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QUESTION

Yes or no? Do photovoltaic (PV) panels make more electricity when the day is hotter?

ANSWER

No

FACT

PV panels work more efficiently when they are cooler. This is why solar is so viable in northern latitudes—places like Germany and Canada—where strong production on clear winter days can help to make up for lower overall hours of sunlight.

QUESTION

Yes or no? Could a photovoltaic (PV) panel be tinted green?

ANSWER

Yes

FACT

Tinted polycrystalline and custom laminate photovoltaic panels can be made in a variety of colors and can even display a printed image!

QUESTION

Yes or no? Can a concentrated solar power plant provide energy 24 hours a day?

ANSWER

Yes

FACT

By storing heat in molten salt storage containers, steam turbines can be operated through the night using the collected heat from the previous day.

QUESTION

True or false? We can melt steel with solar power.

ANSWER

True

FACT

The Heliodyssee-Grand Four Solaire (solar furnace) in Odeillo, France (the Pyrénées) opened in 1970. The temperature at its focal point reaches 3,500°C (6,330°F), more than twice the melting point of steel.

QUESTION

Does the speed of wind increase or decrease as the space it flows through becomes constricted?

ANSWER

Increase

FACT

The Venturi effect explains how velocity increases when fluid flows through a constricted space. This effect can be used to increase the energy generated by wind turbines of similar diameters.

QUESTION

What year was the first recorded demonstration of concentrated solar power used to directly power refrigeration?

A. 1961 B. 1878 C. 2002

ANSWER

B. 1878

FACT

Augustin Mouchot and his assistant Abel Pifre won a Gold Medal at the 1878 Universal Exhibition in Paris for the production of ice using concentrated solar heat.

QUESTION

I live in Melbourne, Australia. What is the best side of my roof to use for solar panels?

North, South, East, or West?

ANSWER

North

FACT

Because Melbourne is in the southern hemisphere, the sun travels east to west always across the northern part of the sky.

QUESTION

What is another name for a solar panel?

A. Power light box B. Photovoltaic panel

C. Sun generator D. Becquerel's box

ANSWER

B. Photovoltaic panel

FACT

While Edmund Becquerel is the French physicist who is credited with discovering the photovoltaic effect in 1839, the solar panel isn't named after him. The unit of one "Becquerel" used to measure radioactivity is actually named after his son Henri who was also a physicist!

QUESTION

Yes or no? A renewable energy power plant can be a place where you take your family on a picnic.

ANSWER

Yes!

FACT

The Land Art Generator is working with people around the world to design our energy landscapes as beautiful public parks and reflections of culture.

QUESTION

True or false? We must choose between using land to grow food or using it to make energy.

ANSWER

False

FACT

Agrivoltaics is the combined land use of solar (photovoltaics) and agriculture. Studies have shown that crop yields can be increased by proper installation of solar modules over farmland, especially in arid regions. Wind farms are also perfectly suited to merge with agricultural and grazing land.

QUESTION

What mathematician is often called, "the father of modern optics?"

A. Christiaan Huygens B. Hasan Ibn al-Haytham C. Willebrord Snellius

ANSWER

B. Hasan Ibn al-Haytham

FACT

Born during the Islamic Golden Age, Ibn al-Haytham was the first to explain how vision occurs when light reflects from an object, passes in a straight line to one's eyes, and is processed in the brain.

