LIGHT AND SOLAR ENERGY

LEARNING LAB

#1240RR

168 PCS

7+

INVENTING CAN BE LEARNED

20 EXPERIMENTS INCLUDED

INVENTING CAN BE LEARNED

Gigo Learning Lab's complete series includes individual packages and school sets. The special features of Gigo's Learning Lab are as follows:

1. Using Gigo's "building block" construction-based curriculum, every class has a ready-toassemble model, and includes time designed to promote individual creativity.

2. Promotes thinking outside-the-box of the traditional educational framework by learning innovation through play!

3. We are all innately good at something, so we should take into account both individual development and the ability to work as part of a team effort.

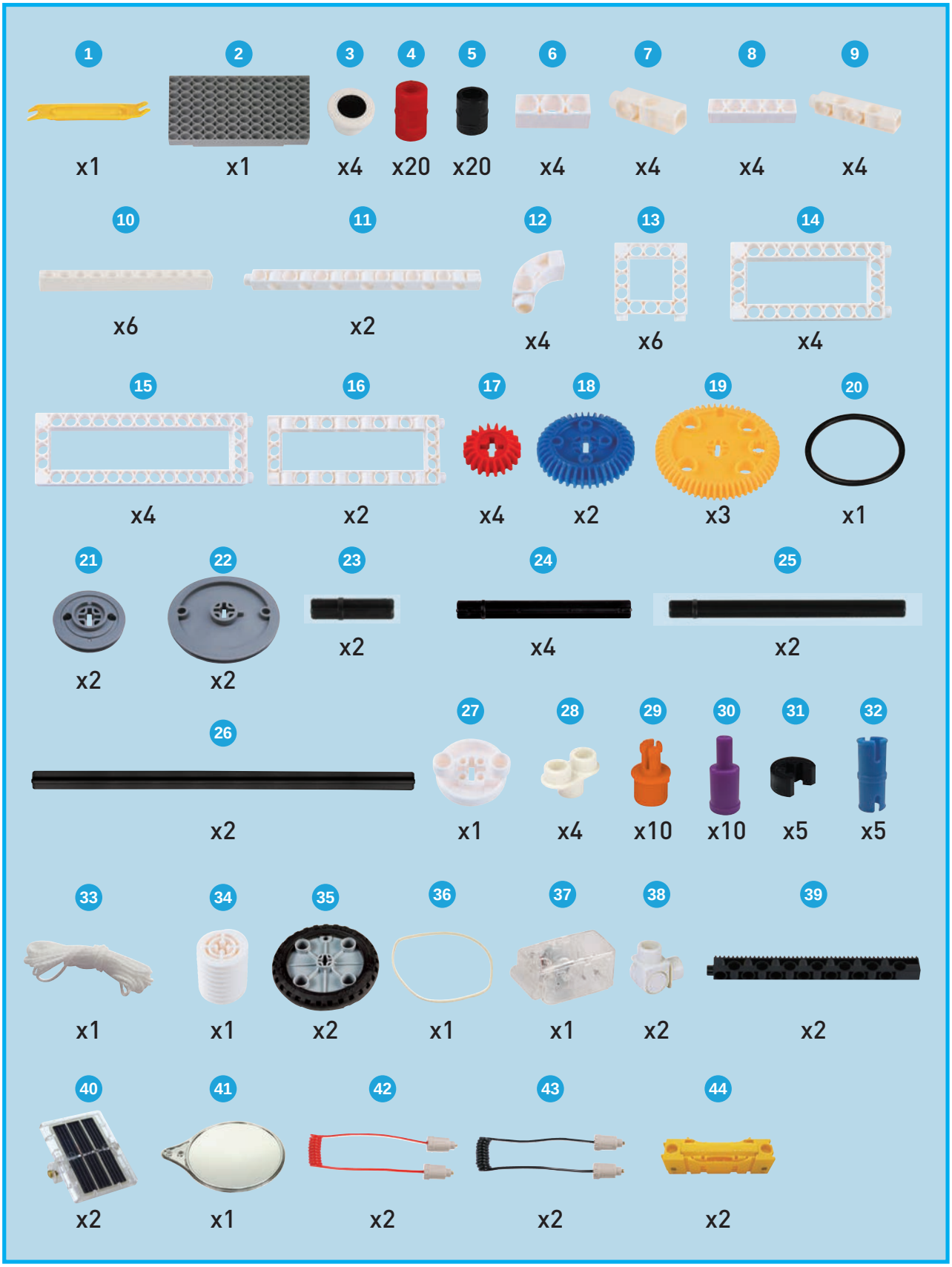
4. Course levels are designed from elementary to difficult, combining a life sciences-based curriculum with applications from daily life.

5. Experiment using Gigo's "building blocks", which can be used over and over again, saving both time and effort.

We hope that kids can enthusiastically learn scientific knowledge through fun hands-on experience, developing their problem-solving abilities, as well as a positive attitude towards science. Our mission is to help children apply their newfound knowledge to daily life, furthering their innovational skills and abilities.

Index

Parts List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Parts List：

No.	Description	Item No.	Qty.
1	B-PEG REMOVER	7061-W10-B1Y	1
2	C-BASE GRID	7125-W10-A1SK	1
3	B-EYE-1	7128-W22-1	4
4	C-LONG PEG	7061-W10-C1R	20
5	B-SHORT PEG	7344-W10-C2D	20
6	C-3 HOLE ROD	7026-W10-Q2W	4
7	C-3 HOLE DUAL ROD	7413-W10-Y1W	4
8	C-5 HOLE ROD	7413-W10-K2W	4
9	C-5 HOLE DUAL ROD	7413-W10-X1W	4
10	C-11 HOLE ROD	7413-W10-P1W	6
11	C-15 HOLE DUAL ROD	7413-W10-Z1W	2
12	C-BENDED ROD	7061-W10-V1W	4
13	C-5X5 FRAME	7413-W10-Q1W	6
14	C-5X10 FRAME	7413-W10-I1W	4
15	C-5X15 FRAME	7413-W10-J1W	4
16	C-5x13 DUAL FRAME	7061-W10-U1W	2
17	C-20T GEAR	7026-W10-D2R	4
18	C-40T GEAR	7346-W10-C1B	2
19	C-60T GEAR	7026-W10-W5Y	3
20	C-OD56 O-RING	R12-09S	1
21	C-OD33mm PULLEY	7344-W10-N2S1	2
22	C-OD53mm PULLEY	7344-W10-N1S1	2
23	C-30mm AXLE II	7413-W10-N1D	2
24	C-70mm AXLE II	7061-W10-Q1D	4
25	C-100mm AXLE II	7413-W10-L2D	2
26	C-150mm AXLE I	7026-W10-P1D	2
27	C-ROD CONNECTOR	7026-W10-L2W	1
28	C-TWO-IN-ONE CONVERTER	7061-W10-G1W	4
29	C-AXLE	7026-W10-H1O	10
30	C-CAM CONNECTOR	7413-W10-S1P	10
31	C-AXLE FIXING	3620-W10-A1D	5
32	C-20mm AXLE CONNECTOR	7413-W10-T1B	5
33	C-2000mm STRING	R39-W85-200	1
34	C-WORM GEAR	7344-W10-A1W	1
35	C-RACING TIRE	1115-W85-F2S	2
36	C-100mm RUBBER BAND	R10-05	1
37	C-16X MOTOR	1114-W85-E1K	1
38	C-HINGE	7061-W85-F1W	2
39	C-150mm RACK	7061-W10-T2D	2
40	C-1.5V MOVABLE SOLAR PANEL	1170-W85-A1	2
41	C-SUN COLLECTOR	7362-W25-K1	1
42	C-WIRE CONNECTOR	7050-W85-5R	2
43	C-WIRE CONNECTOR	7050-W85-5D	2
44	C–1.5V BATTERY HOLDER WITH FUSE II C–1.5V BATTERY HOLDER LID III	7050-W85-O1 7455-W10-C1Y	2

Keep the instruction since it contains important information.

Requires 2 AA / LR06 batteries–not included.

TIPS AND TRICKS:

Here are a few tips for assembling and using the models.
Read them carefully before starting.

For more assembly tips, please refer to

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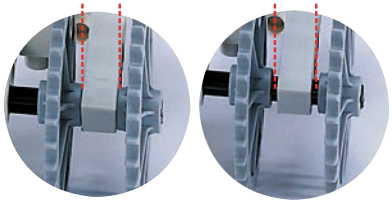


Fig.1 Fig.2

A. Pay attention to the hole:

When fixing gears onto the frame with drive axle be sure to keep a proper space (about 1mm) between the gear and the frames (Fig. 2). And try to turn the gear to ensure every gear in the gear train turning smoothly so that the least friction will be created and most efficient power transmission can be expected.

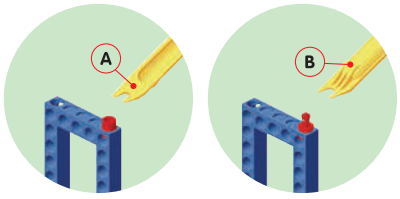
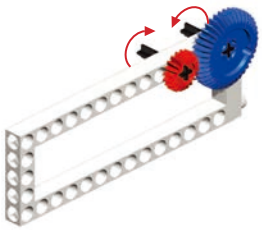


Fig.3 Fig.4

B. B-Peg remover:

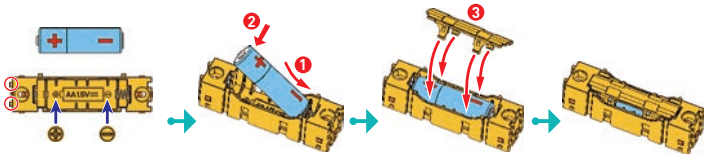
Using peg remover to pull peg off as Fig.3 shows.
Using peg remover to pull axle off as fig.4 shows.



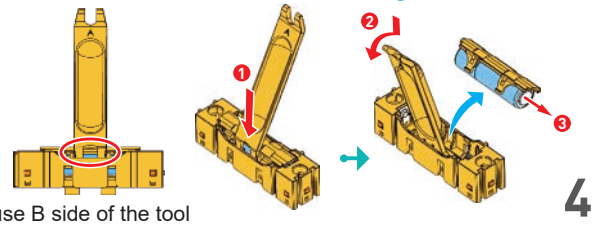
C. Gear wheels:

The models will often have several gear wheels installed in a row, or gear train. In order for the models to work well, thesae gears will have to mesh well. Otherwise, the force from one gear wheel won't be properly transferred to the next.

How to insert battery:



How to remove battery:



use B side of the tool

1 Sundial

Scientific Application

The Sun and its Position

Today, after school, Gigi was walking alongside the school building as the Sun was setting. She began made small marks with chalk to mark the place of the shadows on the ground. After she had finished marking the shadow of 20 trees, she turned around to appreciate her work; however, she noticed that the shadow of the tree furthest away had got longer! Confused, she ran back into the classroom and asked her teacher why.

Gigi's teacher asked her to make a shadow by shining a lamplight on her hand. Her teacher then told her to slowly lower the lamp. Gigi noticed that shadow of her hand on the table was getting longer and longer the more she lowered the lamplight. When her teacher moved the angle of the light source, Gigi discovered that the position of the shadow also changed.

Afterwards, Gigi's teacher shined the light horizontally so that the shadow of her hand was cast onto the classroom wall. Her teacher then began moving her hand until the shadow on the wall began to look like a dog! Gigi was so impressed that she began trying to do the same thing.

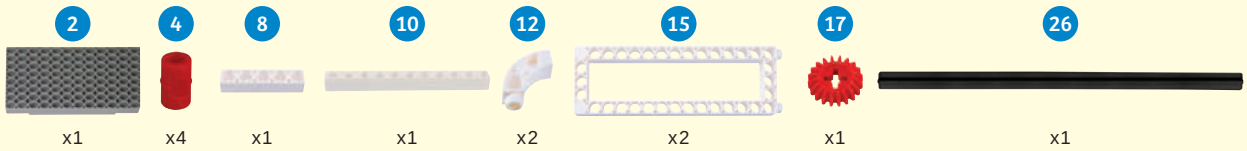
Daily Application

Light always has a direction. When the Sun's position in the sky changes, so does the position of the shadows cast by objects in the Sun's light. In the past, people exploited this phenomenon to invent devices that could tell the time of day. This device was known as a "sundial". A sundial is a device with a thin strip called a style, which casts a shadow in whichever direction the Sun is shining. The surface that the style's shadow is cast upon has different lines representing the different hours of the day. As the Sun moves across the sky, the shadow of the stylus lines up with the corresponding "hour" of the day.

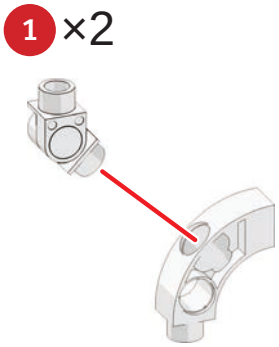
Brainstorming

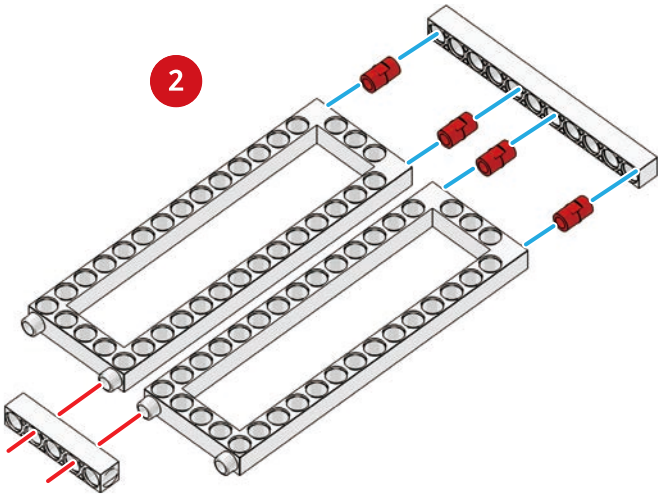
What is the Sun's position in the sky at different times during the day?

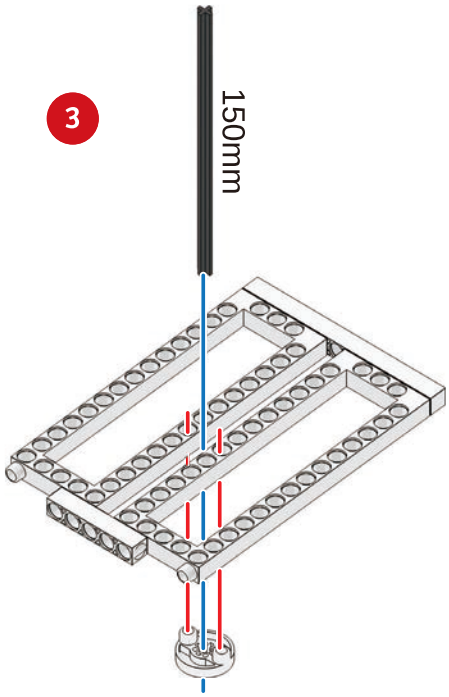
Parts List

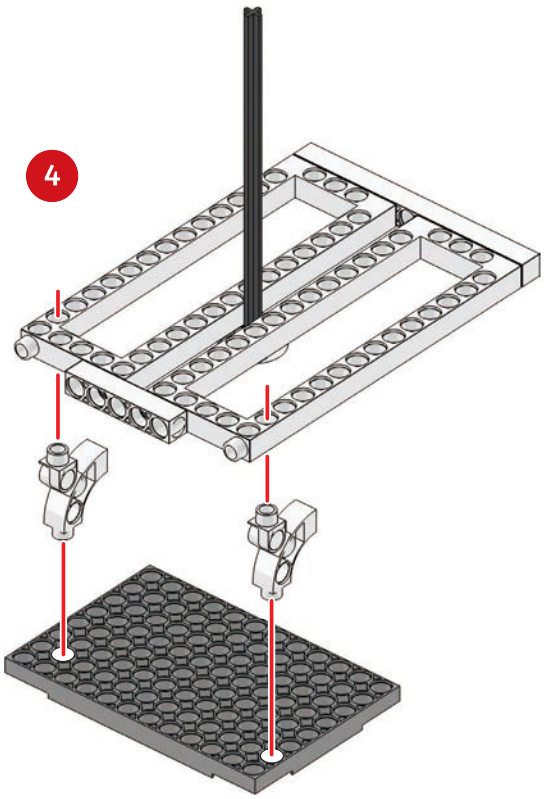


※ P. 77 Paper card-Sundial Clock









1 Sundial

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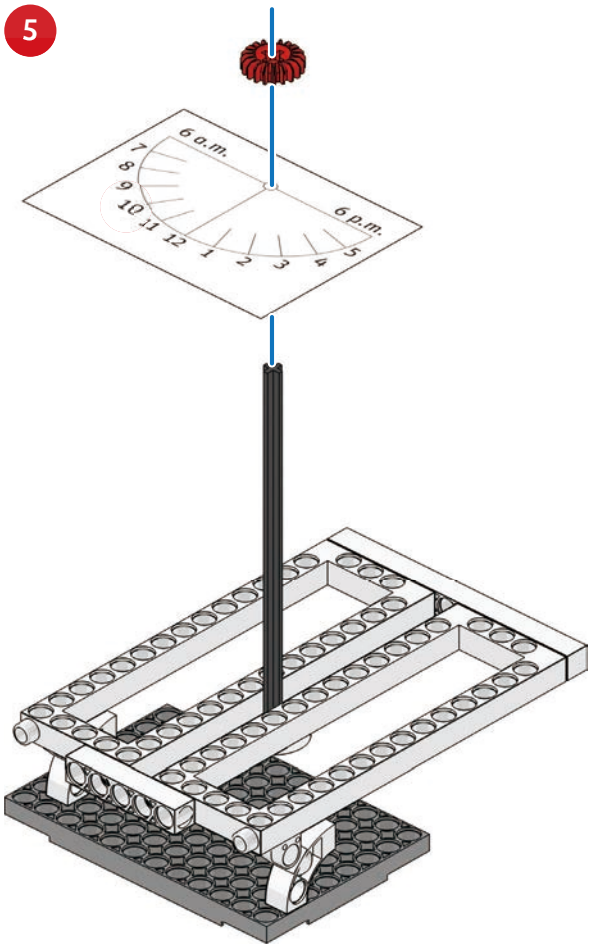

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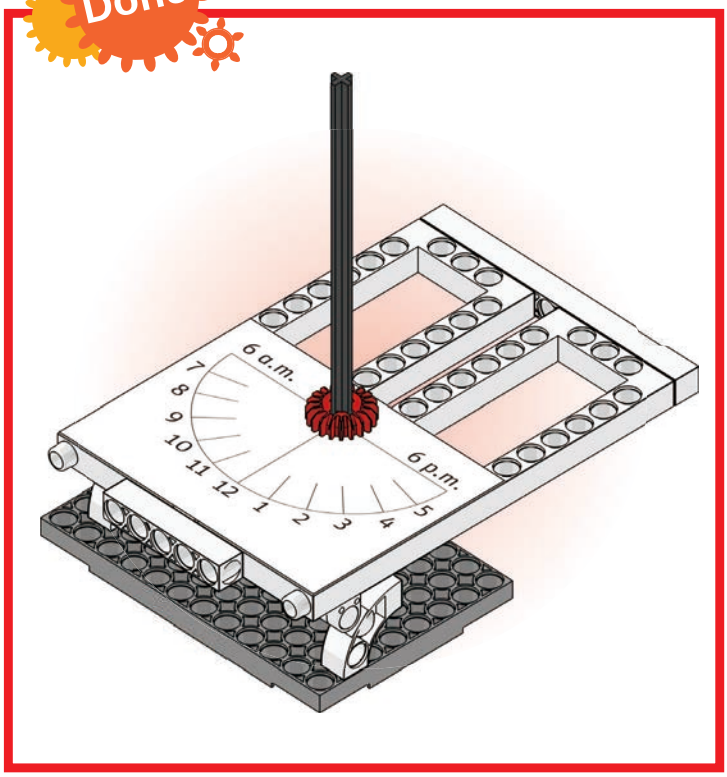


Model Operation Video

Hands-on Experiment

Based on your model, try to draw a semicircular sundial and mark the times from 06:00 to 18:00

Hands-on Creativity

Make the sundial scale more accurate and then take it outside to work with a compass and see whose time is more accurate.

Evaluation

Smart Manual
Web Service

1	2	3
Model Assembled	Experiment Complete	Model Creation

2 Tightrope Walking

Scientific Application

Solar Path Story

Gogo used to watch the stars and the moon with his father when he was little. Later, after he started going to school, he joined the astronomy club. He worked hard to learn as much as he could about astronomy every day after school.

One night, Gogo was entranced by a meteor shower. He saw hundreds of shooting starts in the sky at around 3:00 AM. He also was a self-taught astronomy photographer. He enjoyed taking long exposure shots of stars.

Since the teacher discussed the Sun's orbit in the class, Gogo realized that the star's arc-shaped trajectory, seemingly rising from the east and setting in the west, is just a the part that we get to see. We only see this part, because of how we rotate around the Sun, and this relative motion between the Earth and stars means what we can see in the sky changes over time. Out of the stars we can observe from Earth, the Sun is the only one we can see during the day. While at night, we are able to see many more as the Sun does not overpower their light.

Kids, can you feel the Earth's rotation as it revolves around the Sun? Which phenomena help explain the Earth's rotation?

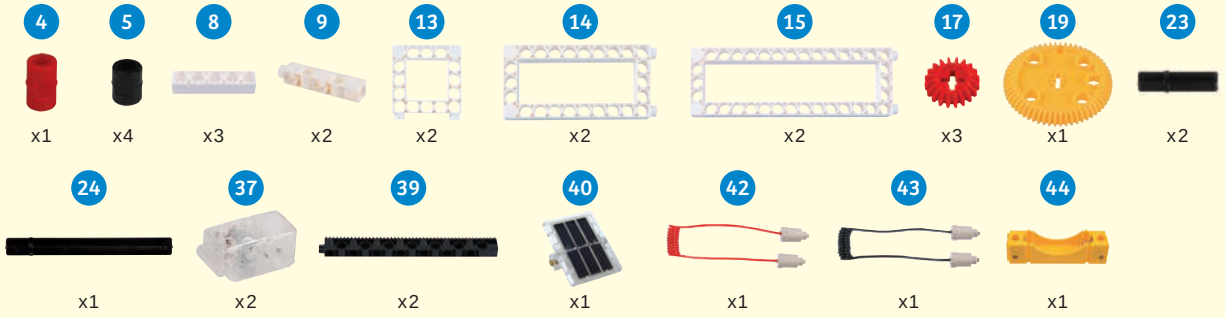
Daily Application

"When two objects are attracted to each other, and one of them is a planet, we usually call this force of attraction "gravity". If the two mutually attracting objects are planets, there must be an effective range, or distance; and if the two planets form an independent system, any matter beyond the gravitational range will be in a gravity-free state. In outer-space there is a lot of matter floating around, as it bumps into other matter, it sticks together and the gravity force becomes stronger, attracting more matter. Eventually, many bits start floating around one another and form orbits. In our solar system all the planets are revolving around the Sun, alongtheir own elliptical path.

Brainstorming

How does the Sun's path differ in summer to winter?

