Which track is faster?

■ Since we know that forces are involved with all motions, the next experiment attempts to determine whether the path has any influence on the motion.

Set up the model for experiment 2 (acceleration) with the two different track shapes. One track is arched upward and the other downward. When you are through, start the experiment.

Task:
Place a ball at the top of each track. Before releasing the ball consider which track is faster! Now you can release the balls simultaneously. Moreover you can consider why the balls roll to the bottom at all. Here is a tip - the reason is the same as why things fall to the floor.

And - did you bet on the right track?

On the track arched downward the ball is faster than on the track with the upward arch.
Why? Is one track perhaps longer than the other? No - you installed three sections in each. Perhaps it has something to do with the shape of the track? Let's check with the mathematical encyclopedia.

Considered mathematically ...

■ The problem of the fastest track was solved in 1696 by the mathematician Johann Bernoulli and is known in mathematics as the Brachistochrone problem. When he attempted to solve this very complex problem, Bernoulli found out that the fastest of all curves is a track which arches downward, a so-called cycloid or rolling curve. This curve is even faster than a straight line, although this would represent the shortest connection between two points. The rolling curve is called a cycloid, because this curve can be generated by rolling a cylinder along a plane.

CARD 1

Discover Robotics & Programming

5 POINTS

Card 1 Overview

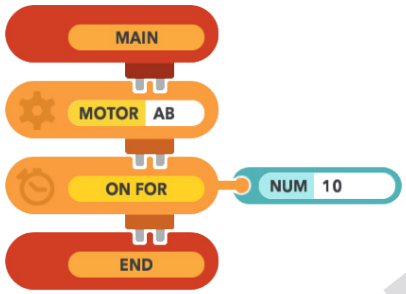
Meet RiQ

A robot must be mechanical, electrical and programmable to be autonomous, meaning it can complete complex tasks on its own. Learn about these three systems by constructing RiQ with The Brain and DC motors from the motor testing station. Being able to turn on the motors is different than being able to direct and control RiQ. After building RiQ, take control of the settings of his DC motors.

P1 Build RiQ

Learn the mechanical components of RiQ the robot using fischertechnik™ building manipulatives. Grab the step-by-step build plans to get started.

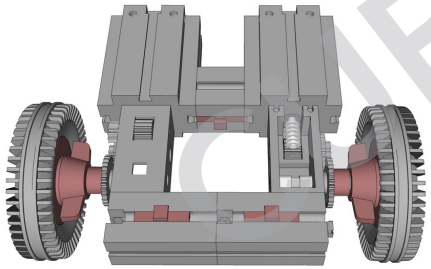
You've used the **ON FOR** before with the motor testing station, now put it into action with a real robot. Build this program in Cortex:



This program tells motors A and B to run for one second.

As before, compile and run the program. Check the progress on the status bar!

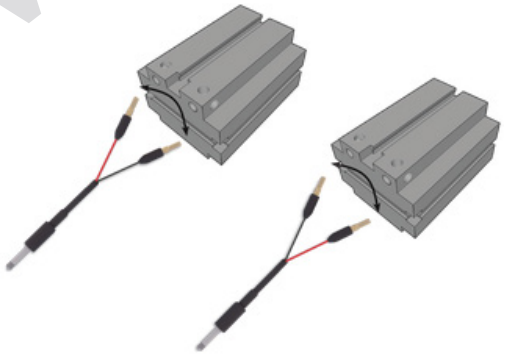
The motors should run for 1 second! If not, check: are the motors connected to Ports A and B?



If set up on the floor, RiQ should either roll forward, backward or spin for 1 second. It all depends on the polarity of the motors.

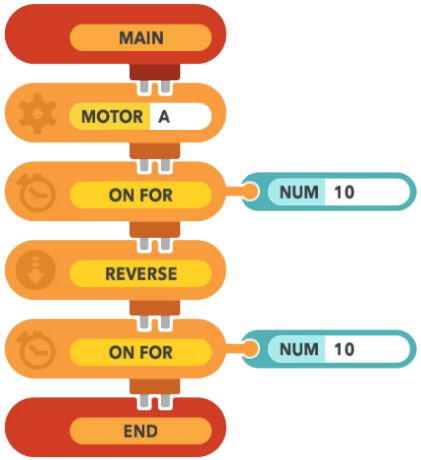
Pick up RiQ to view the underside of the motors. Each one controls a separate wheel.

Switch the red and black cables on a single motor, and run the program again. RiQ should switch between spinning and moving straight.



Change the cables of both motors. Reversing the polarity makes RiQ reverse direction. Set the cables so RiQ drives forward when the program runs.

Cortex can do the same thing with the **REVERSE** command. Add a reverse command to RiQ's program:



This program tells RiQ to go forward for one second, then reverse for another second.

When ready, compile and run the program. Save it for P2.

Look closely at The Brain when this program runs. Watch the LED lights next to each motor port. Remember, green is positive polarity and red is negative polarity.

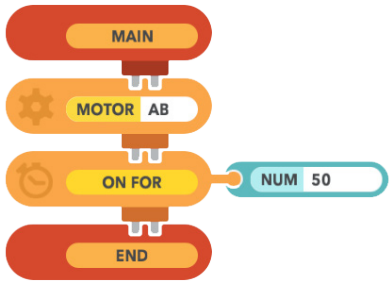
CARD 1

Discover Robotics & Programming

P2 Motor Speed with SET PWR

Not all motors are created equal. Some are stronger, some are weaker and each is at a unique stage of its mechanical life. For RiQ, this makes driving forward a bit of a challenge. Bring in **SET PWR** commands to help him out.

Open the program from P1 and change the duration to 5 seconds.

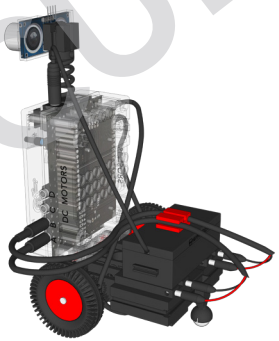


Run the program and watch closely to see which way RiQ turns.

If the right motor is stronger, RiQ turns left. If it's the left that's strong, RiQ goes right.

Check to see which ports your motors are pulled into. (This image shows the left motor in A and the right in B.) Which port is your strongest motor connected to: A or B? Remember this port for the next program.

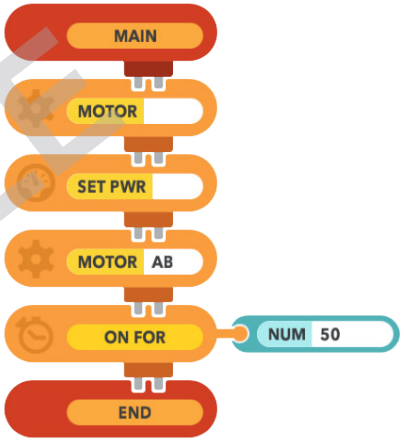
All motors default to 100% power, but 100% power on a weak motor isn't the same as 100% on a strong motor. To make RiQ drive straight, dial down the power on the stronger motor.



Modify your program to set the power of the stronger motor:

Set the power of the stronger motor.

Experiment with the **SET PWR** command until RiQ drives straight. Save the program for C1.



C1 Straight Line

Program RiQ to drive 60 cm in a straight line. Adjust the power on 1 motor and (if needed) the polarity of 1 or both motors to allow RiQ to move as straight as possible.

C2 Circle RiQ

Program RiQ to drive in 1 complete circle with a radius between 15 and 30 cm. RiQ should start and end in the same place.

Hint: Adjust the speed on at least 1 motor.

DP Make RiQ's First Polygon

Now that RiQ can drive perfectly straight and curve, program him to draw (using the pen and holder) a recognizable shape.

Key Terms

- **Polarity** - The direction of current flow. Changing polarity changes the direction of the motors.
- **SET PWR** - Sets power level on selected motors.
- **Radius** - The distance from a center of a circle to the edge.