QUESTION

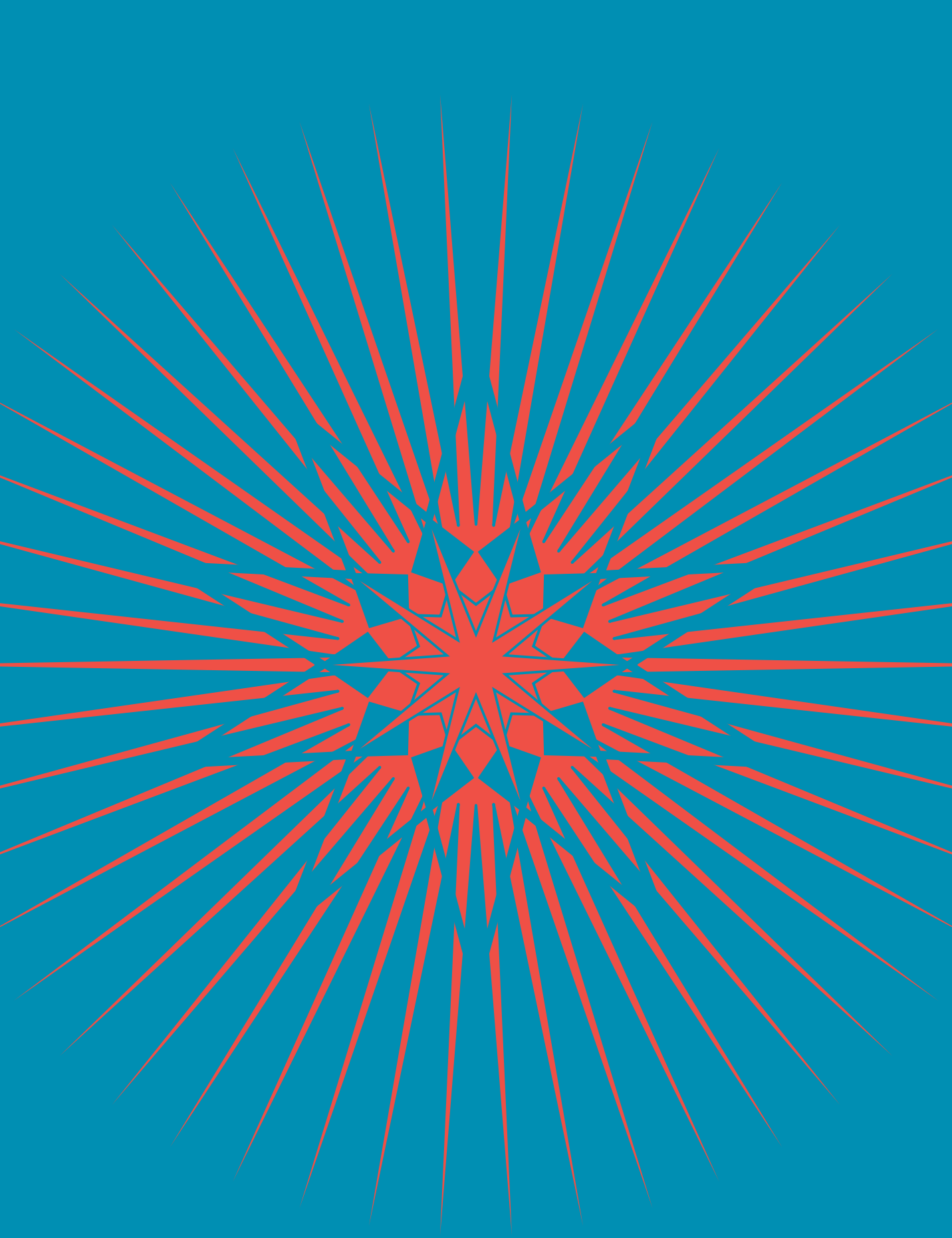
True or false? Organic photovoltaic (OPV) solar modules need to be directly facing the sun in order to generate electricity.

ANSWER

False

FACT

While standard PV panel energy production drops off rapidly when the sun is not directly facing the panel, OPV provides consistent energy production across a 150° range of angle. This means that they can be placed more creatively on an artwork like *Cloud Field*, by Ignacio Martí (see the puzzle).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QUESTION

True or false? A Stirling engine is made of 100% silver.

ANSWER

False

FACT

A Stirling engine is an external combustion engine that operates when a heat source is placed directly on the heat cylinder wall. It's named after Robert Stirling, the Scottish inventor. *Unexpected Scenarios*, by Riccardo Daniel, Kei Shiho, and Francesco Feltrin (see the puzzle) uses a Stirling engine to generate electricity from stored solar thermal energy.

QUESTION

True or false? The renewable energy sector creates more jobs in the United States than the fossil fuel energy sector.

ANSWER

True

FACT

According to U.S. Department of Energy data from 2017, for every 1 job in the fossil fuel sector, there are 2.5 jobs in the renewable energy sector.

QUESTION

Is light a particle or a wave?

ANSWER

It's both! You get this answer right no matter which you choose.

