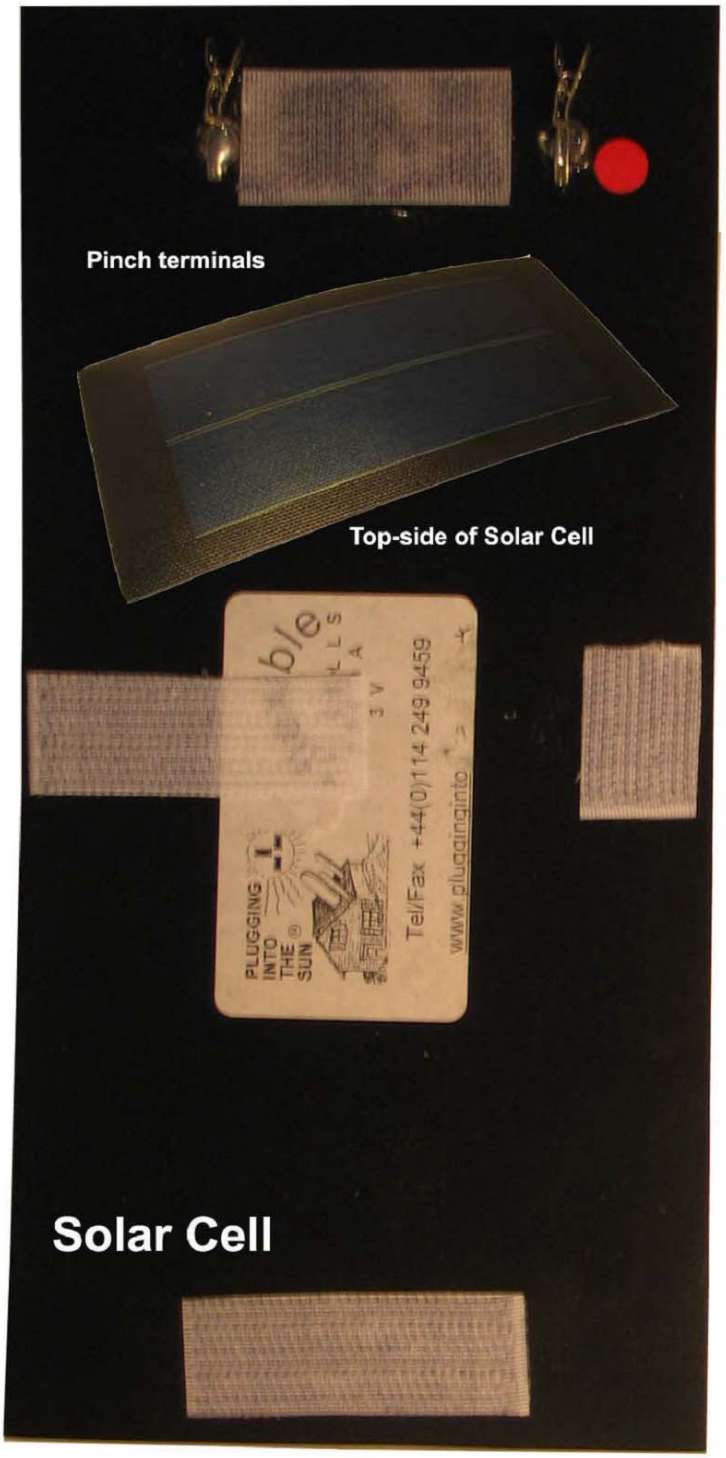
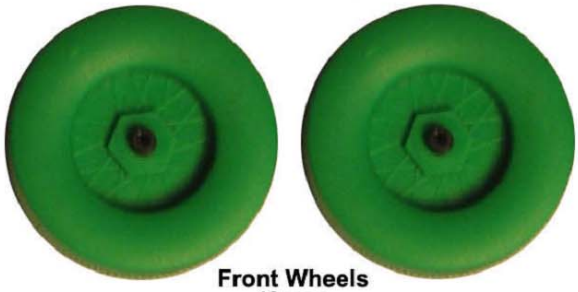
2-Q SOLAR MODEL CAR
- ASSEMBLY GUIDE