Check for Understanding

- What is polarity?
- If RiQ's wheels are running in opposite directions, what could you check to make them go the same way?
- What are two ways to make RiQ reverse directions?

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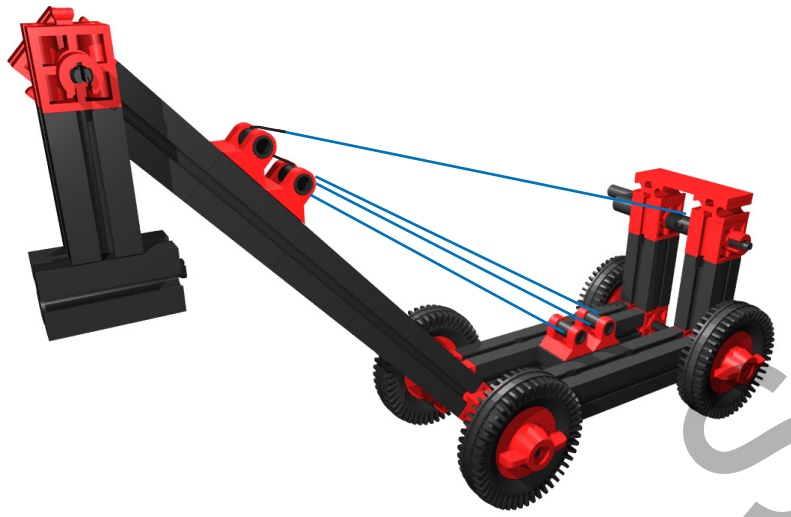
Project #1

PULLEYS

Engineering

Crane



Each step is color coded in order of assembly.

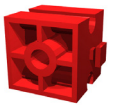
- First
- Second
- Third
- Fourth
- Fifth
- Sixth

Icon Legend

- Set assembly aside.
- Build the number shown.
- Rotate assembly.
- Flip assembly.

Materials you will need:

Building Block 30 (Qty 15)

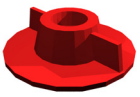


Building Block 15 with Bore (Qty 9)

Building Block 15 with 2 Pins (Qty 2)

Tire 45 (Qty 4)

String (Qty 1)

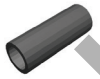


Hub Nut (Qty 4)

Flat Hub Collet (Qty 4)

Clip Axle 30 (Qty 2)

Clip Axle 75 (Qty 2)



Bearing Sleeve (Qty 4)

Axle Coupling (Qty 1)

Clip Axle 45 (Qty 1)

Clip 5 (Qty 3)

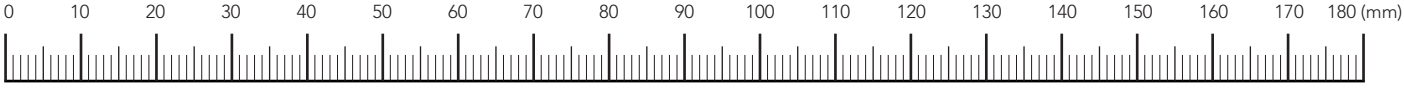
Building Block 7.5 (Qty 2)

Hinged Block Claw (Qty 4)

Crank Shaft (Qty 1)

Spacer Ring (Qty 4)

Mounting Plate 15x45 (Qty 1)



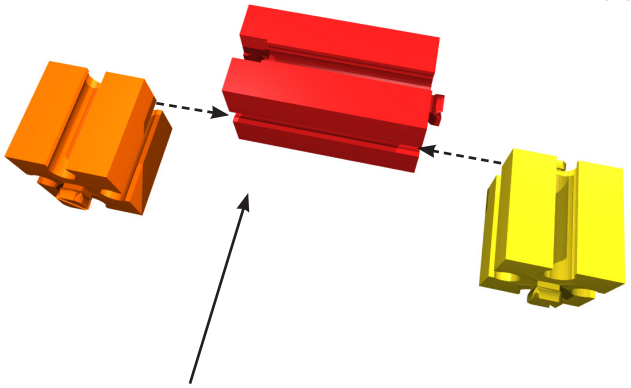
1


x1


x2

Shown in actual color.

Parts shown in color-coded building order.



All steps have an "exploded view" which helps with assembly.

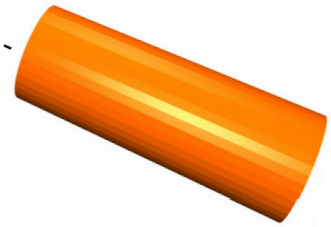
The assembly should look like this before proceeding to the next step.

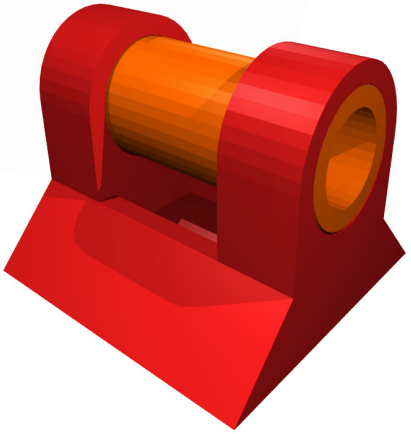
2


x2


x2

Bearing Sleeves can be challenging to insert into Hinged Block Claws. Pressing the Bearing Sleeve against a hard surface may help.





First Second Third Fourth Fifth Sixth

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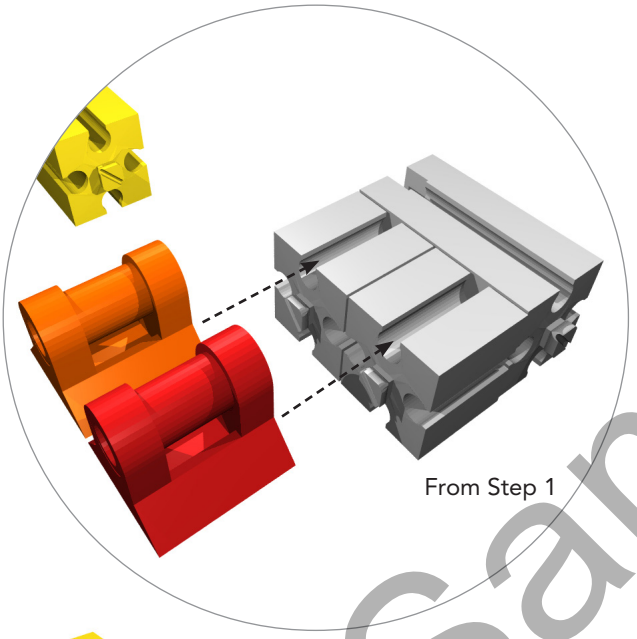
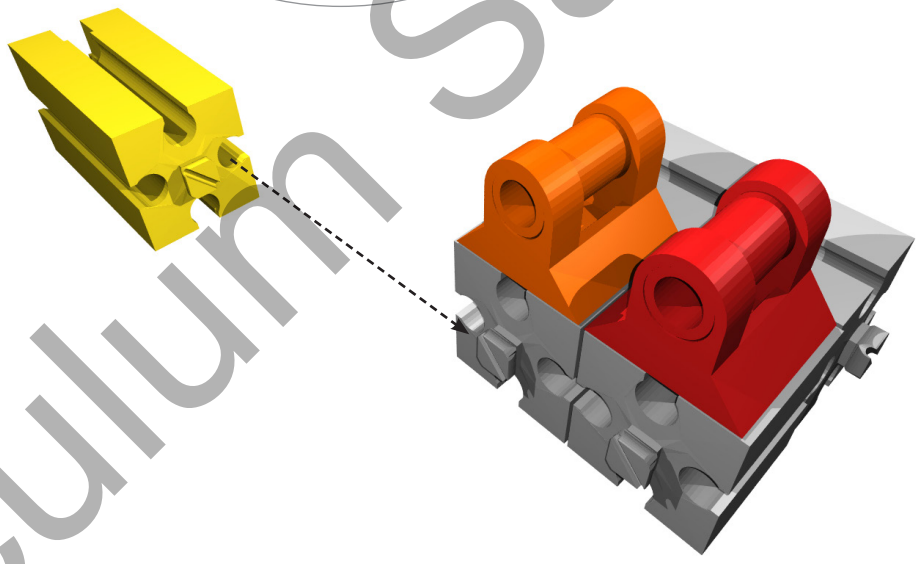
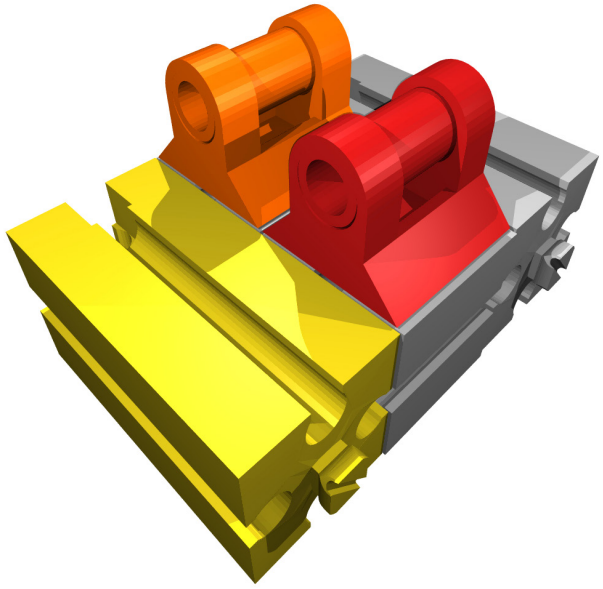
3