Parts List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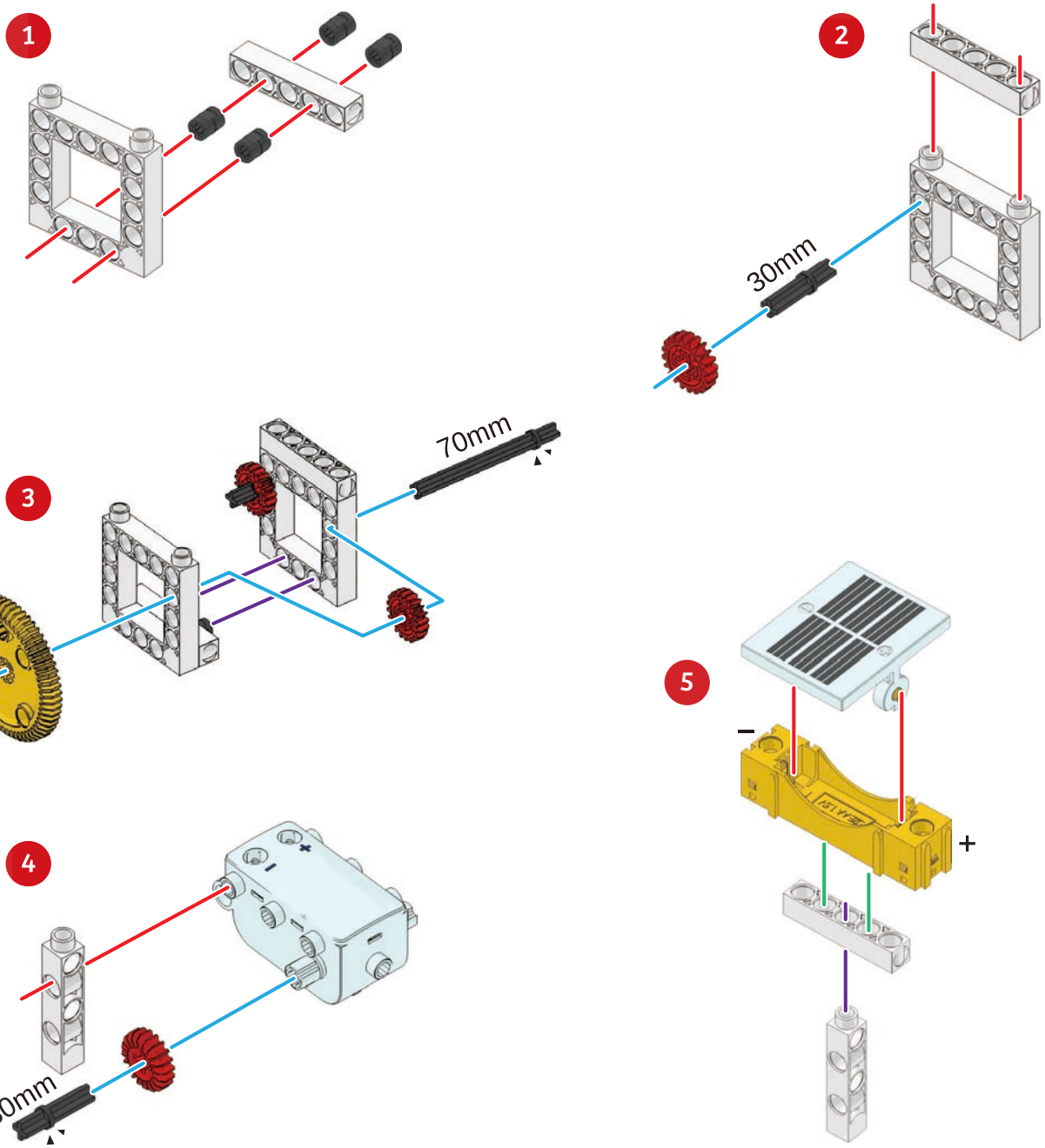
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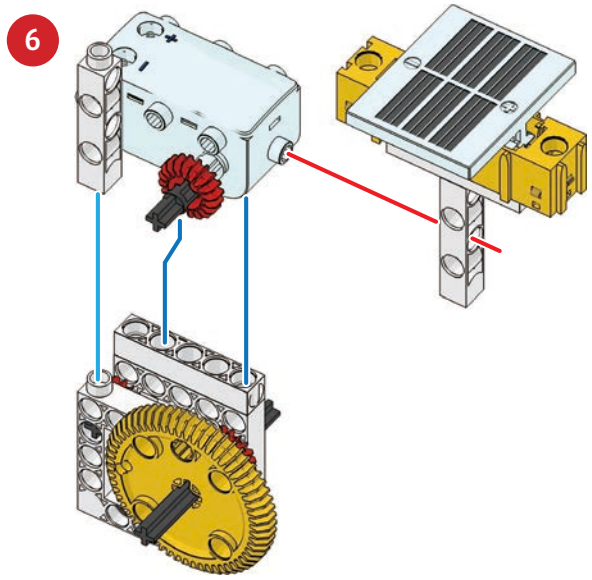
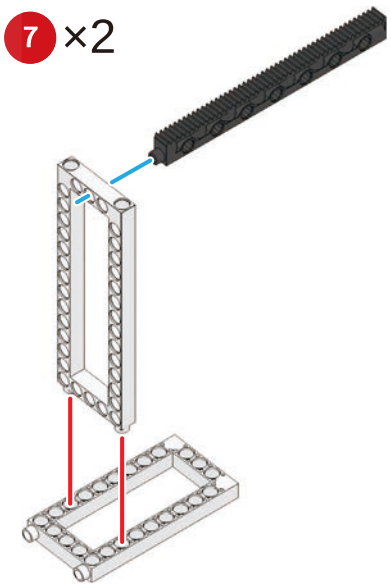
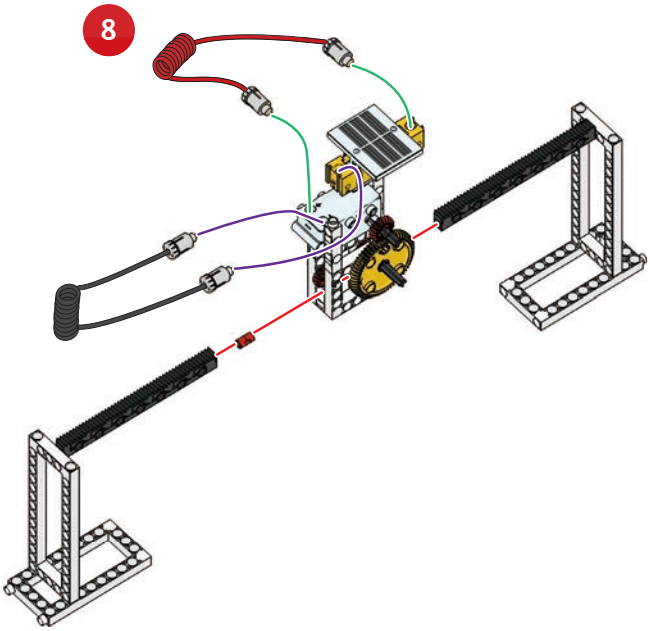
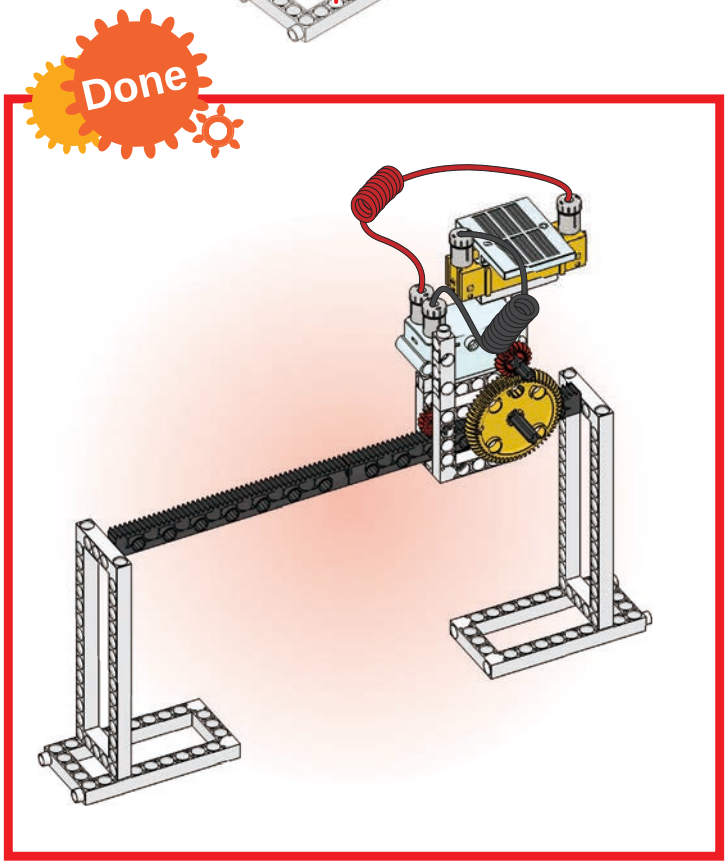
2 Tightrope Walking









Model Operation Video

Hands-on Experiment

What methods can we use to make the model move in reverse?

Hands-on Creativity

Try modifying the model to make it go faster!

Evaluation

Smart Manual
Web Service

1 Model Assembled

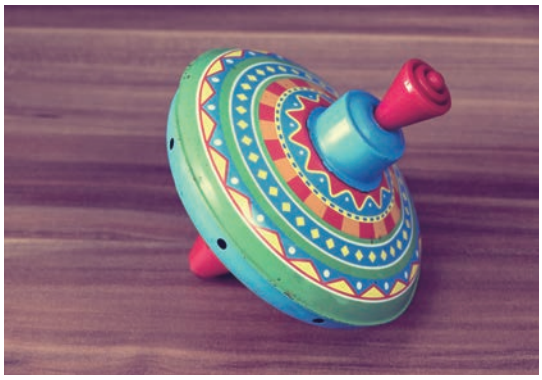
2 Experiment Complete

3 Model Creation

3 Solar Gyro

Scientific Application

Earth's Rotation



Have you ever played with a gyroscope? Do you know why and how it can rotate? Is the axis of the gyro perpendicular to the ground? If you give it a push, a gyro will rotate around its own axis. In fact, a gyro's rotation is not perpendicular to the ground; it deviates from the perpendicular line to a certain degree, but the momentum generated by rotation balances the torque, keeping the gyro rotating. The friction during the rotation, however, will decrease the rotating momentum and slow down the gyro as it becomes further inclined. Eventually it will stop spinning as it falls over.

The Earth is rotating just like a gyro! But the Earth's rotation never stops. The Earth is located in the solar system, which was originally just a nebular dust cloud, driven by gravity and momentum. The nebular cloud then gradually changed from a disorderly state into an orderly flat galaxy due to the effects of rotation and gravity. The Sun was the most dense thing in the solar system and thus the weight of the Sun pulled other objects into orbit around it and finally the entire galaxy was rotating as one. The direction of rotation was gradually established, following the right-hand rule, meanwhile, rotation even continued inside planets (like the Earth) which still has a spinningmolten iron core today.

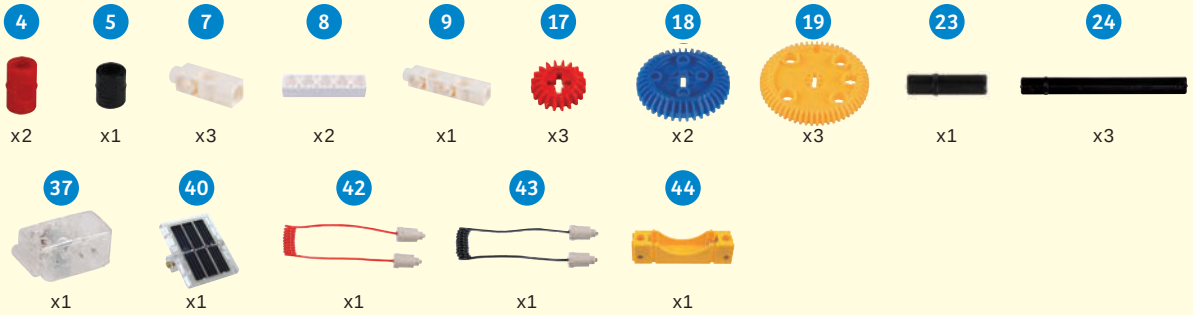
Daily Application

Earth is in an ideal distance from the Sun. If Earth were a bit closer to the Sun, like Mercury or Venus, it would be too hot for any living things to survive; on the other hand, if Earth were a bit farther away from the Sun, as is Mars, it would be so cold that its surface would have been always frozen. Also, Earth's rotation cycle is in a moderate length. If it were too long, as is Mercury, its sunny side would have been over-exposed to the Sun, making the surface burning hot (over 400°C), while the shady side would have not received any sunshine, making the surface cold like ice (as cold as -173°C) Earth's axis of rotation tilts to one side, and as a result, Earth's equatorial plane and zodiac plane are not parallel, with a nearly 23-dgree inclination. If such an inclination were smaller, the four seasons would not have been possible, and if it were larger, the seasonal temperature difference would have been so dramatic that some areas would have been in permanent day-light summer, while others in a permanent dark night like winter.

Brainstorming

What would happen if Earth stops its rotation?

Parts List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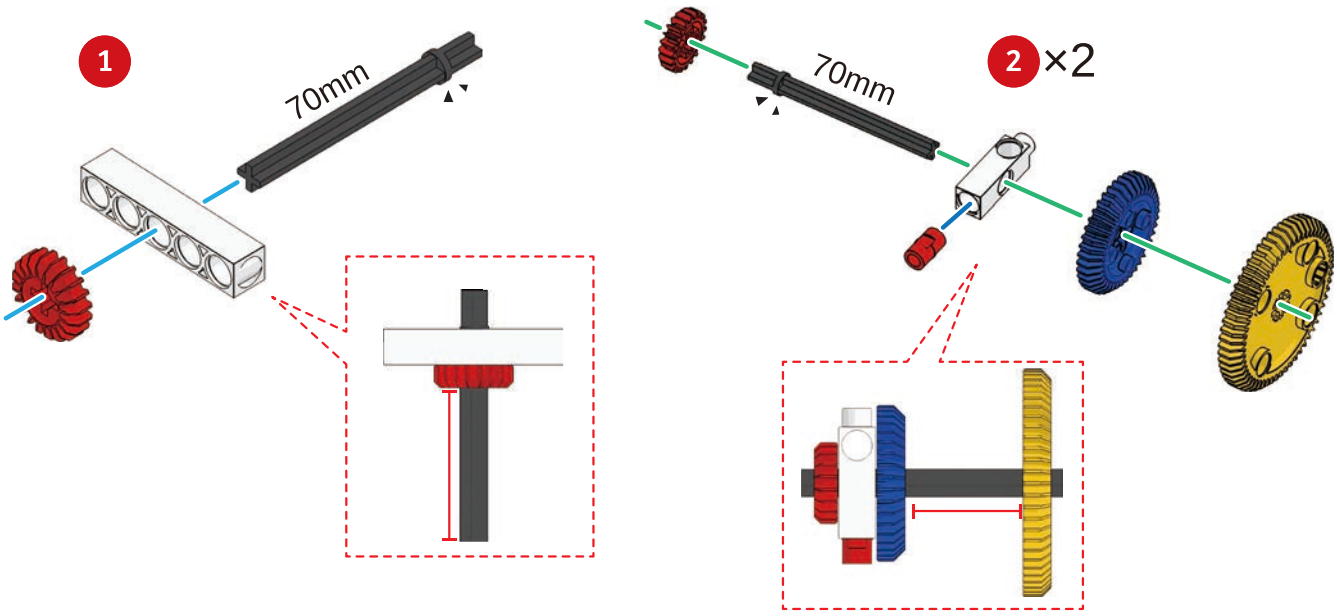
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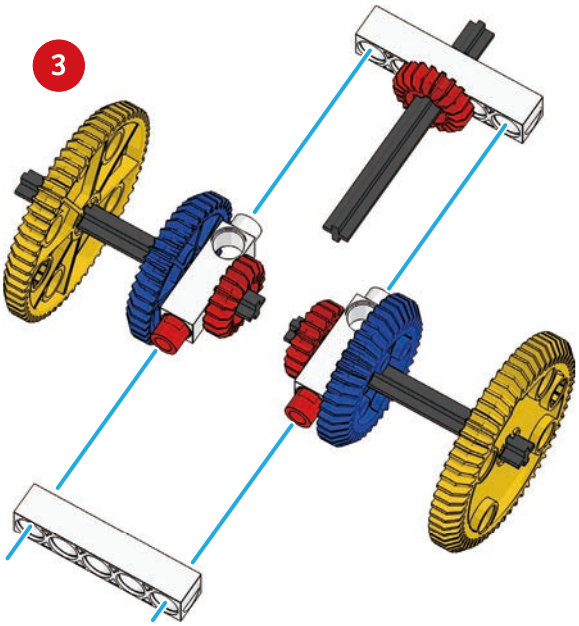
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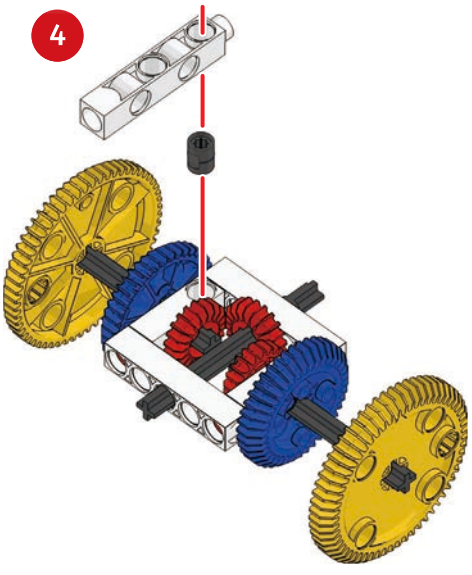
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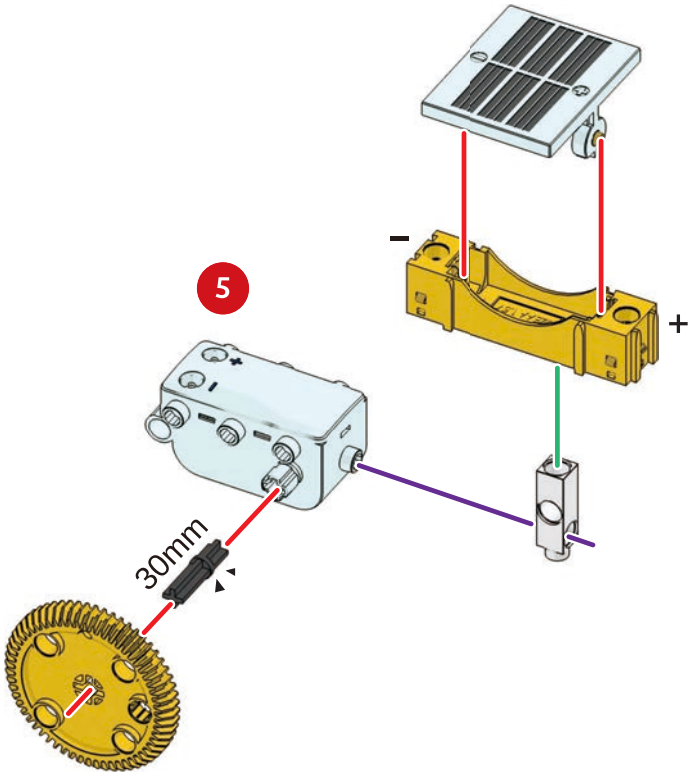
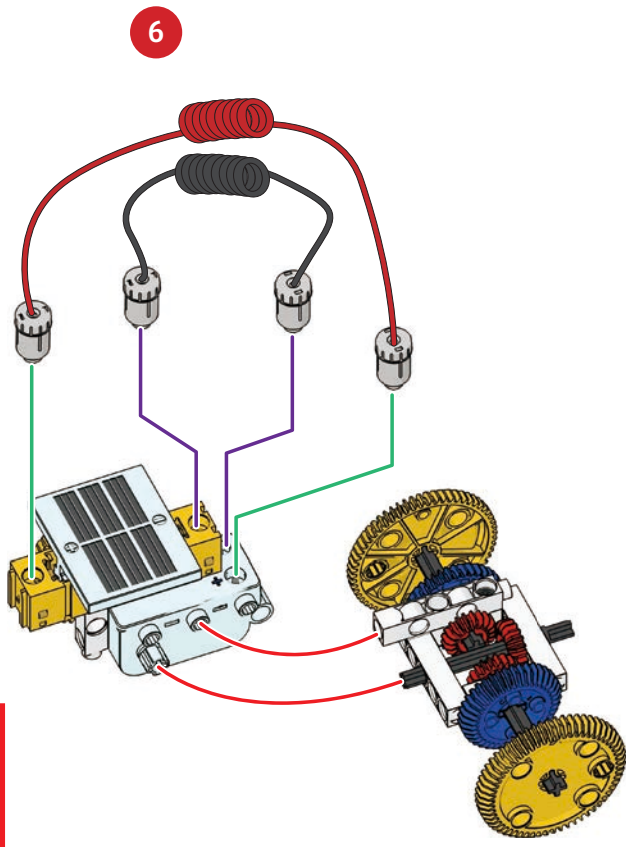
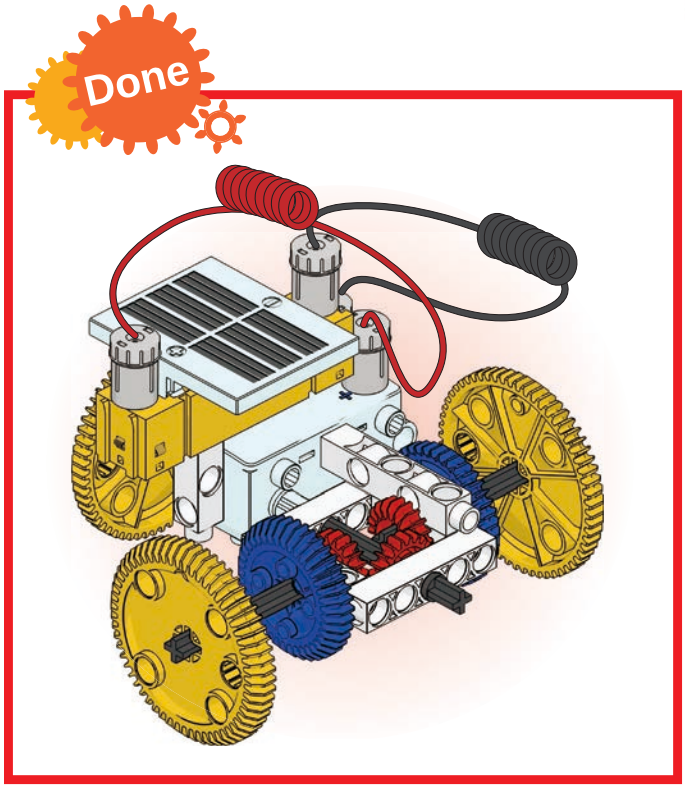
3 Solar Gyro







Model Operation Video

Hands-on Experiment

How can we make the model rotate faster?

Hands-on Creativity

Use colored paper to remodel your solar-system gyro.

Evaluation

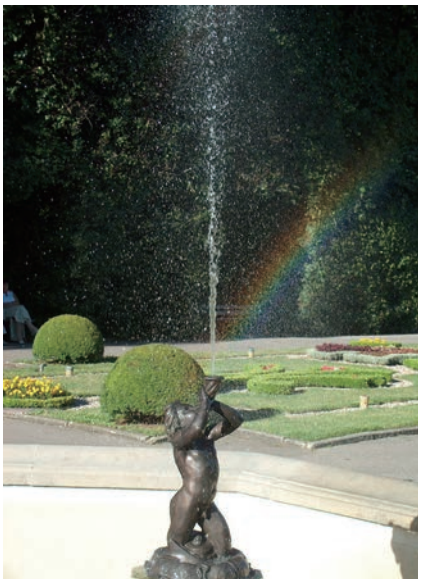
Smart Manual
Web Service

1	2	3
Model Assembled	Experiment Complete	Model Creation

4 Commercial Signboard

Scientific Application

Solar Spectrum



One summer evening, Gigi and her mummy were watering the garden. The water hose spurted out columns of water that produced rainbows under the strong sunlight. Gigi was amazed by this and wondered how rainbows could suddenly just appear in her garden! She rushed back to her desk and searched the encyclopedias for an answer.

Gigi kept nodding her head as she read, as she learned and understood. “Okay! The brightness of rainbows is determined by the size of the water droplets. The larger the droplet size, the brighter the rainbow, and vice versa. Wow! The reason I could see the rainbow was because the Sun was behind me, while I was looking to the east, the rainbow was in the direction opposite to the Sun. Now I get it. Rainbows can also be seen around waterfalls and fountains. I’ll be sure to look for them in the park next time I’m there.”

But, why did rainbows never show up around noon time? The answer was a bit too difficult for Gigi to grasp:“At noon time, the center of the rainbow arch happens to be in the direction of the shadow made by the observer’s head, and the rainbow is above the observer’s head shadow, in a 40° to 42°-degree angle to the horizontal line of the observer’s eyes. As a result, when the Sun is up in the sky at an angle of greater than 42°, the rainbow’s position will be below the horizon, making it not visible.”

Kids, will you be able to help Gigi with this question? Draw a rainbow, along with the positions of the observer and the Sun relative to the rainbow.

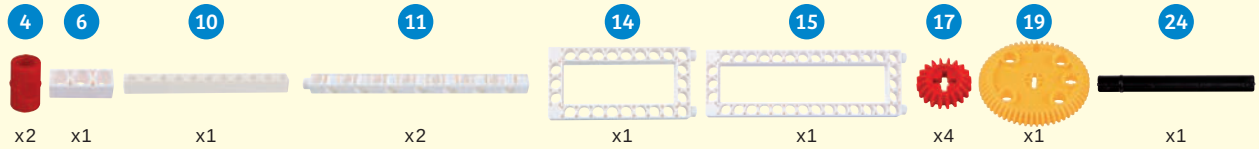
Daily Application

The Sun’s spectrum is made of continuous light of different wavelengths, some of which are visible, while others invisible. The visible light has wavelengths of 400~760nm, radiating into the colors red, orange, yellow, green, blue, indigo and violet. When they are all present, they create white light. The invisible light frequencies have two types: infrared and ultraviolet. The most commonly seen commercial signboards are made of canvas, plastics, and a light box. Shops used to prefer illuminating signboards, but excessive brightness and environmental consideration have made the choice of energy-saving LED screen more popular in place of the traditional incandescent lamps.

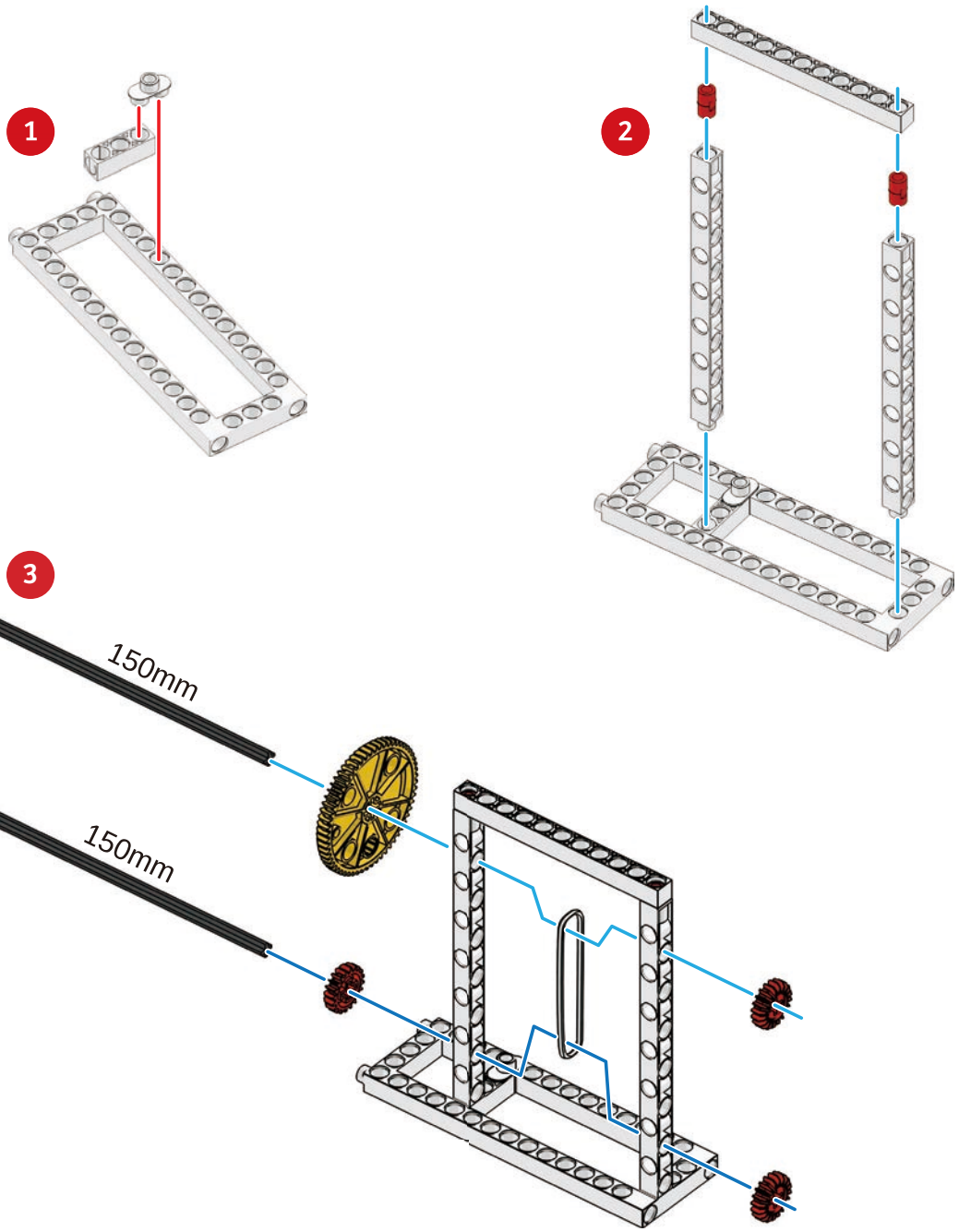
Brainstorming

Have you ever watched the color changing in the sky over the course of a day?