FACT

According to Albert Einstein, "We have two contradictory pictures of reality; separately neither of them fully explains the phenomena of light, but together they do."

QUESTION

True or false? Solar power is a renewable form of electricity.

ANSWER

True

FACT

The sun has been around for 4.5 billion years and has burnt up almost half of the hydrogen in its core. That means that we have 5 billion more years of sunshine left before the sun swallows the Earth as a red giant, at which point we won't be too worried about making clean electricity.

QUESTION

True or false? You can't bend a photovoltaic panel.

ANSWER

False

FACT

There are many kinds of flexible thin-film solar panels. Even monocrystalline silicon cells can be curved because the silicon wafers can be sliced very thin. Organic photovoltaic (OPV) is super flexible!

QUESTION

The equation for energy is

power × time = energy

If all the lights in my room add up to 100 watts (power) and I leave them on all year (8,760 hours), how much energy did I consume?

A. 876,000 watt-hours

B. 100,000 watt-hours

C. 8,760 watt-hours

ANSWER

A. 876,000 watt-hours

FACT

100 watts x 24 hours x 365 days = 876,000 watt-hours. Two solar panels might make that much electricity in one year.

QUESTION

According to the U.S. Fish and Wildlife Service, what is the greatest man-made cause of bird deaths?

A. Wind turbines B. Buildings

C. Fossil fuel oil pits, evaporation ponds, and other environmental poisons

ANSWER

B. Buildings

FACT

Each year 600 million birds are lost to building glass strikes, 72 million are killed by environmental poisons, and 234 thousand are lost to land-based wind turbines.

QUESTION

How many people in the world still lack access to electricity?

A. 400 million B. 800 million C. 1.1 billion

ANSWER

C. 1.1 billion (Source: IEA)

FACT

One out of every seven people do not have access to electricity. The UN Development Goals target ending energy poverty globally by 2030. This will require many more kilowatt-hours which must come from clean and renewable energy resources.

QUESTION

True or false? We can power the world with solar technology alone.

ANSWER

True

FACT

Using less than 500,000 square kilometers of land area we could safely power the global economy of 2030 using solar PV technology. Urban areas already cover 600,000 square kilometers of the planet, so this can be accomplished mainly on rooftops.

QUESTION

The earliest example of a wind-powered machine is from what year? *A. 50 B. 1531 C. 1708*

ANSWER

A. 50

FACT

Heron of Alexandria made a musical organ that was powered by a wind turbine.

QUESTION

What year was the first solar photovoltaic cell demonstrated?

A. 1921 B. 1952 C. 1839

ANSWER

C. 1839

FACT

In 1839, experimenting in his father's Paris laboratory, 19-year old Edmond Becquerel created the world's first photovoltaic cell using silver bromide coated platinum electrodes.

QUESTION

True or false? Someone flew around the entire world in a plane powered only by the solar panels on its wings.

ANSWER

True

FACT

André Borschberg and Bertrand Piccard completed a circumnavigation of the globe with the 100% solar-powered aircraft Solar Impulse on July 26, 2016. The journey began and ended in Abu Dhabi, UAE.


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QUESTION

True or false? In the renewable energy sector, CIGS stands for "Carbon Induction Graphite Solenoid."

ANSWER

False

FACT

CIGS stands for "Copper Indium Gallium Selenide." These four chemical elements are semiconductor materials that together make a very thin and flexible solar module like the one used on the leaves of *The Solar Seesaw*, by Luca Fraccalvieri and Ahmad Nouraldeen (see the puzzle).

QUESTION

Which of the following sectors of the economy accounts for the greatest greenhouse gas emissions?

A. Industry B. Transportation

C. Energy Production (electricity and heat)

D. Residential and Commercial

ANSWER

C. Energy Production

FACT

According to the International Energy Agency, greenhouse gas emissions are as follows: 59% Energy Production, 8% Agriculture, 16% Transportation, 8% Industry, and 9% Residential and Commercial.

QUESTION

How many average United States single-family homes can be powered by one average size wind turbine?

A. 20 B. 400 C. 85

ANSWER

B. 400

FACT

The most common wind turbine is 1.5 MW capacity. Over the course of a year it can easily provide 4,000 MWh of electricity. According to the U.S. Energy Information Administration, the average single-family home in the United States consumes 10 MWh of electricity per year.

