WIND POWER

GREEN ENERGY

7324

133 PCS

8+

8 MODELS TO BUILD

BUILD WIND-POWERED GENERATORS TO ENERGIZE YOUR ELECTRIC VEHICLES!

GREEN ENERGY

››› TABLE OF CONTENTS

››› FEATURES & SAFETY INFORMATION

FEATURES

The pioneer of future "Green Energy" – the endless Wind!
Allow children to explore the most environment-friendly electricity generation by wind power even at home! Create your own vehicles and activate them with the generated electricity!

1. UNIQUENESSES

The first kit including 2 block windmills and a 3-level Gear Box to fit all wind conditions.

a. Windmill with long blades: Similar to the real windmill for wind power generation, great to be used on beaches or under strong wind

b. Windmill with short blades: Similar to the shape of airfoils, workable even under weak wind, can generate electricity with wind power in the backyard of a house.

c. Both the two windmills can be used for teaching indoors with electric fans only.

d. 3- level Gear Box: For adjusting gear ratio depending on the strength of wind to accelerate power generation.

e. Tube: for fixing windmills easily for experiments.

2. LEARNING

a. The 37-page color manual thoroughly demonstrates the 2 windmills and 6 model vehicles. Following the experiments shown on the manual, children can happily learn from foundations.

b. When in the indoor, lead children to choose different windmill blades, quantities and angles, and adjust the levels of the Gear Box to fit different wind levels of the electric fans. Find the best combination to make the LED the brightest!

c. Based on the indoor experiences, teach children to observe the strength of wind outdoors and accordingly set the windmill to charge the battery in the shortest period of time!

d. During the experiments, accompany children to realize the power of wind and the storage of energy. Using the battery which is charged full to activate the interesting models!

3. CREATIVITY

Adding more unique experiences and ideas, encourage children to make their own models of wind power, electricity and mechanism with their particular ambition and creativity!

4. COMPETITION

Challenge yourself! Under the same wind condition, see whose windmill can firstly charge a battery full and activate the models! Let's join GIGO Rube Goldberg Machine Contest!

RECOMMENDATIONS

This specialized kit makes it possible to investigate how natural resources such as wind can be used in GIGO mechanism by assembling each model to produce energy, or by transforming them from one form to another. These activities can stimulate children's independent thinking, and furthermore lead children to discover how different types of energy are formed and where these energies can be applied in real life.

1. Please read the instructions, follow the safety rules and keep them for reference. We recommend you to make the models in the given order. You will then be able to understand the assembly of the parts and soon make more different models you wish.

2. This is a kit designed for children over 8 years of age. It helps children discover wind power and electricity during assembly.

3. Discuss the safety warnings and possible risks involved with children before allowing them to build the models.

4. Do not insert the wire connectors and other components into any electrical sockets, which will cause a serious damage. Only rechargeable batteries and general batteries are allowed for this kit.

5. CLEANING:
* Before cleaning, take out the batteries.
* Only use a cloth that has been slightly dampened with water.
* Never use a detergent.

SAFETY GUIDELINES

1. The general batteries must not be recharged.
2. Only an R6-size (AA) rechargeable battery and NiMH type can be charged under the supervision of an adult.
3. Pay attention to the safety warnings and recycling instructions on the rechargeable batteries.
4. Do not force open the battery.
5. Do not throw the battery into the fire.
6. Pay attention to the correct polarity.
7. Pay attention to the charging time.
8. Do not short-circuit rechargeable batteries. They could explode!
9. Do not mix rechargeable and non-rechargeable batteries.
10. The exhausted batteries must be disposed of as hazardous waste.

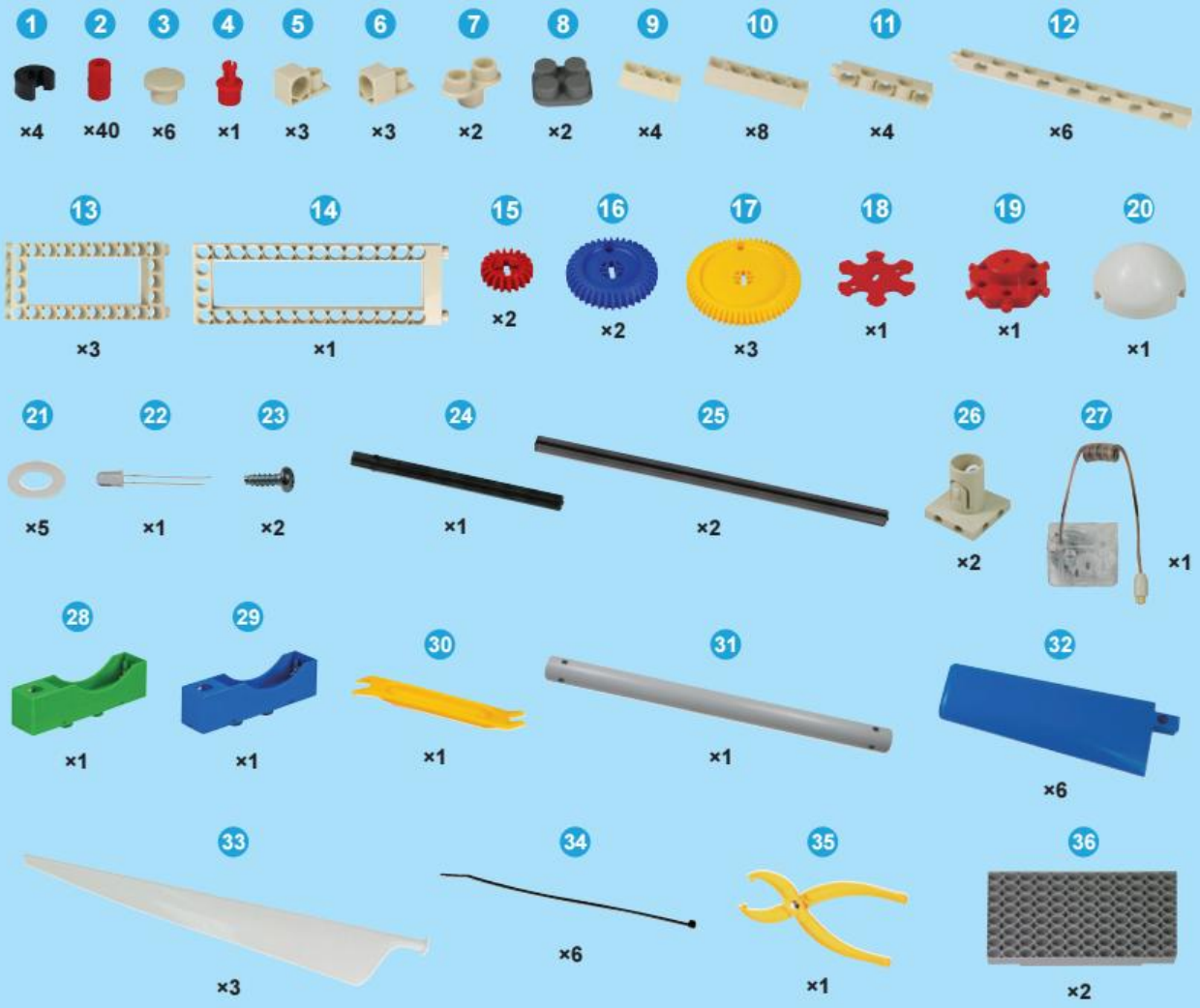
WARNING

Only for use by children aged 8 years and older.
NOTE: An age higher than 8 years may be stated.
Instructions for parents are included and have to be observed.
1. Remove the batteries when not planning to use the device for a long period of time.
2. Misuse of batteries can cause them to leak, which damages and corrodes the area around the battery, creating the danger of fire, explosion and personal injury.

WARNING TO PARENTS

This kit is not suitable for children under 3 years of age. It contains small parts that a child could swallow.This kit must be kept out of the reach of very young children.

What's inside your experiment kit:



Checklist: Find – Inspect – Check off

No.	Description	Qty.	Item No.
1	C–AXLE FIXING	4	3620–W10–A1D
2	C–LONG PEG	40	7061–W10–C1R
3	C–SHORT BUTTON FIXER	6	7061–W10–W1SK
4	C–AXLE	1	7026–W10–H1R
5	C–LATERAL CONVERTER	3	7061–W10–J1SK
6	C–FRONT CONVERTER	3	7061–W10–J2SK
7	C–TWO–IN–ONE CONVERTER	2	7061–W10–G1SK
8	C–BASE GRID CONNECTOR	2	7026–W10–I1SK
9	C–3 HOLE ROD	4	7026–W10–Q1SK
10	C–5 HOLE ROD	8	7413–W10–K1SK
11	C–5 HOLE DUAL ROD	4	7026–W10–S1SK
12	C–15 HOLE DUAL ROD	6	7413–W10–H1SK
13	C–5X10 FRAME	3	7026–W10–U1SK
14	C–5X15 FRAME	1	9060–W10–C1SK
15	C–20T GEAR	2	7026–W10–D2R
16	C–40T GEAR	2	7026–W10–E2B
17	C–60T GEAR	3	7026–W10–W4Y
18	C–UNIVERSAL ADAPTER–COVER	1	3680–W10–B1R

No.	Description	Qty.	Item No.
19	C–UNIVERSAL ADAPTER–BODY	1	3680–W10–A1R
20	C–ROUND HUB	1	7324–W10–B1W
21	C–WASHER	5	R12#3620
22	C–LED	1	E40–04
23	C–SCREW	2	M20–12
24	C–100mm AXLE III	1	7413–W10–L1D
25	C–150mm AXLE I	2	7026–W10–P1D
26	C–TUBE ADAPTER	2	7324–W10–E1SK
27	C–30X MOTOR WITH WIRE CONNECTOR	1	7328–W85–A1
28	C–1.5V BATTERY CHARGER	1	7324–W85–F1G
29	C–1.5V SINGLE OUTLET BATTERY HOLDER	1	7324–W85–F2B
30	B–PEG REMOVER	1	7061–W10–B1Y
31	E–410mm TUBE	1	1060–W17–410S
32	C–SHORT BLADE	6	7324–W10–C1B
33	C–LONG BLADE	3	7324–W10–A1W
34	C–CABLE TIES	6	R40#3680
35	E–RELEASE PLIERS	1	1060–W85–M1Y
36	C–BASE GRID	2	7125–W10–A1SK

FORMATION OF WIND

How is 'wind' formed? What are the functions of wind? How is wind utilized?

The earth's surface is surrounded by atmosphere. With continuous solar radiation shedding on the earth's surface, regions subject to different solar heat exposures will accordingly produce varied 'air pressures.' Since 'temperature' is an important determining factor of air pressures, an elevated temperature will cause hot air to ascend and air pressure to reduce. On the other hand, a low temperature will cause cold air to descend and air pressure to increase resulting in differential pressure. The air circulation induced from the earth's self-rotation and uneven distribution of solar radiation results in the formation of 'wind.'

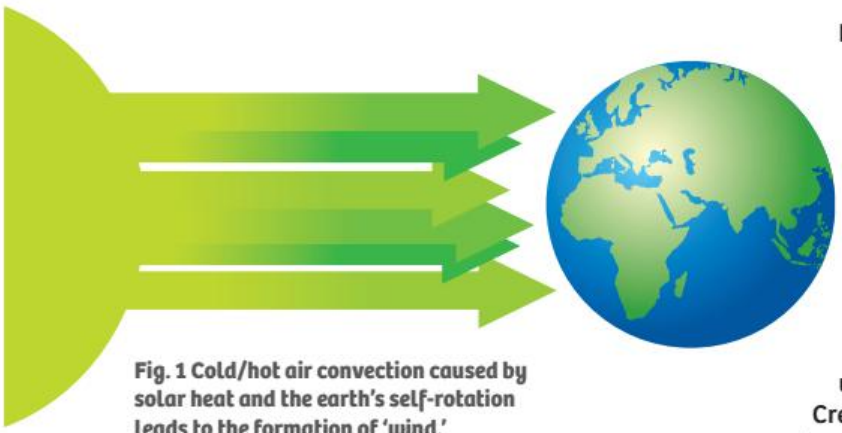


Fig. 1 Cold/hot air convection caused by solar heat and the earth's self-rotation leads to the formation of 'wind.'

Human beings began utilizing wind as power energy in a very early stage of civilization. The Chinese and Persians designed windmills for irrigation, water-fetching, and grain/crop grounding about 1,000 years ago. Later, European countries also started using wind power. For examples, the Netherlands improved windmills for use and people in Crete, a Greek Island, had fetched water with one hundred canvas windmills. By the Medieval Period, windmills became an important energy source in Europe and extensive research on windmills was conducted. In 1890, meteorologists in Denmark created the first wind turbine and turned a new leaf for technological development of wind power. With the maturity of the techniques of wind turbines, wind power generation became more and more effective.

Wind power developments kept progress in the early 20th century. In the early 1900s, wind power was still solely used for agricultural needs. It was not until the 1970s when the energy crisis occurred that wind generation finally received great attention in the world and wind turbines underwent systematic development. Wind generation related assessments, research, and redevelopment also took place in our nation at that time. In 1990, wind generation was gradually applied commercially. As alternative energy gained emphasis, the developments of wind power generation headed toward a new era.

Fig. 2 Shows the earliest conventional windmill, modern wind turbine, and wind farm (Data source: Bureau of Energy, MOEA).

WIND STRENGTH SCALE

The strength of wind can be measured by observing the sea or land condition under wind effects, and represented based on the wind strength scale. At present, the most common scale used internationally is the Beaufort Scale, which was created in 1805 by Sir Francis Beaufort, an Irish-born British admiral. The scale is firstly applied to observation on sea under wind forcing, and sequentially also applied to land. Via revisions over ages, the scale becomes standard as the table below:

The formula for actual wind speed and Beaufort Number is $V = 0.836 * (B^{3/2})$

(B= Beaufort Number; V= Actual wind speed (m/s))

Table 1 Beaufort Scale used for land observation

Beaufort Number	Wind speed		Description	Wind Effects on Land
	kts	m/s		
0	<1	<0.3	Calm	Calm. Smoke rises vertically.
1	1-2	0.3-1.5	Light air	Wind motion visible in smoke but not in vanes.
2	3-6	1.5-3.3	Light breeze	Wind felt on exposed skin. Leaves rustle. Vanes moved.
3	7-10	3.3-5.5	Gentle breeze	Leaves and smaller twigs in constant motion. Light flags extended.
4	11-15	5.5-8.0	Moderate breeze	Dust, leaves, and loose paper lifted. Small tree branches moved.
5	16-20	8.0-10.8	Fresh breeze	Small trees in leaf begin to sway.
6	21-26	10.8-13.9	Strong breeze	Large branches in motion. Whistling heard in telegraph wires. Umbrella used with difficulties.
7	27-33	13.9-17.2	High wind, Moderate Gale, Near Gale	Whole trees in motion. Inconvenience felt when walking against wind.
8	34-40	17.2-20.7	Fresh Gale	Twigs broken off trees. Progress impeded.
9	41-47	20.7-24.5	Strong Gale	Larger branches broken off trees, and some small trees blown over. Slight structural damage occurs, such as chimney collapsed.
10	48-55	24.5-28.4	Whole Gale/Storm	Trees are broken off or uprooted. Considerable structural damage occurs.
11	56-63	28.4-32.6	Violent storm	Seldom experienced. Accompanied by wide-spread damage.
12-17	≥64	≥32.6	Hurricane-force	Maximum and extensive damage occurs. Very rarely encountered.

From the Beaufort Number 3-7, the wind is categorized as Gentle Breeze, Moderate Breeze, Fresh Breeze, Strong Breeze, and Near Gale (the actual wind speed is around 3-17m/s). These wind levels are applicable to wind generators.

2. UNVEIL THE MYSTERIES OF BLADE DESIGN AND NUMBER

Traditional windmills come with more blades, a variety of shapes in cross-section, and low efficiency in converting wind into energy.

The cross-sections of modern wind turbine blades and airplane wings show convex tops and flat bottoms. When wind/air passes through the upper/lower side, the faster air flow in the upper side is due to a lower pressure and the slower air flow in the lower side is due to a higher pressure (Bernoulii Law). Therefore, the side with a higher pressure produces an ascending pressure against the side with a lower pressure to reduce the frontal pressure in elongated blades. The water drop-shaped cross-section is less likely to produce a vortex when air passes through the upper/lower sides; thus, higher energy conversion efficiency is achieved. Gigo's long/short windmill blades all take on a cross-section design that coincides with Principles of Fluid Mechanics.

Fig. 3 Dutch Windmills and water-pumping windmills in villages in the central parts of the United States.

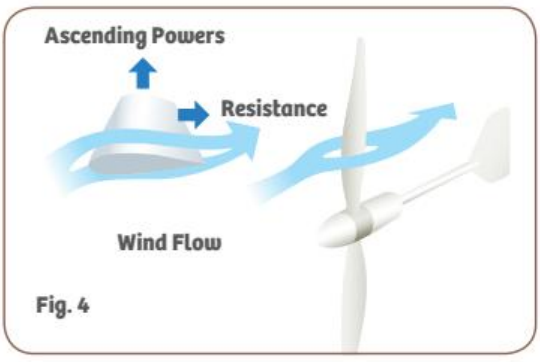


Fig. 4

Fig. 5

Fig. 6

Most wind turbines in use now take on the 3-blade design. Experimental findings show that the power generation capacity of fans with 6 blades is higher because the blade of a commercial turbine on a tower normally measures 120 meters where the current speed exceeds that of the ground. Also, since enormous rotational torque is produced by the ultra long blades. All blades therefore take on an elongated design in coincidence with Principles of Fluid Mechanics.

Gigo Wind Power Block Kit facilitates the completion of numerous green energy related experiments. Although it is true that the model's efficiency cannot match up with a commercial wind turbine, one will gain valuable science-based knowledge through the hands-on experience.

Fig. 7 The Real Wind Turbine looks larger, compared to the engineer.