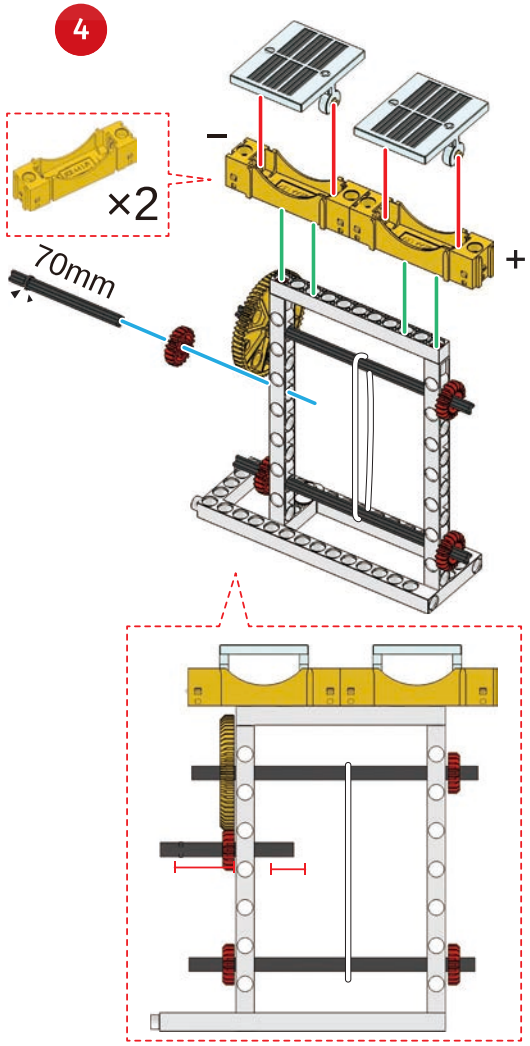
Parts List

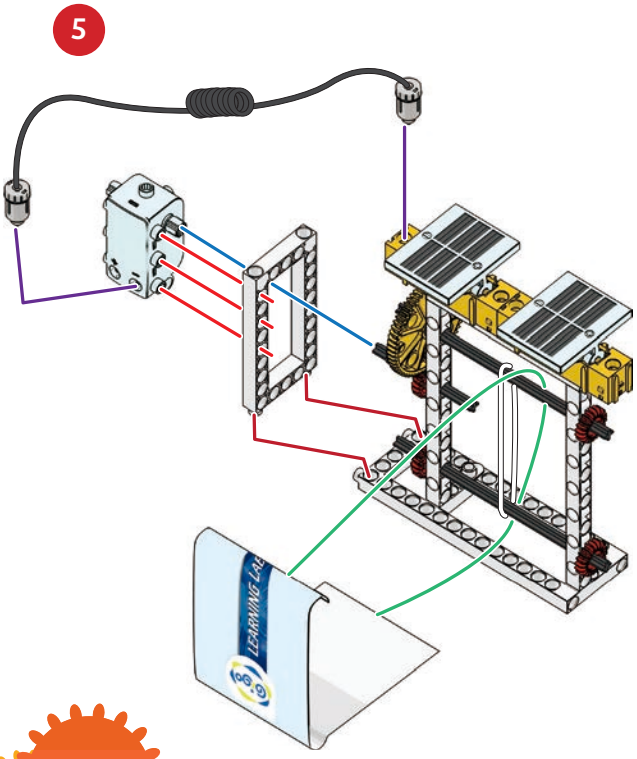


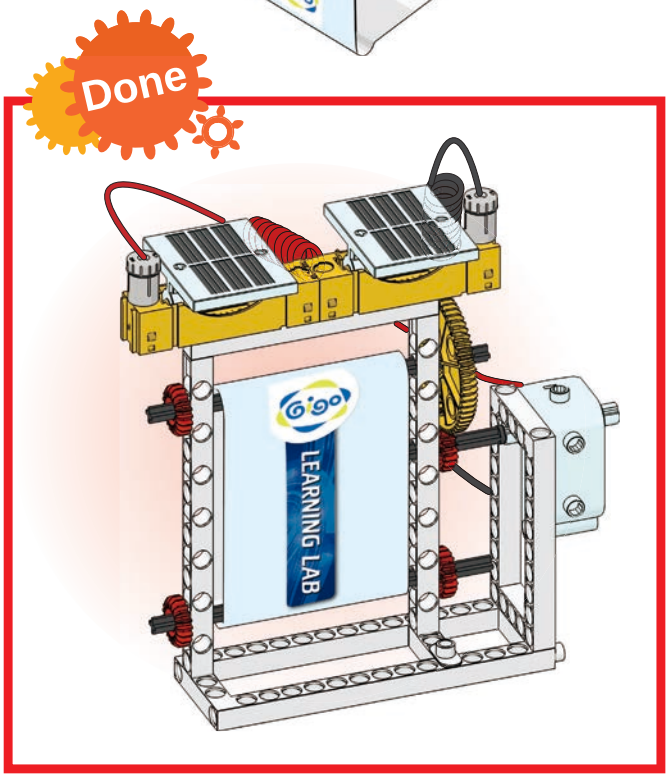
※ P. 78 Paper Card - Commercial Signboard

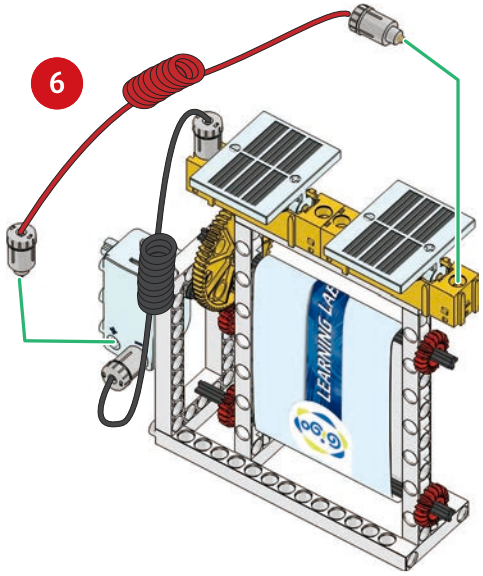


4 Commercial Signboard









Model Operation Video

Hands-on Experiment

When comparing different light sources, can you see the difference of the commercial signboard's spinning speed.

Hands-on Creativity

Let's design the contents of a commercial signboard and have a drawing contest.

Evaluation

Smart Manual
Web Service

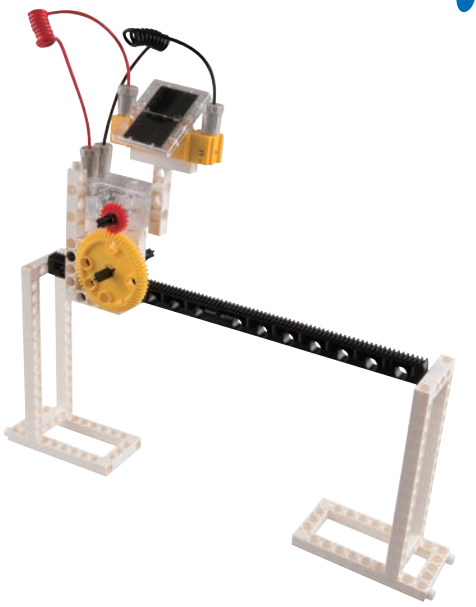
1	2	3
Model Assembled	Experiment Complete	Model Creation

5 Monograph 1

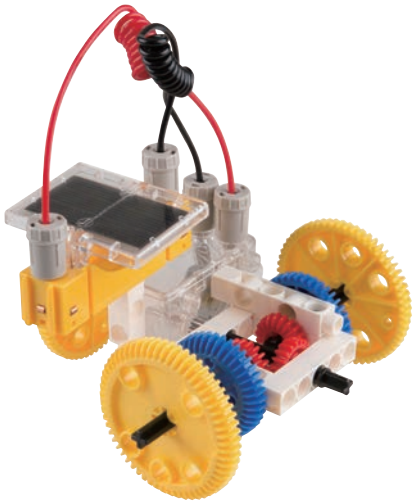
In order to explore different places and conditions on Earth and the wonders of the cosmos, people invented and launched solar-powered satellites. Try and build a satellite.

Model Review

1. Sundial



2. Tightrope Walking



3. Solar Gyro

4. Commercial Signboard

Design Concept

My Artwork

Evaluation

1 Model Design

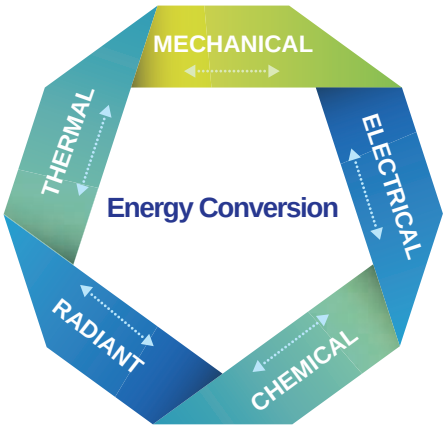
2 Model Creation

3 Winner!

6 Swinging Signboard

Scientific Application

Energy Transformation

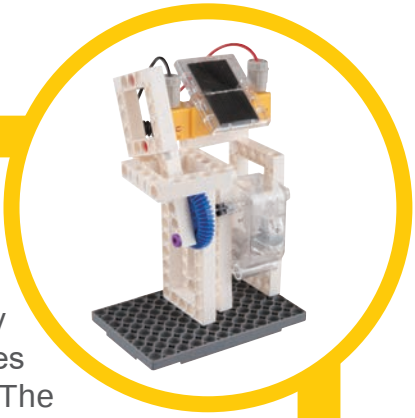


In the 19th century, there were two people in Europe who successively discovered important laws of energy-conservation and energy-transfer. One was Doctor Julius Robert Mayer, a German, and the other was James Prescott Joule, a British beer businessman. The concepts they proposed were too novel and were unable to be verified at that time, so they were not recognized by the scientific community at the time.

Mayer worked tremendously hard for recognition, but people mostly thought he was crazy. Then, after he lost his beloved son, he attempted suicide by jumping off a building. He was rescued, but sent to a mental hospital.

Joule chose to keep a low profile and continue his experiments. When the research results became significant he publicly announced his findings. He argued that mechanical energy can be quantitatively converted into heat; and conversely, the heat of a thousand calories can also be converted into a power of 423.9 kilograms (kgf • m). He was immediately challenged by William Thomson, who shouted, “Nonsense! Heat is a substance, a heat element, and has nothing to do with power.” Joule responded calmly, “If heat cannot generate power, then why do the steam engine’s pistons move? If energy conservation is not true, why has a perpetual-motion machine never been built?” His reply immediately brought enthusiastic discussions. Later, when Thomson inadvertently obtained Mayer’s paper, he reflected on his opinion and came to Joule’s beer factory to apologize. After this time, the two worked closely together. A few years later, they co-published an accurate description of the laws of energy conservation andenergy transfer.

Daily Application

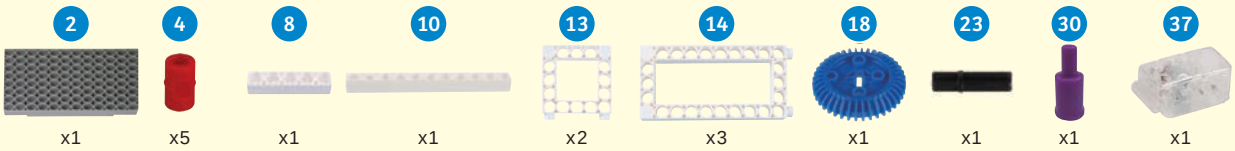


The fundamentals of energy conservation and energy transfer are: (1) energy will neither be generated, nor disappear, only change form. In the course of the conversion or transfer, the total energy remains unchanged. (2) The law of energy conservation states that it is impossible to build a perpetual-motion machine. The impossibility of a perpetual-motion machine also proves the law of the conservation of energy. In shops one can often see dynamic displays that repeat a movement. These are tricks to attract people's attention and encourage them to come in and stay. Dynamic advertisements are better than static ones for catching and keeping people's attention.

Brainstorming

If energy could be generated out of thin air, what the world would look like?

Parts List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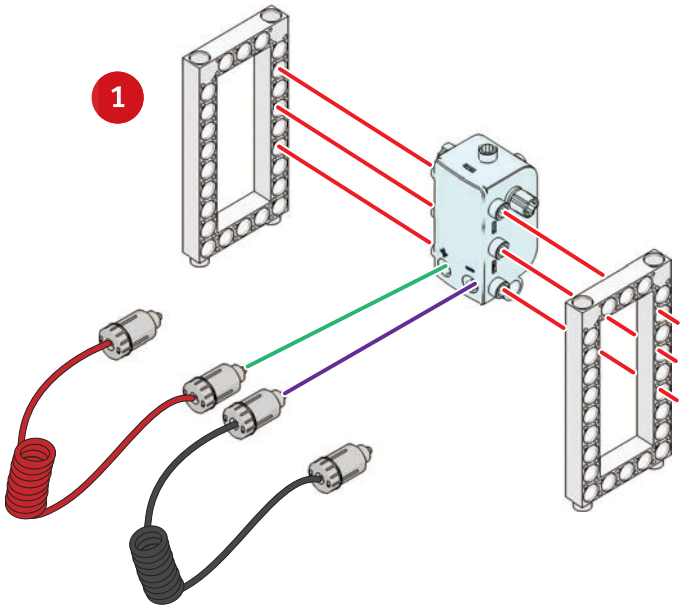
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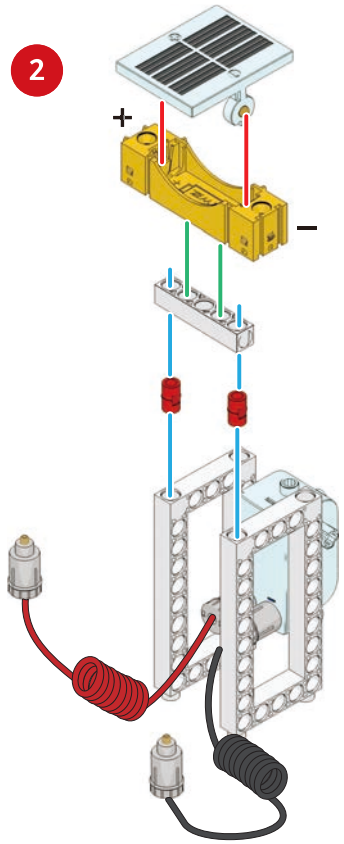
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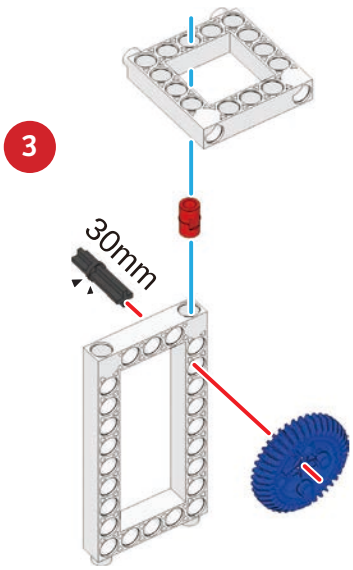
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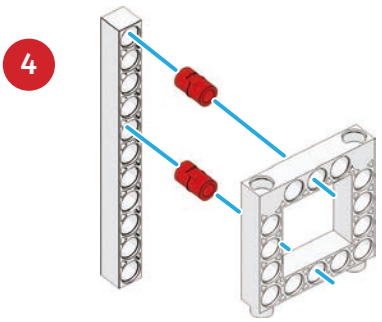
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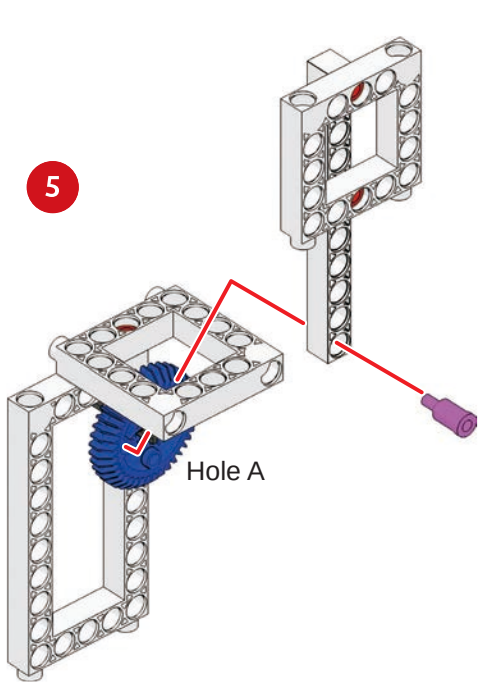
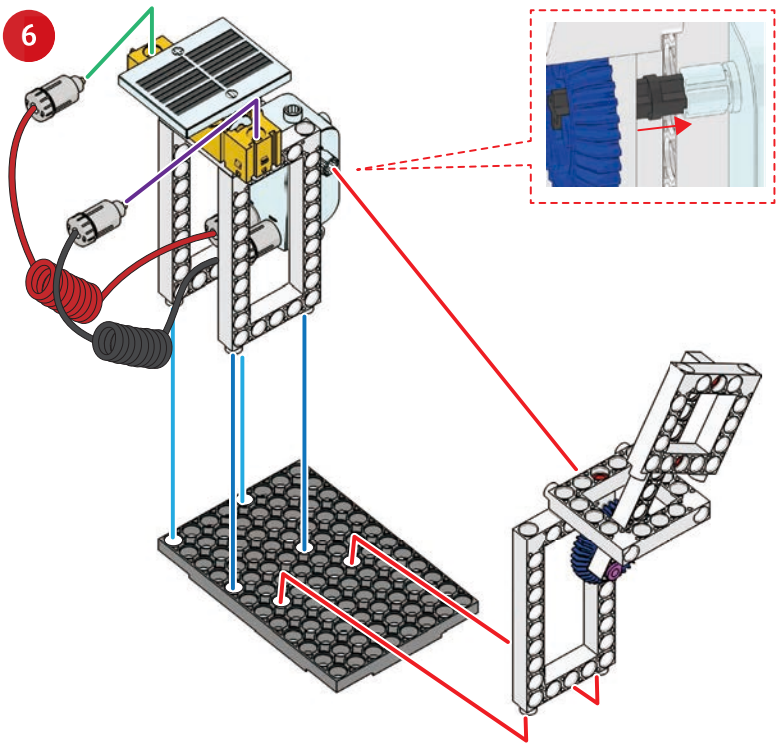
6 Swinging Signboard





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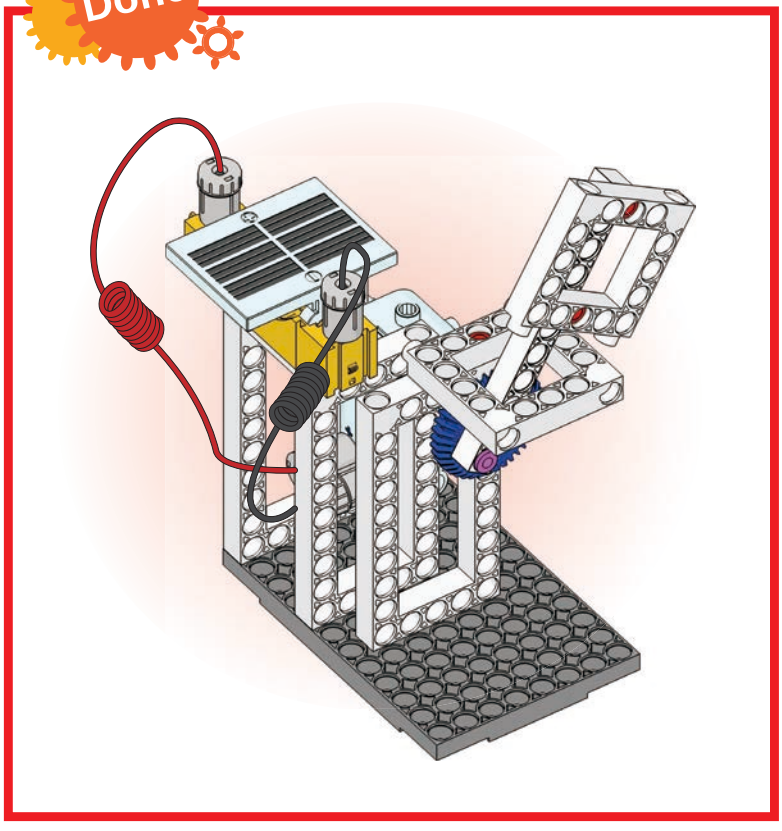


Model Operation Video

Hands-on Experiment

How can you make the signboard swing with a bigger range?

Hands-on Creativity

Remodel the swinging signboard, and draw a better pattern on paper. Cut it out and paste it to the upper side of the model.

Evaluation

Smart Manual
Web Service

1	2	3
Model Assembled	Experiment Complete	Model Creation

7 Sun Chasing Machine

Scientific Application

Energy Transformation in Plants

Gogo likes to study plants. He was really excited about today's lesson. After introducing the concept of photosynthesis and how plants interact with their environment, Gogo's teacher brought up several questions with the class.

Teacher: If we were to cover a flower with a cardboard box, why would the flower die within a few days?

Gogo: Because there is no sunlight in the cardboard box, the plant cannot photosynthesize, meaning it will not be able to get the nutrients it needs to stay alive.

Teacher: What if we punch a hole in the corner of the cardboard box? What would happen then?

Gogo: Then the plant would begin growing in the direction of its light source. This is known as phototropism. If you were to lay a plant down sideways and place a light underneath it, the plant would continue to grow sideways. This is because of a combination of phototropism and gravitropism.

Kids, with the knowledge of phototropism and photosynthesis, can you consider how important they are to Earth's environment?

Note: the important features of photosynthesis are as follows.
(1) Transforms inorganic into organic. Photosynthesis of plants indirectly or directly provides food for humans and animals.
(2) Transforms solar energy into available chemical energy. Essential energy sources such as coal, wood and natural gas are all converted from solar energy by photosynthesis.
(3) It maintains the balance of carbon dioxide and oxygen in our atmosphere.

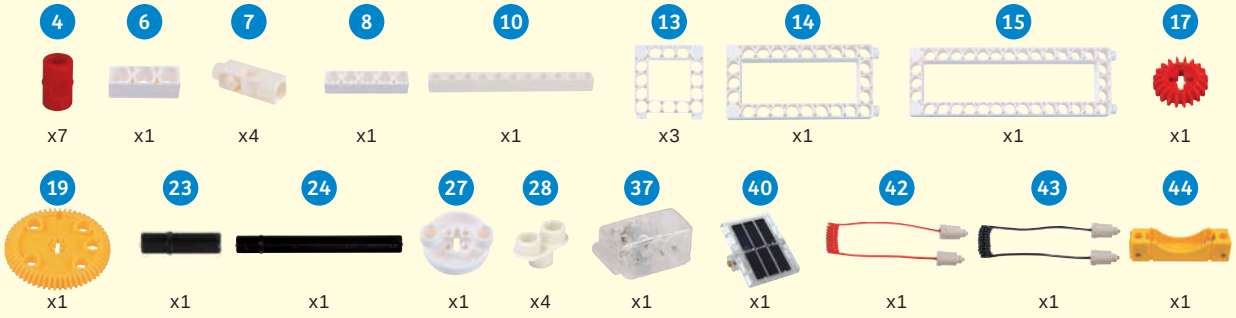
Daily Application

Due to over-exploitation of land and excessive use of chemical fertilizers and pesticides, Earth's soil and water is increasingly polluted. As a result, more advanced nations are building indoor, hydroponic facilities for cultivating plants. In order to make more efficient use of energy and reduce electricity bills, they developed facilities to integrate innovative solar power technology as a supplement to their conventional power sources. Using this dual-power exchange system, the facility is able to supply electricity for both the indoor lighting and water circulation systems.

Brainstorming

There are three things necessary for a plant to have in order to survive. What would happen if there were no sunlight?

