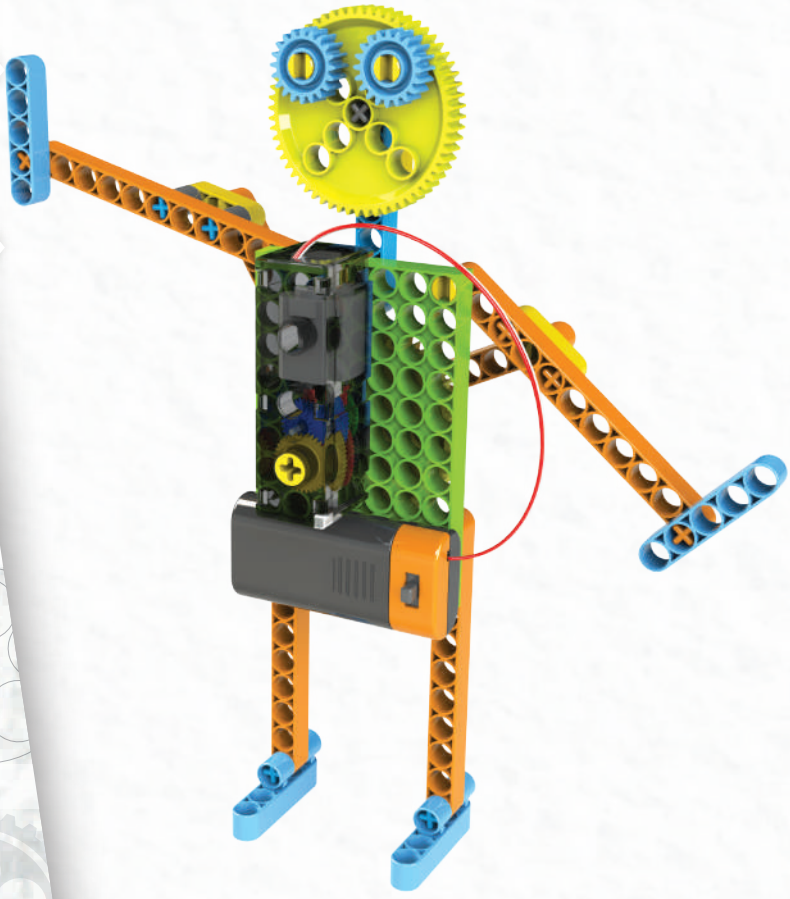
Blix ROBOTIX

DISCOVERING MOTIONS

QUICK CONSTRUCTION

POWER SCREW MECHANISM

GEAR SYSTEM



STEM.ORG ACCREDITED™ EDUCATIONAL EXPERIENCE

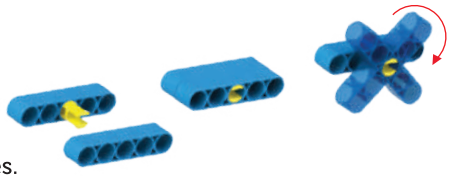
Name: _____

Class: _____

Call: _____

HOW TO CONSTRUCT

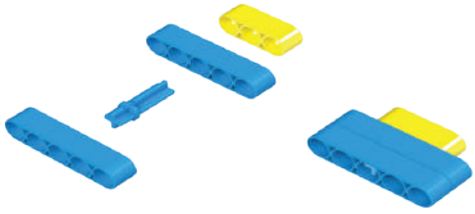
I - CL2 - Use this connector to loosely connect 2 pieces.



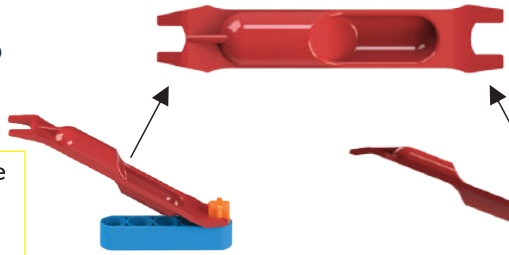
II - CT2 - Use this connector to attach 2 pieces.

III - CT3 - Use this connector to attach 3 pieces.

During assembly ensure position of collar is same as in the image in manual.



How to dismantle

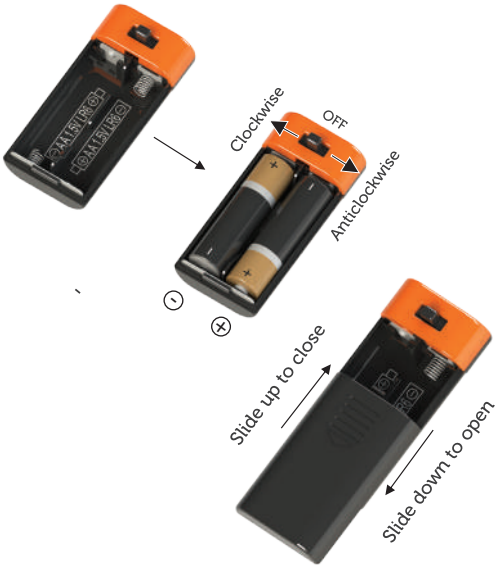


- Narrow edge to remove connectors
- Fit the tool into narrow side of connector collar

- Broad edge to split two pieces

Safety Guidelines

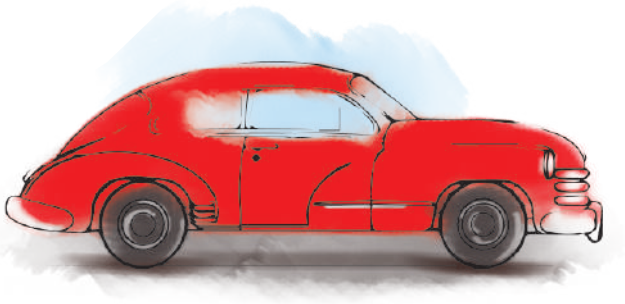
1. Do not mix old and new batteries.
2. Do not mix alkaline, standard (Carbon-Zinc) or rechargeable (Nickel-Cadmium) batteries.
3. Batteries are to be inserted by matching (+) and (-) polarity markings as shown in the image.
4. Non-rechargeable batteries are not to be charged.
5. Rechargeable batteries are to be removed before being charged.
6. Exhausted batteries are to be removed from toy.
7. The supply terminals are not to be short- circuited.
8. The kit is not intended for children under 3 years old.
9. Remove batteries before cleaning any part of the toy.
10. Prevent wire from coming in contact with the moving parts.

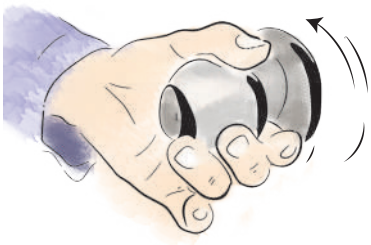


Add 2 x 1.5 V "AA" size batteries

Introduction

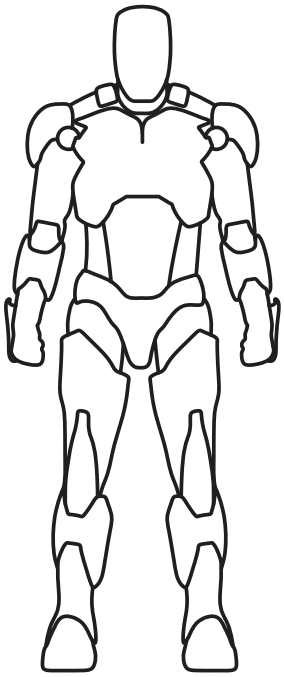
Hello creators!
Why are we focusing so much on motion? Why is it important?
You must observe many machines and objects, move in certain ways to make your life easier and fun. For example, a car has wheels that go round and round so that the car can move forward and take you from one place to another.





> Every machine, including your own human body, can move in many different ways that help you perform different tasks. Just look at your hands, your wrists and fingers move in such a way, that you can rotate a knob, dribble a basketball, wave to somebody, hold a pencil and write, and a lot more.

> Can you imagine any other machine that can do so many wonderful things? Difficult, right? That is why we need to understand motion because to really become a creator, you need to understand how to create the motions that are required to do a job.

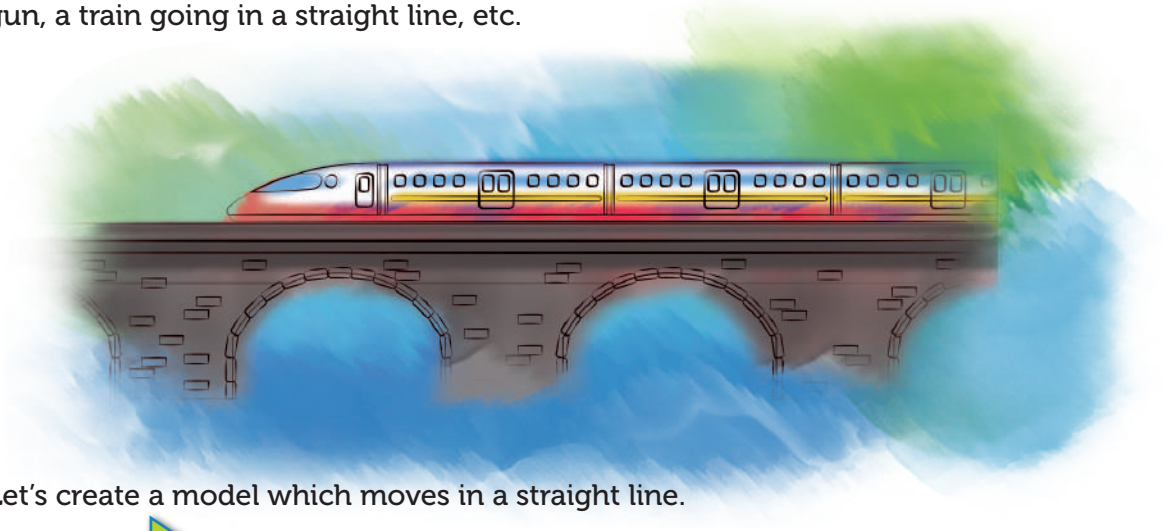


MOTIONS:

For easy understanding, motion is classified into different types. Let's have a look at each one of them.

1. Rectilinear Motion:

This is the type of motion that takes place in a straight line. Like a bullet shot from a gun, a train going in a straight line, etc.



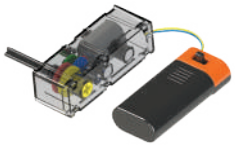
Let's create a model which moves in a straight line.

Basic Car

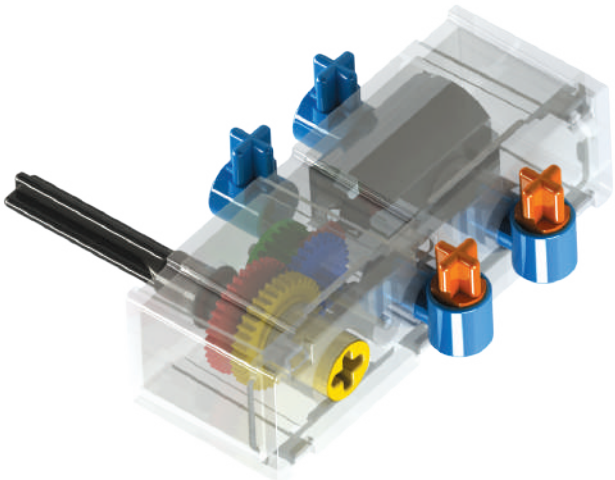
Step 1

CT2	2 pcs.

CH2	4 pcs.



Motor with Battery Box 1 pc.

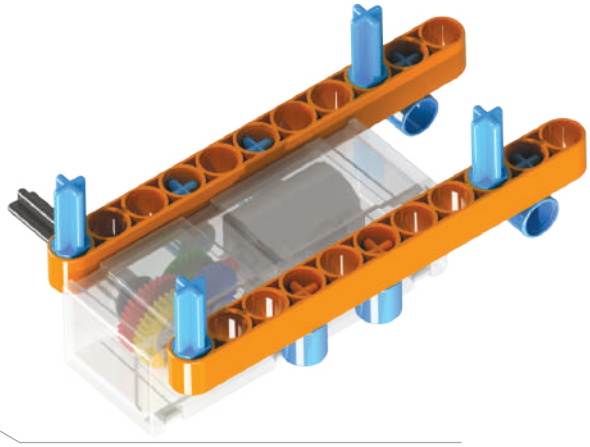


Step 2

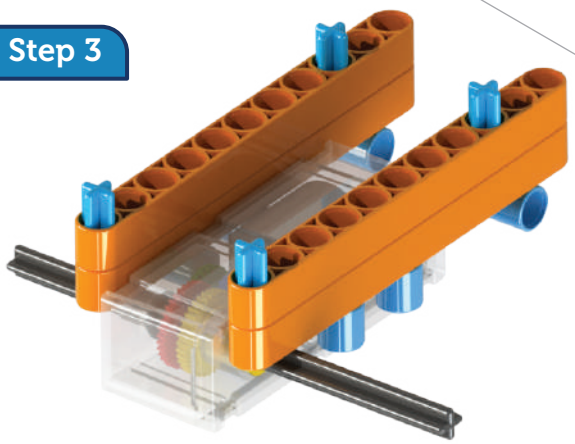
CT3 | 4 pcs.

CH2 | 2 pcs.

P11 | 2 pcs.



Step 3



P11 | 2 pcs.

SH60 | 1 pc.

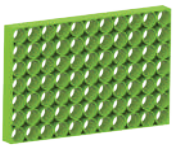
use 2-2 TW1 for front axle
use 1-1 TW1 for rear axle

Step 4

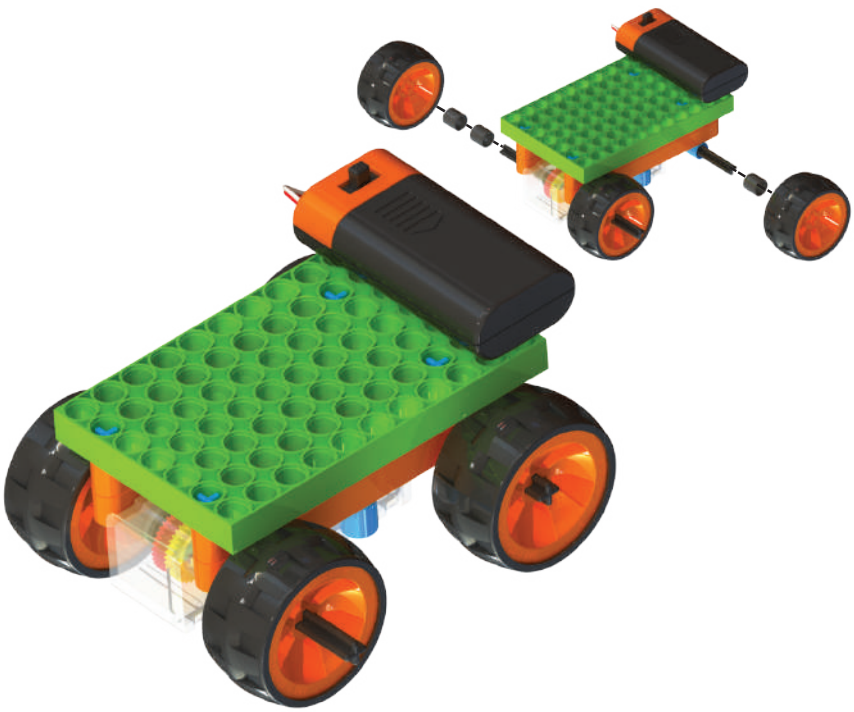
TW1 | 6 pcs.

SH100 | 1 pc.

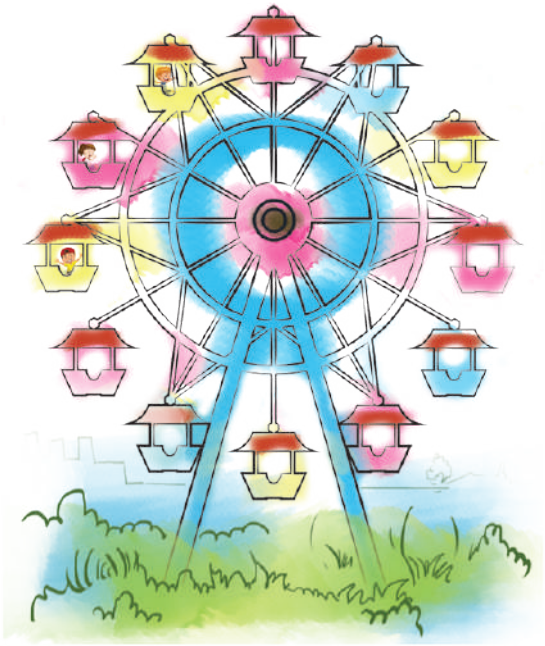
Wheels | 4 pcs.

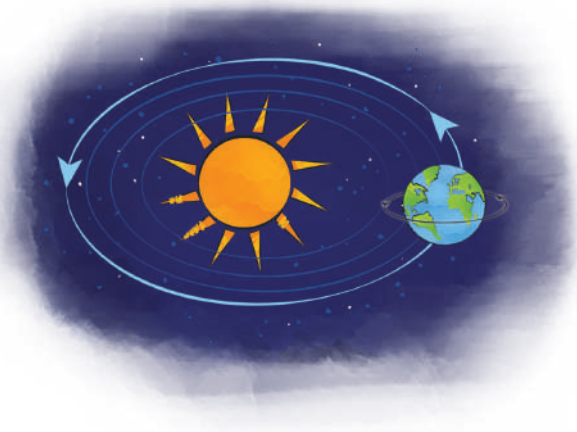


P7 X 11 | 1 pc.



2. Circular Motion:





> When an object moves in a circular path, we call it circular motion. Like the earth going around the sun, or yourself moving in a giant wheel.

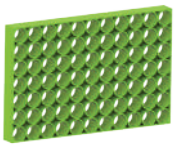
Let's create a model that moves in a circular path.

Giant Wheel

Step 1

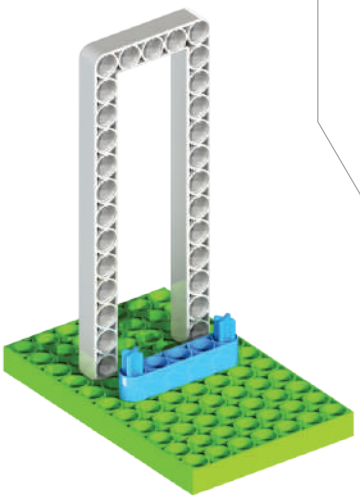
CT3 | 2 pcs.

