Course: Basics of Environmental Engineering (Climatology)

Main topic: Solar Radiation

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Contents

Interactive quiz answers

1. Solar Radiation Multiple Choice Questions:

What is the primary source of solar radiation on Earth?

a) Sun

b) Moon

c) Stars

d) Planets

Answer:

2. Which form of electromagnetic waves does solar radiation primarily consist of?

a) Ultraviolet

b) Infrared

c) X-rays

d) Gamma rays

Answer:

3. What is the total solar energy reaching the Earth's surface approximately?

a) 1000W

b) 500W

c) 2000W

d) 1361W

Answer:

4. What happens to solar radiation that is not absorbed or scattered by the atmosphere and reaches the ground directly?

a) It forms shadows

b) It causes rainbows

c) It creates auroras

d) It generates heat

Answer:

5. Which component of solar radiation is responsible for photosynthesis in plants?

a) Ultraviolet radiation

b) Visible light

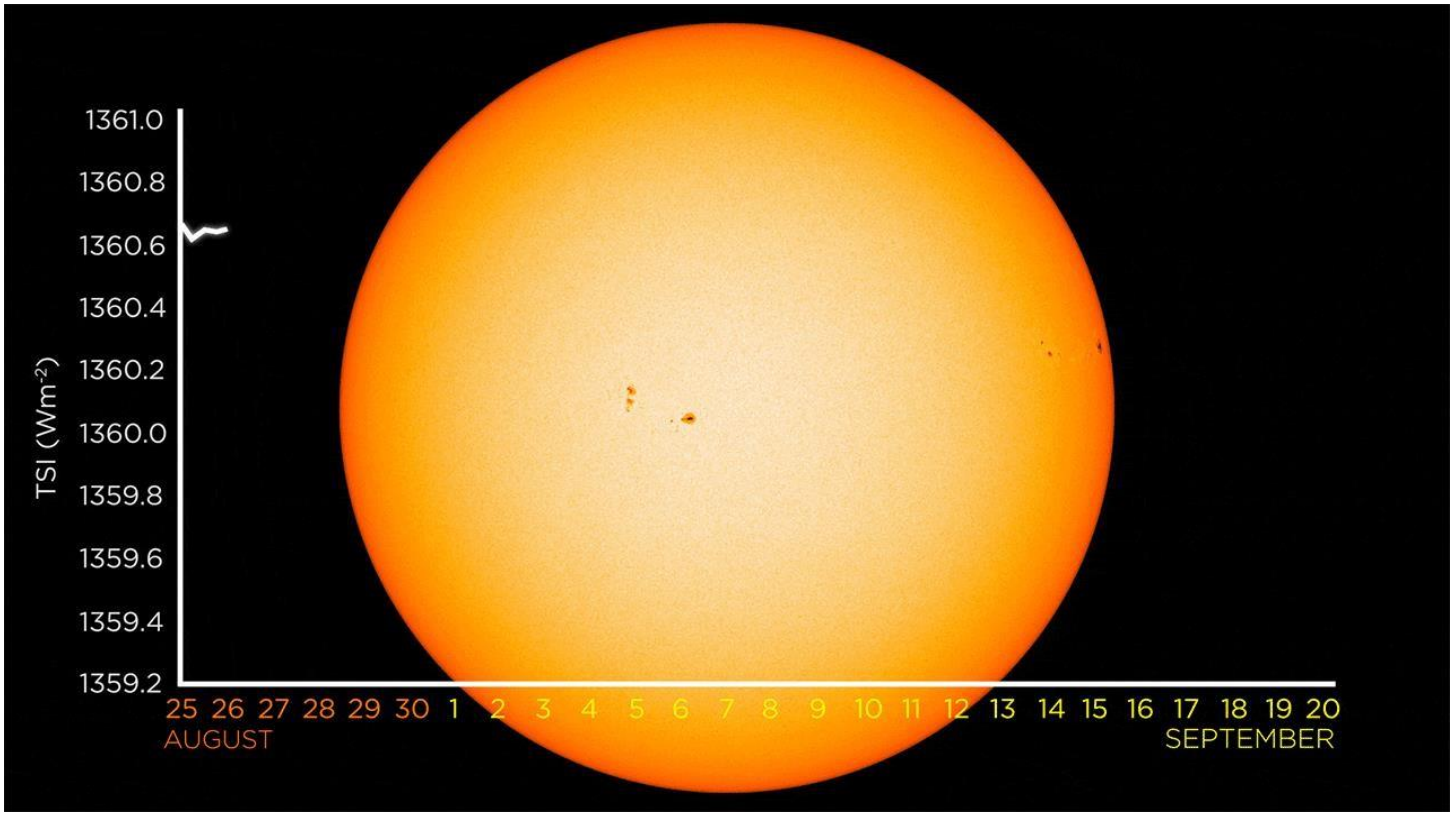
c) Infrared radiation

d) X-rays

Answer:

Introduction

- Solar radiation is defined as, “The flux of radiant energy from the sun”
- The Solar Radiation is the primary source of energy on earth and life depends on it.