Parts List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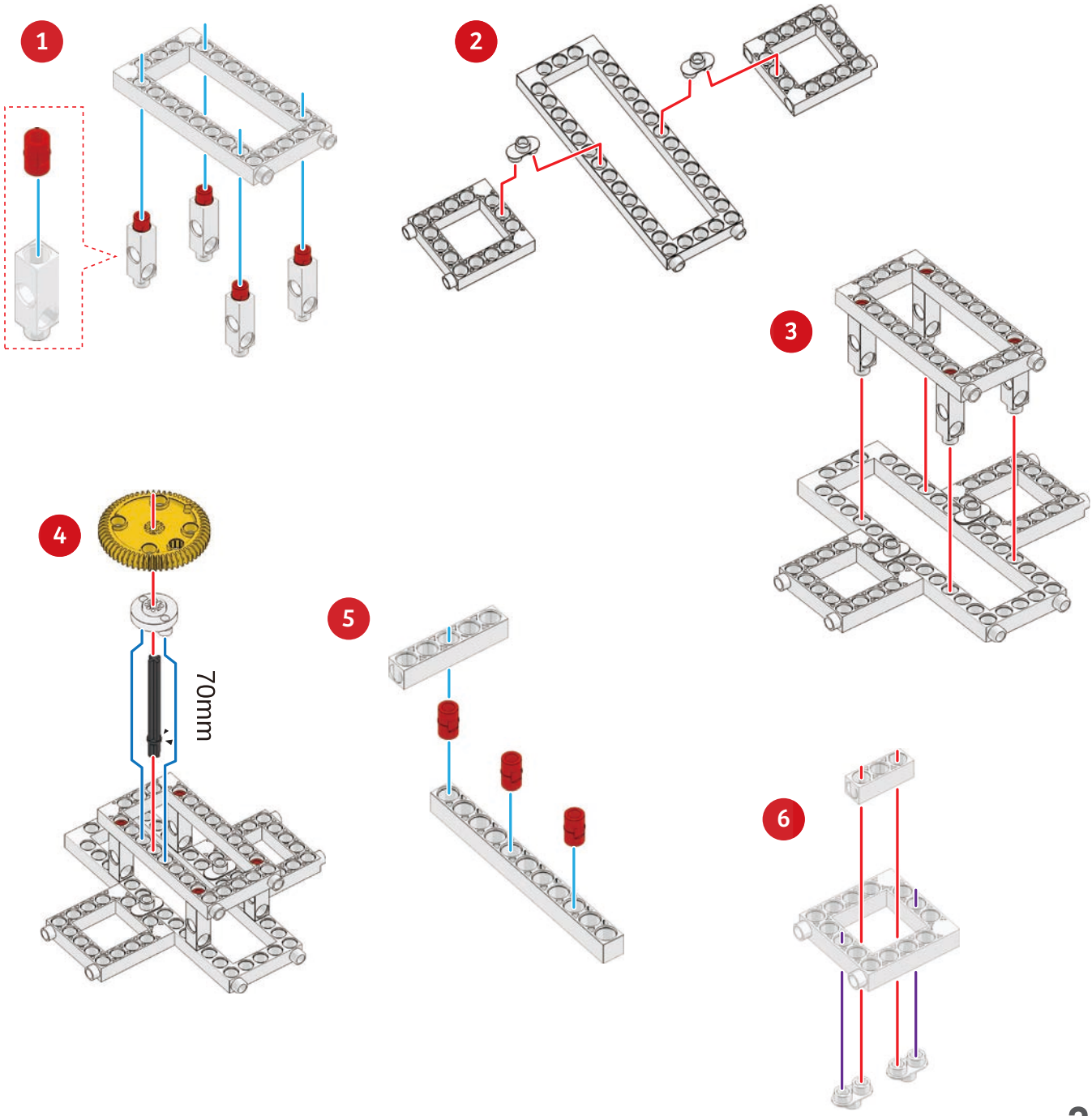
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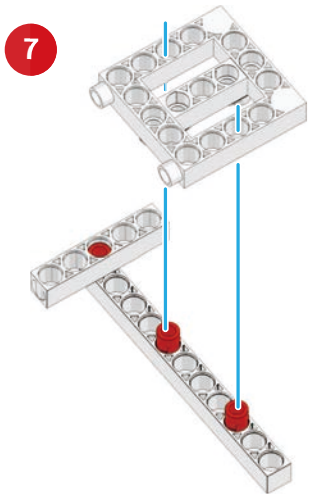
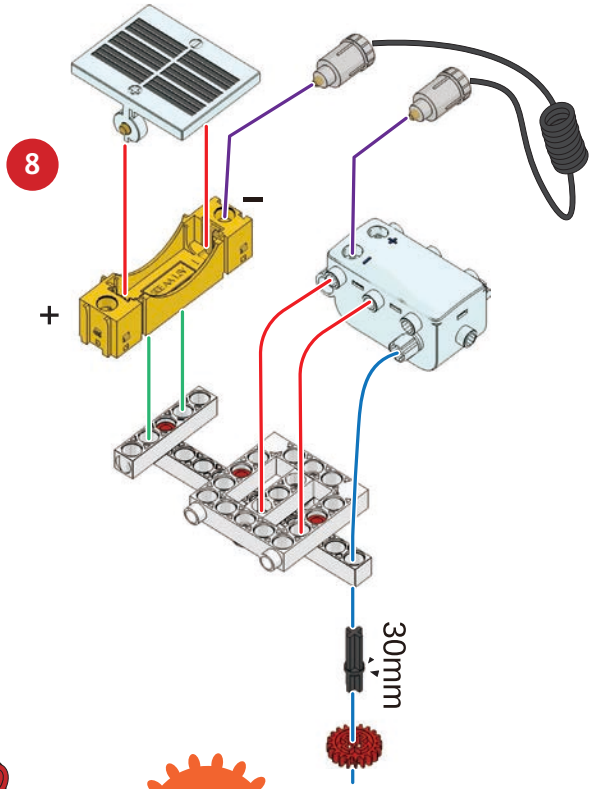
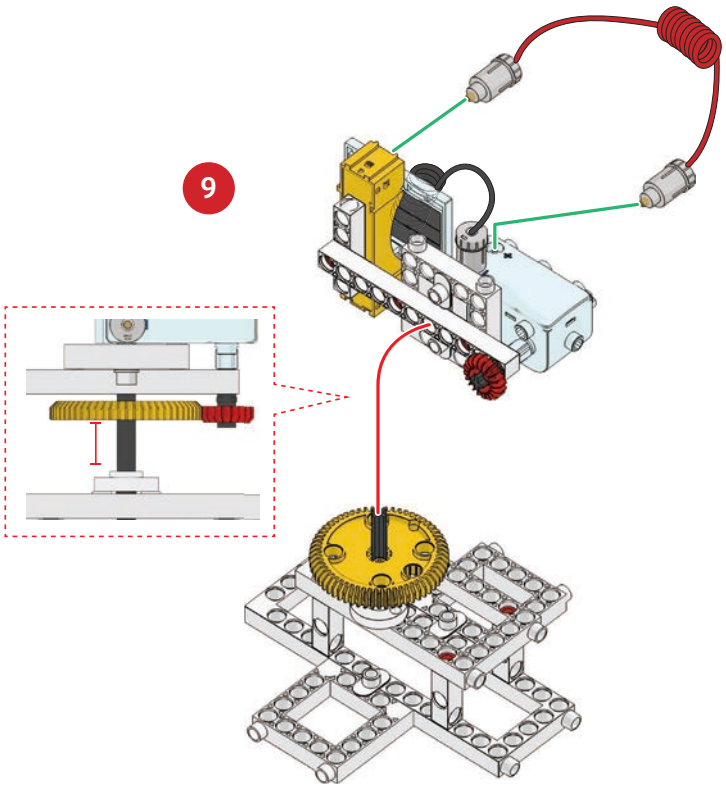
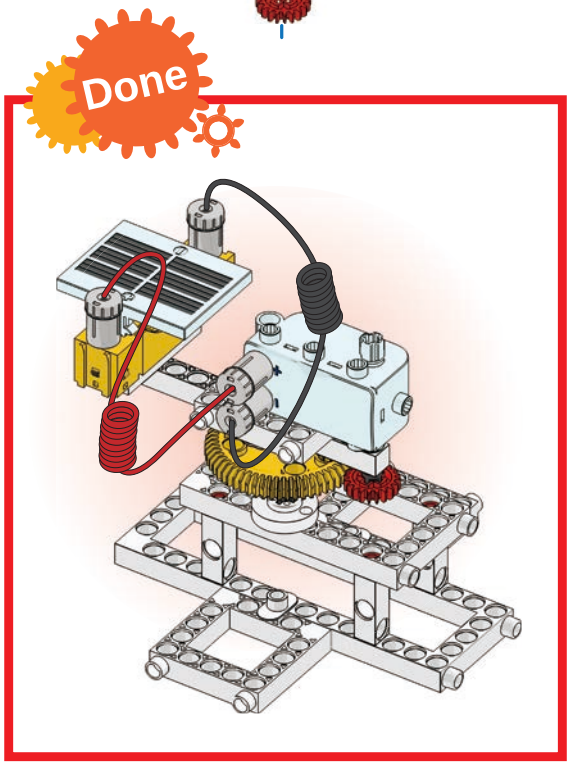
7 Sun Chasing Machine









Model Operation Video

Hands-on Experiment

Observe the model's motion once under sunlight, and another time without sunlight. What is the difference?

Hands-on Creativity

The Sun's path is different every day. How can we make the model easily adjust its angle of declination in order to directly face the Sun?

Evaluation

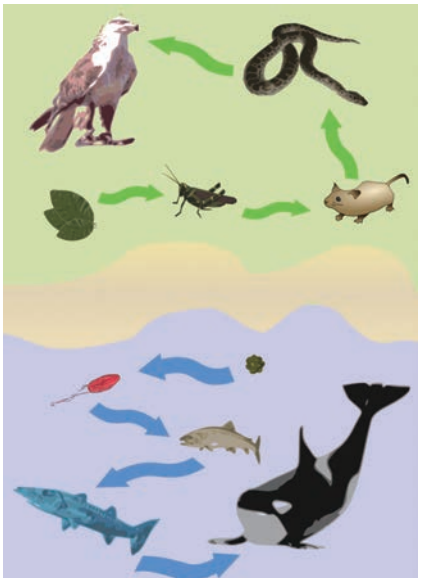
Smart Manual
Web Service

1	2	3
Model Assembled	Experiment Complete	Model Creation

8 Duck

Scientific Application

Energy Transformation in Animals



Gogo was hungry, and Daddy cooked lamb in a tasty sauce, with sweet potato leaves, and corn soup. At the dinner table, Gogo thought of the ecosystem and food chain that the teacher had discussed in class, and then started talking to himself, saying “Sweet potato leaves are a green plant capable of photosynthesis, thus it is a producer; while lambs are herbivores, absorbing and digesting the energy produced by the plants. But there is no decomposer in the system.”

Daddy was very happy that Gogo could apply what he had learned about the food chain, and said, “Food is the energy source for all creatures, repairing damaged functions and helping creatures grow. In the ecosystem, energy exchange and flow is a cyclical process. Every ecosystem starts with the initial energy provided by the Sun, and then through photosynthesis, carbon dioxide and water are combined by plants to transform the solar energy into chemical energy, which then starts to move in the food chain, and finally the animal and plant residues are decomposed and the nutrients are released back to the soil, ready to begin again as plants. Nature provides a valuable resource for the growth and development of all things. We should always be grateful for the food we have and not be wasteful.”

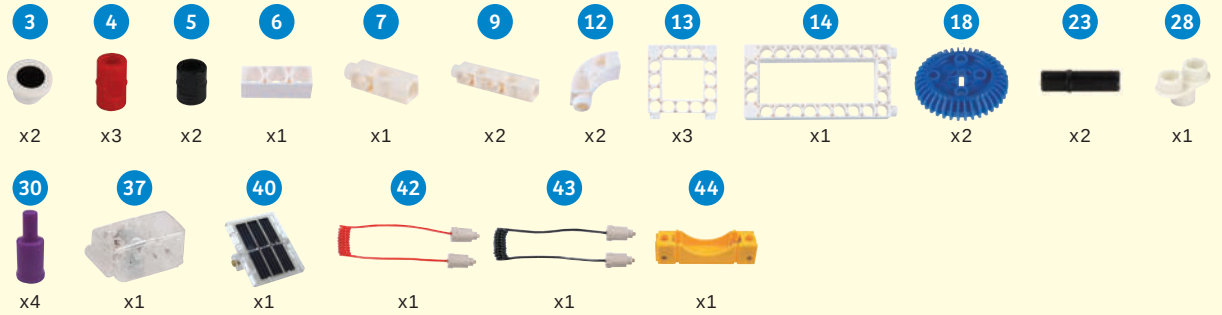
Daily Application

When an ecosystem is in a stable yet dynamic balance, the plants, animals and surrounding environment are all harmoniously co-existent; this is the ecological balance theory. Even if an ecosystem reaches its ecological balance, however, it doesn’t mean that everything will remain unchanged. Typhoons can destroy trees, overhunting can endanger predators, and droughts can deplete food resources. Things like this are known as “interference.” Humans usually try to prevent interference. Nevertheless, some recent studies suggest that interference is in fact a mechanism of the system to maintain its functions and operations. The resilience theory emphasizes the ecosystem’s ability to survive over such a long time and self-regulate. The more resilient an ecosystem is; the bigger interference it can endure.

Brainstorming

In an ecosystem, what’s the impact of a dramatic decrease of predators?

Parts List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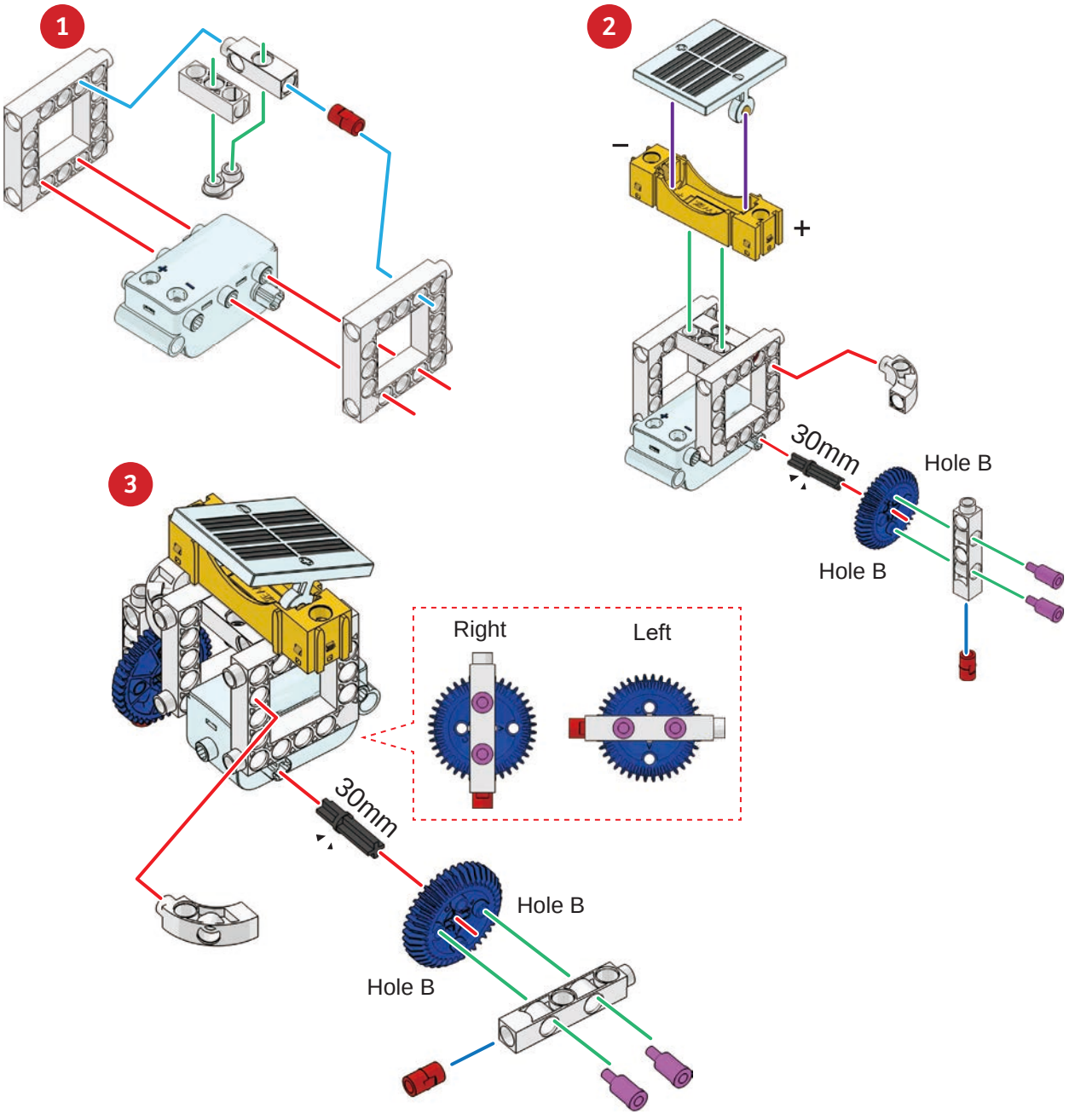
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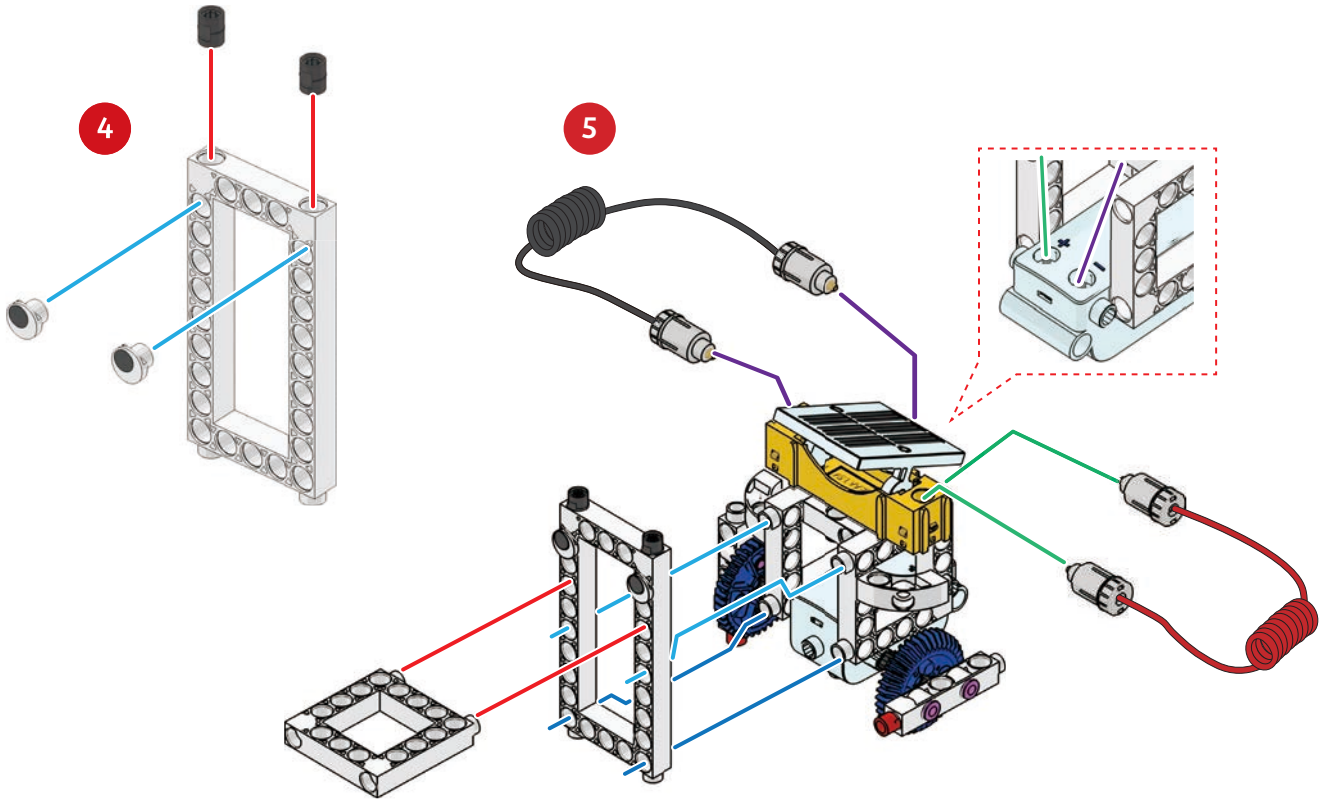
8 Duck



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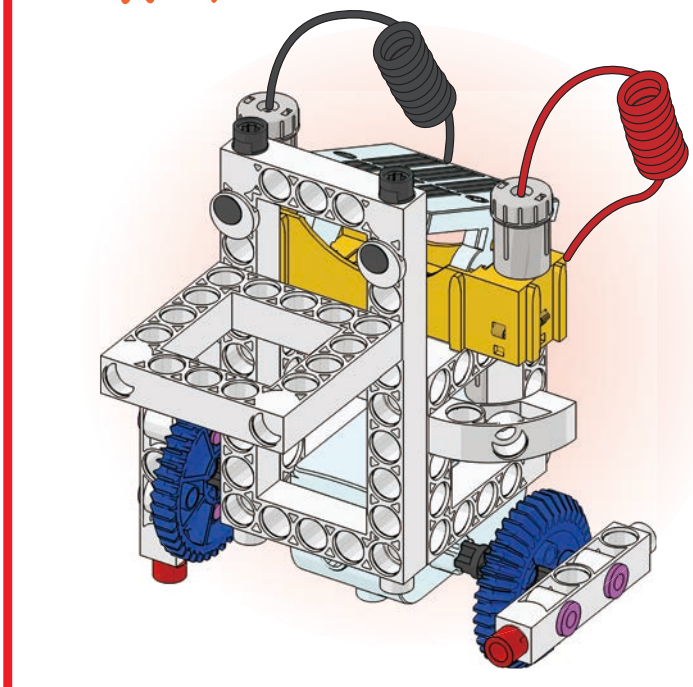


Model Operation Video

Hands-on Experiment

Does changing the solar panel's position affect the duck's walking speed?

Hands-on Creativity

Remodel the duck into another animal, such as a penguin.

Evaluation

Smart Manual
Web Service

1 Model Assembled

2 Experiment Complete

3 Model Creation

9 Solar Thermal Collector

Scientific Application

Light-to-Heat Conversion

Gigi is a sweet girl. She often sees a little boy in her neighborhood sitting alone on the front porch of his house. Because of his poor eyesight, he always stays at home. Gigi tried to come up with a way to help connect him with the outside world.

One hot afternoon, Gigi noticed that the Sun was shining brightly, and so she came up with a great idea: there was a way to teach the boy something new, even without him having good eyesight! Gigi showed him how solar thermal energy works.

In direct sunlight, Gigi told the boy to stick his hand out with his palm face up. Then she took an ice cube out from the basket and placed it in his hand. Even though it was really bright outside, the little boy was unable to see very well. Nonetheless, he could feel the ice quickly melting into a puddle of water in his palm! This sensation allowed the little boy to understand the significance of solar thermal radiation. The boy graciously thanked Gigi for her willingness to teach him. From what you have learned about solar thermal energy, can you think of some other applications it may have?

Daily Application

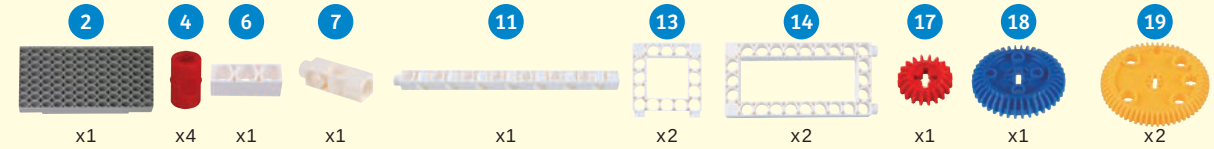
The Sun provides both light and heat. It is a very convenient source of energy. Wherever there is sunlight, you can tap into solar energy.

Solar water heaters are pieces of equipment that channel the heat from the Sun, in order to heat up water. This is one kind of renewable energy. There are two kinds of solar water heating equipment: active and passive. Passive water heaters generally are designed with a water tank and an inclined solar panel. Active water heaters also include a motor that can keep water circulating, as well as a temperature-control function.

Brainstorming

During the Siege of Syracuse, the famous Greek inventor Archimedes set enemy ships on fire using a series of reflecting mirrors to channel the Sun's solar energy. What others applications can solar energy be used for?

Parts List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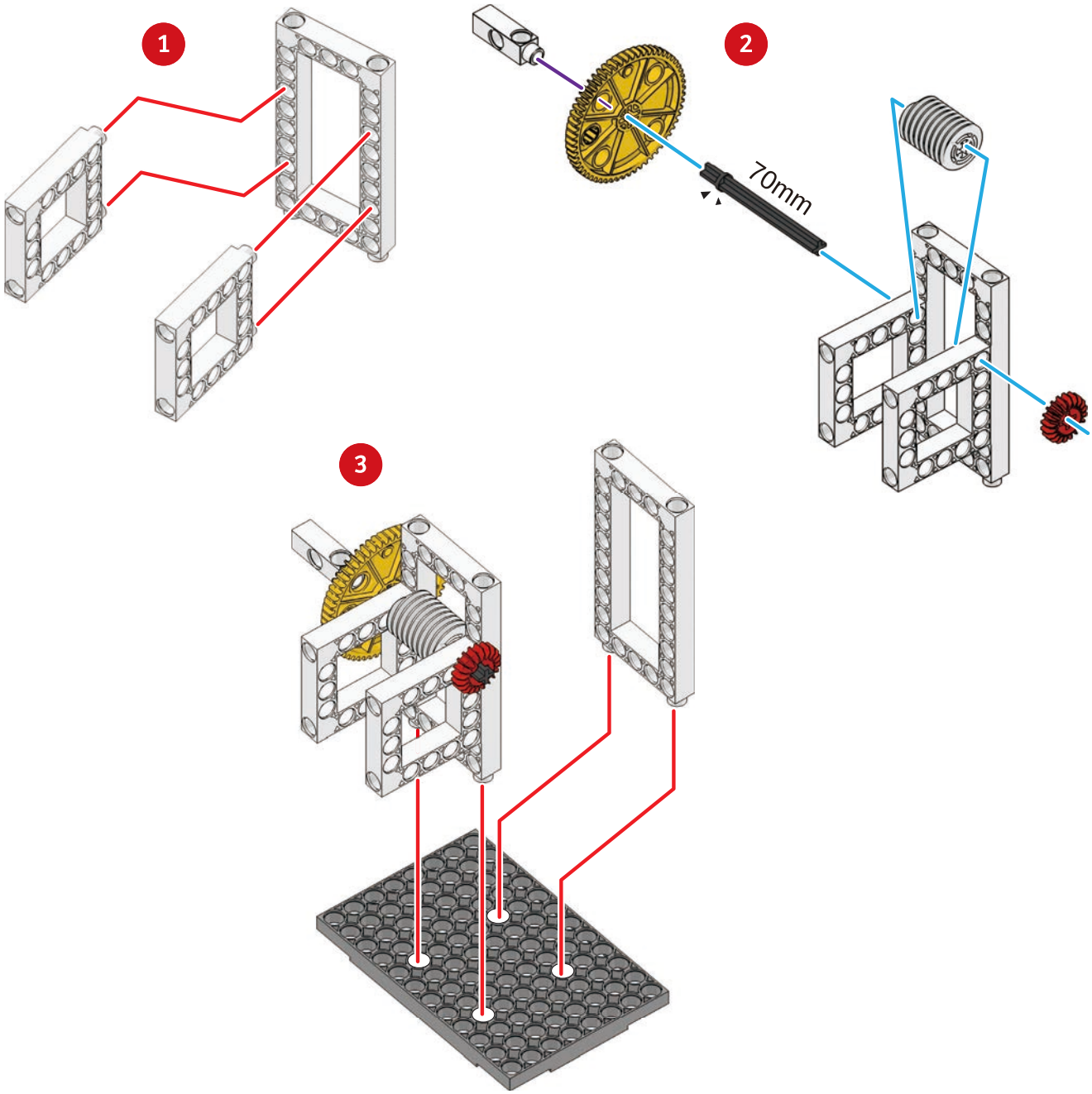
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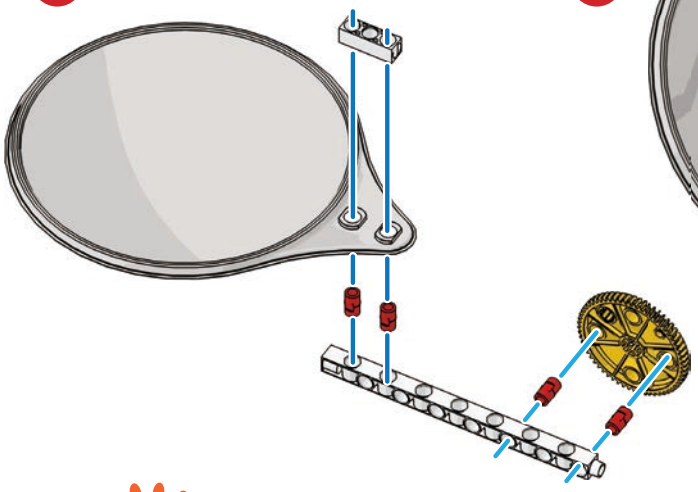
9 Solar Thermal Collector

4



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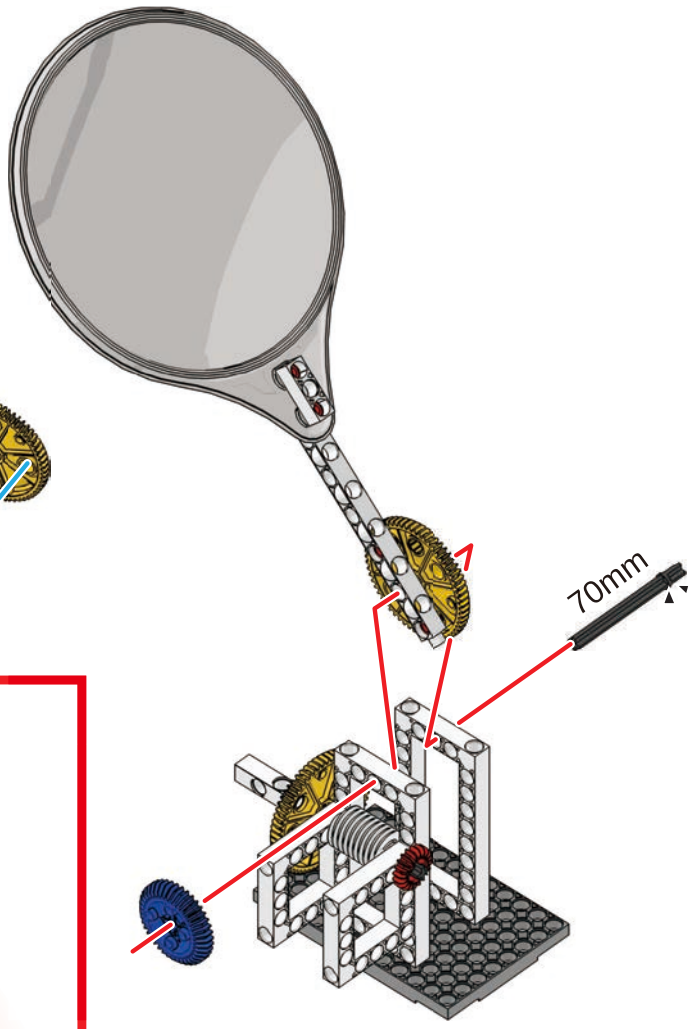

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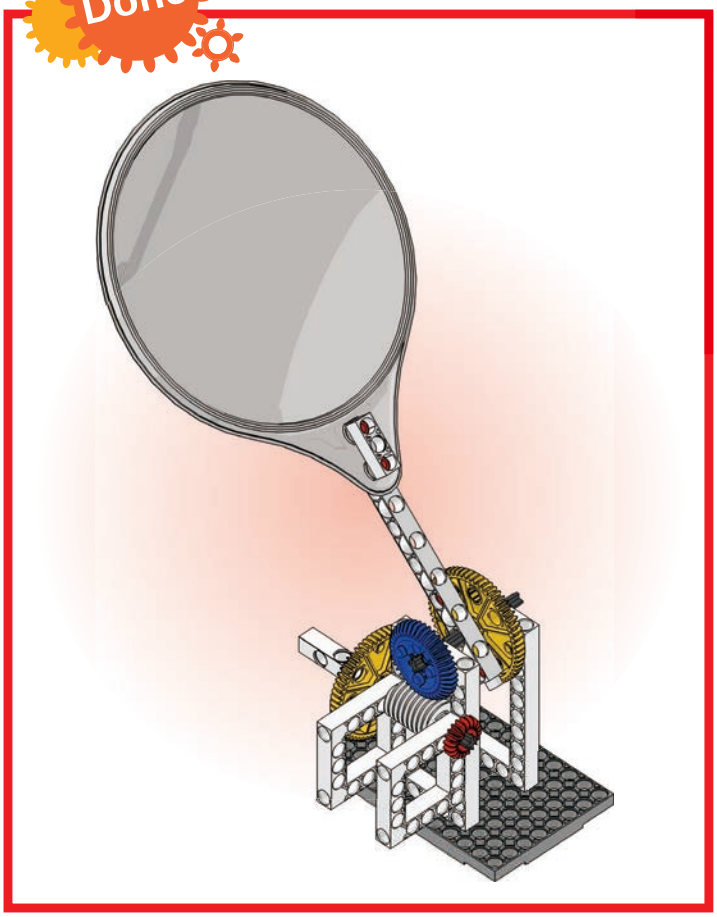


Model Operation Video

Hands-on Experiment

Observe from different angles, to see if the Light Collection Plate's sunlight aggregation position is different.