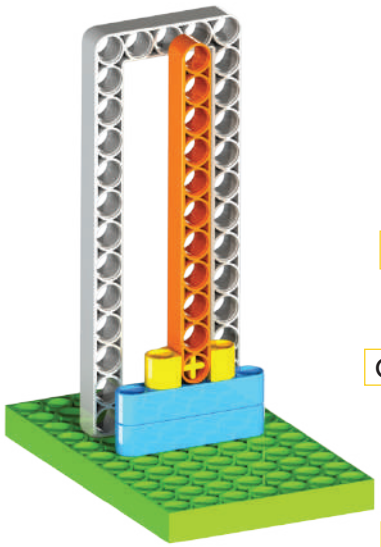
P5 | 1 pcs



P7 X 11 | 1 pc.

PU5 X 13 | 1 pc.





Step 2

PC3 | 1 pc.

CT2 | 2 pcs.

P5 | 1 pcs

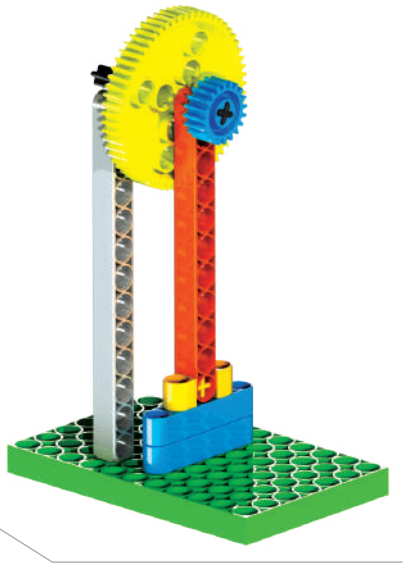
P11 | 1 pc.

Step 3

G(20) 1 pc.

SH60 1 pc.

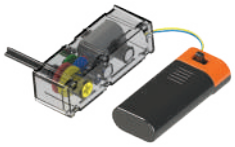
G(60) 1 pc.



Step 4

Turn the Model

G(20) 1 pc.



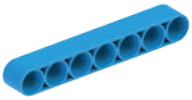
Motor with Battery Box 1 pc.

Step 5

G(60) 1 pc.

Step 6

CT2	8 pcs.



P7	4 pcs.

Step 7

P3	4 pcs.

CL2	4 pcs.

Step 8

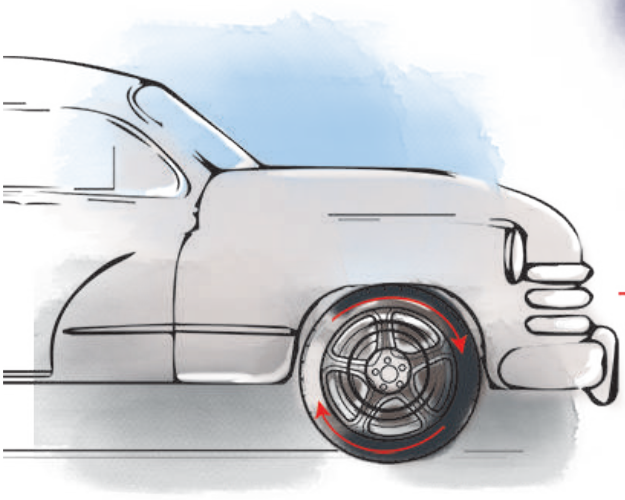
CT2	4 pcs.

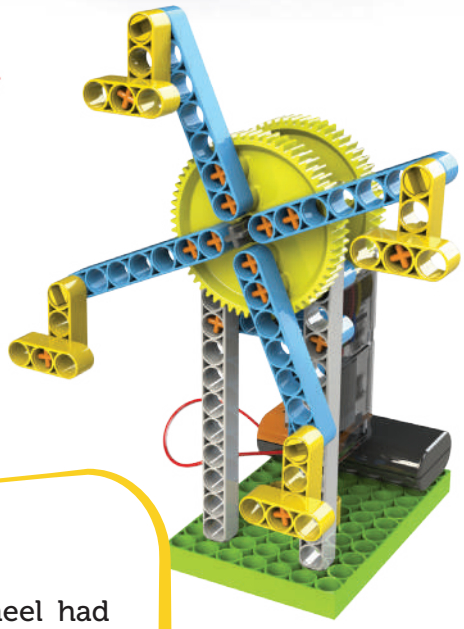
P3	4 pcs.

*Do not dismantle your giant wheel just yet; we will use it in the next segment.

3. Rotational Motion

This is a little different from circular motion because, in rotational motion, a body rotates around its own self. Like the earth rotating around its own axis, or a wheel on a car.



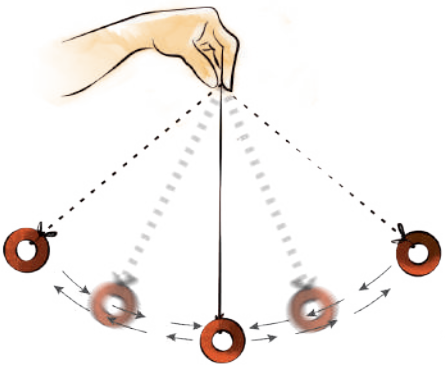


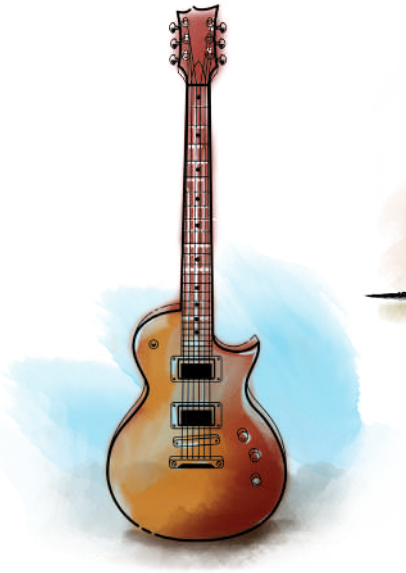
In the last model, each seat in the giant wheel had circular motion around the center of the giant wheel. But if you consider the motion of the Yellow gear, it rotates around its own axis. This is called **rotational motion**.

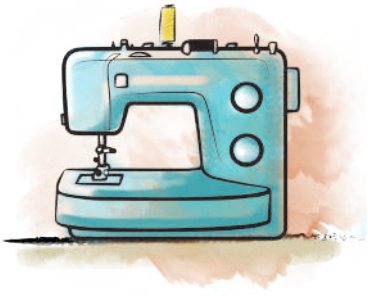
You might notice that we used the earth as an example in both rotational and circular motion because it has both! It rotates around itself, which gives us day and night and it also revolves around the sun which gives us seasons.

4. Periodic Motion

The motion that repeats itself at regular intervals of time is called periodic motion. You might have seen this happening in a clock pendulum, which moves side to side in regular periods of time. Or the string of a guitar, that vibrates quickly at regular intervals to give you music.







Let's create a SWING which will have a periodic motion.

A - Swing

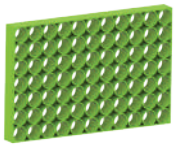
Step 1

CT2	6 pcs.

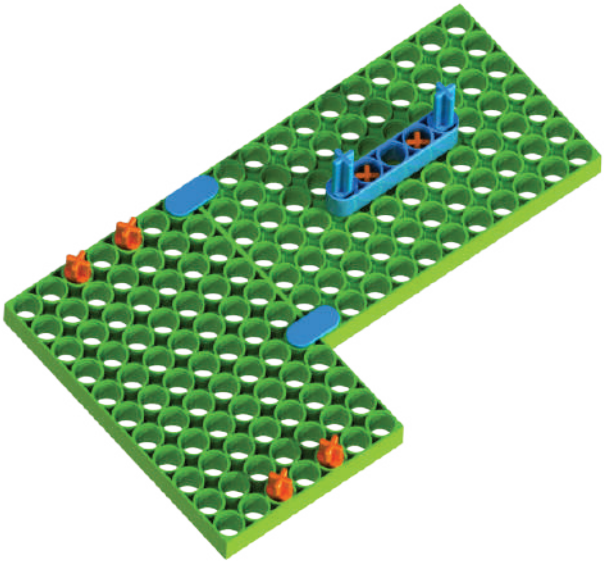
CT3	2 pcs.

CT(1x2)	2 pcs.

P5	1 pc.



P7 X 11	2 pcs.



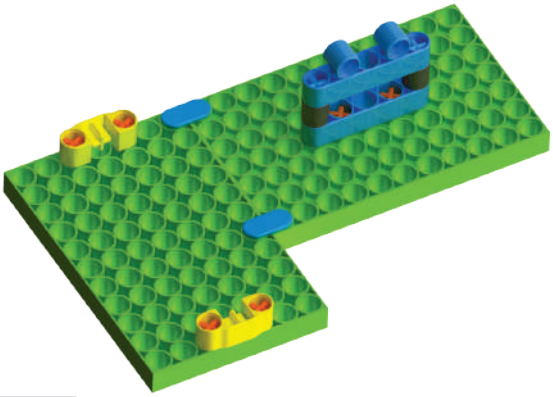
Step 2

TW1 | 2 pcs.

CH2 | 2 pcs.

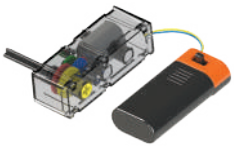
PC3 | 2 pcs.

P5 | 1 pc.

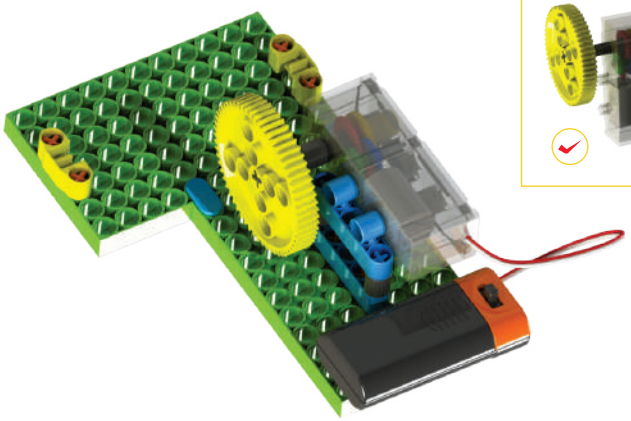


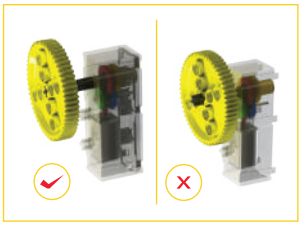
Step 3

G(60) | 1 pc.



Motor with Battery Box 1 pc.

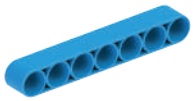




Step 4

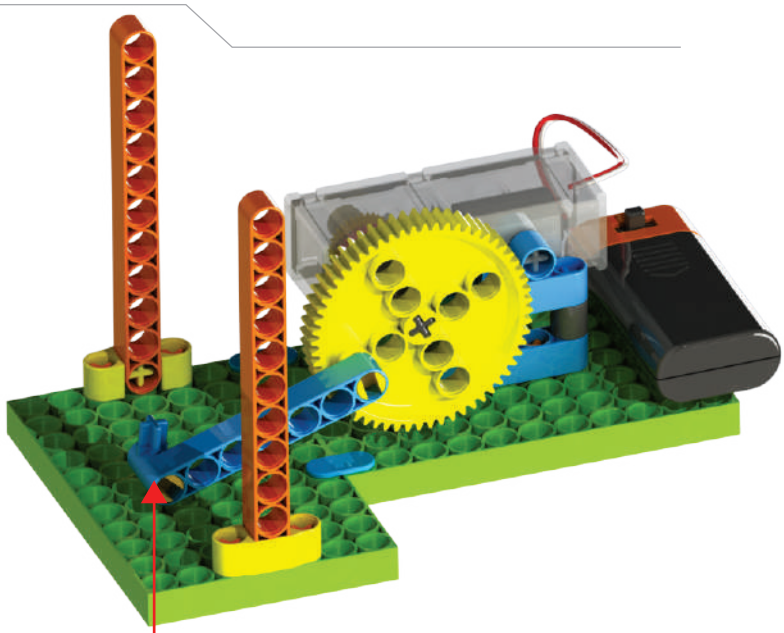
CL2 | 2 pcs.

CH2 | 1 pc.



P7 | 1 pc.

P11 | 2 pcs.

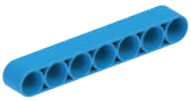


Attach CL2 & CH2 here

Step 5

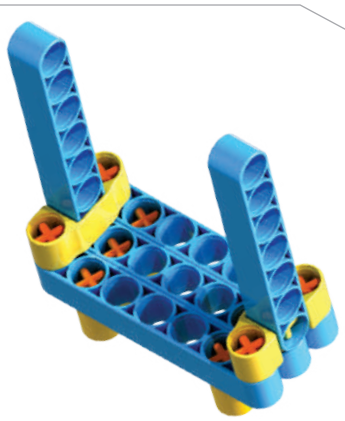
CT2 | 6 pcs.

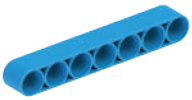
P3 | 2 pcs.



P7 | 3 pcs.

Step 6





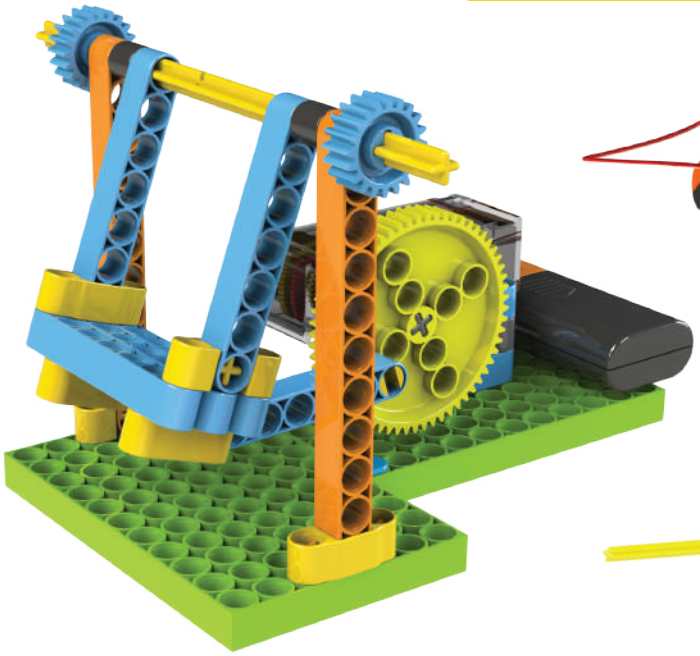
P7 | 2 pcs.

PC3 | 2 pcs.

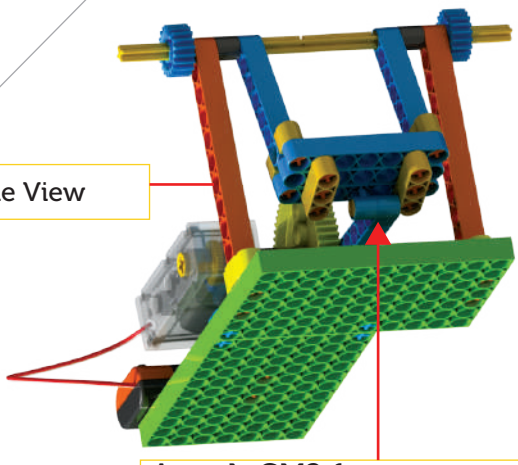
CT2 | 4 pcs.

Step 7

Assembly of step 4 & step 6



Backside View



Attach CH2 from step 4 assembly at this point.

TW1 | 2 pcs.

G(20) | 2 pcs.

SH170 | 1 pc.

Two regular types of periodic motion:
A. Oscillatory motion like we saw in the above model of a swing.
B. Reciprocating motion, like the one in a sewing machine which goes up and down.
Don't worry; we will see many more examples of such motions ahead.

B - Power Press Machine

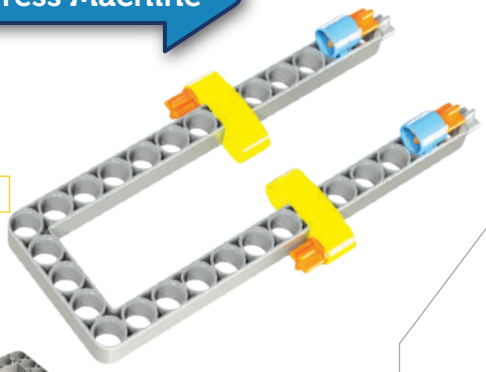
Step 1

CT2 | 4 pcs.

PC3 | 2 pcs.

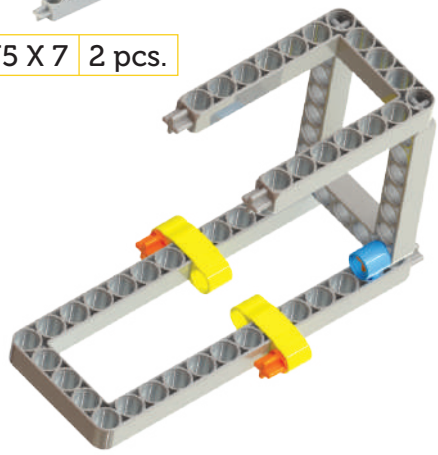
PU5 X 13 | 1 pc.

CH2 | 2 pcs.

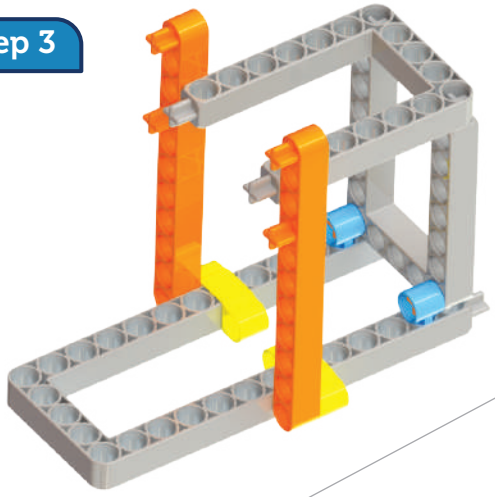


Step 2

PU5 X 7 | 2 pcs.

