SolarX

Solar Tracking System

Education & Setup Booklet

- 4 Unplugged STEM Activities
- 4 Computing STEM Activities

robotistan

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SolarX

SolarX is an educational maker kit that you can set up and program yourself, and learn about electronic programming as well as solar technologies and energy resources.

What is Solar Panel?

The solar panel absorbs the sunlight with the help of the cells on it and converts it into solar energy by absorbing it.

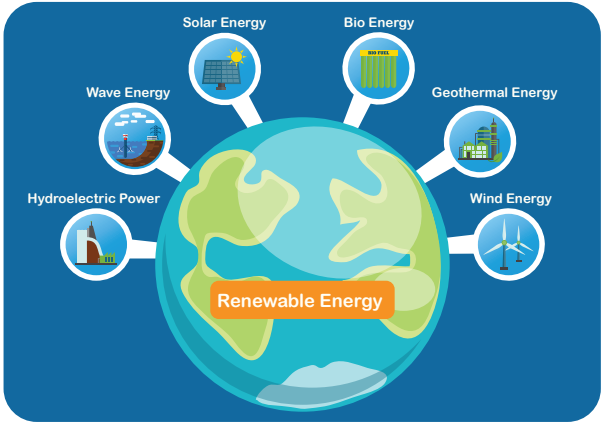
Information Box:

Solar panels work by converting sunlight to electricity. If there is dust/dirt on the surface of the solar panel, the efficiency may decrease as the amount of light absorbed by the solar panel is reduced.

Do You Know This?

Do you know that solar panels need sunlight, not the heat spreaded by the Sun?

Solar energy is one of the renewable energy sources because it is obtained from natural sources. Renewable energy sources are energy that can be obtained continuously from the energy flow that exists in natural processes. For example, since sunlight will continue as long as our world exists, solar energy obtained from sunlight is a renewable energy source. Some energy sources obtained from natural resources are as follows;



Information Box:

Now that, we have learned about renewable energy sources, let's examine what nonrenewable energy sources are and how they are determined.

Nonrenewable energy sources are energy sources that are non-sustainable, that is, they can be exhausted as they are used. For example, petrol is a nonrenewable energy source because it is exhaustible.

How Do Solar Panels Absorb?

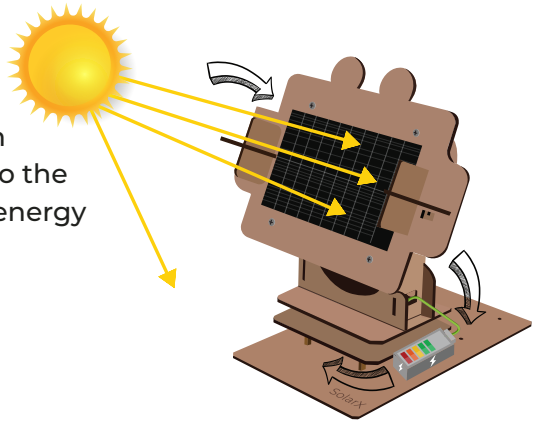
There are photovoltaic (PV) cells on the solar panels that absorb sunlight. These cells absorb sunlight (photons) and convert it into electrical energy. When sunlight reaches the panels, it starts to power photovoltaic (PV) cells by generating direct current (DC) electricity. These cells transmit direct current electricity to the solar inverter with the help of some cables.

What is Robotistan SolarX?

SolarX is an electronic development kit that includes 2 LDR modules(totally 4 LDR sensors), 2 servo motors, a solar panel and wooden parts. In addition, SolarX has a development board that uses the Robotistan Nano Microcontroller board compatible with Arduino. Thanks to this board, SolarX's circuit connections can be done easily.

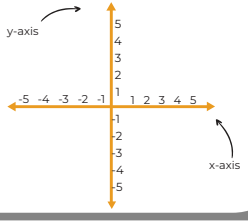
How Does Robotistan SolarX Work?

Under favour of LDR sensors and servo motors, SolarX can move in 2 different (horizontal-vertical) axes according to the amount of light it detects. With these movements, it aims to obtain maximum energy by bringing the position of the solar panel on it to the position where the sunlight is the maximum. SolarX can store this energy and provide to be used it later.



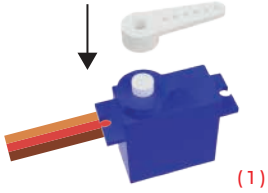
Information Box:

The vertical movements of Solar X are on the Y-axis, and the horizontal movements are on the X-axis.

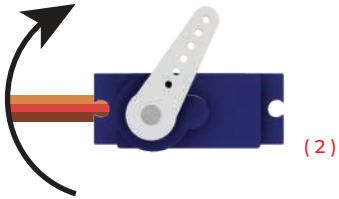


Attention: Servo Motor Calibration

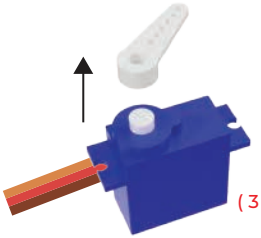
Before starting the assembly, you have to manually calibrate the angles of the servo motors. Otherwise, Servo Motors won't be working properly.



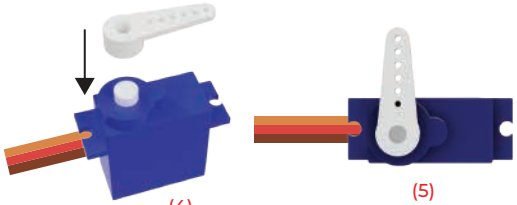
Attach the servo horn to the servo motor (1)



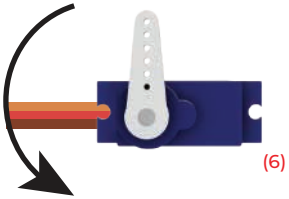
Then slowly turn the servo horn clockwise until it stops. It is not a problem if the servo horn is not the same as the angle shown in the image above. The important thing here is that you have hit the last angle of the servo. (2)



Remove the servo horn from the servo motor (3)



Reattach (4) and reposition the servo horn perpendicular to the servo motor as shown. (5)

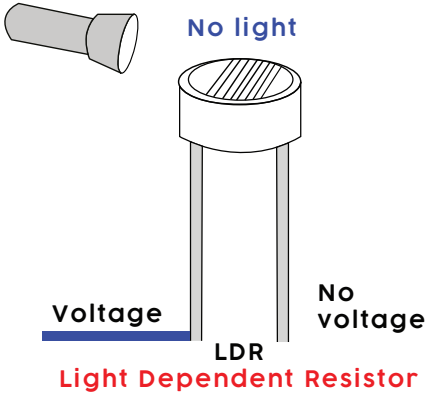


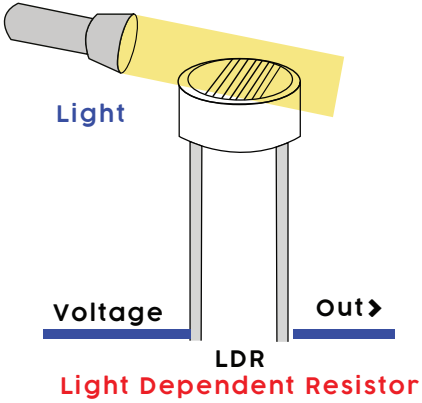
Slowly turn the servo horn counterclockwise (6) until it is parallel with the servo motor, as seen in the image.(7)

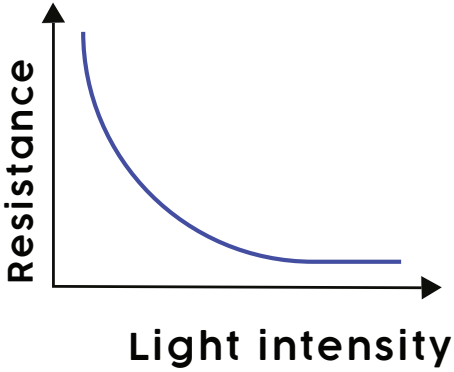
When this step is finished, it means that the servo motor is in the center position. It is important that you apply this process to other servo motors in the set. Afer processing the other motors, remove the servo horn and set aside for assembly.

How Does LDR Sensor Work?

LDR (Light Dependent Resistor) is a circuit element that allows us to detect the amount of light in the environment by changing the amount of resistance. As the intensity of the light falling on the LDR sensor increases, the resistance value decreases. As the light intensity decreases, the resistance value increases.