Hands-on Creativity

What else can we do to make the Light Collection Plate change angle?

Evaluation

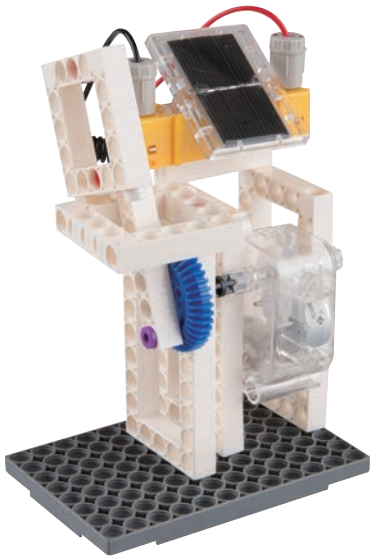
Smart Manual
Web Service

1	2	3
Model Assembled	Experiment Complete	Model Creation

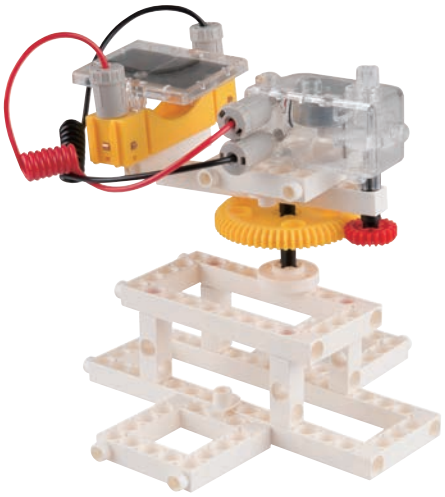
10 Monograph 2

With all the laws and models we've just learned about, please make a solar heat collector that can track the path of the Sun for a higher light-to-heat conversion rate.

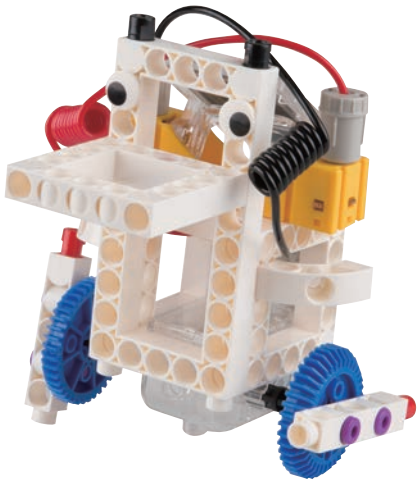
Model Review



6. Swinging Signboard



7. Sun Chasing Machine



8. Duck

9. Solar Thermal Collector

Design Concept

My Artwork

Evaluation

1 Model Design

2 Model Creation

3 Winner!

11 Solar Crane

Scientific Application

Photoelectric Effect

After school, Gogo and his younger brother passed by a construction site on their way home. They saw a crane (lifter) moving things. Curiously, his younger brother asked, “What does it use for power?” Gogo replied, “Electricity.”

Then, his younger brother asked, “Well, where does electricity come from?” Gogo said, “Electricity is generated by power plants and transmitted over here. There are different power plants, such as solar power plants, thermal power plants, wind power plants, and hydroelectric power plants.” The younger brother continued, “How come the Sun can generate power?” Gogo found it a bit too difficult for him to answer the question, so he told his brother that they should get home first, and then find the answer.

When they got home, Gogo looked to Daddy for help. Daddy said, “Solar power is something as recent as in the last century, it is attributable to Einstein’s theory of the optimized photoelectric effect, which makes photovoltaic power and solar panels possible. However, currently solar panel photovoltaic conversion rates are only around 15-20% on average, leaving much room for improvement. Theoretically, any machine powered by electricity can use solar power. Of course, the crane you saw on the road is one of them.”

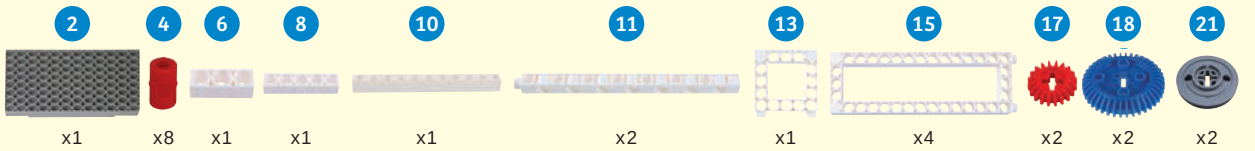
Daily Application

Phototubes are an application of the photoelectric effect, which uses metal illuminated under a light in order to produce electricity. Photomultiplier tubes further increase the sensitivity of the photocathodes inside, making them far more sensitive to light than conventional phototubes. This allows them to detect weak optical signals. Photomultiplier tubes possessing high sensitivity and low levels of noise are used to measure light and are widely available.

Brainstorming

What things in our everyday lives generate power from light energy?

Parts List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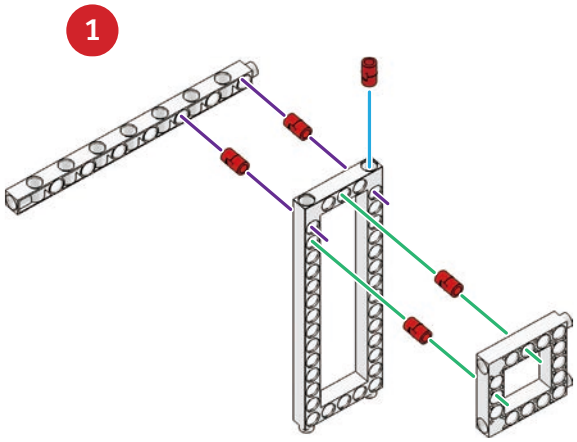
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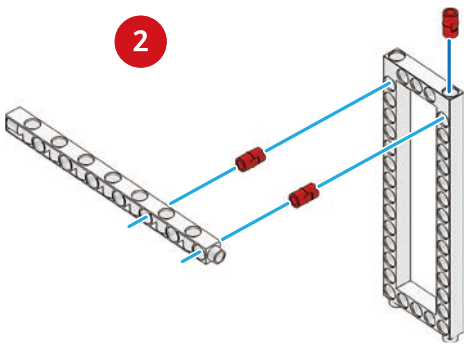
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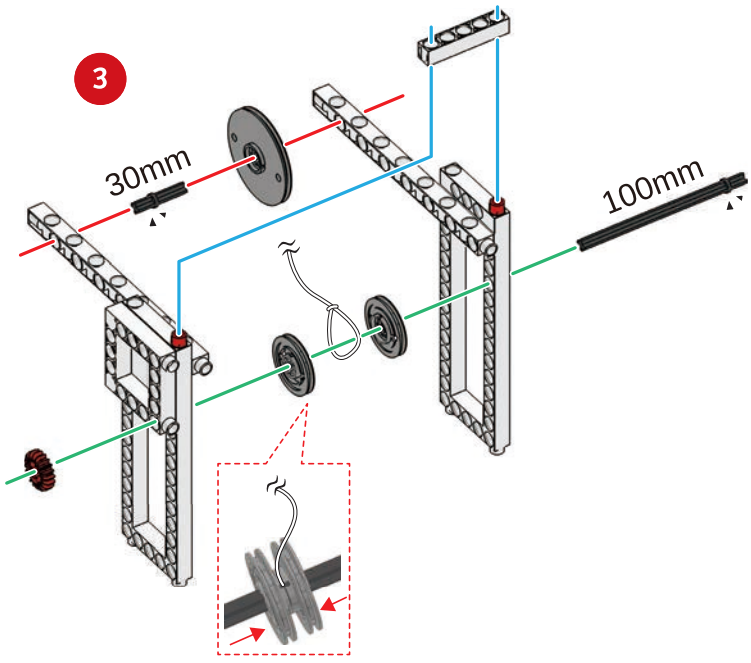
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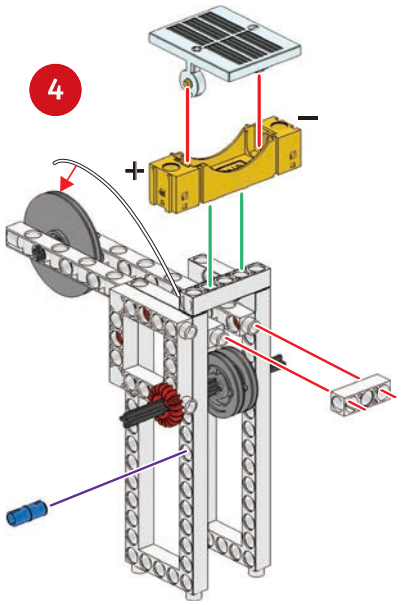
30mm
100mm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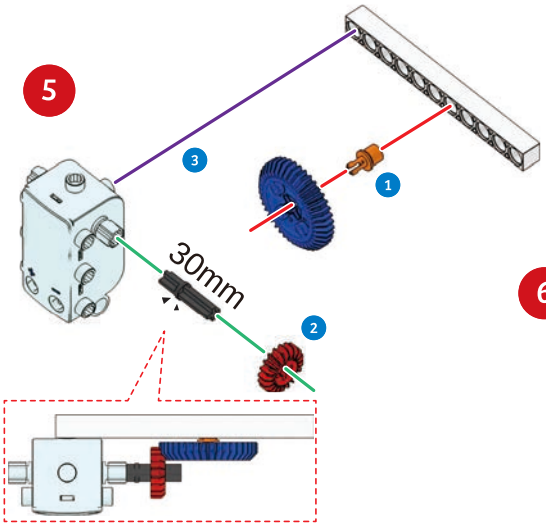
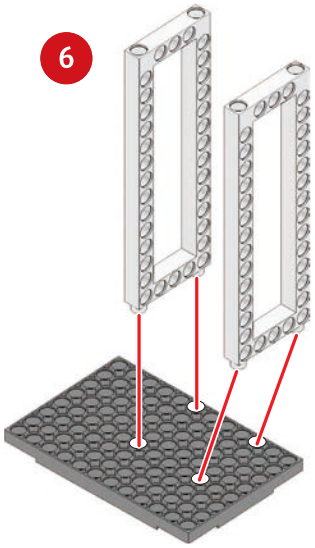
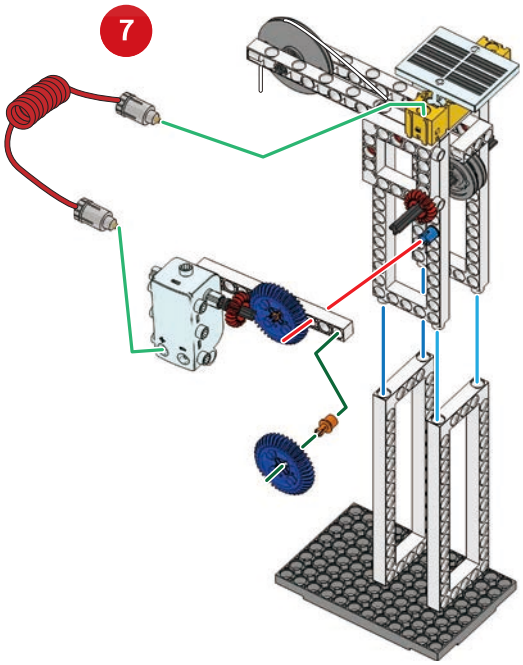
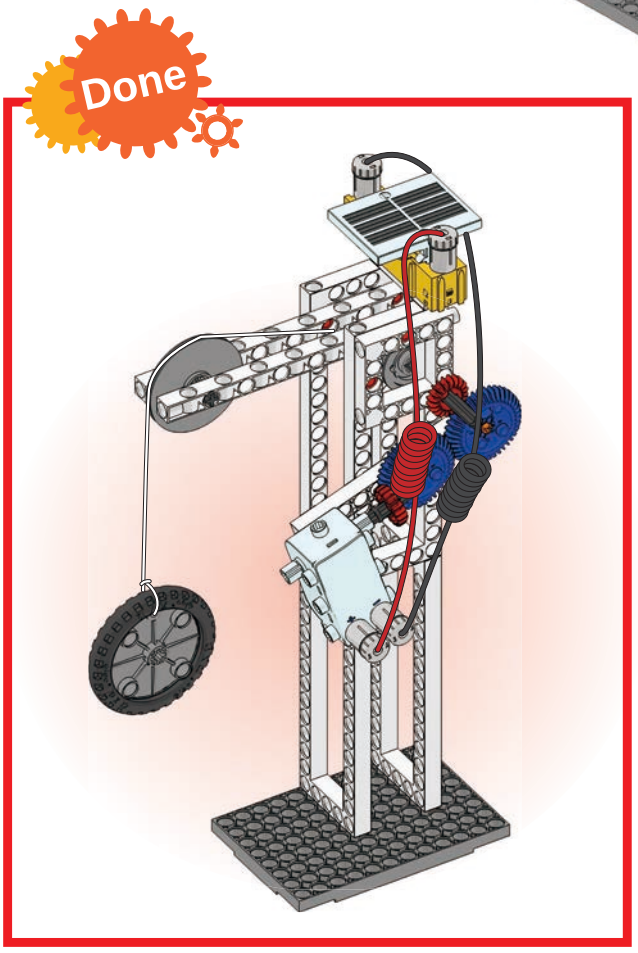
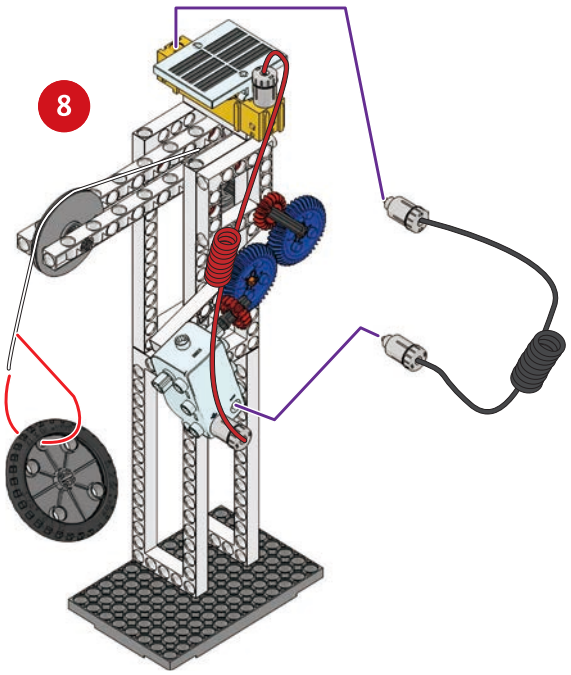
11 Solar Crane











Model Operation Video

Hands-on Experiment

How can we make the crane go down?

Hands-on Creativity

Design a handle switch that can be used to control the upward and downward movement of the crane.

Evaluation

Smart Manual
Web Service

1 ★ Model Assembled

2 ★ Experiment Complete

3 ★ Model Creation

12 Radar

Scientific Application

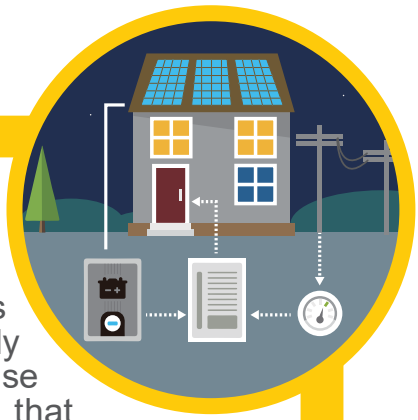
Intermittent Energy

When Daddy was parking in the parking lot, Gogo noticed that the car sometimes made alarming sounds. Curiously, he asked, “Why does the car make an alarm sound?” Daddy said, “The sound was made by the reversing radar built into the car’s bumper. When reversing, the driver can easily lose sight what is happening behind the car, due to blind spots. The reversing radar plays the role of human eyes, helping the driver know how much space there is to maneuver. This makes reversing safer and faster.”

After getting home, Gogo searched the internet for radar related information. An article read, “Conventional radars use electromagnetic waves to detect the shape, speed and distance of targets. With the progress in various technological fields such as microelectronics, radar technology continues to evolve. Today, radars have evolved from simple electromagnetic wave detection to a variety of comprehensive optical detection systems including infrared, ultraviolet, and lasers.”

Kids, do you know any other uses for radar?

Daily Application

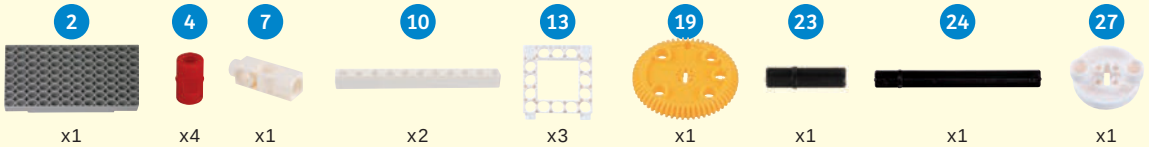


The Sun is a non-rotary star. For human beings living on Earth, however, there is a day and night cycle. Using the Sun as an energy source, we need to consider the nature of its intermittence, i.e. days and nights. To more efficiently utilize solar power, some people have suggested the use of adjustable solar panels that can trace the Sun, so that the sunlight reflecting angles can be optimized for energy input. Others people have suggested well-equipped energy storage systems are important, to hold energy gathered during the day release it for use at night. Or, the solar power could be connected to the power grid for an uninterrupted power supply.

Brainstorming

Why do people get up after sunrise, and rest after sunset?

Parts List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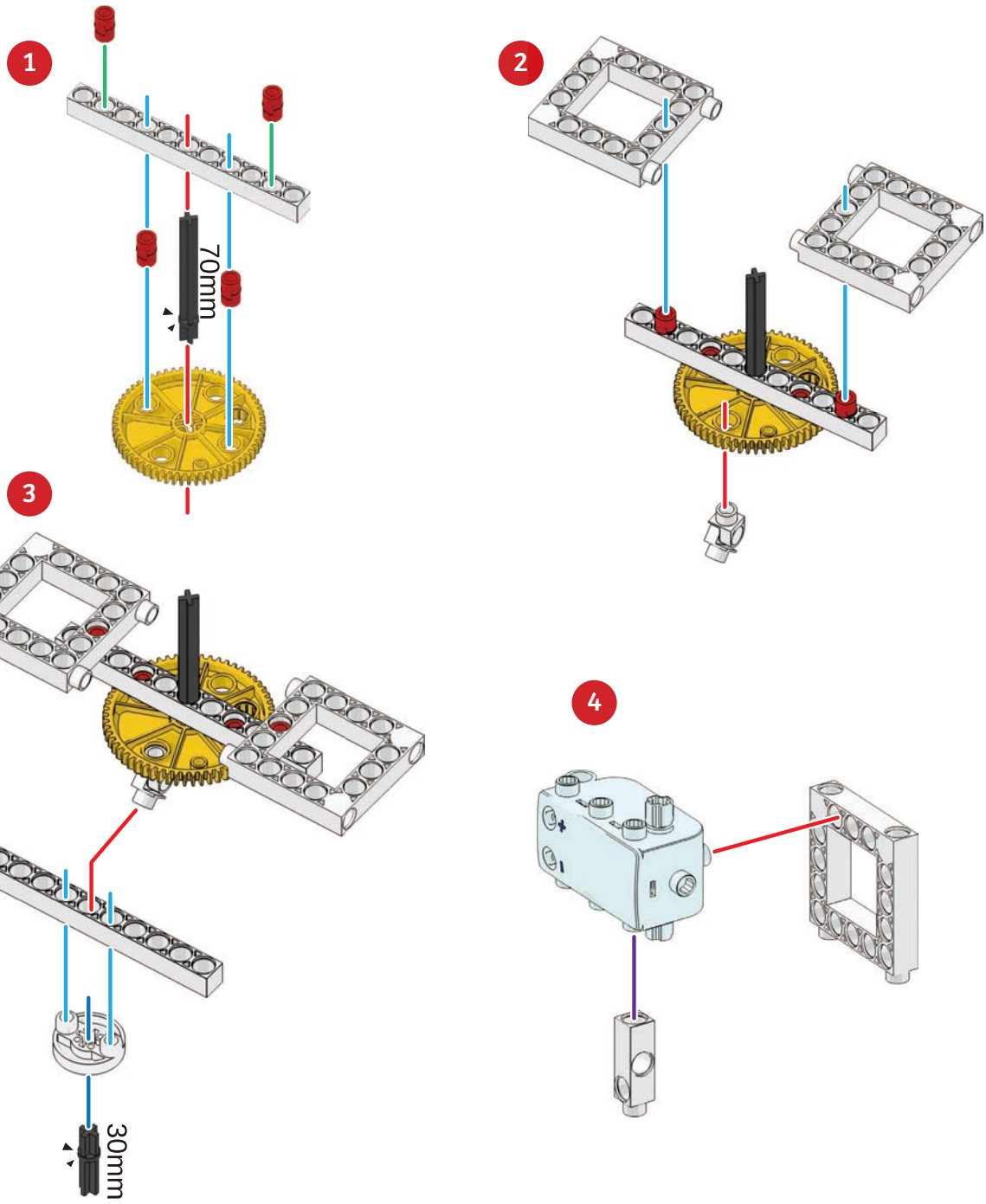
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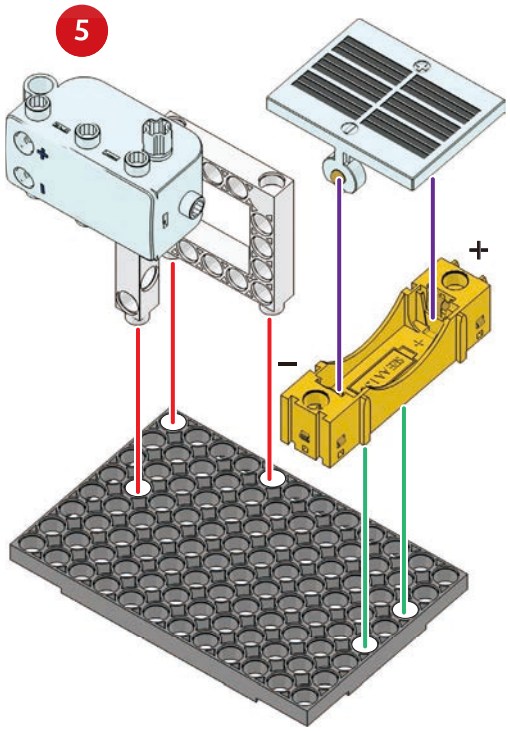
12 Radar

5



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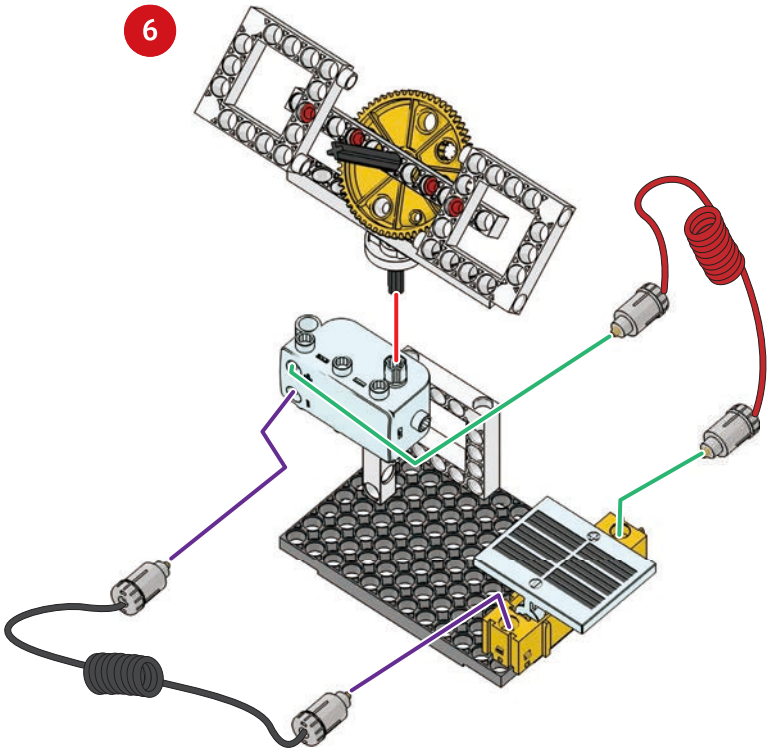

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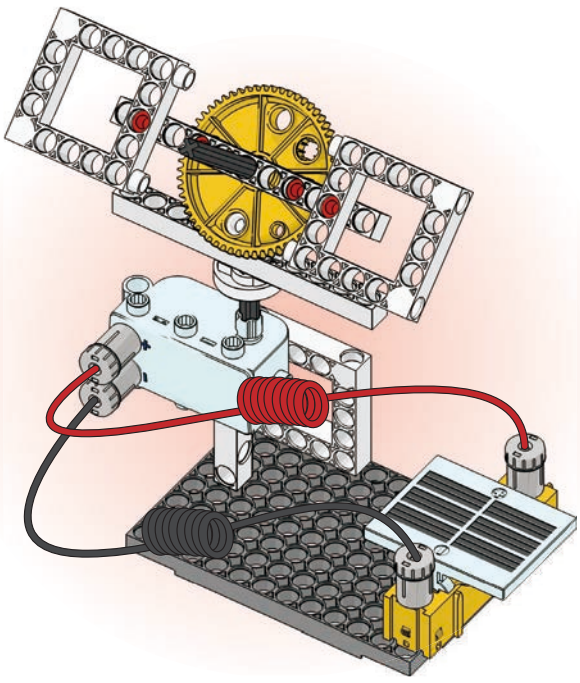


Model Operation Video

Hands-on Experiment

Remodel the stationary solar panels into Sun-tracking ones.

