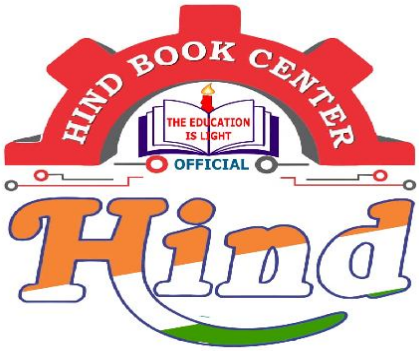

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RSE

BY RAHUL SIR

Reference book

- BH Khan.

BASIC

ENERGY: It is capacity to produce an effect.

Energy can be:

(i) Stored within a system

(ii) Can be transferred from one system to another (By Heat, work, mass)

Oil Crisis of 1973:

This year brought an end to the era of secure and cheap oil. In October of that year, OPEC (Organisation of petroleum Exporting countries) put ban on oil production and started oil-pricing control strategy. The year "1973" is called as year of oil shock.

Government of all countries took this matter very seriously and for the first time, a need for developing source of energy was felt.

Classification of energy Resources:

1. Based on Usability of Energy:

a) Primary energy resource:

These are resources already present in nature prior to undergone any human made transformations. E.g., Coal, crude oil, sunlight, wind, vegetation, uranium.

These are located, explored, extracted, processed and are converted to a form as required by the consumer. These resources are generally available in raw form (i.e., cannot be used as such) and are, therefore known as raw energy resource.

b) Secondary energy resource:

The form of energy which is finally supplied to a consumer for utilization is called as secondary energy resource.

E.g., Electrical energy, thermal energy (in the form of steam or hot water), chemical energy (in the form of hydrogen), oil

2. Based on traditional use:

a) Conventional energy resource:

Energy resources which are being traditionally used for many decades and were in common use around the oil crisis, are called as conventional energy resource.

E.g., Fossil fuel, Nuclear and hydro resources.

coal petroleum

b) Non-conventional energy:

Energy resources which are considered for large scale use after oil crisis. E.g., Solar, wind, biomass, etc.

3. Based on long-term availability:

a) Non-renewable energy resource:

Resources which are finite and do not get replenished (fill up again) after their consumption are called as non-renewable energy resource. E.g., Fossil fuel, uranium. These are also called as brown energy, because produces pollution.

b) Renewable energy resource:

Resources which are renewed by nature again and again and their supply is not affected by the rate of their consumption are called as renewable energy resource.

These are also called as green energy as produces very less or no pollution.

E.g., Solar, wind, Geothermal, Ocean (tide, wave, thermal), biomass, Hydro

Hydro → conventional as well as Renewable Energy Resource

Difficulties in harnessing renewable energy:

- It is present it dilute form (useful energy is very less).
- It is highly fluctuating type of energy. It depends on weather conditions. Hence, continuous supply of such energy can't be ensured always.
- Large area of land is required to produce energy for commercial applications.

Aim of subject:

To find replacement of fossil fuel.

Syllabus:

1.SOLAR RADIATION

2. SILAR COLLECTOR

3. SOLAR APPLICATION

4. ENERGY STORAGE

5. BIOMASS ENERGY

6. WIND ENERGY

7. TIDAL ENERGY

8. PHOTO-VOLTAIC CONVERTORS

9. FUEL CELL

RSL BHARTI SIR

SOLAR RADIATION

SUN (As a Source of energy)

- It is a large sphere of intensely hot gaseous matter.
- Surface temperature of Sun is around 5800K (Effective blackbody temperature calculated by using Stefan-Boltzmann's law)
- Core of Sun:
  Density is round 100 times of water
  Pressure is around 10^9 atm.
  Temperature $(8 \times 10^6 \text{ to } 40 \times 10^6)$K
- Such a higher inner core temperature is maintained by huge energy released due to "continuous fusion reaction". Several fusion reactions have been suggested to be source of energy radiated by the sun. The most important of them is

$$4\,{}_1H^1 \longrightarrow {}_2He^4 + 26.7\ MeV$$

$1\,eV = 1.6 \times 10^{-19}$ Joule.