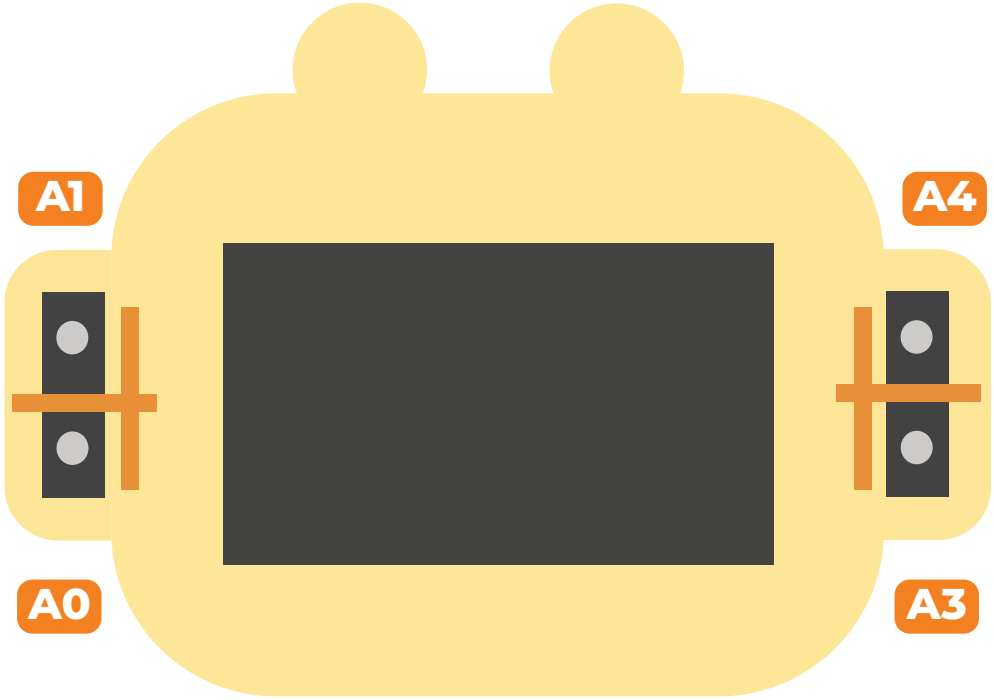






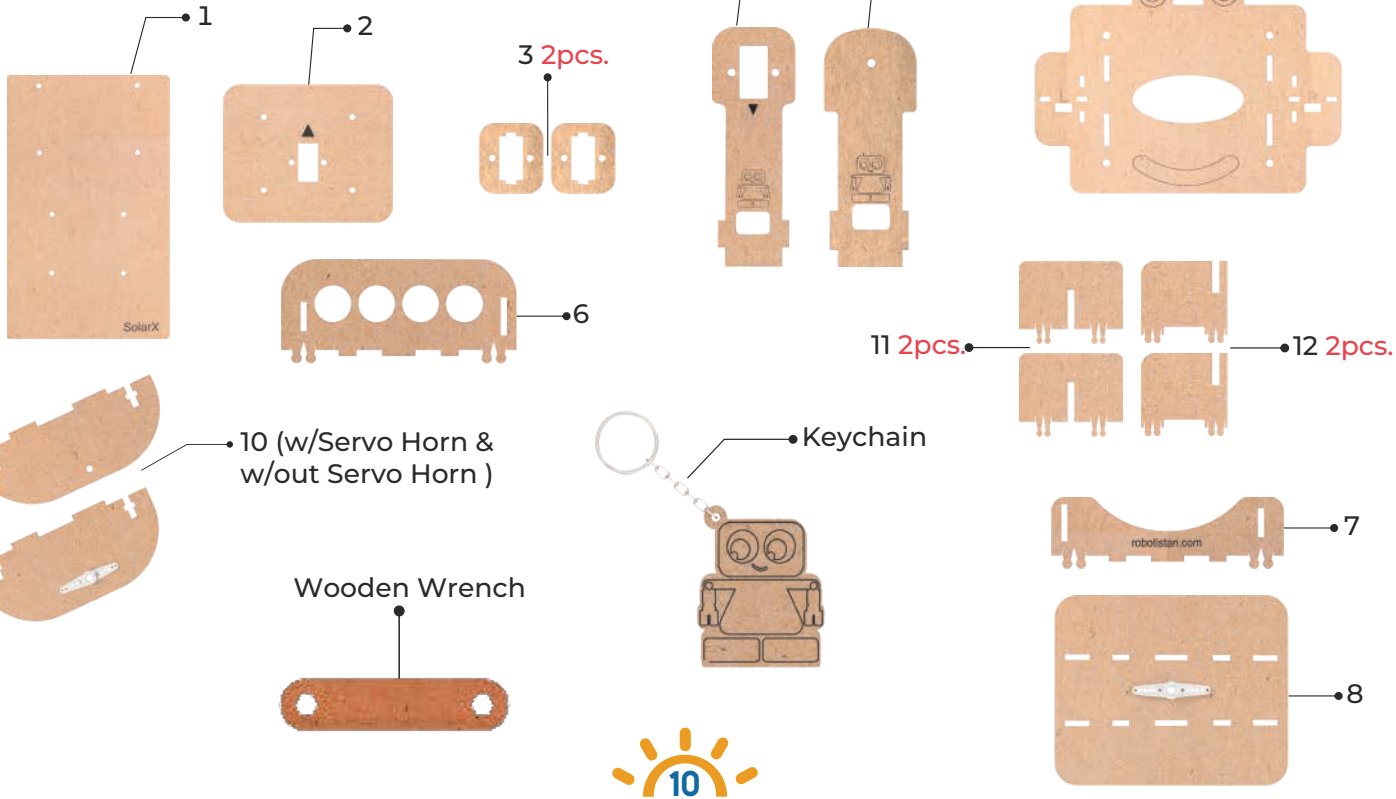
Information Box:

Take a look at this helpful diagram to see the pin numbers for the Robotistan Nano that correspond to the Solar X light sensors.



Let's Get To Know The Set Content

Wooden and Metal Parts



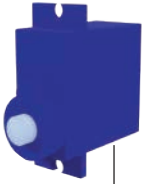
Electronic Circuit Elements

- M3 Nut *(Plastic)* ***4pcs.***
- M3 x 8 mm Screw *(Plastic)* ***4pcs.***
- M3 x 25 mm F-M Spacer *(Plastic)* ***4pcs.***
- M3 x 20 mm F-M Spacer ***4pcs.***
- M3 x 10 mm F-M Spacer ***4pcs.***
- M3 x 15 mm Screw ***4pcs.***
- M3 x 12 mm Screw ***5pcs.***
- M3 Nut ***12pcs.***
- M3 Nyloc Nut ***1pcs.***

Robotistan SolarX MainBoard

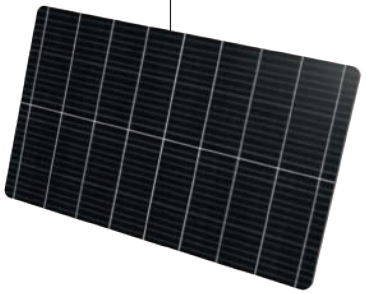
Connecting Cables 2pcs.

