

POWERED BY THE SUN

Congratulations, you have just purchased a very unique solar powered model. In the age of rising energy costs, the idea of a free and virtually limitless energy source seems too good to be true. For years scientists have experimented with various methods of capturing the abundant energy radiated from our sun. Today, although far from perfected, solar technology has been advanced to a point where we have learned how to harness and utilize the sun's power. Time, research and money will bring to the market place new products that will be energy savers needed by the entire world. Your Solar model is designed to demonstrate the potential of solar energy. We hope that you will enjoy and educate others regarding this energy source of the future.

SPACE AGE TECHNOLOGY

Your Solar model is powered by means of a tiny disc which actually converts light into electricity. This disc, more commonly referred to as a photovoltaic (photo meaning light and voltaic meaning producing electricity) or solar cell, is the result of the extensive research and development which went into the space program. Scientists originally developed photovoltaic cells as a means of recharging batteries and powering various systems contained in spacecraft. These tiny cells have contributed greatly to the success of the space program.

Research and development of solar cells increased on a fairly large scale. Cost was not the big factor weight was the big factor, even the critical factor. Every additional ounce put into orbit had to be carefully considered. The efficiency of solar cells increased and manufacturing techniques improved. Solar cells become lighter and less expensive. In many cases, batteries could be eliminated completely and solar cells used to supply all the electrical power required to operate the equipment aboard satellites. This research has helped to open the door to the unlimited potential for applying solar technology to industry and to our private lives.

CARE AND MAINTENANCE OF SOLAR CELLS

Though it may be hard to believe, these lightweight solar cells never wear out or require any maintenance. Do not drop or abuse the solar cell or solar cell module, as the material it is made from is similar to glass and will break. We are not responsible for solar cells which are damaged due to mishandling. The motor provided with your Solar model requires no maintenance and its operation should exceed the models lifetime.

To clean, a simple blowing with your breath removes dust and most foreign objects. We recommend wiping with a soft cloth and glass cleaner.

HOW DO SOLAR CELLS WORK?

Most of the solar cells in volume production today are made with silicon. This plentiful natural resource makes up more than one fourth of the earth's crust and is the chief component of ordinary sand. The silicon used in the production of solar cells must be purified to a very high degree. A large part of the cost of solar cell production results from the painstaking task of removing all but the slightest traces of impurities in order to produce the highest quality silicon.

To make the solar cell which powers your Solar model, we start with a thin disc of almost pure silicon crystal. When the silicon crystal is being formed, a small amount of boron is added. The boron gives the crystal structure a unique characteristic. It actually has a positive electrical charge. Since this part of the solar cell has a positive charge it is referred to as "P" type silicon and it forms the base of the cell.

Next, a very thin layer of silicon crystal is formed over the disc of "P" type silicon. However, instead of adding boron, this time a small amount of phosphorous is added to the mixture. The phosphorous provides a negative charge and thus is referred to as "N" type silicon.

The two halves of the solar cell, one “P” type silicon and the other “N” type silicon, cancel each other out to produce a neutral cell.

When sunshine penetrates to the junction of the “N” type and “P” type silicon cell layers it creates a flow of electrons throughout the crystal structure. The crystal structure of silicon contains empty areas which will accept electrons. As one electron moves to fill a hole, it creates another hole. It is this flow of electrons which produces electricity.

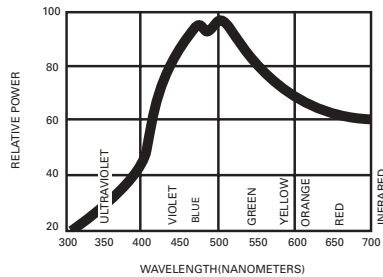


FIGURE 1

Sunlight contains many colors of light. Color and the relative power in each color of light is determined by the measure of the wavelength. Figure 1 plots the relationship between wavelengths and color along the spectral distribution of ordinary daylight.

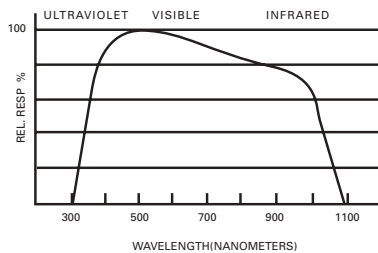


FIGURE 2

The relative response of a typical silicon solar cell across the light spectrum is represented in figure 2. As we can see from this chart, silicon solar cells have a high response over a broad range of wavelengths.

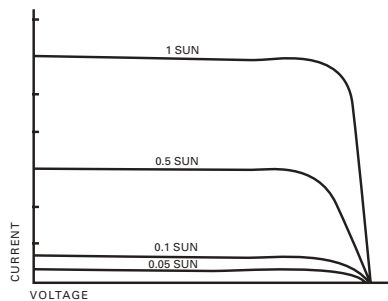


FIGURE 3

In most circumstances, solar cells are not exposed to maximum levels of sunlight. Figure 3 shows the resulting output of a solar cell when exposed to maximum and lesser amounts of sunlight. Notice that the terminal voltage is not significantly effected by the amount of light.



FIGURE 4

The average number of peak sun hours per day varies from one area of the country to another. Figure 4 shows the yearly average peak sun hours and in turn the potential for solar energy applications for different parts of the country.

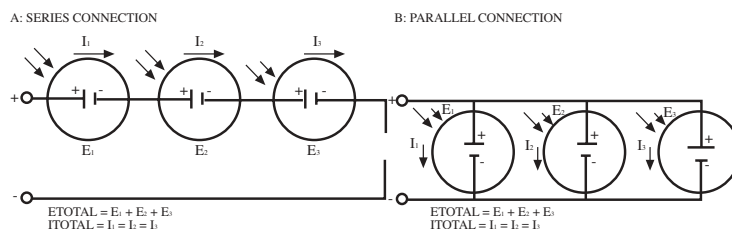


FIGURE 5

In order to transmit the electricity provided by sunlight activating the “N-P” junction of the solar cell, simply attach a conductor (copper wire) to each half of the cell. The resulting electrical current is determined by the square area of the cell being used at about one-half volt. To vary the amount of current or voltage produced, cells can be connected in series and/or parallel. Figure 5 illustrates that when multiple solar cells are connected in series the voltage (E) is increased, but the current (I) remains constant. Conversely, when multiple solar cells are connected in parallel the result is increased current without altering voltage output.