x1



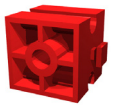


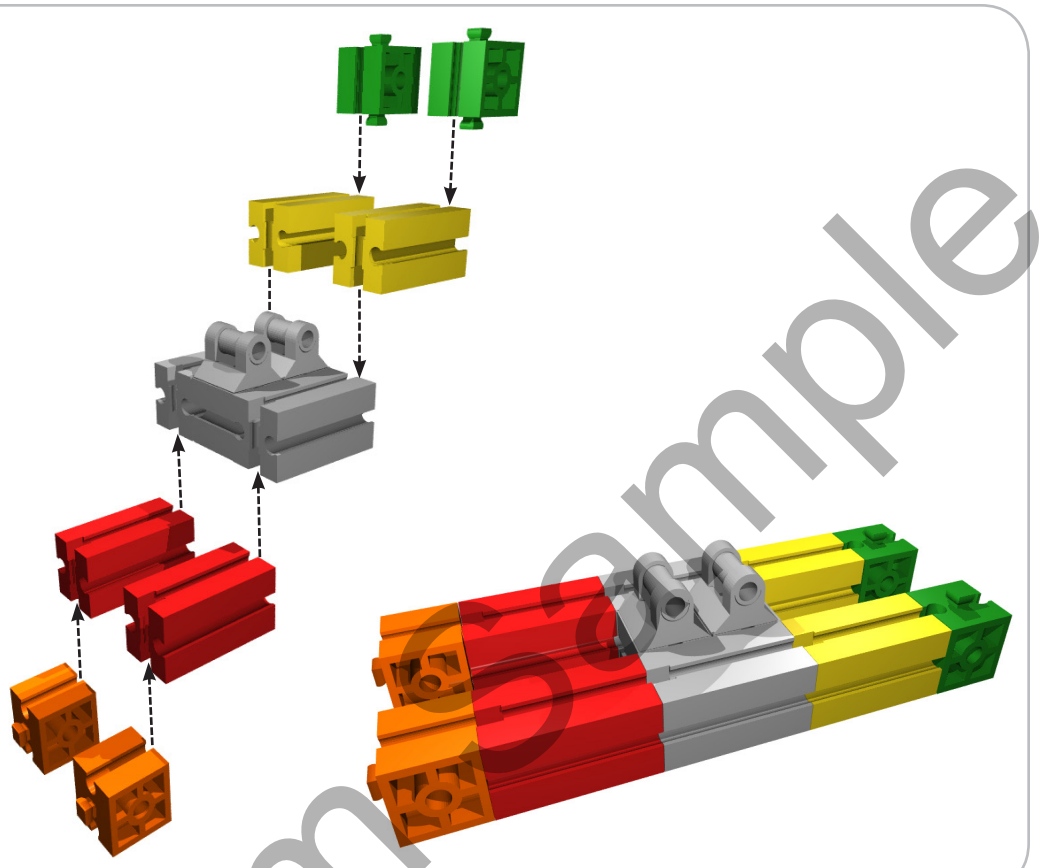


PCS edventures!

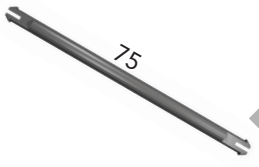
4


x4


x4



5

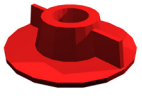


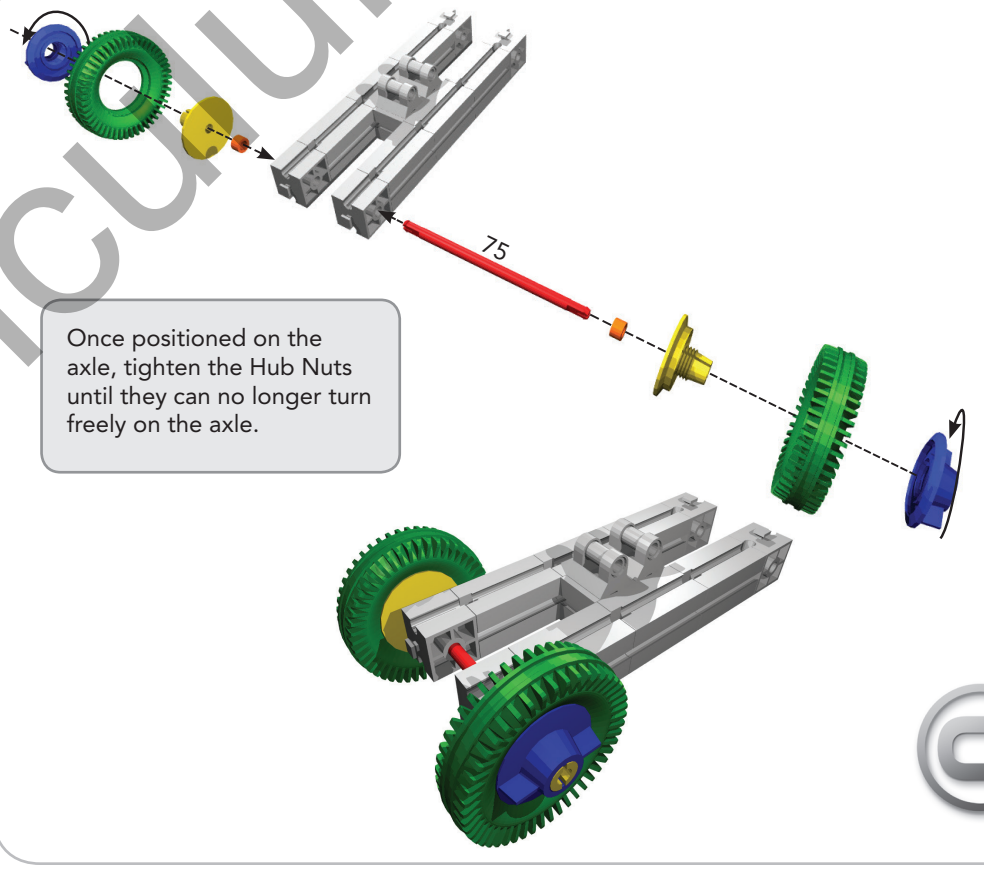
x1


x2


x2


x2

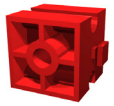

x2

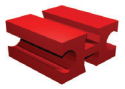


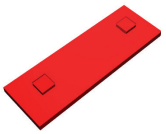
Once positioned on the axle, tighten the Hub Nuts until they can no longer turn freely on the axle.

