

## Triangle Game

### Student Objective:

The student

- will be able to explain in their own words the meaning of fundamental terms and concepts in electronics and solar energy
- will connect and apply electronic and solar energy terms or concepts to other related terms

### Materials:

- Triangle game board
- instructions
- playing pieces
- tape

### Key Words:

(Key words depend on game vocabulary used. Below are the key words used in this solar energy version)

amperage	peak irradiance
array	peak sun hours
azimuth	phase change
capillary water	photon
conduction	photovoltaic
convection	photovoltaic cell
desalinization	radiation
direct current	STC (standard test conditions)
efficiency	series circuit
electrolysis	solar collector
electrolyte	solar window
electromagnetic spectrum	solar incidence
element	solar irradiance
frequency	solar noon
hertz	solar still
hydrogen	speed of light
I-V curve	thermal
infrared waves	conductivity
insolation meter	thermal energy
maximum	transverse waves
power point	voltage
Ohm's law	watt
parallel circuit	

### Time:

1 hour

### Procedure (prior to class):

1. Cut out game pieces
2. Print out Key Words/Definitions page
3. Game board may be enlarged or laminated

**Procedure (in class):**

1. Assign students to small groups
2. Distribute a triangle game board, instruction sheet to each group
3. Place the terms at the front of the class for the teams to refer to if there are disputed answers
4. Discuss the rules of the game with the class and demonstrate a completed triangle using non-technical solar energy terms.
5. Allow 30-40 minutes for game time.

**Internet Sites**

**<http://www.wordcentral.com/>**

Merriam Webster, Word Central student dictionary

## Triangle Game

The Sunshine State Standards will vary according to vocabulary used. Below are the benchmarks covered by using the solar energy key words included with this activity.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
<b>Earth and Space</b>																					
<b>Standard 5</b>	SC.912.E.5.				X				X												
<b>Standard 6</b>	SC.912.E.6.						X														
<b>Physical Science</b>																					
<b>Standard 10</b>	SC.912.P.10.	X			X										X	X					
<b>Language Arts Standards</b>		LA.910.1.6.1, LA.910.1.6.4, LA.910.1.6.6, LA.910.1.6.8, LA.1112.1.6.1, LA.1112.1.6.4, LA.1112.1.6.6, LA.1112.1.6.8																			

### Science Standards

#### Standard 5: Earth in Space and Time

- SC.912.E.5.4 - Explain the physical properties of the Sun and its dynamic nature and connect them to conditions and events on Earth.
- SC.912.E.5.8 - Connect the concepts of radiation and the electromagnetic spectrum to the use of historical and newly-developed observational tools.

#### Standard 6: Earth Structures

- SC.912.E.6.6 - Analyze past, present, and potential future consequences to the environment resulting from various energy production technologies.

#### Standard 10: Energy

- SC.912.P.10.1 - Differentiate among the various forms of energy and recognize that they can be transformed from one form to others.
- SC.912.P.10.4 - Describe heat as the energy transferred by convection, conduction, and radiation, and explain the connection of heat to change in temperature or state of matter.
- SC.912.P.10.14 - Differentiate among conductors, semiconductors, and insulators.
- SC.912.P.10.15 - Investigate and explain the relationships among current, voltage, resistance and power.

### Language Arts Standards

#### Reading Process - Standard 6: Vocabulary

- LA.910.1.6.1 and LA.1112.1.6.1 - The student will use new vocabulary that is introduced

- and taught directly.
- LA.910.1.6.4 and LA.1112.1.6.4 - The student will categorize key vocabulary and identify salient features.
  - LA.910.1.6.6 and LA.1112.1.6.6 - The student will distinguish denotative and connotative meanings of words.
  - LA.910.1.6.8 and LA.1112.1.6.8 - The student will identify advanced work/phrase relationships and their meanings.

## Triangle Game

Key Words will vary depending on the vocabulary used. Below are the key words/definitions for the solar energy game pieces included in this unit.

**ampere (amp)** - a unit of electrical current or rate of flow of electrons. One volt across one ohm of resistance causes a current flow of one ampere. One ampere is equal to  $6.25 \times 10^{18}$  electrons per second passing a given point in a circuit. The symbol is I

**array** - a mechanically integrated assembly of modules or panels together with support structure to form a unit that produces DC power

**azimuth** - the angular measure, which in the northern hemisphere is between due south and the point on the horizon directly below the sun.

**capillary water** - the thin film of water that coats the soil particles even in the driest soil

**conduction** - the movement of heat through materials by transferring kinetic energy directly from particular to particular

**convection** - the circulatory movement or transfer of heat through fluids such as gasses or liquids due to differences in temperature (less dense, hotter fluids rise and cooler fluids, being more dense, sink)

**desalinization** - process of removing salt and other chemicals and minerals from water

**direct current (DC)** - a one way flow of electric current - from positive to negative.

**efficiency** - the ratio of output compared to the input of a device.

**electrolysis** - the chemical process or change produced by breaking molecules into smaller components (called decomposition) using an electrolyte and electric current

**electrolyte** - a substance with free ions (such as acids, bases, or salts) that is capable of conducting an electric current by means of a decomposition chemical change

**electromagnetic spectrum** - the full range of frequencies, from radio waves to gamma rays, that characterizes light.

**element** - a substance composed of atoms having an identical number of protons in each nucleus;

elements cannot be reduced to simpler substances by normal chemical means.