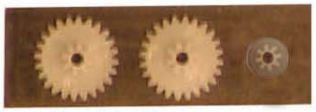

Front Axle Support


Front Wheels
40 mm

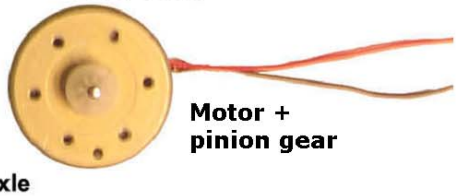
Front Axle


Gearbox Casing B

Gearbox Casing A


3 - 1 Gear

Double Gears


Motor + pinion gear

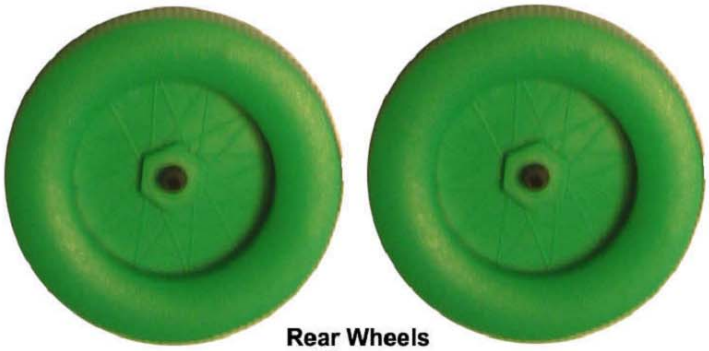
Rear Axle


Motor Clip


Push-fit Tool


Penny


Garden Ties


Rear Wheels
50 mm

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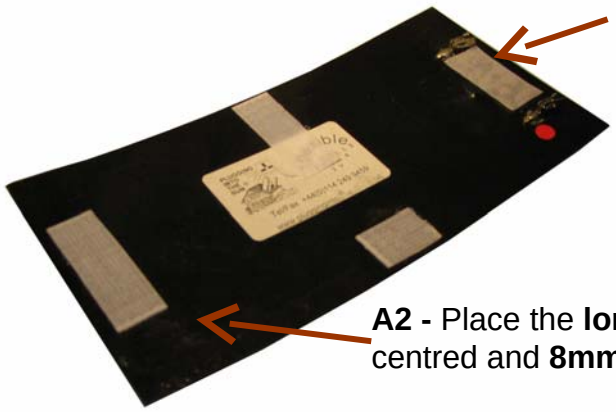
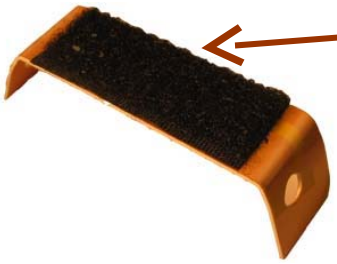
Initial assembly instructions – when the kit is new/used for the first time

A1-7: PRE-ASSEMBLY STEPS



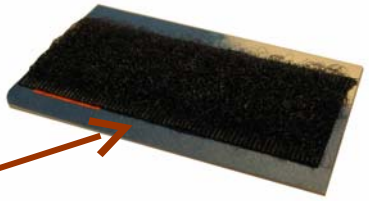
A1 - Place **shorter spiky** Velcro pad, **centred** near terminals and **14mm** from **back edge**

A2 - Place the **longer spiky** Velcro pad centred and **8mm** from **front edge**

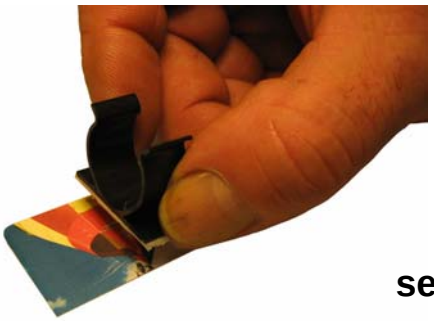


A4 - Attach **longer fuzzy** Velcro pad to front axle support*****

A5 – Attach **shorter fuzzy** Velcro pad to **motor clip plate***



****These components are made from recycled mobile phone sim and credit cards***



A6 - Before removing backing paper from adhesive strip of motor clip - **Make sure motor clip is straight (perpendicular to long edge of plate) and centred**