3. PRINCIPLE OF WIND POWER

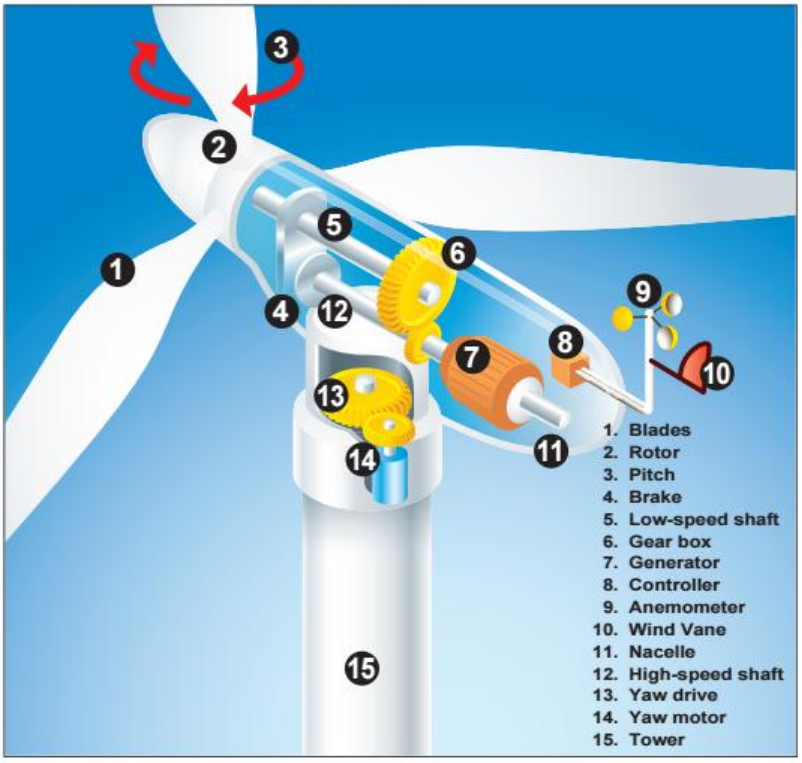


Fig. 8

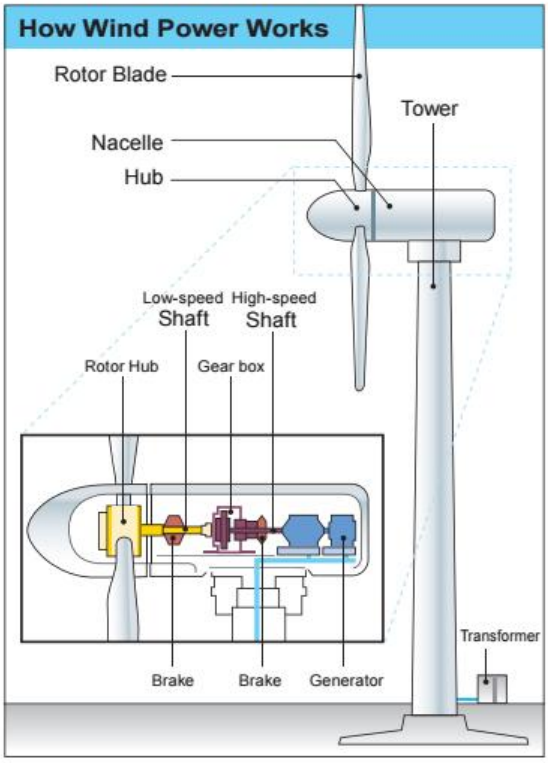


Fig. 9

Wind is a natural and best sustainable energy for its replenishment which helps reduce the consumption of fossil fuel. Due to the characteristics of cleanness, pollution free, and tourism potential of wind, and the mature development of technology, people manufacture wind for commercial purpose in recent years and make wind become the fastest growing recyclable energy. When wind turns windmill blades, torque is generated to accelerate the gearbox, power the generator, and then create wind power. The process shows how wind power is converted into mechanical power, and then turned into electrical power through generators. For house use, the electrical power needs a further transformation by transformers, and finally distributed to consumers via electricity transmission system. The real wind power generator belongs to the type of alternating current generators. Its electrical power has to be rectified into a direct current when stored in a battery.

4. DIRECT CURRENT GENERATOR

According to Fleming's right hand rule, when the right index finger is pointing towards a magnetic field, the thumb is meanwhile indicating the motion direction of the conductor while the middle finger is showing the direction of the electrical current (positive charge of current). This is the principle behind power generator.

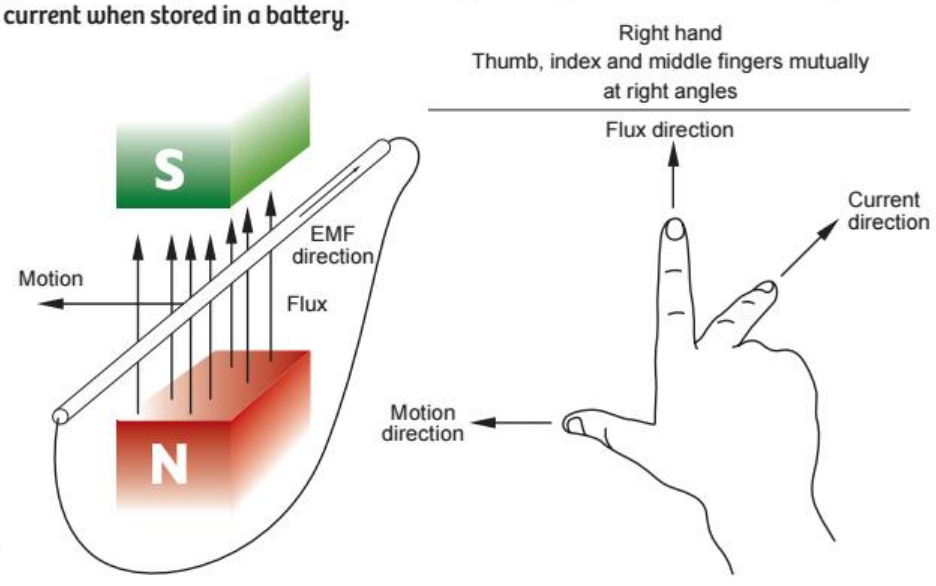


Fig. 10 The biggest difference between a direct current generator and an alternating current generator is the commutator connecting the coil, also known as "brushes" structure.

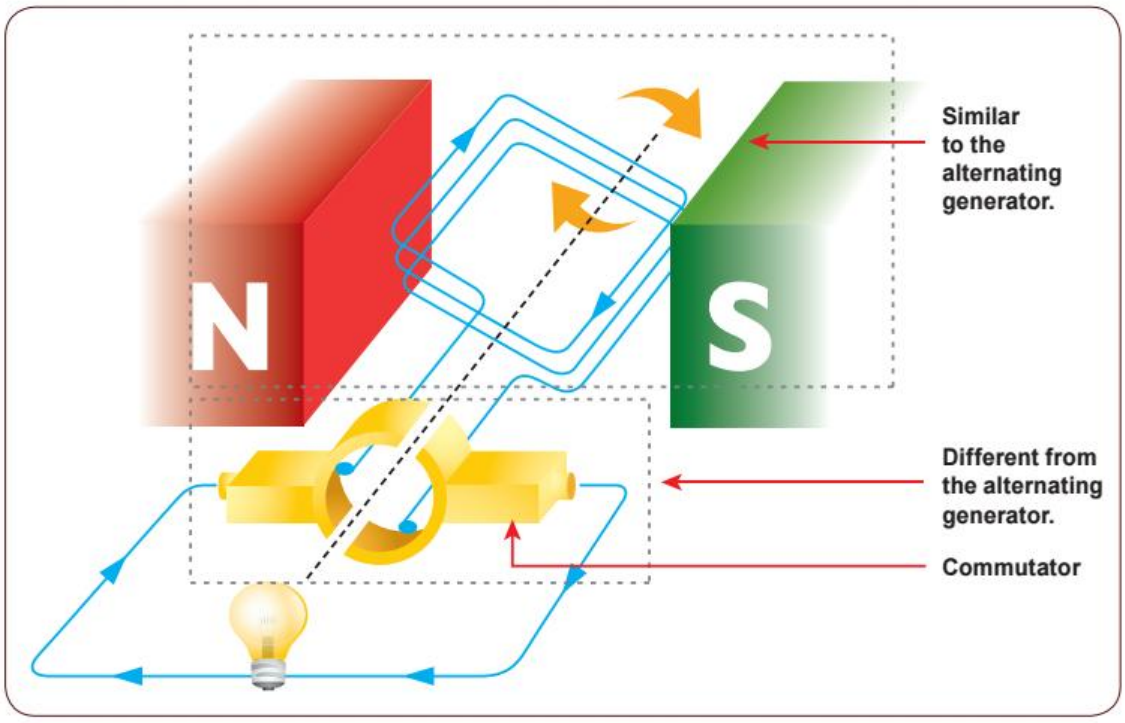


Fig. 11

When the coil passes through the vertical position, the commutator changes the connecting direction of the coil and the external wiring, making the electric current outside of the coil always moving in a uni-direction. When there is a conversion between the positive and negative charge in loop, the terminal block of the contactor interchanges as well, and thus the positive and negative voltage discharged from contactors are fixed, as shown in Photo 3.6(b). This type of connecting-exchanging process is known as "commutation". The rotatable semi-circle conductor as "commutator segments" and the position-fixing contactor as "brushes" set up the device of "commutator".

Current generated by a direct current generator:

During the coil's rotation of one cycle,
Current I is constantly changing.

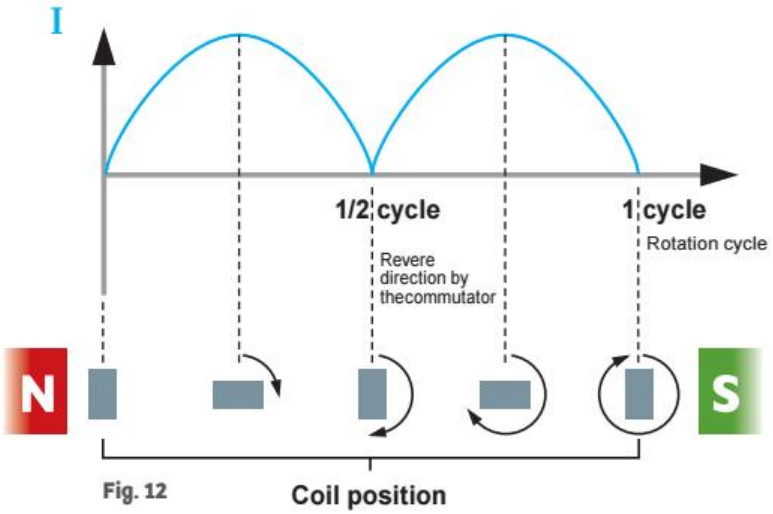


Fig. 12

5. USING A MOTOR AS A GENERATOR:

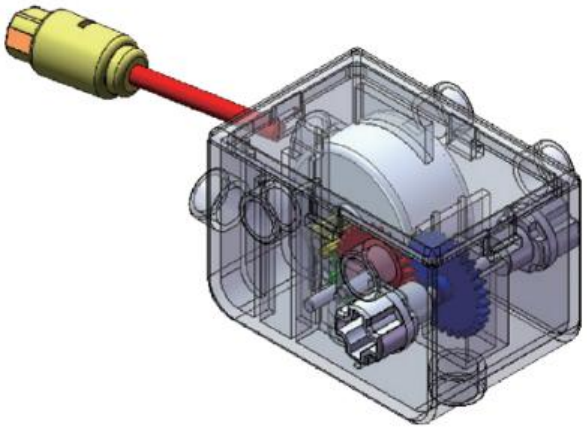
The Universal Adaptor Motor (3680-W85-A1R) and Reverse Generator (1114-W85-E1): Their motor and generator share the same basic structure, and in other simpler words:

Generator (motor) = current = (magnetic field action) = motion

Generator = motion = (magnetic field action) = current

Therefore, applying a current on a motor will create motion; on the other hand, applying motion on a motor will create a current!

6. REVERSE GENERATOR WITH WIRE CONNECTOR



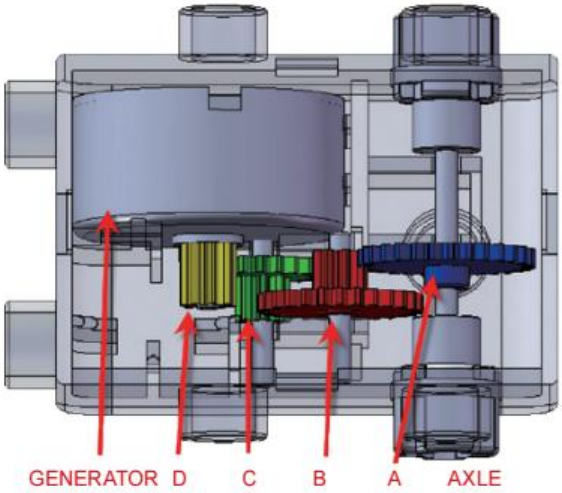


Fig. 13

In this experiment, we use a special generator component, as shown in Figure 13. On its most right side, an axle is placed to rotate the input fans, and then the wind power generated by the fans will be transmitted via the gear A, B, C and D to the generator. Through the device, a train value is produced as:

THE GEAR BOX = 30/8 × 28/8 × 20/8 = 32.8125.

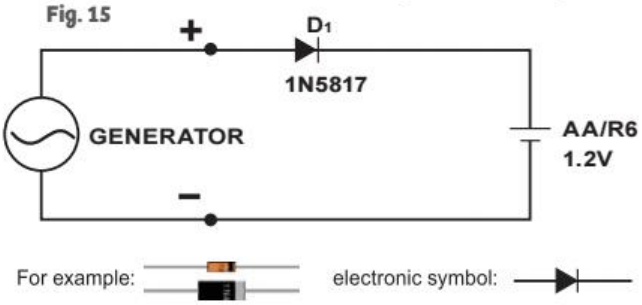
This indicates that when the axle for the input fan rotates at the speed of 1 rpm, the generator shaft will rotate at the speed of 32 rpm. If the rotation speed of the axle for the input fan achieves 100 rpm and that of the generator shaft accordingly becomes 3200 rpm, the generator can produce a 3V direct current (DC). The faster the rotation speed is, the higher the voltage of the produced current.

7. PRINCIPLE OF BATTERY CHARGER

Fig. 14

A diode is installed into the green battery holder.

Fig. 15



A diode allows only unidirectional electric current. The electronic symbol (the arrow) indicates the permitted direction for the electric current to flow. Generally speaking, only if the electric current is a forward current with the voltage of 0.7 V, it will be able to pass through the circuit. However, when the electric current flows in the counter direction (as in the case that the positive and negative poles of the solar panel or the wire connecter are set reversely), it will be blocked, which is showed by the electronic symbol.

Using the device under ideal conditions of wind speed, the wind turbine can be mobilized, and a current from the positive electrode of the wire passes into the positive electrode of the rechargeable battery in the battery charger and slowly charges the battery. As wind speed becomes too slow, the voltage from the power generation will reduce as well. However, a reverse current leakage will not take place since the diode in the battery charger functions as a protector. Keep the device under stable wind conditions, the wind turbine can fully charge a 1.2V 1200mAh rechargeable battery in 3-4 hours.

TIPS AND TRICKS FOR MODEL BUILDING

Fig. 16

Fig. 17

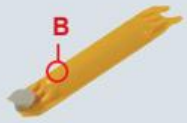


Fig. 18

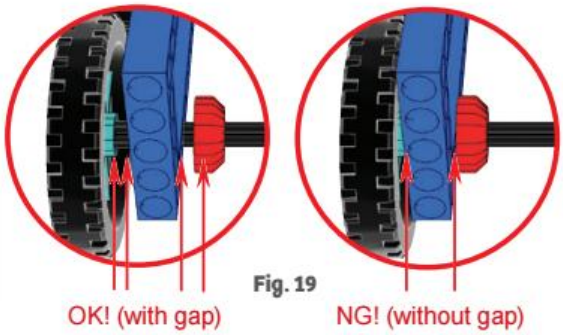


Fig. 19

1. Use the end "A" of Axle/Peg Remover to pull off the long peg (Fig. 16).
2. Use the end "B " of Axle/Peg Remover to pull off the axle (Fig. 17).
3. Use the end "B" of Axle/Peg Remover to pull off the short button fixer (Fig. 18).
4. When fixing a gear or a tire onto the framework with a drive axle, be sure to keep a gap of about 1mm between the gear or the tire and the framework to decrease the friction caused in operation so that a smooth motion can be expected (Fig. 19).

How to assemble and disassemble Tube Support and Tube

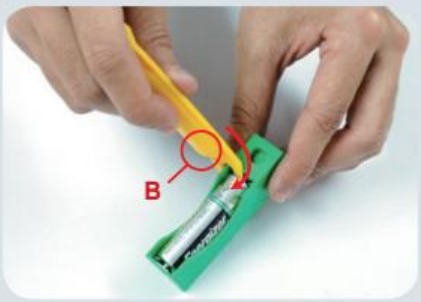
Note: Do not hold the tube support and the tube where you insert each piece as finger may be pinched (Fig. 20).

Fig. 20

Push the tube support into tube and turn the tube until a "click" is heard. They are then fixed together (Fig. 20).

Fig. 21

Put release pliers into holes that have safety lock pins coming through and squeeze the pliers to release the tube and the tube support (Fig. 21).



How to remove the battery

Fig. 22

Using the "B" end of peg remover to remove the battery out of the battery holder as Fig. 22 shows.

HOW TO ADJUST THE GEAR BOX

Fig. 23

Hold the gear box and the yellow gear you are to shift as shown in Fig. 23 and move this yellow gear backward so that it will mesh with the upper red gear, while the other two gear sets are left unmeshed, to adjust the gear ratio at 3:1.

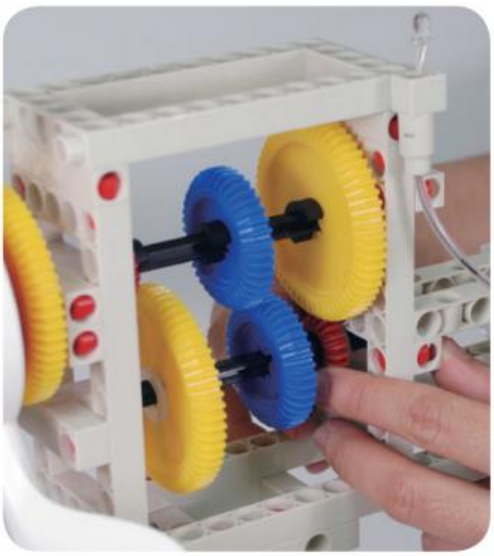


Fig. 24

Hold the gear box and the red gear you are to shift as shown in Fig. 24 and move this red gear backward so that it will mesh with the upper yellow gear, while the other two gear sets are left unmeshed, to adjust the gear ratio at 1:3.