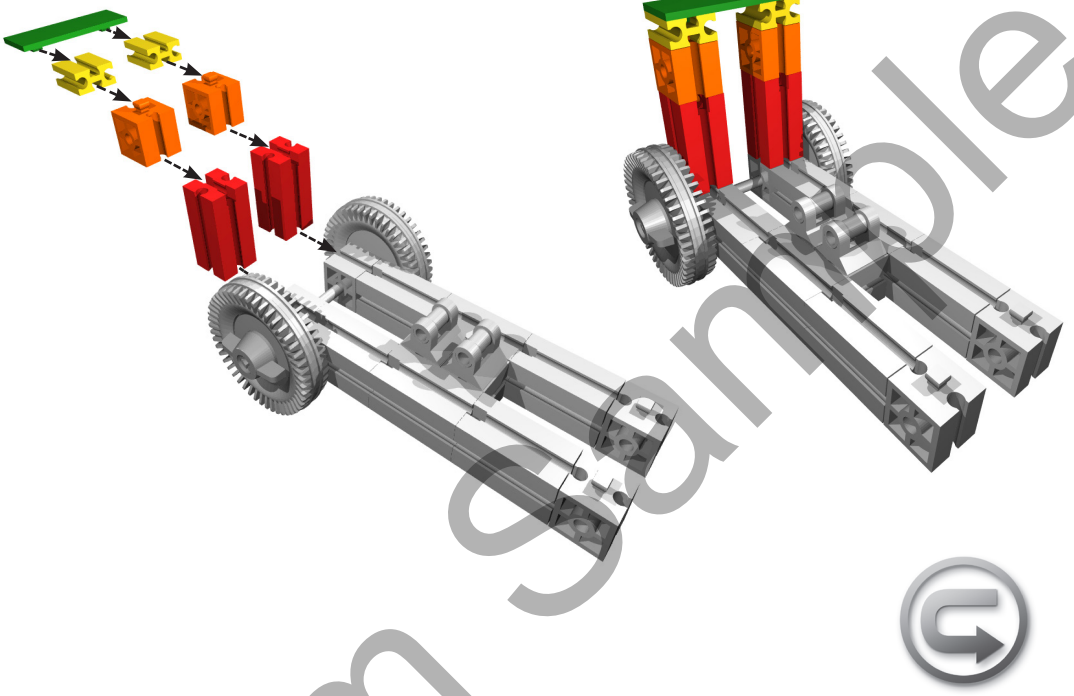
6


x2


x2


x2


x1



7

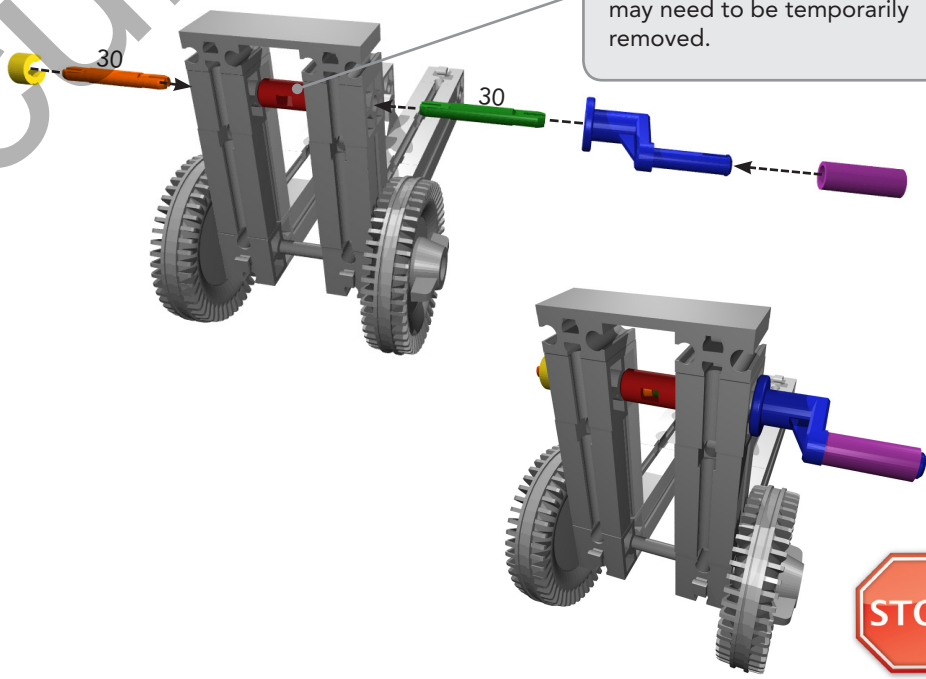

x1

x2


x1

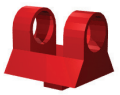

x1


x1

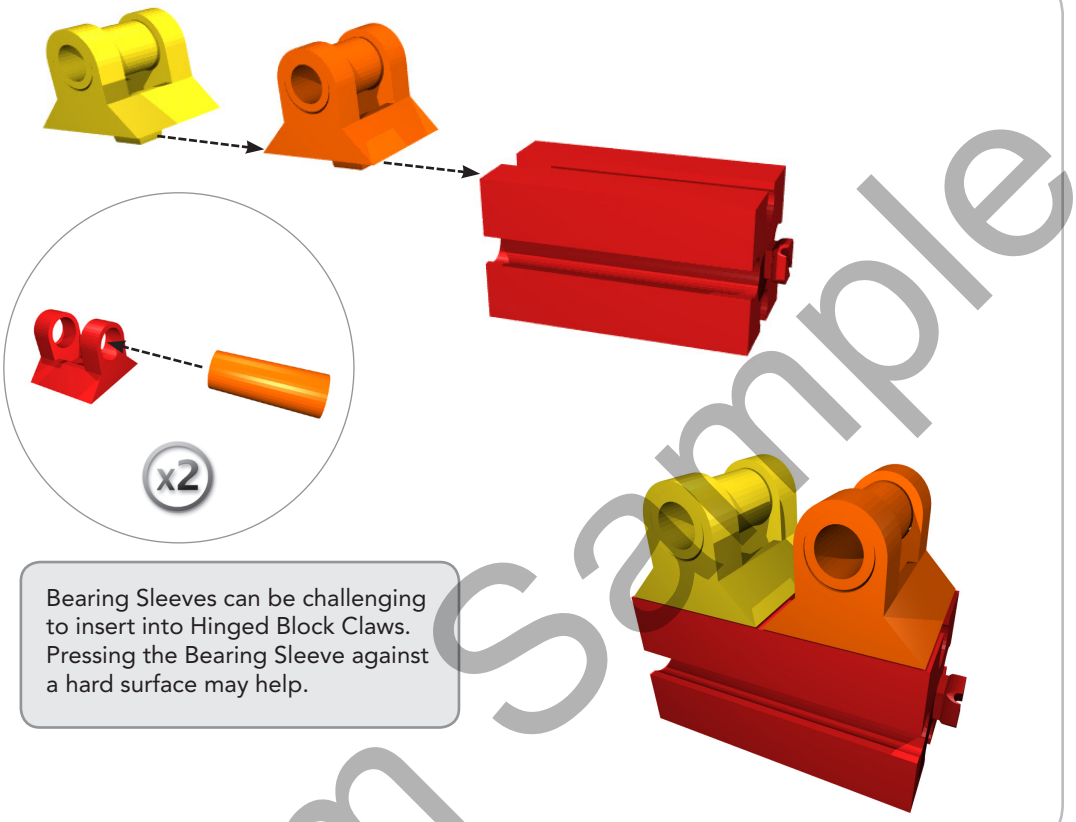


8


x1


x2

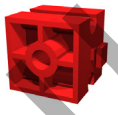

x2

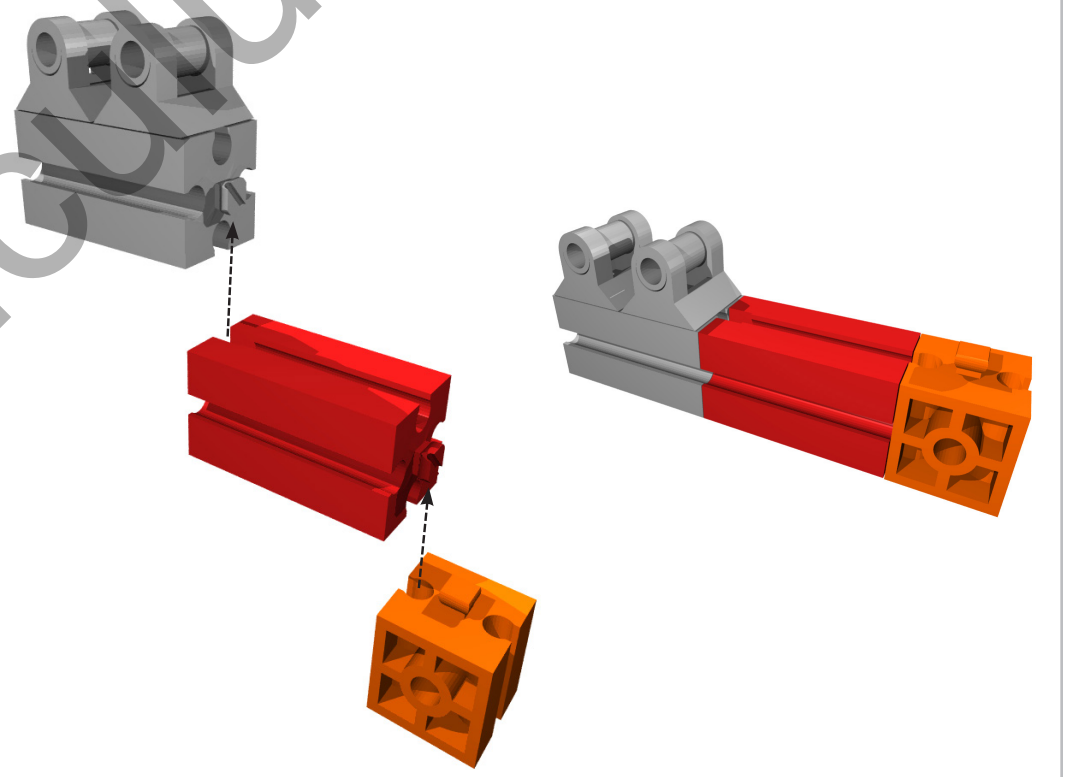


Bearing Sleeves can be challenging to insert into Hinged Block Claws. Pressing the Bearing Sleeve against a hard surface may help.