Attach motor clip to to **sanded central section of plate** on opposite side to Velcro pad

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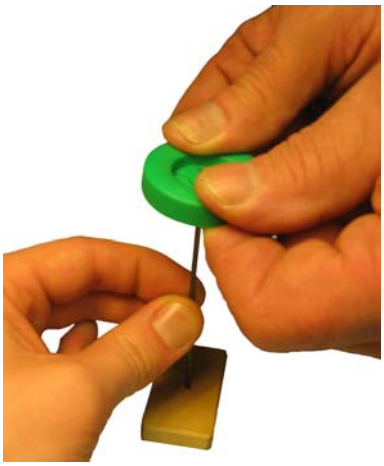
WARNING: The axle shafts are thin, and could potentially pierce the skin. Do not push the axle into the wheel using the bare palm of your hand.

Always use the push fit tool, and push the wheel using both thumbs on the edges. When assembling the wheels, work in pairs.



1.1 From a standing position

-Place one end of the front axle ***(without the white gear)*** into the small hole of the push fit tool

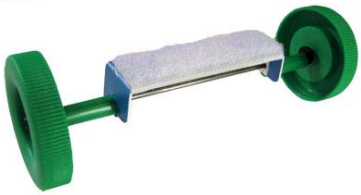
-One person holds the axle and the other person takes a small, 40cm wheel and places the hole in the reducer over the top end of the axle

-Place **thumbs on the edges** of the wheel

-**Gently** push the wheel onto the axle '**half way'** into the black reducer

1.2 REDUCE 'PLAY' IN FRONT WHEEL ASSEMBLY

There is a small length of straw in the front wheel assembly bag.



Cut the straw into two lengths [2x **21mm]**. When threading axle support over the axle, place each piece of straw between wheel and folded end of axle support, as shown in picture above. You may need to adjust length of straw.

1.3 Thread **both** holes of the axle support over the axle

1.4 Place the attached wheel onto a 1p coin so the axle doesn't push through the reducer

Repeat step 1.1

1.5 Attach front wheel assembly to the long, spiky Velcro pad

-Ensure that the axle is **aligned/parallel** to the front edge

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2 Assembly of 9:1 transmission gear

2.1 Notice that the motor is fitted into the casing (Part A) with a small white gear attached near the top of motor shaft

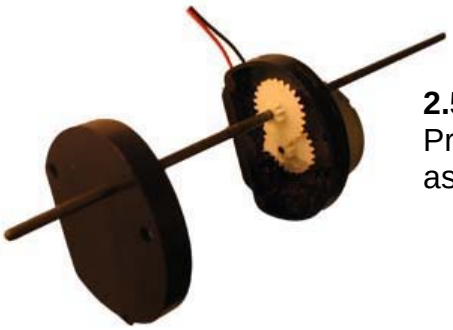
2.2 Feel the white, toothed double gear between your thumb and forefinger. One side is smooth and the other side will feel rough as it has an 8-toothed gear.

-Slide the double gear **flat side down** (the smaller 8-toothed gear will be on the top) onto the left-hand spindle

2.3 Thread the longer end of the axle shaft, smooth side of gear down, through hole on the left of the gears

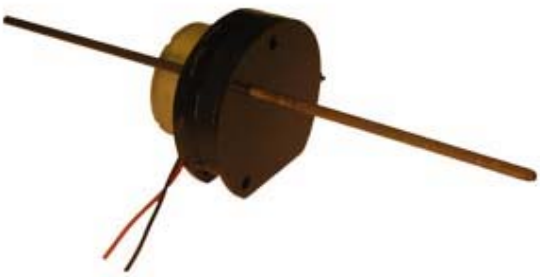
2.4 Test gears by turning axle shaft and watch gears meshing together

