Learning about: Solar power

Introduction to solar panels

Sun is Earth's ultimate power supply since the birth of our solar system. Its distance from earth and the provision of massive constant energy create the perfect conditions for sustaining life. People came up with an ingenious way to harness this energy and convert solar energy into electricity by using solar panels.

Discover:

- How do solar panels work?
- How does weight affect speed?
- What is the effect of connecting two or more solar panels together?

Level Of Difficulty ★★★★☆

Materials Needed:
- Engino® Solar power (STEM30).
- Stopwatch, measure tape, big stapler.

Procedure:

1. Find the instructions online and build the **solar chopper car** model.

2. Find a sunny spot outdoors and mark a distance of 1m using your measure tape.

3. For **test 1**, place the model at the starting point and switch on the motor. With the help of a stopwatch count how much time (in seconds) it takes for the chopper car to cover the distance of 1m. Complete the "Time" column in (1a).

4. Repeat the same procedure for (1b) and (1c) and complete the table. Then calculate the average time (in seconds) by adding the three measurements and dividing by 3. Write your answer in the "Average time" column for test 1.

5. For **test 2**, add a relatively large weight (e.g. 1-2 big staplers) on the cabin of the model (above the motor). Repeat the same procedure as before, for the same distance of 1m and complete (2a), (2b) and (2c). Then calculate again the average time for test 2.

6. For **test 3**, remove the weight and cover half of the surface of the panel as shown in test 3. Count the times again for the same distance and calculate their average.

7. Based on the experiment's results, answer **questions 2, 3** and **4**. While making your calculations, keep in mind that distance (S) is always 1m.

1. Complete the "Time" column in seconds according to your measurements and calculate the average time for each test.

Test	Time (seconds)	Average time (seconds)	Model modification
1	(a)	7.18	
	(b)		
	(c)		
2	(a)	10.32	
	(b)		
	(c)		
3	(a)	9.51	
	(b)	*Note that numbers may vary, but the trend should remain the same.*	
	(c)		

2. Compare the average times of tests 1 and 2. What is your conclusion about the **effect of the weight** on the car's speed?

*In test 2 the model needed more average time (10.32 s) to travel the distance of 1m than in test 1 (7.18 s). This means that the added **weight reduces the speed** of the car.*

3. Compare the average times of tests 1 and 3. What is your conclusion about the **effect of covering half of the area of the solar panel** on the car's speed?

In test 3 the model needed more average time (9.51 s) to travel the distance of 1m than in test 1 (7.18 s). This means that covering half of the area of the solar panel reduces the speed of the car.

4. Use distance (S) to average time (T) ratio in order to calculate the **average velocity U** (speed) of your model for each test.

Test 1: $U_1 = \frac{S}{T_1} = \frac{1}{7.18} \Rightarrow U_1 = 0.14$ m/s

Test 2: $U_2 = \frac{S}{T_2} = \frac{1}{10.32} \Rightarrow U_2 = 0.10$ m/s

Test 3: $U_3 = \frac{S}{T_3} = \frac{1}{9.51} \Rightarrow U_3 = 0.11$ m/s

Learning about: Solar power

Solar panels' efficiency

There are various ways of harvesting the energy from the sun, depending on the type of the method used such as parabolic trough, disc or tower. All of them, though, are affected by two main factors: the amount of sunlight that hits the solar panels and the angle of the panels in respect to the sun.

Discover:

- How the efficiency of the solar panel is affected by the amount of sunlight?
- How the angle of the solar panel in respect to the sun affects its efficiency?

Level Of Difficulty ★★★☆☆

Materials Needed:
- Engino® Solar power (STEM30).
- Stopwatch, cardboard paper and sticky tape.

Procedure:

1. Find the instructions in pages **21-24** and build the **solar fan** model.

2. Choose an appropriate time to carry out the experiment, when the sun is at its highest point. This is when the shadows of objects become the smallest during the whole day.

3. For **Test 1**, the solar panel will be at an **angle of 45 degrees in respect to the ground** (as shown in the table). So, if the sun is at its highest point, the panel also forms an angle of 45 degrees with the sun.

4. For **case (a)**, cover 2/3 (66%) of the solar panel by sticking a cardboard paper with tape, as shown in the next table. Place the model in a sunny spot, start your stopwatch and count how many complete revolutions the fan makes in **1 minute**. These are called **revolutions per minute**, **RPM** for short.

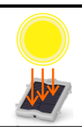
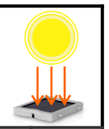
5. Count again the rpm for **case (b)**, where the panel is covered by 1/3 (33%) and **case (c)**, where the panel is not covered.

6. For **Test 2**, reconnect the solar panel so that is placed parallel to the ground. This way, the panel becomes perpendicular to the sun.

7. Follow the same procedure as in test 1 and cover the solar panel by 66% for **case (d)**, 33% for **case (e)** and do not cover for **case (f)**. Use a stopwatch to count the rpm for each case and complete the table.

8. Compare the cases of each test in **question 2** and the tests with each other in **question 3**. Then complete **exercise 4**.

1. Complete the RPM columns according to your measurements.

Test 1: Solar panel placed in an angle of 45 degrees in respect to the ground and the sun. 			**Test 2: Solar panel placed parallel to the ground and perpendicular to the sun.** 		
Case	**Model setup (surface covered)**	**RPM**	**Case**	**Model setup (surface covered)**	**RPM**
(a)	 **66% covered**	12	(d)	 **66% covered**	28
(b)	 **33% covered**	24	(e)	 **33% covered**	38
(c)	 **not covered**	36	(f)	 **not covered**	44

2. Compare cases (a), (b) and (c) of test 1 together and cases (d), (e) and (f) of test 2. What do you observe? What factor affects the efficiency of the solar panel?

*When the solar panel is not covered (cases c and f) the fan makes more revolutions per minute. This shows that **the more surface of the panel is facing the sun, the more energy is produced**.*

3. Compare the results of test 1 with those of test 2. What other factor affects the efficiency of the solar panel?

*In test 2 the revolutions per minute are more than in test 1. This shows that **the solar panel is more efficient when is placed perpendicular to the sun** than placing it with a smaller angle.*

4. Describe briefly how photovoltaic power systems work, providing some examples.

*These systems use photovoltaic (solar) cells to convert sunlight directly into electricity due to the **photovoltaic effect**, as electrons on the panel become free when light hits it. Cells can be found in satellites on top of roof houses and even in pocket calculators.*

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