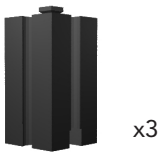
9

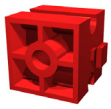

x1

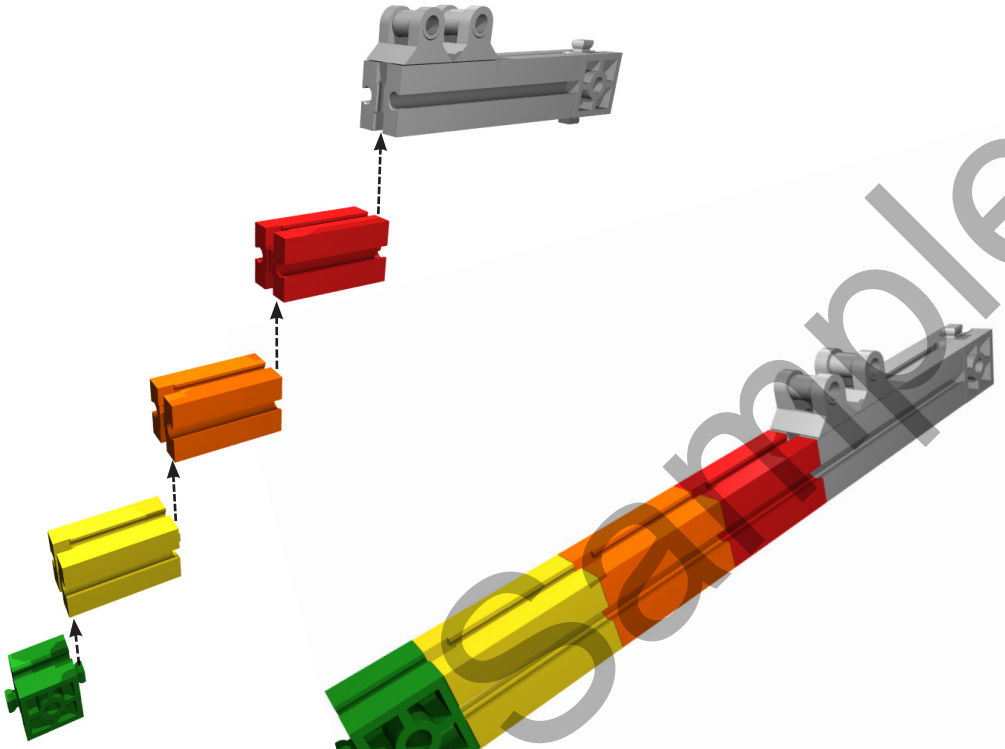

x1



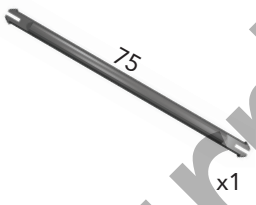
10

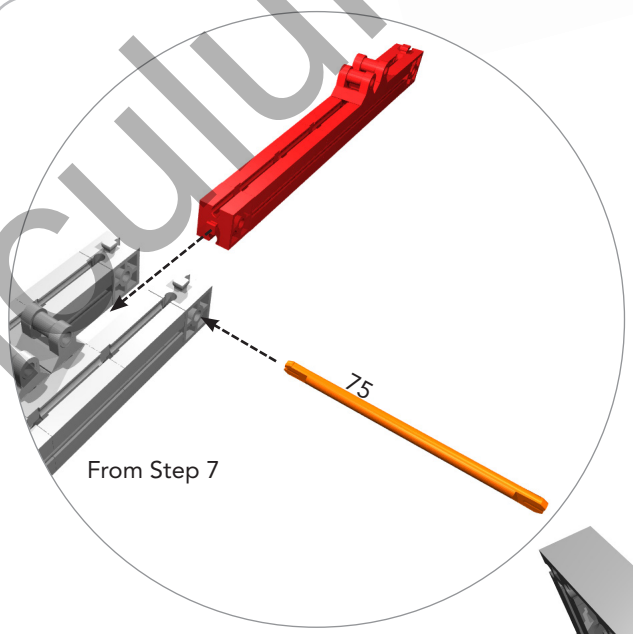


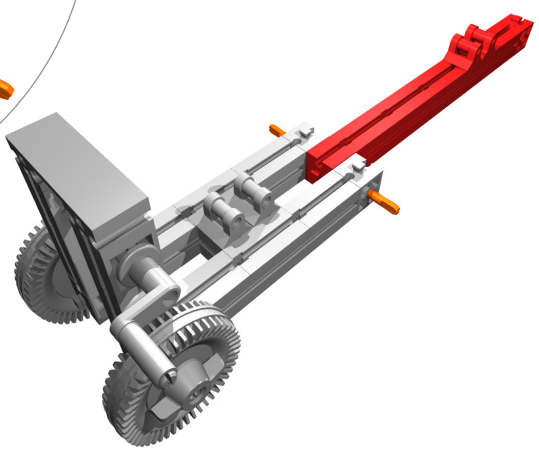