Gear Box

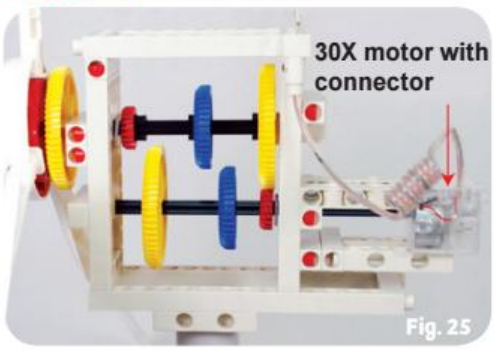


Fig. 25

Gear Ratio 1:3

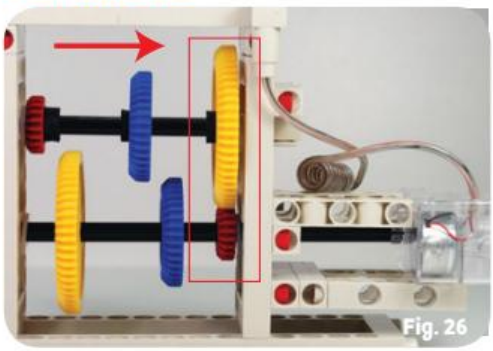


Fig. 26

Fig 26 shows you only the upper yellow gear (60T) meshed with the lower red gear (20T) so that the current gear ratio is 1:3.

Gear Ratio 1:1

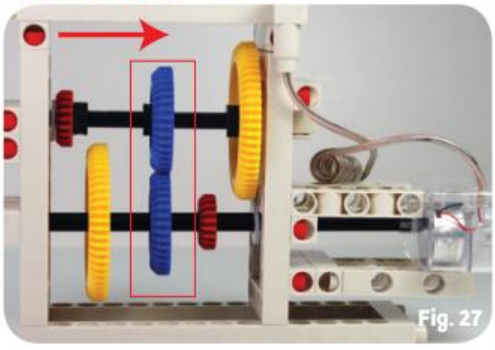


Fig. 27

If you shift the gears so that only the upper and the lower blue gear (40T) are meshed together the gear ratio of this gear box will be changed to 1:1. (Fig. 27)

Gear Ratio 3:1

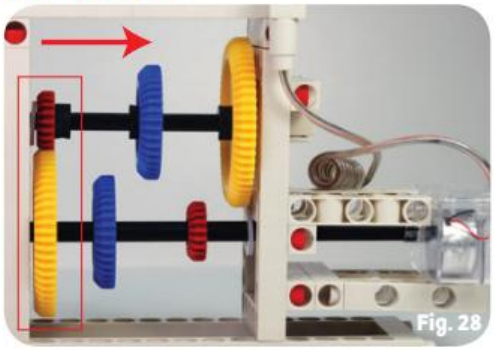


Fig. 28

If you shift the gears so that only the upper red gear (20T) and the lower yellow gear (60T) are meshed together the gear ratio of this gear box will be changed to 3:1. (Fig. 28)

PLEASE REFER TO THE MEASUREMENTS GIVEN IN THE FOLLOWING FIGURES FOR SETTING UP THE FAN AND THE WINDMILL FOR MAKING EXPERIMENTS INDOORS.

- **18" Industry Fan**
  The Windmill with Long Blades

Fig. 29

- **18" Industry Fan**
  The Windmill with Short Blades

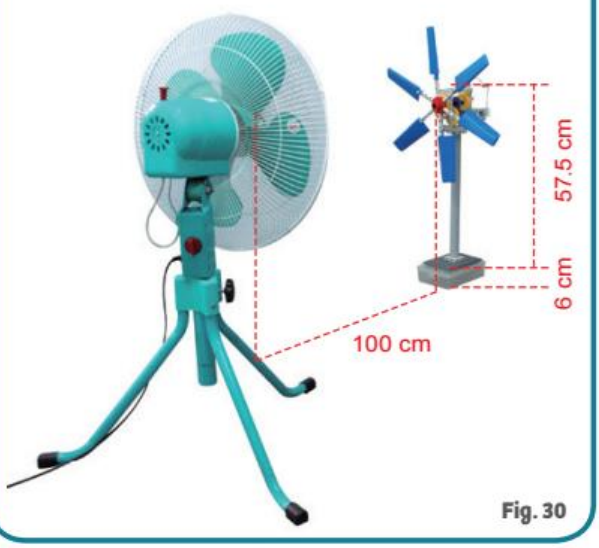


Fig. 30

- **16" House Fan**
  The Windmill with Long Blades

Fig. 31

- **16" House Fan**
  The Windmill with Short Blades

Fig. 32

Outdoors

- Fixing the windmill on a bamboo rod with 2 Cable Ties (Fig. 34).

  Fastening the Cable Ties to ensure the windmill is immovable (Fig. 33).

Fig. 33

Fig. 34

Indoors

- Press the Gear Box with your hand (Fig. 35) while fixing the windmill base to the ground with tapes (Fig. 36).
- Putting two iron blocks or stones with the weight of 1.3 Kgs for each on the base to further fix the windmill (Fig. 37).

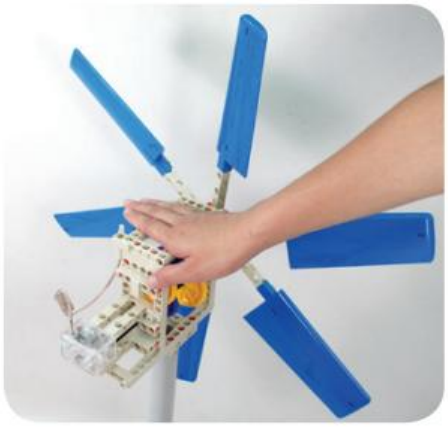


Fig. 35

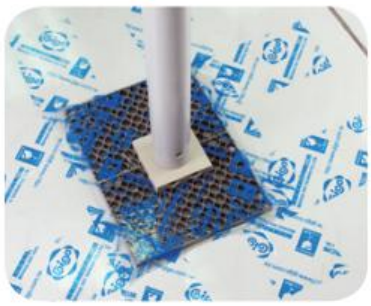


Fig. 36

Fig. 37

- The experiment of power generation can be run by fingers un der the condition without wind in doors.

  Hold the wind mill with the left hand and rotate it with a right finger (Fig.38 & 39).

Fig. 38

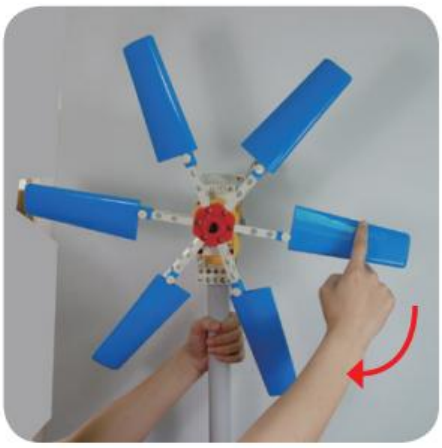


Fig. 39

Experiment 1: Adjust the gear ratio of gigo gear box

Use a windmill with short blades (Fig. 41) to observe the variation of power generation (the brightness of the LED bulb) under the same wind speed. Fix the angles of the blades and change the gear ratios by shifting the gears at the lower axle.

Fig. 40 shows you the upper yellow gear (60T) meshed with the lower red gear (20T) so that the current gear ratio of this gear box is 1:3.

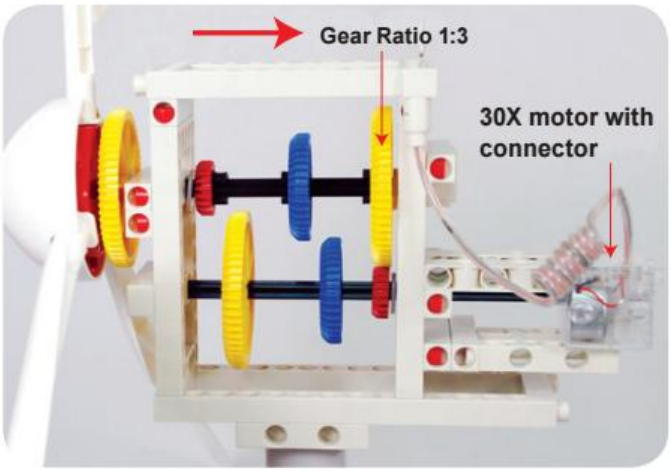


Fig. 40

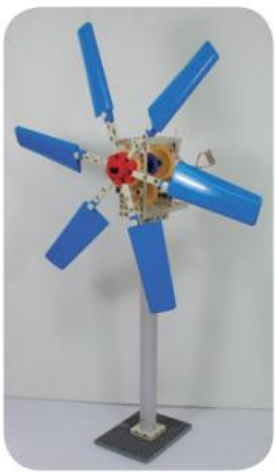


Fig. 41

SELECT GEAR RATIO 1:1 IN EXPERIMENTS 2-4

Experiment 2: Use a windmill with short blades (Fig. 41) to observe the variation of power generation under different wind speeds (wind levels of a fan). Do you figure out any correlation between wind speed and power generation (the brightness of the LED bulb)?

Experiment 3: Use a windmill with short blades (Fig. 41) to observe the variation of power generation (the brightness of the LED bulb) under the same wind speed. Change the angles of the blades. Can you find the best and most efficient angle to make the LED brightest?

Experiment 4: Use a windmill with short blades (Fig. 41) to observe the variation of power generation (the brightness of the LED bulb) under the same wind speed. Change the blade numbers (6 blades, 4 blades, 3 blades, 2 blades). Note to arrange the blades in symmetry with equal intervals. Can you find the best and most efficient blade numbers to make the LED brightest?

Experiment 5: Use the windmill with long blades (Fig. 43) and repeat Experiments 1-3. Can you also find the best and most efficient conditions for this new device?

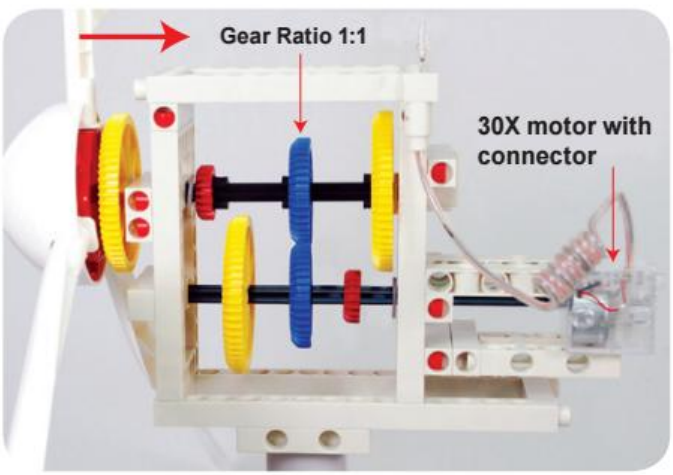


Fig. 42

Fig. 43

WITH THE FOLLOWING EXPERIMENT, A MINI POWER PLANT CAN BE BUILT.

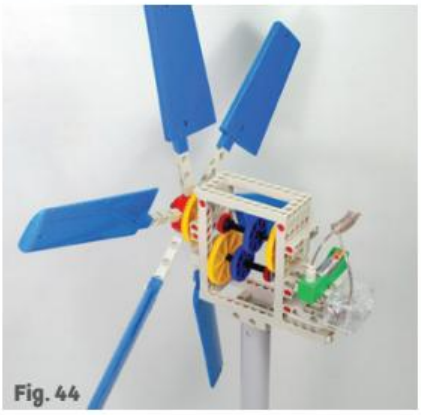
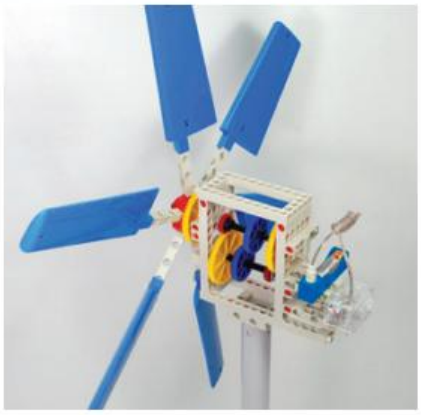


Fig. 44

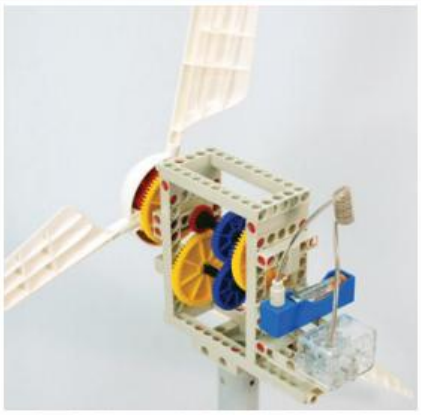
Charge electricity by the green charger with a rechargeable battery.



Activate the windmill by the blue battery holder with fully charged battery or a disposable AA battery.

Fig. 45

Charge electricity by the green charger with a rechargeable battery.



Activate the windmill by the blue battery holder with fully charged battery or a disposable AA battery.

After the windmill is assembled, securely fasten its base with heavy objects/bricks.

How to charge a battery using the windmill:

1. Remove the LED and connect the wire connectors to the green charger.
   Note: The blue battery holder looks like the green charger, but it is not a charger.
2. Adjust the blade to the optimized angle obtained in the earlier experiment.
3. Secure the rechargeable batteries (below R6/AA 1.2V 1600mAh).
   Do not use rechargeable batteries with excessive charging values; otherwise, the results will not be apparent)
   Note: Never insert disposable AA batteries in the green charger to avoid the risk of an explosion.
4. Utilize natural wind outdoors or an electric fan at home to blow the windmill and allow the batteries to be charged.

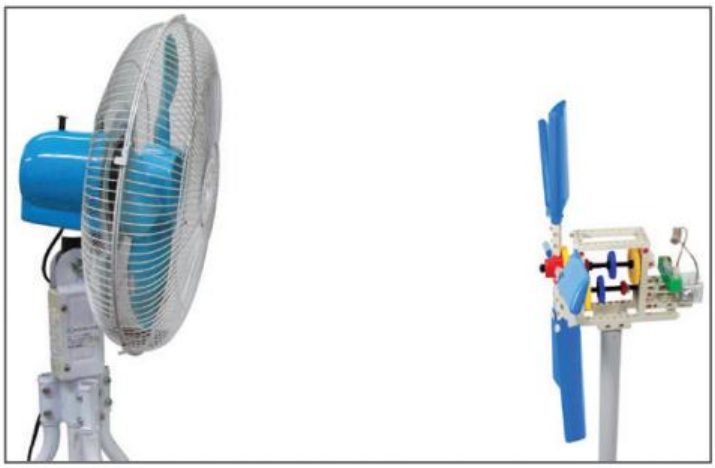


Fig. 46

5. Can also utilize the blue battery holder with fully charged battery to activate the windmill in case there is no wind.
6. If the rechargeable battery is not fully charged, use a regular battery (disposable AA battery) in the blue battery holder to activate the windmill.
7. Interestingly, the fast-rotating windmill slows down when rechargeable batteries are inserted. It is a normal phenom enon because the flat batteries constitute an ultra high capacitance. The effect is negligible like water being poured into a large pond. As the voltage slowly increases after sometime, the windmills will start to rotate.
8. Under a normal wind speed (4m/s, a 1300 mAh), rechargeable battery can be fully charged in 1~1.5hr and a 2400 mAh rechargeable battery in 2~2.5hr.
9. There will be an extended charging time as wind speeds vary. The varied voltages will form a voltage pulses that en hance the charging capacity. No risk of overcharging will take place if left unattended over a long period of time. (Since the wind turbine voltage under wind speed 4m/s is about 4.5. In case of excessive winds, the windmill blade will de tach and reduce in the rotation speed due to the centrifugal force).

ADVANCED REFERENCE I

Adjust the angle using the angle meter (draw up the angle values on paper in advance in place of matching)

Fig. 47

Since the LED brightness cannot be quantified, use a DMM to test the relationship model between voltage and blade angle after removing the LED light.

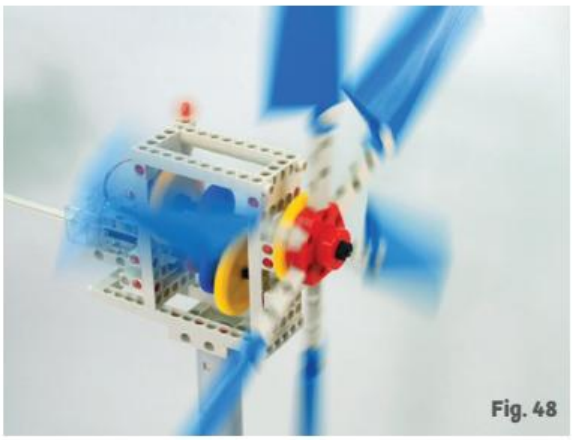


Fig. 48

ER Diagram of blade angle change vs. voltage change for fans with 6 short blades.

Blade angle (with the ultra shaft and included angle of the universal connector as basis)	14" Stand fan	16" Industrial electric fan
0	0	0
5	0.6	1.2
10	1.01	2.72
15	2.39	3.51
20	2.42	4.05
25	2.16	3.04
30	1.88	2.44

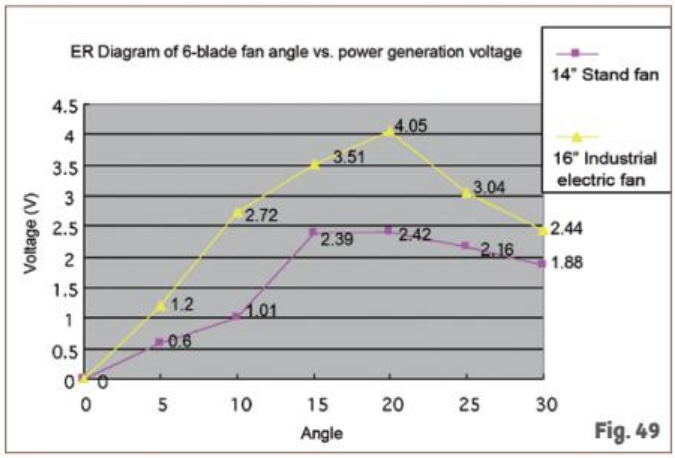


Fig. 49

Conclusion: The experimental values show that short fan blade angles (20 degrees) obtain optimized results.

Testing of fans with 3 long blades

The straight side of fans with 3 long blades and the included angle of the universal connector serve as the gear ratio basis: 3:1			Gear ratio: 1:1	
Angle	14" Stand fan	16" Industrial electric fan	14" Stand fan	16" Industrial electric fan
10	1.40	1.56	not rotating	1.6
0	1.73	2.10	1.9	2.5
-10	1.55	1.65	1.76	1.89

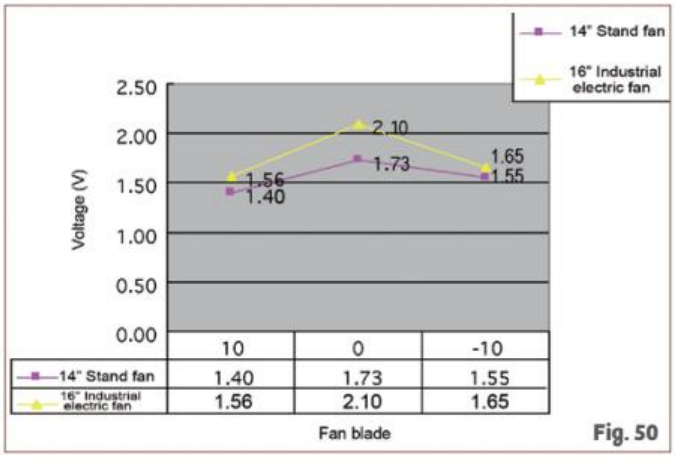


Fig. 50

The experimental values show that long blade fans (degree) obtain optimized results.