**frequency** - a property of a wave that describes how many wave patterns or cycles pass by in a period of time. Frequency is often measured in units called Hertz (Hz), where a wave with a frequency of 1 Hz will pass a point at 1 cycle per second.

**hertz** - the derived SI (international standard) unit of frequency, defined as a frequency of 1 cycle per second.

**hydrogen** - a colorless, highly flammable gaseous element, the lightest of all gases and the most abundant element in the universe.

**I-V curve** - the plot of electrical output (voltage and current) characteristics of a photovoltaic cell or module at a particular temperature and irradiance.

**infrared waves** - electromagnetic radiation with wavelengths and frequencies between those of microwaves and visible light (wavelength ranges from 1 mm to 1000  $\mu\text{m}$ ). Some of the Sun's infrared waves reach the Earth's surface but most are absorbed by the greenhouse gases in the atmosphere.

**insolation meter** - a device used to measure the amount of solar irradiance. Also called a *pyranometer*.

**maximum power point ( $P_{mp}$ )** - the point where the product of current and voltage is at maximum power.

**Ohm's Law** - the current in a circuit is directly proportional to the voltage across the circuit, and inversely proportional to the total resistance of the circuit.

$$I = V / R$$

$$V = I \times R$$

$$R = V / I$$

By substituting the equation for power ( $P = V \times I$ ), variations in Ohm's law can also be expressed as follows:

$$P = I^2 \times R$$

$$P = V^2/R$$

**parallel circuit** - an type of electrical circuit in which each device provides two or more separate paths or connections for the current to travel

**peak irradiance** - standard peak sunlight condition,  $1\text{kW}/\text{m}^2$ .

**peak sun hours** - the equivalent number of hours at peak sun conditions ( $1\text{kW}/\text{m}^2$ ) that produces the same total insolation as actual sun conditions.

**photon** - a tiny particle or bundle of radiant energy

**photovoltaic** - a device that generates electricity when exposed to light.

**photovoltaic cell** - the smallest, basic photovoltaic device that generates electricity when exposed to light. Cells can range in size from microscopic to 8 inches square.

**radiation** - the way we receive heat from the Sun each day. The energy is emitted in the form of waves or photons (electromagnetic waves) and can be transferred through the vacuum of space.

**STC (standard test conditions)** - the standard reference environment for photovoltaic cell operation is an environment of 1000W/m<sup>2</sup> irradiance, 1.5 air mass, and cell temperature of 20° C.

**series circuit** - an type of electrical circuit in which all the current travels on a single line or path through each device or resistor in the circuit.

**solar collector** - a device used to collect energy from the sun.

**solar window** - the critical area of the sun's path that should be free of obstructions for any solar collector. This area is defined on top and bottom by the sun's path in the summer and in the winter, and in the east and west by the sun's position three hours before solar noon and three hours after solar noon.

**solar incidence** - the angle that the sun's rays strike the earth in relation to surface normal at a given longitude and latitude.

**solar irradiance** - the measure of the power density of sunlight. Expressed in watts per square meter. The solar constant for earth is the irradiance received by the earth from the sun, 1367 W/m<sup>2</sup>, at the top of the atmosphere and  $\approx 1000$  w/m<sup>2</sup> after passing perpendicularly through the atmosphere.

**solar noon** - the time of day when the sun is at its highest point in the sky. At this time in the northern hemisphere, the sun's shadow will point directly north.

**solar still** - a device that uses solar energy to evaporate a liquid.

**speed of light** - 299,792,458 meters per second or  $3.0 \times 10^8$  m/s

**thermal conductivity** - the measure of a substance's ability to conduct heat. The higher the value, the more conductive the substance.

**thermal energy** - internal energy; sum of kinetic and potential energy of random motion of particles making up the object. Commonly known as 'heat'; its symbol is Q

**transverse waves** - waves such as light waves that can transfer energy at the speed of light in a vacuum without a medium.

**voltage** - a measure of the force or 'push' given the electrons in an electrical circuit; a measure of electric potential. One volt produces one amp of current when acting against a resistance of one ohm. Symbol is V

**watt** - a measure of electrical power or amount of work done in a unit of time. One amp of current flowing at a potential of one volt produces one watt of power.

## Triangle Game

A game to demonstrate the connections between vocabulary term and concepts covering electronics and solar energy

### **Individual Player Version**

The Object: To be the player with the most points at the end of the game.

The Set Up: Vocabulary terms are placed on small slips of paper and turned face down on the playing surface. Each player writes their name on the back of the triangle game board.