Hands-on Creativity

Under different intensities of light, test the number of rotations of the radar within one minute.

Evaluation

Smart Manual
Web Service

1	2	3
Model Assembled	Experiment Complete	Model Creation

13 Solar Architecture

Scientific Application

Solar Energy Generation

The sun shines light on the Earth and brings heat with it, as some of the light becomes trapped inside the atmosphere. We often put wet clothes out to dry in the sun; also, we can preserve food by sun-drying. Sun-drying is a simple and cheap way to dehydrate food.

The sun is a large and continuous source of energy, but sometimes weather can interfere with solar panels and solar cells. Despite this, people are still researching and developing new kinds of solar cells that can work in colder or low-light conditions. Unlike fossil fuels, which have a limited supply and may cause pollution, solar energy is entirely renewable. Solar power systems are used to convert solar energy into electrical energy that can be used directly, or stored in batteries for use later.

Solar power generation systems are safe and silent, and modern designs have a life-span of up to 20 years. This means it is a good way to generate power for green buildings! Installing a solar power generation system on the roof is usually sufficient to power a building during the day, and if there is excess power generated, then the power can be sold back to the electrical grid!

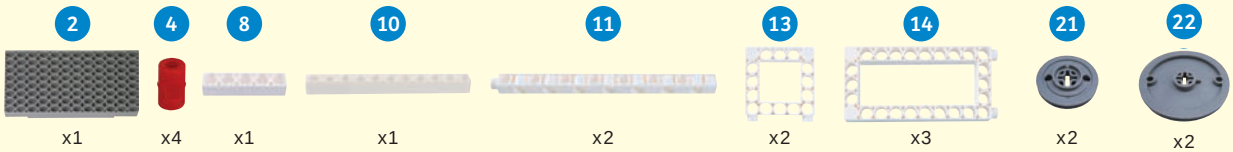
Daily Application

The solar power generation system uses the photons the sun gives off to create a flow of current exhibiting what is known as the “photovoltaic effect". Since the photovoltaic effect does not produce any pollution or carbon dioxide, it is both environmentally friendly, and a reliable renewable energy source.

Brainstorming

What is the benefit of using a solar power?

Parts List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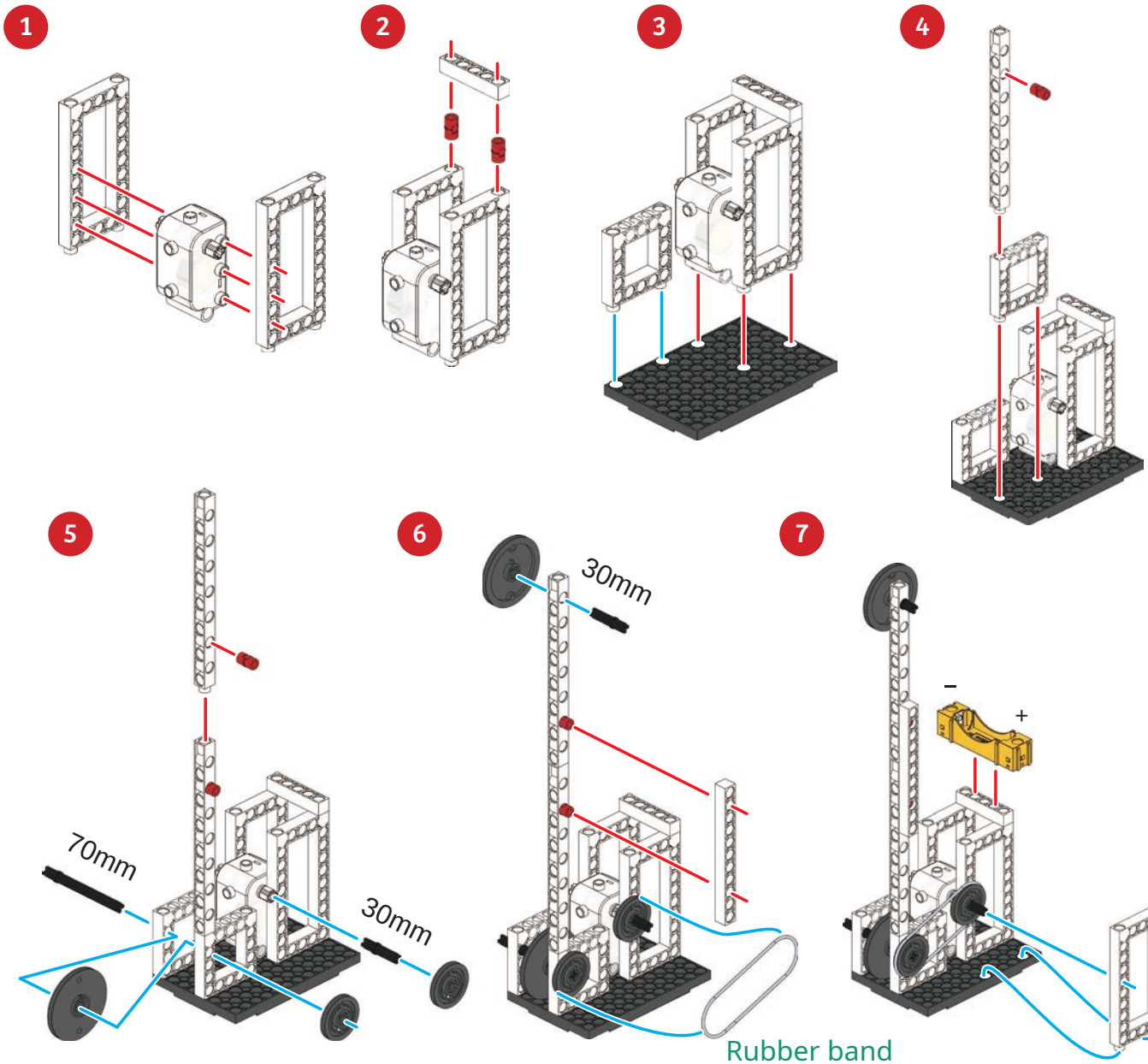
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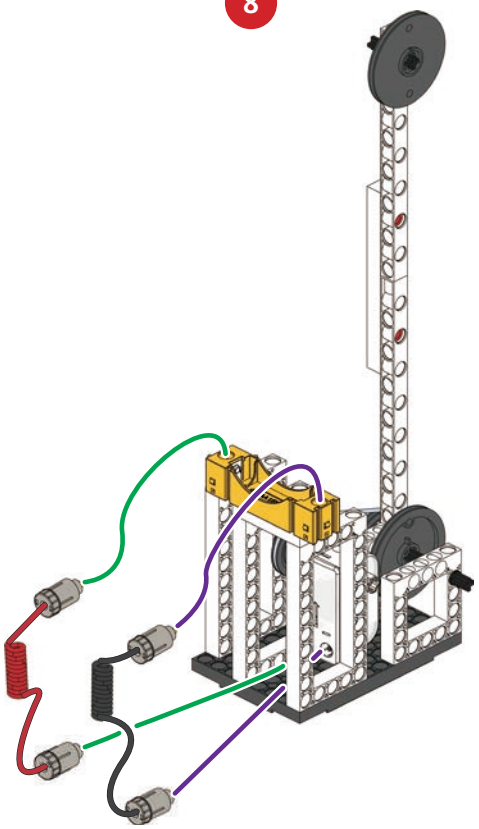
13 Solar Architecture

8



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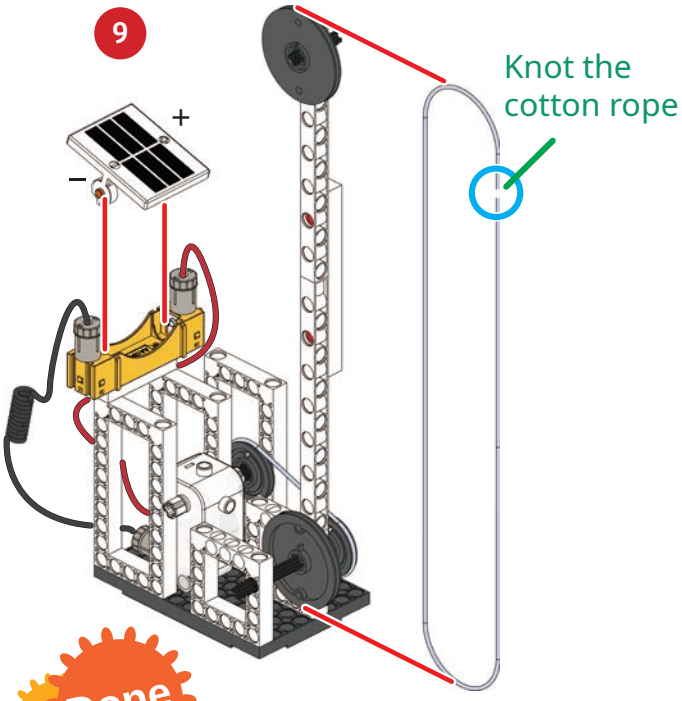

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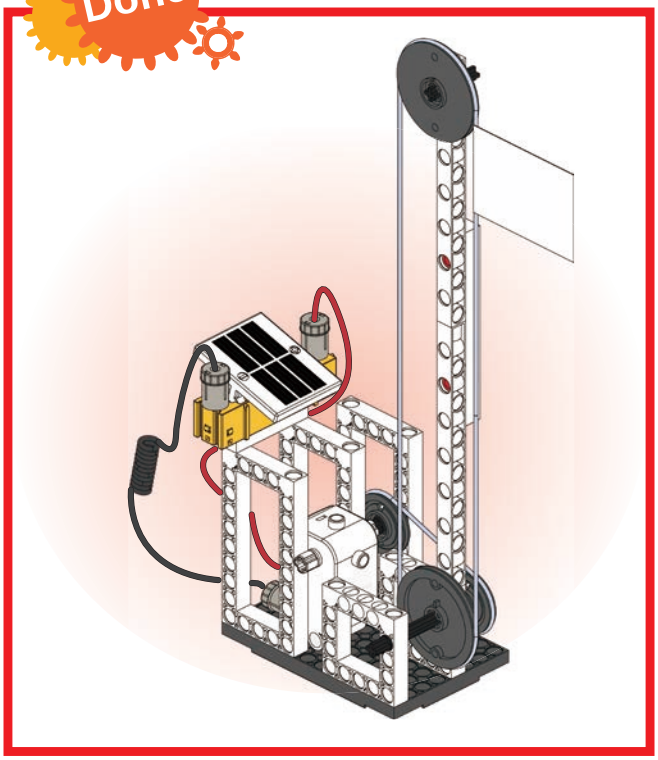

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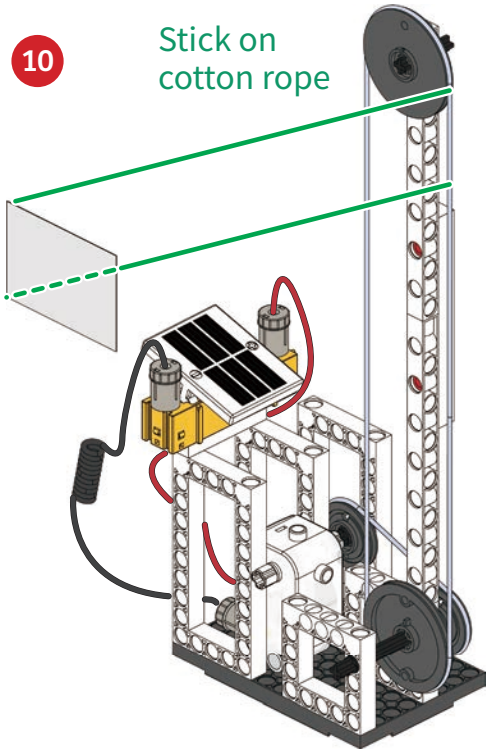


Model Operation Video

Hands-on Experiment

Change the angle of the solar panel to find out at which angle the model will react the fastest?

Hands-on Creativity

Use reflective objects available in everyday life to gather sunlight on the solar panel. Observe any change in the model's behavior. (Note: Do NOT use any magnifying lens; this may melt the solar panel.)

Evaluation

Smart Manual
Web Service

1 Model Assembled

2 Experiment Complete

3 Model Creation

14 Solar Bicycle

Scientific Application

The Pros and Cons of Solar Power

The semester was over, and today was the day for campus cleaning. Gigi was responsible for waste recycling. She saw some used batteries, mobile phones, and bikes, as well as a used solar panel from the lab. She sorted the different items for recycling and asked her teacher, "Where does this stuff go after it is recycled? And what will it become?"

Her teacher explained, "These electronic and metal wastes are usually recycled for reuse. Some countries require that manufacturers recycle waste, usually there is some exchange of old goods for new ones, at a discount. There are businesses dedicated to the collection of waste, whose reusable components are then extracted and reused as auxiliary materials in other products, such as the silicon-containing textiles for water repellent jackets, and some can even be reused as anode materials in lithium batteries."

Spotting an old bike with broken pedals and chains, alongside an old solar panel, the teacher suggested they renovate the used stuff by connecting the solar panel and a motor with the bike's rear wheel, so that at times when the sunlight is strong enough, the solar power will work to power the vehicle, and at other times the rider will have to push the bike along.

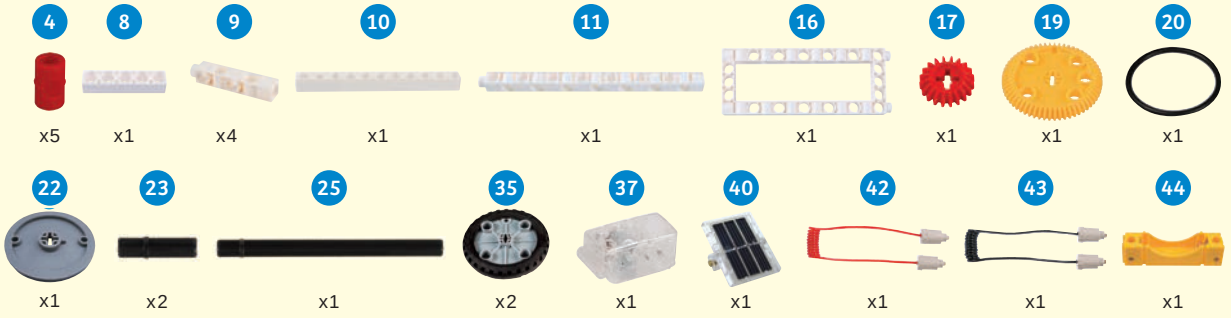
Daily Application

Every product has its own life cycle. From production to waste, it's just like a human being from birth to death. Similarly, even though the solar power is green energy, the solar panel has to be manufactured using heavy-metals which creates waste. These toxins can damage the environment if not properly treated before being discarded and buried in a landfill. The life cycle of a solar panel is 25 years on average, and the optimal way to recycle old panels is a main focus of solar panel future development.

Brainstorming

What are the advantages and disadvantages of using solar energy?

Parts List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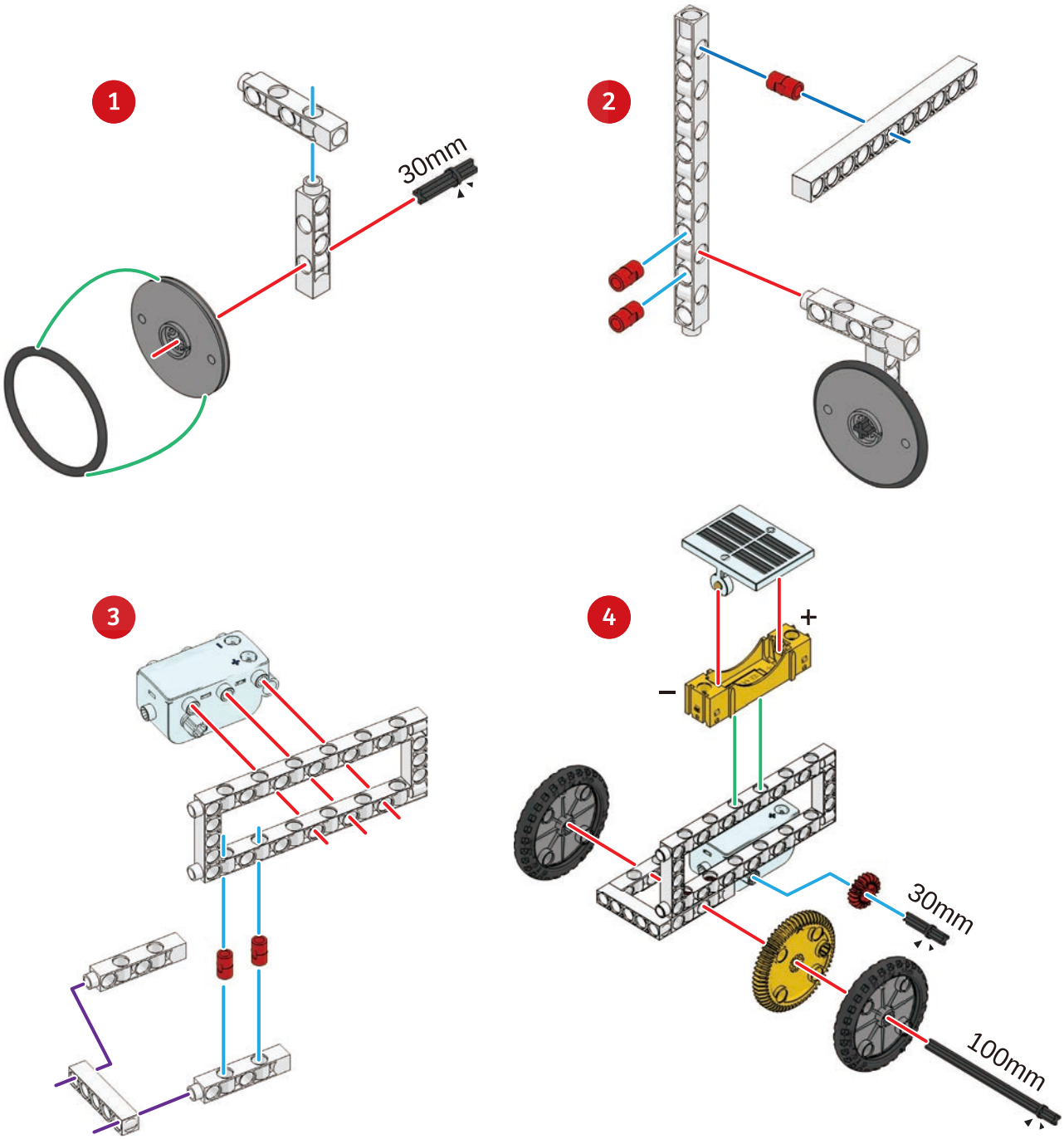
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14 Solar Bicycle

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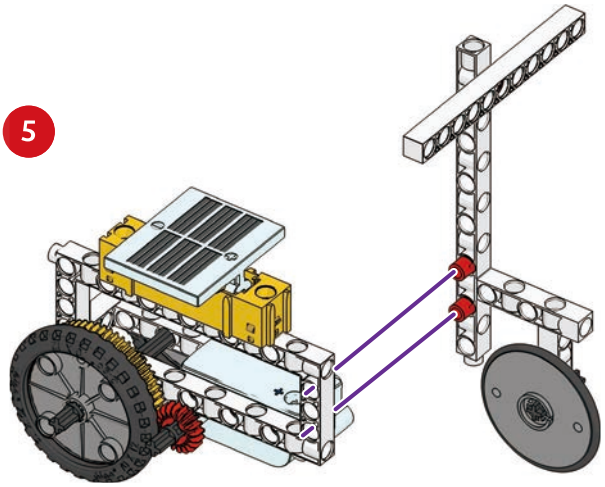

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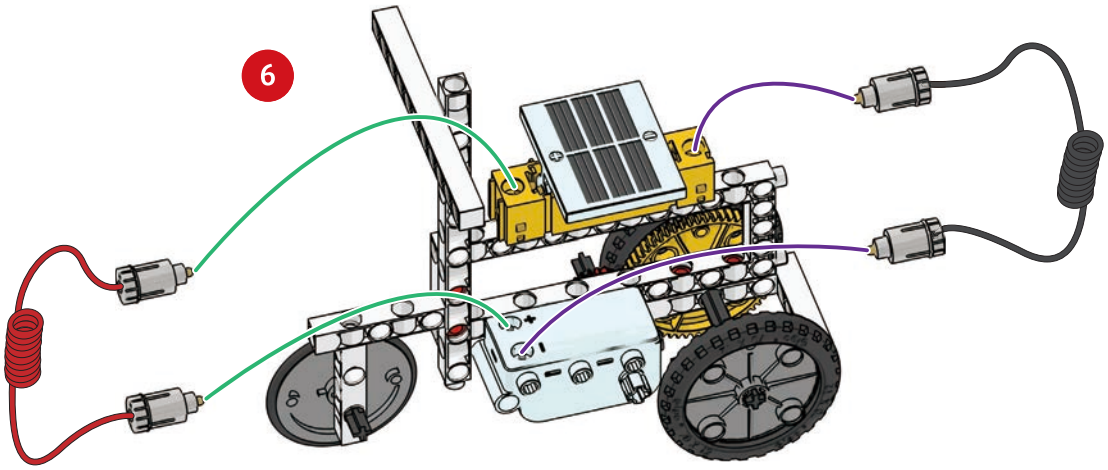

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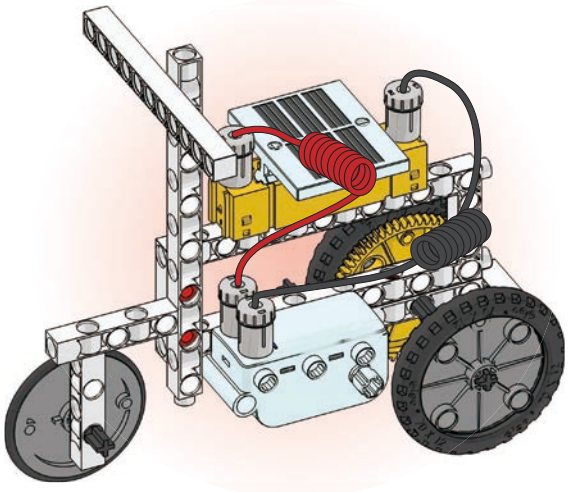


Model Operation Video

Hands-on Experiment

Compare the speed of the bicycle under different light sources.

Hands-on Creativity

Try modifying your bicycle. Afterwards, hold a race!

Evaluation

Smart Manual
Web Service

1 ★ Model Assembled

2 ★ Experiment Complete

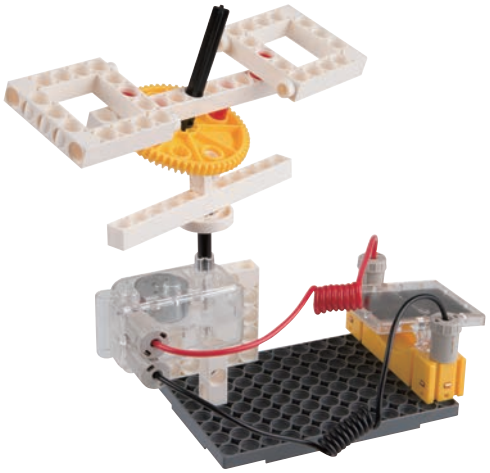
3 ★ Model Creation

15 Monograph 3

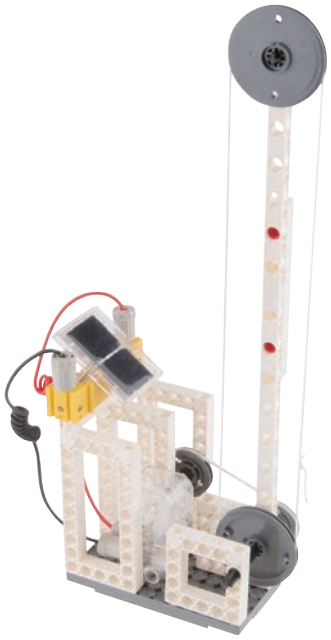
Sunlight is one of the Earth's most accessible natural resources; however, there are large differences in the intensity of sunlight during the day.
Design a car with a reflective light device to increase the amount of light shining on the solar panel, so that the car can move even when the light is weak.

Model Review

11. Solar Crane



12. Radar



13. Architecture

14. Solar Bicycle

Design Concept

My Artwork

Evaluation

1
Model Design

2
Model Creation

3
Winner!

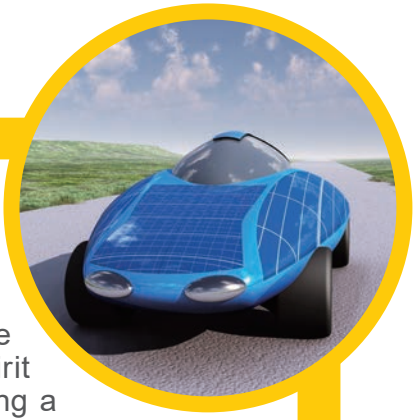
16 Solar Vehicle

The World Solar Challenge is held once every two years in Australia. During the competition, many different kinds of solar vehicles are gathered and put on display. Their designs are not only environmentally-friendly, but innovative too. Great care is put into the aesthetics and capability of the cars. Each car is the pride and joy of their team. The race starts in Darwin, and ends at Adelaide, crossing through the desert interior of the Australian continent.

The only energy source for the participating cars is solar energy. Each team needs to travel 3,000km in just 8 days, and since the Sun rises and sets, their cars are only operable from 8:00-17:00 daily. Talk about a challenge!

Kids, have you ever seen a solar-powered vehicle before?

Daily Application



Solar vehicles are a type of vehicle that utilizes solar power as its primary source of energy. Solar vehicles don't produce any noise or emit any pollution like internal-combustion engines do. In order to avoid consuming the limited resources of the Earth, it combines state-of-the- art technology with the spirit of conservationism and environmentalism, as well as providing a practical and efficient form of transportation. Solar-powered race cars are designed to accommodate many solar panels. Solar cars that are intended for general use apply a solar panel mounted to the roof of the vehicle; however, these kind of vehicles are still in the R&D stage, and have not officially entered the market for purchase. With the limitations of currently available technology, it's still difficult to make a mechanism entirely powered by solar energy.

Brainstorming

What kinds of issues do solar-powered vehicles run into?