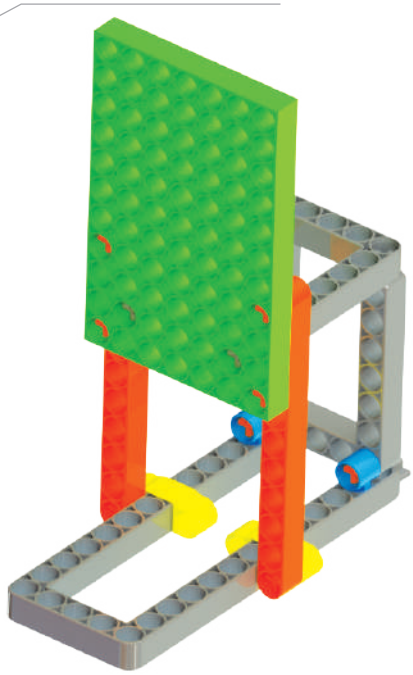


Step 3

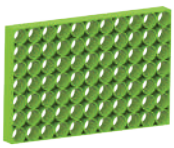


CT2 | 4 pcs.

P11 | 2 pcs.



Step 4

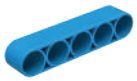


P7 X 11 | 1 pc.

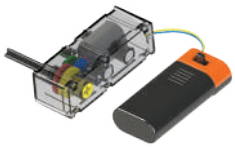
Step 5

TW1	4 pcs.

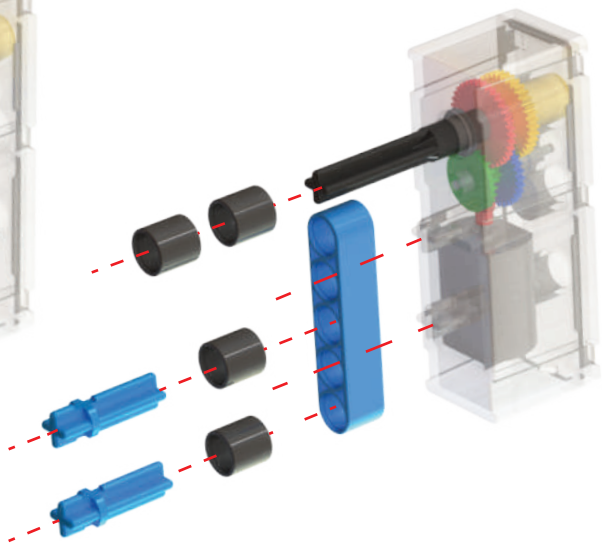
CT3	2 pcs.



P5	1 pc.

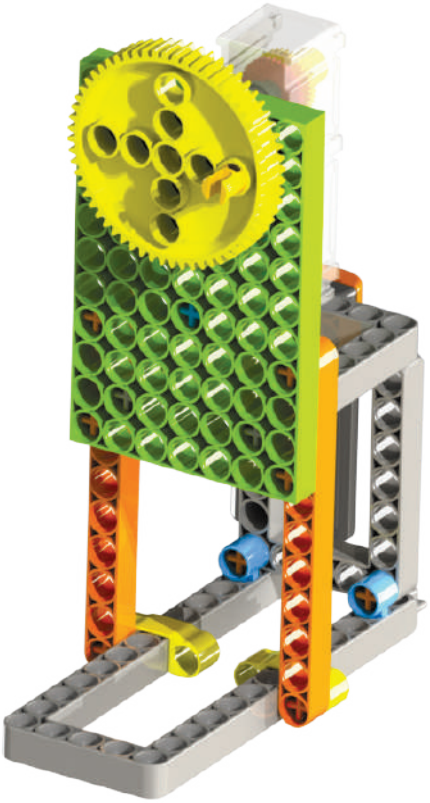


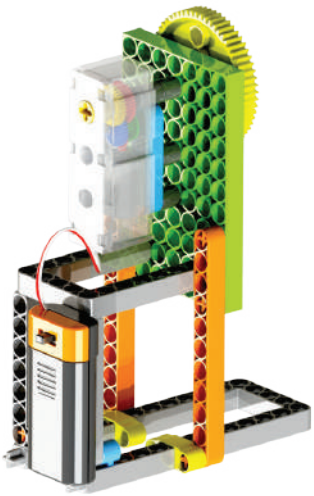
Motor with Battery Box 1 pc.



Step 6

Assembly of step 4 and step 5





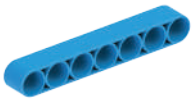
Backside view

CL2	1 pc.

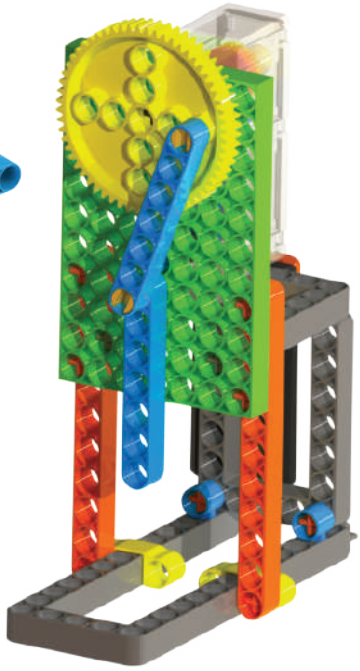
G(60)	1 pc.

Step 7

CL2 | 1 pc.



P7 | 2 pcs.



Step 8

CT2 | 2 pcs.

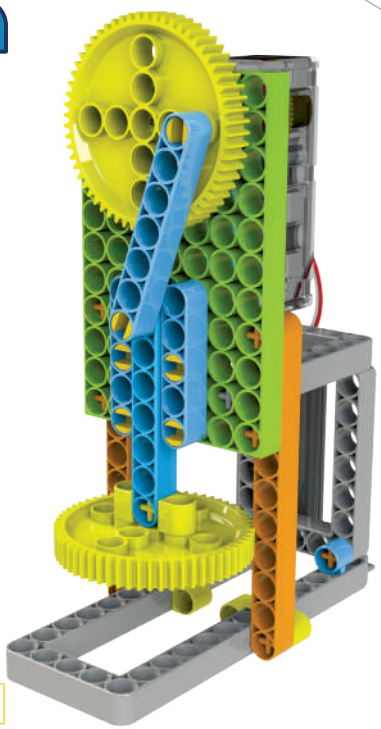
PC3 | 1 pc.

CL2 | 4 pcs.

Step 9

P5 | 2 pcs.

G(60) | 1 pc.



The Power press machine is used widely to make objects out of sheet metal like steel cutlery, plates, tin toys, etc.
This mechanism is also used for paper punching to cut paper in different shapes and sizes. Most toy boxes are also cut in their exact shapes with machines that work like this.

MECHANISMS:

Now that we understand motion, one thing you might have noticed, is that in all the models that you see, motion started off as rotational motion of the motor and then with the different pieces, we converted that rotational motion into different types of motion. This is done with the help of mechanisms. Let's understand a few of these mechanisms while we create miniature versions of real-life machines.

1. Linkages

Let's build a Waving Robot to understand this concept better.

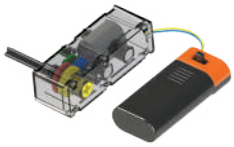
Waving Robot

Step 1

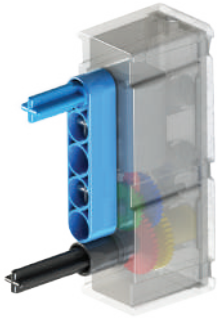
TW1 | 1 pc.

CT3 | 1 pc.

P5 | 1 pc.



Motor with Battery Box 1 pc.

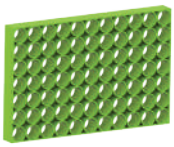


Step 2

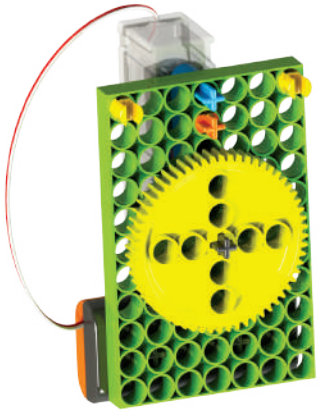
CL2 | 2 pcs.

CT2 | 1 pc.

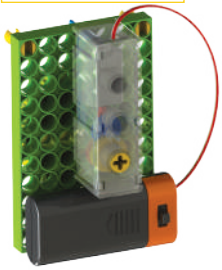
G60 | 1 pc.



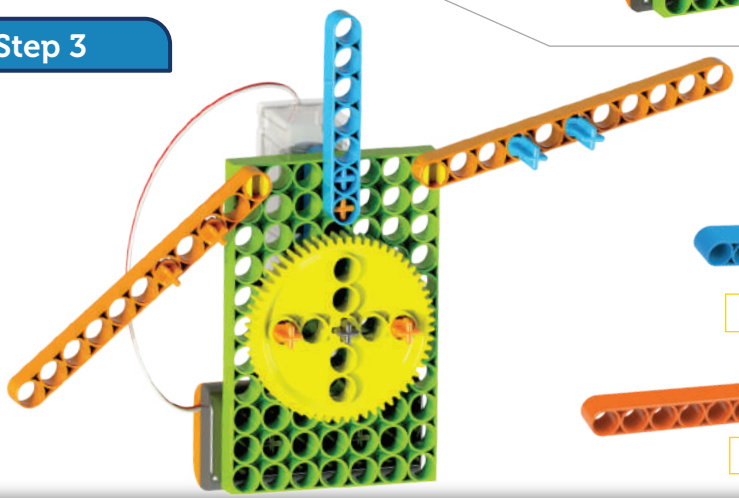
P7 X 11 | 1 pc.



Backside view



Step 3



P7 | 1 pc.

P11 | 2 pcs.

CT2 | 4 pcs.

CT3 | 2 pcs.

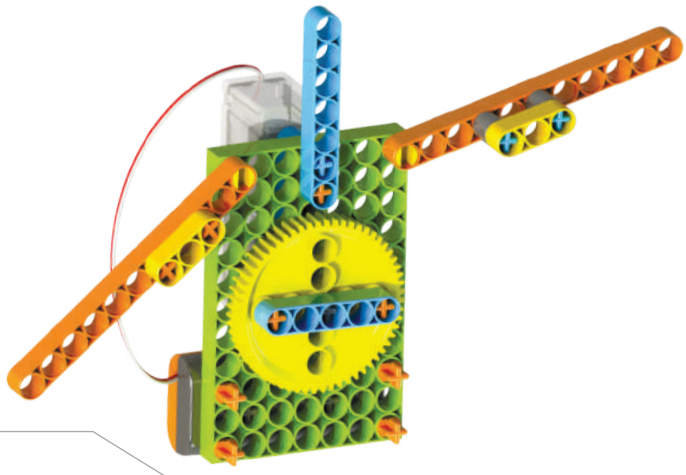
Step 4

CT2 | 4 pcs.

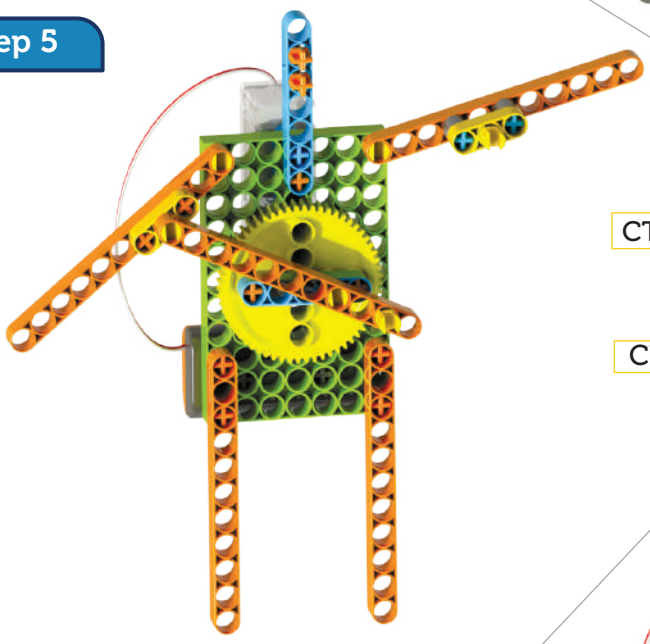
TW1 | 2 pcs.

P3 | 2 pcs.

P5 | 1 pc.



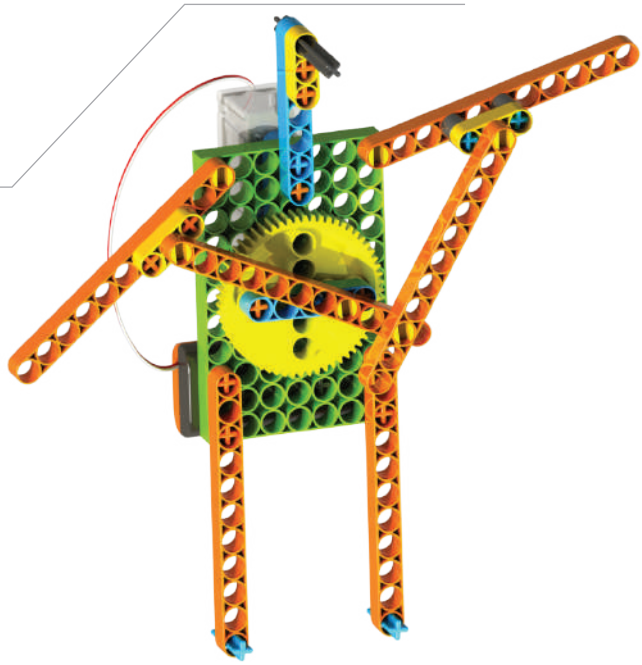
Step 5



CT2 | 2 pcs.

CL2 | 4 pcs.

P11 | 3 pcs.



Step 6

CT3 | 2 pcs.

P3 | 1 pc.

SH60 | 1 pc.

P11 | 1 pc.

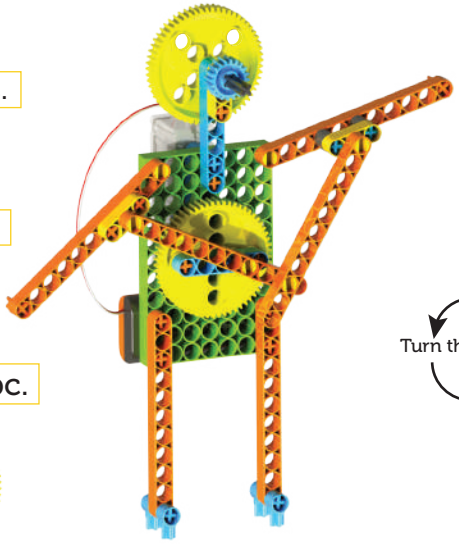
Step 7

CT2 | 2 pcs.

CH2 | 4 pcs.

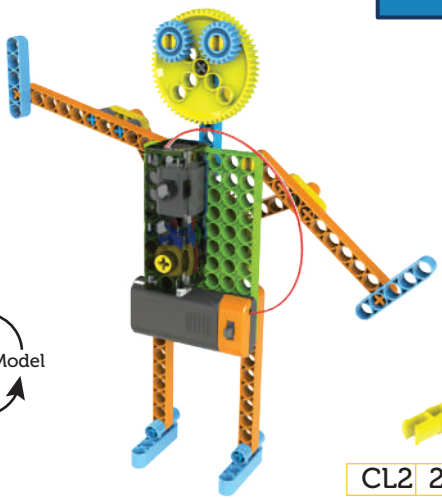
G(20) | 1 pc.

G(60) | 1 pc.



Turn the Model

Step 8



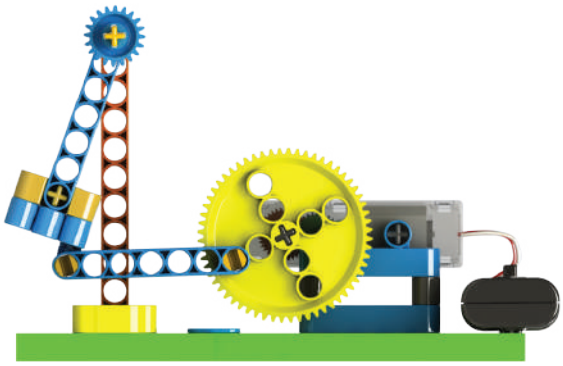
CL2 | 2 pcs.

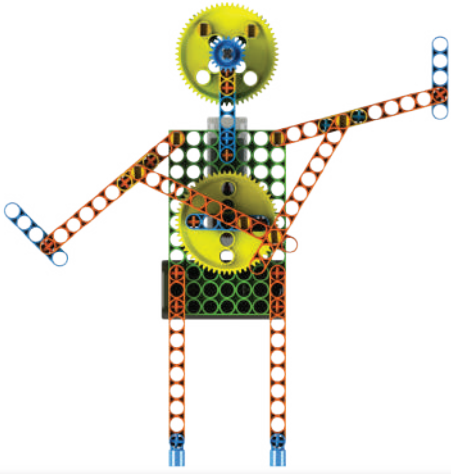
P5 | 4 pcs.

G20 Idler | 2 pcs.

These are some of the simplest mechanisms to create different motion. You might've noticed the robot, and the swing that you made, had P-11 beams behind them that connected the gear and the hands. They are nothing but **links.**

The beams that push and pull but do not bend or break, are called links and the CL-2 connector that connects the links and allows them to move are called **joints.** Can you point out the **links and joints** in the examples below?

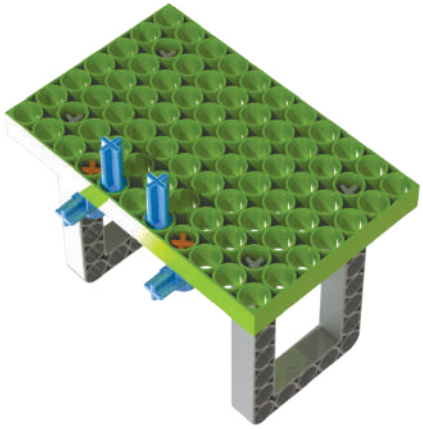




MECHANISMS: 2. Crank & Slider

Let's build a replica of a Powder Pounding Machine to understand this concept a little better.

Powder Pounding Machine



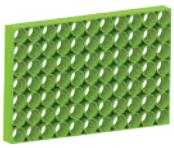
Step 1

CT2 | 2 pcs.

PU5 X 7 | 2 pcs.