In above equation, 4 hydrogen atoms combine together to form one helium atom. The mass of helium is less than that of four hydrogens, the difference of mass is been converted to energy in a fusion reaction.

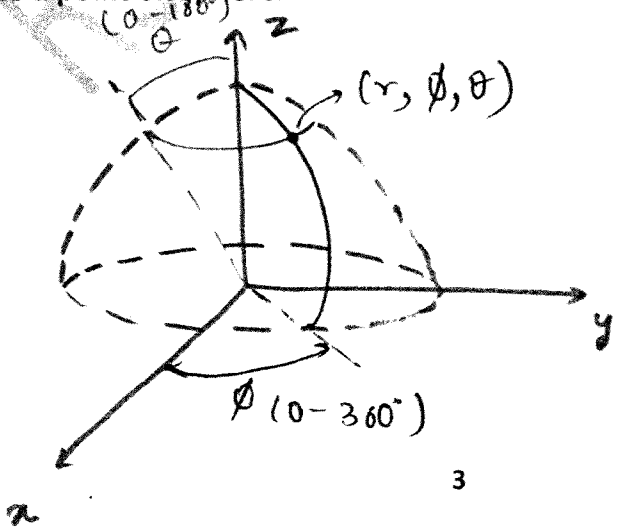
- Solar energy can be used by three technological processes.
  (i) Helio-chemical: Solar → Food + oxygen (Photosynthesis)
  (ii) Helio-electrical: Solar → Electricity (PV cell)
  (iii) Helio-thermal: Solar → Thermal energy (water Heater)
  Pool - Top

Helio ⟶ SUN

SUN AND EARTH GEOMETRY

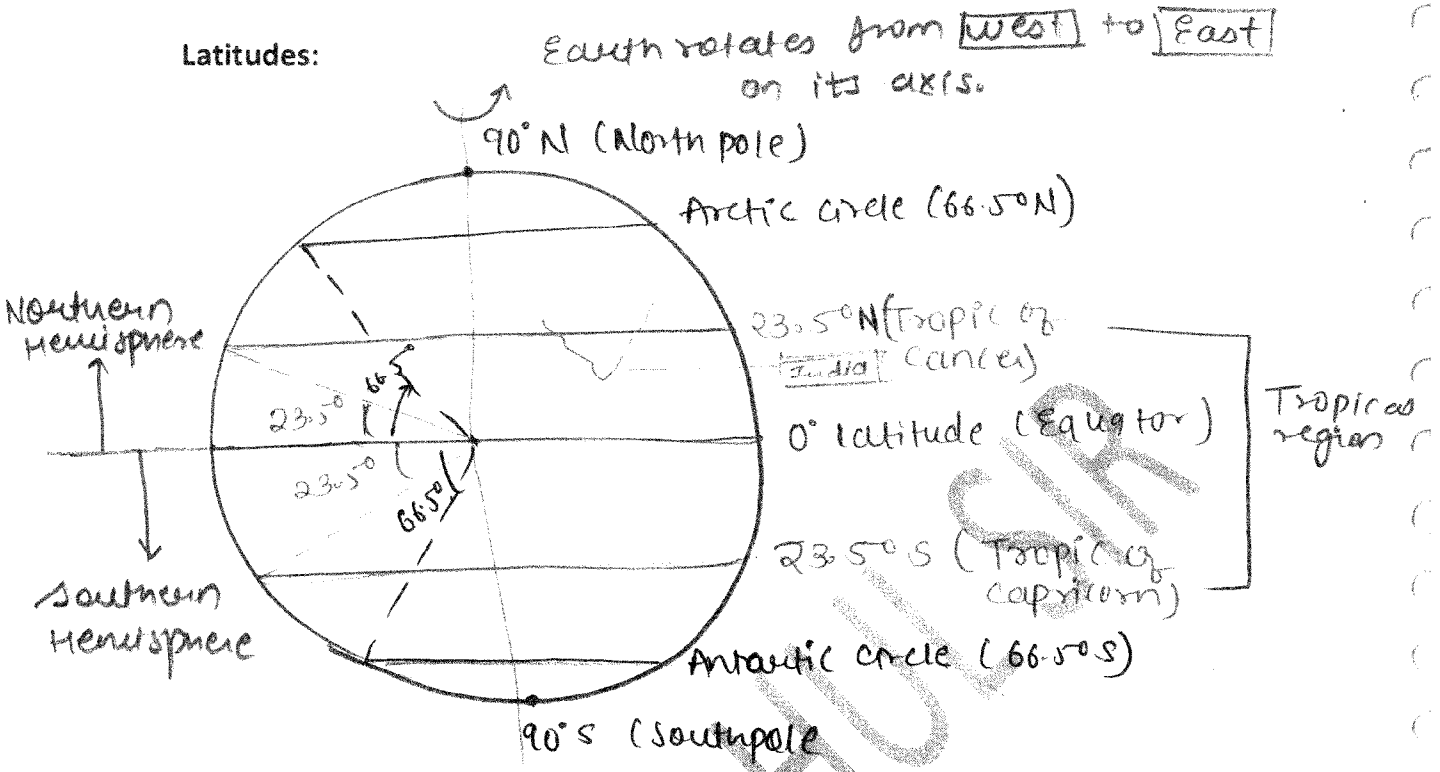
Position on earth: Position on earth is specified by latitudes and longitudes.