OPERATION OF THE SOLAR MODEL

Your model will function best when the solar cell or solar cell module is placed in direct sunlight. For best performance, place in an east, south or west window. In the event you don’t have a window facing the sun or you prefer unlimited operation, an artificial light source can be utilized to power your model. The distance from the artificial light source to your model will depend on the wattage of your light source. We recommend using a 100 WATT incandescent light approximately 5 inches above your model to obtain maximum performance. (For not more than 3 minutes as the heat may melt the plastic frame)

SOLAR CELL MODULE

If your model comes supplied with an encapsulated solar cell module for remote light pick up, place the solar cell module in a window (with supplied clear suction cup) or inside a table lamp. As you can see you can operate your Solar model day or night. The solar cell is encapsulated in a protective and laminated with special resin to prevent damage and comes complete with miniature wire.

Do not subject the solar cell module to an excessive heat location, as it will warp the plastic frame. Remember, it is not heat that makes your model function, it is light. A little experiment will tell you what setting makes your model work best!

Please handle all models with care.

WHAT DOES THE FUTURE HOLD?

Although the solar cell described in the previous section will provide enough power to operate your Solar model, a more efficient system must be developed in order to produce enough electricity to satisfy average consumer needs. Some of the concepts currently under study include solar cell arrays on individual buildings which will be designed to supply all of that building’s electrical requirements; massive central systems erected in selected locations which receive abundant sunlight capable of serving an entire distribution system and even central orbiting systems in space which will beam power back to earth and then on to individual users.

Practical applications of solar energy will be plentiful in the years to come. Some uses in the not too distant future include: electrical power for remote areas; battery recharging for appliances, radios and TV’s.

The technology of solar energy is still in the formative stages, however much of what is known today can and is being applied by innovative individuals. Our company, is one company

dedicated to advancing the use of solar power and we are one of the leaders in our own particular specialty. Our products are designed to be both educational and entertaining. We feel that with the development of this free, non-polluting energy source... the future looks bright.

HOW MUCH POWER CAN YOU GET FROM SUN BATTERIES

There is no limit to the amount of electricity you can produce from sunlight. The more cells you use, the more power you get. Just remember that you increase the voltage by connecting the cells in series. As shown in Figure 6, 7, 8, 9, 10, 11 and 12. If you make the connection in parallel, you increase the current (amperage). See Figure 13, 14, 15, 16, 17 & 18.

To increase the voltage, connect the cells in series but the current (I) remains constant (negative point connect to positive point).

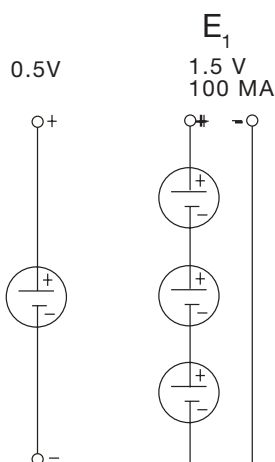


Figure 6

Figure 7

E_1
1.5V 100mA connecting system
(see Figure 7).

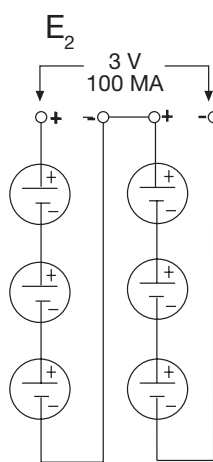


Figure 8

E_2
3V 100mA connecting in series
system, negative connect to
positive (see Figure 8).

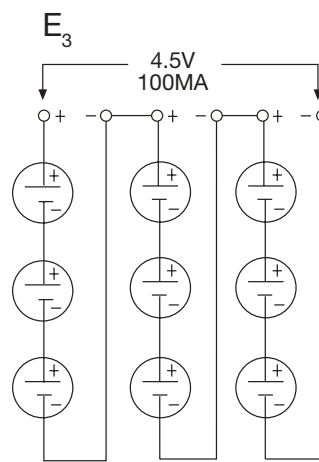


Figure 9

E_3
4.5V 100mA connecting in series
system, negative connect to
positive (see Figure 9).

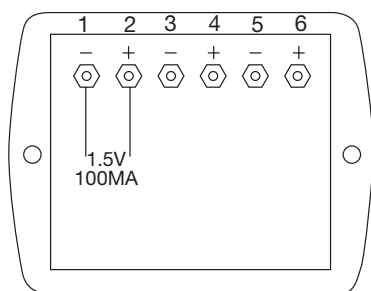


Figure 10

Screw point No.1 and No.2 are
the output (see Figure 10 & 30).

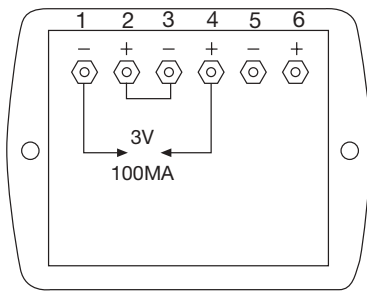


Figure 11

Screw point No.2 connect to No.3, then
No.1 screw point and No.4 are the
output (see Figure 11 & 31).

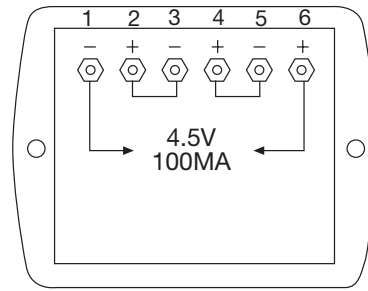


Figure 12

Screw point No.2 connect to No.3,
screw point No.4 connect to No.5,
then screw point No. 1 and No.6
are the output (see Figure 12 & 32).

To increase the voltage, formula as follows:

$$E_{\text{total}} = E_1 + E_2 + E_3 \text{ e.g.: } (E_1)1.5V + (E_2)1.5V + (E_3)1.5V = 4.5V$$

$$I_{\text{total}} = I_1 = I_2 = I_3 \text{ but the current (I) remains constant} = 100\text{mA}$$

To increase the current (amperage), connect the cells in parallel. (Positive point connect to positive point, negative point connect to negative point). The more cells you use, the more power you get.