LDR Module ***2pcs.***

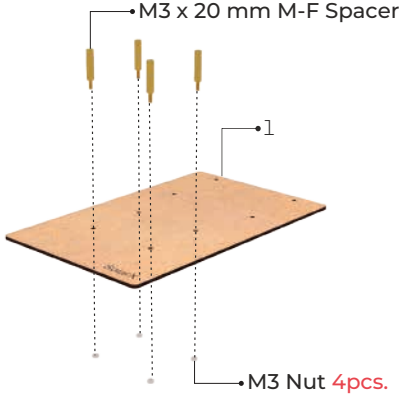


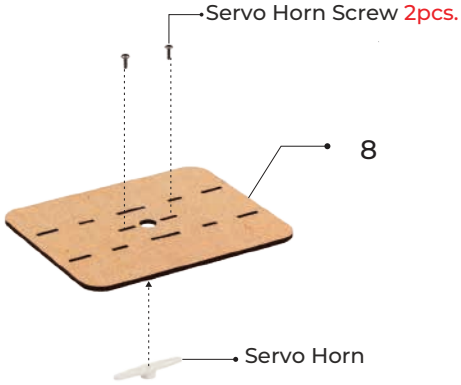
Servo Motor ***2pcs.***

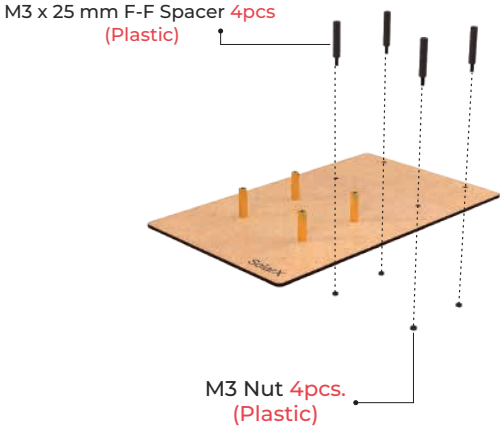
Solar Panel

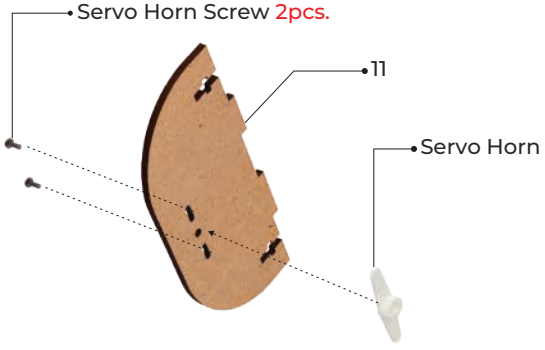


The Installation Steps

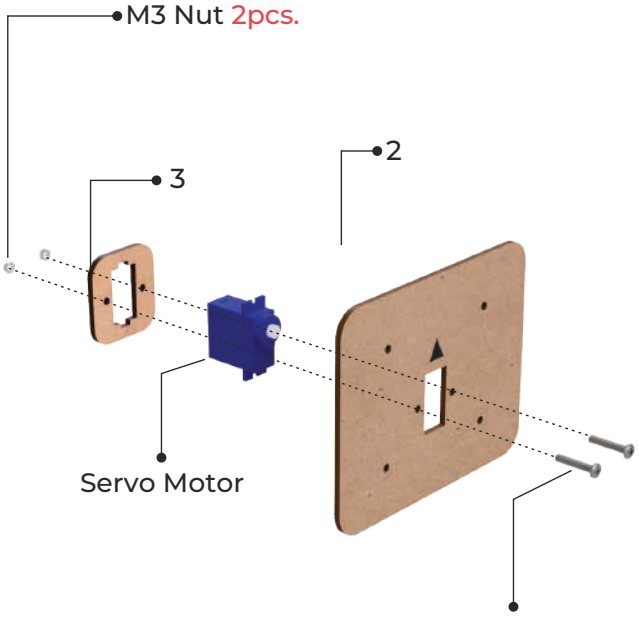


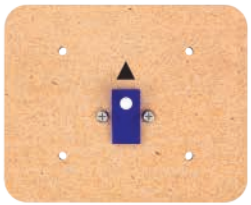




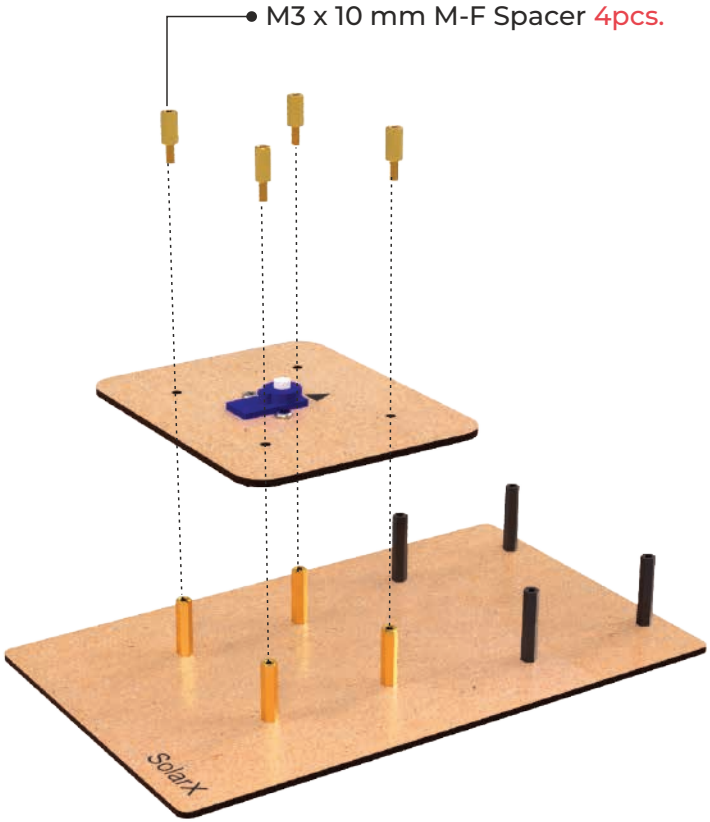


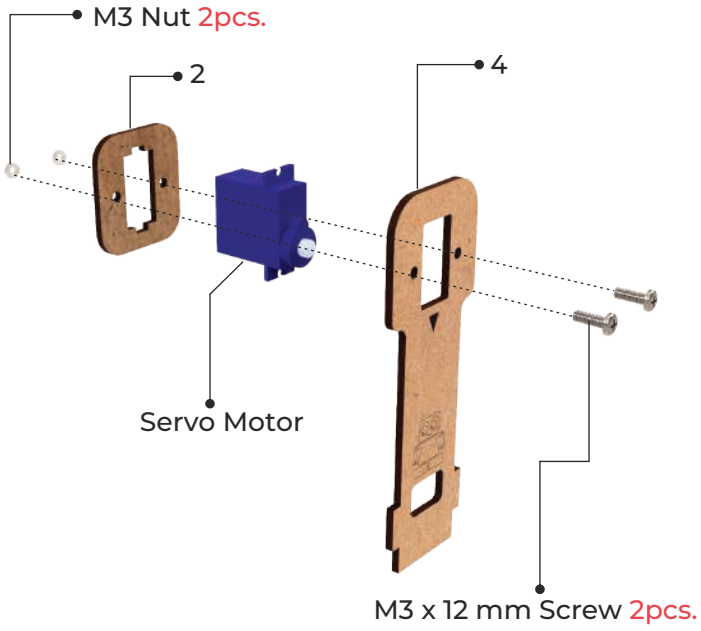
Servo Horn and Servo Horn Screws can be found inside the Servo Motor's package.

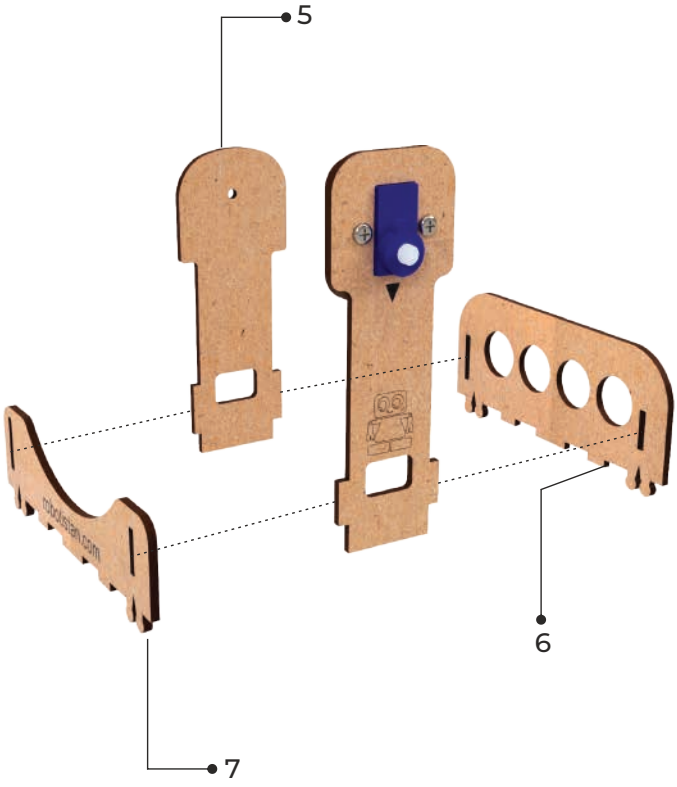




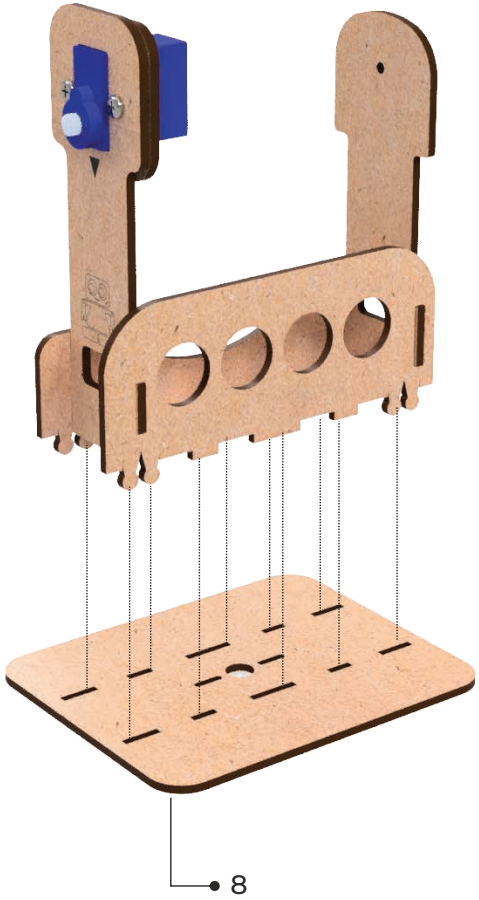
Make sure Servo Motor is facing right direction as seen in the image.



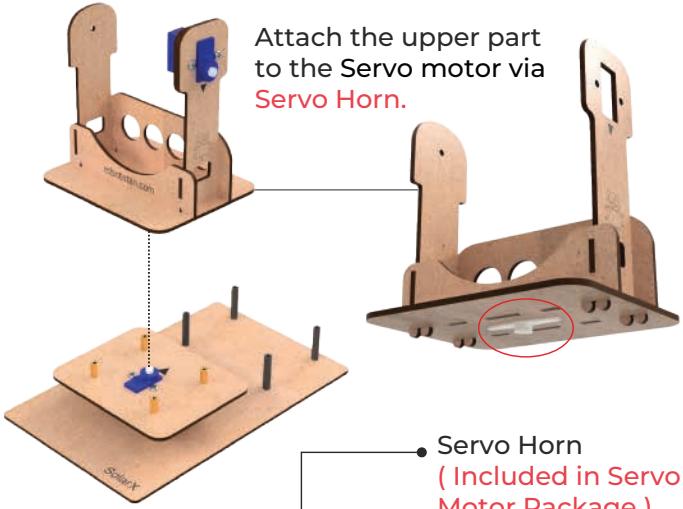




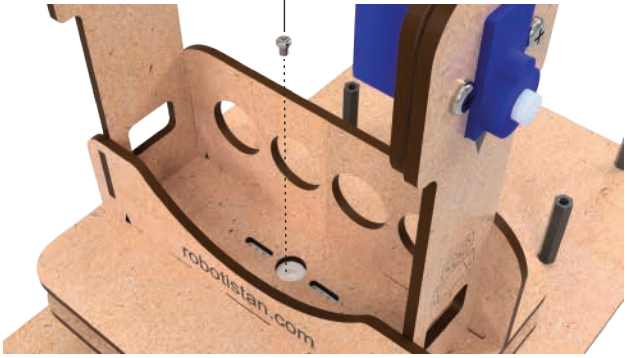
Make sure Servo Motor is facing right direction as seen in the image.

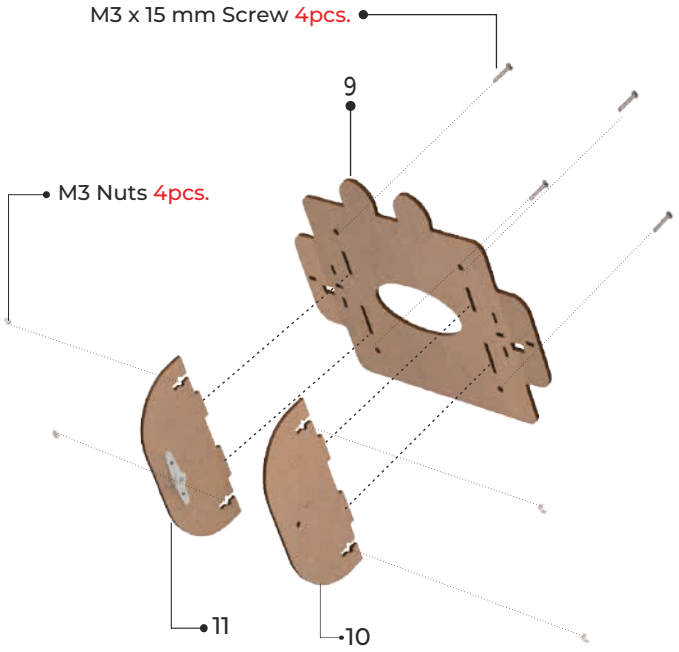


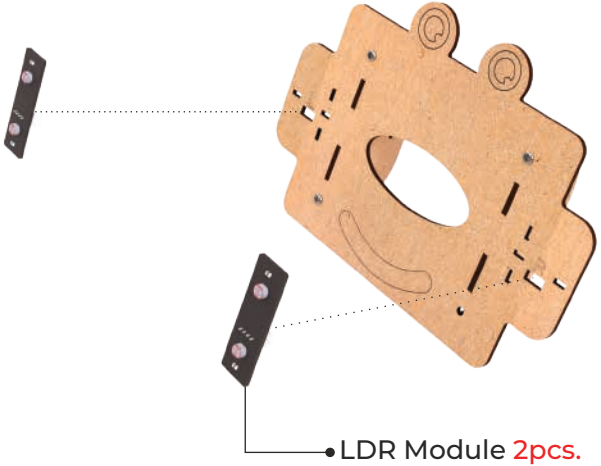
Attach the upper part to the Servo motor via Servo Horn.