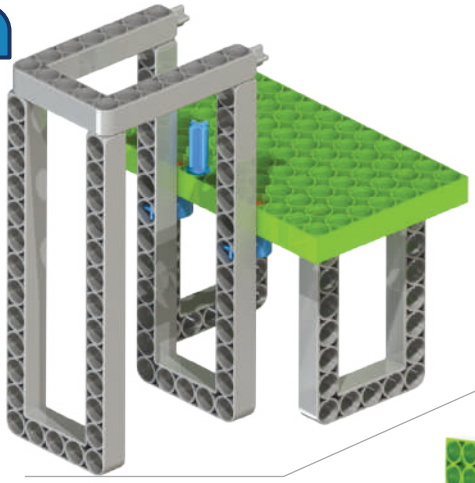
CT3 | 2 pcs.

CH2 | 2 pcs.



P7 X 11 | 1 pc.

Step 2



PU5 X 7 | 1 pc.

PU5 X 13 | 2 pcs.

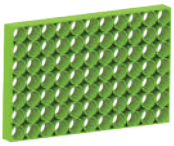
Step 3

TW1 | 2 pcs.

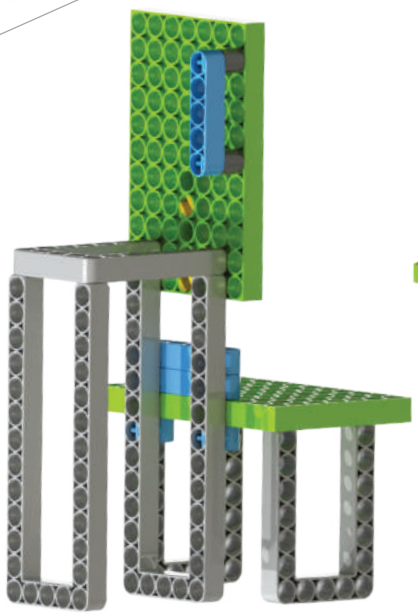
CL2 | 2 pcs.

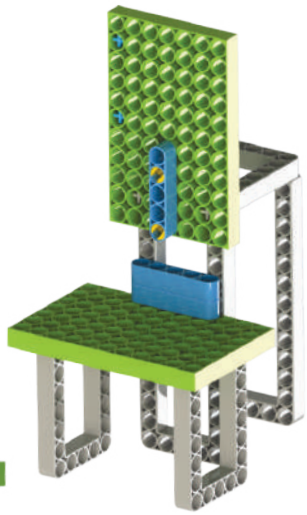
CT3 | 2 pcs.

P5 | 4 pcs.

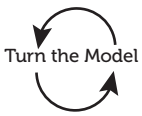


P7 X 11 | 1 pc.

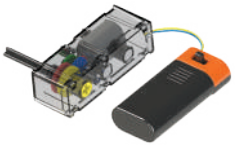




Backside view



Step 4



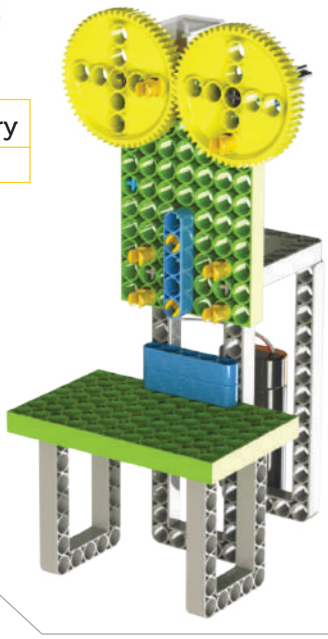
Motor with Battery Box 1 pc.

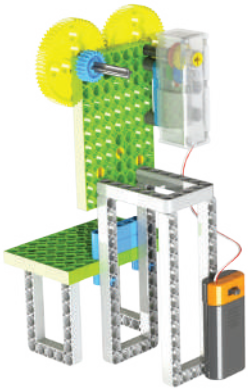
CL2 6 pcs.

G(20) 1 pc.

SH60 1 pc.

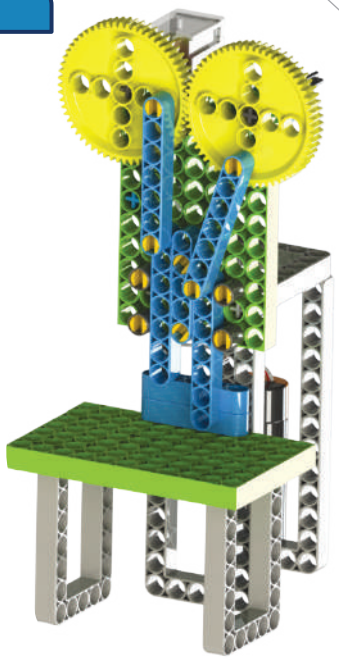
G(60) 2 pcs.





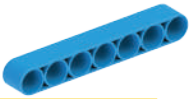
Backside view

Step 5



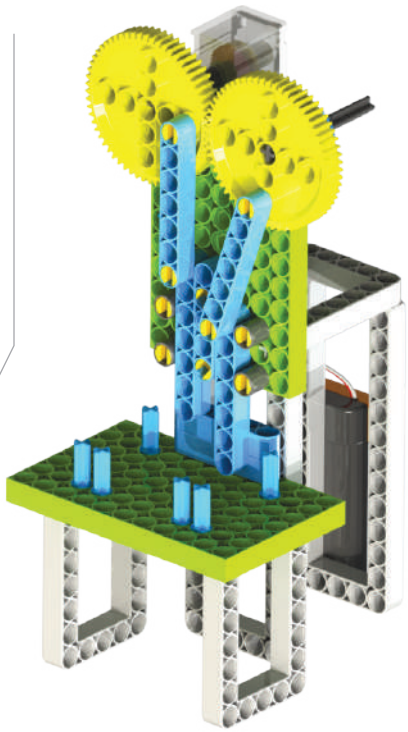
TW1 4 pcs.

CL2 2 pcs.



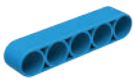
P7 4 pcs.

Step 6

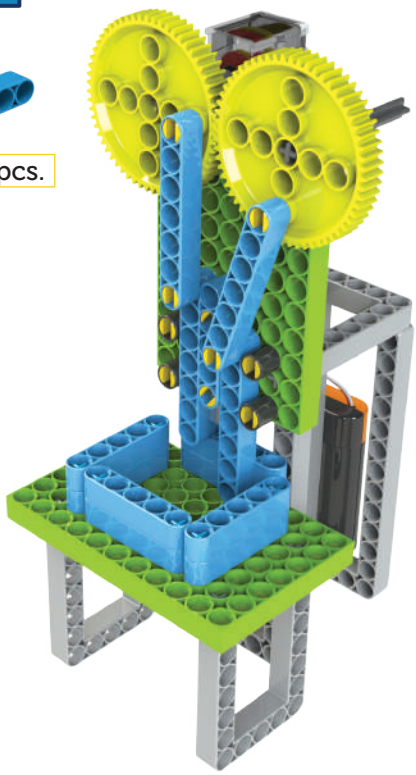


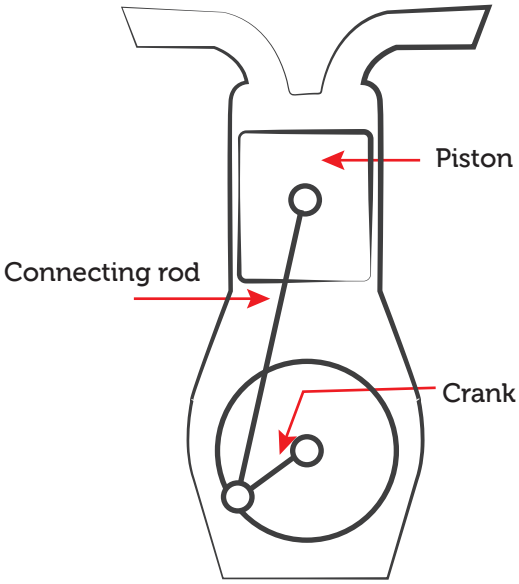
CT3 6 pcs.

Step 7



P5	6 pcs.



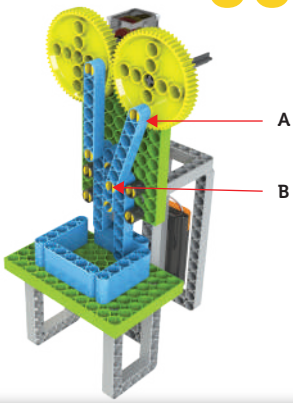


Crank and Slider is a popular mechanism used in power presses, car engines (where the slider is the piston that moves in the cylinder), etc.

Q.) Can you figure out what kind of motion is this mechanism creating?

Output motion: _____

Q.) What happens when you change the positions of CL2 in G60 and P7 pieces?



3. Cam and Follower:

Let's build a quick model to understand this concept better.

IC Engine Valve

Step 1

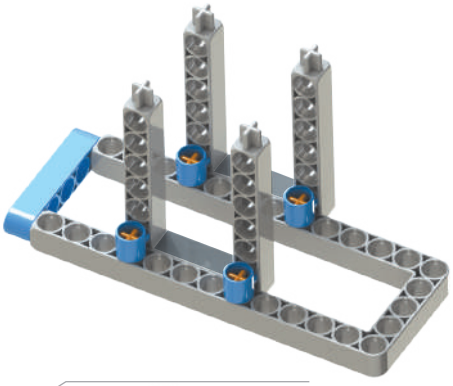
CT2 | 4 pcs.

P5 | 1 pc.

CH2 | 4 pcs.

PU5 X 7 | 2 pcs.

PU5 X 13 | 1 pc.



Step 2

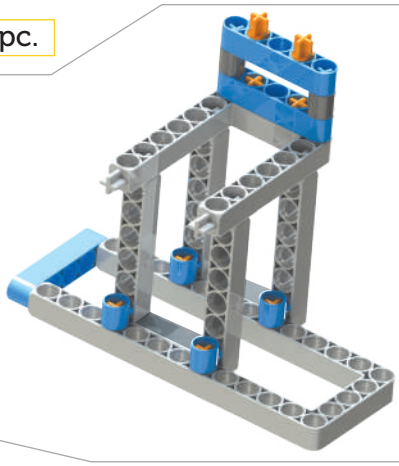
TW1 | 2 pcs.

CT2 | 4 pcs.

CT3 | 2 pcs.

P5 | 2 pcs.

PU 5 X 7 | 1 pc.



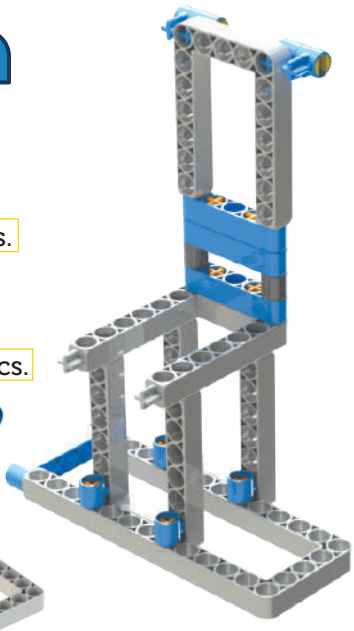
Step 3

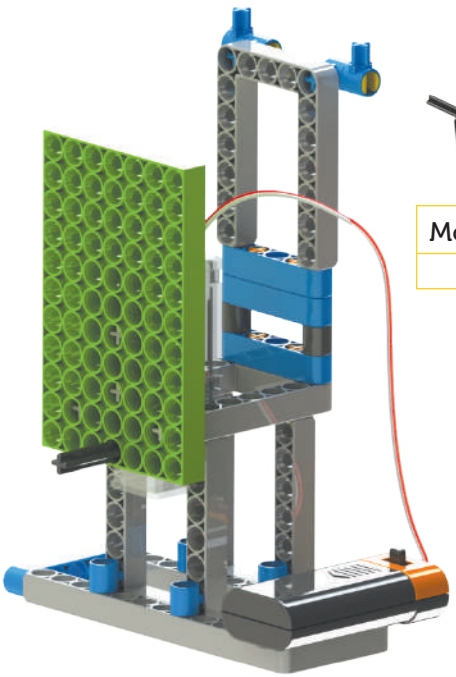
CL2 | 2 pcs.

CH 2 | 4 pcs.

P5 | 1 pc.

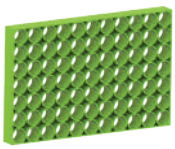
PU 5 X 7 | 1 pc.





Step 4

Motor with Battery Box 1 pc.

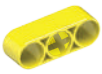


P7 X 11 | 1 pc.

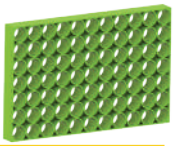
Step 5

CT2 | 1 pc.

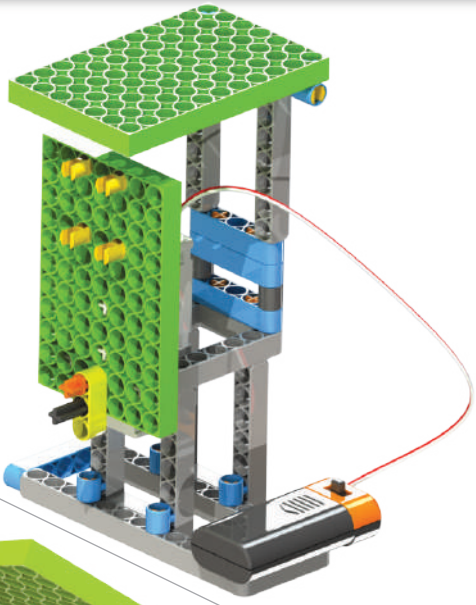
CL2 | 4 pcs.



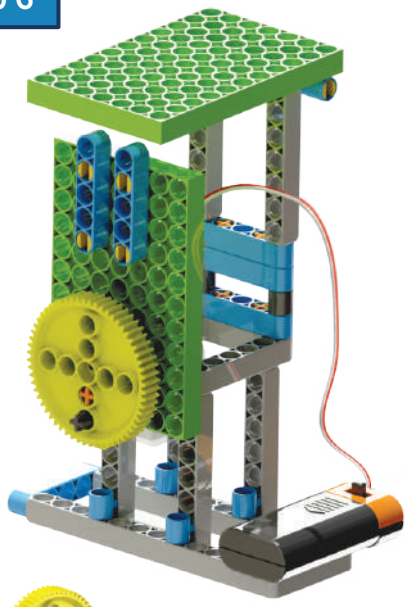
P3 Plus | 1 pc.



P7 X 11 | 1 pc.

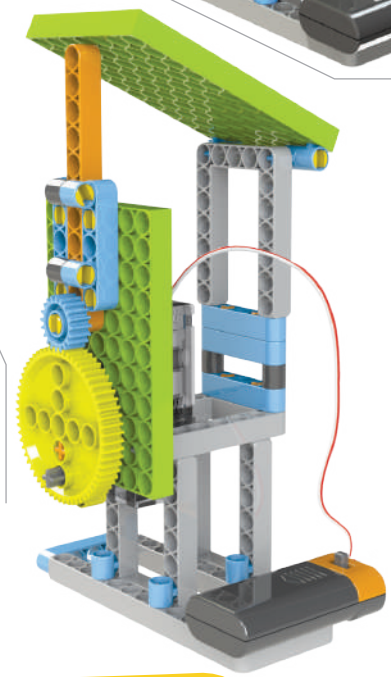


Step 6



G(60) | 1 pc.

P5 | 2 pcs.



Step 7

TW1 | 2 pcs.

CL2 | 3 pcs.

CH2 | 2 pcs.

G20 Idler | 1 pc.

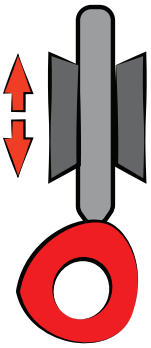
P11 | 1 pc.

We have used the gears in this model in a way to simulate a **cam and follower** mechanism.
Cams are used in all car engines, toys, and many other machines.
Can you figure out what kind of motion is this machine creating?

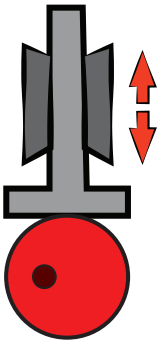
Output motion: _____

Cams can be made of many different shapes and sizes depending on the application.

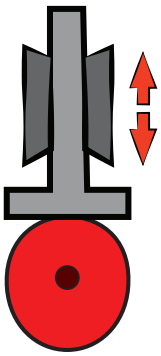
Types of Cams:



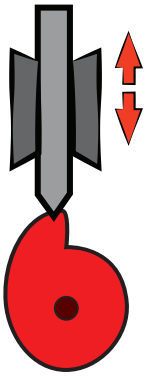
Radial



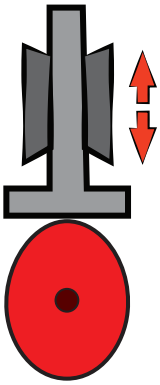
Eccentric



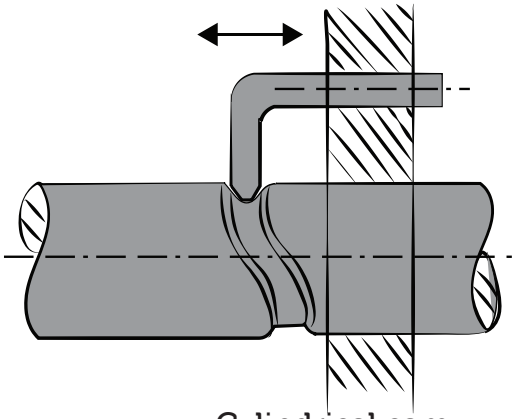
Oval



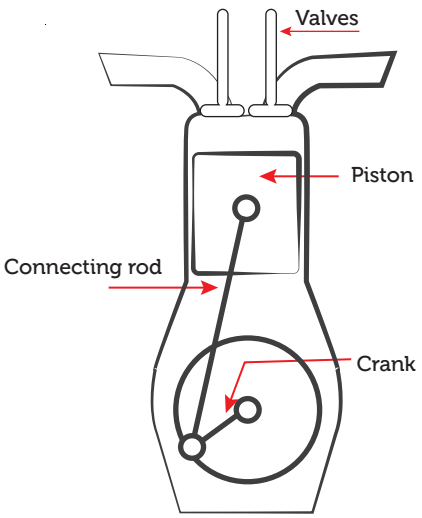
Snail



Elliptical

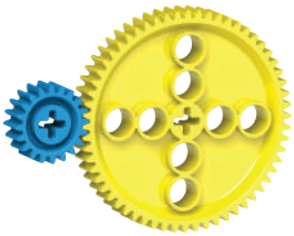


Cylindrical cam



4. GEAR:

Remind's you of the gear stick near the driver in a car, isn't it? Well why is that stick there? Have you noticed when it is used? Do you feel more speed when the gear goes up? And do you feel the engine growl when you don't change the gear on time? So why put such clunky, noisy device in a car? Gears are all around us in all machines that we use daily such as cars, watches, toys, printers, etc. They are fascinating and integral part of our world today.