Define a point on sphere:



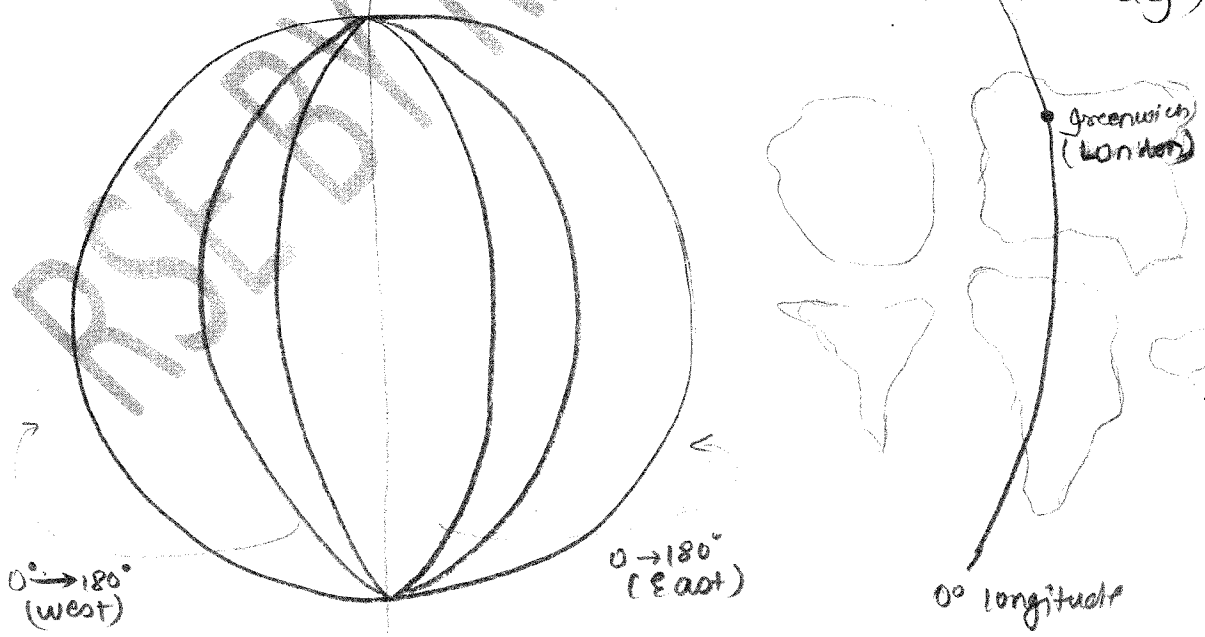
θ, ϕ - symbols for Heat Transfer.