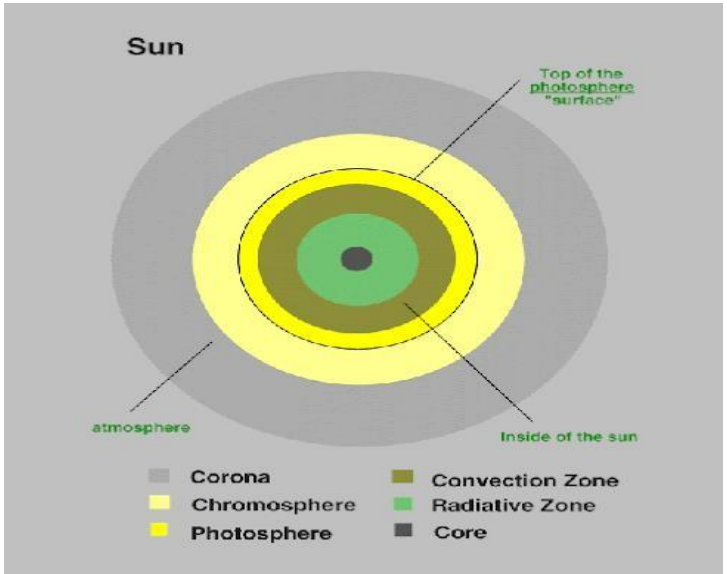


https://scitechdaily.com/total-and-spectral-solar-irradiance-sensor-measures-solar-energy-input-to-earth/ , solar iradiance

Sun &Factors influence the Intensity of Solar Radiation

The solar surface is composed of three gaseous layers:

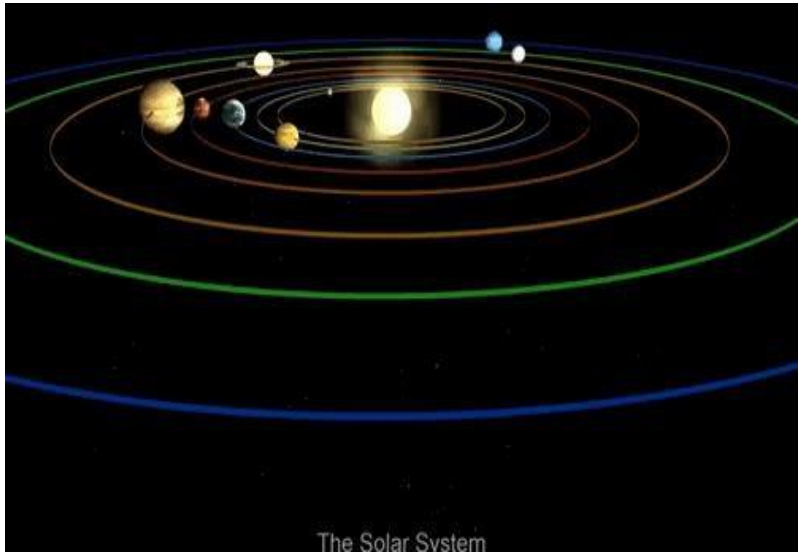
1. The inner most surface layer is called “Photosphere” and its temperature is 6000 °c
2. The middle surface layer is called the Chromosphere and its temperature is 5000 °c
3. The outer surface layer is called the “Corona”



https://solar-center.stanford.edu/hidden-pic/photosphere.html, Sun parts

Sun &Factors influence the Intensity of Solar Radiation

- All the planets revolve around the sun in elliptical orbits
- It looks bright and big because of its nearness to the the earth than the other stars
- It is at a mean distance of 150 million kilometers