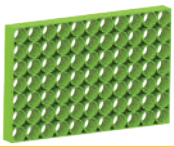


Let's make a geared car to understand how gear works.

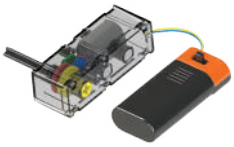
Geared Car

Step 1

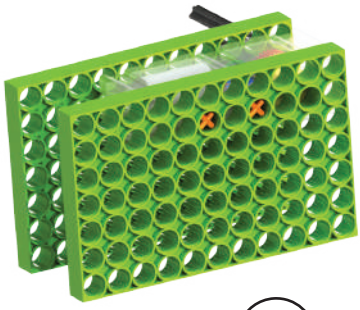
CT2 | 2 pcs.

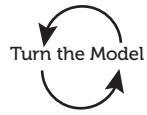


P7 X 11 | 2 pcs.

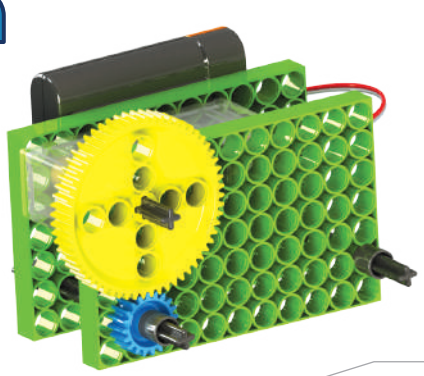


Motor with Battery Box 1 pc.





Step 2



TW1 | 4 pcs.

G(60) | 1 pc.

G(20) | 1 pc.

SH100 | 2 pcs.

Step 3

Wheels | 4 pcs.

5. POWER SCREW: SCISSORS LIFT

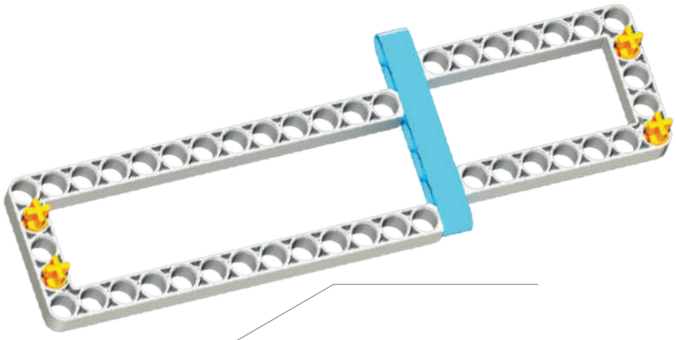
Step 1

PU 5 X 7 | 1 pc.

CT2 | 4 pcs.

PU 5 X 13 | 1 pc.

P7 | 1 pc.



Step 2

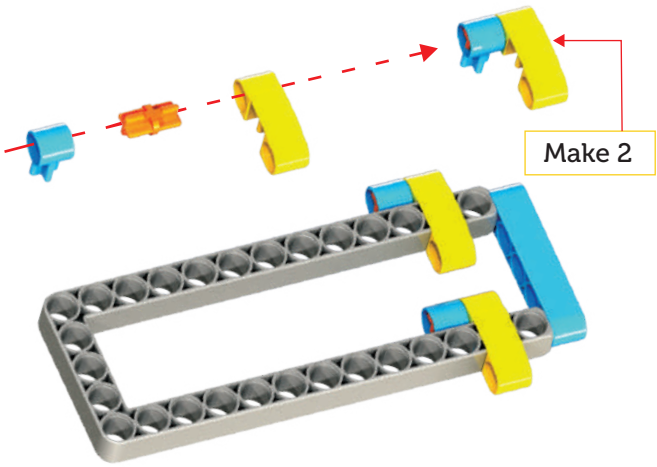
CT2 | 2 pcs.

P5 | 1 pc.

CH 2 | 2 pcs.

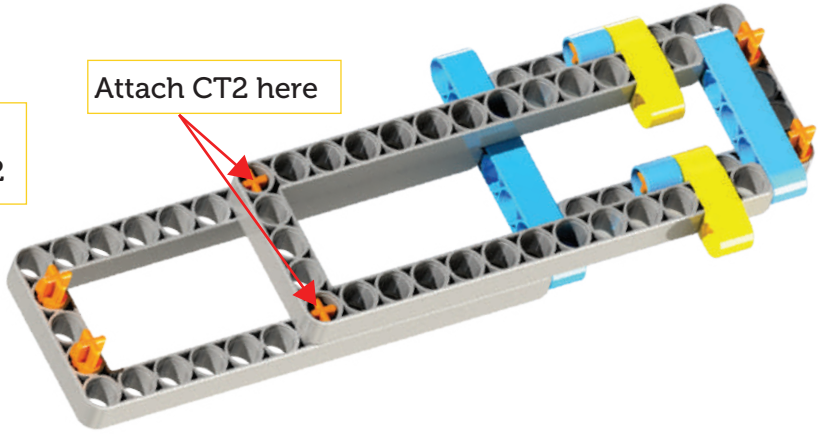
PU 5 X 13 | 1 pc.

PC3 | 2 pcs.



Step 3

Assembly of step 1 & step 2

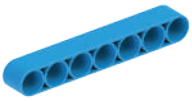


CT2 | 2 pcs.

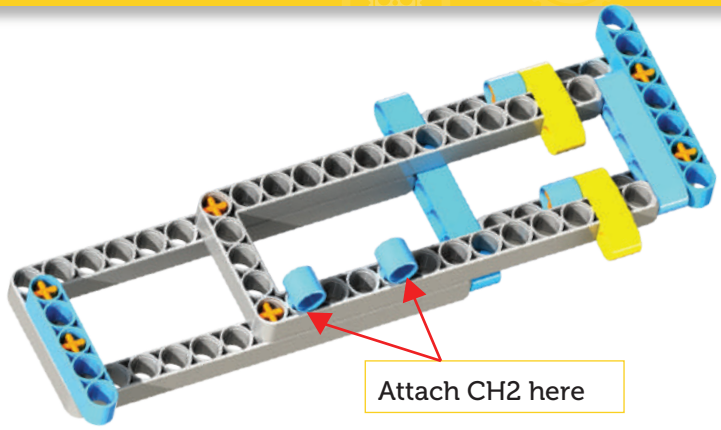
Step 4

CH 2 | 2 pcs.

P5 | 1 pc.



P7 | 1 pc.



Step 5

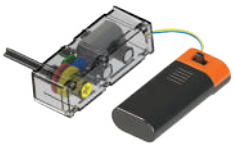
CT3 | 2 pcs.

CT2 | 2 pcs.

Power Screw
1 pc.

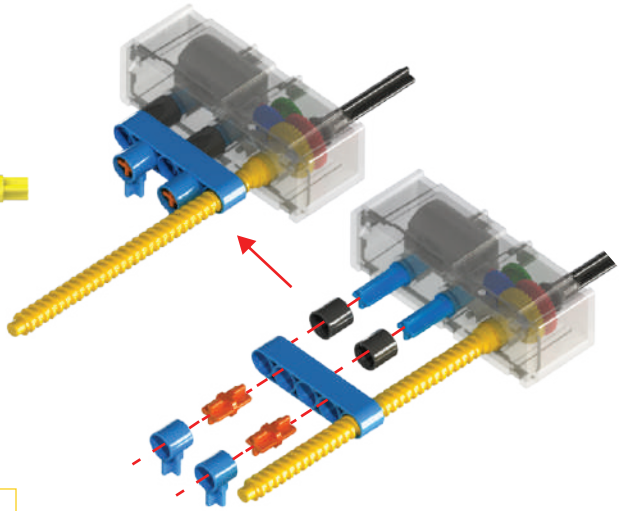
TW1 | 2 pcs.

CH2 | 2 pcs.

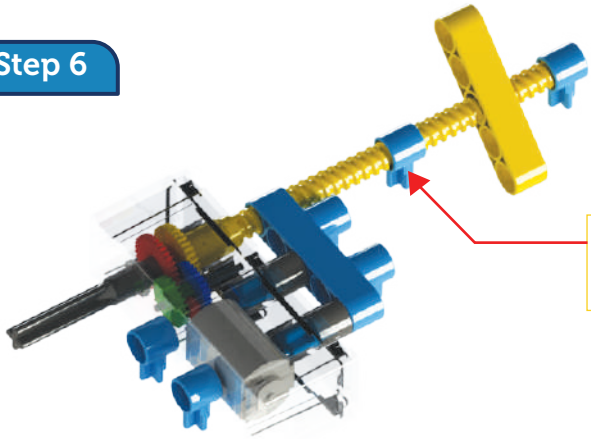


Motor with Battery
Box 1 pc.

P5 | 1 pc.



Step 6

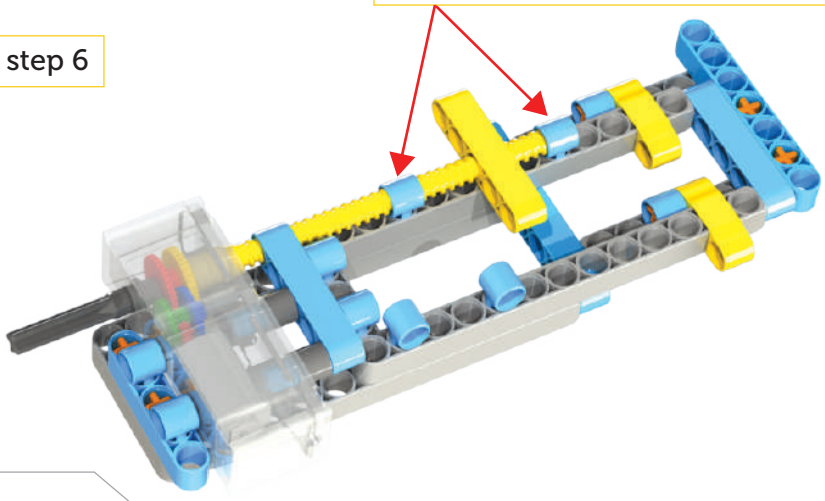


CH2 | 4 pcs.

P5 Nut | 1 pc.

Step 7

Assembly of step 4 & step 6



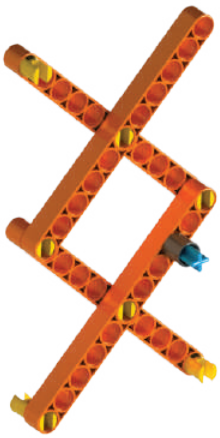
Step 8

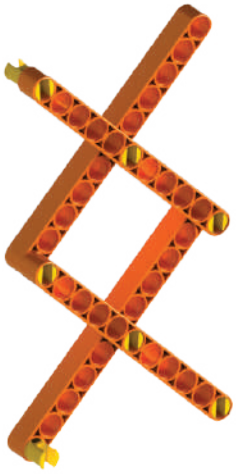
TW1 | 1 pc.

CL2 | 14 pcs.

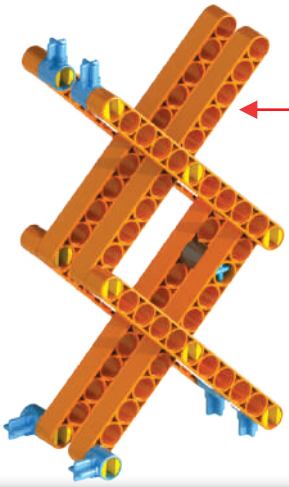
CT3 | 1 pc.

P11 | 8 pcs.





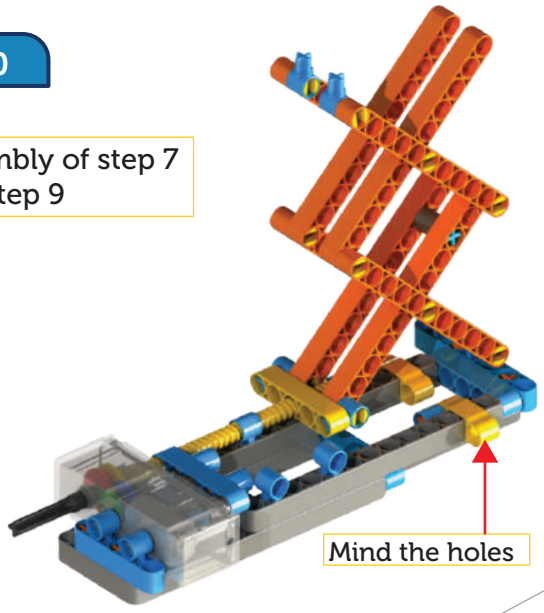
Step 9



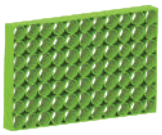
CH2 | 6 pcs.

Step 10

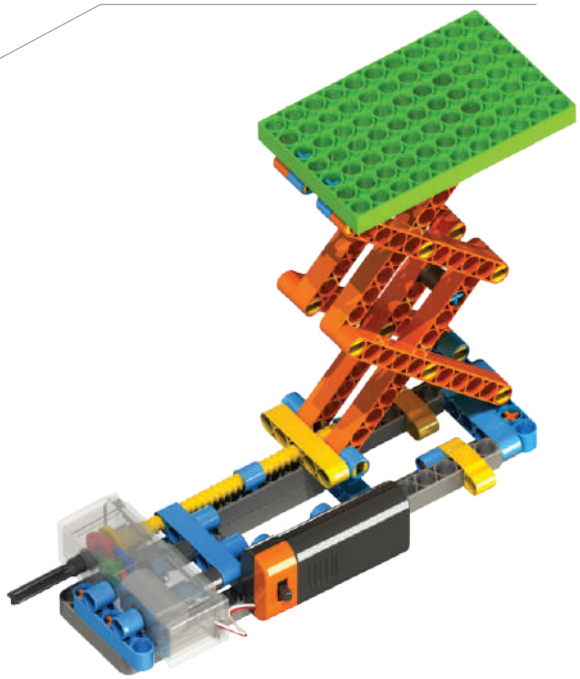
Assembly of step 7 and step 9



Step 11



P7 X 11	1 pc.



Can you figure out what kind of motion is this mechanism creating?

Output motion: _____

It is a commonly used mechanism in cars that have electric seats. It works in a similar fashion as did your scissor lift, but instead of pushing the end of the scissor lift, it pushes your seat forward and backward.

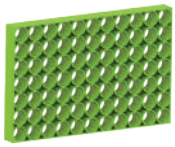
A mechanism that creates a linear motion is also called a **Linear Actuator**.

6. RACK AND PINION: LIFT

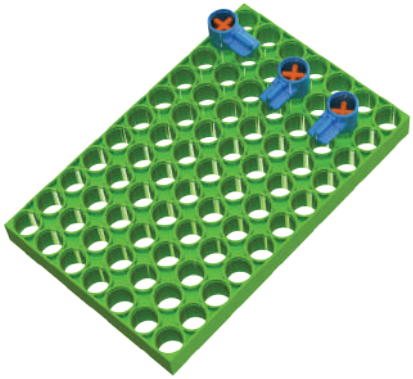
Step 1

CT2	3 pcs.

CH2	3 pcs.



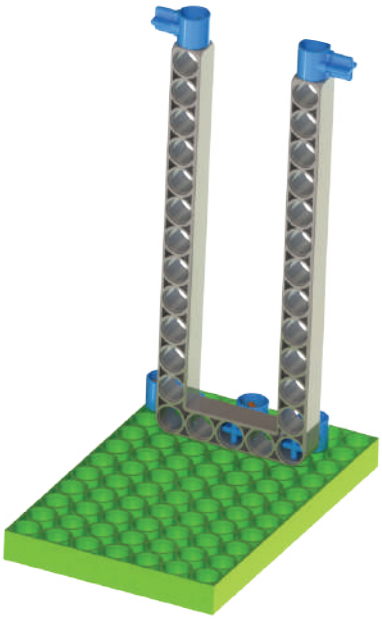
P7 X 11	1 pc.



Step 2

CH2	2 pcs.

PU 5 X 13	1 pc.

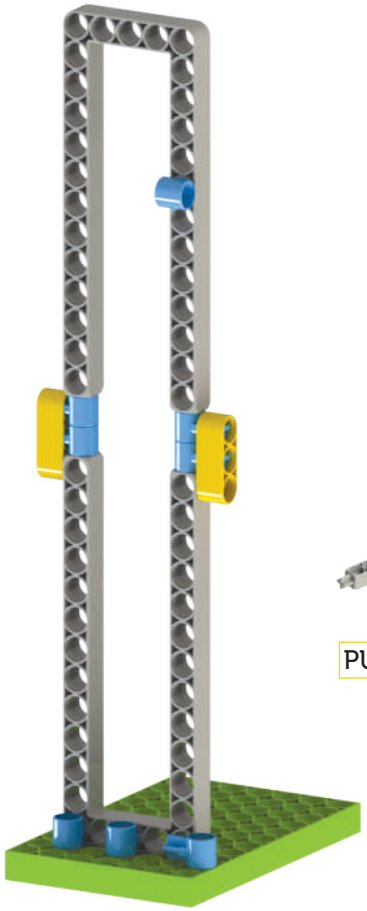


Step 3

P3	2 pcs.

CH2	3 pcs.

PU 5 X 13	1 pc.

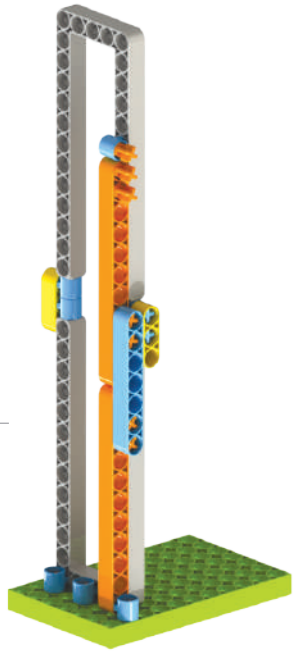


Step 4

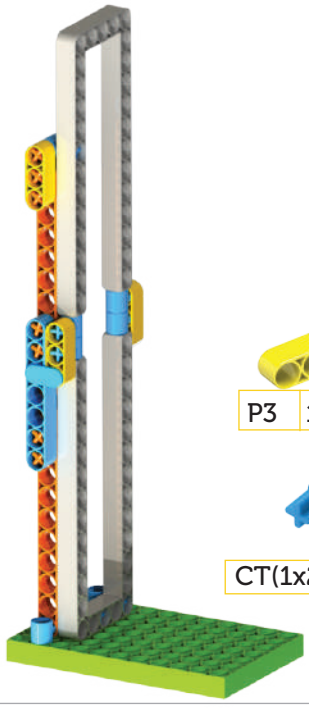
CT2	7 pcs.