Latitudes:



Longitudes

- Earth completes 1 rotation (i.e 360°) in around 24 hrs. So, it rotates 1° in around 4 mins $\left(\frac{24 \times 60}{360} = \frac{4\text{min}}{\text{deg}}\right)$



0° longitude
(Or)
PRIME MERIDIAN
(Or)
Greenwich Meridian

PREVIOUS

Apparent motion of sun:

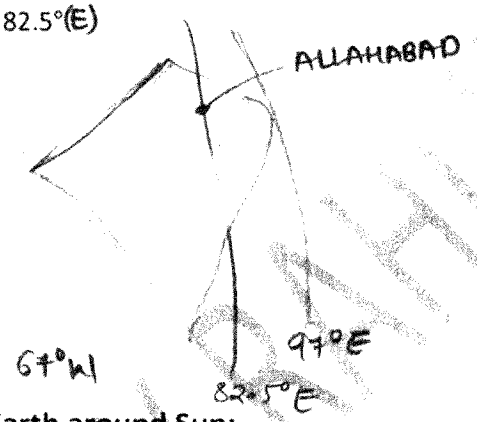
Although sun is stationary in our solar system but due to rotation of earth on its own axis (from west to east) sun appears to be moving from east to west relative to earth at any location on earth.

It appears to rising in east and setting in west to an observer on earth.

Scaling of time on earth:

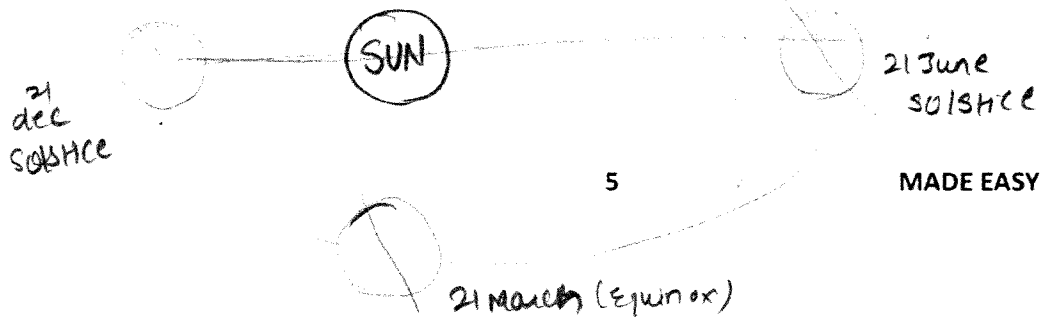
It is done on the basis of sun rising and setting. It can be observed that different places in a country will see rising and setting of sun at different moment. So, for that purpose standard longitude is decided in any particular country to define standard time of that country.

E.g., For India it is 82.5°(E)

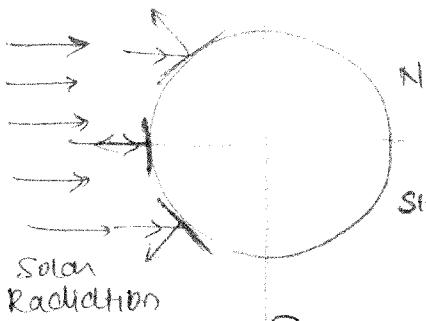


Revolution of Earth around Sun:

- Earth revolves around sun on elliptical path and takes around one year for complete revolution.
- The distance between Sun and Earth keep on varying all around year.
- The earth is tilted on its axis of rotation. As The axis of earth is tilted, both hemisphere northern (NHS) and southern (SHS) receives different amount of solar radiation at different time of year and so have different temperatures.
- **Solstice:** At solstice sun rays are normal on either Tropic of Cancer (21 June) or on Tropic of Capricorn (21 December).
- **Equinox:** At equinox sun rays are normal on Equator (21 march and 21 September).
- **Aphelion**: It is point when distance between earth and sun is maximum (4th July)
- **Perihelion:** It is point when distance between earth and sun is minimum (4th Jan).