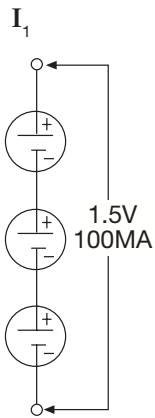


Figure 13

I_1
1.5V 100mA connecting system (see Figure 13).

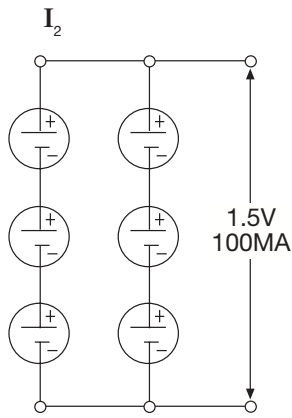


Figure 14

I_2
1.5V 200mA connecting in parallel system (see Figure 14).

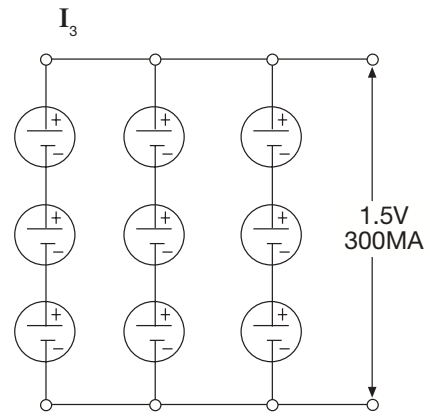


Figure 15

I_3
1.5V 300mA connecting in parallel system (see Figure 15).

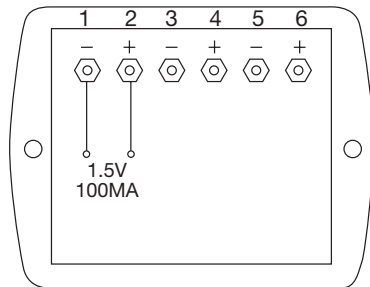


Figure 16

Screw point No.1 and No.2 are the output (see Figure 11 & 30).

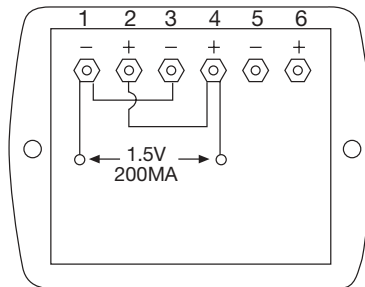


Figure 17

Positive screw point (No.2) connect to positive (No.4), negative (No.1) connect to negative (No.3), then No.1 and No.4 are the output at 1.5V 200mA (see Figure 17, 20 & 21).

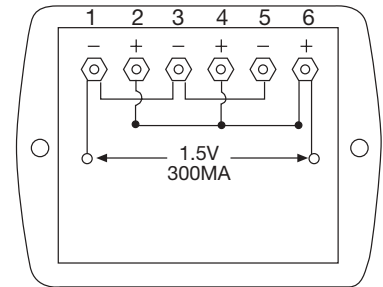


Figure 18

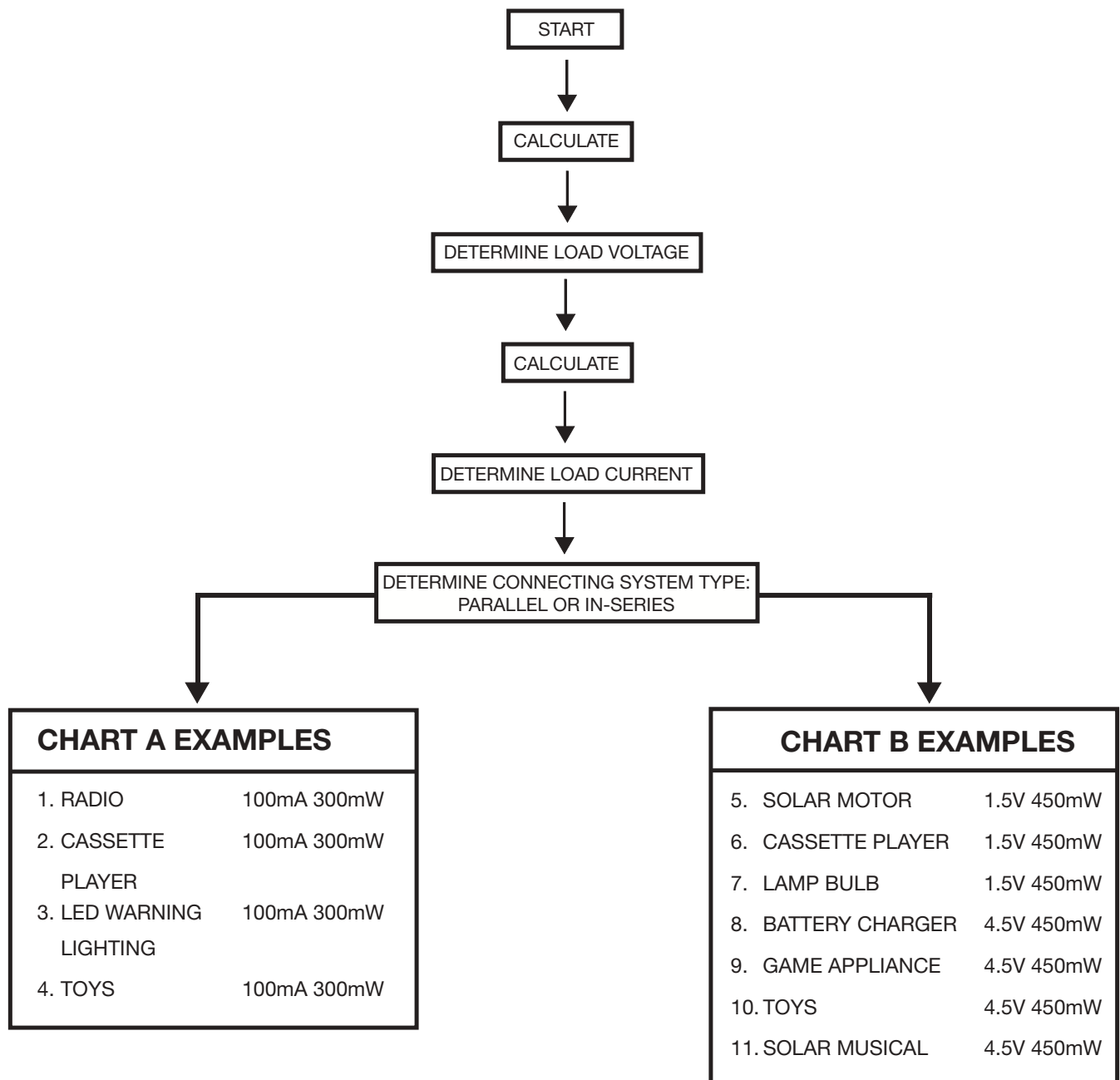
Positive screw point (No.2) connect to positive (No.4), negative (No.1) connect to negative (No.3), positive (No.4) connect to positive (No.6), negative (No.3) connect to negative (No.5), then No.1 and No.6 are the output at 1.5V 300mA or No.1 and No.2 are the same output at 1.5V 300mA (see Figure 18, 20, 21, 22, 23 & 24).