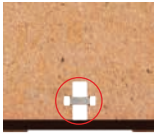
Servo Horn
(Included in Servo Motor Package)





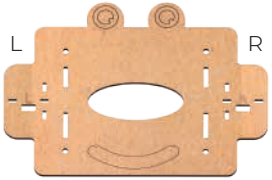


1

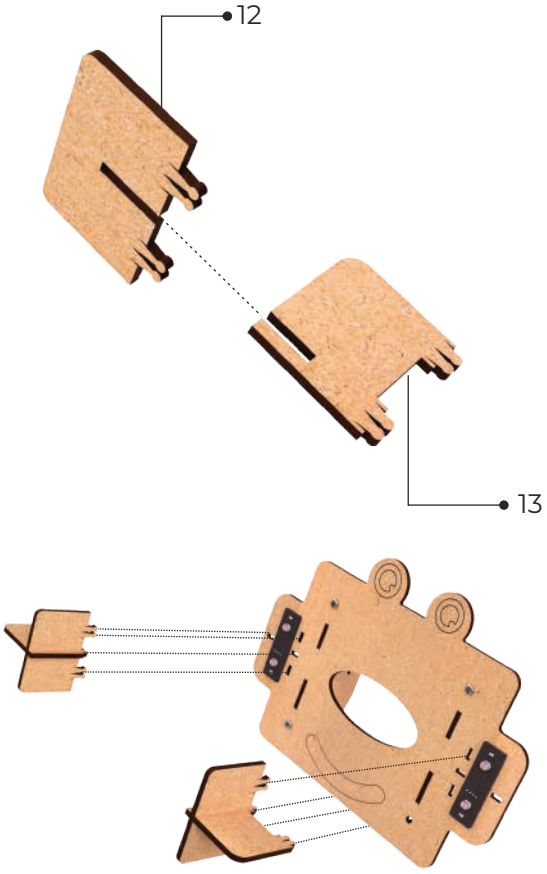


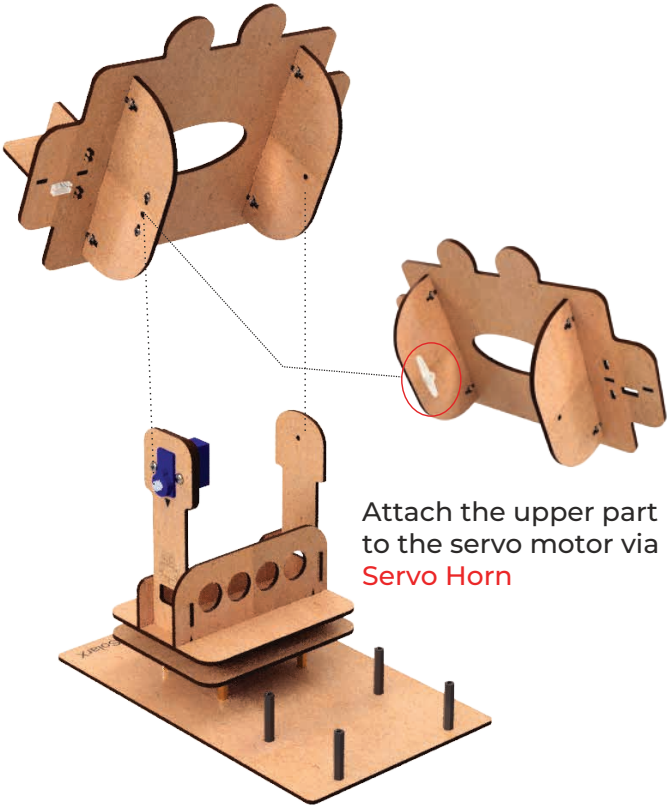
2

T- Joints: For the T- Joint first place M3 Nut to the slot then, use M3 x 15 mm Screw to tighten the joint.

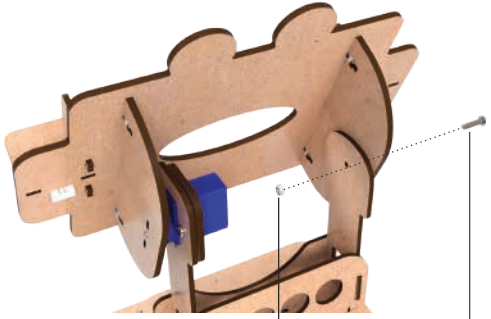


You can use Left and Right sign to tag the LDR modules It is essential for solar tracking to work properly.





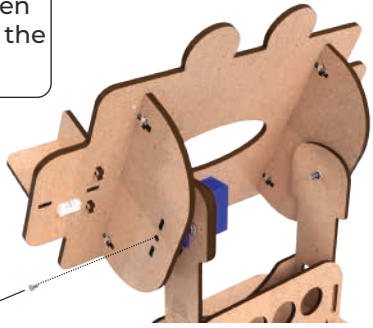
Attach the upper part to the servo motor via Servo Horn



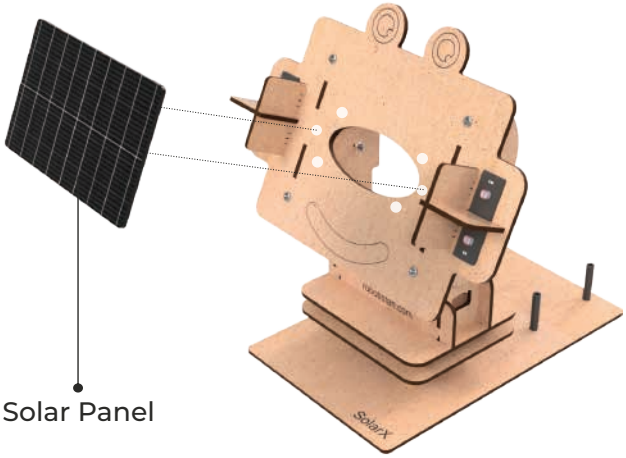
M3 x 12 mm Screw

M3 Nyloc Nut

You can use wooden wrench to tighten the nyloc Nut



Servo Horn Screw
(Included in Servo Motor Package)

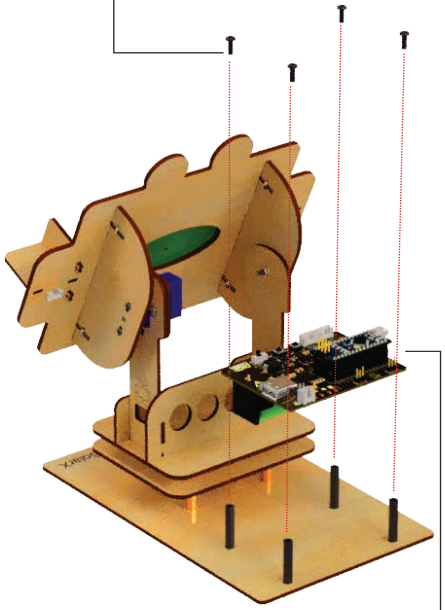


Solar Panel

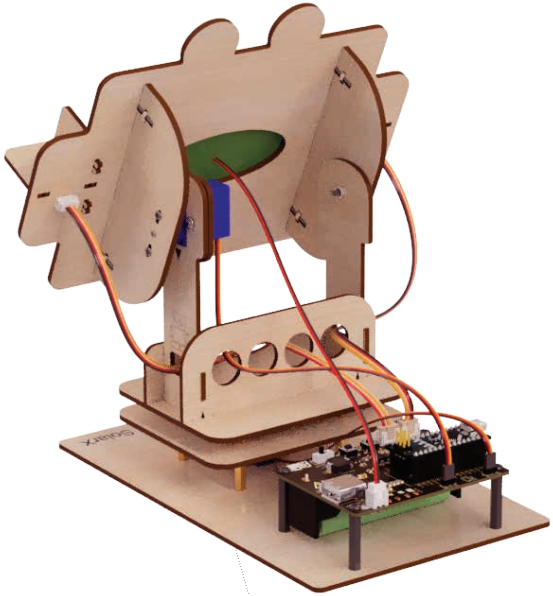
You can use Double Sided Tapes for attaching the Solar Panel

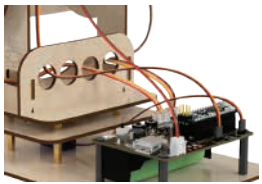
M3 x 8 mm Screw
4pcs. (Plastic)

After turning off the SolarX Mainboard, insert the battery by paying attention to polarity.