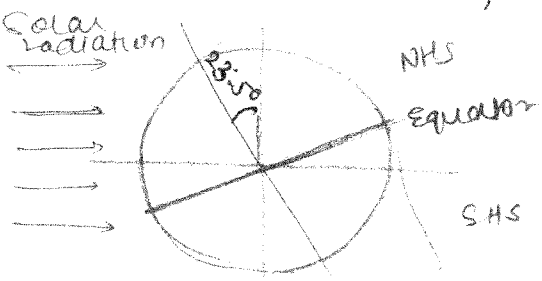
If Axis of Rotation is not tilted



Axis of Rotation

NHS & SHS would receive same amount of solar radiation and would have same season

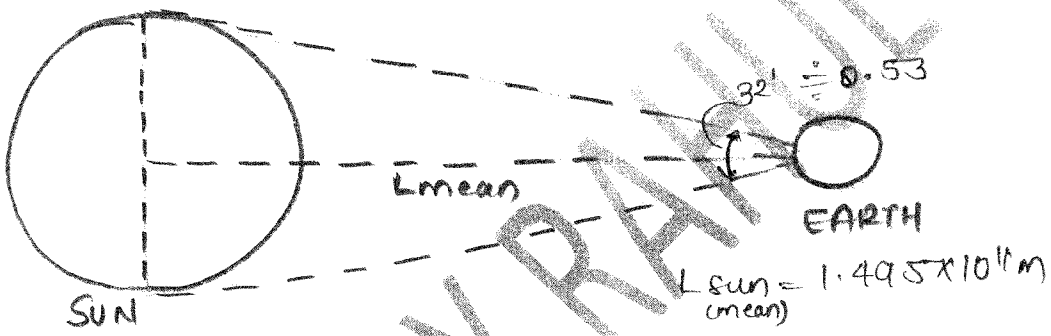
But in actual Axis is Tilted



Both Hemispheres Receives different amount of solar radiation during entire year. So, Both Hemispheres have different temp throughout year.

ONE ASTRONOMICAL UNIT

It is average distance between Sun's centre to earth's surface.



Spectral Energy Distribution of Sun:

It is given by Planck's distribution, treating sun as black body. 99% of extra-terrestrial radiation emitted by sun lies in the range of 0.2 to 4 μm.

In which,

Around 6.4% → Contains UV ($\lambda < 0.38\ \mu m$)

Around 48% → Contains visible region ($0.38\ \mu m < \lambda < 0.78 \mu m$)

Around 45.6% → Infrared region ($\lambda > 0.78\ \mu m$)

Note: Extra-terrestrial radiation peaks in visible range.

RSE BY RAHUL SIR

Solar radiation and earth's atmosphere:

The radiation available on the earth's surface is less than what it is received outside the earth's atmosphere and this reduction depends upon:

1. Effect of atmospheric gases:

The earth's atmosphere contains various gaseous constituents, suspended dust and other minute solid and liquid particulate matter. These are air molecules, ozone, oxygen, nitrogen, carbon dioxide, water vapor, dust, etc.

Atmospheric gases deplete solar radiation by

(i) Absorption: Absorption of various wavelength occurs by different molecules. The absorbed radiation increases the energy of the absorbing molecules thus raising their temperature. Such as ozone absorbs significant amount of UV radiation.

(ii) Scattering: Some scattering of incoming radiation takes place by dust particles and air molecules. A part of scattered radiation is reflected back to space and remaining is directed downward to earth's surface from different directions as **"diffuse radiation"**.

Cloudy atmosphere:

- A major part of incoming solar radiation is reflected back into space by clouds.
- Another part is absorbed by the clouds.
- Rest is transmitted downward to the earth surface as diffuse radiation.

Albedo:

Total solar radiation reflected back to space by earth is called as albedo of earth-atmosphere system. It has a value of 30% of incoming solar radiation.

Terrestrial Radiation: It is a region near to earth's surface.