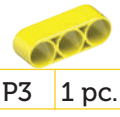
P7	1 pc.

P11	2 pcs.



Step 5

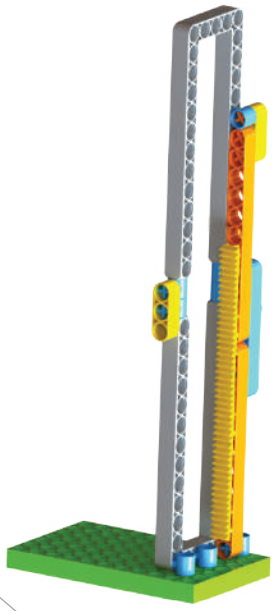


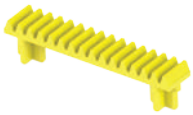


P3	1 pc.

CT(1x2)	1 pc.

Step 6





Rack	3 pcs.

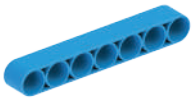
Step 7

CT2	4 pcs.

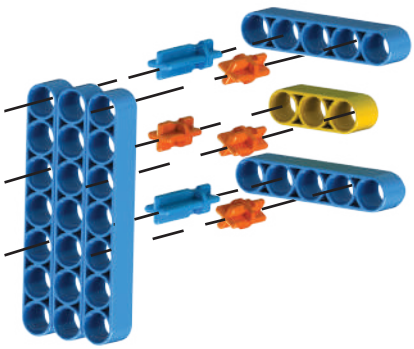
P3	1 pc.

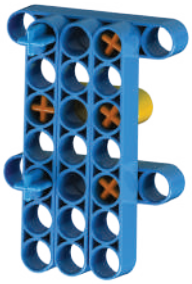
CT3	2 pcs.

P5	2 pcs.



P7	3 pcs.

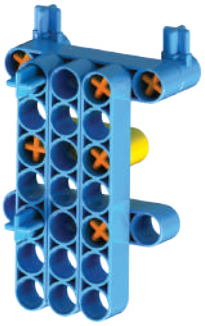




Step 8

CT2 | 2 pcs.

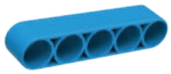
CH2 | 2 pcs.



Step 9

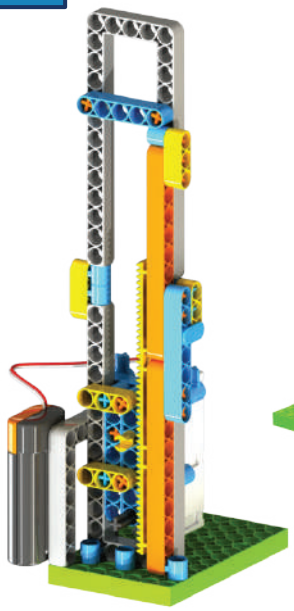
Assembly of step 6 and step 8

CT2 | 2 pcs.



P5 | 1 pc.

Step 10



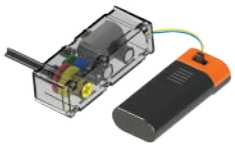
Backside view

PU 5 X 7 | 1 pc.

CT2 | 2 pcs.

CL2 | 1 pc.

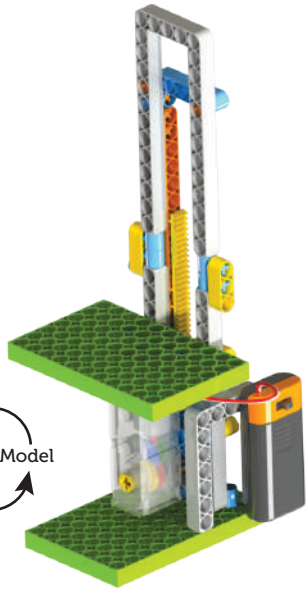
P3 | 2 pcs.



Motor with Battery Box 1 pc.

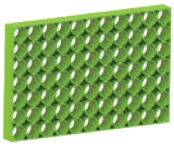
Step 11

Attach P7x11 at center of gearbox



Backside view

G(20) | 1 pc.



P7 X 11 | 1 pc.

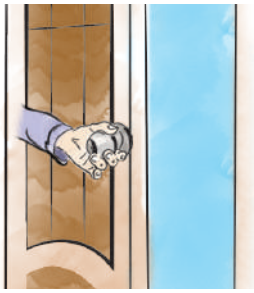
G20 Idler | 1 pc.

*Do not dismantle your lift just yet; we will use it in the next segment.

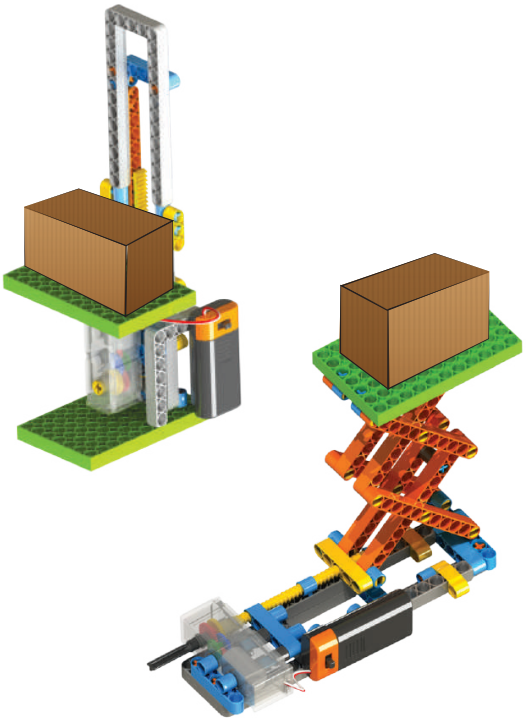
7. MECHANICAL ADVANTAGE:

How does the same motor with different mechanisms create greater force?
This phenomenon is called **'Mechanical Advantage'.**
To understand mechanical advantage, let's ask a few questions:

1. Why do older trucks, buses and even some cars have very big steering wheels? And what would happen if they had small steering wheels like modern-day cars?
2. Why do we have doorknobs on the far side of the door?
3. Why does a CT2 connector come out so easily with a removal tool but not with our hands?



Let's do an activity with our power screw lift and rack and pinion lift: Put some weight on the lift and let it go up.

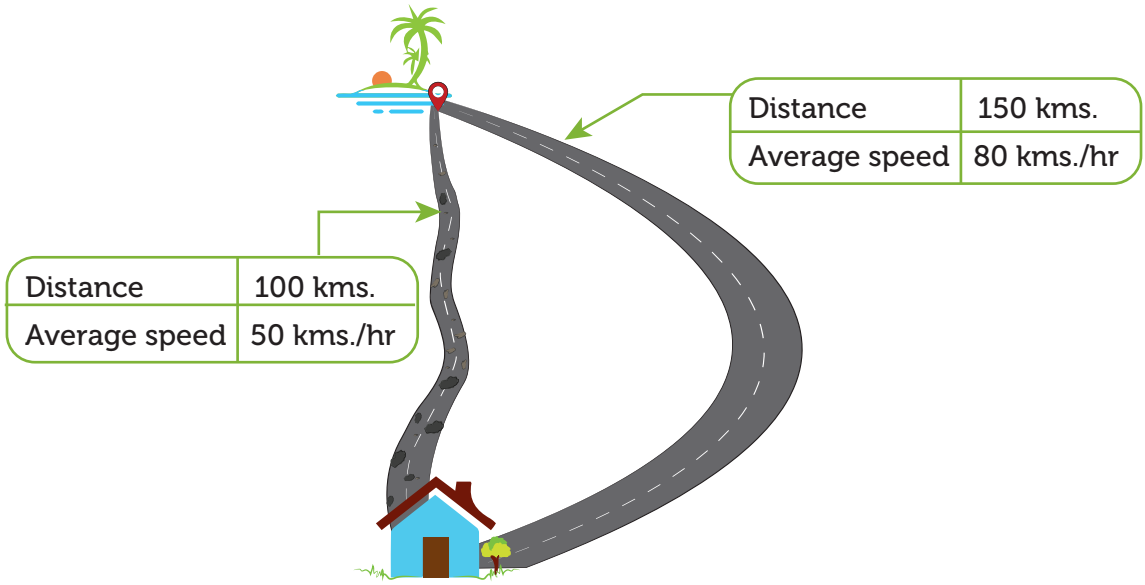


Mechanical advantage is nothing but the use of a mechanism to create a greater force at the output for a smaller force at the input.
Generally, this takes place at the cost of speed and displacement. That is why you will notice, that a power screw lift operates at a much slower speed but creates more force whereas rack and pinion lift is fast but has less force. This is similar to how gears work. Bigger gears on the output shaft, decrease speed but increase torque (twisting force) and vice versa.
We shall revisit this topic in the coming sessions.

Let us assume you want to go for a holiday to a nearby city. The city is pretty far and there are two roads that can take you there.

Option 1	Option 2
One is a much shorter road which goes directly to your destination, but the road is narrow with a lot of potholes.	One is a big national highway with smooth wide roads but the route is much longer.

How do you decide which of these roads takes you to your relaxing holiday faster? To make this decision, we need to gather some data. It is as follows.

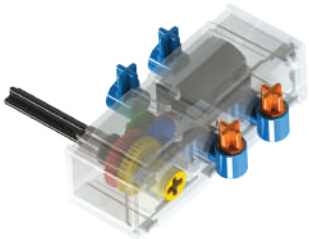


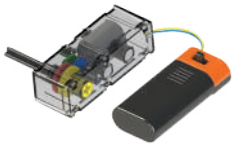
Can you determine which road you should take?

BASIC CAR

Now let's try another experiment. For that, we will need to build a basic car. Follow the steps below to build it.

Step 1



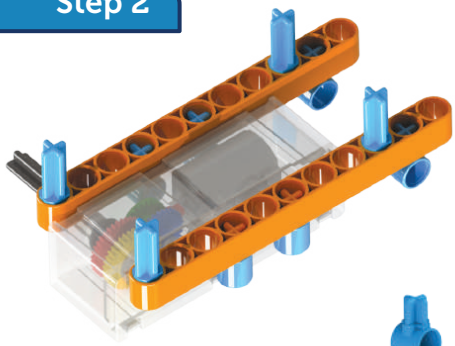


Motor with Battery Box 1 pc.

CT2 | 2 pcs.

CH2 | 4 pcs.

Step 2

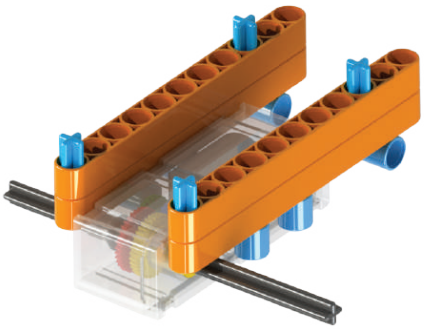


CH2 | 2 pcs.

P11 | 2 pcs.

CT3 | 4 pcs.

Step 3



P11 | 2 pcs.

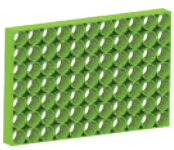
SH60 | 1 pc.

Step 4

TW1 | 6 pcs.

SH100 | 1 pc.

Wheels | 4 pcs.



P7 X 11 | 1 pc.

use 2-2 TW1 for front axle
use 1-1 TW1 for rear axle

Had a good time building your car?

Now, here is a challenge for you.
Can you find out the speed of the car that you have built?
Discuss with your group and come up with an idea!

Now what do you think will happen if we increase the size of the wheels?
Will it become faster or slower?

Why don't we try it to be sure?
Replace the wheels of your car with the big gears (G60).
Here the gears will behave as big wheels.

Calculate the speed of your new car with big gear wheels and fill this table to compare your observations:

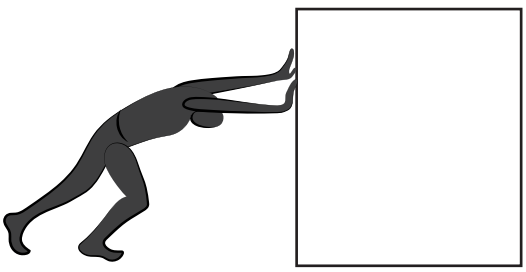
	Wheels	Big gear wheels
Diameter of wheel		
Distance traveled		
Time taken		
Speed of your car		

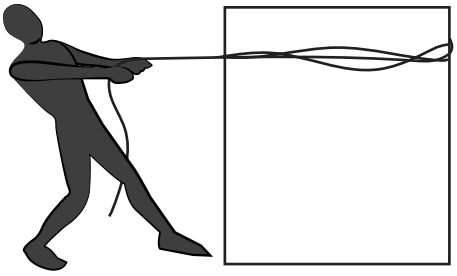
Did you expect the car to go faster?
If just changing tires made cars faster, why don't sports cars just use much bigger tires to go faster?

9. FORCE

While you made a Scissors lift, you might have noticed that the speed was very low, but did you notice how it had the ability to carry some serious weight. While a rack and Pinion lift could move quickly but just doesn't have the same weight carrying ability. This ability to push or pull is called force. While both Power Screw and Rack and Pinion apply force, force applied by Power Screw is **higher** than the force applied by Rack and Pinion.

Force is a push or a pull upon an object resulting from the object's interaction with another object.





Dual Axle Gear Box

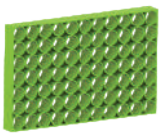
Step 1

TW1 | 2 pcs.

CT3 | 2 pcs.

P7 | 1 pc.

P11 | 1 pc.

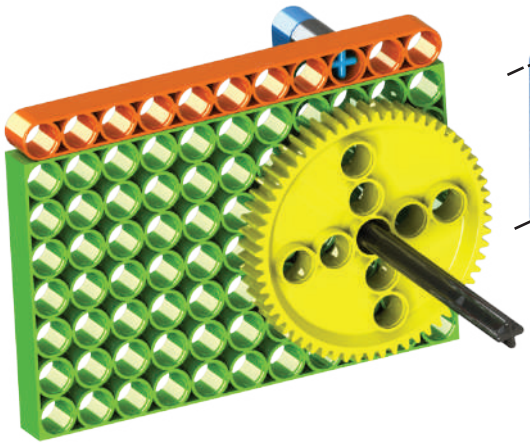


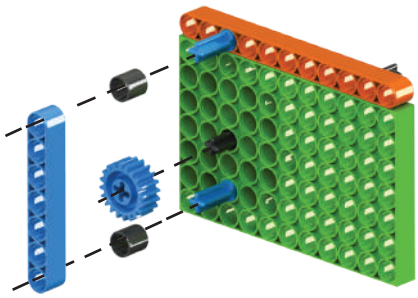
P7 X 11 | 1 pc.

G(20) | 1 pc.

G(60) | 1 pc.

SH100 | 1 pc.

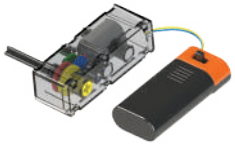




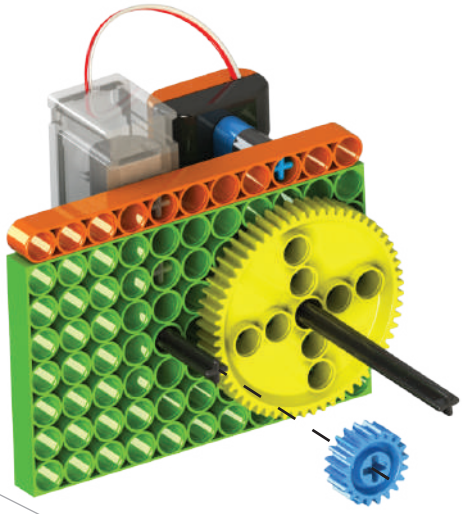
Backside view

Step 2

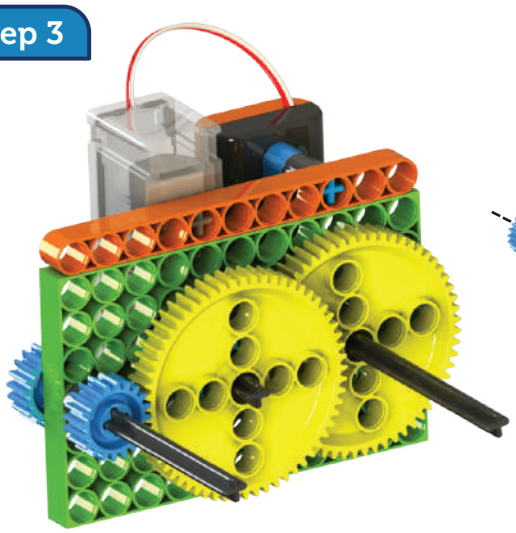
G(20) 1 pc.

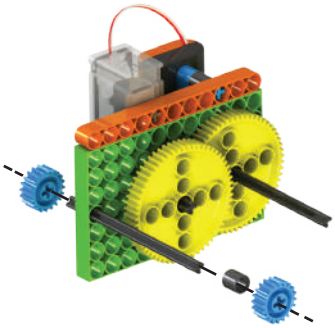


Motor with Battery Box 1 pc.



Step 3





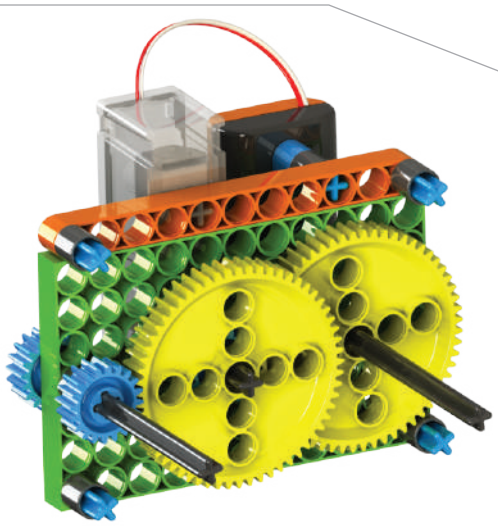
TW1 1 pc.