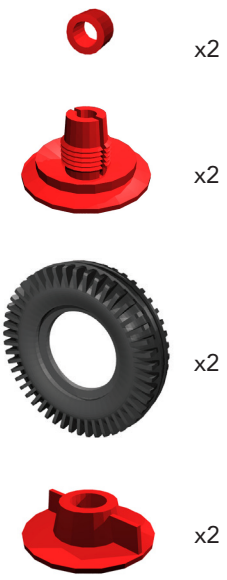
11

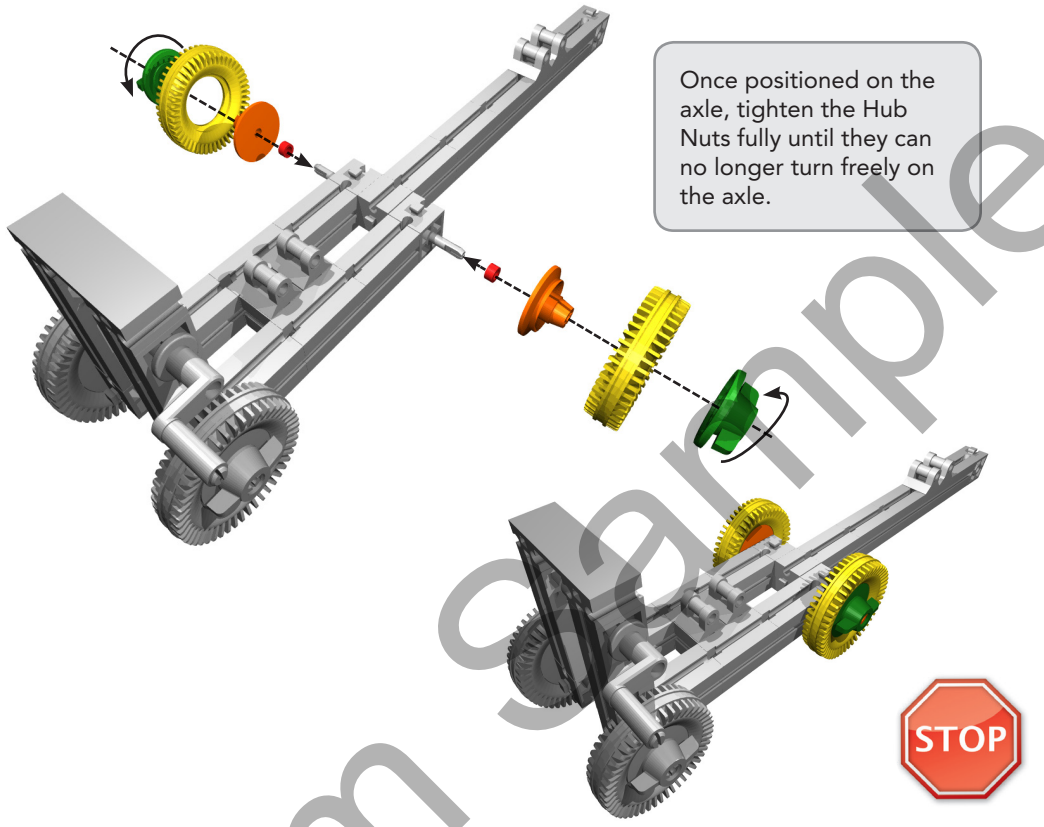






12





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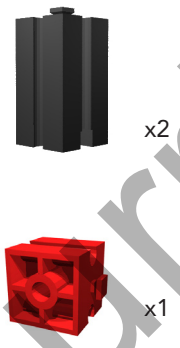
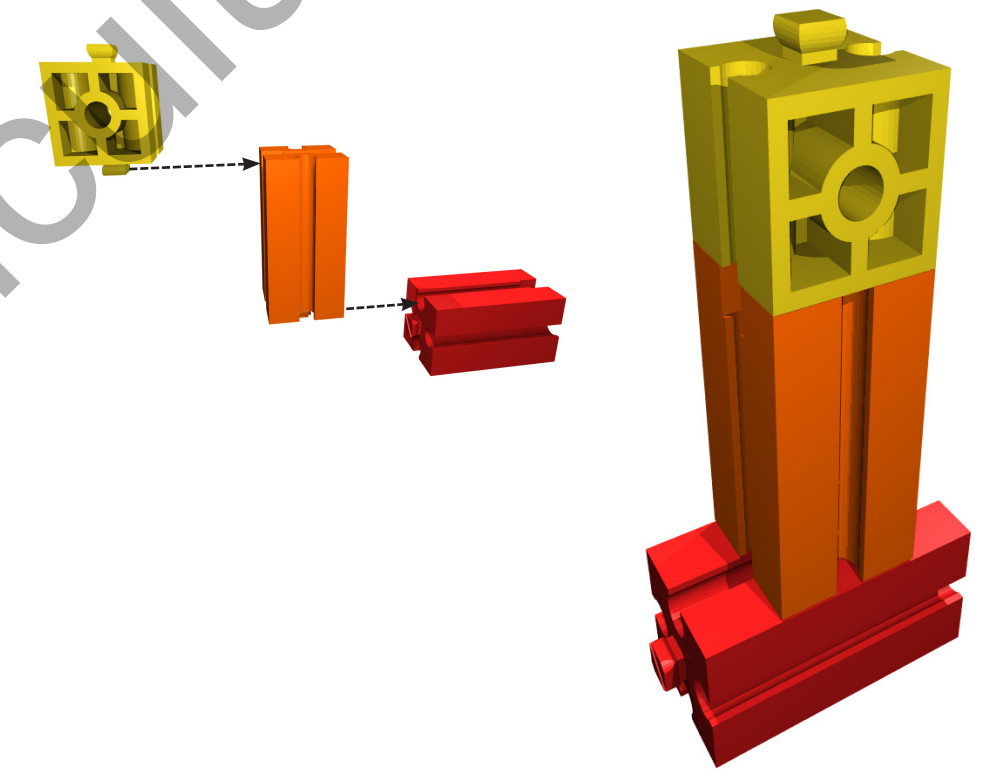
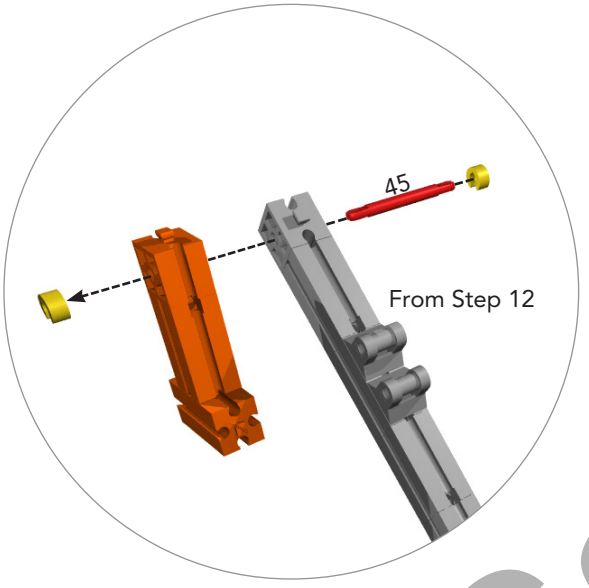




