Solar Energy – Student Activity

Earth's resources are classified as renewable or non-renewable, according to the time they take to replenish. Resources are typically considered to be renewable if they replenish within a human lifespan. Some renewable resources are considered inexhaustible as they are perpetually being renewed. These resources can be used as renewable energies.

Solar energy is an example of a renewable energy resource. Solar energy is generated from nuclear fusion reactions within the Sun, emitted as electromagnetic radiation. This energy from the Sun can be collected by photovoltaic (PV) cells which then convert it to electricity. Household solar panels are comprised of many individual PV cells linked together.

ACTIVITY: The conversion of sunlight to electricity can be easily demonstrated via a flow diagram. Draw a diagram to show the steps in generating electricity from the Sun, including the following: inverter, sunlight, solar panel.

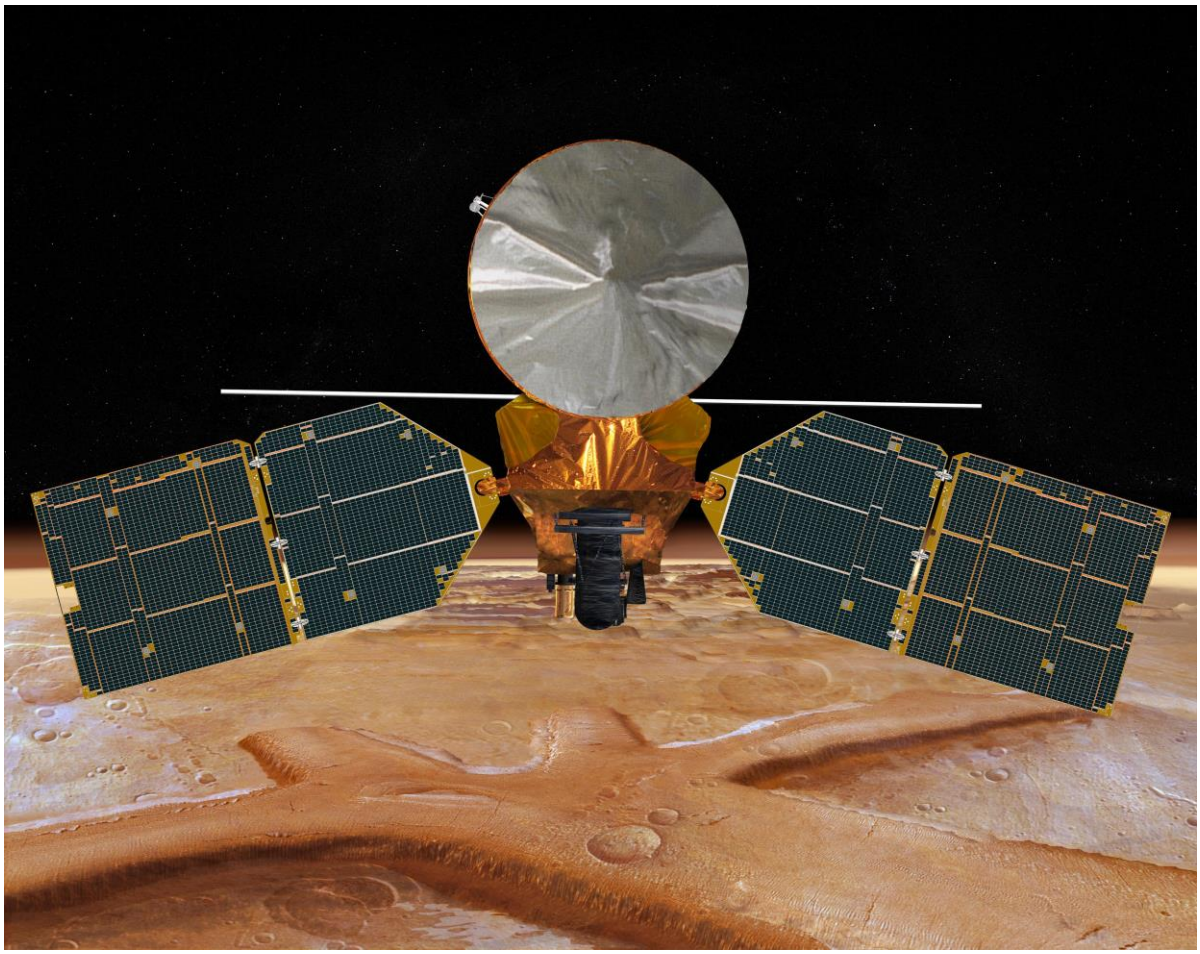
Complete the sentence:

The energy source is the _____. When the _____ falls onto the _____ _____ it is converted to electricity. The _____ changes the low voltage electricity generated from the _____ _____ into high voltage electricity used by appliances.