QUESTION

True or false? A neighborhood can come together and make their own renewable energy power plant.

ANSWER

True

FACT

Community energy projects are happening all around the world. If we all do our part, we can be the solution to the climate puzzle!

QUESTION

Most solar photovoltaic (PV) cells are made from what semiconductor material?

A. Silicon B. Germanium C. Selenium

ANSWER

A. Silicon

FACT

Silicon (Si) is a semiconductor material that is very prevalent in nature. It is formed into crystal ingots and sliced into the thin octagonal cells that you can see on a common solar panel. Typically each panel has 60 or 72 cells.

QUESTION

What is the highest solar photovoltaic (PV) conversion efficiency (the amount of the sun's energy falling on the solar cell that is converted into electricity)?

A. 16.0% B. 22.8% C. 46.0%

ANSWER

C. 46.0% (Source: NREL)

FACT

These special 46.0% efficient multi-junction cells are used in concentrator photovoltaic (CPV) systems. The best you can get for your rooftop is answer B, 22.8% (monocrystalline by SunPower).

QUESTION

True or false? Because a solar panel uses sunlight to generate electricity, it must be opaque and not let any light through.

ANSWER

False

FACT

Some types of solar panels like organic photovoltaic, dye-sensitized solar cells, and luminescent solar concentrators allow certain wavelengths of light to pass through the solar panel, only using a part of the light spectrum to generate electricity.

QUESTION

True or false? You can generate electricity directly from heat.

ANSWER

True

FACT

A thermoelectric generator operates on the Seeback effect to create a constant flow of electricity when one side of the device is heated while the other side stays cold.

QUESTION

Does hot air rise or fall?

ANSWER

Rise

FACT

This phenomenon is called the stack effect. A solar updraft tower can generate electricity by running a turbine with the rapid flow of hot air up a tall chimney from a greenhouse at ground level. In 1982, a solar updraft tower was built in Manzanares, Spain. The 195-meter tall chimney generated 50 kW at peak capacity.

QUESTION

True or false? Sunlight can be used to make liquid fuel.

ANSWER

True

FACT

Using only sunlight, carbon dioxide, and water, solar thermochemical fuel can be produced and used as jet fuel and for large industrial heating applications. When solar fuel is combusted it releases the same CO_2 that was used in its production, so it is CO_2 neutral.

QUESTION

Which renewable energy resource does not derive its energy originally from the sun?

A. Wave B. Tidal C. Wind

ANSWER

B. Tidal

FACT

Tidal energy relies on the movement of water as influenced by the gravity of the moon. Wave energy is derived from wind energy, which is driven by the heat of the sun on the Earth's atmosphere.

QUESTION

Which of the following is a kind of ocean wave energy conversion device?