-If necessary make fine adjustment to position of small motor gear so everything runs smoothly



2.5 Thread the axle through the hole in the casing part B. Press the two halves together so they 'snap'. (You may need assistance to do this)

2.6 With repeated use, parts A&B might not snap together tightly; if this happens use garden ties to secure casing. Thread ties through two outer holes to fix casing parts together. Trim ends of ties to ensure ends do not touch wheels



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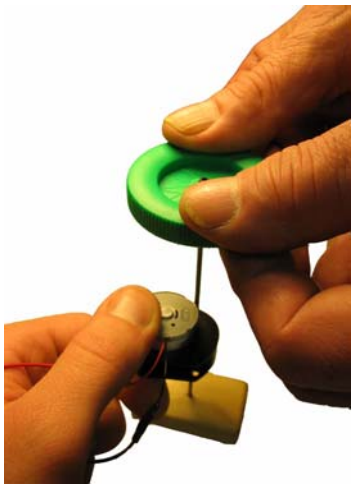
3 Attaching wheels and gearbox (work in pairs)



3.1 From a standing position
-Place one end of the axle into the small hole in the push fit tool

-One person holds the motor casing between their thumb and forefinger and the other person takes the large wheel and places the hole in the reducer over the top end of the axle

-Place **thumbs on the edges** of the wheel

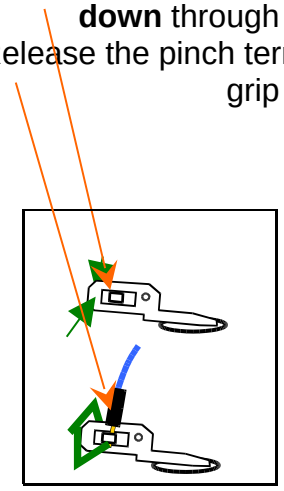
-**Gently** push the wheel onto the axle shaft '**half way'** into the black reducer

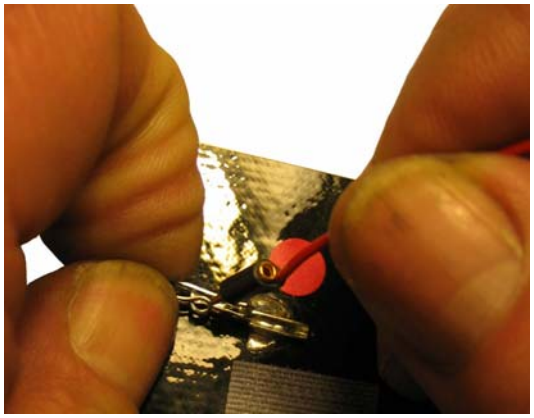
3.2 Place the attached wheel onto a 1p coin so the axle doesn't push through the reducer

3.3 Repeat step 3.1

3.6 Pinch the pinch terminal and a hole will pop out

-Push the gold motor plug **straight down** through the hole
-Release the pinch terminal to grip the plug





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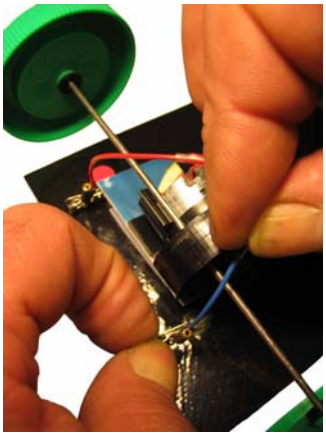
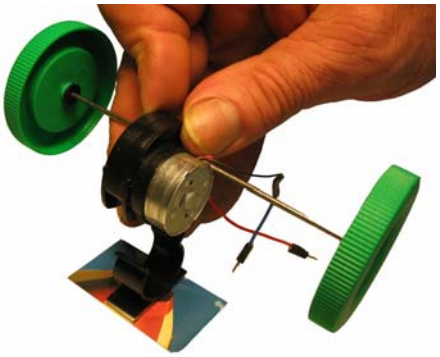
Repeat step 3.7 for the other terminal