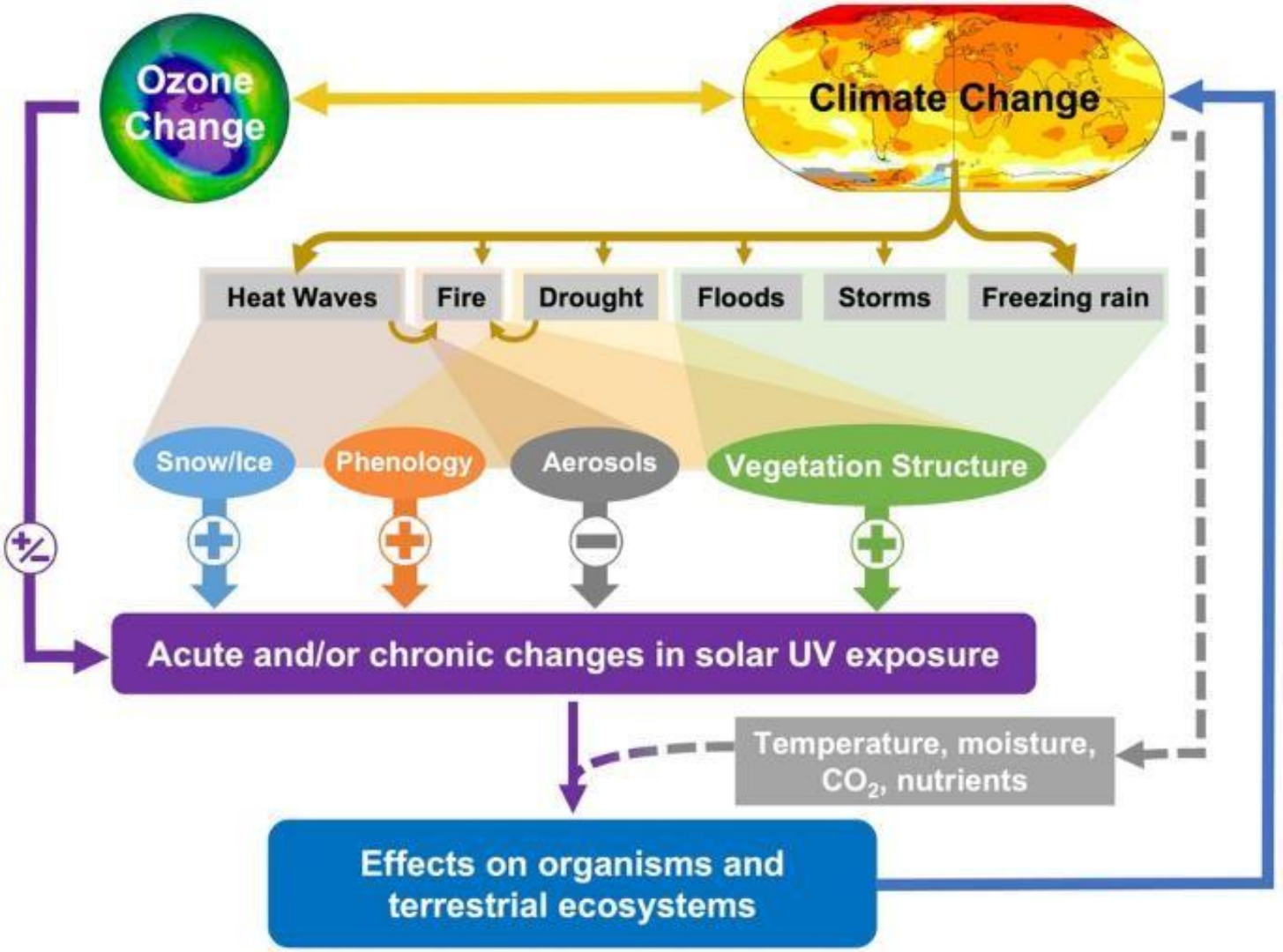


https://www.youtube.com/playlist?list=PLX0PLdYC6Kdqv11nzFvBUIe1Pmf2xKpjm, Solar system

Sun &Factors influence the Intensity of Solar Radiation

- ✓ Its diameter is 1,392,000kilometres(the diameter of earth is 12,756 kilometres
- ✓ Its volume is approximately 1.3 million times more than the earth
- ✓ Even though it is gaseous, it weighs more than 300,000 times much as the earth.
- ✓ It takes 8 minutes 20 seconds for its rays to reach the earth.

Sun &Factors influence the Intensity of Solar Radiation



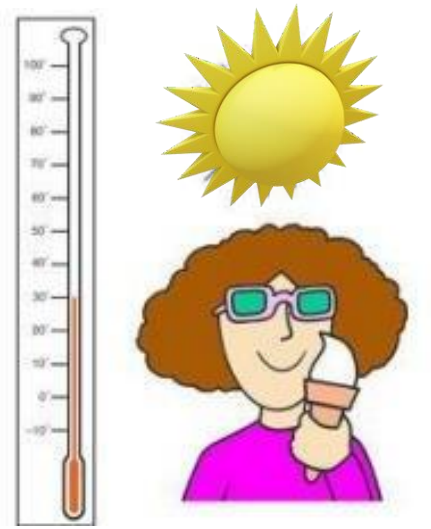
https://link.springer.com/article/10.1007/s43630-023-00376-7

Process of energy Transmission

Heat energy is transmitted by processes.

Radiation: is the process of transmission of energy from body to another without the aid of a material medium(solid, liquid, gas, etc.)

Example : The energy transmission through space from the sun to the earth.

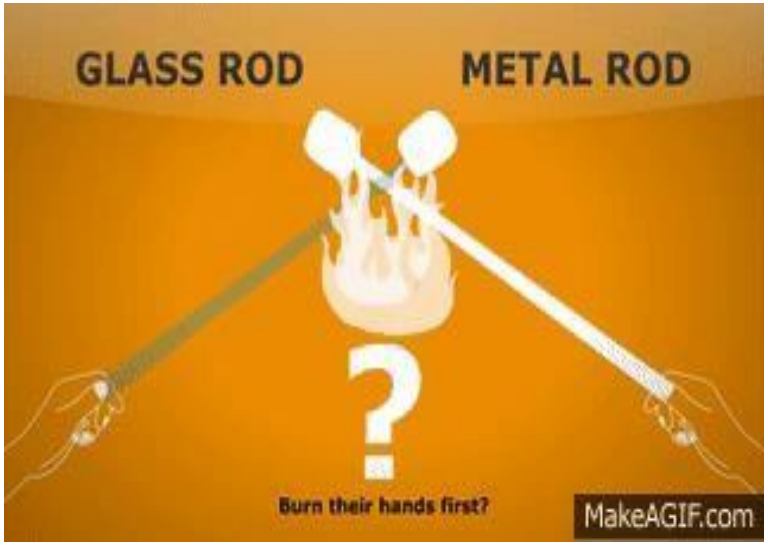


Process of energy Transmission

Heat energy is transmitted by processes.

Conduction:

- This is the process of heat transfer through matter without the actual movement of molecules of the substances or matter.
- Heat flows from the warmer to cooler part of the body so that the temperature between them are equalized.



https://makeagif.com/gif/physics-energy-heat-transfer-conduction-f-dS0M

Process of energy Transmission

Heat energy is transmitted by processes.

Convection:

- This is the process of transmission of heat through actual movement of molecules of the medium.
- This is predominant form of transmission of energy on the earth as all the weather related processes involve this process.

Example: Boiling of water in a beaker.