Solar Energy – Student Activity

Powering Space Exploration

Solar energy is a readily accessible source of power and is used extensively by the National Aeronautics and Space Administration (NASA) in space exploration. The Mars Exploration Rovers (MER) Spirit and Opportunity, and the Mars Reconnaissance Orbiter were all powered by huge solar panels which were designed to capture as much energy from the Sun as possible on Mars.



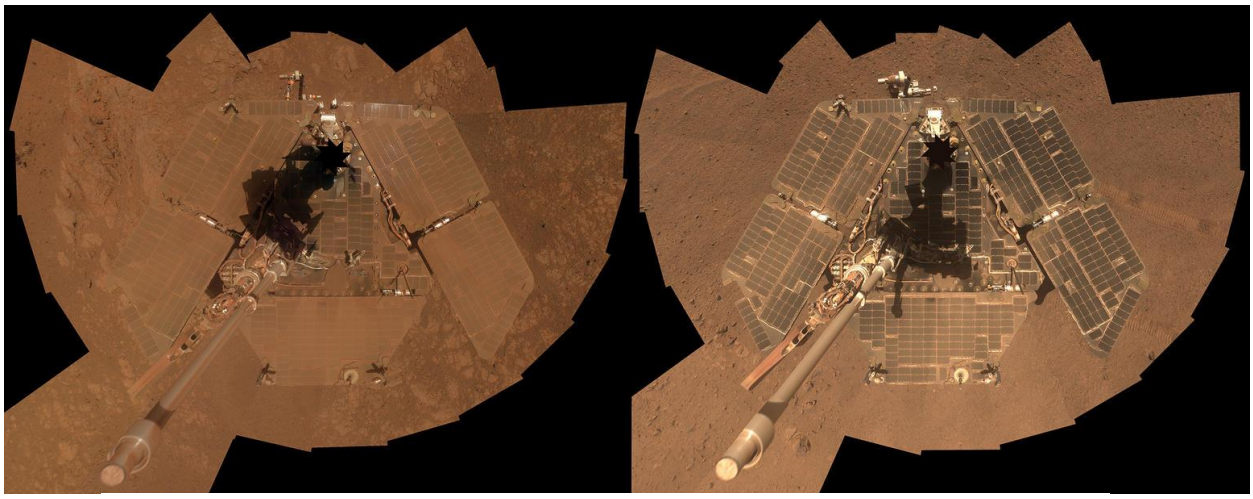
Sun-tracking solar panels on Mars Reconnaissance Orbiter
(Image credit. NASA/JPL-Caltech/Cornell Univ./Arizona State Univ.)

Maximum Efficiency

The Mars Exploration Rovers (MER) work remotely and must have the best technologies to ensure a continuous and reliable energy source. The images below show Opportunity in January and March 2014, before and after the rover's self-cleaning mechanism was able to remove a large amount of dust that accumulated on its solar panels on the Martian planet.

In 2018, the MER Opportunity was impacted by a massive global dust storm on Mars which blocked the rover's photovoltaics for a long time. Opportunity was unable to recharge, and in 2019 NASA officially declared the rover dead.

Solar Energy – Student Activity



MER Opportunity on Mars before (left) and after (right) self-cleaning the solar panels (Image credit NASA/JPL-Caltech/Cornell Univ./Arizona State Univ.)

Three main factors that can impede the intensity of sunlight reaching a solar panel are:

1. ***Blocking***
2. ***Angle***
3. ***Distance from the Sun***

ACTIVITY: Work through the activity steps to demonstrate how the angle of a light source changes the intensity of the light

1. Hold a torch directly above a sheet of graph paper so that it is at 90^0 to the paper
2. Trace around the area illuminated on the paper and count the number of squares that are lit up at this angle
3. Keeping the torch at the same distance from the paper, tilt it until it is at 45^0 to the paper
4. Trace around the area illuminated on the paper and count the number of squares that are lit up
5. Repeat Step 3, tilting the torch to approximately 10^0 to the paper. Measure the angle using a protractor for accuracy.