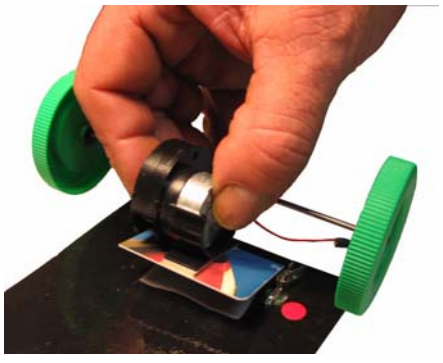


3.5 Attach rear wheel assembly to the short, spiky Velcro pad

-Ensure that the axle is **aligned/parallel** to the back edge



3.4 With front end of car at top, push the **silver motor** (not any part of the black casing) into the motor clip with **casing on your right, ensuring the axle sits well away from any part of the clip.**
-The wires should not interfere with the axle.



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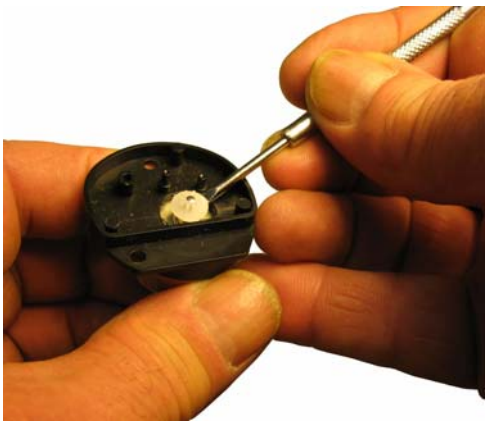
Different gear ratios

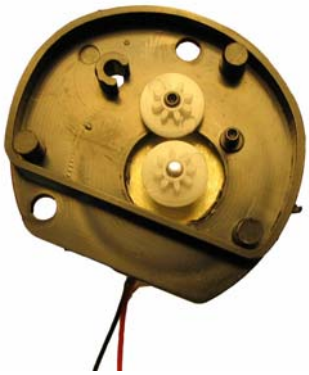
Ratios	Name	Characteristics	Solar Car Performance
27:1	1st gear	Slowest axle-speed and the most torque (turning force)	The best gear for poor light conditions and climbing steeper gradients
9:1	2nd gear	Medium axle-speed and medium torque	A good 'all round' gear ratio
3:1	3rd gear	Fastest axle-speed and the least torque	The best gear for good light, the car will go fastest in this gear

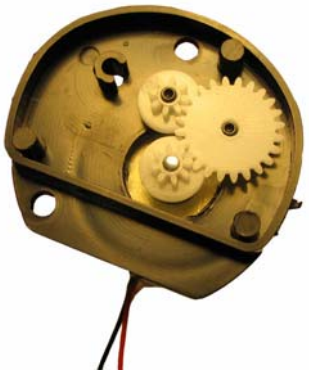
Assembly of 3:1 transmission gear



4.1 Adjust the position of the gear **to the top of the motor shaft**, using your fingers or a small flat-bladed screwdriver

4.2 Slide the small gear **flat side down** onto the left-hand spindle





4.3 Feel the white, toothed double gear between your thumb and forefinger. One side is smooth and the other side will feel rough as it has an 8-toothed gear

-Slide the double gear **flat side up** (the smaller 8-toothed gear will be on the bottom) onto the right-hand spindle

4.4 Thread the longer end of the axle, smooth side of gear down, through hole

4.5 Test gears by turning axle shaft and watch gears meshing together

-If necessary make fine adjustment to position of motor gear so everything runs smoothly

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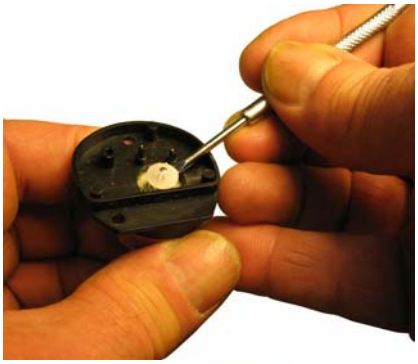
Assembly of 27:1 transmission gear