Basic Solar Radiation laws

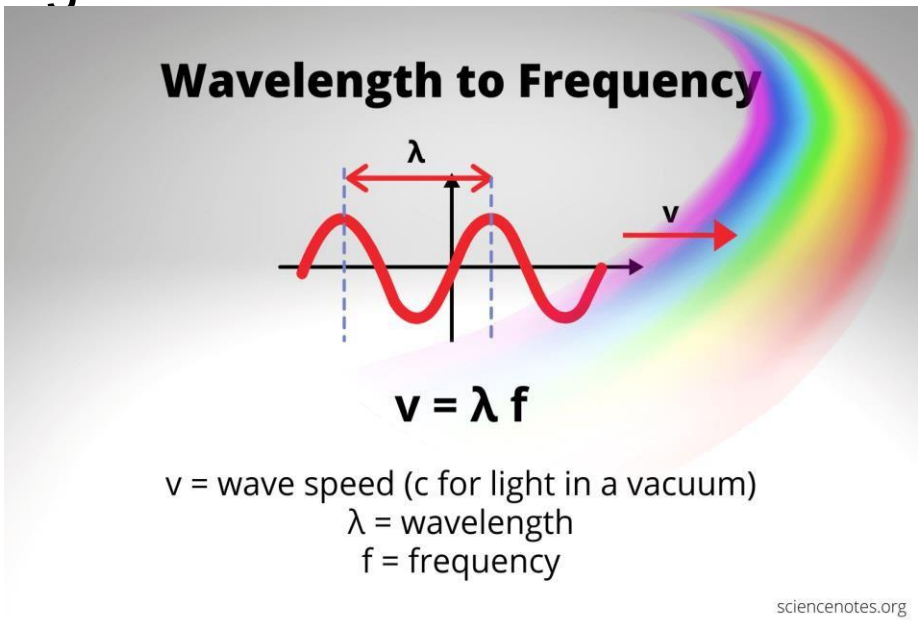
❖ Wavelength

The wavelength of electromagnetic radiation is given by equation:

$\lambda = v/f$ where,

λ =Wavelength(the shortest distance between consecutive crests in the wave trance)

❖ C (speed of light)= velocity of light



Basic Solar Radiation laws

Planck's Law

The electromagnetic radiation energy content(E) of each quantum is proportional to the frequency given by equation given :

$E = h\nu$ where

h=Planck's constant : 6.625×10^{-34}

J*s

Basic Solar Radiation laws

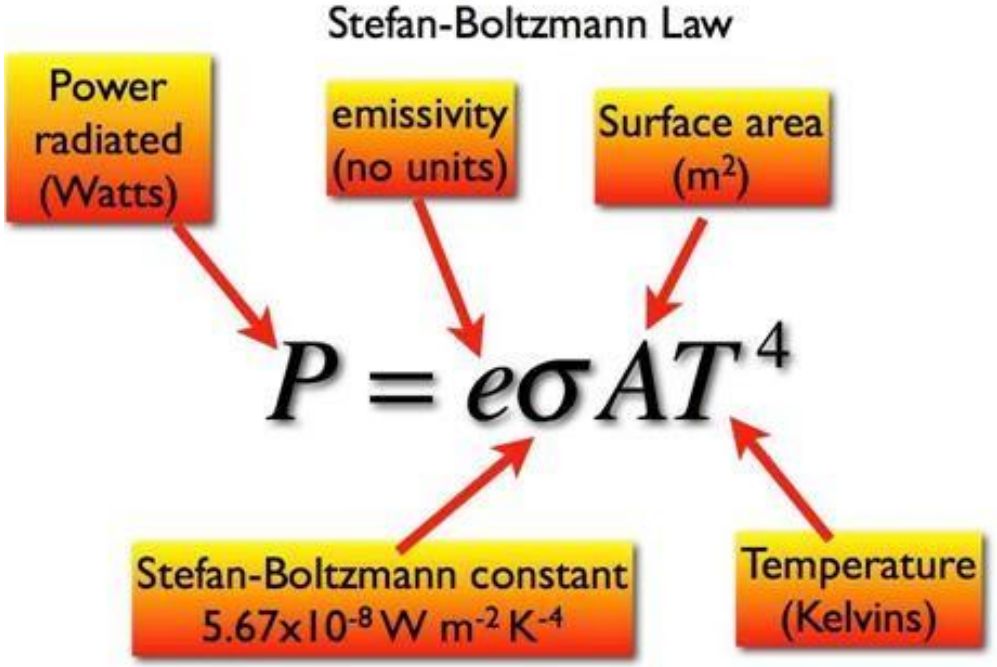
Kirchoff's Law

- A good absorber of radiation is a good emitter, in similar circumstances.
- This law states that the absorptivity 'a' of an object for radiation of a specific wavelength is equal to its emissivity 'e' for the same wavelength.

Basic Solar Radiation laws

Stefan Boltzmann's law

The intensity of radiation emitted by a radiating body is directly proportional to the fourth power of the absolute temperature of that body.



Basic Solar Radiation laws

$$\sigma = \frac{2\pi^5 k_B^4}{15h^3c^2} = 5.670374419x10^{-8}\frac{W}{m^2K^4}$$

σ = Stefan-Boltzmann constant

pi = pi ~= 3.14

k_B = Boltzmann constant

h = Planck's constant

c = speed of light in vacuum

Flux= σT^4,

Where T= (273 + ^{0}C) because temperature is in Kelvins

σ= Stefan Boltzman's constant, which is equal **5.670 374 419**... x 10^{-8} W m^{-2} K^{-4}

Instrument to measure solar radiation

Campbell – stokes Sunshine Recorder

- Principle
- Sun’s are concentrated on a chemically sensitised card by a spherical lens
- This card produces a trace as the sub rays fall during the hours of bright sunshine.
- As the card is graduated in hours and tenths , the daily duration of sunshine can be easily determined.