A. Point absorber B. Flocculator

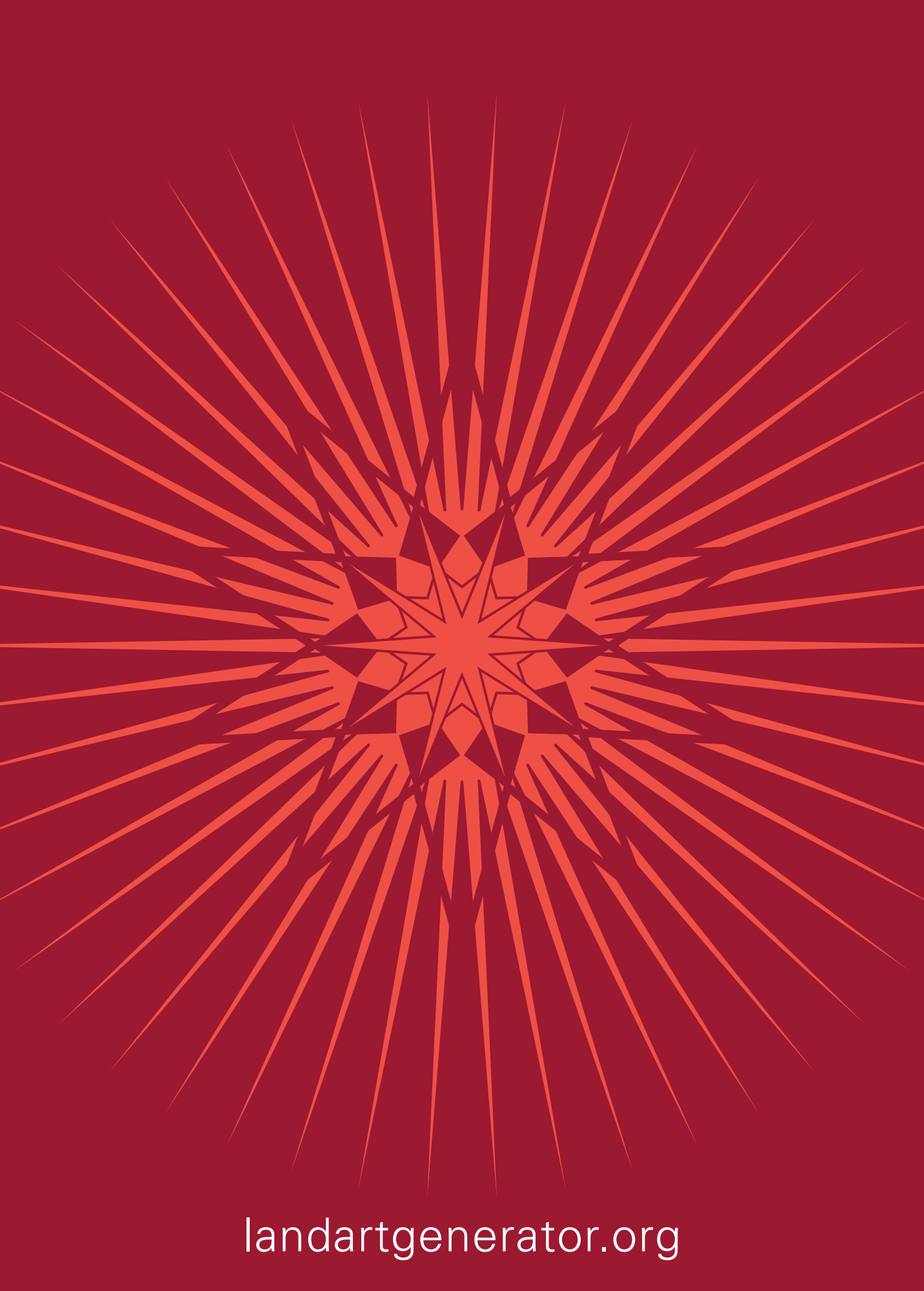
C. Undulator D. Water spout

ANSWER

A. Point absorber

FACT

Types of wave energy converters include: point absorber (or buoy), oscillating water column, surface attenuating, overtopping, oscillating wave surge, and submerged pressure differential.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QUESTION

What is a heliostat?

A. A mirror that tracks the sun's movement in order to reflect its light to a constant location. B. A temperature control mechanism for the sun. C. A surgical tool used for clamping.

ANSWER

A. A mirror that tracks the sun's movement.

FACT

A concentrated solar power tower, like *The Solar Compass*, by Santiago Muros Cortés (see the puzzle), uses heliostats to focus the sun's energy and generate electricity from the heat.

QUESTION

You have an old 100-watt light bulb that you keep on all year. How many pounds of carbon dioxide did you put into the atmosphere?

Hint: for every watt-hour of electricity, 0.00156 pounds of carbon is emitted.

There are 8,760 hours in a year.

A. 12 lbs B. 1,366 lbs C. 580 lbs

ANSWER

B. 1,366 pounds = 100 watts x 8,760 hours x 0.00156 pounds

FACT

That's the equivalent of burning 1.4 barrels of oil or driving a car 2,438 km. It would take a tree 100 years to offset the emissions from that one old light bulb you left on.

QUESTION

According to the U.S. Environmental Protection Agency, how many acres of mature forest are needed to offset the carbon emissions of one average United States single family home?

A. 1.1 acres B. 5.6 acres C. 9.2 acres

ANSWER

C. 9.2 acres

FACT

Offsetting our CO_2 emissions with trees is not easy. In fact you would need to plant a brand new forest 40 times the size of Texas to offset all U.S. CO_2 emissions.

QUESTION

Which is more efficient at converting energy: your body or a solar panel?