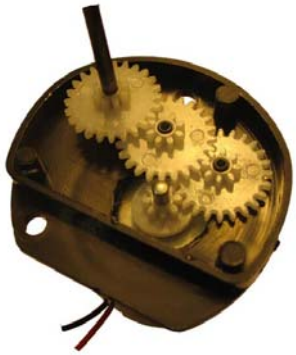


5.1 Adjust the position of the small gear **so you can see half the motor shaft**, using your fingers or a small flat-bladed screwdriver

5.2 Feel the white, toothed double gear between your thumb and forefinger. One side is smooth and the other side will feel rough as it has an 8-toothed gear

-Slide the double gear **flat side down** (the smaller 8-toothed gear will be on the top) onto the right-hand spindle

5.3 Slide the other double gear **flat side down** (the smaller 8-toothed gear will be on the top) onto the left-hand spindle



5.4 Thread the longer end of the axle, smooth side of gear down, through hole to the left of the gears

5.5 Test gears by turning axle and watch the gears meshing together

-If necessary make fine adjustment to position of the small motor gear so everything runs smoothly

Car body shell

Make a car body shell by following the instructions in the Body Construction Guide. The instructions and blank body shell templates can be downloaded using the password **bodyshop** in SPECIAL FILES AND DOWNLOADS on the front page of website.

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Trouble shooting

Problem:	Checks / Solutions:
Gearbox does not run smoothly	**ENSURE THAT IN ALL GEAR RATIOS THAT THE MOTOR IS FITTED LEVEL INTO CASING A** *-Bent axle* ⇒ replace axle *-Gear teeth clogged* ⇒ remove obstructions from within teeth **ratio 3:1** *-Small motor shaft pinion gear and double gear not meshing smoothly* ⇒ adjust position of pinion gear on motor shaft near the top at about 1 mm below tip of shaft *-Right double gear wrong way round* ⇒ insert double gear on SHORTER RIGHT peg with 8 tooth gear towards bottom of spindle *-Single gear wrong way round* ⇒ insert flat side towards bottom of LONGER CENTRAL peg **ratio 9:1** *-Small motor shaft gear and double gear not meshing smoothly* ⇒ adjust position of pinion gear 1mm near tip of motor shaft for gear ratio 9:1 *-Double gear fitted in error* ⇒ remove large gear, it is not used in ratio 9:1 **ratio 27:1** *-Small motor shaft gear and double gear not meshing smoothly* ⇒ adjust position of pinion gear to BOTTOM of motor shaft for gear ratio 27:1 *-Motor shaft gear may be meshing with both double gears : this jams the gearbox* ⇒ adjust position of motor PINION gear to mesh with ONLY RIGHT double gear cog only.
Car runs backwards	Polarity reversed ⇒ reverse terminal connections or reverse position of motor OR change gear ratio.
Wheels do not turn / the car runs slowly	*-Insufficient light intensity at solar cell* ⇒ read 'How much light…' below *-Gear ratio not ideal for conditions* ⇒ change gear ratio higher or lower **or** alter diameter of wheels larger or smaller *-High electrical resistance* ⇒ check soundness of connections between motor plugs and solar terminals **or** check for broken motor wires *-Rolling resistance too high* ⇒ try car on a smooth and level surface **or** change ratio *-Bent axle at either end* ⇒ remove axle and check it by rolling on a smooth surface, replace if not straight *-Axles not parallel* ⇒ make adjustments with reference to assembly guide criteria *-Axle tight in bearing at either end* ⇒ pull wheels along axle and away from bearing to leave some free-play (1-2mm) *-Axle fitted tightly in hole of casing* ⇒ move axle in hole to enlarge hole

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2-Q SOLAR MODEL CAR
Trouble shooting

Introduction: The model solar car kit has been specifically designed for the builder of the car to learn using their creative and inventive skills through a process of trial and error; experiencing the affects of any changes they make first hand. This approach is highly effective in creating enthusiasm and encouraging invention; while allowing one to gain knowledge and problem solving skills crucial to real life application of Scientific, Mathematics, Technology and Engineering concepts.

