Stewards Pooi Kei Primary School

STEM Project
Solar Energy
Aims of the project

1. Recognise the factors affect the efficiency of conversion of solar energy into electrical energy by solar panels set-up to generate voltage with a closed circuit (Engineering). Use voltmeters and hence use micro:bits with coding to measure voltages generated by the solar panels set-up (Technology).

2. Predict, measure, record (Mathematics), identify variables and infer the conclusion from the facts (Science).

3. Try to improve the set up of solar panels to maximise the voltages generated.

4. Understand the use of solar panels in our daily life.

Name: _____ (   )

Class: J. 6 _____

Introduction

Solar energy

Solar energy is a clean and renewable energy source. A photovoltaic cell or solar cell is a device that collects and converts the energy of light directly into electricity. Photovoltaic cells with a larger light-receiving area are called "solar panels". Conventional photovoltiac cells range in energy conversion efficiencies from 10% to 25%.

Types of light received by solar panels

- Direct beam: direct beam comes from the sun directly. Installing a solar tracker on the solar panel increases the amount of sunlight received through orienting the panel towards the sun.

- Diffuse sunlight: Diffuse sunlight comes from everywhere and is reflected off the atmosphere, the ground or other objects.

Types of solar panels

- **PV Type:** Mono-crystalline (Crystalline)

  Cell efficiency: 20% - 25%

- **PV Type:** Poly-crystalline (Crystalline)

  Cell efficiency: 10% - 24%

- **PV Type:** Amorphous silicon (Thin-film)

  Cell efficiency: 6% - 9%

Solar energy in Hong Kong

Solar energy potential in a given location is mainly determined by blockage which refers to buildings or objects located directly in the sun's path. Even temporary blockage of sunlight limits the number of hours and days of solar energy in a year.

Solar energy potential is the highest in the summer and in average this figure is relatively steady over the course of a year in Hong Kong.

For the best results, position the solar energy equipment at an elevated angle of $22.5°$ facing south in Hong Kong.

Solar Panels in Stewards Pooi Kei Primary School

Solar panels are installed on the roof of our campus. They generate electrical energy to provide electricity for the lights along the corridors. Our school invites all J6 students to investigate factors to affect energy conversion efficiency of solar panels and hence to design the set up to maxmise the energy conversion efficiency

Self Pre-learning

1. Solar energy contains h_____ and l_____ energy.

2. How is solar energy converted by solar panels?

   _____ energy of solar energy is converted into _____ energy.

3. What are the advantages of using solar panels? (any 2 examples)

   _____

4. What are the disadvantages of using solar panels? (any 2 examples)

   _____

5. What factors affect the solar energy conversion efficiency of solar panels?

   _____

   _____

> **Inquiry question:** Which factors affect energy conversion efficiency of solar panels?
>
> **Materials:** solar panel(2), voltmeter(1), electric wire(3), lamp(1), black craft paper (1), white A4 paper(1), protractor(1), ruler(1)

Hypothesis: More solar panels used, the higher the voltages generated.

Prediction

Which closed circuit will generate a higher voltage? (Put a "✓" in appropriate box(es))

☐ one solar panel	☐ two solar panels (connection 1)	☐ two solar panels (connection 2)
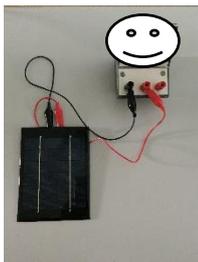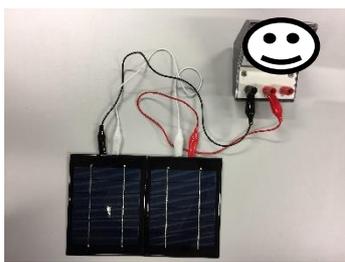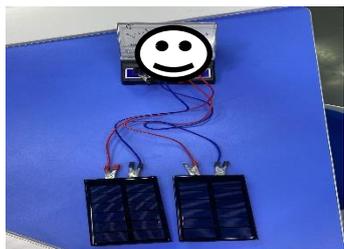
In the fair test, which of the following factors are needed to **be changed, be measured or remain unchanged**? (Put a "✓" in appropriate box(es))

Unique factor to be **changed** (independent variable)	☐ Number of solar panels used ☐ Voltage generated
Factor to be **measured** (dependent variable)	☐ Number of solar panels used ☐ Voltage generated
Factor(s) remains **unchanged** (controlled variable)	☐ Type of solar panels ☐ Type of the lamp ☐ Type of the voltmeter

Measure the voltage generated by solar panel(s) under the light source (lamp) and **record** it in the following table. Repeat the test three times.