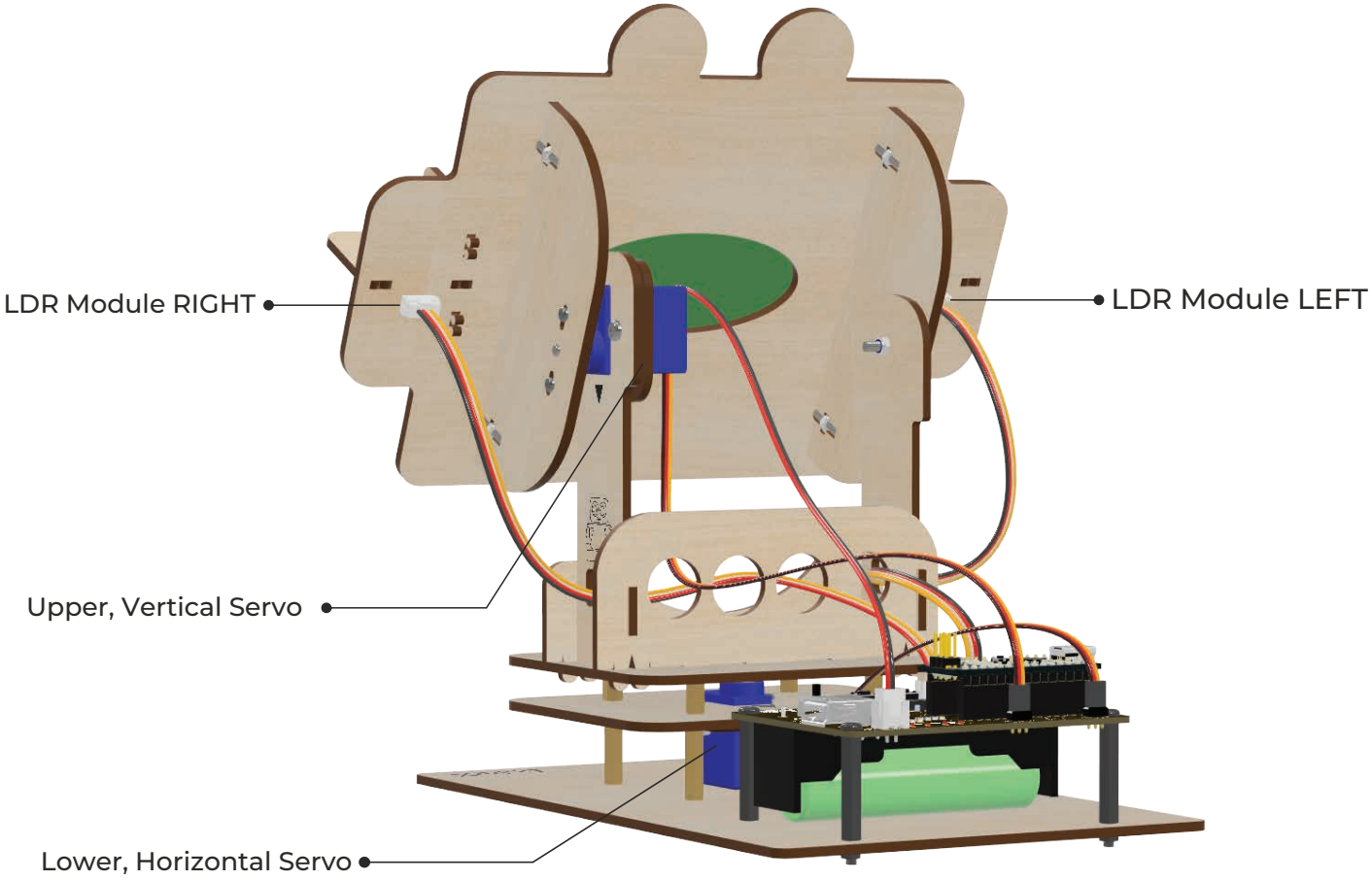


Solar X MainBoard

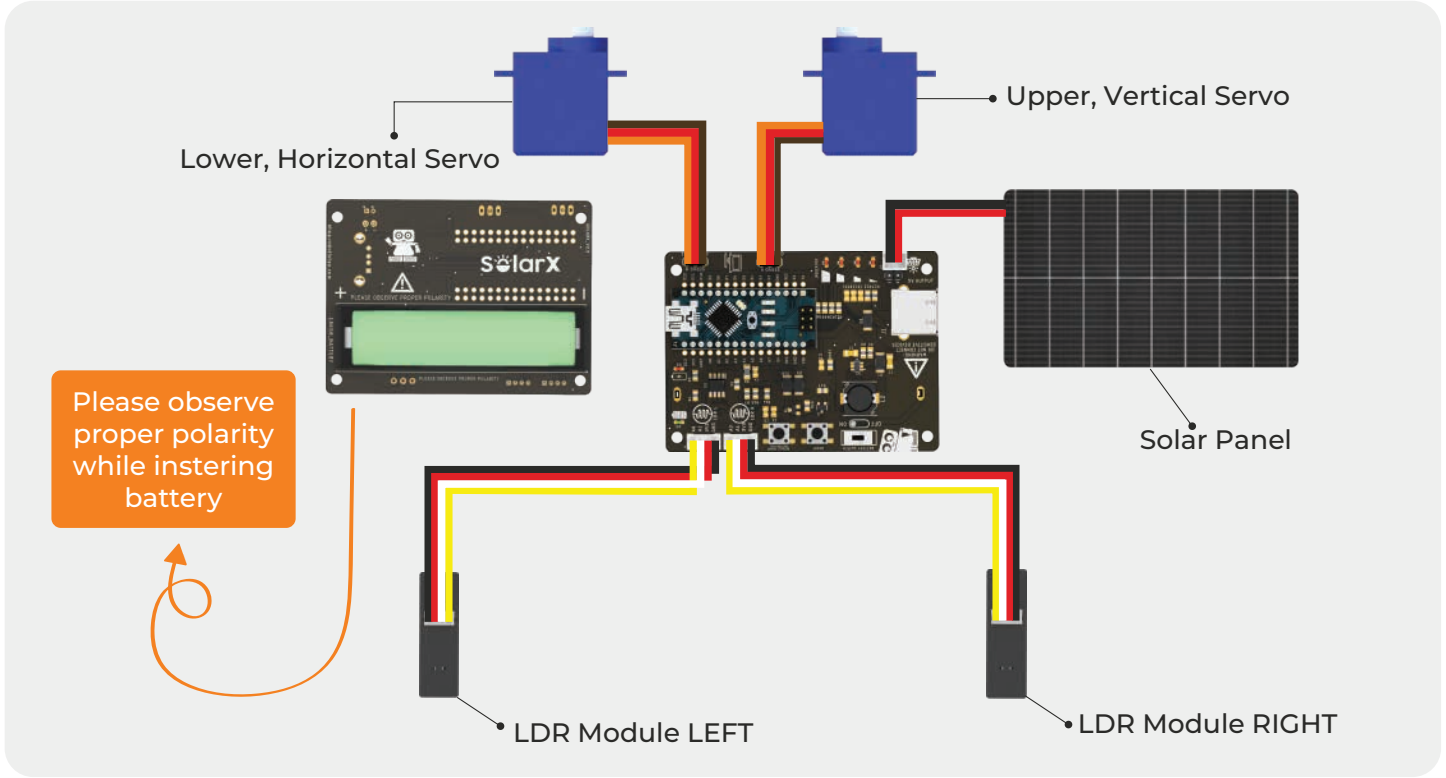




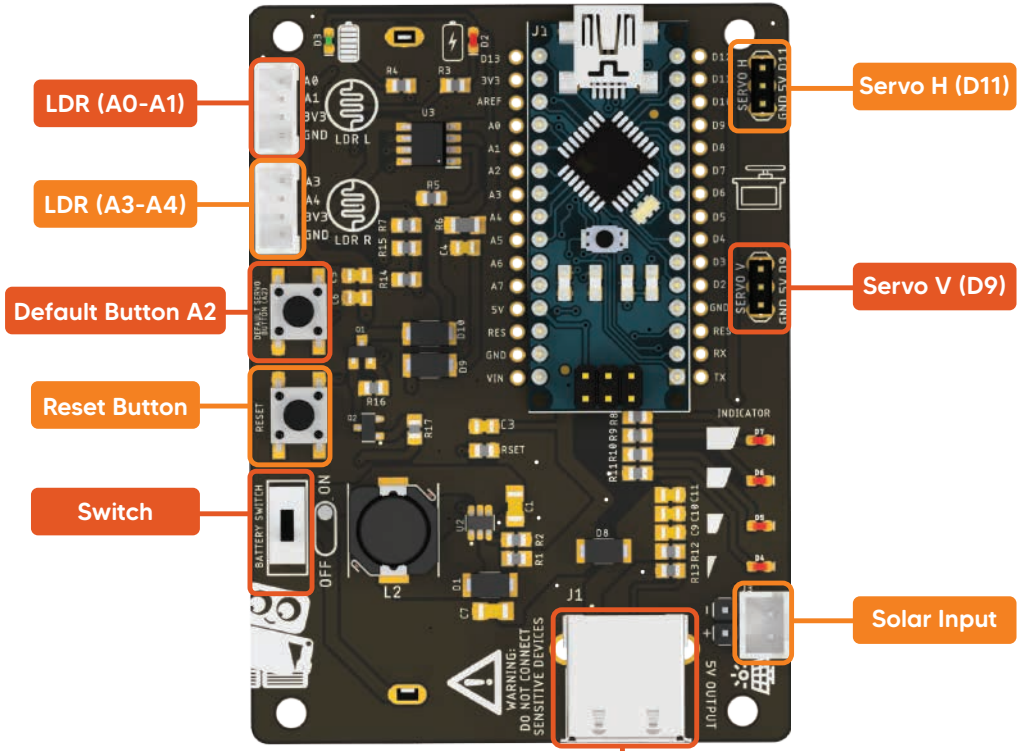
You can organise the cables as seen in the image.
(Except Solar Panel's Cable)


LDR Module RIGHT
LDR Module LEFT
Upper, Vertical Servo
Lower, Horizontal Servo

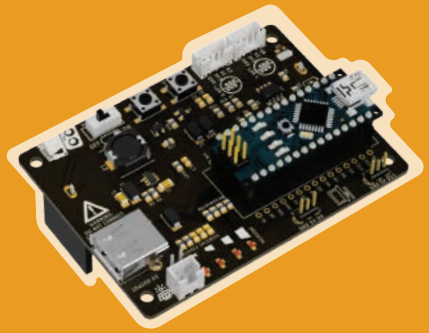
Circuit Setup



Robotistan Nano Microcontroller Board

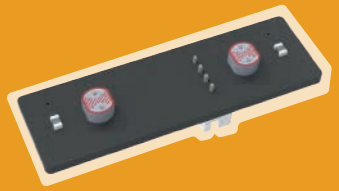


SolarX Main Board:



SolarX Main Board is a development board that uses the Robotistan Nano microcontroller. Thanks to this card, electronic circuit elements in Robotistan SolarX are easily connected to the connector on the card with the help of a single cable. In this way, the circuit setup becomes very easy.