G(20) 2 pcs.

SH100 1 pc.

G(60) 1 pc.

Step 4



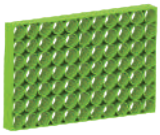
TW1 4 pcs.

CT3 4 pcs.

Step 5

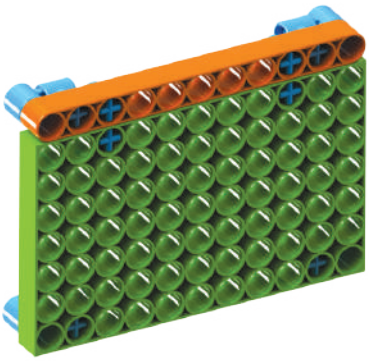
CT(1x2)	2 pcs.

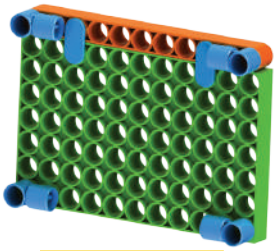
CH2	8 pcs.



P7 X 11	1 pc.

P11	1 pc.

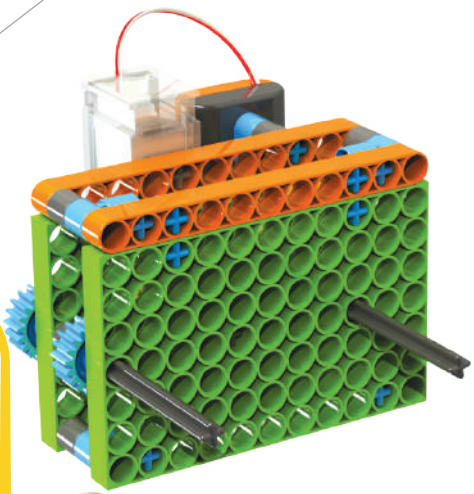


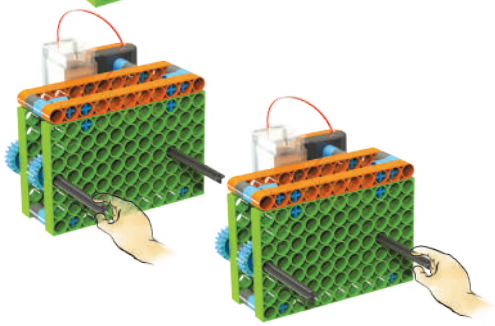


Backside view

Step 6

Assembly of step 4 & step 5





Try and hold the shafts as shown.

What was the difference that you observed between the 2 shafts?
Now we know that with mechanisms we can change force, but while changing force, speed also changes.

Do you know?
We can attach many gears and build a super BLIX gearbox and attach with our motor which can move an actual car.

Then why do we need such a huge engine in our car?

10. POWER

The term that takes both force and speed into account is called power.
We saw in the above experiment that gears can either give us more speed or more force. If we need both force and speed in a single shaft, we will have to use a bigger motor which should have more power. Any engine or motor has a fixed power rating which cannot change. Using mechanisms, we can change the force or speed, but power will always remain constant. That means, force and speed together make power.

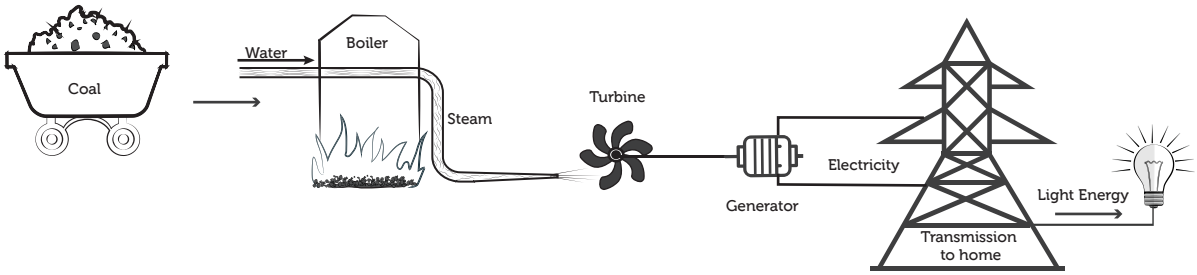
We earlier mentioned that there are fixed power ratings for engines and motors. But have you noticed that when the battery goes low, the speed and the force of the motor decreases? Meaning power is reducing. Ah! Meaning power of our motor is dependent on the battery. Similarly, the power of an engine is dependent on the quality of fuel you put into it. This is because power can only be created from energy, and both batteries and fuel have chemical energy stored inside of them.

Energy is nothing but the ability to do work. And energy comes in all types of forms. See the example below to understand how we convert energy from nature into energy that we use every day.

Energy Law: Law of conservation of energy

Energy can neither be created nor be destroyed but it can be converted from one source to other.

How Do we use this energy?



Chemical Energy → Heat Energy → Kinetic Energy → Electrical Energy → Light Energy

Sources of Energy	Type of Energy
Sun	Solar
Wind	Wind
Fossil Fuel	Chemical
Water	Hydro Electric
Nuclear fission	Nuclear
Tides	Tidal
Biomass	Chemical
Hydrogen	Nuclear

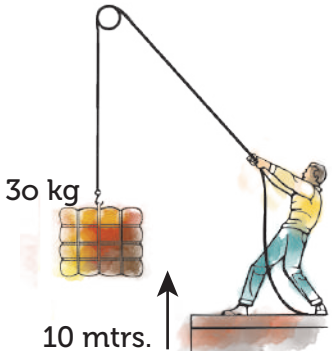
Unit of energy is Joules (J)

Fun fact: One liter of diesel has more chemical energy as compared to one liter of petrol. This is one of the reasons why a diesel engine is more fuel-efficient because it needs less fuel for the same power.

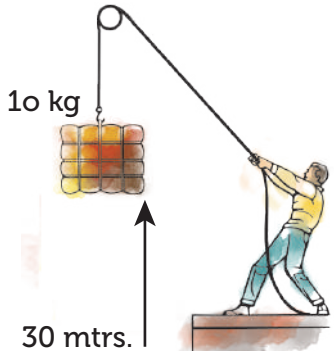
12. WORK

We all know what work means. It means to do a task to get a desired result. Work also has a meaning in physics, which is similar but not the same. Let's look at 3 scenarios

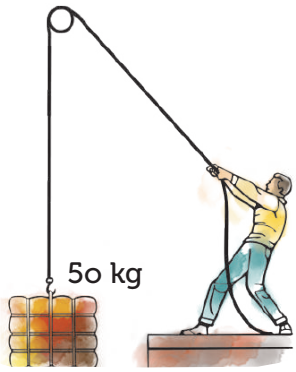
1. Boy moves a 30 kg object by 10 meters.



2. Boy moves a 10 kg object by 30 meters.

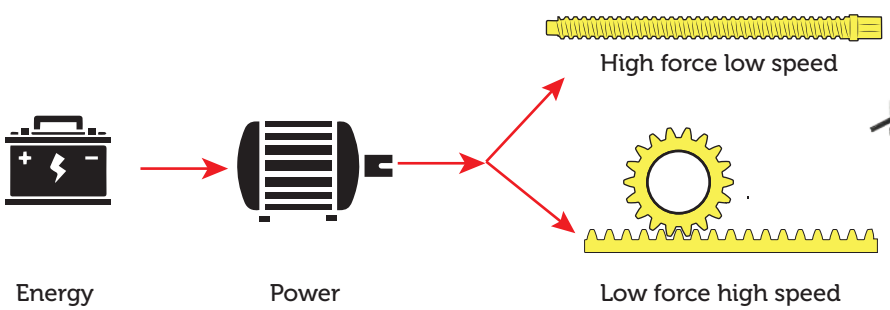


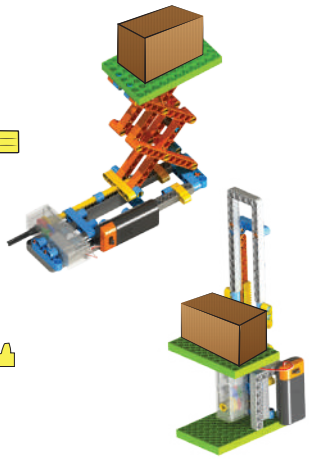
3. A boy tries to move a 50 kg object but it doesn't move.

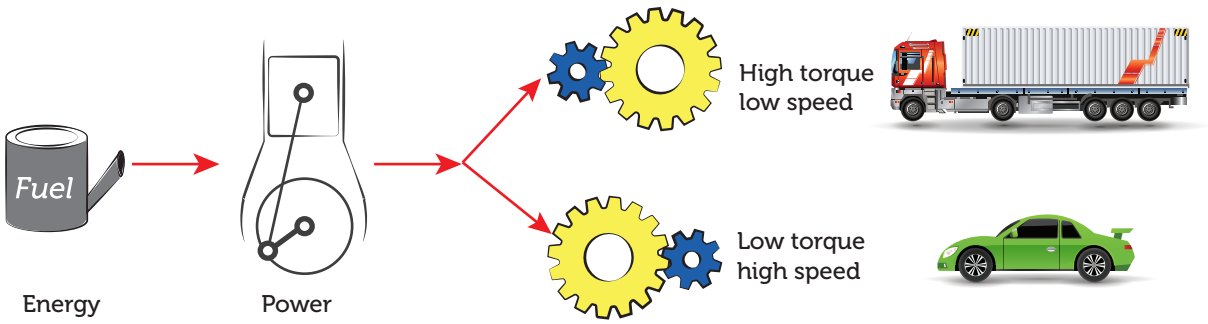


Can you figure out who is doing most work?

Relationship of Energy – Power – Force - Work





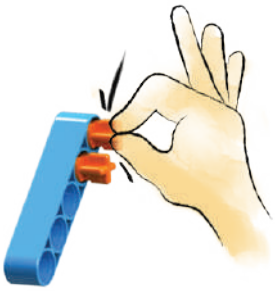


13. SIMPLE MACHINES

Isn't it funny? After seeing all the cool machines and mechanisms, we now are going to learn about the simplest machines.

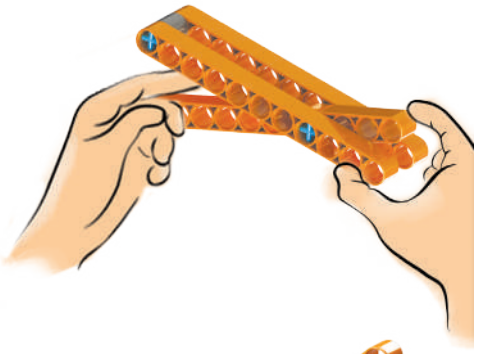
All machines and mechanisms, when broken down to their most basic form will most likely be one of the 6 simple machines below. Even the most complex machines are basically nothing but a combination of the following simple machines.

1. Can you pull out a CT2 when it is fitted in a hole? How does the REMOVAL TOOL make it easier?

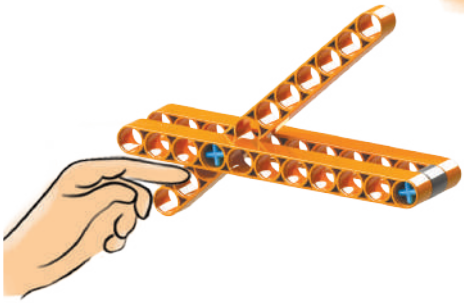


2. How difficult it is to pull a water-filled bucket, right? But, with pulley, it is a lot easier, why?

3. Try and make pliers using the available pieces. Put your finger in between its claws and operate it, how does the force applied at one end gets transferred to the other end?

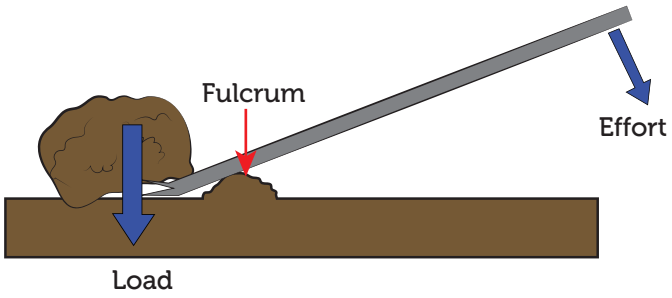


Does anything change if you keep the finger on the other end and operate the pliers?



1. Lever:

Levers are simple devices used to create tremendous mechanical advantage. Refer the image below to understand it's working.



Examples of levers that we use every day:

Removing tool

Back end of a hammer to remove a nail

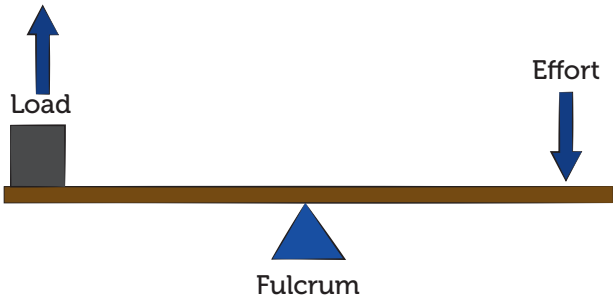
The '**Load**' is the object you are trying to move.
The '**Effort**' is the force applied to move the load.
The '**Fulcrum**' is the point where the load is pivoted.

Unknowingly, you have used a lever multiple times while building your machine models. While the connectors fit too tightly for us to be able to remove them by hand, the simple removing tool easily allows you to remove them without much effort.

A class 1 lever has the fulcrum in the center.

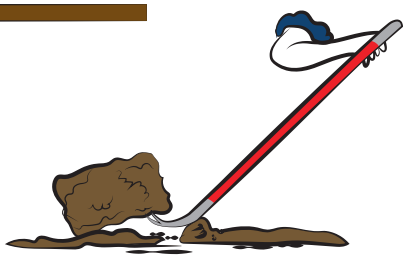
Class 1 Levers:

A class 1 lever has the fulcrum in the center.



Examples:

Pliers

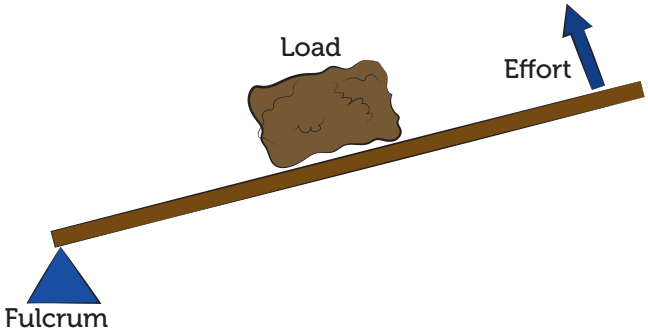


Crowbar

It is similar to our removing tools

Class 2 Levers:

A class 2 has the load in the center. Usually load is near the fulcrum.



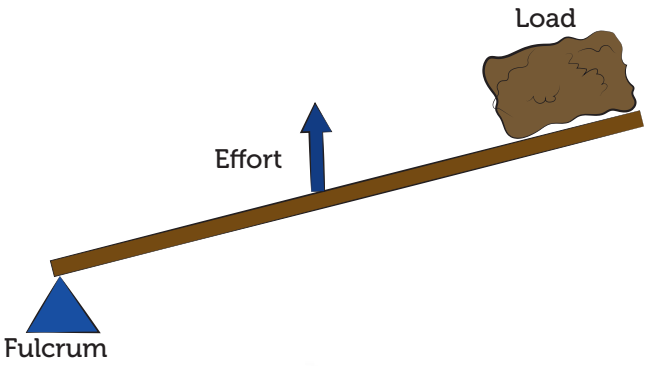
Examples:

Nutcracker

Wheel Barrow

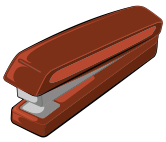
Class 3 Levers:

A class 3 lever has an effort in the middle.



Examples:

Tongs

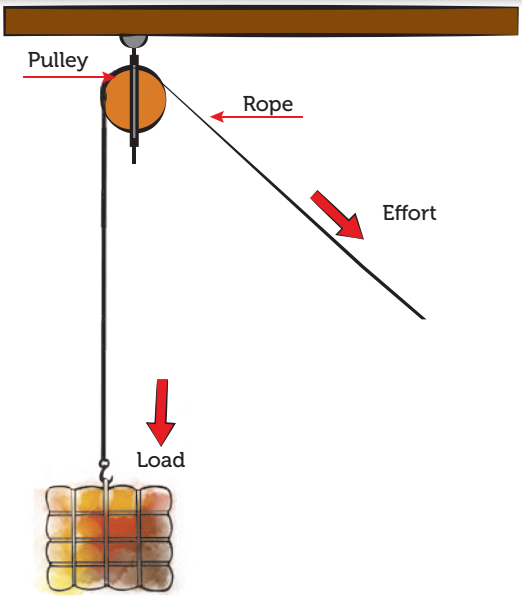


Stapler

2. INCLINED PLANE

An inclined plane, also known as a ramp, is a flat supporting surface tilted at an angle, with one end higher than the other, used as an aid for raising or lowering a load.

3. PULLEY



A pulley consists of a grooved wheel and a rope that runs through the groove. The wheel rotates on an axle that passes through its center. A pulley is used to lift heavy objects. When the free end of the rope is pulled, the load gets lifted.

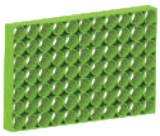
A pulley helps us in 2 ways,
1. It helps by changing direction, so if you need to pull a bucket of water out of a well, it is much easier to pull it downwards, and a pulley helps us do that
2. When you add multiple pulleys, just like other mechanisms, it can create mechanical advantage and allow a person to pick up far heavier loads than he could without a pulley system.

Let's make a model to understand how a pulley makes it easier for us to lift objects.

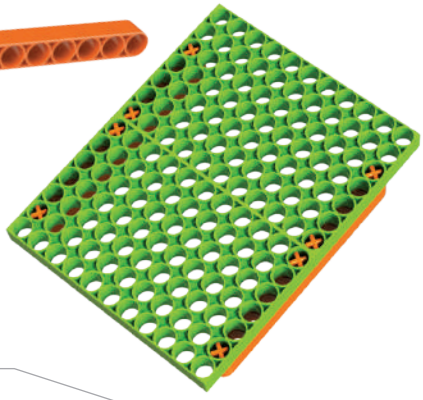
Step 1

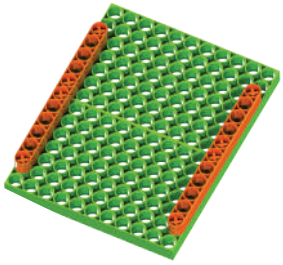
CT2 | 8 pcs.