Problem solving: For example: the gearbox motor assembly is designed so that the builder exercises his/her forensic skills to diagnose the problem and get the motor working again [the gears meshing correctly and the wheels spinning].

There are also other design changes one can make to improve the performance of the car: making their own wheels [http://www.pluggingintothesun.rog.uk/centreofwheel.pdf], adjusting the angle and orientation of cell to light source [http://www.pluggingintothesun.org.uk/case2.pdf] , changing gear ratios in relation to size of wheels [http://www.pluggingintothesun.org.uk/case3.pdf] track surface and condition can also be considered, as well as many other variables.

Follow the steps below **if the motor is not working** (wheels not spinning) or gear box is not running smoothly, when motor is connected to PV cell and PV cell is facing toward a natural light source (The Sun):-

1. Remove rear wheel from lid side (part B) of casing. You may need to firmly hold axle with a small pliers in order to pull off the wheel.
2. Remove the lid.
3. Remove the rear axle and cog
4. Remove the double gear cog
5. Hold the PV cell toward natural light source. Observe if the pinion gear on the shaft of the motor spins around – if it does it tells you that the PV cell and motor are working but there is friction being casing between the gears cogs and as a result they are not meshing smoothly to turn the wheels.
6. The adjustments necessary are described on page nine of the assembly instructions.

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How much light does the solar (photovoltaic*) cell need?
Getting the best from your photovoltaic (solar electric) cell

A bright light source has more energy!
A solar cell converts light energy into electrical energy. If the intensity of light falling on the cell goes down, the electrical power output falls also. The electrical current output from the cell is very sensitive to light intensity. Maximum power output is produced when the incident light beam (i.e. when it is pointed at the sun) is perpendicular (90 degrees) to the cell surface.

Solar power is best obtained from the sun!
The UNI-SOLAR solar cell is designed for daylight or natural wavelengths of light (including diffuse light i.e. light scattered by cloud cover), not wavelengths from artificial light sources. However, soft white fluorescent lighting works best with the UNI-SOLAR cell.
The power output of the solar cell will be inversely proportional to the square of the distance from the light source to the surface of the solar cell. In other words, the motor in our solar car/boat kit will work when the solar cell is directly under the artificial light source, but if you double the distance you will only get 1/4 of the light intensity and the motor will probably stop working.

Dull days!
Diffuse sunlight from a cloudy sky can provide enough energy for the solar motor of the car/boat or mini-water pump to spin – but not always to run these devices. For the car, it will depend on gear ratio, wheel surface and size, the surface you run the car on, time of day and season.
Solar radiation is very variable – from place to place, from time to time and from season to season. For example, in the UK during the winter months, when the sun is 'lower' in the sky, diffuse sunlight may not run the car or boat during the early morning hours but by mid-day the car and boat will work.

OK so there is no sun at all today...
A 100W standard tungsten filament bulb held closely to (but not touching) the collector side of the solar cell will spin the motor. However, it is not the way to show how solar energy works. Remember that about 95 of the 100watts going into the lamp is given off as heat not light! Beware of burns to hands and melting plastics. A halogen security lamp (500w), OHP projector lamp or high intensity spotlight will power the car, but again the heat build-up is a safety issue.

NOTE - *Low energy lamps will not power the motor.*

Explaining natural energy use
Natural energy sources such as the sun, the wind and waves vary in intensity all the time. Harnessing and storing this energy is an important aspect of renewable energy, which is well illustrated by this solar electric model car kit.
Please try not to demonstrate solar power in very poor light conditions, unless you already know that the electrical device can work under those conditions. For example, a 12V piezo buzzer will work under poor light conditions with the solar cell in this kit.

(* The term '*photovoltaic*' is derived by combining the Greek word for light, *photos*, with *volt,* the name of the unit of electromotive force.)

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