To increase the current (amperage I), formula as follows:

$$I_{\text{total}} = I_1 + I_2 + I_3 \quad \text{e.g.: } (I_1)100\text{mA} + (I_2)100\text{mA} + (I_3)100\text{mA} = 300\text{mA}$$

$$E_{\text{total}} = E_1 = E_2 = E_3 \quad \text{But the voltage (V) remains constant at 1.5V}$$

HOW TO MAKE A SOLAR PANEL FOR YOUR APPLIANCE



CALCULATION AND FORMULATION

$$\begin{array}{ll} 1\text{W} = 1000\text{mW} = 10^3\text{mW} & 1\text{mW} = 0.001\text{W} \\ 1\text{A} = 1000\text{mA} = 10^3\text{mA} & 1\text{mA} = 0.001\text{A} \\ 1\text{V} = 1000\text{mV} = 10^3\text{mV} & 1\text{mV} = 0.001\text{V} \end{array}$$

P = WATT(W), E = VOLTAGE(V), I = CURRENT(A)

$$P = EI, \quad I = \frac{P}{E}, \quad E = \frac{P}{I}$$

EXAMPLE 1

CHART B, ITEM NO.11 SOLAR MUSICAL 4.5V 450mW

Calculate the current (I) and then determine the connecting system.

1. $I = \frac{P}{E}$
2. $I = \frac{450\text{mW}}{4.5\text{V}}$
3. $I = \frac{0.450\text{W}}{4.5\text{V}}$
4. $I = 0.1\text{A}$
5. $I = 100\text{mA}$
6. So a solar musical unit required 4.5V 100mA
7. Now we know the voltage is 4.5V and the current (I) is 100mA, then we have to determine the system with connecting in series circuit.
8. Each row of solar cells output is:
Voc: 1.5V±0.1V (each row)
Isc: 90mA±10mA (each row)
See Figure 7, 8, 9, 12 & 32
9. We use the figure of 1.5V and 100mA for simple calculation.
10. We select 4.5V 100mA with increased voltage by connecting in-series circuit system.
11. To increase the voltage, connect the cells in series but the current (I) remains constant (negative point connect to positive point).
To increase the voltage, formula as follows:
 $E_{\text{total}} = E_1 + E_2 + E_3$ e.g.: $(E_1)1.5\text{V} + (E_2)1.5\text{V} + (E_3)1.5\text{V} = 4.5\text{V}$
 $I_{\text{total}} = I_1 = I_2 = I_3$ But the current (I) remains constant = 100mA
12. How many rows of solar cells are needed to make a solar panel work for a solar musical unit of 4.5V 100mA:

$$\begin{aligned} \text{Rows of cells} &= \frac{\text{Solar musical unit } 4.5\text{V}}{\text{Each row of cells } 1.5\text{V}} \\ &= 3 \text{ rows of cells} \\ \text{So } 3 \text{ rows cells} \times 1.5\text{V} &= 4.5\text{V} \end{aligned}$$

* In series connecting method, see Figure 9, 12 & 32

EXAMPLE 2

CHART B, ITEM NO.5 SOLAR MOTOR 1.5V 450mW

Solar motor requires the power of 1.5V 450mW, then we need to use the following steps to calculate the current (that is I) of the motor:

Calculate the current (I) and then determine the connecting system.

1. $I = \frac{P}{E}$

2. $I = \frac{450\text{mW}}{1.5\text{V}}$

3. $I = \frac{0.450\text{W}}{1.5\text{V}}$

4. $I = 0.3\text{A}$

5. $I = 300\text{mA}$

6. After calculate of the above, we know that a solar motor requires a 1.5V 300mA solar panel.

7. Then we have to determine the connecting system to make the current of the solar panel for 300mA.

8. The parallel connecting system will increase the current (amperage I).

9. Each row of solar cells output is:

Voc: $1.5\text{V} \pm 0.1\text{V}$ (each row cells)

Isc: $90\text{mA} \pm 10\text{mA}$ (each row cells)

See Figure 13, 14 & 15

10. Therefore, we select the parallel connecting system, which will bring the solar module with 1.5V 300mA output.

11. To increase the current (amperage I), connect each row of cells in parallel (negative point connect to negative point, positive point connect to positive point).

To increase the current (amperage I), formula as follows:

$$I_{\text{total}} = I_1 + I_2 + I_3 \quad \text{e.g.: } (I_1)100\text{mA} + (I_2)100\text{mA} + (I_3)100\text{mA} = 300\text{mA}$$

$$E_{\text{total}} = E_1 = E_2 = E_3 \quad \text{But the voltage (V) remains constant at } 1.5\text{V}$$

12. How many rows of solar cells are needed to make a solar panel work for a solar motor of 1.5V 300mA.

Each row of cells are 1.5V 100mA, so 3 rows of cells are needed to connect in parallel system to increase current:

$$I_{\text{total}} = 3 \text{ rows of cells} \times 100\text{mA} = 300\text{mA}$$

But the voltage(E) remains constant

Or another calculation method:

$$\begin{aligned} I_{\text{total}} &= I_1 + I_2 + I_3 \\ &= (I_1)100\text{mA} + (I_2)100\text{mA} + (I_3)100\text{mA} \\ &= 300\text{mA} \end{aligned}$$

* In parallel connecting method, see Figure 15, 18, 20, 21, 22, 23 & 24

EXAMPLE 3

CHART A, ITEM NO.1 RADIO 100mA 300mW

Calculate the voltage (E) and then determine the system connecting.