ANSWER

They are the same efficiency and so you get the answer right no matter which you choose!

FACT

Your body converts food calories into kinetic energy (the movement of your muscles) at 20% efficiency. The rest of the energy is converted into heat. The same is true for a solar panel converting sunlight into electricity. 80% is lost to heat during the process.

QUESTION

True or false? Cow and pig poop can help power our economy.

ANSWER

True

FACT

Anaerobic digesters are a very simple technology that turns farm waste into biogas that can be used just like natural gas. The technology was first used in the tenth century B.C.E. in Assyria where biogas was used to heat bath water.

QUESTION

True or false? You can light up your garden by simply plugging into the ground.

ANSWER

True

FACT

Microbial fuel cells produce electricity by harnessing the natural bio-electrical systems that convert chemical energy into electrical energy. All you need to do is place an anode deep in the ground and a cathode on top of the soil.

QUESTION

True or false? Piezoelectric is a genre of music that mixes jazz and punk.

ANSWER

False

FACT

Piezoelectric generators convert mechanical strain into electrical energy. They can be inserted into sidewalks to harvest the energy of movement.

QUESTION

True or false? Renewable energy is only available when the sun is shining or the wind is blowing.

ANSWER

False

FACT

Renewable energy can be stored in utility-scale electrochemical batteries (like lithium-ion), in water reservoirs (pumped hydro), in thermal mass (molten salt), in flywheels, in compressed air, or it can be used to make biofuels or hydrogen gas.

QUESTION

What is the least expensive way to generate electricity at the scale of cities? *A. Coal B. Nuclear*
C. Solar D. Natural Gas

ANSWER

C. Solar

FACT

Utility solar is selling at 2 cents per kilowatt-hour (kWh) in 2019 (actual lifetime power purchase agreements). Existing coal power plants aren't profitable for less than 3.7 cents per kWh. Existing nuclear is 2.8 cents per kWh and natural gas is 4 cents per kWh. (Source: Lazard)

QUESTION

What is the most effective way to reduce our carbon footprint?

A. Solar power B. Wind power

C. Reduce consumption

D. Carbon capture

ANSWER

C. Reduce consumption

FACT

A "negawatt" is a watt of energy that is never needed. The most effective way to reduce our impact on the planet is to use less. Turn lights off, conserve heat, and try not to buy stuff you may end up throwing away soon.

QUESTION

The amount of energy that all of humanity consumes in one year is equal to the solar energy that hits the surface of the earth over how much time?

A. 57 minutes B. 8.5 hours C. 6 weeks

ANSWER

A. 57 minutes

FACT

In less than an hour, more energy from the sun strikes our planet than the population of the world consumes in an entire year.