Result Diagram of the Charging Experiment

Perform a charging test after electrically discharging the R6/AA 1.2V 1300mAh and R6/AA 1.2V 2400mAh rechargeable batteries.

Fig. 51

The strongest industrial electric fan 6 long blades. Optimized conditions (20 degrees)

Charging Time (Min)	Battery Testing	
	R6/AA 1.2V 1300mAh	R6/AA 1.2V 2400mAh
0	0	0
30	0.9	0.6
60	1.2	0.98
90	1.32	1.1
120		1.2
150		1.37

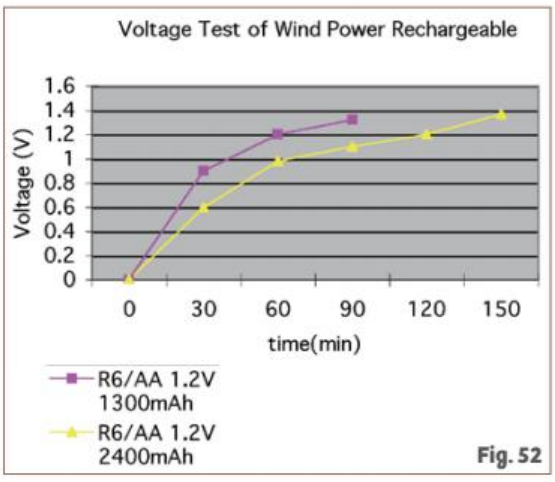


Fig. 52

Reference for parents and instructors:

1. All the experiments above adopt 'Quantitative Analysis.' Three variables are included: the fixed conditions of each experiment are called 'controlled variables'. 'Dependent variables' represent experimental outcomes and 'independent variables' are those factors assumed to have an effect on dependent variables.
2. Under different testing conditions, the best experimental result can be derived from repeatedly experiments on different independent variables. Since the result is for the 'optimized design' and has to been obtained from variant experiments, it is highly beneficial for kids to develop their ability on problem solving and truth seeking.
3. In the case to measure the correlation between wind speeds and power generation (the brightness of the LED bulb), it is difficult to concretely quantified the result and make it data-based only upon the brightness of the LED bulb. In order to more accurately record the experimental outcomes, a multi-meter is suggested to be used for measuring voltage changes (DC-V).
4. This teaching aid for wind generation is excellent for experiments and happy learning either outdoors with natural wind or indoors with an electric fan.

ADVANCED REFERENCE II

An Analysis on Fan Blade Angle vs. Power Generation Capacity.

Quantitative Analysis is adopted to verify the optimum blade angle through a measuring instrument. In "Experiment 3: Is There Any Change in Power Generation Capacity (Change in Brightness of LED Lights) for Wind Turbines with Short Blades? Can You Find the Best Fan Blade Angle?'" the LED light on/off and brightness are determined by the power generation voltage. When it is lower than 1.7V, the LED light will not turn on and a higher voltage will produce a brighter LED light. The higher the rotational speed of the turbine is, the higher the voltage will be (distal shaft). Thus, fixed test conditions such as fixed wind speed are called controlled variables, the blade angle is the independent variable, and the voltage output is the dependent variable.

Fig. 53

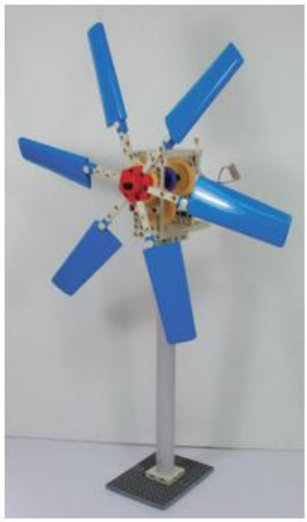


Fig. 54

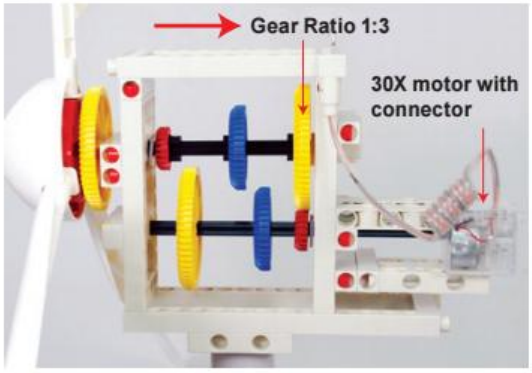
MEASURING INSTRUMENT (NOT INCLUDED THIS KIT.)

Fig. 55

From the left:

- Anemometer,
- Digital Multi-Meter (DMM),
- Tachometer,
- Angle meter,

TESTING RESULTS BY 16"HOME-USE FAN



16"HOME-USE FAN

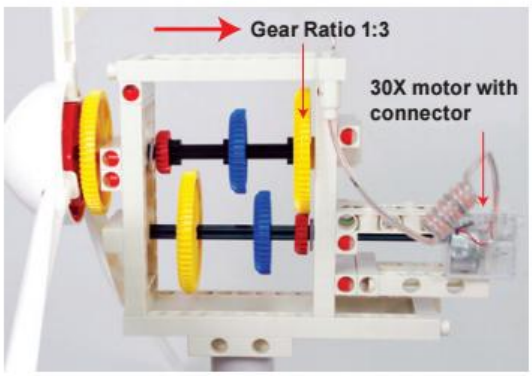
3 Short Blades	Gear Ratio 1:1	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle		
		Weak		

4 Short Blades	Gear Ratio 1:1	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle	✓	✓
		Weak		

6 Short Blades	Gear Ratio 1:1	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle	✓	✓
		Weak		

3 Long Blades	Gear Ratio 1:1	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle		
		Weak		

TESTING RESULTS BY 18" INDUSTRY FAN



18" INDUSTRY FAN

2 Short Blades	Gear Ratio 1:1	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle	✓	✓
		Weak	✓	✓

3 Short Blades	Gear Ratio 1:1	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle	✓	✓
		Weak	✓	✓

4 Short Blades	Gear Ratio 1:1	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle	✓	✓
		Weak	✓	✓

6 Short Blades	Gear Ratio 1:1	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle	✓	✓
		Weak	✓	✓

3 Long Blades	Gear Ratio 3:1	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle	✓	✓
		Weak		

6 Short Blades	Gear Ratio 1:3	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle	✓	✓
		Weak		

6 Short Blades	Gear Ratio 3:1	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle		
		Weak		

3 Long Blades	Gear Ratio 1:3	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle		
		Weak		

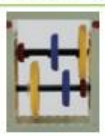
2 Short Blades	Gear Ratio 1:3	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle		
		Weak		

3 Short Blades	Gear Ratio 1:3	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle	✓	✓
		Weak		

2 Short Blades	Gear Ratio 3:1	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle		
		Weak		

4 Short Blades	Gear Ratio 1:3	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle	✓	✓
		Weak	✓	✓

3 Short Blades	Gear Ratio 3:1	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle	✓	✓
		Weak	✓	✓

6 Short Blades	Gear Ratio 1:3	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle	✓	✓
		Weak	✓	✓

4 Short Blades	Gear Ratio 3:1	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle	✓	✓
		Weak	✓	✓

3 Long Blades	Gear Ratio 1:3	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle	✓	✓
		Weak		

6 Short Blades	Gear Ratio 3:1	Wind Speed	Blades Turning	LED Lighted
		Strong	✓	✓
		Middle	✓	✓
		Weak	✓	✓

Wind Mill with Long-Blade Model 1

Parts Needed

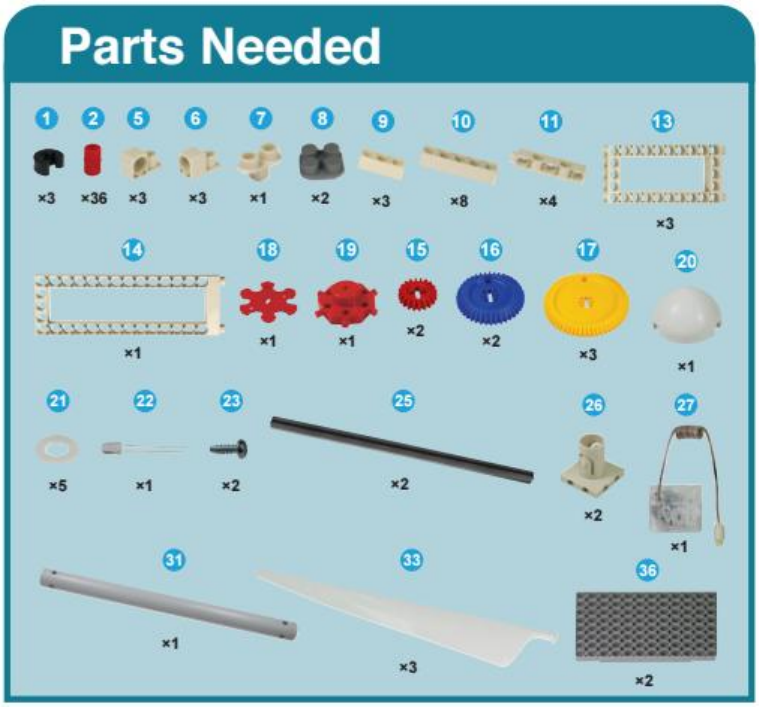


Fig. 56

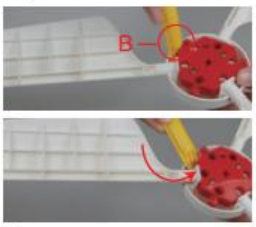
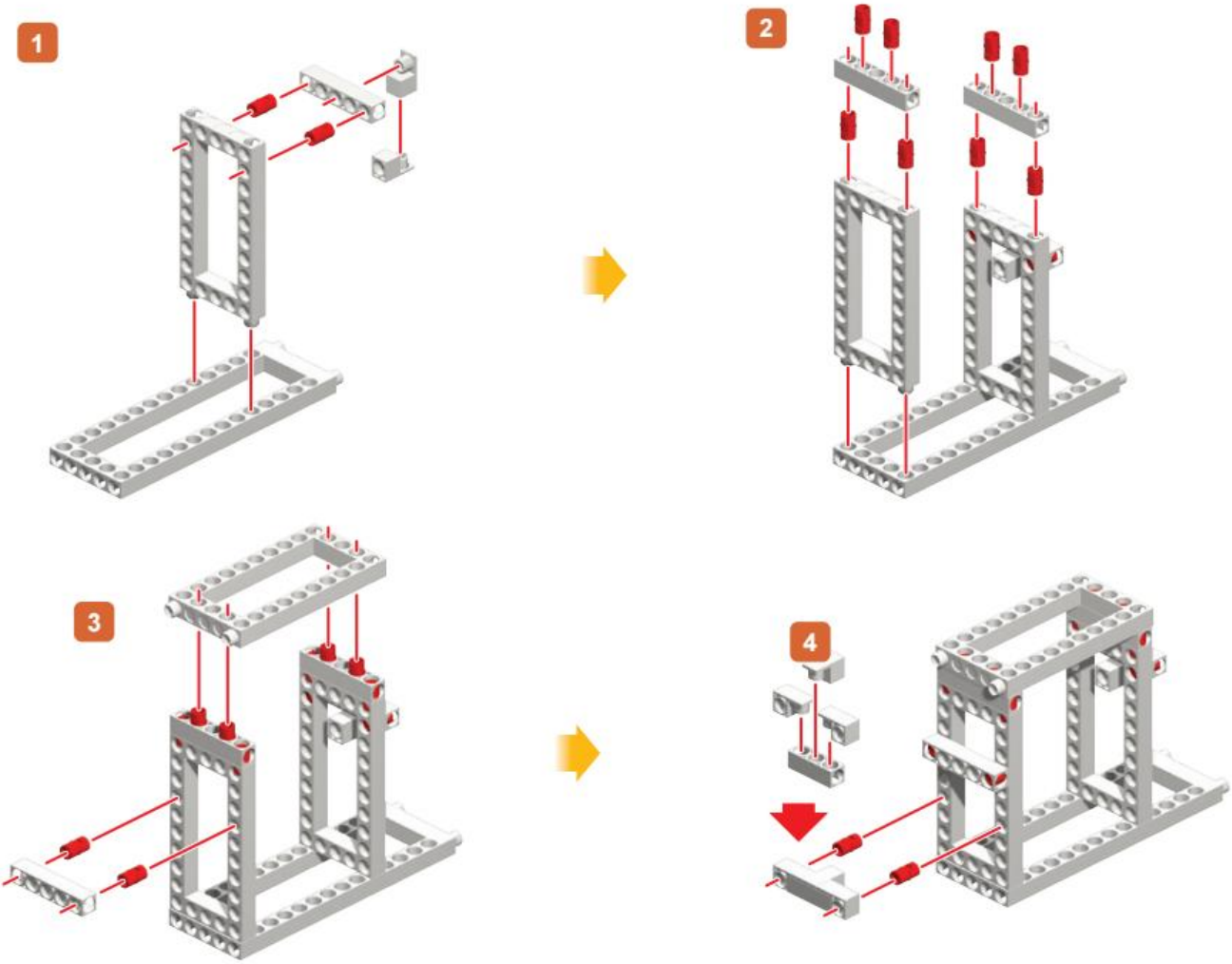


Fig. 57

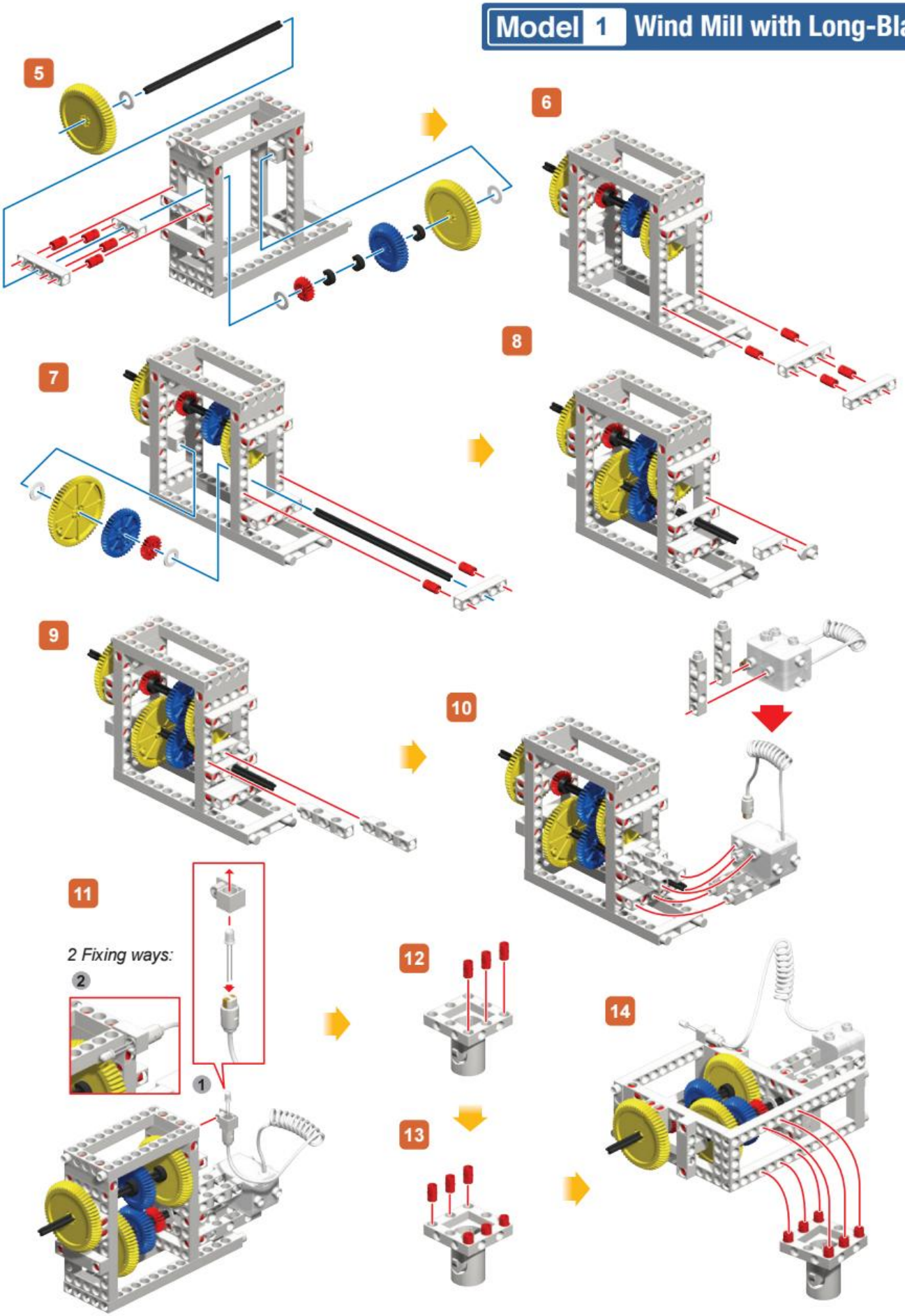
Notes for Assembly

Adjust blade angles:

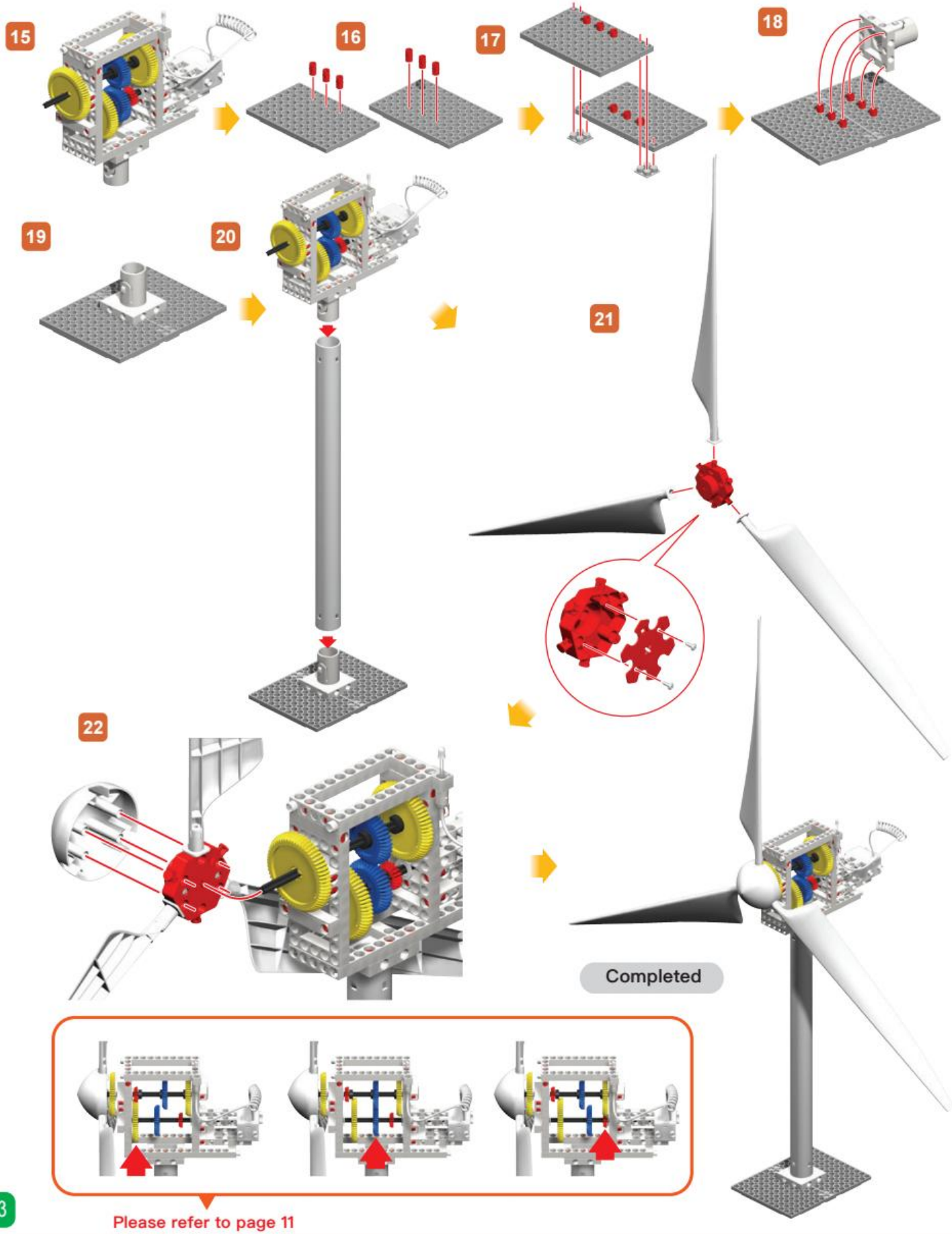
1. Refer to Fig. 56: Fix the Hub with your left hand and adjust the angles of the bottom end of the blade.
2. How to take apart the Universal Adaptor from the Hub? Insert the end "B" of Peg/ Axle Remover between the Universal Adaptor and the Hub, and tilt the Universal Adaptor to take them apart (Fig. 57).
3. If the windmill rotates clockwise, the LED will not light up. Please insert the LED again in the opposite direction.



Model 1 Wind Mill with Long-Blade



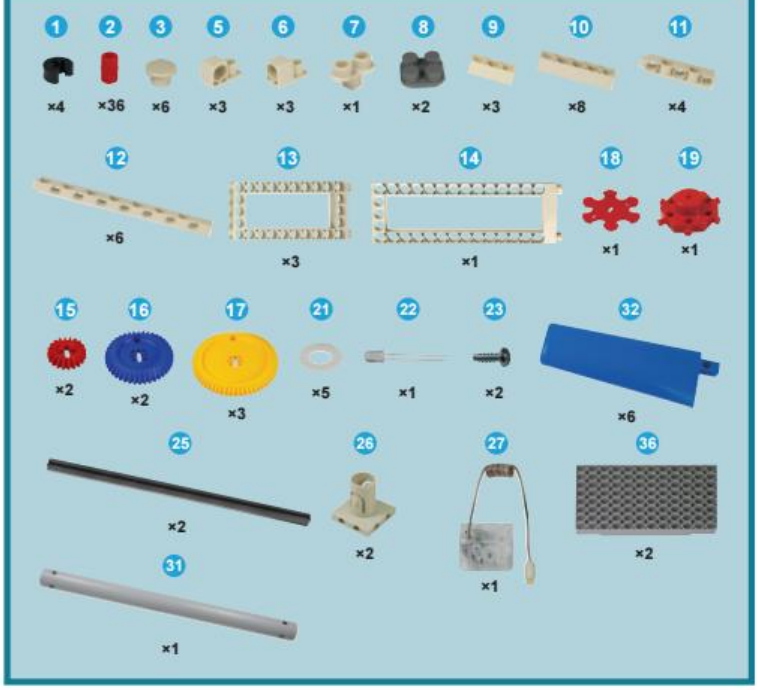
Wind Mill with Long-Blade Model 1



Please refer to page 11

Model 2 Wind Mill with Short-Blade

Parts Needed



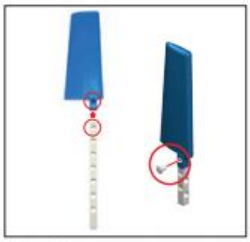
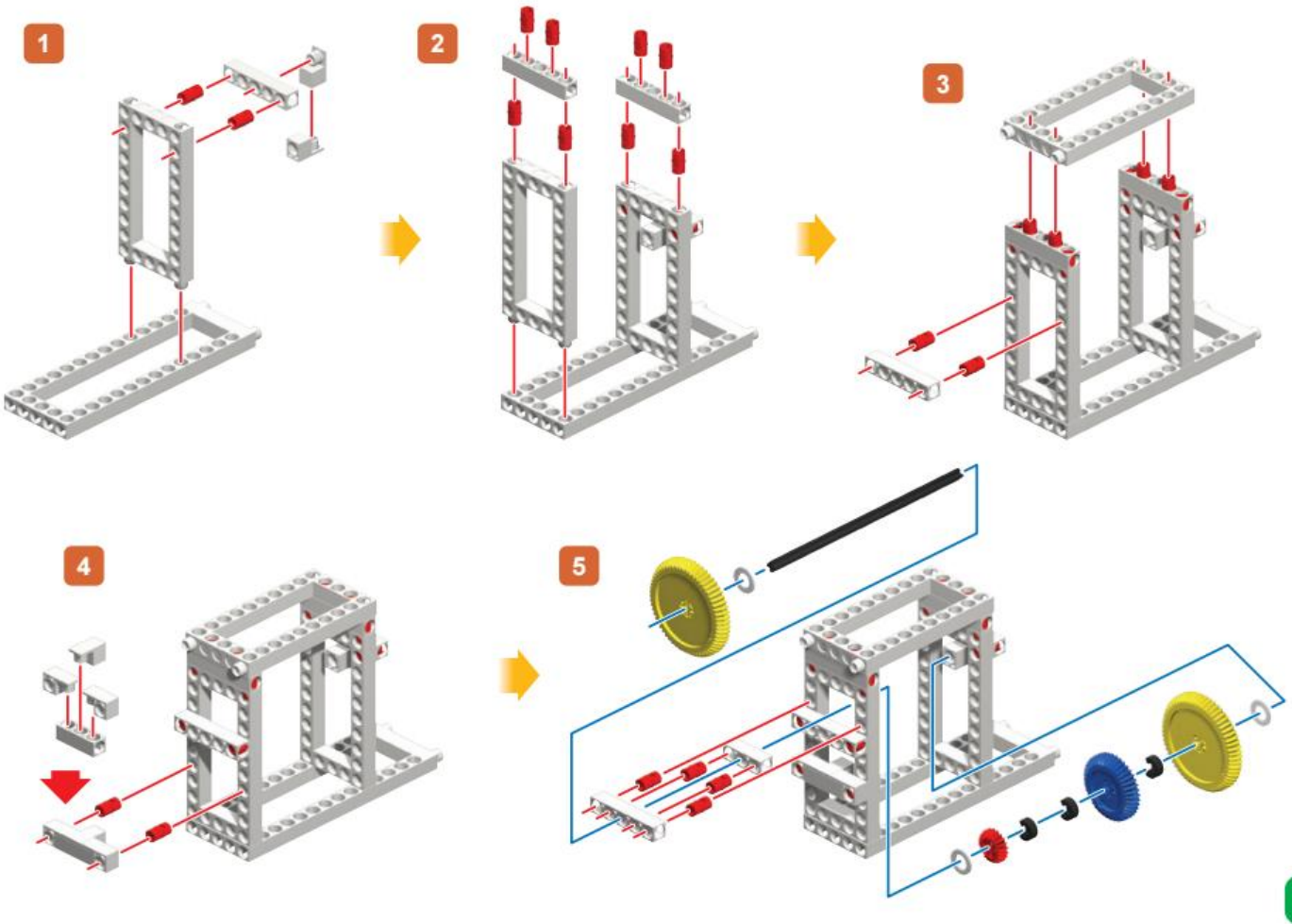


Fig. 58

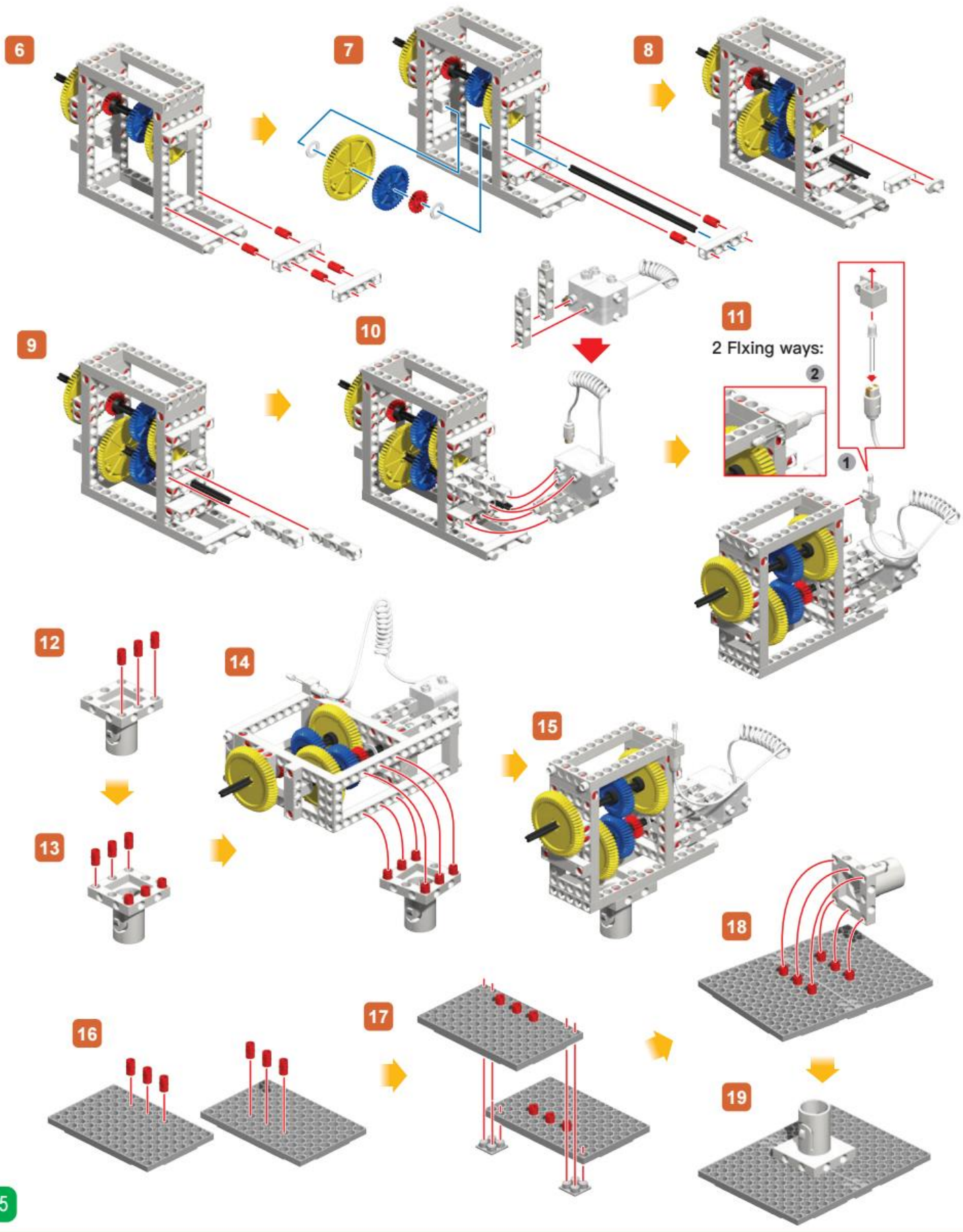
Notes for Assembly

Join the short blade and the long rod:

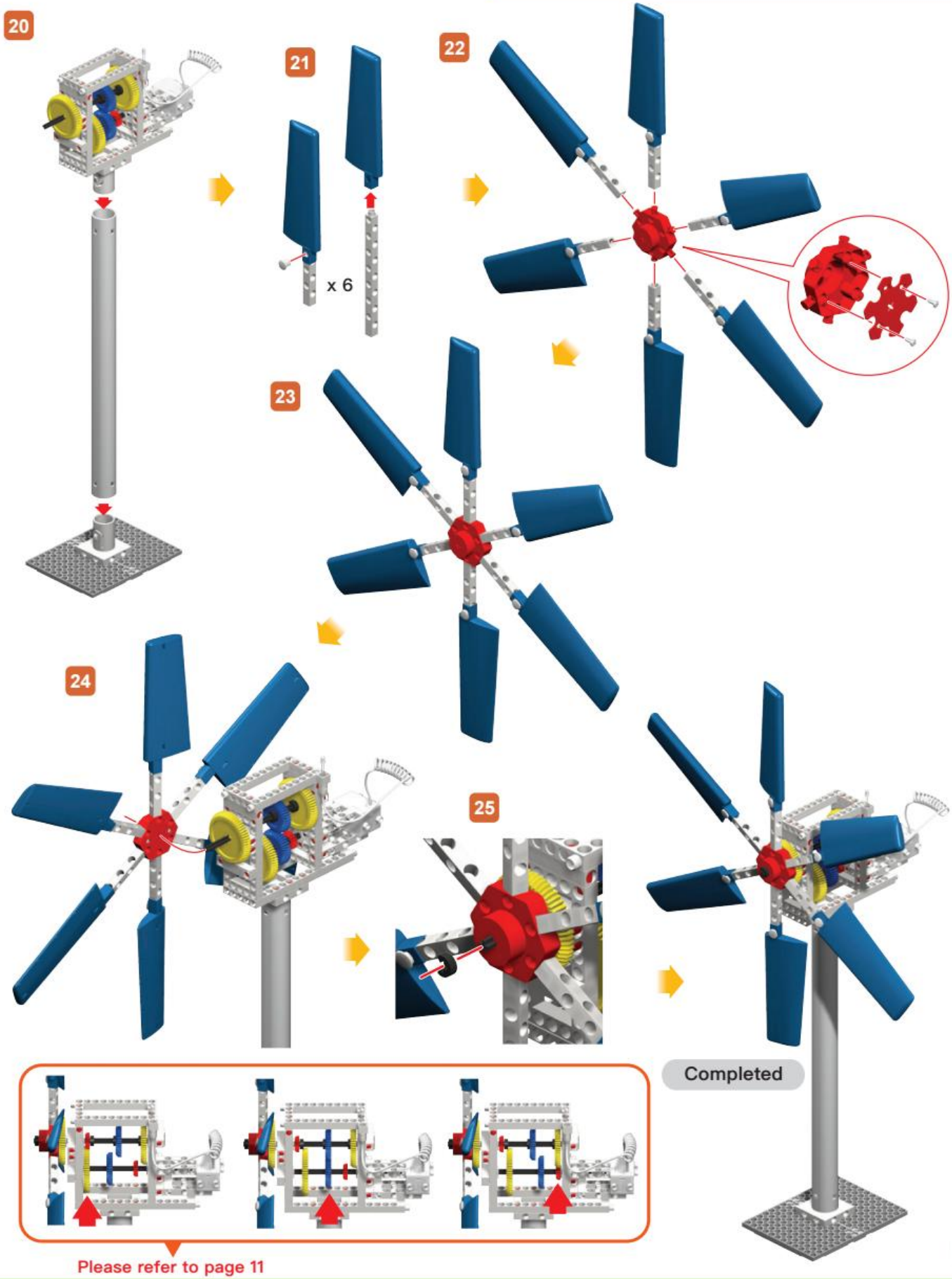
1. Insert the Long Rod into the Short Blade with the face where there is a hole at the edge up to join them together. (Fig. 58)
2. Fastening the combination with the Button Fixer as Fig. 58 shows.