1. $E = \frac{P}{I}$

2. $\frac{300\text{mW}}{100\text{mA}}$

3. $E = \frac{0.3\text{W}}{0.1\text{A}}$

4. $E = 3\text{V}$

RADIO CONSUMPTION IS 3V 100mA

5. We selected 3V 100mA with increase voltage by connecting in-series circuit system

6. To increase the voltage, connect the solar cells in series system (3V 100mA). Connect the rows of solar cells with positive point (No.2) to negative point (No.3) by jumper wire and the screw point No.1 and No.4 are the output.

To increase the voltage, formula as follows:

$E_{\text{total}} = E_1 + E_2$ e.g.: $(E_1)1.5\text{V} + (E_2)1.5\text{V} = 3\text{V}$

$I_{\text{total}} = I_1 = I_2 = I_3$ But the current (I) remains constant = 100mA

7. 2 rows of cells x 1.5V = 3 Volt

8. Connecting method see Figure 8,11 & 31

THE FOLLOWINGS ARE THE ANSWERS FOR CHART A & CHART B:

CHART A EXAMPLE ANSWER

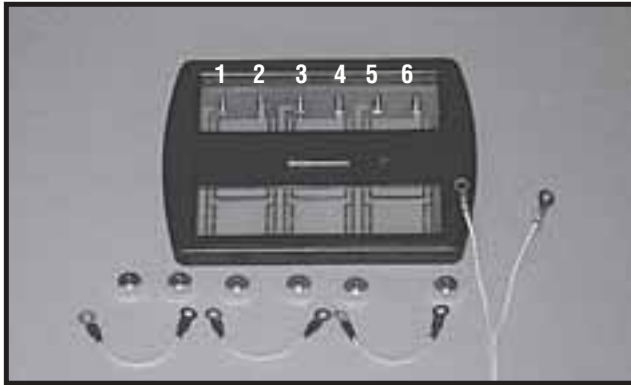
1. RADIO	3V 100mA 300mW
2. CASSETTE PLAYER	3V 100mA 300mW
3. LED WARNING LIGHTING	3V 100mA 300mW
4. TOYS	3V 100mA 300mW

CHART B EXAMPLE ANSWER

5. SOLAR MOTOR	1.5V 300mA 450mW
6. CASSETTE PLAYER	1.5V 300mA 450mW
7. LAMP BULB	1.5V 300mA 450mW
8. BATTERY CHARGER	4.5V 100mA 450mW
9. GAME APPLIANCE	4.5V 100mA 450mW
10. TOYS	4.5V 100mA 450mW
11. SOLAR MUSICAL	4.5V 100mA 450mW
12. TORCH CHARGING	4.5V 100mA 450mW

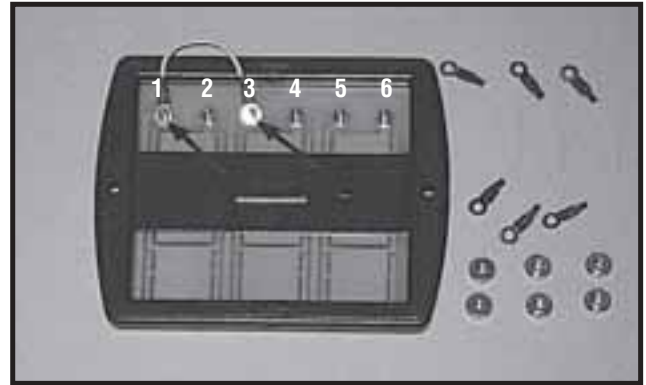
IF YOU DO NOT WANT TO MAKE ANY CALCULATION, JUST SKIP AND FOLLOW THE SIMPLE INSTRUCTIONS BELOW:

Figure 19



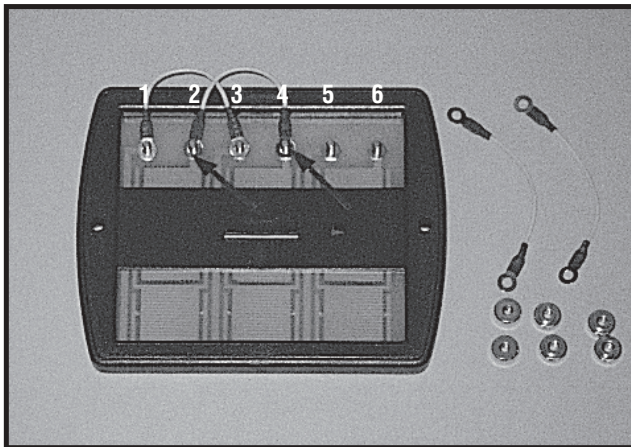
Undo screw nuts and prepare the jumper wires

Figure 20



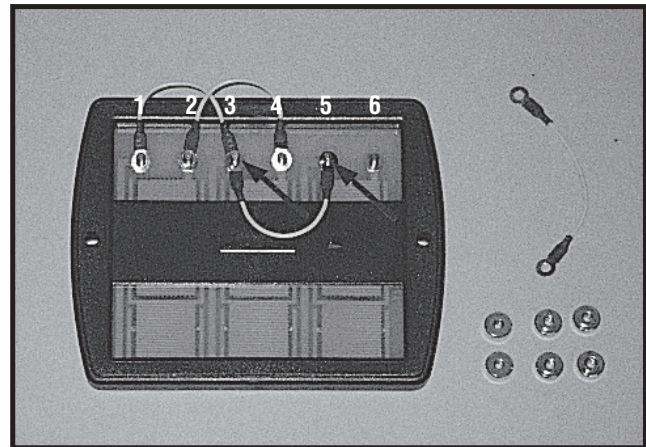
1.5V 300mA with parallel connection method: No.1 screw connected to No.3 screw with jumper wire