Parts List


4
x2
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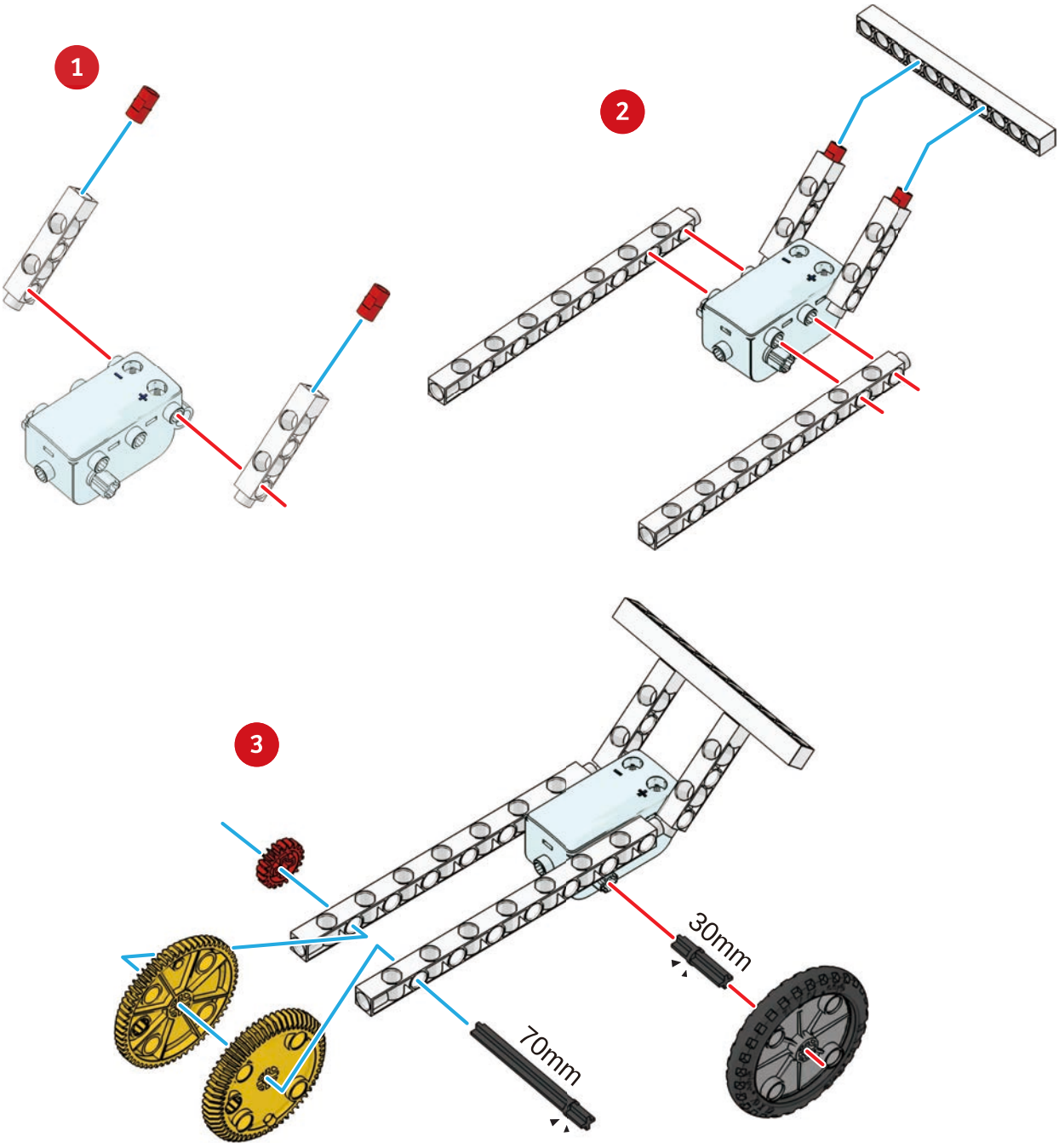
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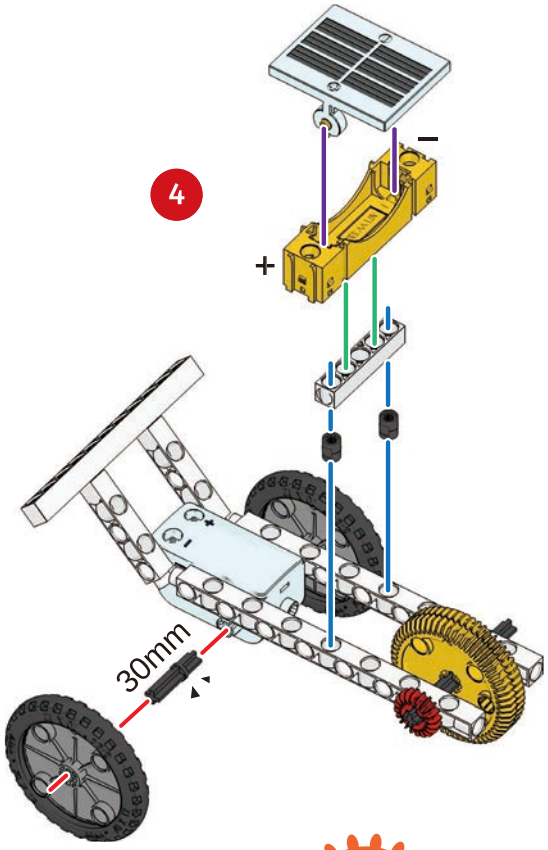
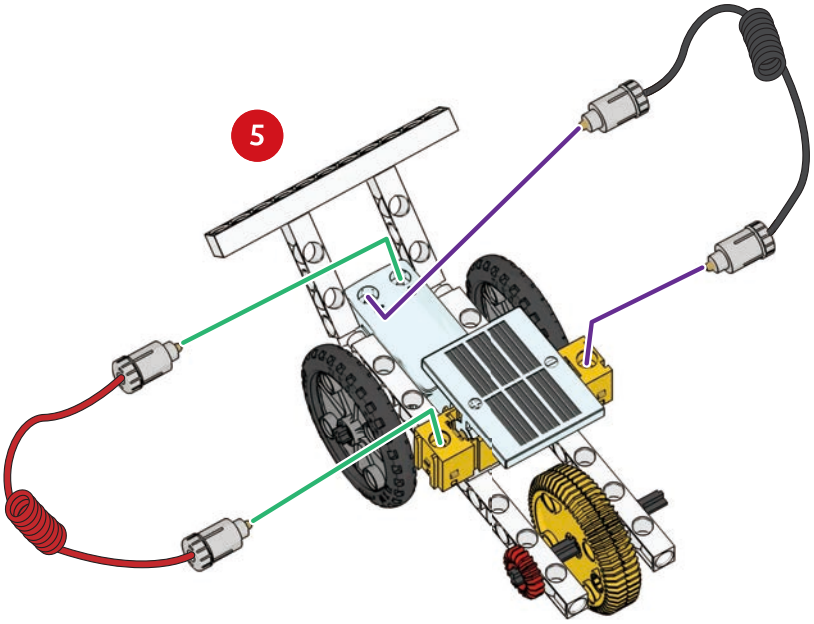
30mm
70mm

16 Solar Vehicle





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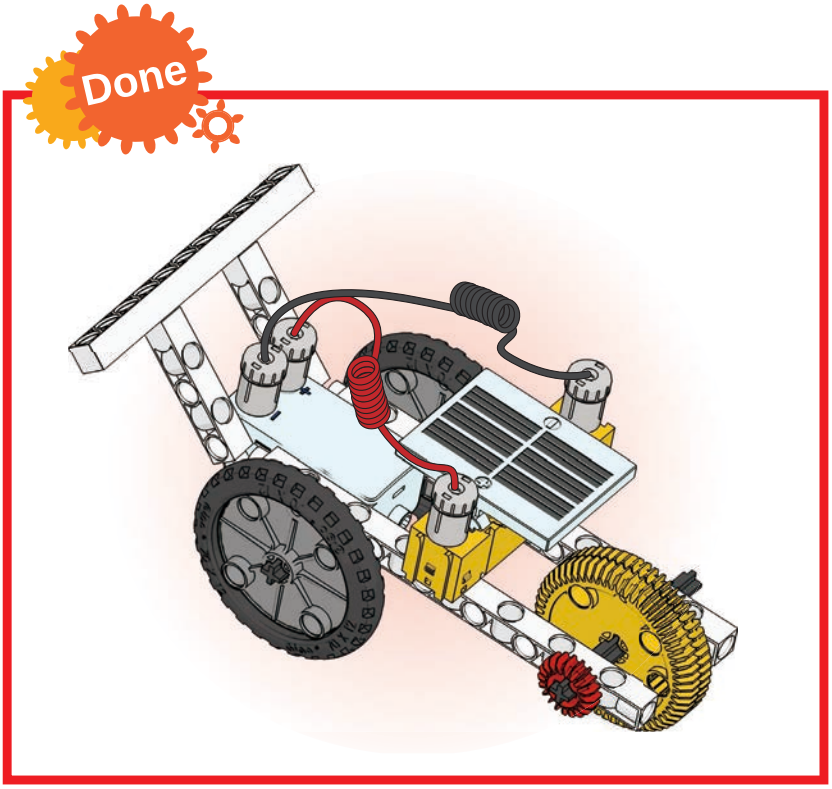


Model Operation Video

Hands-on Experiment

Record the speed of the car under different light conditions.

Hands-on Creativity

Try modifying your bicycle. Let's hold a solar car race.

Evaluation

Smart Manual
Web Service

1	2	3
Model Assembled	Experiment Complete	Model Creation

17 Hybrid Car

Scientific Application
Hybrid Energy

From outward appearances, hybrid energy cars look like any other car, but they are much more than that. The outer body panels look like a regular vehicle, and the chassis is similar, but under the hood they are very different. Hybrid vehicles have two methods of propulsion, an electric motor and an internal-combustion engine. They use both gasoline and electricity.

It may sound confusing, but because of the onboard computer, the two engines cooperate, automatically supporting each other's weaknesses and benefitting from each other's strengths. For example, when driving around town, it is easy and quiet to use an electric motor, when running at low speeds. But when travelling up a steep slope, or accelerating hard, the computer switches over to the gasoline engine when more power is required. In this way, hybrid vehicles conserve gasoline, and can even recycle energy.

Hybrid cars use the friction, and change in momentum, from braking to recycle energy. This converts the force of preventing the wheels from turning, back into electrical energy that can be stored in the battery.

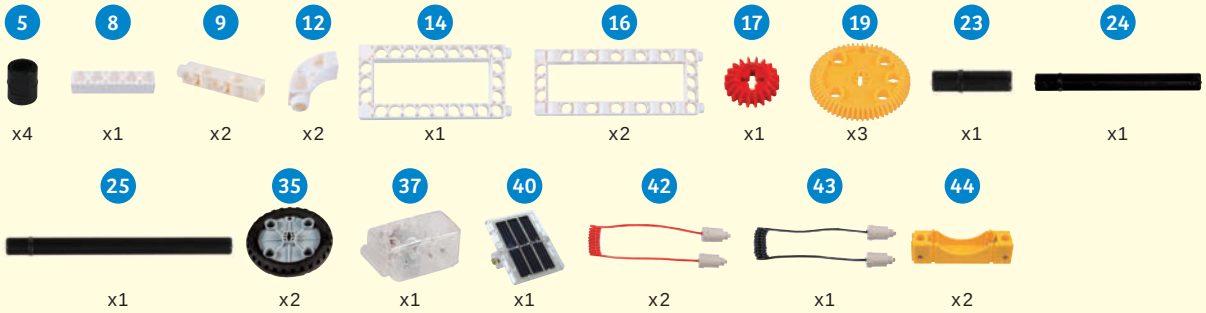
Daily Application

Hybrid vehicles are able to regenerate their batteries while using their gasoline engine, and through recycling exhaust waste. They use this system to increase efficiency, and reduce energy use overall. The principle of the hybrid power system is to convert energy in the most efficient way possible. Another example of energy recycling is waste heat boilers in waste incinerator plants. These incinerators help to reduce waste accumulation, while the extra heat energy is used to produce electricity.

Brainstorming

What are the pros and cons of hybrid systems and single-source systems?

Parts List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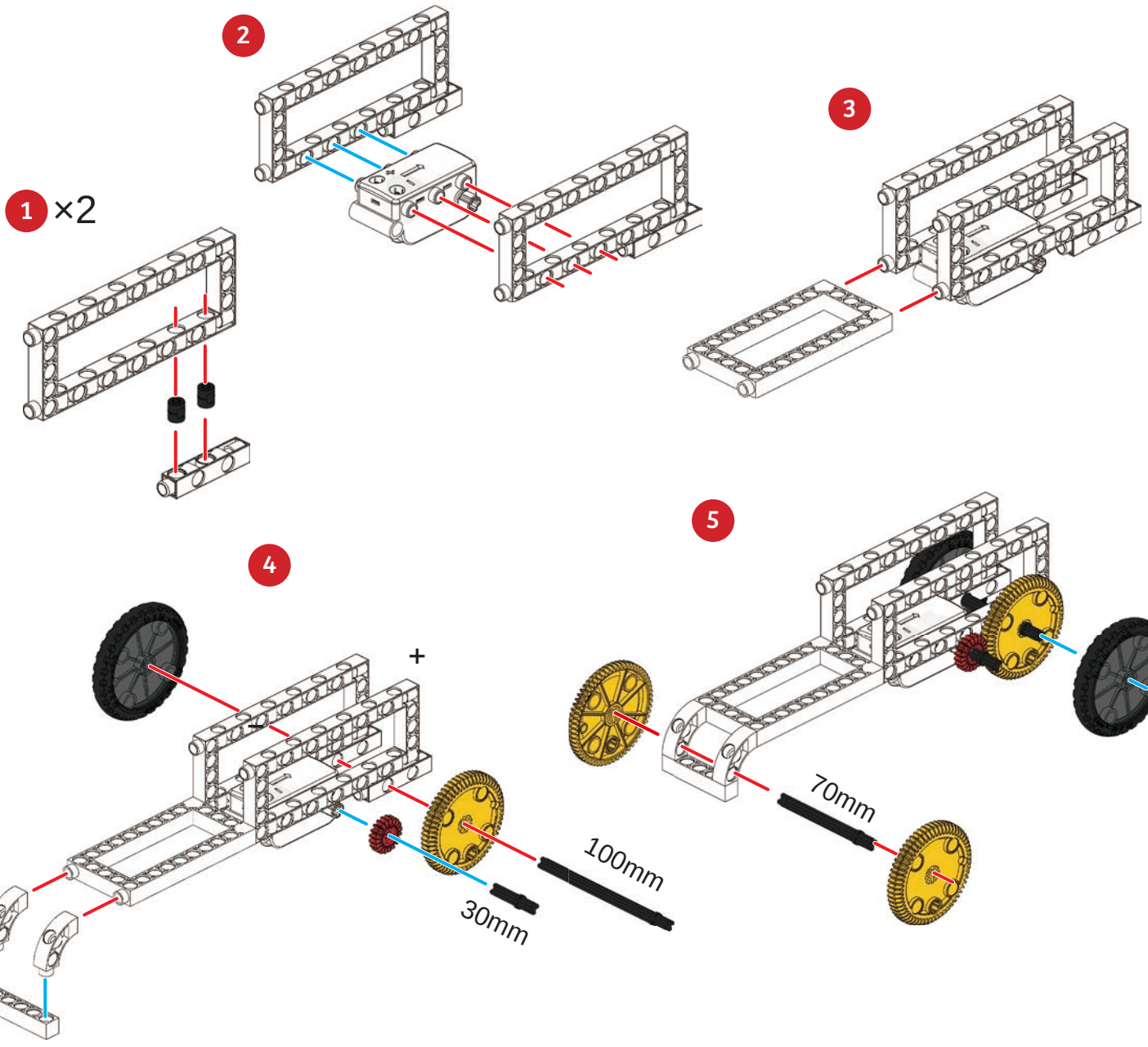
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17 Hybrid Car

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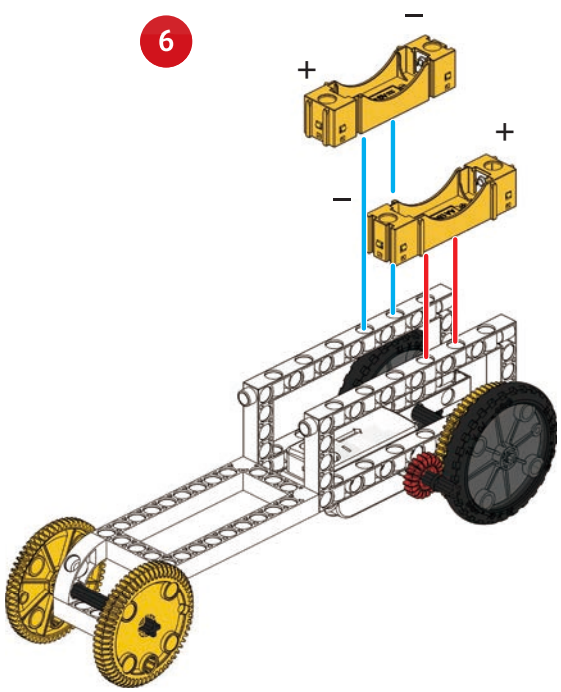

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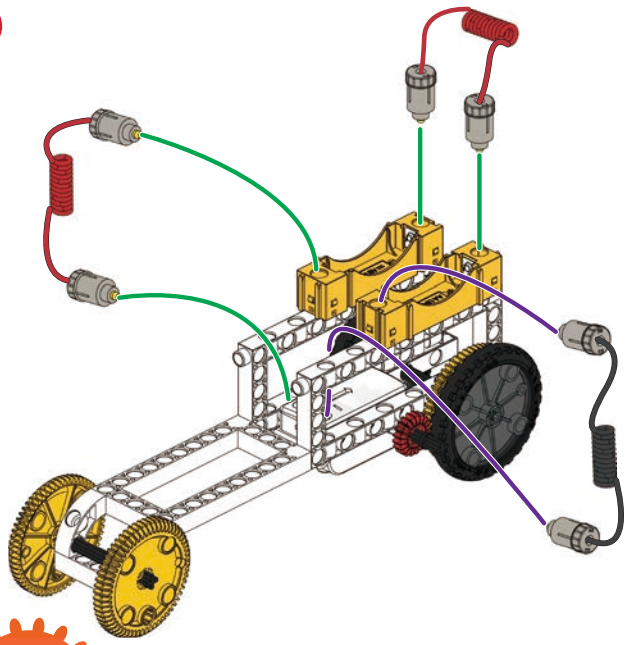

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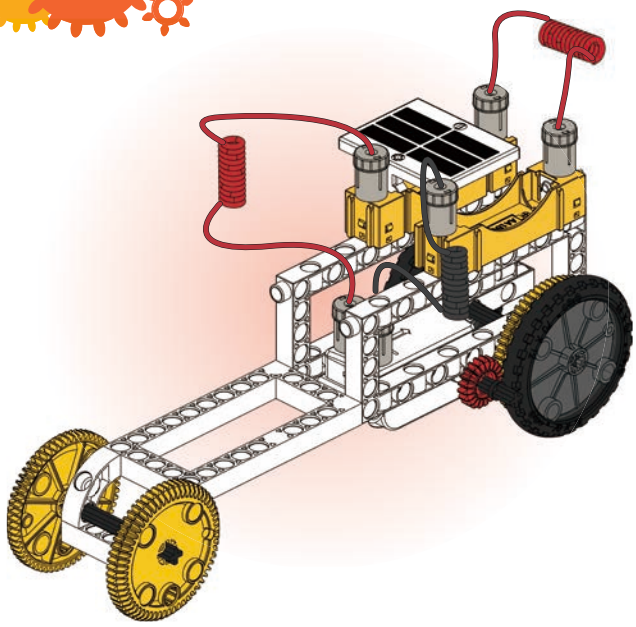

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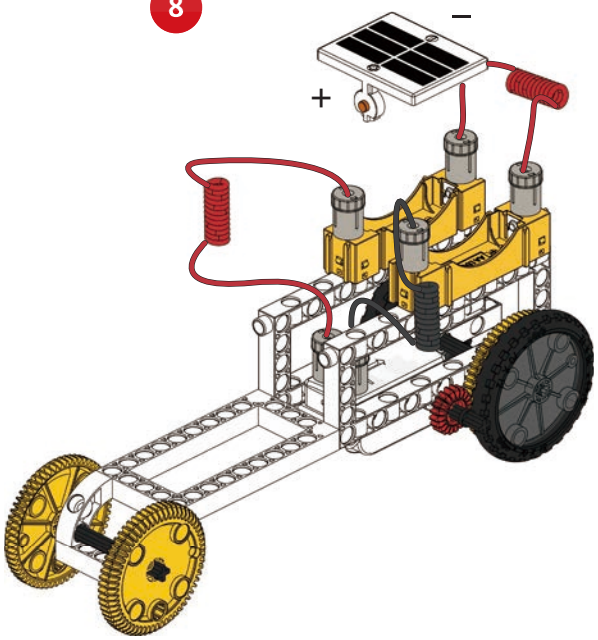


Model Operation Video

Hands-on Experiment

Record the difference in speeds among solar-powered cars, electric cars, and a hybrid car.

Hands-on Creativity

Try to modify the model with other components and create a hybrid cement mixer.

Evaluation

Smart Manual
Web Service

1	2	3
Model Assembled	Experiment Complete	Model Creation

18 Hand-held Imitational Beast

Scientific Application

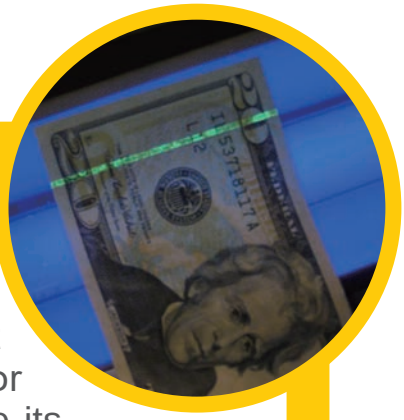
Bionics

Theo Jansen, a Dutch artist, observed the limb posture of animals walking, and through precision calculations created a large self-propelled mechanism, called the Strandbeast. It is capable of passing over sand dunes, detecting obstacles, and changing forward direction. He used plastic tubes and film, together with tape and wood for ensure that the Strandbeast was not too heavy, and could be activated just by wind power.

Theo Jansen publicized the secret construction technique for the beast and worked the public up into a frenzy. Many were inspired by his invention and created all kinds of Strandbeasts, with different types of power sources. For example, there is a drill powered walking machine created by Izzy Swan, and a generator powered giant walking-pod robot created by Scott Parenteau and Steve Hawthorne.

Kids, do you think it's possible to use solar energy to drive an imitational beast?

Daily Application

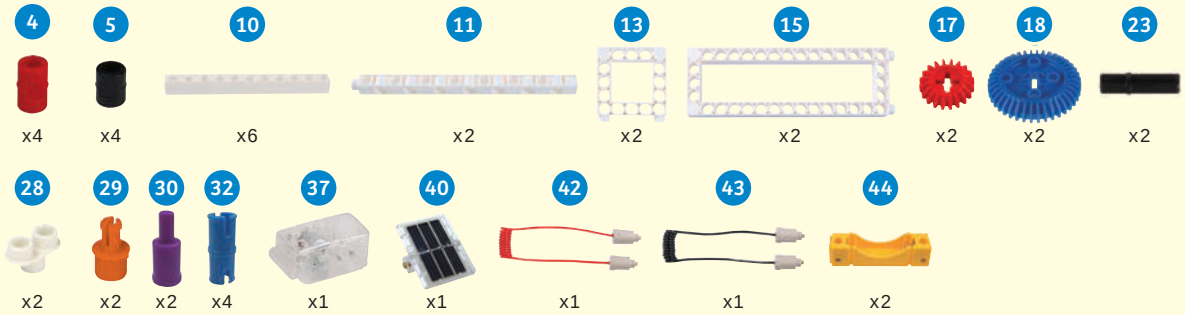


Through observation of nature and imitation of the functions of animals and plants we find, bionics was born. With this discipline, relevant technological equipment for solutions to human issues can be created. For example, through the chameleon's ability to change its skin color, scientists have invented military camouflage equipment. The tiny pores on paper currency (banknotes) and credit cards are an imitation of the tiny pits on the butterfly's wings, applying the principle of sunlight refraction, to reveal fake money.

Brainstorming

Which equipment in our daily life has imitational functions of animals or plants?