Wind Mill with Short-Blade Model 2

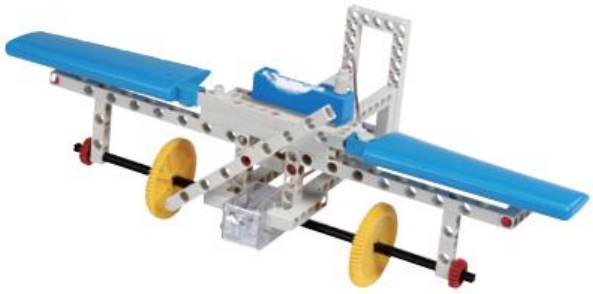


Model 2 Wind Mill with Short-Blade

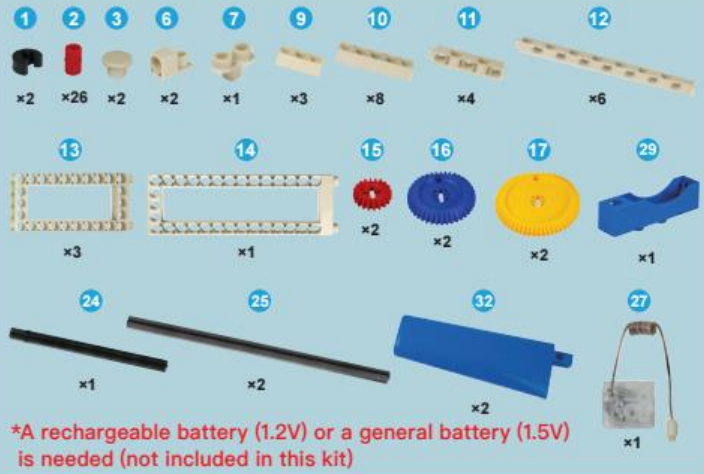


Please refer to page 11

Glider Model 3



Parts Needed



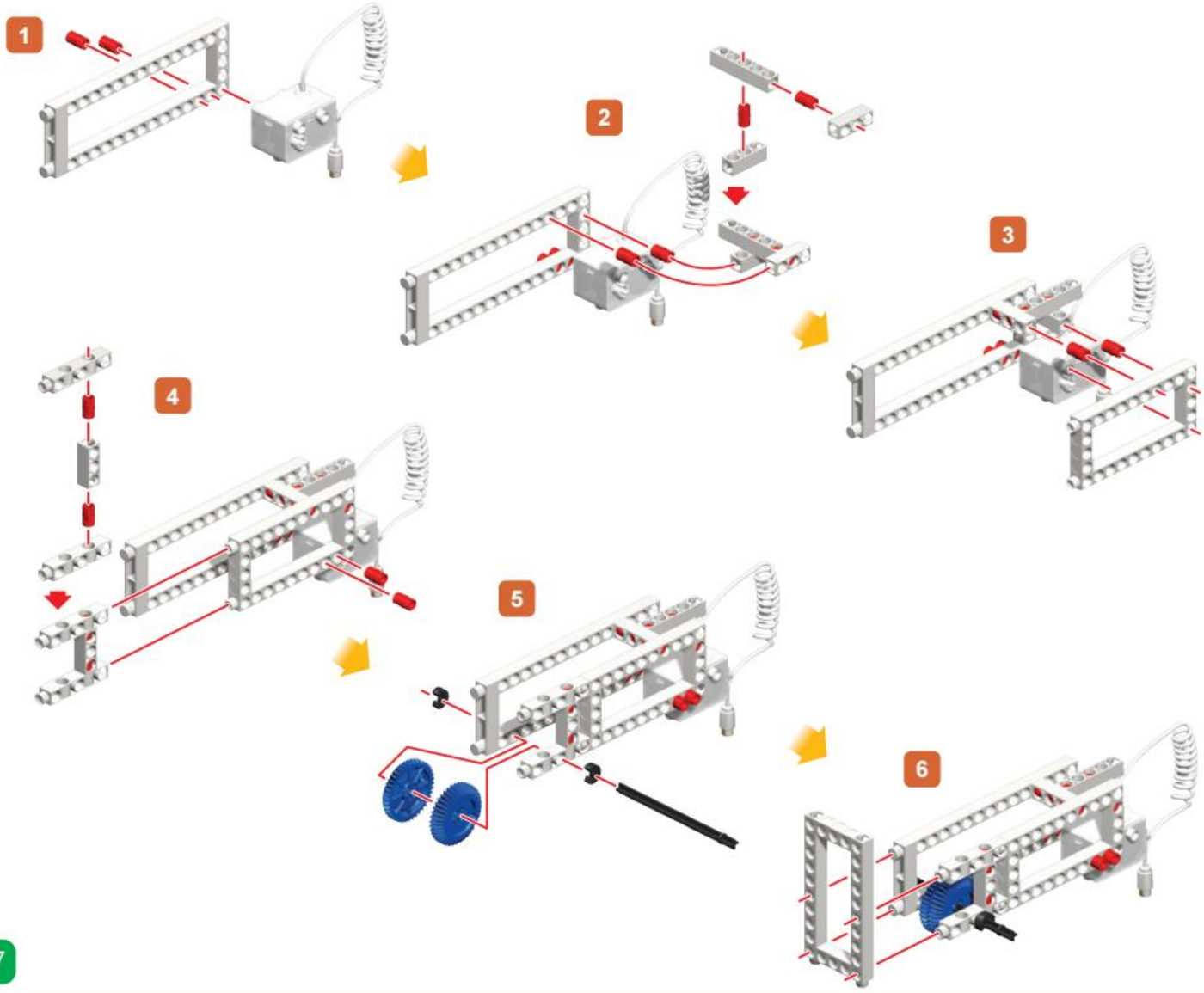
*A rechargeable battery (1.2V) or a general battery (1.5V) is needed (not included in this kit)

Fig. 59

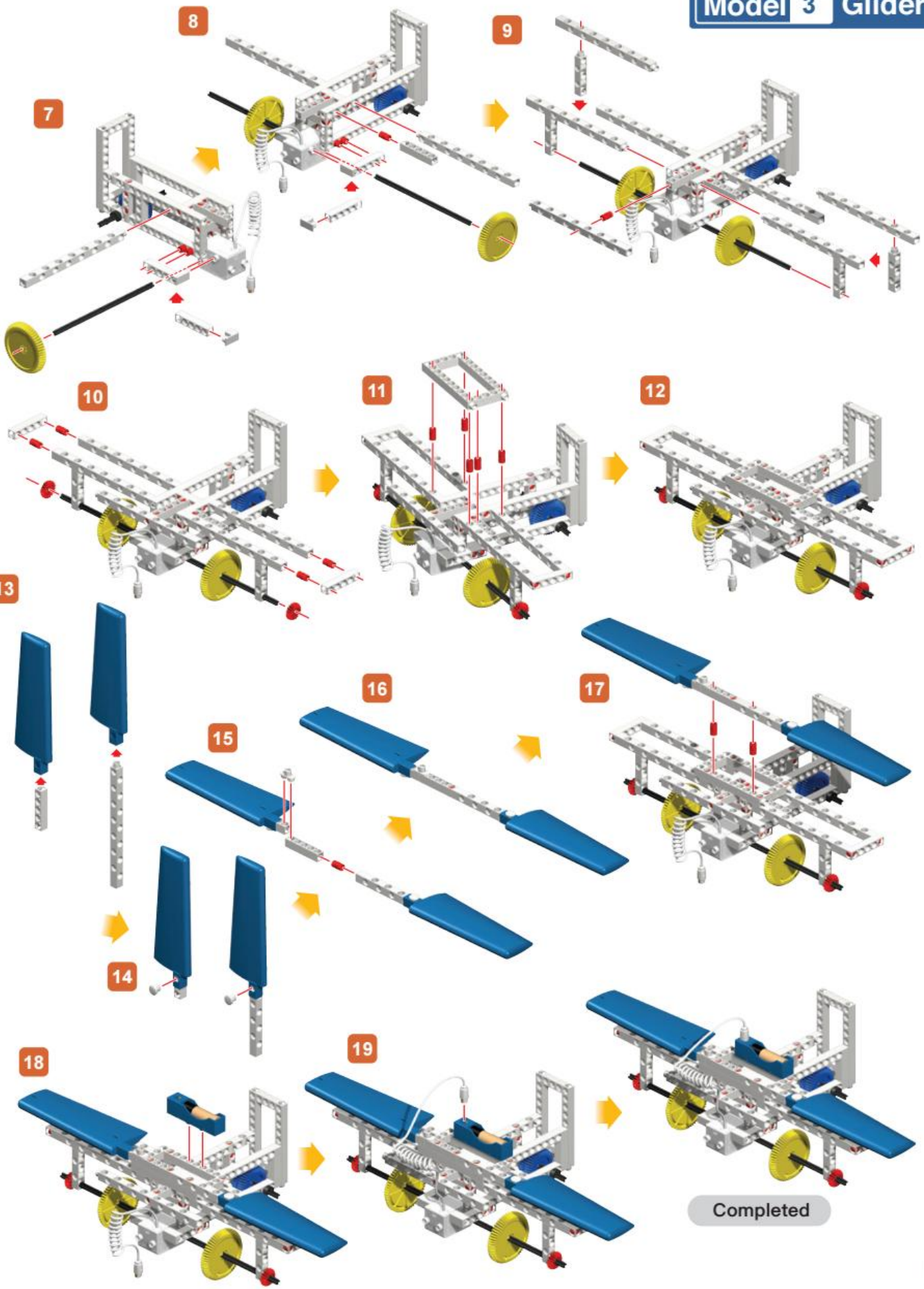
Notes for Assembly

How to insert a battery?

1. Charging the battery with the windmills with long or short blades, and then insert the full-charged battery into the blue battery holder to activate the models.
2. Match the positive pole of the battery to the positive pole of the blue battery holder, and so does the negative pole and then insert the battery as Fig.59 shows.

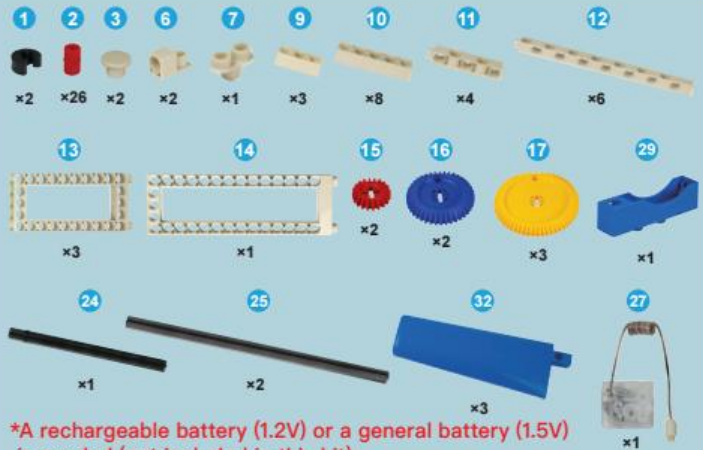


Model 3 Glider



Sail Car Model 4

Parts Needed



*A rechargeable battery (1.2V) or a general battery (1.5V) is needed (not included in this kit)

Notes for Assembly

How to insert a battery?

1. Charging the battery with the windmills with long or short blades, and then insert the full-charged battery into the blue battery holder to activate the models.
2. Match the positive pole of the battery to the positive pole of the blue battery holder, and so does the negative pole and then insert the battery as Fig.60 shows.

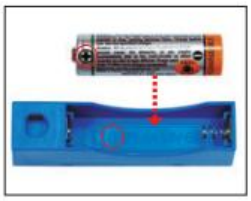
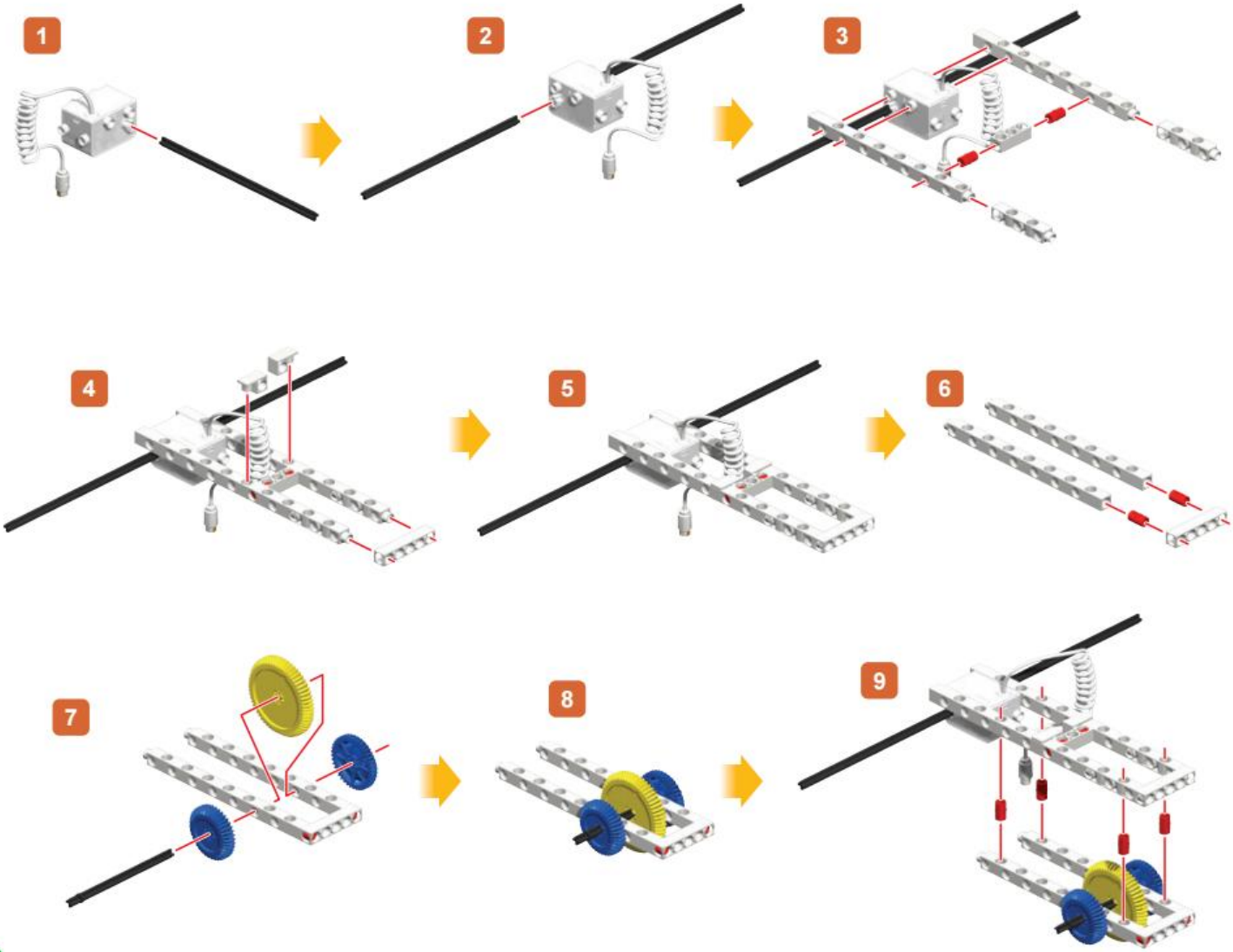
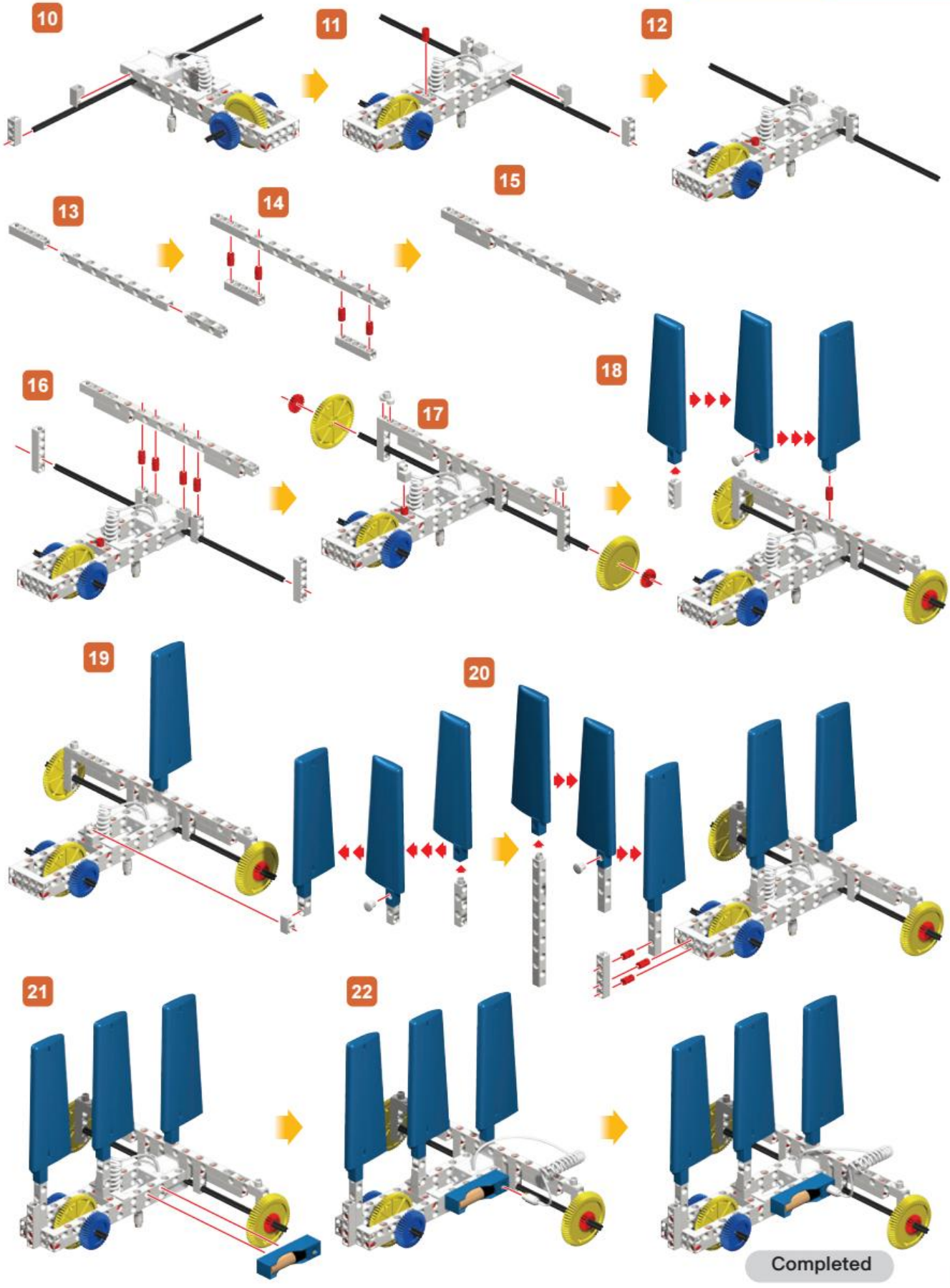


Fig. 60

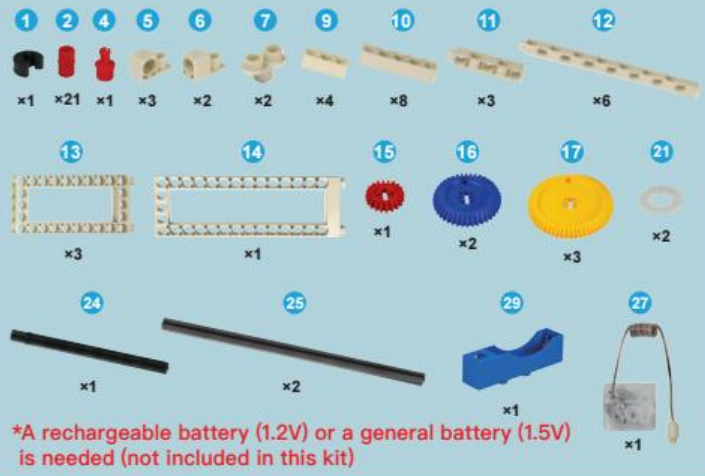


Model 4 Sail Car



Tricycle Model 5

Parts Needed



*A rechargeable battery (1.2V) or a general battery (1.5V) is needed (not included in this kit)

Notes for Assembly

How to insert a battery?