The Play:

1. The first player randomly chooses a term, defines that term, and uses it in a sentence.
2. The player then attaches (glue or tape) the term to any intersection point on the game board.
3. The next player randomly chooses a term, defines the term and uses it in a sentence. If the player is able to demonstrate a relationship between his/her term and another term, they place their term on another point of that same triangle. If the player can not demonstrate a relationship with any of the other terms on the game board they must attach their term to an intersection point on any open triangle.
4. Play continues with terms being attached to the game board.
5. When a player is able to explain a relationship between their term and the other two terms on the points of a triangle, they initial the completed triangle and receive a game point.

The Winner: When the time allotted for play is complete, the player with the most game points (completed triangles) wins.

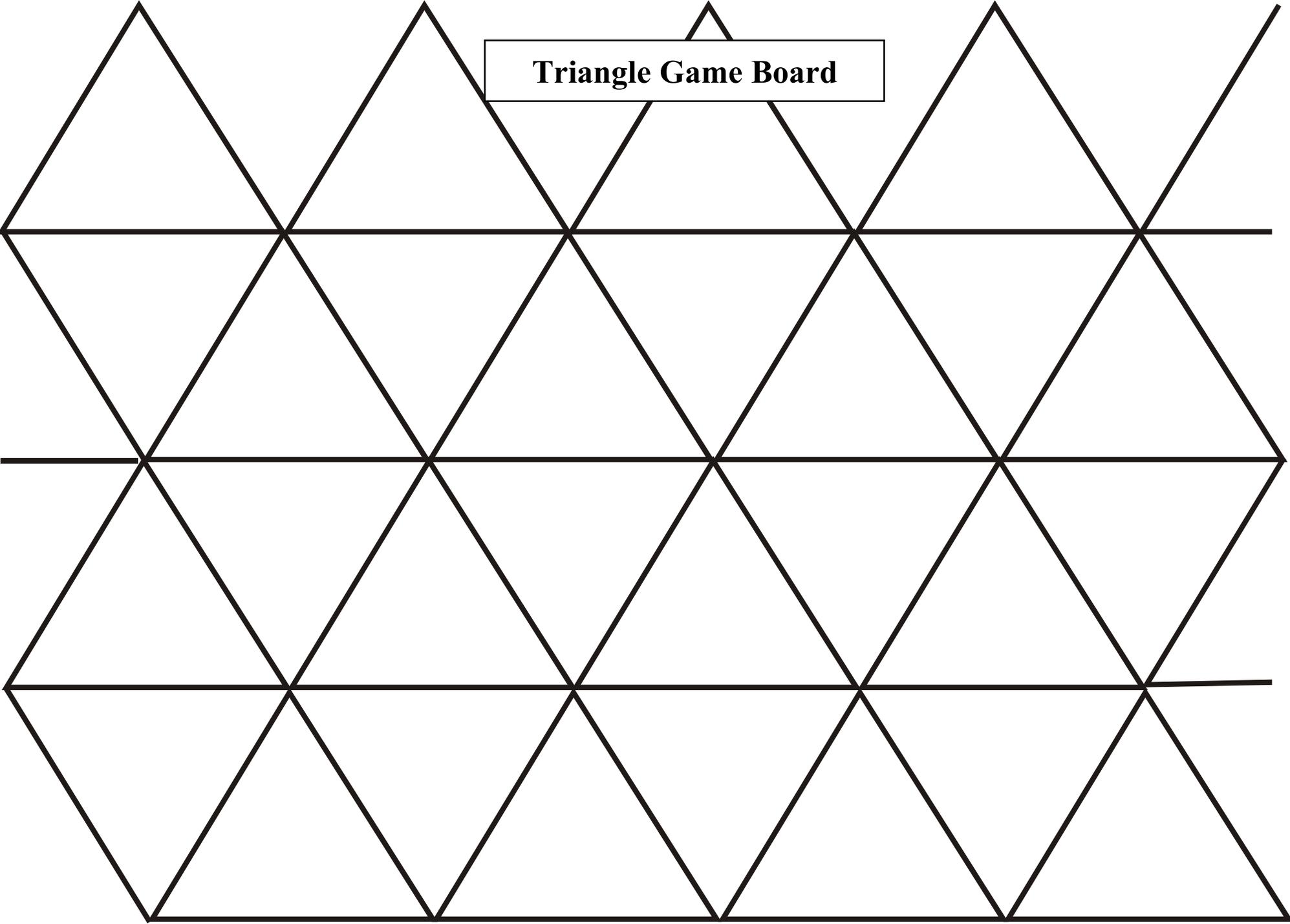
### **Team Version**

The Object: To be the team with the most completed triangles at the end of the game.

The Set Up: Same as Individual Player Version

The Play: The same as Individual Player Version, except that cooperation between team members is encouraged and players do not put their initials in completed triangles.

The Winner: When the time allotted for play is complete, the team with the most completed triangles wins.



**Triangle Game Board**

## Triangle Game

electromagnetic spectrum

watt

frequency

amperage

photon

direct current

transverse waves

I-V curve

speed of light

azimuth

thermal energy

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photovoltaic

conduction

parallel circuit

solar irradiance

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voltage

electrolysis

**hydrogen**

**maximum power point**

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**thermal conductivity**

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**hertz**

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**array**

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**solar still**

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