QUESTION

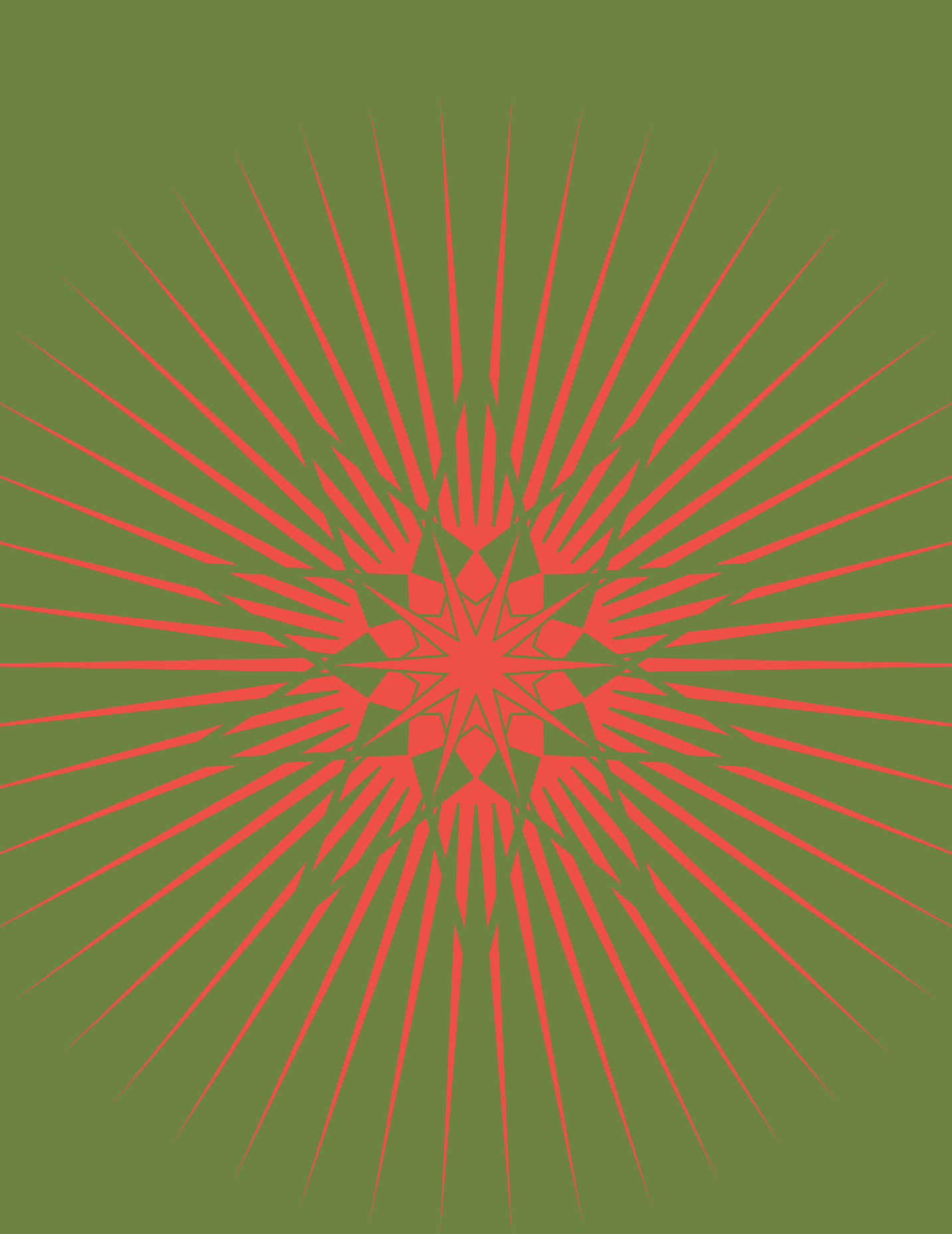
True or false? Algae can power a jet airplane.

ANSWER

True

FACT

Jet fuel can be made 100% from algae. Referred to as algal biofuel, it can be made by extracting oils (lipids) from algae or by using a process called pyrolysis to produce syngas.



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INSTRUCTIONS FOR PLAY

The goal of the game is to be the first player to solve a complete six-piece puzzle.

1. Place all of the puzzle pieces in a pile with the image face down so the solid color backs are showing.

2. Dealer shuffles the cards and deals six cards to each player. The remaining cards are placed in the draw pile face down. Reserve a space next to the draw pile for a discard pile.

3. Each player then takes 6 puzzle pieces from the pile with back colors that correspond to the back colors of the cards in their hand (the color facing the other players). For example, if you have 2 red cards and 4 blue cards, you will take 2 red puzzle pieces and 4 blue puzzle pieces.

4. The first player (to the left of the dealer) begins play by requesting (from any other player) one puzzle piece they'd like to have in order to complete their preferred puzzle most quickly. The request is made by referencing the color on the back of the puzzle piece, which corresponds to a card

held by the other player. For example, "Rob, I'd like a blue piece please!"

5. The person who holds that puzzle piece (Rob in the example) reads the question on a card, the back of which matches the color of the requested puzzle piece (any blue card Rob is holding). If the first player answers the question correctly, they get a puzzle piece of that color (a blue puzzle piece in the example) from the player holding the card and puzzle piece. The card with the question that has been asked is placed in the discard pile. If the first player gets the question wrong, the card is still placed in the discard pile, but no puzzle piece is exchanged.

6. The player who asked the question draws a card from the draw pile to replace the one they have lost and takes a puzzle piece of the same color from the pile. Every player must always maintain six cards.

7. It is now the next player's turn (to the left). They repeat the same by requesting a color puzzle piece from another player.

8. Play continues in this way until one player has completed a puzzle.

9. If more than one player remains, they may continue playing to finish another puzzle.