Figure 21



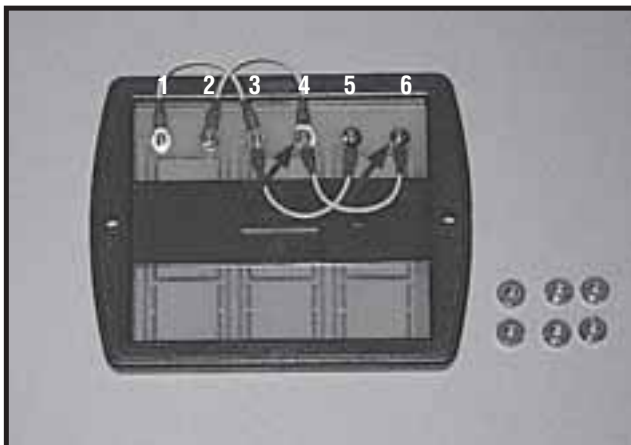
No.2 screw connected to No.4 screw with jumper wire

Figure 22



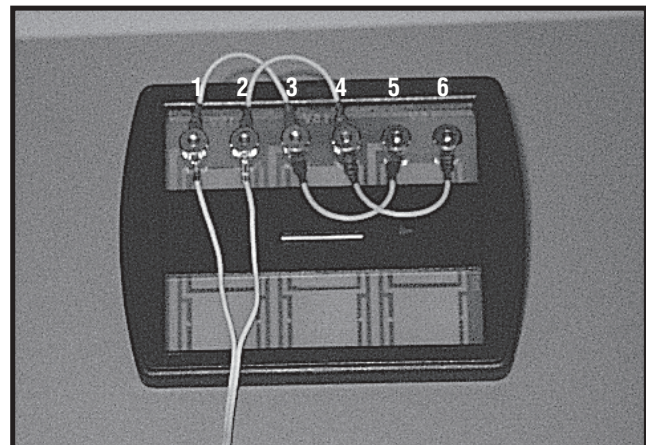
No.3 screw connected to No.5 screw with jumper wire

Figure 23



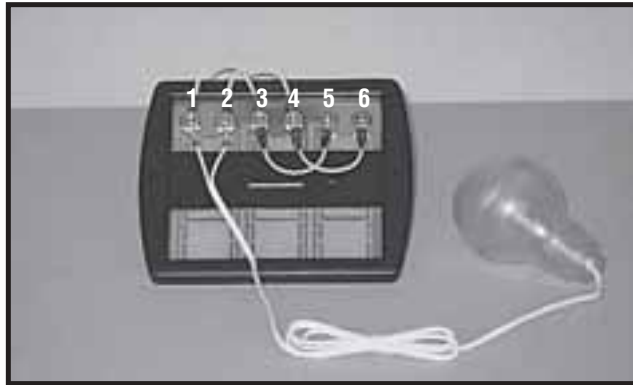
No.4 screw connected to No.6 screw with jumper wire

Figure 24



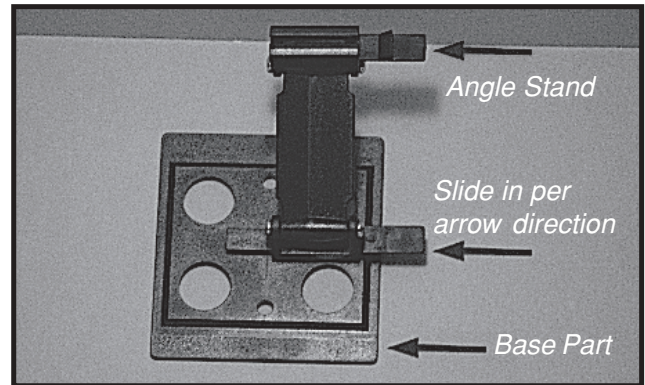
Then connect two wires to No.1 and No.2 screws for your appliances

Figure 25



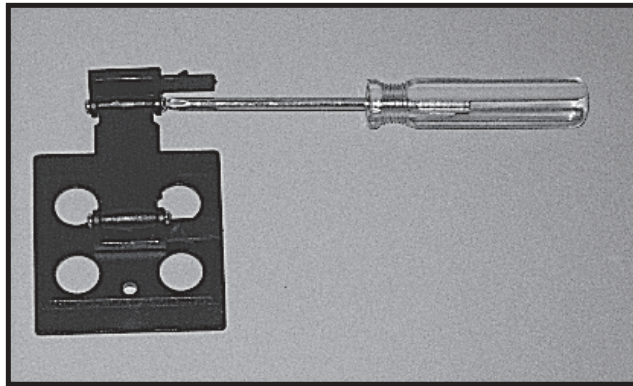
1.5V 300mA system Connect a lamp bulb, motor fan or other appliances to the No.1 and No.2 screws. Or it can be connected No.1 and No.6 as it is in the same circuit.

Figure 26



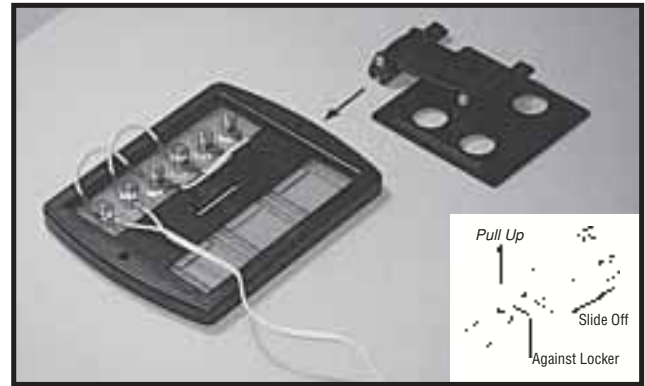
Slide the angle stand to the base part

Figure 27



Tighten a little bit with screw driver for standing itself or adjust angle position if necessary