Table 1. Effect on the area of illumination as the angle of the light source changes

Angle of torch	No. squares illuminated	Observations
90^0		
45^0		
20^0		

Solar Energy – Student Activity

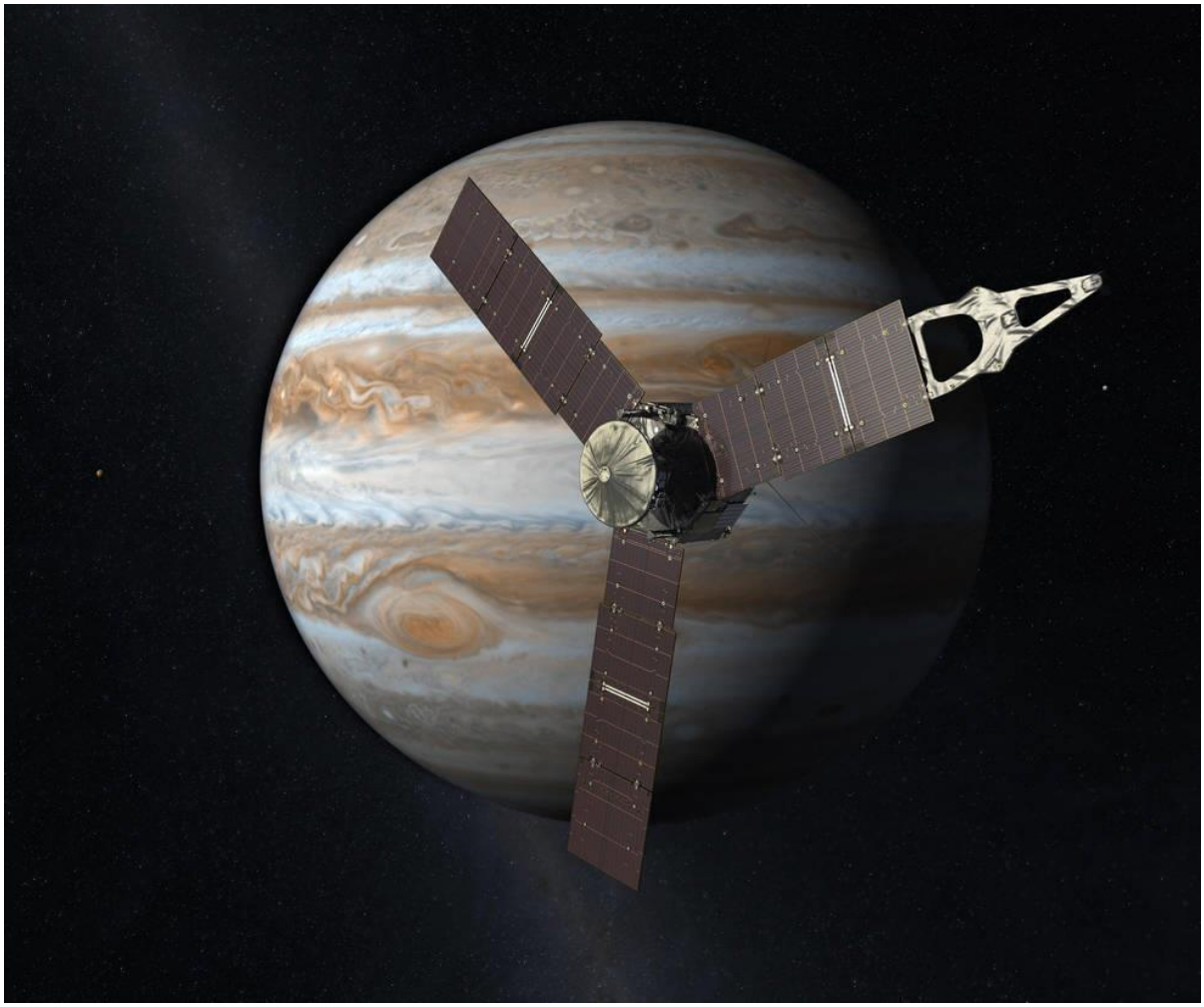
What do you observe about the number of squares that are illuminated as the torch angle changes?

_____

What do you observe about the intensity of the light as the torch angle reduces?

_____

Distance from the Sun places limitations on exploration by solar-powered spacecraft. NASA's Juno spacecraft is currently the most distant solar-powered craft, breaking records in 2017 when it reached 793 million kilometers from the Sun. As Juno uses the Sun as its energy source, the maximum distance it can travel is 832 million kilometres away. As a comparison, Earth is 149.6 million kilometres from the Sun.



The Juno spacecraft and Jupiter
(Image Credit: NASA/JPL-Caltech)

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ACTIVITY: Research the different ways you can measure the relationship between light intensity and distance. Design a simple experiment to compare these using the planning space below. Suggestions include using a light meter, light intensity app, digital camera, or to calculate using a light bulb of known wattage.

PLANNING

ACTIVITY: Complete the activity steps to explore how the angle of the Sun relative to a fixed solar panel changes throughout the year.