1. Charging the battery with the windmills with long or short blades, and then insert the full-charged battery into the blue battery holder to activate the models.
2. Match the positive pole of the battery to the positive pole of the blue battery holder, and so does the negative pole and then insert the battery as Fig.61 shows.

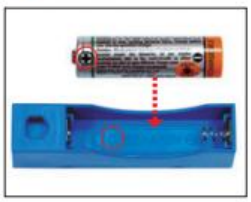
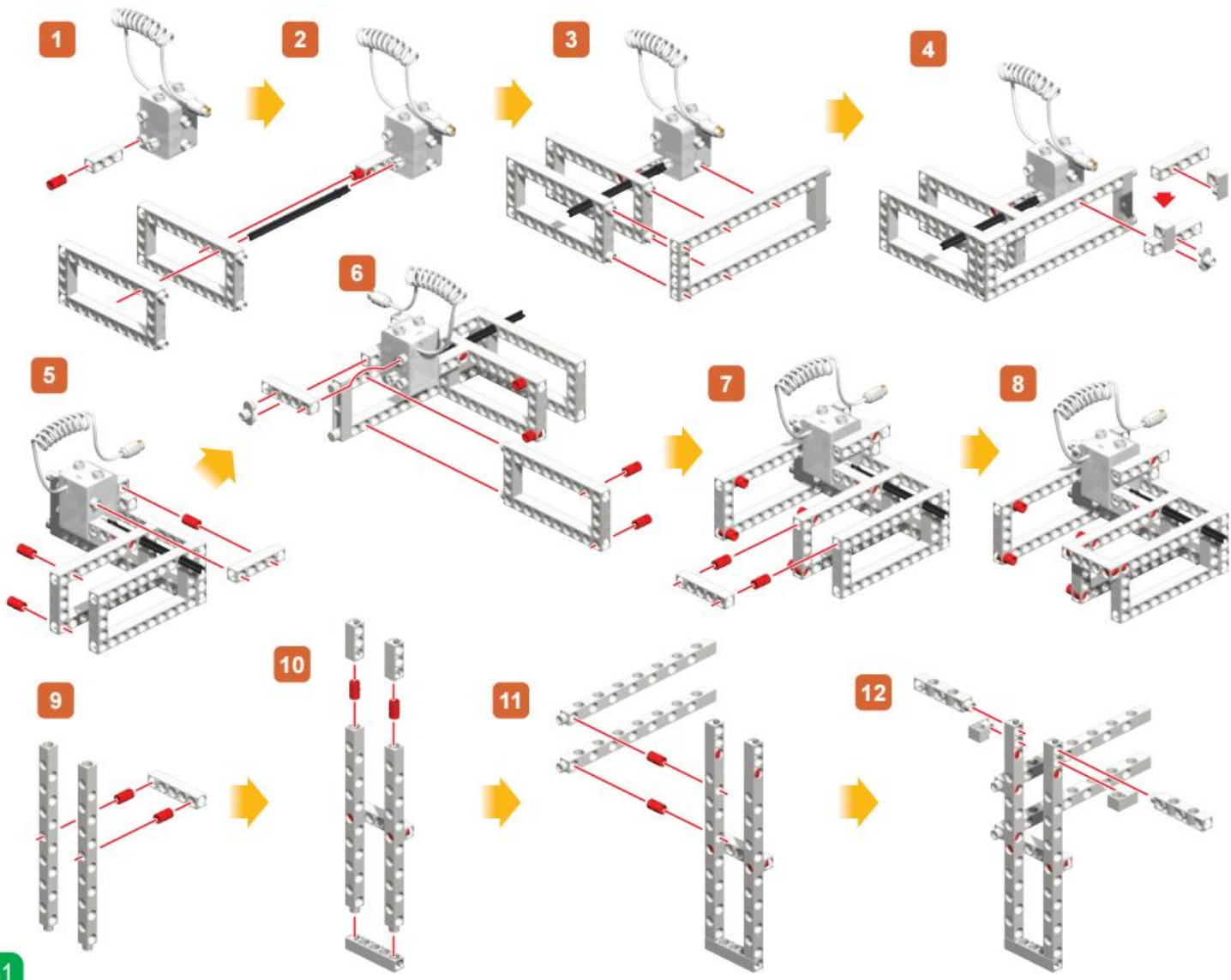
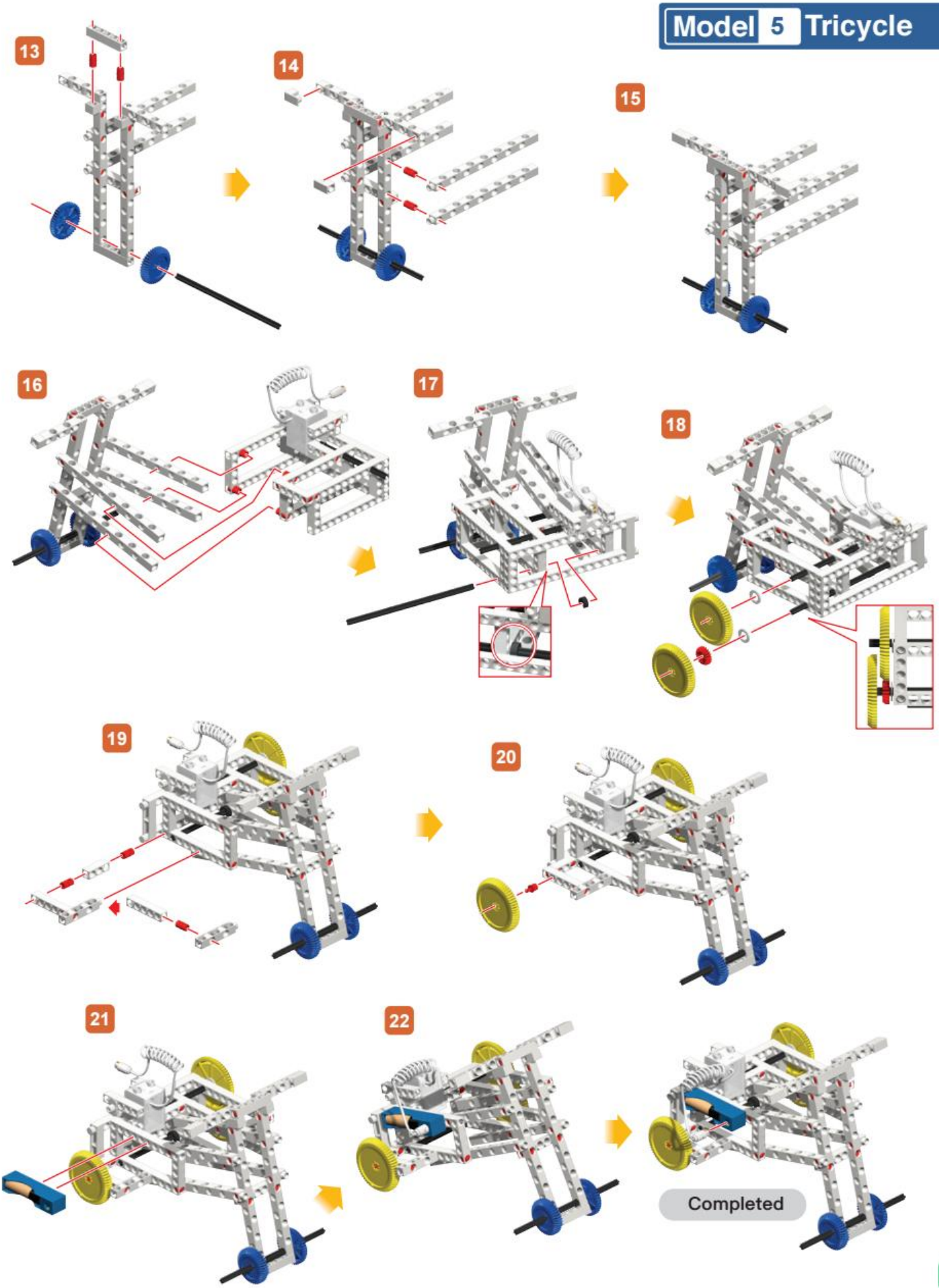


Fig. 61

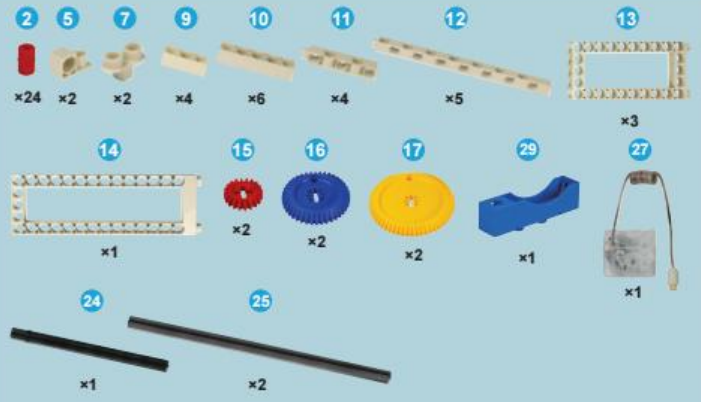


Model 5 Tricycle



Jet Car Model 6

Parts Needed



*A rechargeable battery (1.2V) or a general battery (1.5V) is needed (not included in this kit)

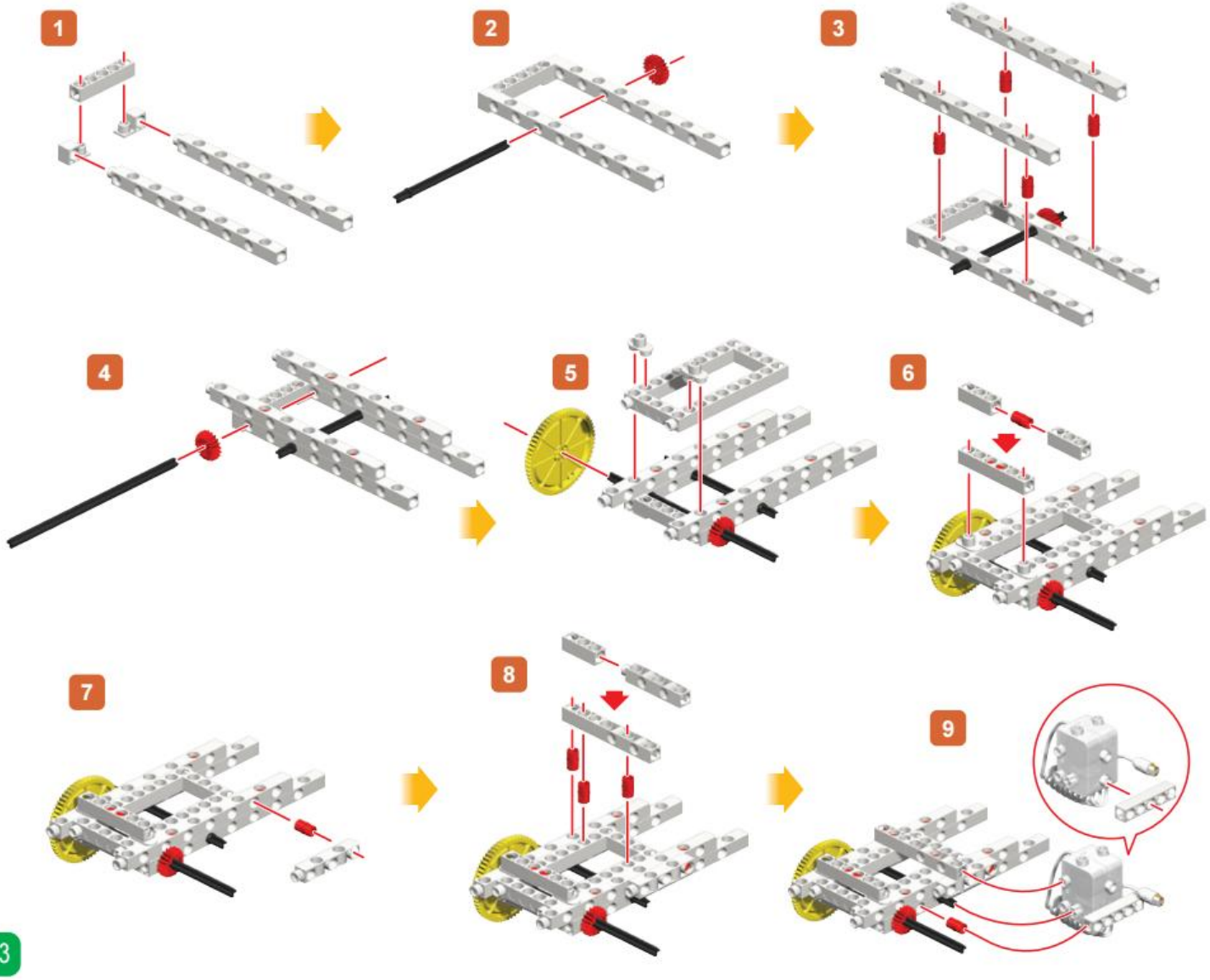
Notes for Assembly

How to insert a battery?

1. Charging the battery with the windmills with long or short blades, and then insert the full-charged battery into the blue battery holder to activate the models.

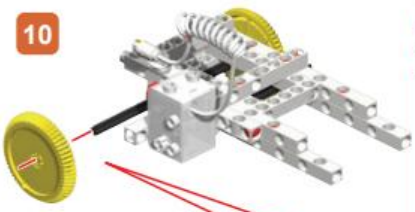
Fig. 62

2. Match the positive pole of the battery to the positive pole of the blue battery holder, and so does the negative pole and then insert the battery as Fig.62 shows.

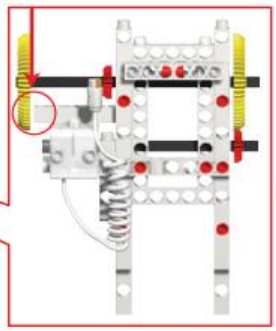


Model 6 Jet Car

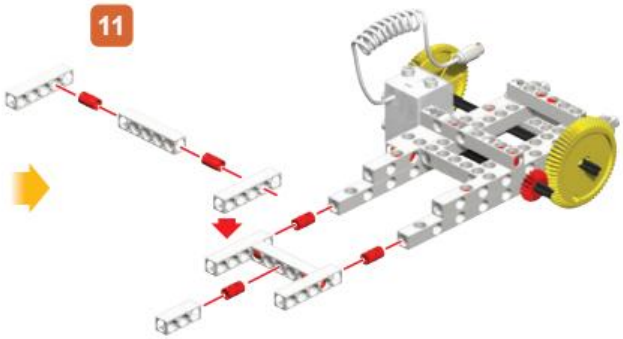
10



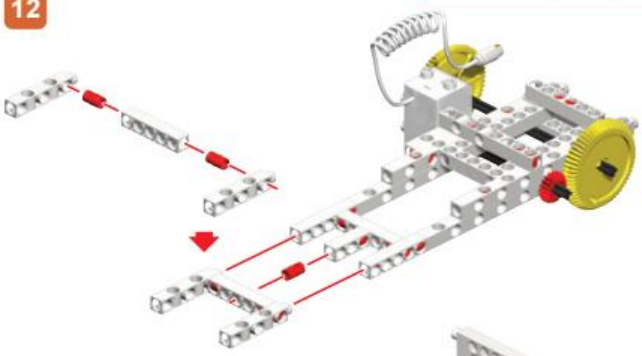
Leave gap for 2mm to avoid friction.