Instrument to measure solar radiation

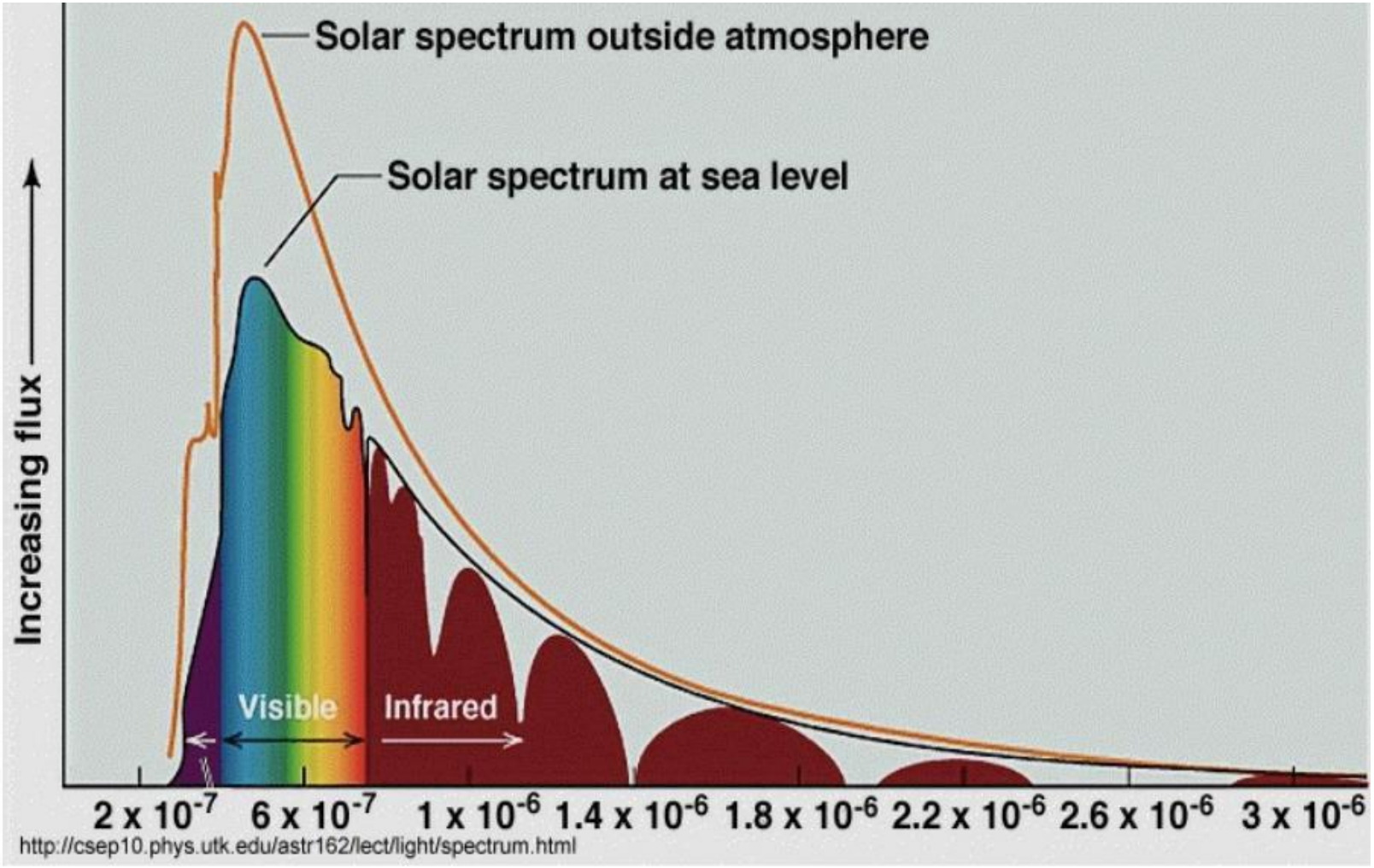
Campbell – stokes Sunshine Recorder

https://en.wikipedia.org/wiki/Campbell%E2%80%93Stokes_recorder, stokes sunshine recorder

Solar spectrum

- Radiant energy is transmitted in form of electromagnetic waves by the sun.
- The energy from the sun is spread over every broad band of wavelength known as solar spectrum.
- It is also known as electromagnetic spectrum. The spectrum does not constitute one band but a combination of different waves which are characterized individually.

Solar spectrum



https://www.coursehero.com/tutors-problems/Earth-Science/23277009-1-Use-the-chart-to-help-you-answer-the-following-questions-a-Explai/

Energy content of different bands in Solar spectrum

Band No	Spectum	Wavelength in Microns	% of Energy
1	γ-rays& X-rays U.V-rays	0.005-0.20 0.20-0.40	9%
2	Violet	0.40-0.43	
3	Blue	0.43-0.49	
4	Green	0.49-0.53	41%
5	Yellow	0.53-0.58	
6	Orange	0.58-0.5.63	
7	Red	0.63-0.70	
8	Infrared rays	>0.70	50%