Figure 28



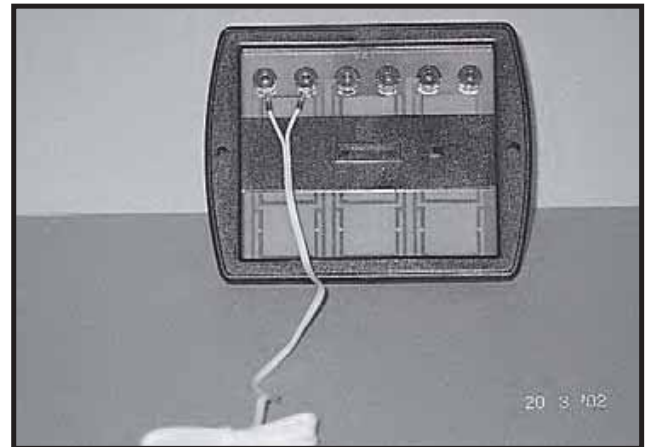
Slide a stand set into the slot of the panel or release by pull up the 'against locker' and slide it off

Figure 29



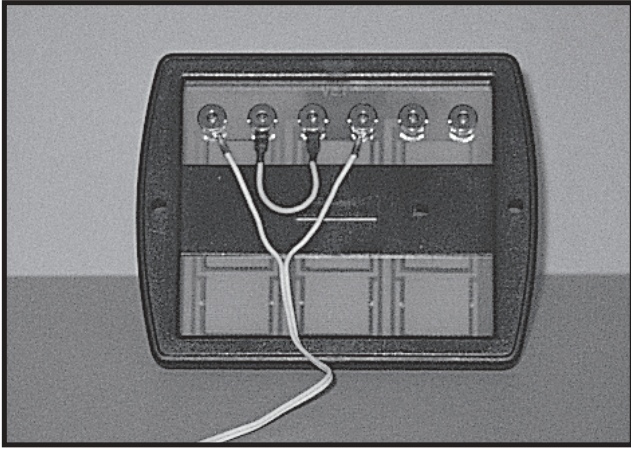
Adjust the angle position to face sunlight for the maximum power

Figure 30



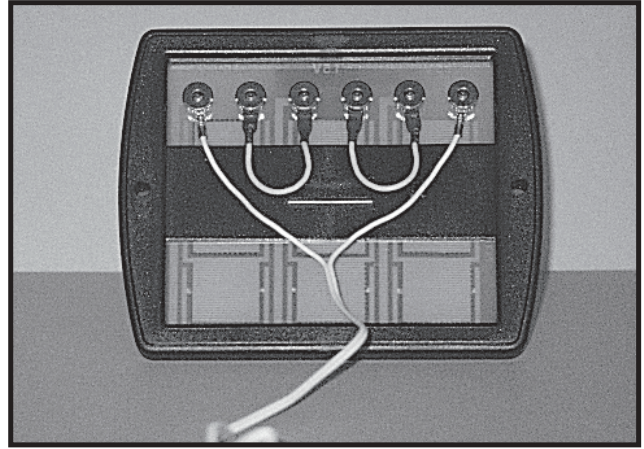
1.5V 100mA connecting system on No.1 and No.2 screws for the first appliance
No.3 and No.4 screws for the second appliance
No.5 and No.6 screws for the third appliance

Figure 31



3V 100mA connecting system: Screw point No.2
connected to No.3
No.1 and No.4 screws are the output
No.5 and No.6 screws can use for other appliance

Figure 32



4.5V 100mA connecting system: Screw point No.2
connected to No.3
Screw point No.4 connected to No.5
No.1 and No.6 screws are the output

Figure 33



4.5V 100mA recommended to power for musical unit,
battery charger, game appliances, etc...

1. Place the solar panel to face sunlight directly for the best performance.
2. If there is no sunlight and you prefer unlimited operation, an artificial light source can be utilized to power your model. The distance from the artificial light of 100W should be 5 inches approximately apart from the solar panel. (For not more than 3 minutes as the heat may melt the plastic frame)

THE FOLLOWING MOTOR AND ACCESSORIES ARE SUPPLIED FOR MODEL NO. GM723 ONLY.

Figure 34



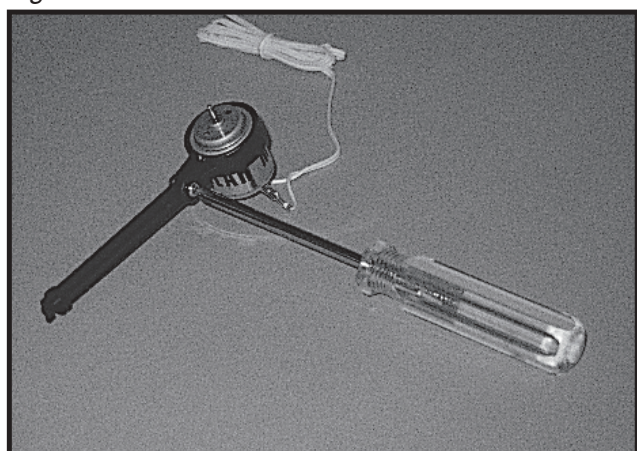
Insert the motor into the plastic holder

Figure 35



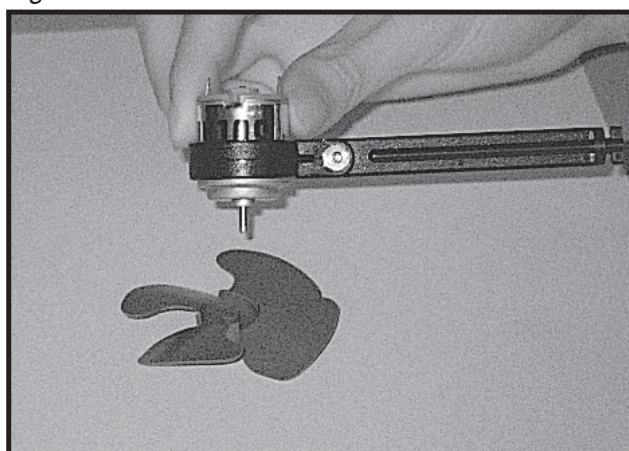
Tighten screw with screw driver and spanner