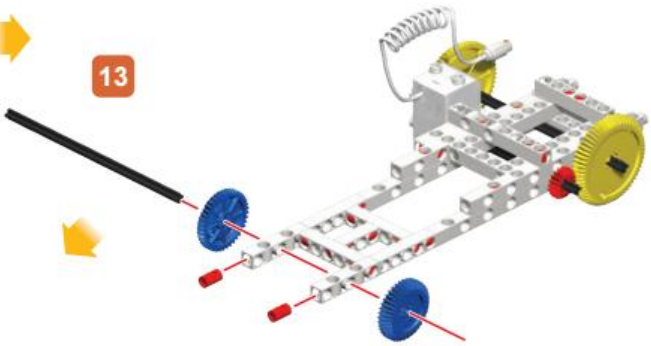
11



12

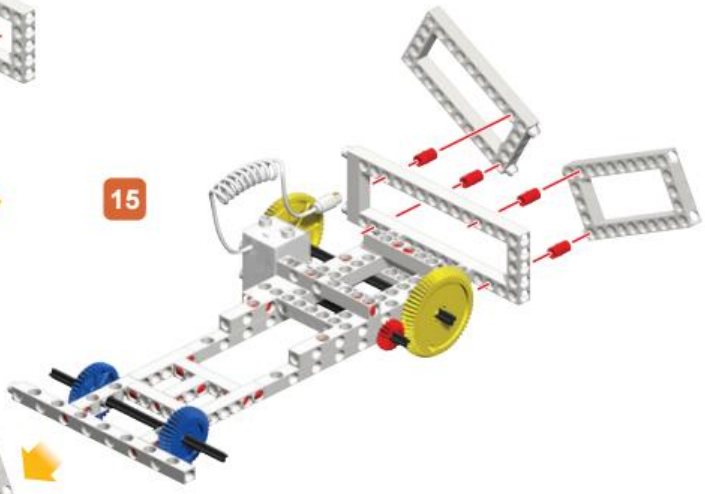


13

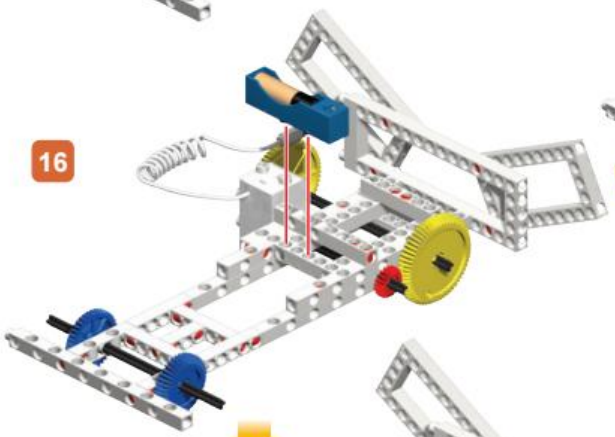


14

15



16

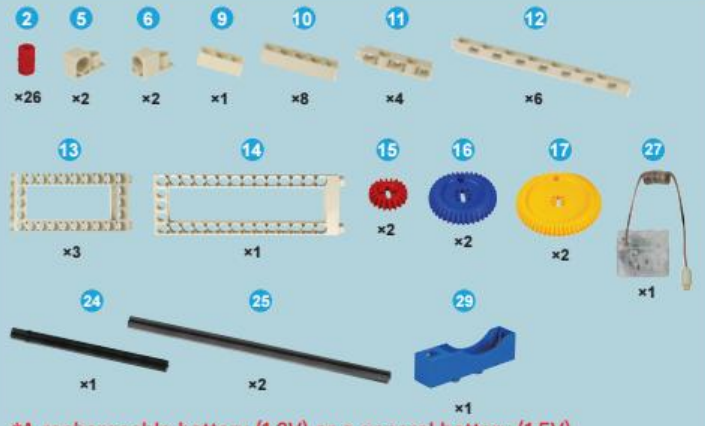


17

Completed

Tractor Model 7

Parts Needed



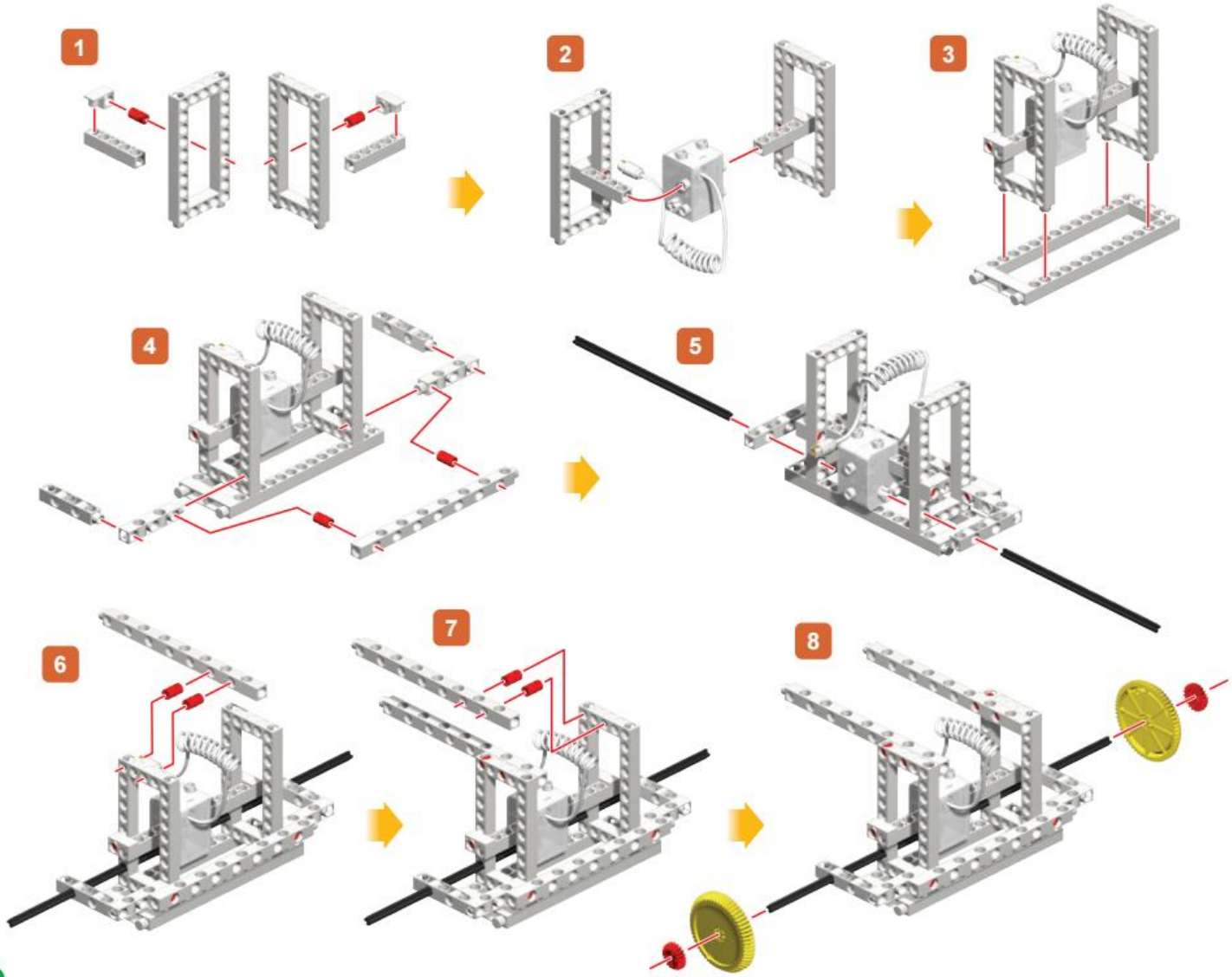
*A rechargeable battery (1.2V) or a general battery (1.5V) is needed (not included in this kit)

Notes for Assembly

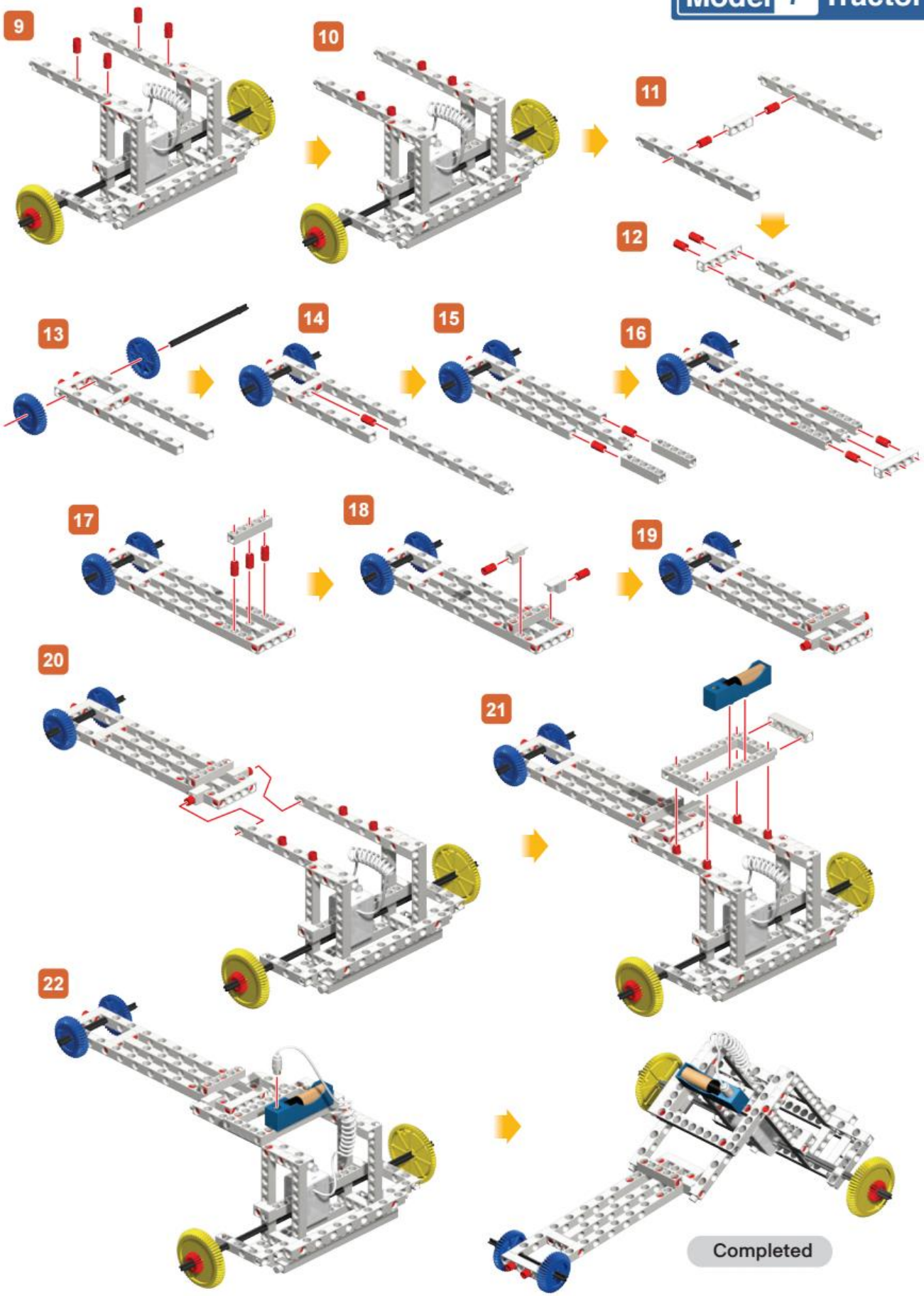
How to insert a battery?

1. Charging the battery with the windmills with long or short blades, and then insert the full-charged battery into the blue battery holder to activate the models.
2. Match the positive pole of the battery to the positive pole of the blue battery holder, and so does the negative pole and then insert the battery as Fig.63 shows.

Fig. 63

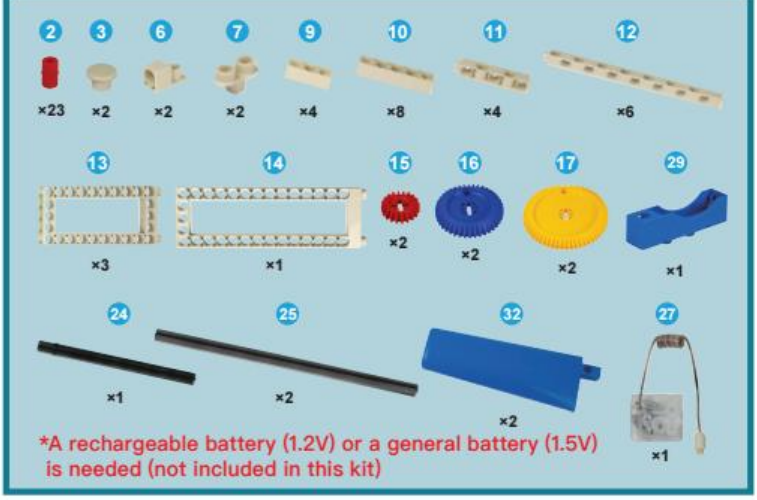


Model 7 Tractor



Race Car Model 8

Parts Needed



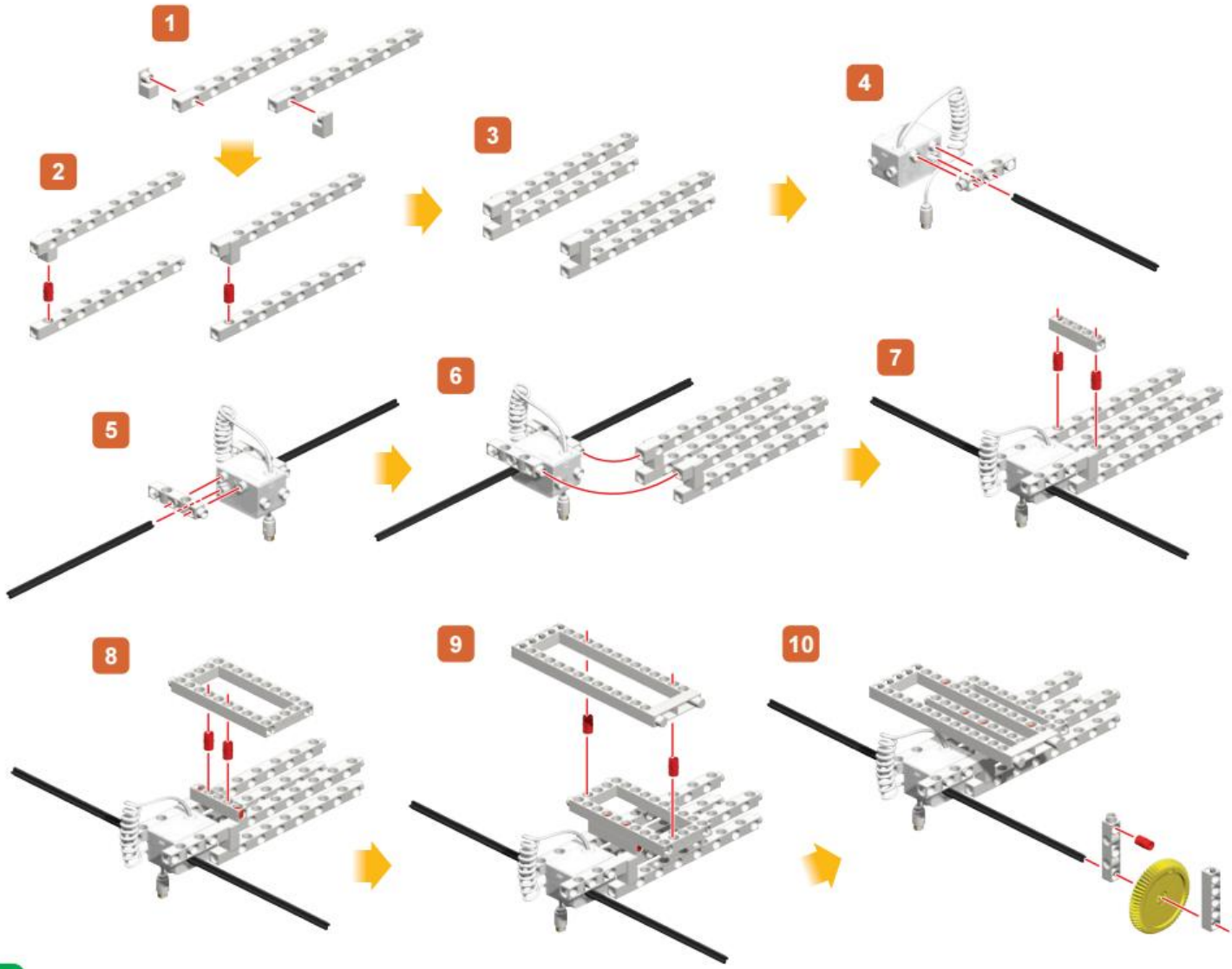
*A rechargeable battery (1.2V) or a general battery (1.5V) is needed (not included in this kit)

Notes for Assembly

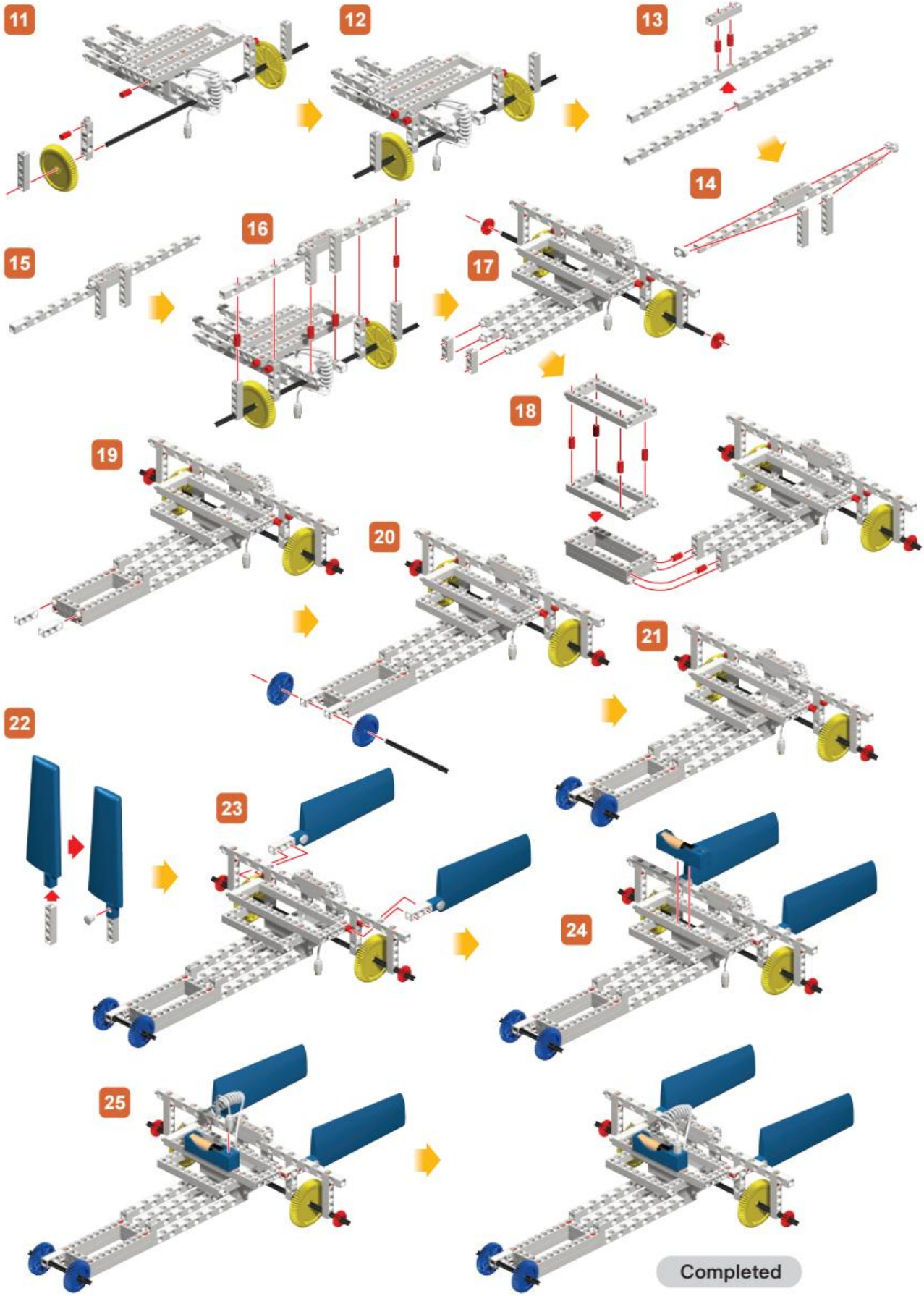
How to insert a battery?

1. Charging the battery with the windmills with long or short blades, and then insert the full-charged battery into the blue battery holder to activate the models.
2. Match the positive pole of the battery to the positive pole of the blue battery holder, and so does the negative pole and then insert the battery as Fig.64 shows.

Fig. 64



Model 8 Race Car



GREEN ENERGY

ELECTRICITY & MAGNETISM
#7065
10 Models to build
137 PCS

ELECTRICITY DISCOVERY 2.0
#7059R
14 Models to build
110 PCS

CROSSBOWS AND CATAPULTS
#7406
10 Models to build
110 PCS

ORNITHOPTER
#7405
4 Models to build
49 PCS

MINI GYRO
#7395
20 Models to build
88 PCS

GECKOBOT
#7409
7 Models to build
176 PCS

SOLAR POWER 2.0
#7303
10 Models to build
120 PCS

WATER POWER
#7323
15 Models to build
165 PCS

WIND TURBINE
#7400
5 Models to build
77 PCS

CE

MADE IN TAIWAN

GENIUS TOY TAIWAN CO., LTD.

www.gigotoys.com