Parts List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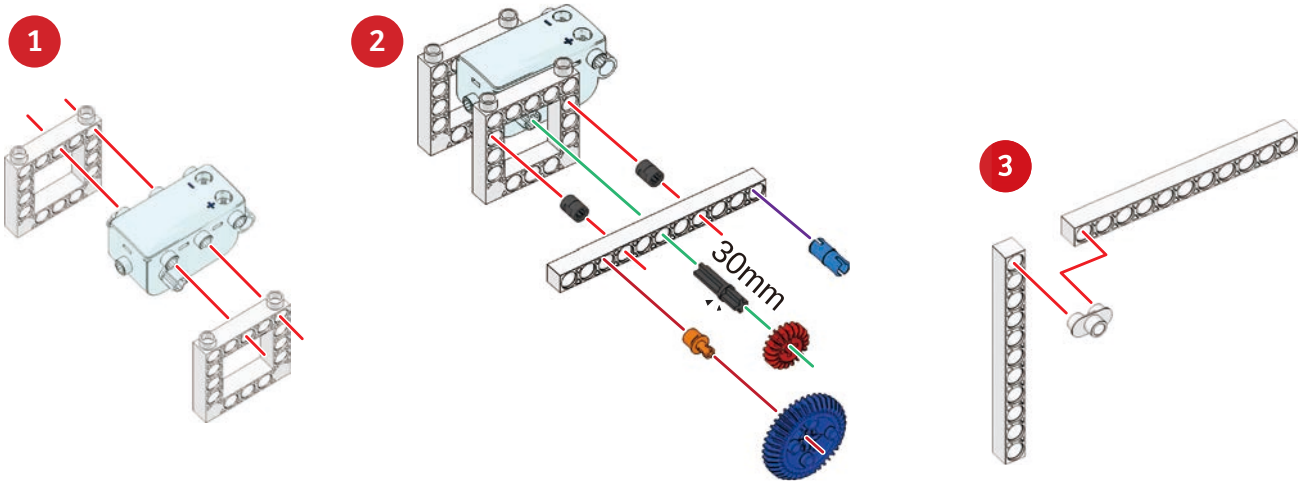
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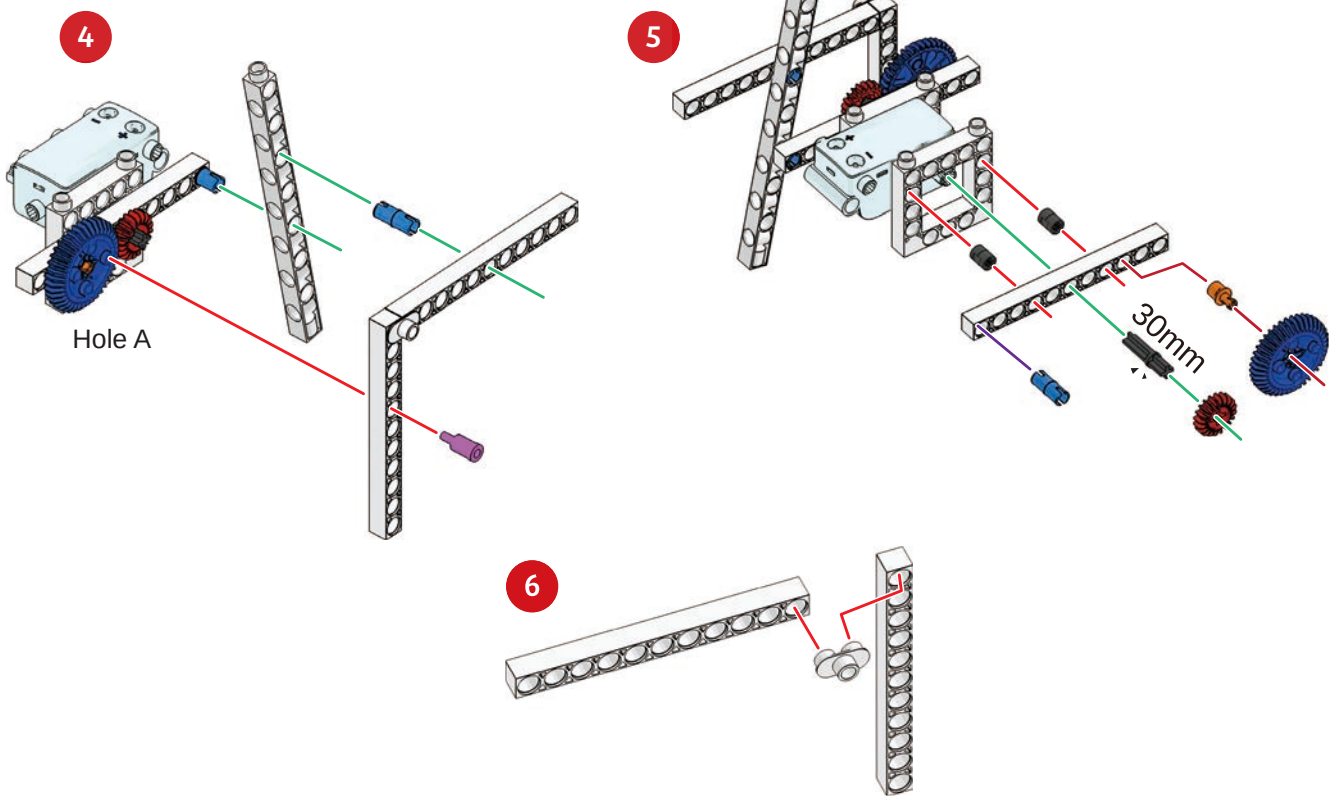
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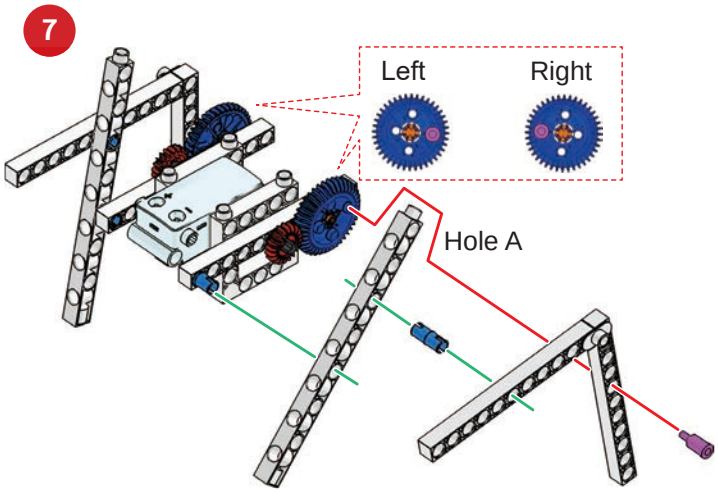
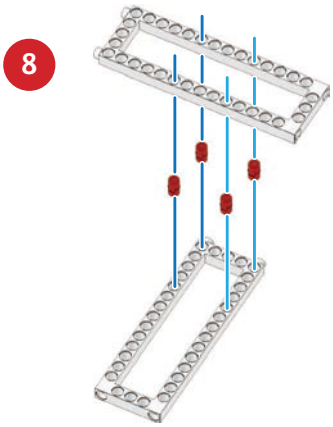
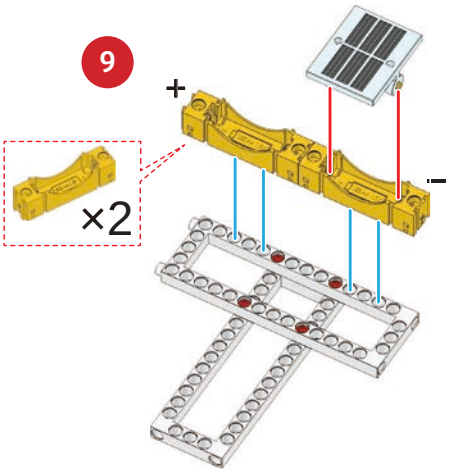
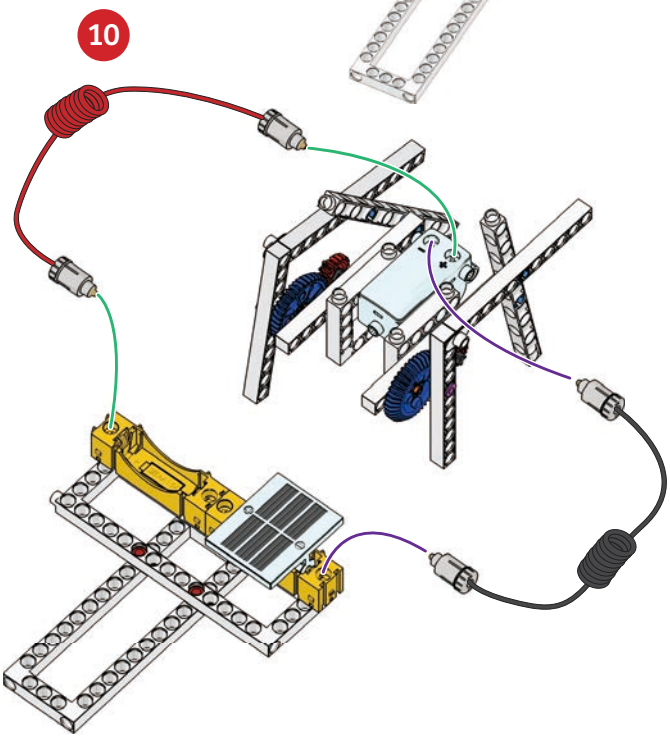
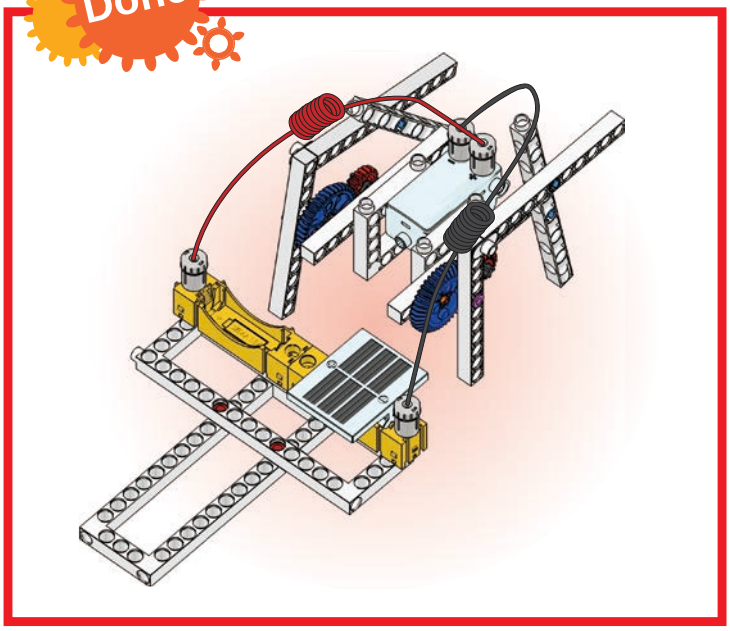
18 Hand-held Imitational Beast











Model Operation Video

Hands-on Experiment

Write down the forward speed of an imitational beast powered by solar energy. Then, remodel it for a faster forward movement.

Hands-on Creativity

Try to modify the model with other components and create a your own imitational beast.

Evaluation

Smart Manual
Web Service

1 Model Assembled

2 Experiment Complete

3 Model Creation

19 Ferris Wheel

Scientific Application

Applications of Solar Power

Summer break came around and Gigi and her family paid a visit to their relatives in California. The relatives gave them a tour to the famous Santa Monica Pier and they took some photos with the Highway 66 road sign, before heading for the Pacific Amusement Park.

No admission ticket was required to enter the park. But people do have to pay for the entertainment facilities. They went on a scary but fun roller coaster and bought some hotdogs and ice cream for a snack. Then, they had more fun playing a shooting game and a hamster game, before riding the Ferris wheel, so they could enjoy the beautiful scenery.

When they were riding the Ferris wheel, Gigi's aunt asked, "Do you know the special thing about the Ferris wheel we are on?" Gigi replied, "You mean, it is the biggest in the world?" Aunty shook her head to say no. "Is it that it is a Ferris wheel by the sea?" asked Gigi. Aunty nodded briefly, then shook her head. "What is it!" said Gigi, with a hint of frustration. Aunty explained, "It is the world first large, solar energy powered entertainment facility, so it is also the only solar powered Ferris wheel!"

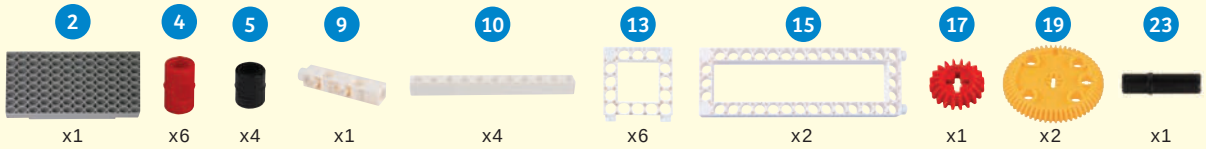
Daily Application

Contemporary portable chargers are plug-in chargers. This makes it very inconvenient while traveling, as it requires additional accessories to adapt to local voltage and socket types. Solar-powered chargers, on the other hand, provide free energy and avoid any unnecessary additions, making it a much more convenient power source. As long as there is sunlight, you can charge your smart devices.

Brainstorming

When the wheel goes up higher and higher, do you feel that your body becomes lighter?

Parts List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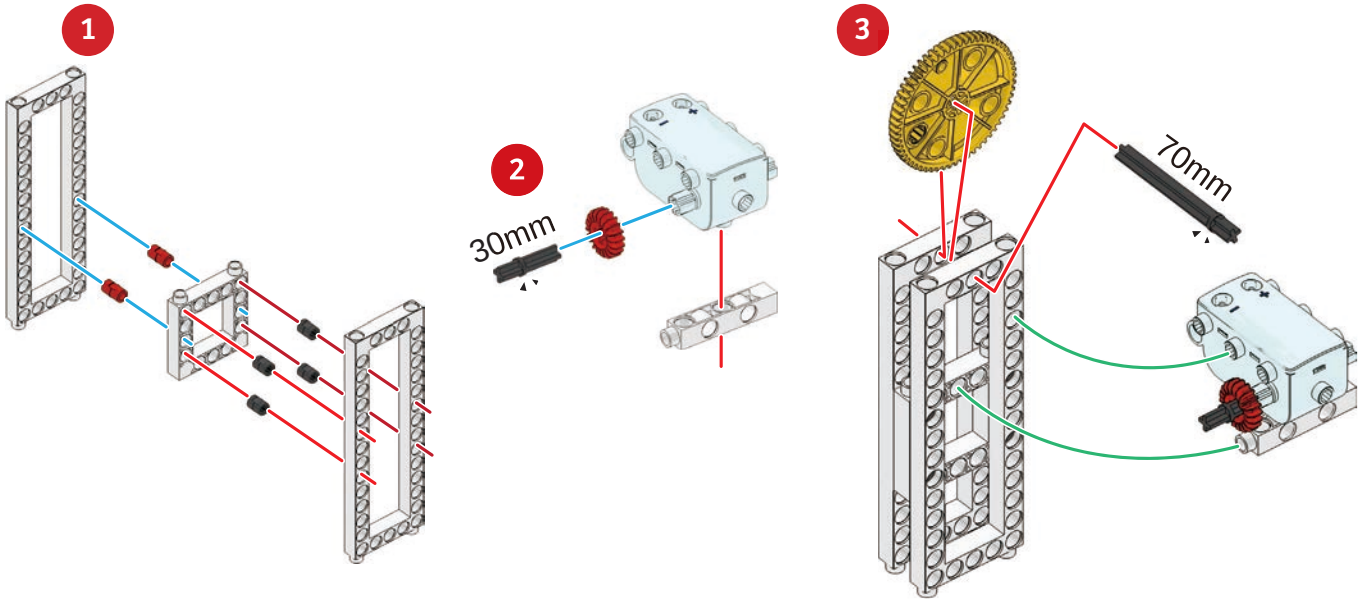
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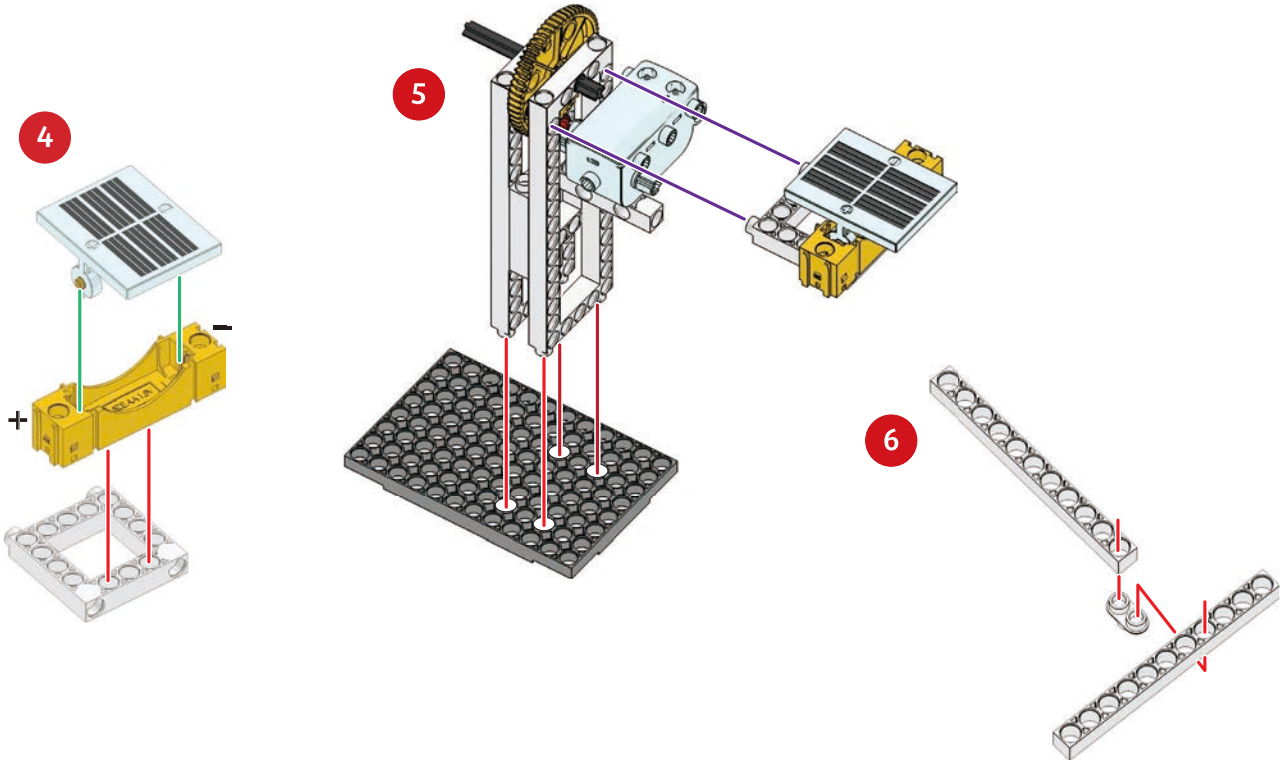
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19 Ferris Wheel

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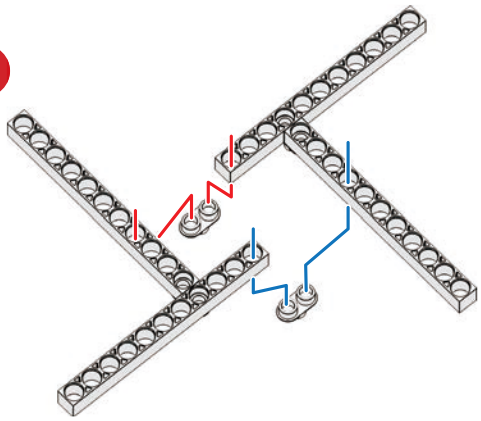

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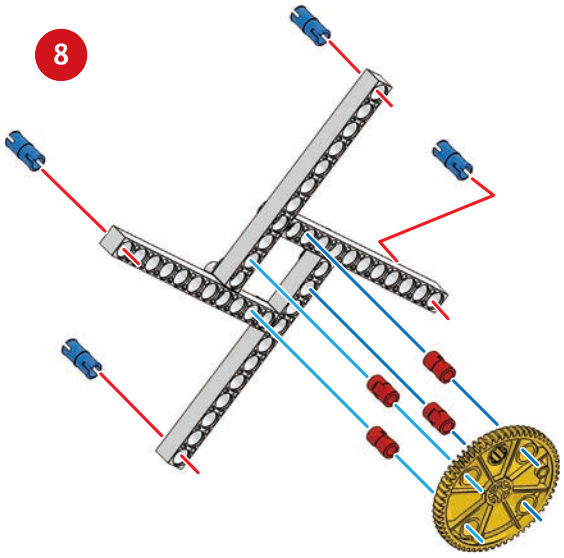

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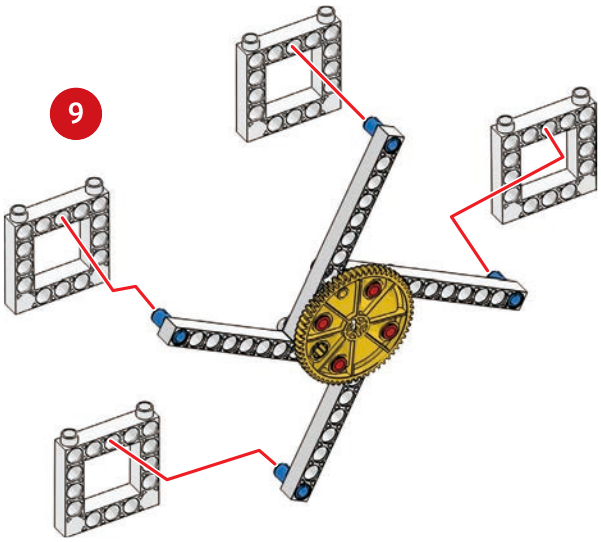

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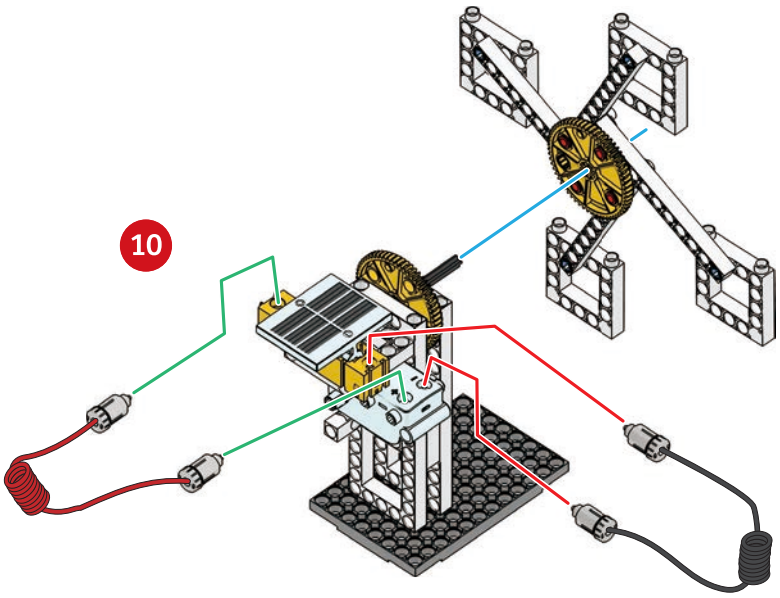

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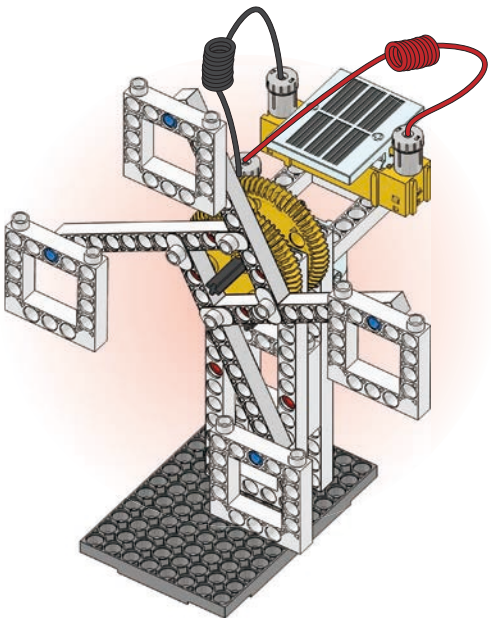


Model Operation Video

Hands-on Experiment

To reverse the model's forward direction, what change can you make to the mechanism?

Hands-on Creativity

Renovate the model for a slower rotation speed.

Evaluation

Smart Manual
Web Service

1 ★ Model Assembled

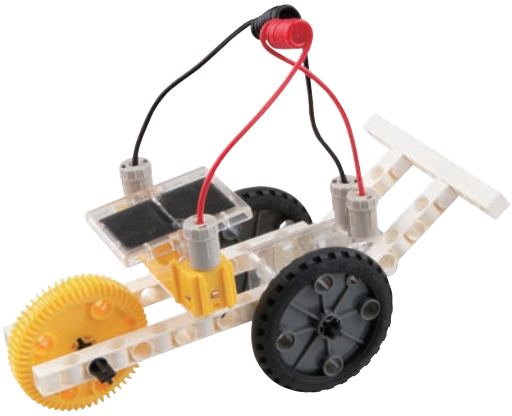
2 ★ Experiment Complete

3 ★ Model Creation

20 Monograph 4

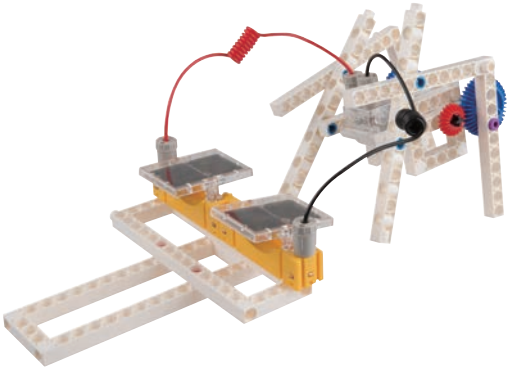
When astronauts go on a mission, they cannot carry along a generator with them at all times; however, solar energy is a very accessible resource. Try to design a lunar rover that can use solar power to navigate the terrain of a new planet.

Model Review



16. Solar Vehicle

17. Hybrid Car



18. Hand-held Imitational Beast

19. Ferris Wheel

Design Concept

My Artwork

Evaluation

1 Model Design

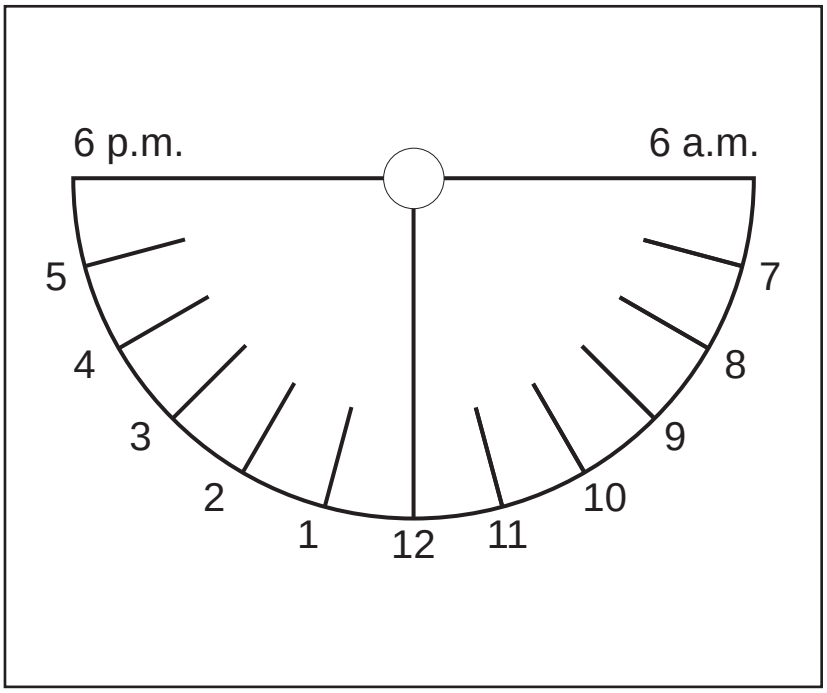
2 Model Creation

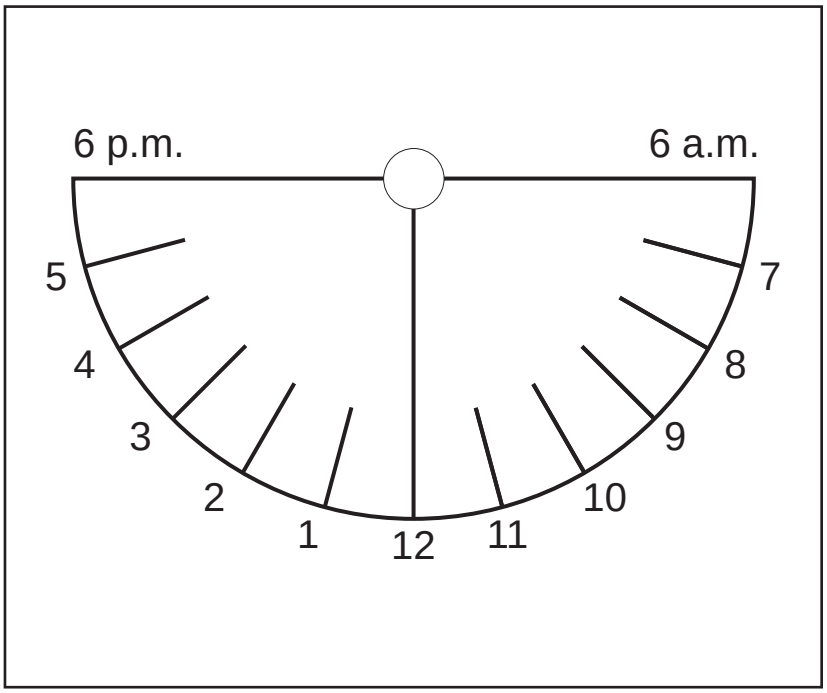
3 Winner!

Appendix - Paper Card

L1 Sundial Clock

(Please copy for use)





L4 Paper Card of Commercial Signboard

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