14

x1

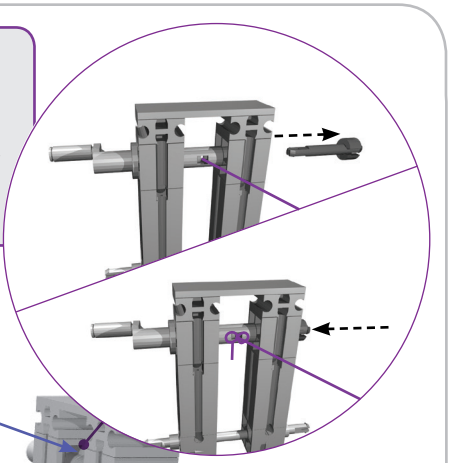
x2

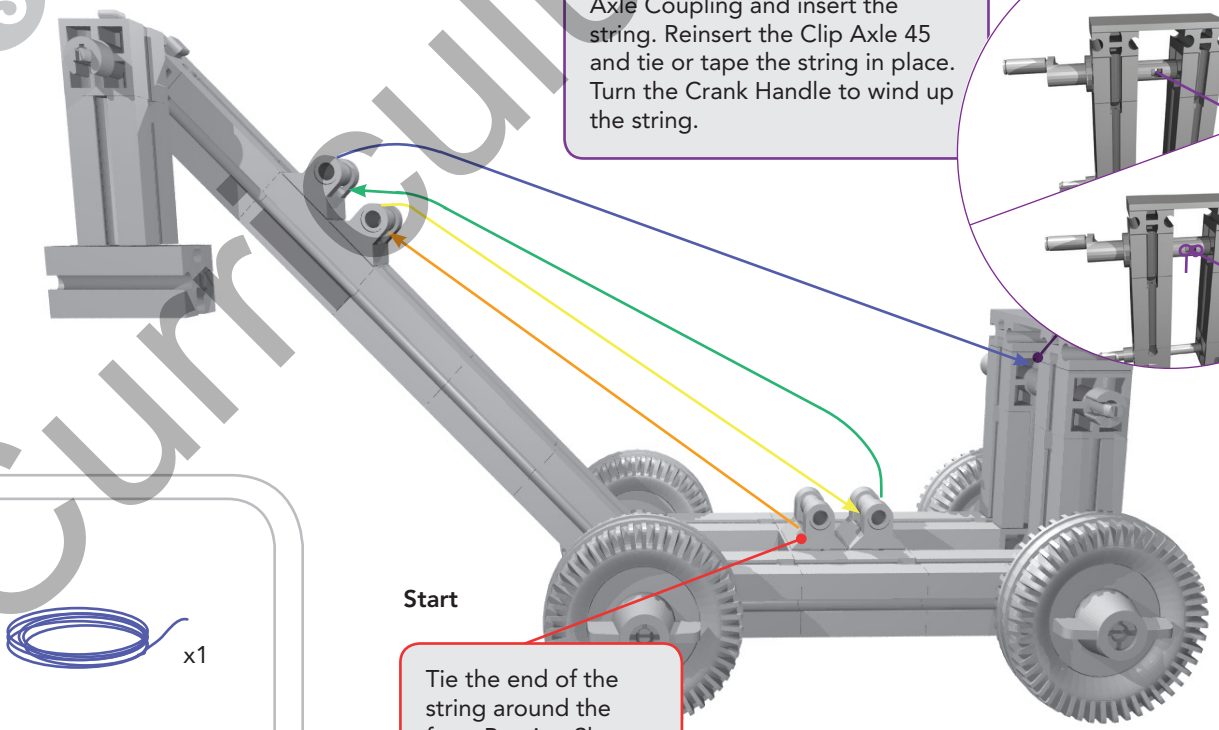


The hook assembly will hang freely.

15

Pull the Clip Axle 45 out of the Axle Coupling and insert the string. Reinsert the Clip Axle 45 and tie or tape the string in place. Turn the Crank Handle to wind up the string.





Start

Tie the end of the string around the front Bearing Sleeve.

x1

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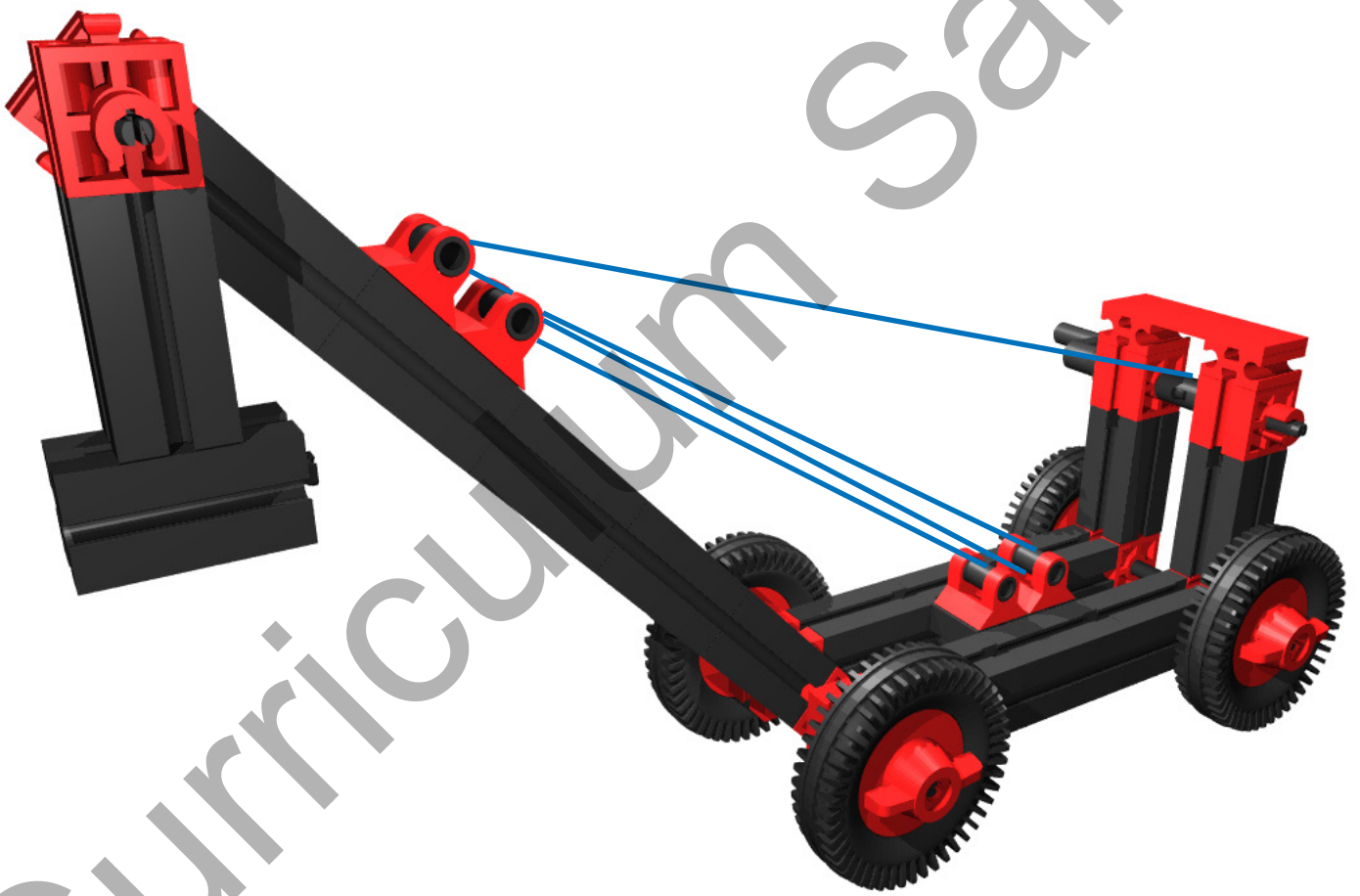
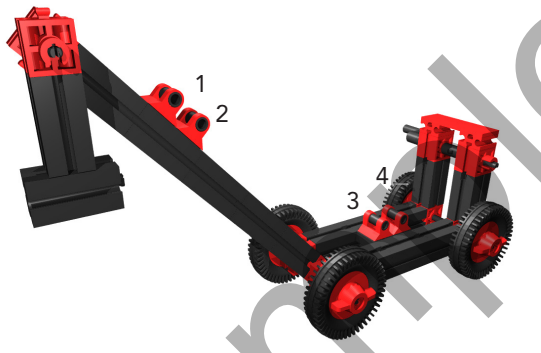
Finished Model