LDR (Light Sensor):



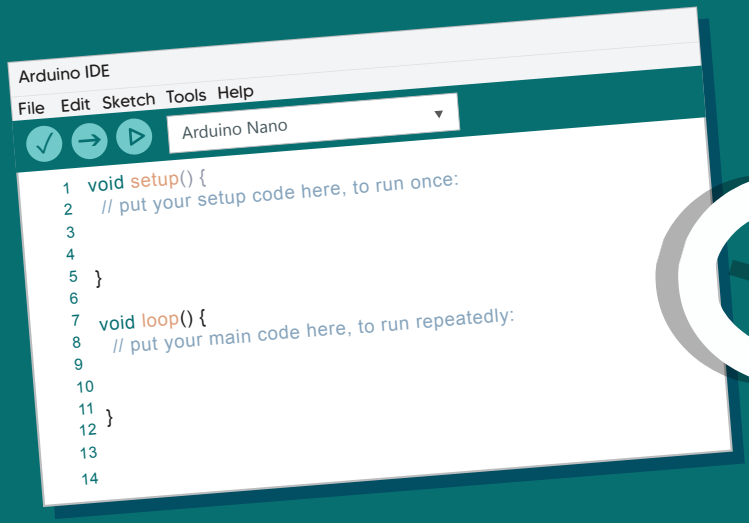
The light sensor or light dependent resistor is an electronic component that measures the amount of light in the environment. It changes the resistance value inversely to the amount of light falling on it. For example, as the amount of light increases, the resistance value decreases.

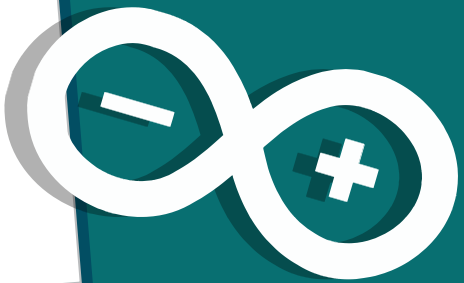
Solar Panel:

Solar panels, also called photovoltaics, absorb energy from the Sun and convert it into electricity.

Servo Motor:

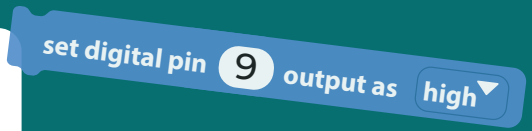
Servo motors are motors that provide angular movement (0-180). Servo motors can move according to the given angle value and stay fixed at that angle value.





Coding with Robotistan SolarX and Installing Steps

The SolarX code comes preloaded to the Arduino Nano, which is included in the kit. SolarX will run automatically when you complete the kit installation and power up the circuit.



Arduino Installing Steps

The SolarX STEM kit is a customizable kit. After making the necessary Arduino IDE connections, you can add some different features for SolarX by making some changes in the code or writing a new code.

You can develop the code of the SolarX STEM kit after making the following Arduino connections.

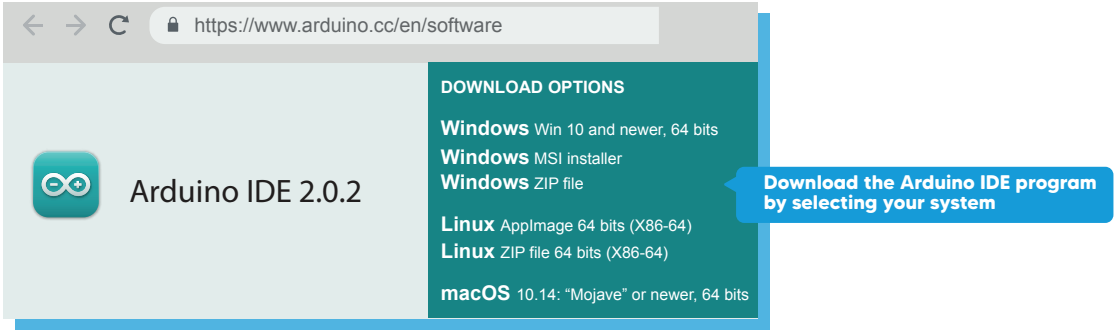
Coding with Arduino

What is Arduino?

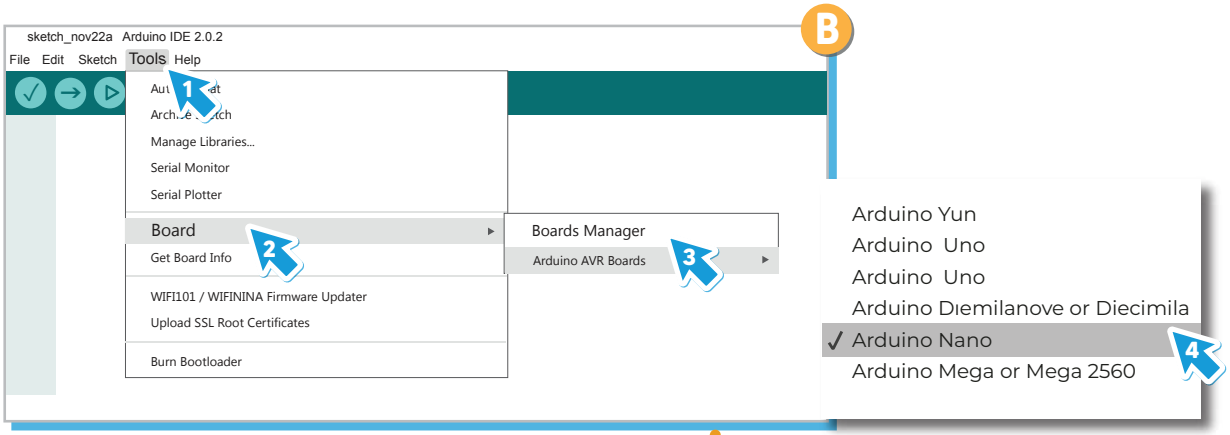
The Integrated Development Environment (IDE) for Arduino is a cross-platform application written in C and C++ languages (for Linux, macOS, Windows). It is used to write and upload programs to Arduino compatible boards, but can also be used in 3rd party cores and vendor development boards.

How to Use Arduino IDE?

A Let's open https://www.arduino.cc/en/software in the browser.



B



Arduino Sample Code for Robotistan SolarX

rbt.ist/solarxv2arduino

Scan the QR code to go to the whole code and the necessary libraries.

solarx | Arduino IDE 2.1.1

File Edit Sketch Tools Help

Arduino Nano

solarx.ino

```ino
#include <Servo.h>

#define STEP_DELAY 15
//Pin Definations of LEDs
#define led1 4
#define led2 5
#define led3 6
#define led4 7

int BUTTON_PIN = A2;
int buttonState = 0;
int solar_mode = 1;

int TOLERANCE = 15;

Servo servohori;
int servoh = 0;
int servohLimitHigh = 170;  //Maximum Limit Of Horizontal Servo
int servohLimitLow = 20;    //Minimum Limit Of Horizontal Servo

Servo servoverti;
int servov = 0;
int servovLimitHigh = 170;  //Maximum Limit Of Vertical Servo
int servovLimitLow = 30;    //Minimum Limit Of Vertical Servo

//Pin Definations of LDRs
int ldrtopr = A4;  //Top R LDR
int ldrbotr = A3;  //Bottom R LDR
int ldrtopl = A1;  //Top L LDR
int ldrbotl = A0;  //Bottom L LDR

void setup() {
  pinMode(led1, OUTPUT);
  pinMode(led2, OUTPUT);
  pinMode(led3, OUTPUT);
  pinMode(led4, OUTPUT);

  servohori.attach(11);
  servohori.write(90);
  delay(1500);
  servoverti.attach(9);
  servoverti.write(90);
  Serial.begin(9600);

  pinMode(BUTTON_PIN, INPUT_PULLUP);
}

void loop() {
  delay(20);
  buttonState = digitalRead(BUTTON_PIN);
  if (buttonState == LOW) {
    digitalWrite(led1, LOW);
    digitalWrite(led2, LOW);
    digitalWrite(led3, LOW);
    digitalWrite(led4, LOW);
    delay(50);
    if (solar_mode == 1) {  //Start Position
      for (int i = 0; i < 3; i++) {
        digitalWrite(led1, HIGH);
        delay(300);
        digitalWrite(led1, LOW);
        delay(300);
      }
      servohori.attach(11);
      servohori.write(90);
      delay(1500);
      servoverti.attach(9);
      servoverti.write(90);
      solar_mode++;
    } else if (solar_mode == 2) {  //Sunlight Position
      TOLERANCE = 3;
      for (int i = 0; i < 3; i++) {
        digitalWrite(led1, HIGH);
        digitalWrite(led2, HIGH);
        delay(300);
        digitalWrite(led1, LOW);
        digitalWrite(led2, LOW);
        delay(300);
      }
      solar_mode++;
    } else if (solar_mode == 3) {  //Flashlight Position
      TOLERANCE = 20;
      for (int i = 0; i < 3; i++) {
        digitalWrite(led1, HIGH);
        digitalWrite(led2, HIGH);
        digitalWrite(led3, HIGH);
        delay(300);
        digitalWrite(led1, LOW);
        digitalWrite(led2, LOW);
        digitalWrite(led3, LOW);
        delay(300);
      }
      solar_mode = 1;
    }
  }