P11 | 2 pcs.



P7 X 11 | 2 pcs.





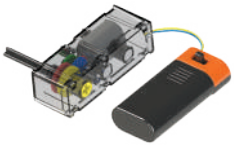
Backside view

Step 2

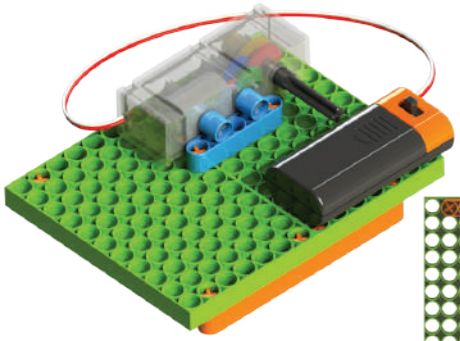
CT2 | 2 pcs.

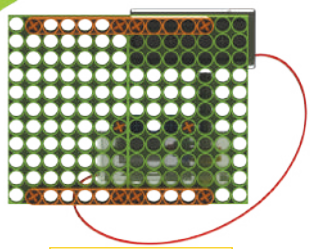
CH2 | 2 pcs.

P5 | 1 pc.



Motor with Battery Box 1 pc.





Backside view

Step 3

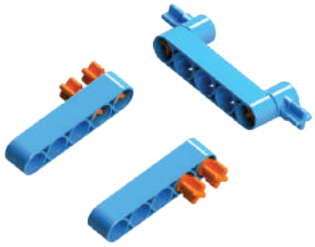
CT2 | 6 pcs.

CH2 | 2 pcs.

P5 | 3 pcs.

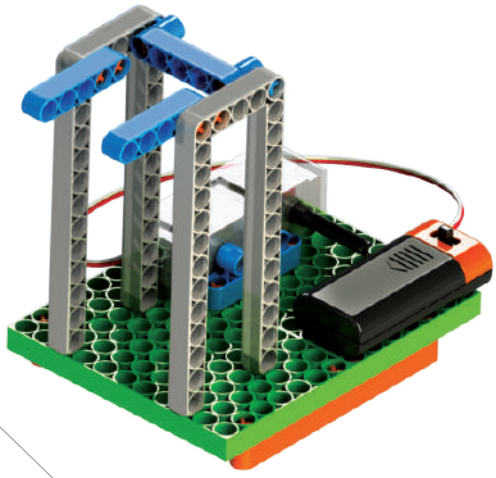
PU 5 X 13 | 2 pcs.

Make this first and then assemble



Step 4

Assembly of step 2 and step 3



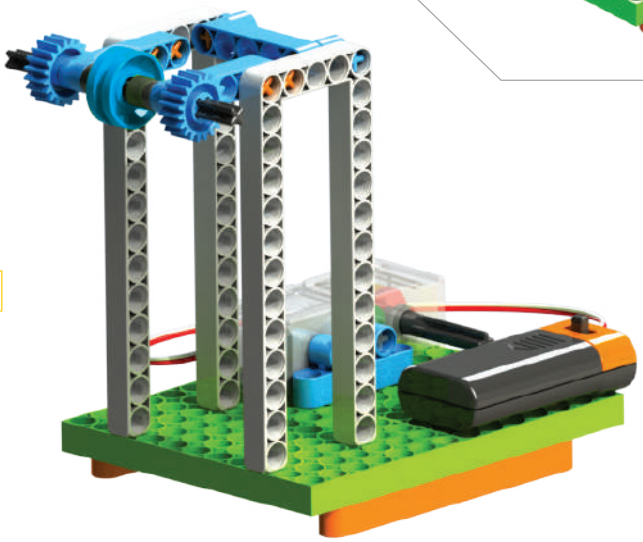
Step 5

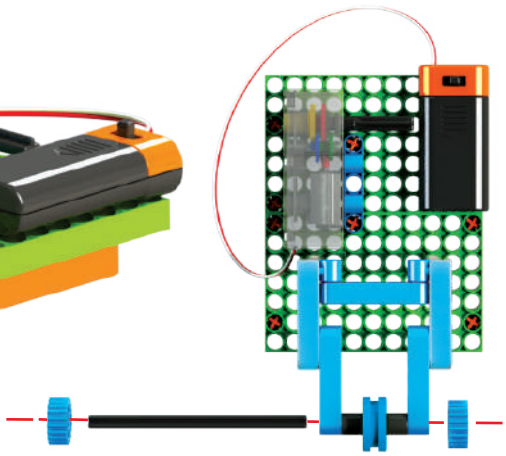
TW1 | 2 pcs.

G(20) | 2 pcs.

Pulley | 1 pc.

SH100 | 1 pc.





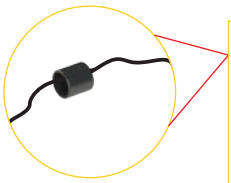
Top view

Step 6

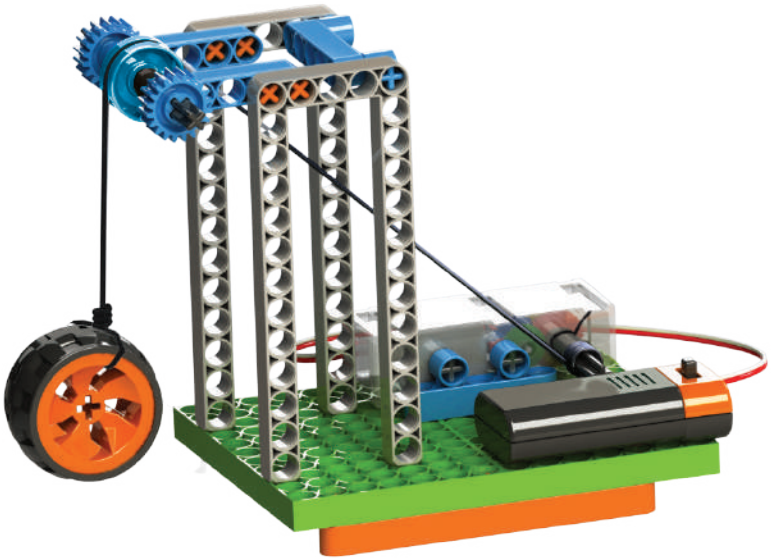
TW1	1 pc.

Thread	1 pc.

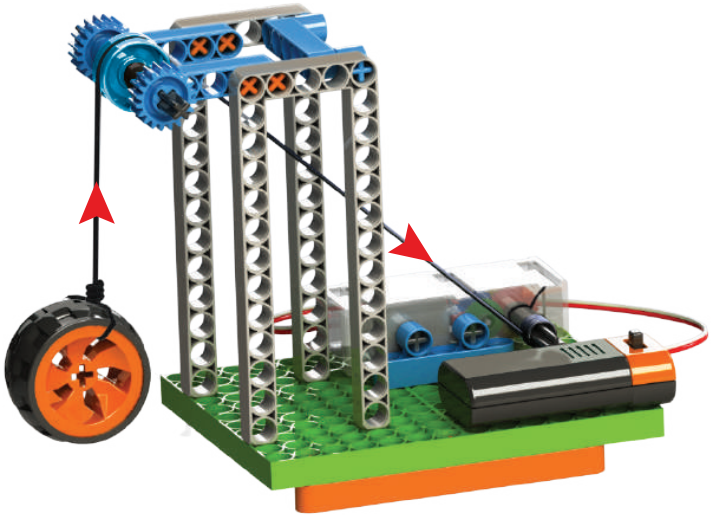
Wheels	1 pc.



Insert the thread into TW1 and then put it on the motor's shaft. Now pass the loose end of the thread through the pulley groove and then tie the wheel to it.



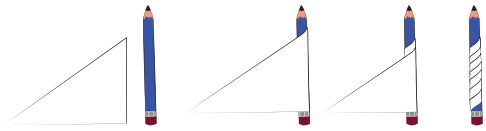
A pulley changes the direction of force.
Can you tell which direction is the motor pulling the thread? And what direction is the tyre moving?



4. Screw

A screw is an inclined plane wrapped spirally around a cylinder. The spiral ridges are called threads. One end of the screw is pointed while the other end has a groove. The grooves help in rotating the screw.

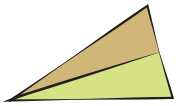
Take a paper and cut it into the shape of a right-angled triangle. Wrap the paper around the pencil.

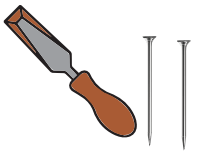


Can you guess how many motions are there in these images?

5. Wedge

A wedge is a pair of inclined planes put together to form a sharp edge. Wedges are mainly used to cut things into pieces or to push things apart.
A wedge has less thickness or area, this helps in increasing the **PRESSURE.**



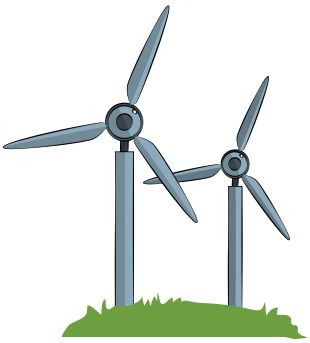


Can we decrease the pressure by increasing the area?

Why do big trucks have 16 or more number of wheels?

6. Wheel and axle

A wheel-and-axle arrangement consists of a circular disc (wheel) connected to a thin cylindrical rod (axle). The wheel, along with the axle, acts as a simple machine. They rotate each other when a force is applied to any one of them. Wheel and axle help us to turn and move things. For example, the axle of the motor rotates, and the wheel mounted on it also rotates.



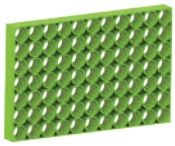
Can you guess in above pictures that weather wheel is rotating the axle or vice versa?

GEARED CAR 1-2

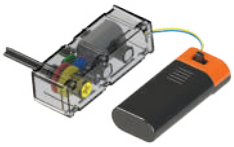
Step 1

CT2 | 2 pcs.

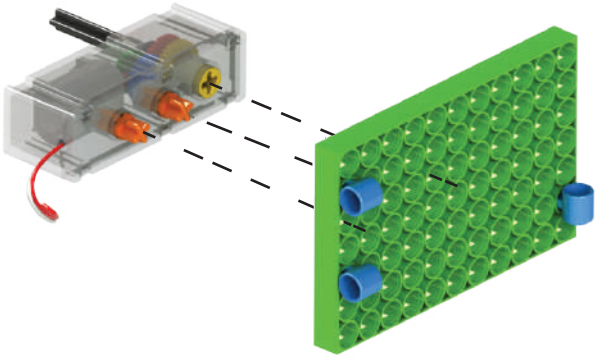
CH2 | 3 pcs.



P7 X 11 | 1 pc.



Motor with Battery Box 1 pc.



Step 2

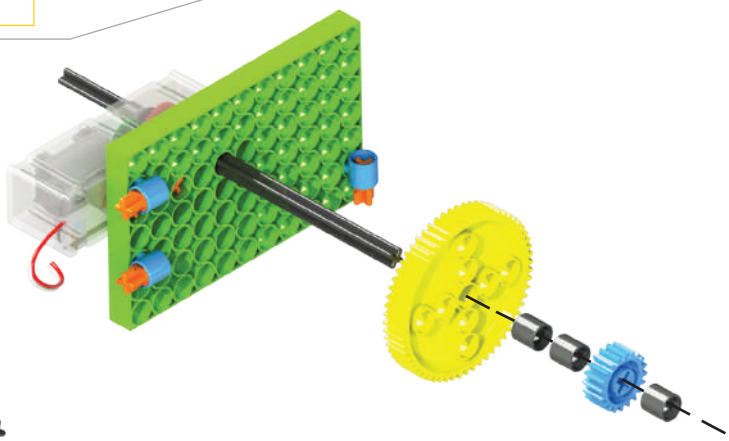
CT2 | 3 pcs.

TW1 | 3 pcs.

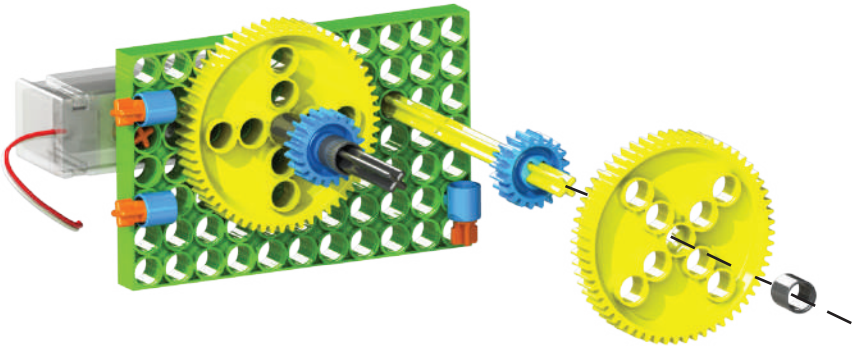
G(20) | 1 pc.

G(60) | 1 pc.

SH100 | 1 pc.



Step 3



TW1 | 1 pc.

G(20) | 1 pc.

G(60) | 1 pc.

SH170 | 1 pc.

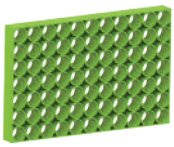
Step 4

CT2 | 3 pcs.

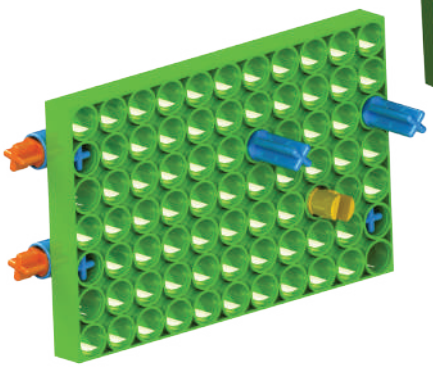
CT3 | 2 pcs.

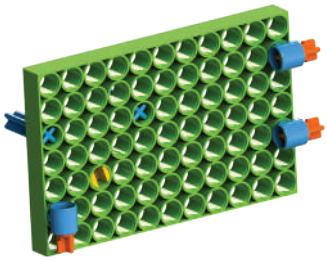
CL2 | 1 pc.

CH2 | 3 pcs.



P7 X 11 | 1 pc.



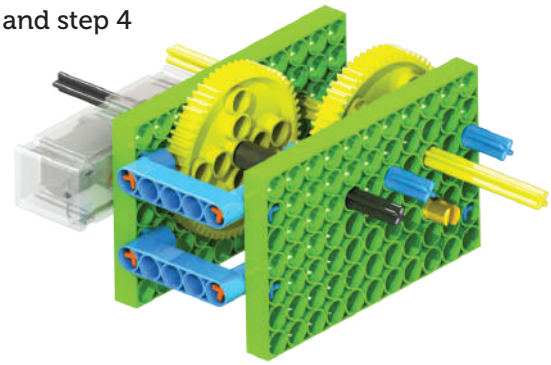


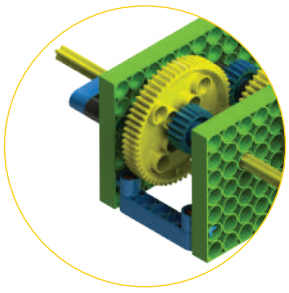
Backside view

Step 5

Assembly of step 3 and step 4

P5 | 3 pcs.





Backside view

Step 6

TW1 | 1 pc.

G(20) | 2 pcs.

Wheels | 1 pc.

G20 Idler | 1 pc.

SH170 | 1 pc.

Step 7

TW1	2 pcs.

P5	1 pc.

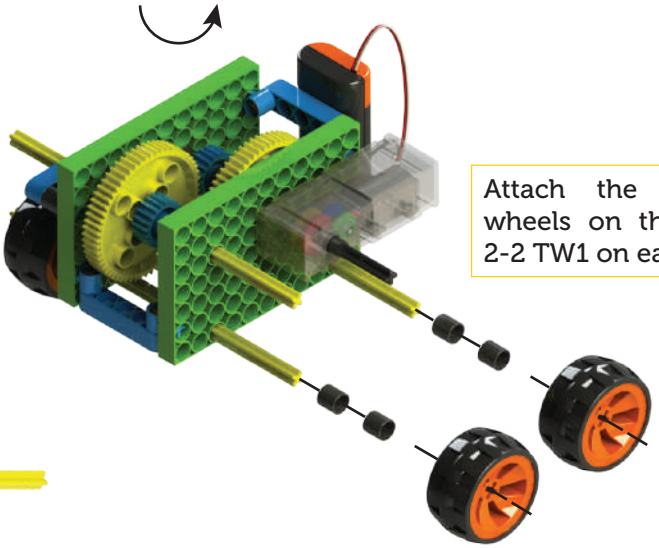
Turn the Model

Step 8

TW1	6 pcs.

Wheels	3 pcs.

SH170	1 pc.



Attach the remaining 3 wheels on the shafts with 2-2 TW1 on each side

Switch on the battery and mesh the G20 gear of SH170 with G60 of SH100.
Now try and mesh the G60 gear of SH170 with G20 of SH100 by moving the SH170.

Push it in or out to change the gear meshing

Do you see any difference?

Notes

DISCOVERING MOTIONS

CT2	28 pcs.

CT3	15 pcs.

CH2	20 pcs.

CL2	18 pcs.

TW1	18 pcs.

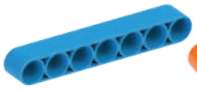
PC3	4 pcs.

P3 Plus	1 pc.

P3	8 pcs.

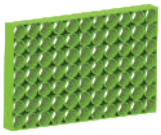
P5 Nut	1 pc.

P5	10 pcs.



P7	6 pcs.

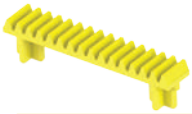
P11	8 pcs.



P7 X 11	2 pcs.

PU5 X 7	4 pcs.

PU5 X 13	2 pcs.



Rack	3 pcs.

Pulley	1 pc.

CT(1x2)	3 pcs.

G(20)	4 pcs.

G20 Idler	2 pcs.

G(60)	4 pcs.

Thread	1 pc.

Power Screw	1 pc.

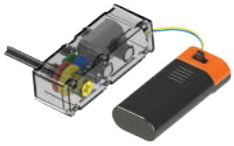
SH60	1 pc.

SH100	2 pcs.

SH170	3 pcs.

Removel Tool	1 pc.

Wheel	4 pcs.



Motor with Battery Box	1 pc.

For suggestions or feedback, please contact on

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