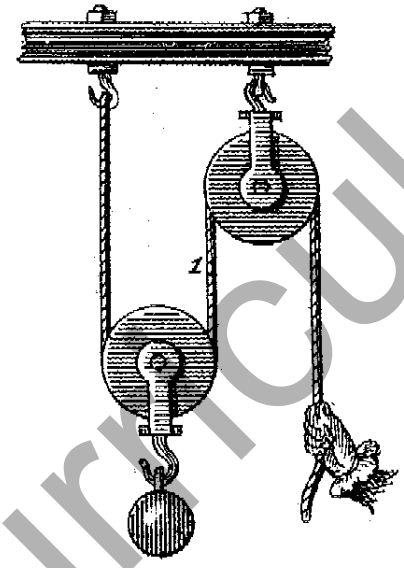


Engineering

A pulley is a simple machine made with a rope or belt wrapped around a grooved wheel. Pulleys are generally used to raise, lower, or move a load. A single pulley only changes the direction of the applied force relative to the load, but the effort required to move the load remains the same. There are four pulleys incorporated in the crane model.



The fischertechnik® crane has three working pulleys. (The fourth pulley is used to anchor the string and isn't classified as a working pulley.) Because the model uses three working pulleys of the same size, the effort required is one-third of what is required if no pulleys are used.



Multiple Pulleys

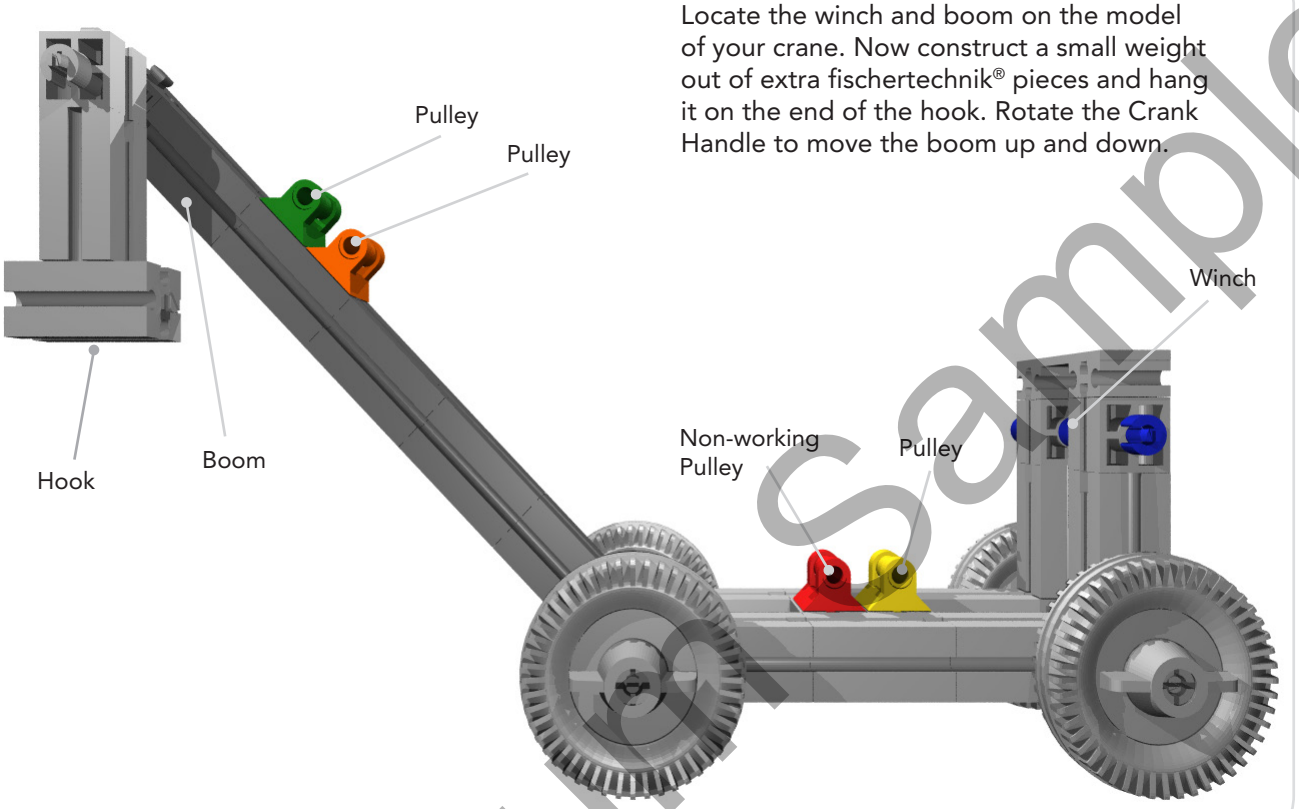
Several pulleys are often used together to reduce the amount of force needed to move a load, as in the crane model. For example, a double pulley system using two working pulleys of the same size would allow an operator to lift a load using half the effort that would be required using a single pulley.

How has it changed the world?

Reflect on how to build anything on a large scale. Large stone blocks or other building materials are lifted using cranes to construct today's impressive skyscrapers, such as the Burj Khalifa in Dubai, which stands at 160 stories high.

Even in ancient times the use of pulley systems on ships allowed heavy cargo to be lifted, moved, and transported to other countries. This same use applies to loading freight train cars, freight trucks, and large ships. Other pulley systems include a conveyor belt, car engine, flag pole, and block and tackle.

Try This



Locate the winch and boom on the model of your crane. Now construct a small weight out of extra fischertechnik® pieces and hang it on the end of the hook. Rotate the Crank Handle to move the boom up and down.

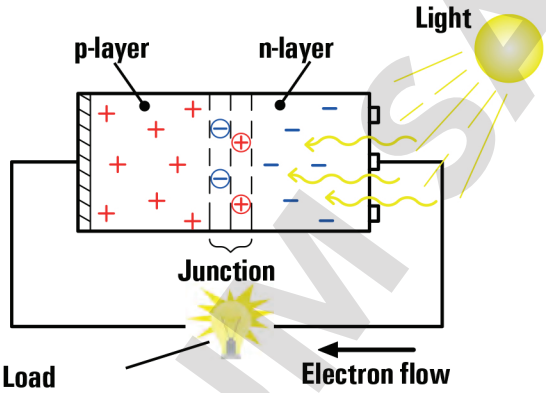
Now, remove the string from the pulleys and attach it directly from the end of the boom to the winch (a mechanical device used to pull or tighten a rope) and repeat the experiment.

1. Which of the two experiments is easier? Why?

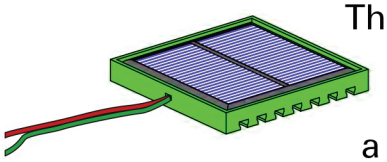
2. How could you add more pulleys? What changes would need to be made to the model?

In simple terms, the electric current is produced by electrons from the n-layer, excited by the incidental light, moving through the connected load (e.g. solar motor) to the p-layer. The more light (that is energy) that falls on the cell, the more mobile the electrons become.

When a solar cell is connected to a load, the electrons tend to move in this direction. You can imagine the current flow as being like a cycle with electrons constantly arriving at the n-layer and then traveling back to the p-layer. This flow of electrons causes electric current to flow and the motor rotates.



Solar models with solar module



The solar module used in the PROFI Solar Power Construction Set consists of four solar cells connected in series. It supplies 2 V voltage and a maximum current of 200 mA. The solar motor has a nominal voltage of 2 V, but starts to turn at 0.3 V (at idle, that is, without the motor's shaft having to drive a model).

Build the ventilating fan model for the first two experiments (see assembly instructions).

Experiment 1:

Determine the brightness required to turn the motor. You can use a lamp with bulb to do this. Test the experimental setup outdoors in the sunshine too.