Table 2. Sun incident angle relative to the fixed solar panel and sunlight hours per day in PERTH, WESTERN AUSTRALIA

	1 Jan			1 Apr			1 Jul			1 Oct		
	9am	**12**	**3pm**	**9am**	**12**	**3pm**	**9am**	**12**	**3pm**	**9am**	**12**	**3pm**
Incident angle	50	25	50	45	3	45	48	21	48	42	6.5	49
Sunlight hours/day	14:03			11:35			9:57			12:17		

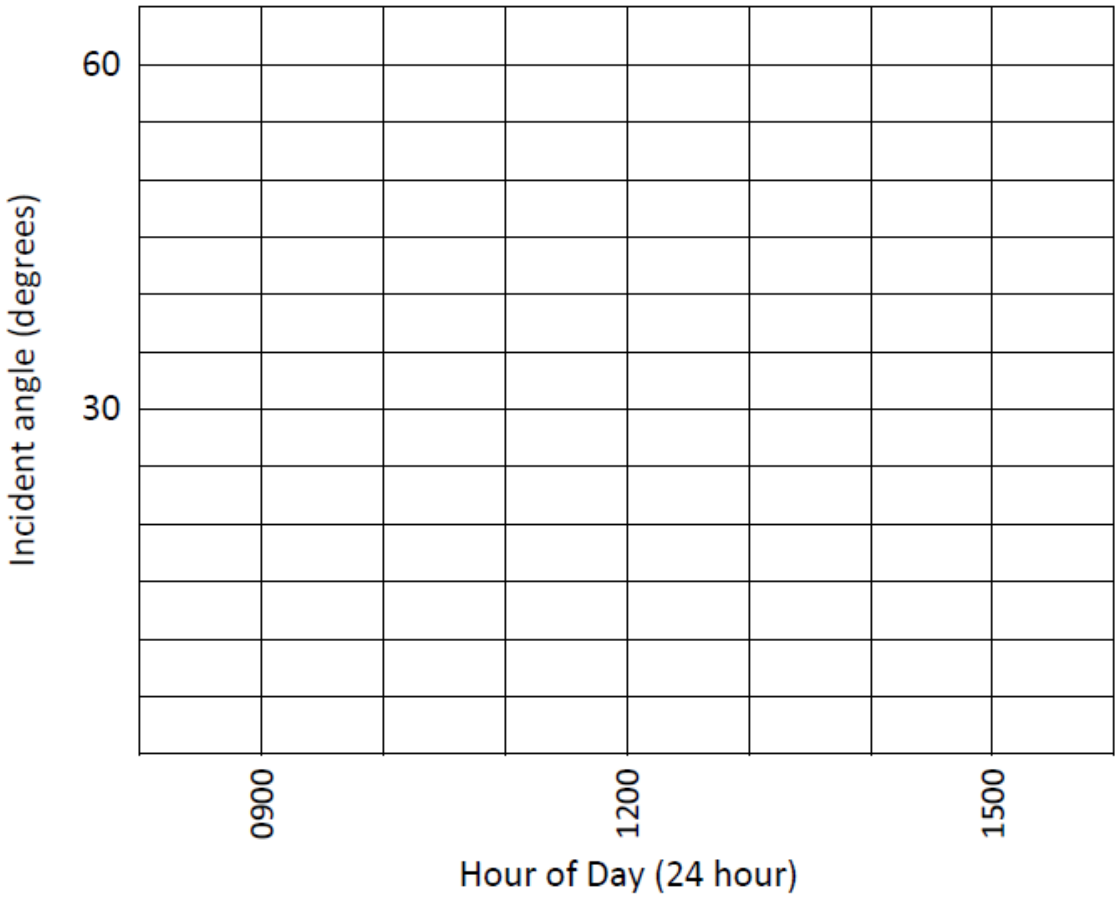
1. Table 2. shows the angle of the Sun at 9am, 12pm and 3pm in Perth, Western Australia on four different dates. Plot these points on the grid below using a different colour for each date. Remember to include a title and key on your graph. Note that the solar panels are tilted at an angle of 33^0 for maximum sunlight exposure, therefore a low incident angle means that the Sun is directly overhead the panels.

2. Interpret a curve for each date by joining up the points, using a different colour for each date. This will provide you with an indication of the path of the Sun and the angle of the sunlight through the year.

Solar Energy – Student Activity

GRAPH TITLE _____

KEY: JAN_____APR_____JUL_____OCT_____



From your graph, in which months does the incident angle reach its lowest point over the panels? These are the months when the maximum solar energy is captured by the fixed solar panels.

_____

Describe one factor that could affect the amount of sunlight reaching the panels during these months

_____

_____

Solar Energy – Student Activity

Based on your graph and on the number of sunlight hours recorded at different times of the year (Table 2), discuss the advantage of sun-tracking to maximise solar energy production.