```

```
  int solarvalue = analogRead(A6);
  int batvalue = analogRead(A7);
  float voltage = batvalue * (10 / 1024.0);

  //Capturing Analog Values Of Each LDR
  int topl = analogRead(ldrtopl);
  int topr = analogRead(ldrtopr);
  int botl = analogRead(ldrbotl);
  int botr = analogRead(ldrbotr);

  //Calculating average of LDR
  int avgtop = (topl + topr) / 2;    //average of top LDRs
  int avgbot = (botl + botr) / 2;    //average of bottom LDRs
  int avgleft = (topl + botl) / 2;   //average of left LDRs
  int avgright = (topr + botr) / 2;  //average of right LDRs


  //Power Measure
  if (voltage <= 3.3) {  //%0 - %20
    digitalWrite(led1, LOW);
    digitalWrite(led2, LOW);
    digitalWrite(led3, LOW);
    digitalWrite(led4, HIGH);
    delay(500);
    digitalWrite(led4, LOW);
    delay(500);
  } else if (voltage > 3.3 && voltage <= 3.5) {  //%20 - %40
    digitalWrite(led1, LOW);
    digitalWrite(led2, LOW);
    digitalWrite(led3, LOW);
    digitalWrite(led4, HIGH);
  } else if (voltage > 3.5 && voltage <= 3.75) {  //%40 - %60
    digitalWrite(led1, LOW);
    digitalWrite(led2, LOW);
    digitalWrite(led3, HIGH);
    digitalWrite(led4, HIGH);
  } else if (voltage > 3.75 && voltage <= 4) {  //%60 - %80
    digitalWrite(led1, LOW);
    digitalWrite(led2, HIGH);
    digitalWrite(led3, HIGH);
    digitalWrite(led4, HIGH);
  } else if (voltage > 4) {  //%80 - %100
    digitalWrite(led1, HIGH);
    digitalWrite(led2, HIGH);
    digitalWrite(led3, HIGH);
    digitalWrite(led4, HIGH);
  }
```

```
  //MOVE - TOP & BOTTOM
  servov = servoverti.read();

  if (avgbot - avgtop > TOLERANCE) {
    if (servov <= servovLimitLow) {
      servov = servovLimitLow;
    } else
      servoverti.write(servov - 1);


  } else if (avgtop - avgbot > TOLERANCE) {
    if (servov >= servovLimitHigh) {
      servov = servovLimitHigh;
    } else
      servoverti.write(servov + 1);
  }
  else {
    delay(5);
  }
  delay(STEP_DELAY);

  //MOVE - RIGHT & LEFT
  servoh = servohori.read();

  if (avgleft - avgright > TOLERANCE) {
    if (servoh >= servohLimitHigh) {
      servoh = servohLimitHigh;
    } else
      servohori.write(servoh + 1);
  } else if (avgright - avgleft > TOLERANCE) {
    if (servoh <= servohLimitLow) {
      servoh = servohLimitLow;
    } else
      servohori.write(servoh - 1);
  } else {
    delay(5);
  }
  delay(STEP_DELAY);
}
```

Block Based Sample Code for Robotistan SolarX

What is Block Based Coding?

Block coding turns programming into a drag-and-drop process by converting text based code into visual blocks. Each block contains real code and when they're combined together, they create animations and games. No matter which block-based programming language you're using, they all have a variety of different blocks that perform different key coding functions.

Solar X can be programmed using block programming editors like mBlock.

What is mBlock?

mBlock is designed for the Science, Technology, Engineering, Arts and Mathematics (STEAM) education. Inspired by Scratch 3.0, it supports both graphical and textual programming languages. Currently, more than 10 million people are using it to learn programming, create their own projects, and share their creations. With mBlock, you can design engaging stories, games, and animations, and program devices such as Makeblock robots and microbit. On mBlock, you can switch to the Python mode simply with one-click. In addition, mBlock integrates cutting-edge technologies including Artificial Intelligence (AI) and Internet of Things (IoT).

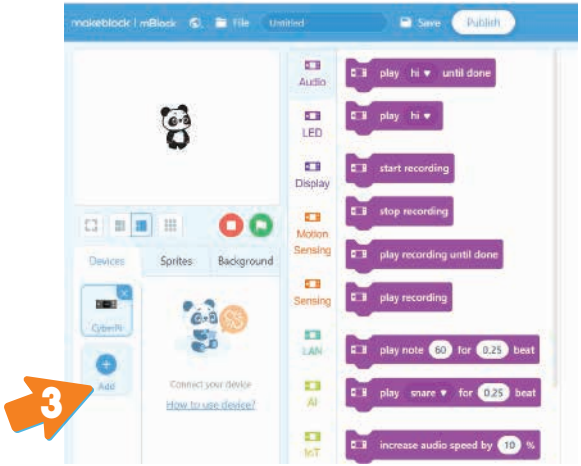
mBlock provides two editors, namely the block-based editor and Python editor.
The block-based editor is the default editor of mBlock .

How to Use mBlock?

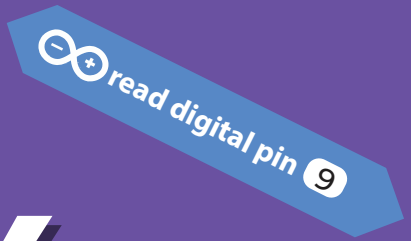
Information Box: Scan the QR code to Download the Offline Editor.

https://www.mblock.cc/en/download/


mblock.cc/en/
1
makeblock | mBlock
Educator
Community
Developer
Help
Download
makeblock
English
Compare code and blocks side-by-side
Code with robots
Learn AI
Code with blocks
2

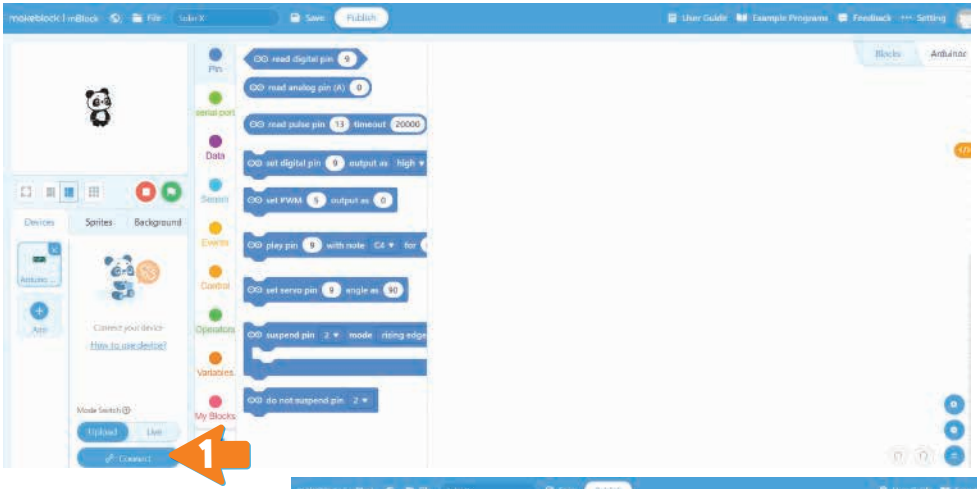

makeblock | mBlock
File
Untitled
Save
Publish
Audio
LED
Display
Motion Sensing
Sensing
LAN
AI
IoT
play hi until done
play hi
start recording
stop recording
play recording until done
play recording
play note 60 for 0.25 beat
play snare for 0.25 beat
increase audio speed by 10 %
Devices
Sprites
Background
CyberPi
Add
Connect your device
How to use device?
3

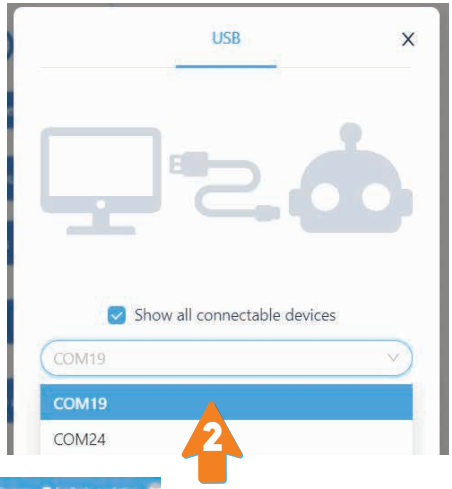

Arduino Nano
Device Library
All
Official development
Non-official development
Arduino Nano
Arduino Nano (old)
Arduino Nano
Arduino Nano
4
5
Cancel
OK

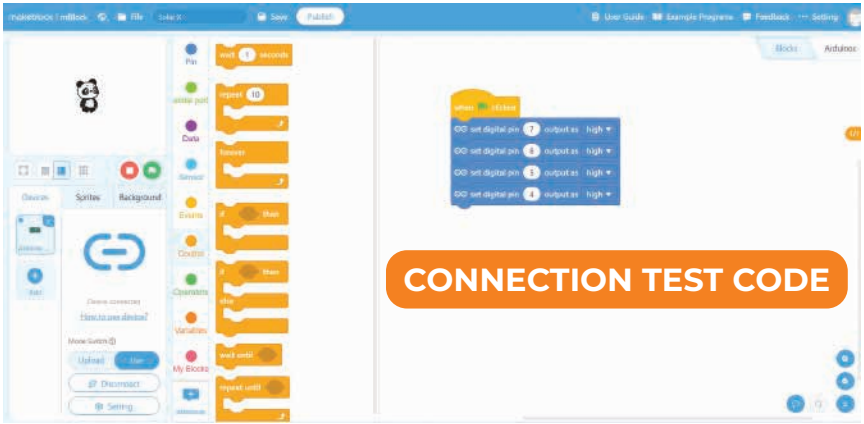


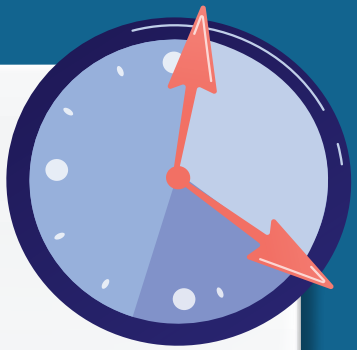
SolarX mBlock Code

rbt.ist/solarxv2mblock

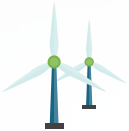

1


USB
Show all connectable devices
COM19
COM19
COM24
2


CONNECTION TEST CODE



Unplugged STEM Activities



Unplugged STEM Activity 1

- Match energy sources with the right type of energy.