Results

Background voltage = _____ V

Volt(s) / V Solar panel(s)	Voltage (1)	Voltage (2)	Voltage (3)	Average voltage*	Net voltage ^
One solar panel					
Two solar panels (1)					
Two solar panels (2)					

* Average voltage = (Voltage (1) + Voltage (2)+ Voltage (3))÷3

^ Net voltage = Average voltage – Background voltage

Questions

From the results, which closed circuit will generate a higher voltage? Why?

_____

_____

Did two solar panels connected to the closed circuit to generate two times of voltage that of one solar panel?   Why?

_____

_____

What are the other factors affecting energy conversion efficiency of solar panels?

Hypothesis:_____

Prediction

Which closed circuit will generate a higher voltage? (Put a "✓" in appropriate box(es))

☐	☐	☐

Measure the voltage generated by solar panel under the light source (lamp) and **record** it in the following table. Repeat the test three times.

Results

Background voltage = _____ V

Volt(s) / V Solar panel(s)	Voltage (1)	Voltage (2)	Voltage (3)	Average voltage	Net voltage

Questions

From the results, which closed circuit will generate a higher voltage? Why?

_____

_____

_____

_____

In the above results and peer evaluations, which factor is the most important in the energy conversion efficiency by the solar panels?   Why?

_____

_____

According to the results of activities, try to **design the set-up** to facilitate one solar panel having the highest energy conversion efficiency (voltage) according to the findings.   Draw and elaborate it.

_____

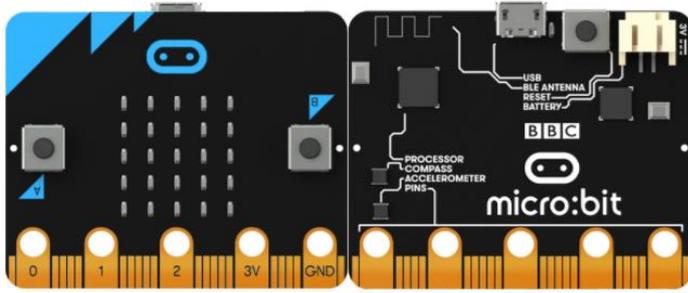_____

_____

Results

Background voltage = _____ V

Volt(s) / V Solar panel(s)	Voltage (1)	Voltage (2)	Voltage (3)	Average voltage	Net voltage
_____°C					

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Advanced STEM Activity

With the knowledge of closed circuit and the coding, we try to code the program to the micro:bit and measure the voltage generated by the solar panels.


```
forever
    show number   analog read pin  P0 ▼   × ▼   -0.0008   + ▼   3.8989
```

Volt(s) / V Solar panel(s)	Voltage (1)	Voltage (2)	Voltage (3)	Average voltage	Net voltage
Voltmeter					
Micro:bit					

Questions

What is the difference between the data collected by the voltmeter and the micro:bit?

_____

_____

Can we use the solar panels to provide the electricity for the operation of micro:bit?

Why?

_____

_____

Self evaluation

Colour the suitable stars.

	Very agree	Agree	Disagree	Very disagree
1. I can gain more knowledge about the energy conversion efficiency of solar panels.	☆	☆	☆	☆
2. I can improve the set up of solar panels to maximise the voltages generated.	☆	☆	☆	☆
3. My interest in learning science has increased.	☆	☆	☆	☆

Reference books

➢ Photovoltaics : design and installation manual / Solar Energy International.

➢ Consumer guide to solar energy : easy and inexpensive applications for solar energy

➢ 3 小時讀通太陽能電池

➢ 太陽電池 (未來能源的終極王牌, 太陽光發電技術)