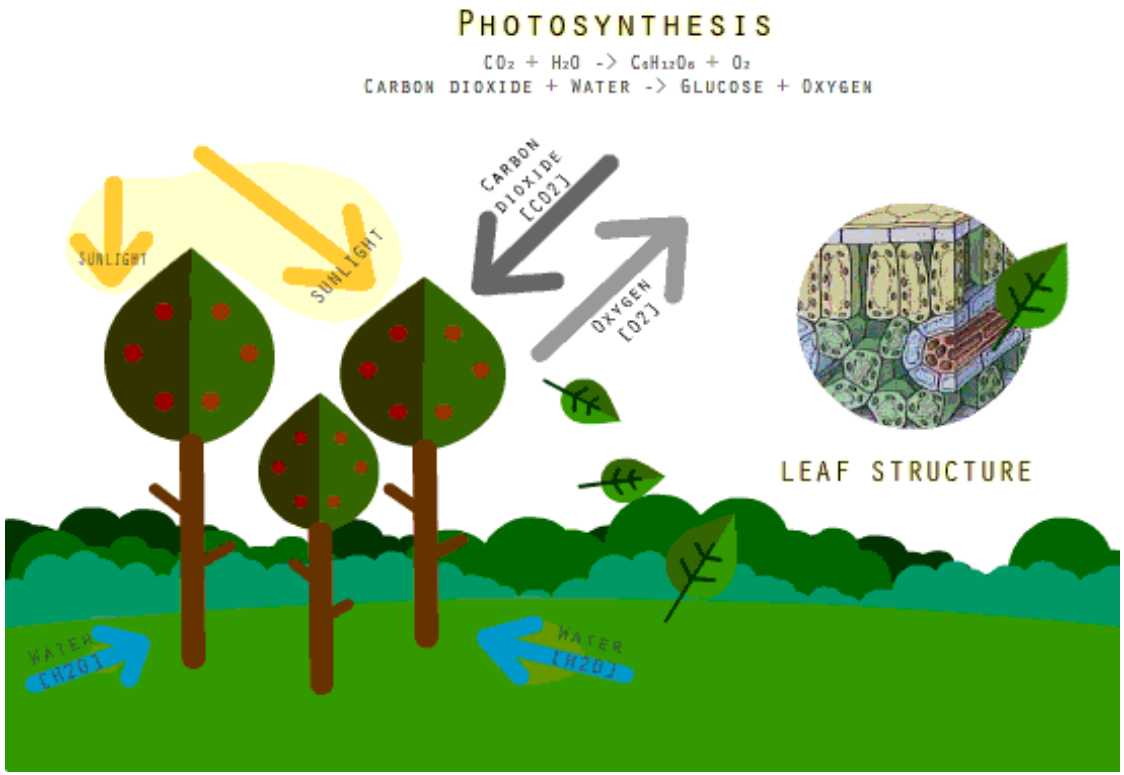
Function of Sun Light

The functions of light are:

- All the plants parts are directly or indirectly influenced by light
- Light of correct intensity, quality and duration is essential termal development
- Poor light availability causes abnormalities and disorders in plants

Function of Sun Light

- Light is indispensable to photosynthesis, flowering, root development
- Photosynthates among different organs of plants and seed dormancy



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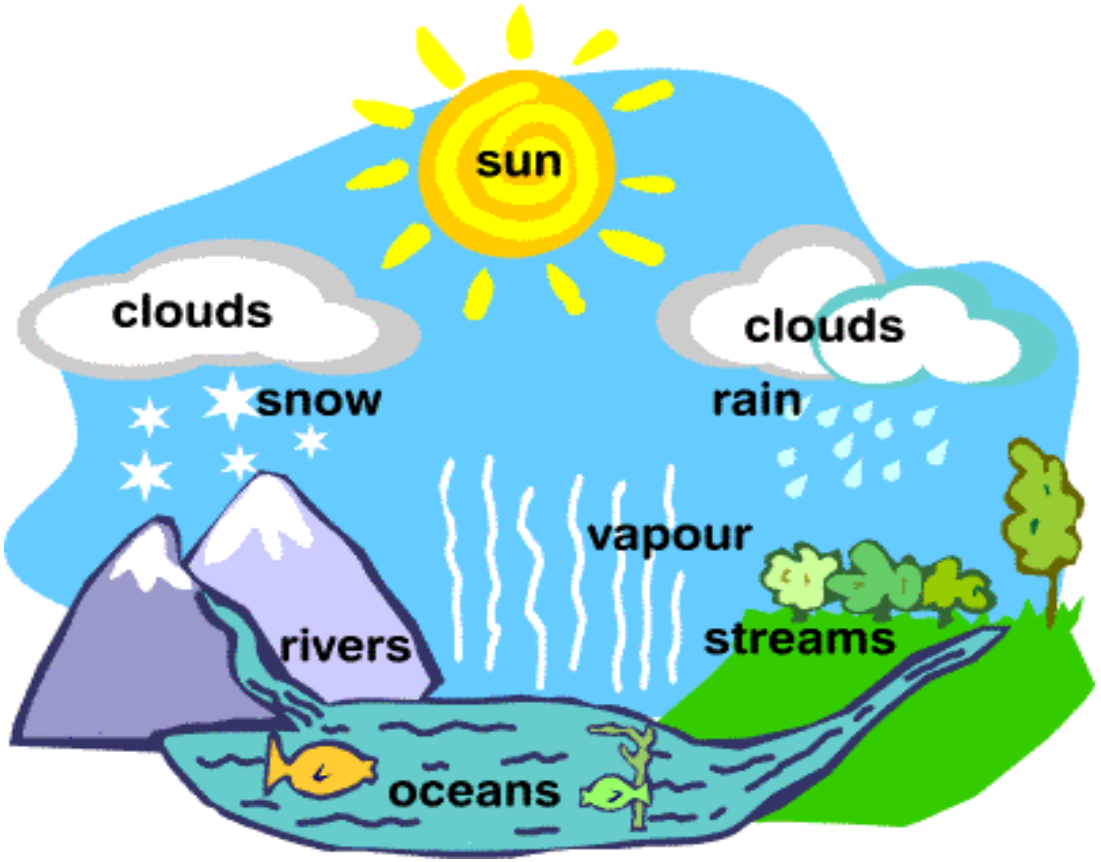
Function of Sun Light

- Light governs the distribution of vegetation on the earth planet
- Effects tiller production
- Effects stability, strength and length of colms