Figure 36



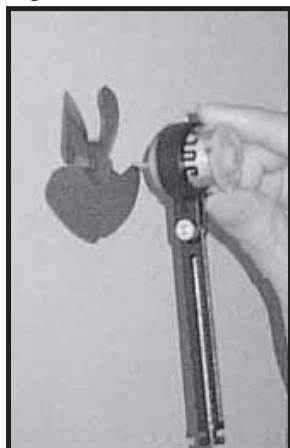
Loose screw from the plastic holder

Figure 37



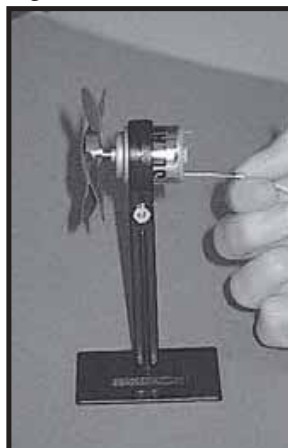
Place fan on the spindle

Figure 38



Tighten the fan on the spindle

Figure 39



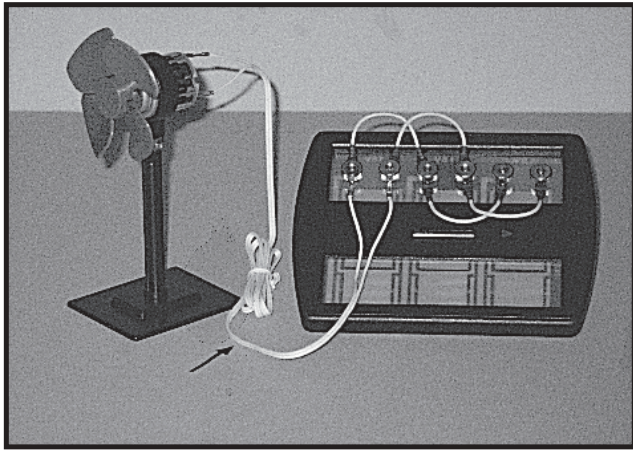
Insert the plastic post in the base key hole and tighten by twist with 90 degree

Figure 40



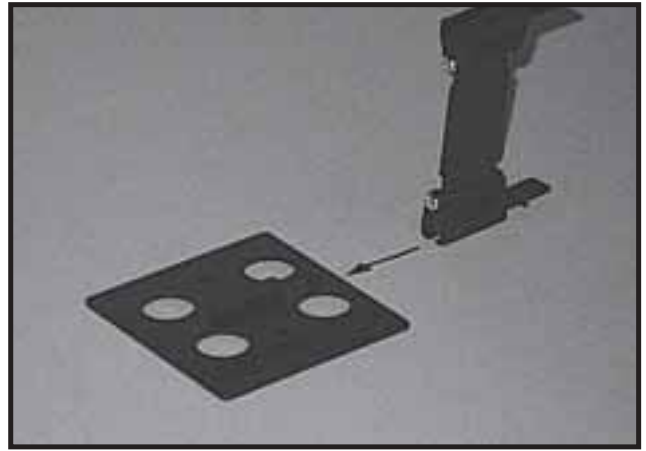
Connect the wire to the motor

Figure 41



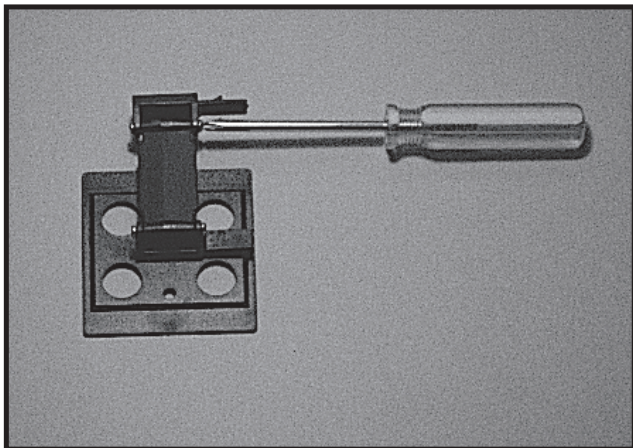
Use 1.5V 300mA connected panel to power a motor fan

Figure 42



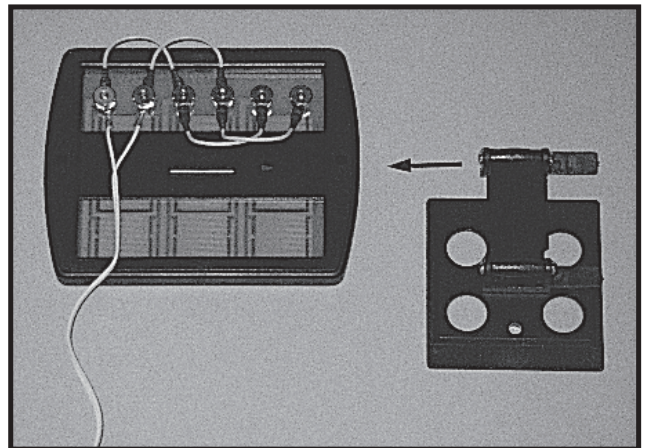
Slide the angle stand into the base part

Figure 43



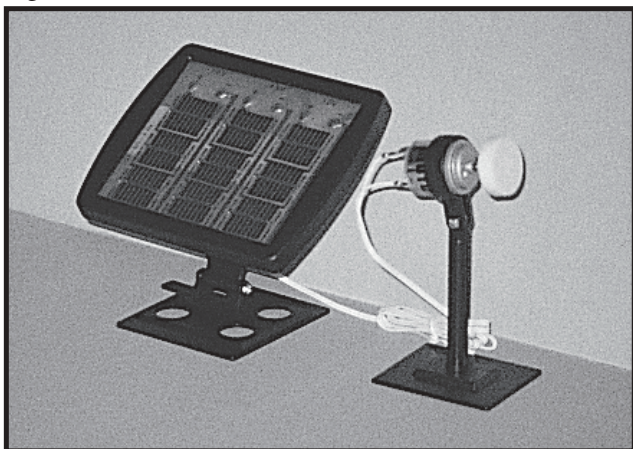
Tighten a little bit with screw driver for standing itself if necessary

Figure 44



Slide the angle stand into the slot of the panel, or it can be released by pull up the 'Against Locker' and slide it off

Figure 45



4.5V 100mA connecting system is recommended for using musical unit, battery charger, game appliances, etc.... Place the solar panel to face sunlight directly for the best performance

