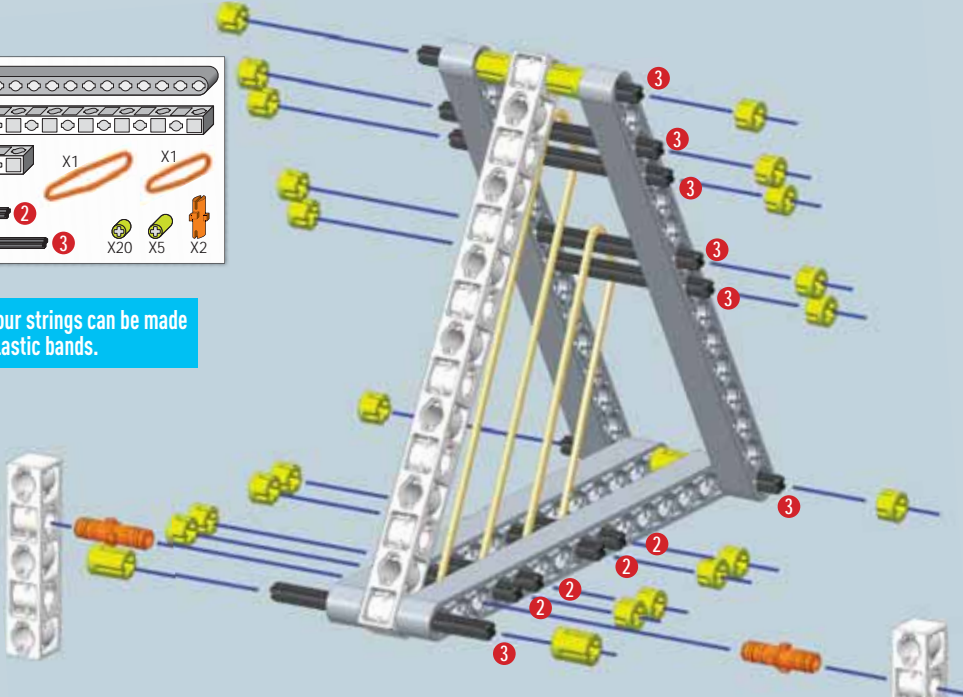
← The hatch is hinged at the base which means it can be converted into a ramp for loading or unloading animals.



50 Play music with a Celtic harp



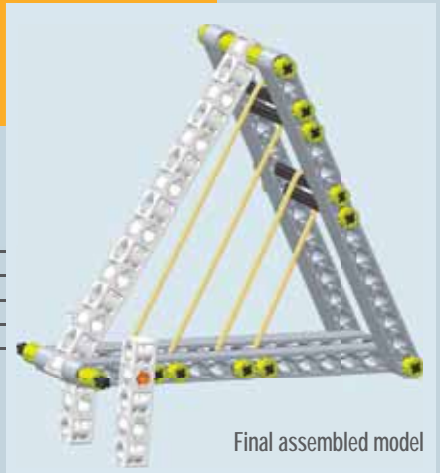
Note how four strings can be made from two elastic bands.



Technical facts and curiosities

When you pluck a harp string with your fingers the air particles start to oscillate, generating sound vibrations in the air. On reaching your ear, these vibrations cross the tympanic membrane and from here travel to the brain, where they are perceived as sound. Sound also travels through liquids and solids. In air, sound travels at about 340 metres a second (m/s), in water it travels at 500 metres a second (m/s), in wood it travels an average of about 3,500 metres a second (m/s) and in iron it travels at over 5,000 metres a second (m/s). Sound does not travel in a vacuum or in space because there is no air.

• Pluck the strings in the order shown



Final assembled model

DID YOU KNOW?

The lever may be one of the oldest machines in the world. In fact, animals such as orang-utans and even birds have been observed using wooden levers to get things done. Ancient peoples used the principle of the lever to do all manner of work. Aboriginal peoples in Australia and the Americas used levers to extend the range and speed of their spears for hunting. Images cut into stone depict people in Egypt using levers to lift water out of a well. This kind of well sweep, or swape, is still used today. It consists of a weight attached to one end of a lever with a bucket at the other end and a fulcrum in between. The lever helps lift the filled bucket from the well. Other ancient images show people using levers for moving heavy objects and fighting wars.

The ancient Greeks didn't just use levers, they figured out what made them work. As you have learned, a small force on the end of a long lever can move a heavy weight. But ancient peoples did not understand forces or weight in a scientific sense. Even the great scientist Aristotle could not figure out that forces create motion. But by studying how levers work, his followers began to come up with the very idea of a force. One of his followers, Archimedes, described the mathematics of how a lever works. Archimedes is best known for shouting, "Eureka!" when he was in the bath. He had an even better quote about a lever: "Give me a lever long enough and a fulcrum on which to place it and I will move the world!" He would need a very long lever indeed.

NATIONAL CURRICULUM COVERAGE

The Mechanics Lab is a great way to explore simple machines as part of the nature of forces at Key Stages 1 and 2 as well as energy changes and transfers at Key Stage 3.

IN THE SCIENCE MUSEUM

Visit the museum's Energy Hall to see how simple levers, gears, and cogs like the ones in your Mechanics Lab gave birth to the Industrial Revolution.

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Read this manual carefully and keep it for future reference.