Function of Sun Light

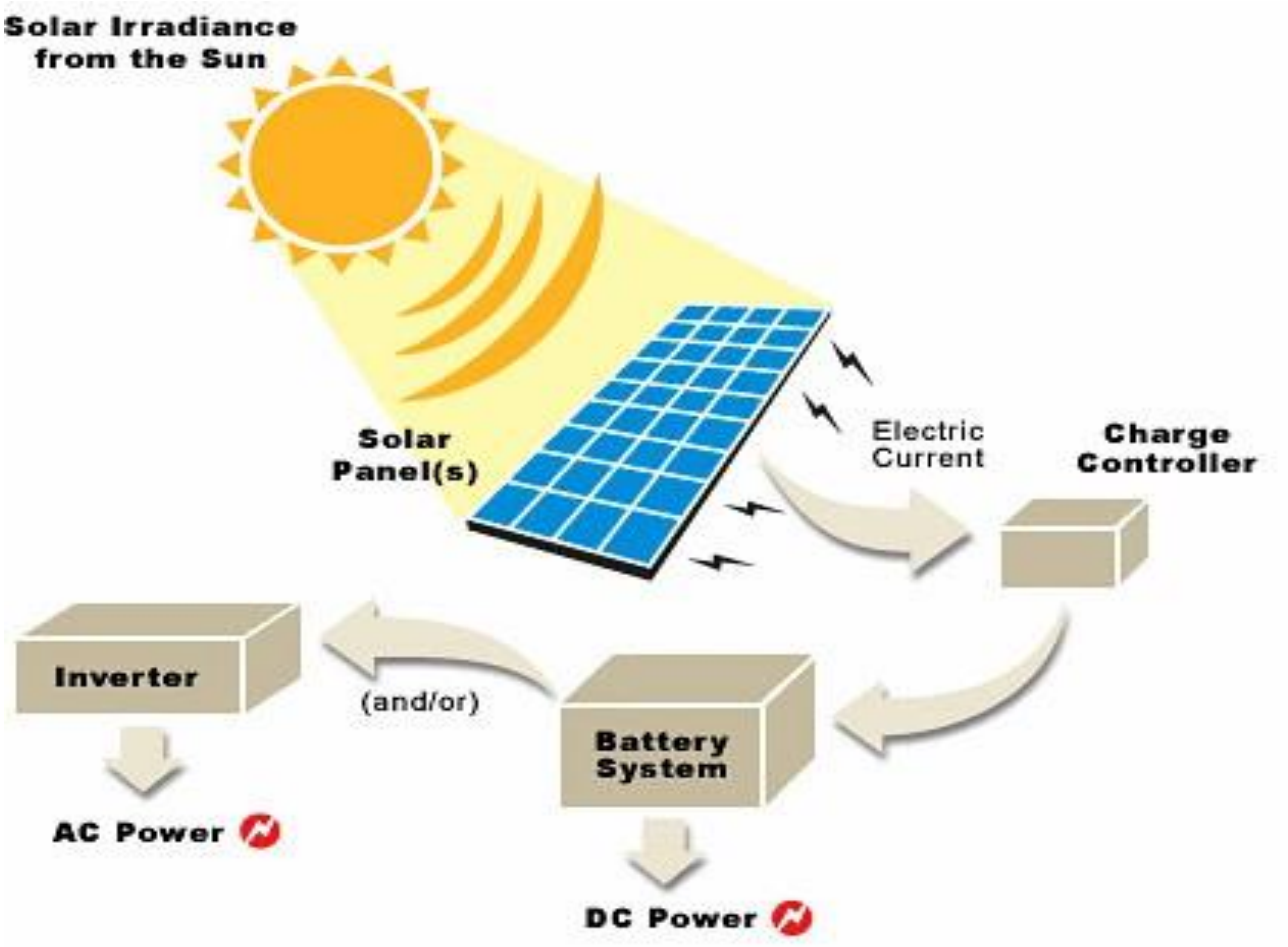
Hydrological cycle



https://www.pinterest.com/pin/786581891137459404/,

Function of Sun Light

Power generation



https://gifer.com/en/7Zgs

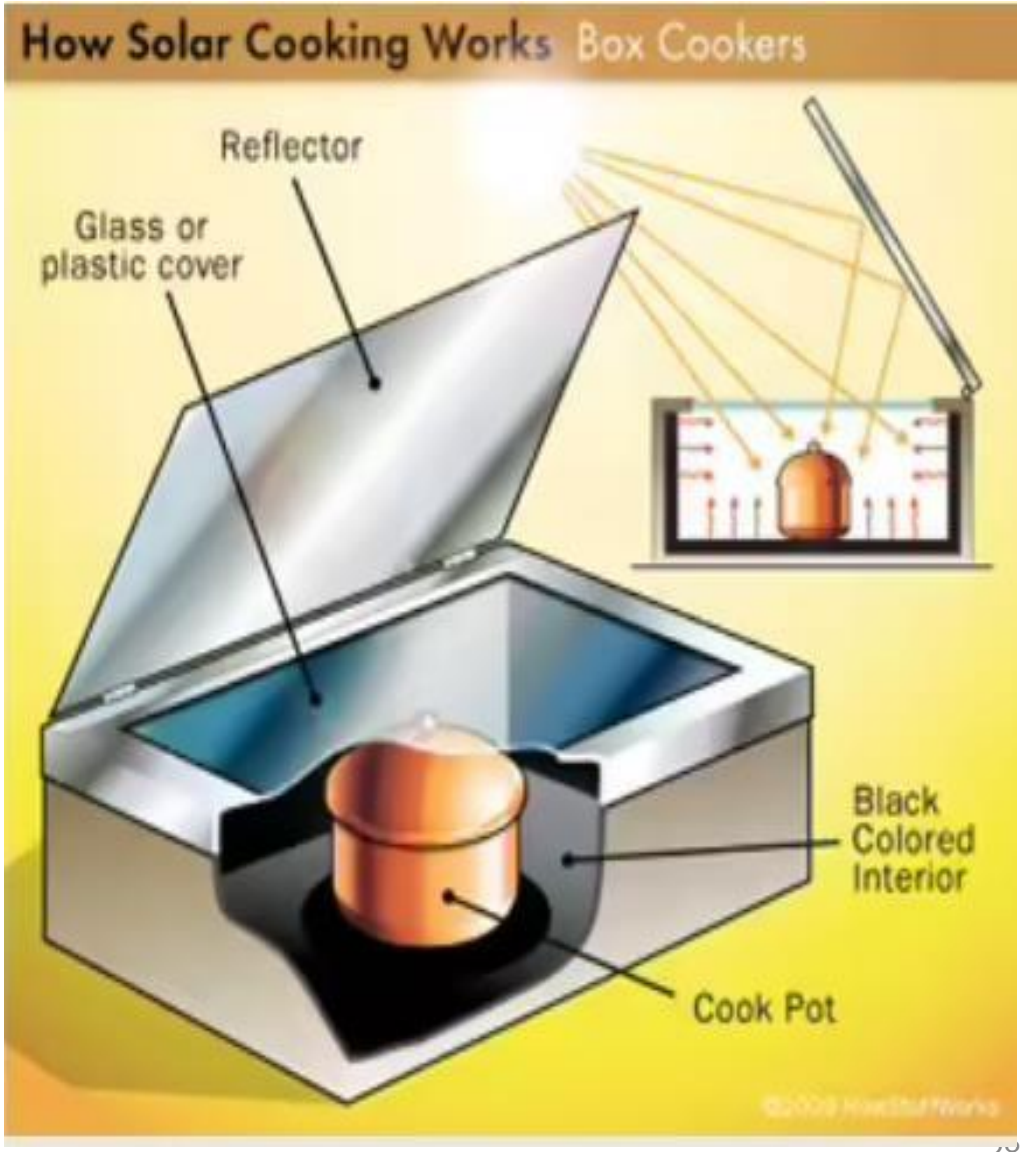
Function of Sun Light

Solar energy can also be converted into heat using various technologies such as solar

- ❖ Thermal Collectors,
- ❖ Solar Water Heaters,
- ❖ Solar Cookers
- ❖ Solar Ovens
- ❖ Solar Air Heaters.

Function of Sun Light

How solar energy
is converted to heat



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Function of Sun Light

How solar energy
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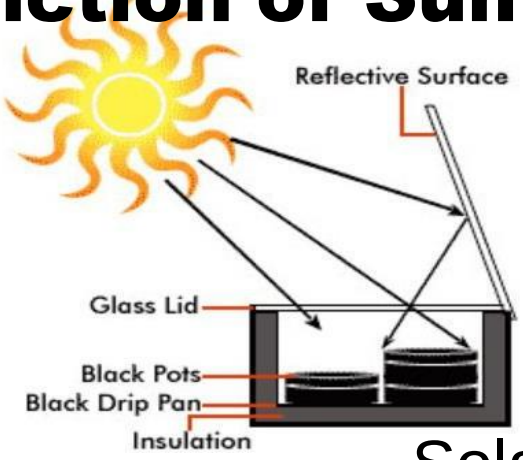


Solar cooker

Solar oven

Function of Sun Light

How solar energy
is converted to heat

Solar air heater

Solar heater

https://www.alibaba.com/showroom/solar-water-heater.html

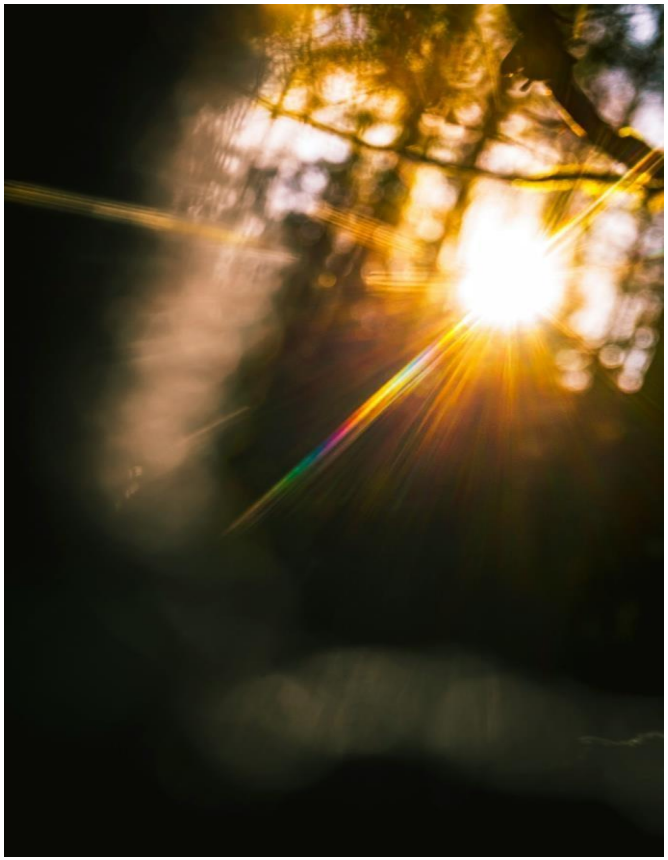
Factors influence the Intensity of Solar Radiation

Solar radiation intensity is influenced by various factors:

Solar radiation intensity is influenced by solar angle, atmospheric conditions, latitude, and season. Direct overhead sunlight is most intense, while factors like cloud cover, water vapor, aerosols, and pollution reduce its reach. Latitude and axis tilt also affect the intensity.

Factors influence the Intensity of Solar Radiation

Solar radiation intensity peaks at noon, decreases in the morning and evening, and increases at higher altitudes due to less atmosphere.



Surface reflectivity affects radiation absorption, with high albedo surfaces reflecting more sunlight and low albedo surfaces absorbing less.

Interactive quiz answers

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d) Planets

Answer:

a) Sun

2. Which form of electromagnetic waves does solar radiation primarily consist of?

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b) Infrared

c) X-rays

d) Gamma rays

Answer:

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3. What is the total solar energy reaching the Earth's surface approximately?

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Answer:

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5. Which component of solar radiation is responsible for photosynthesis in plants?

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Answer:

b) Visible light

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