Natural Gas - Geothermal Energy - Oil - Coal - Solar Energy - Wave Energy - Biomass Energy
Wind Energy

RENEWABLE	NON-RENEWABLE

Unplugged STEM Activity 2

- Match the sensors with their descriptions.

It is the sensor that allows us to detect the amount of light in the environment.	○	○	 Solar Panel
It is the microcontroller board used in SolarX.	○	○	 LDR (Light Sensor)
It is a circuit element that provides angular movement.	○	○	 Servo Motor
It is a board designed to easily communicate with SolarX circuit elements.	○	○	 Robotistan SolarX Main Board
It is a circuit element that converts solar energy into electrical energy.	○	○	 Battery
It stores the generated electrical energy.	○	○	 Robotistan Nano

Unplugged STEM Activity 3

Renewable / AC / Inverter / Heat / Servo Motor / 2 / Electrical / LDR (Light sensor) / non-renewable energy / INPUT

- Solar energy is used for the generation of electricity and _____ generation.
- SolarX only generates _____ energy.
- SolarX moves on _____different axes.
- The circuit element that provides the movement in SolarX is the _____ .
- _____ detects the amount of light in the environment.
- Solar energy is one of the _____ sources.
- In order to use the energy obtained from solar panels in our home, we need to convert DC current to _____ current.
- The light sensor (LDR) is an _____ circuit element.
- _____ , is the type of energy obtained from natural resources that can be depleted with use.
- Energy from solar panels is stored in _____.

- Explain the difference between renewable and non-renewable energy sources?

_____

_____

_____

Unplugged STEM Activity 3

- True (T) or False (F)
  - Oil is a renewable energy source. (__)
  - Energy obtained from sustainable natural sources is called renewable energy. (__)
  - The relationship between the light sensor and the applied resistance is inversely proportional. (__)
  - Servo motors can move 360 degrees. (__)
  - The solar panel absorbs the sun's rays thanks to the photovoltanic cells on it. (__)

- Give 4 examples of places where solar energy is used.

_____

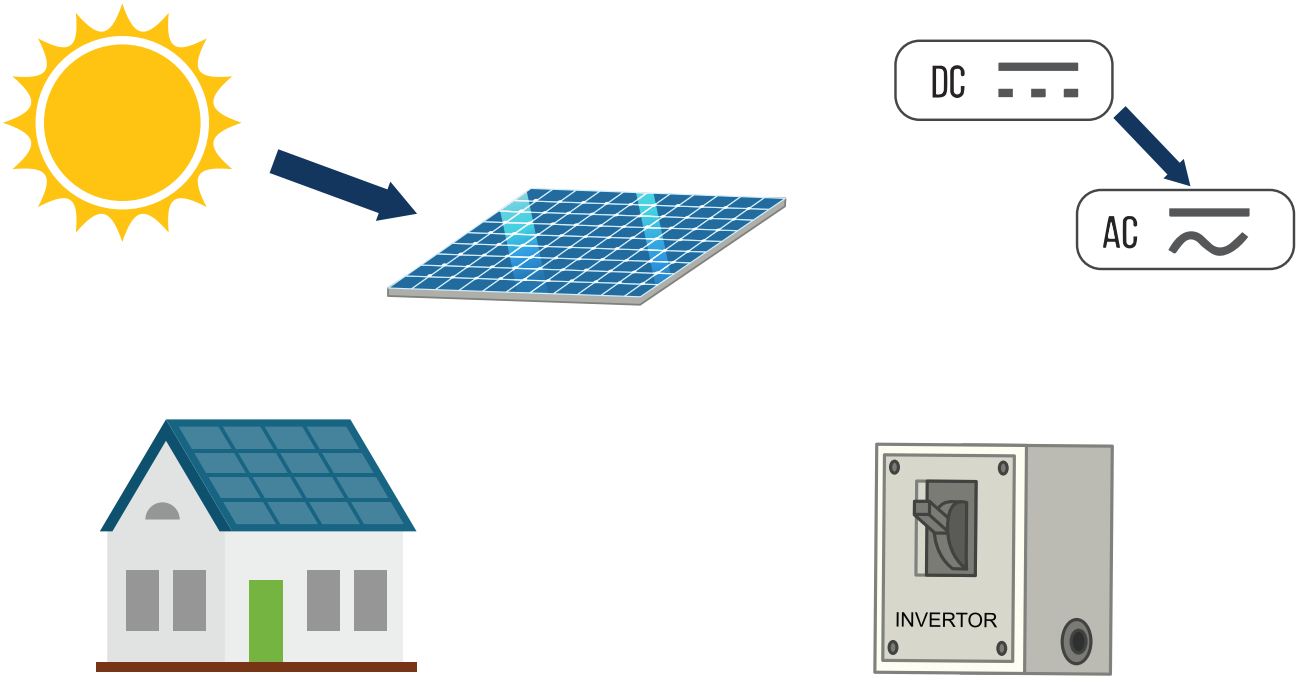
_____

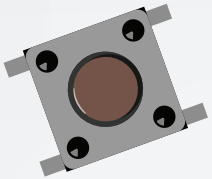
_____

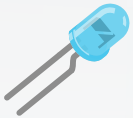
_____

Unplugged STEM Activity 4

- Explain the diagram that explains the working principle of Solar Panels with the help of arrows as given in the example.



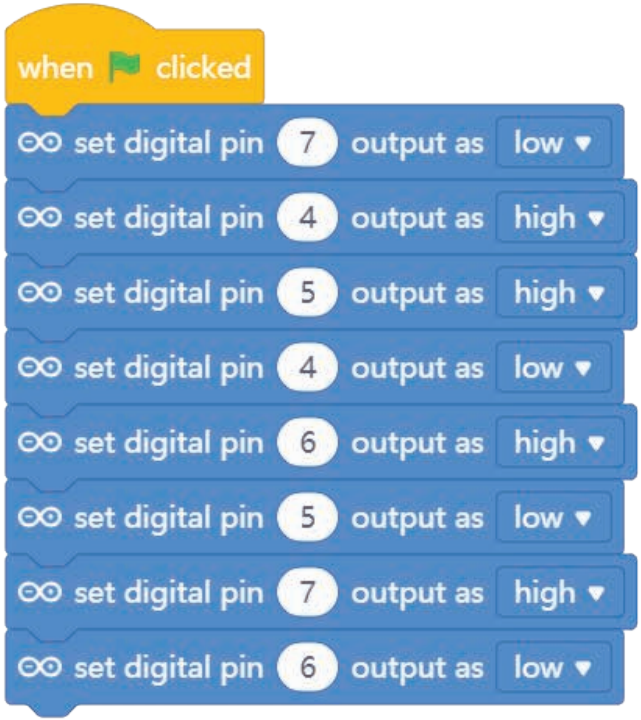



Computing STEM Activities



Computing STEM Activity 1: Solar X LED Salutation



Computing STEM Activity 2: Solar X Servo Salutation

Computing STEM Activity 3: X Axis Control

- Watch the movement of the servos by varying the amount of light in the environment.

Computing STEM Activity 4: Y Axis Control

- Watch the movement of the servos by varying the amount of light in the environment.

Sample Questions

- What is the relationship between the amount of light detected by LDR sensor and the resistance value?
- How does going solar help the environment?
- Will solar panels generate electricity on cloudy or rainy days?
- Do solar panels need cleaning?
- Does the angle of the solar panel matter? If it is important, why is it important?

Educational Achievements

SolarX is a STEM activity kit developed for using in STEM activities. The teachers can develop STEM projects by using this kit in their lessons. SolarX and its education booklet include the following achievements. The student,

- can set up SolarX by using the user manual,
- can write some project code by using Arduino IDE programming environment,
- can generate own code in the Arduino IDE,
- can write some project code by using mBlock IDE programming environment,
- can generate own code in the mblock IDE,
- understands the working logic of light sensor (LDR),
- understands the working logic of servo motor,
- can write C code with light sensor(LDR) and servo motor, and have some knowledge about renewable energy sources.
- Understands the working logic of Solar Panels.

Answer Key

Unplugged STEM Activity 1

RENEWABLE

- Geothermal Energy
- Solar Energy
- Wave Energy
- Biomass Energy
- Wind Energy

NON-RENEWABLE

- Natural Gas
- Oil
- Coal

Unplugged STEM Activity 2

- Solar Panel: It is a circuit element that converts solar energy into electrical energy.
- LDR (Light Sensor) : It is the sensor that allows us to detect the amount of light in the environment
- Servo Motor: It is a circuit element that provides angular movement.
- Main Board: It is a board designed to easily communicate with SolarX circuit elements.
- Battery:It stores the generated electrical energy.
- Arduino Nano: It is the microcontroller board used in SolarX.

Answer Key

Unplugged STEM Activity 3

1- Heat
2- Electric
3- Servo
4- 2
5- LDR (Light Sensor)
6- Renewable
7- AC
8- INPUT
9- non-renewable-energy
10-Inverter

True (T) or False (F)

- False
- True
- True
- False
- True

- Explain the difference between renewable and non-renewable energy sources?

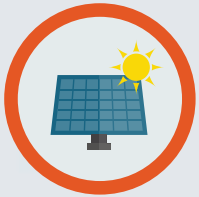
_____

- Give 4 examples of places where solar energy is used.

_____

SolarX

Solar Tracking System



GitHub

Shop Robotistan

This product may contain small parts and could be hazardous for children aged 0-7. Children should use this product under adult supervision.

robotistan