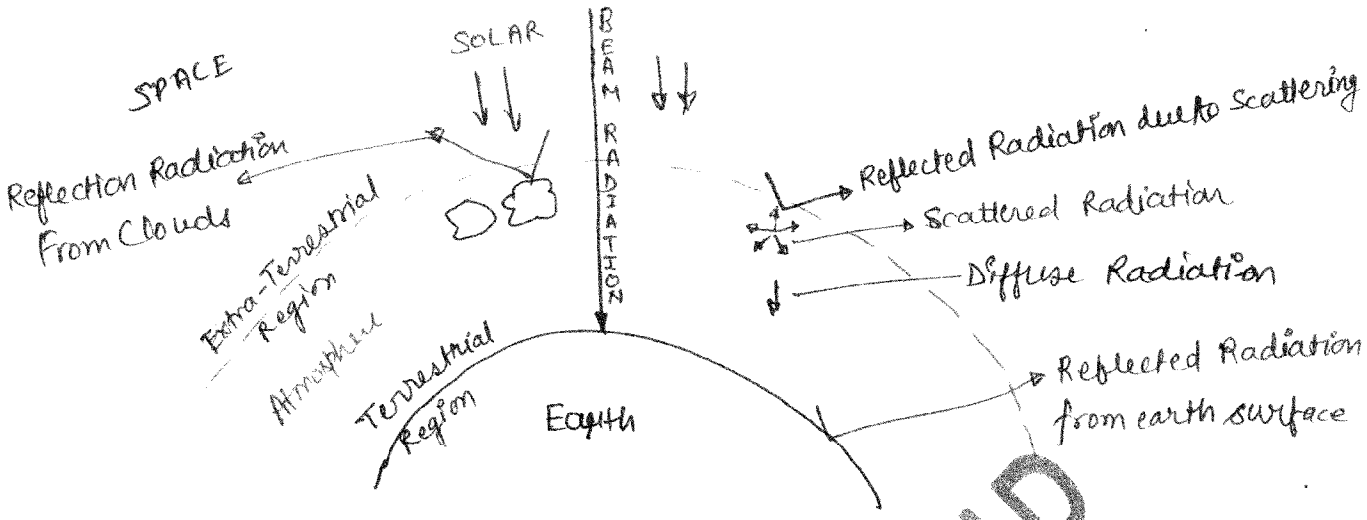
Extra-terrestrial Radiation: It is region on outer most part of atmosphere.

On the surface of the earth, we have two components of Solar radiation:

(a) Beam Radiation: Solar radiation propagating in a straight line and received at the earth's surface without change of direction is called as beam or direct radiation.

(b) Diffuse Radiation: Solar radiation scattered by dust and gaseous molecules is known as diffuse radiation. It does not have unique direction.

(c) Global Radiation: It is sum of beam radiation and diffuse radiation.



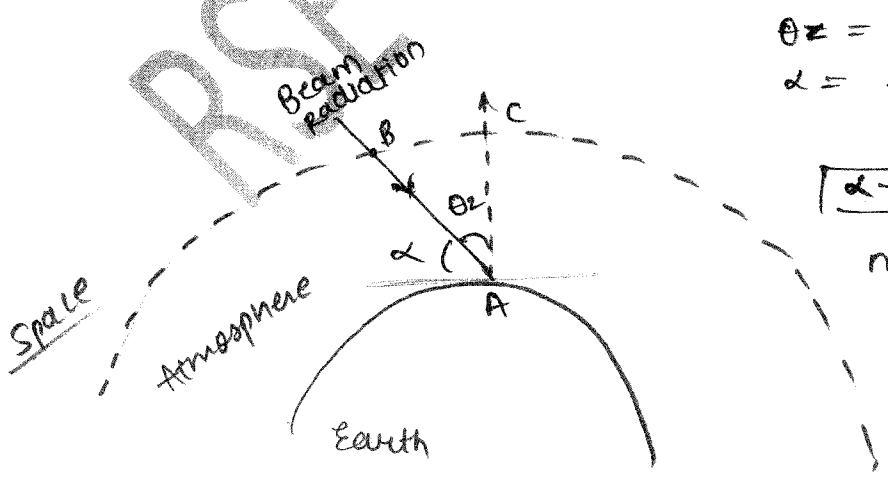
2. Distance travelled through atmosphere:

The second reason for depletion of solar radiation passing through atmosphere is the distance travelled by beam radiation through the atmosphere before it reaches a location on earth's surface.

The path length of a solar beam through the atmosphere is accounted for in the terms of air mass.

Air Mass (m):

It is defined as the ratio of the path length through the atmosphere, which the solar beam actually passes up to ground (BA) to the vertical path length which is minimum through the atmosphere (CA).



θ_z = zenith angle

α = Inclination Angle

$\alpha + \theta_z = 90^\circ$

$m = \frac{BA}{CA} = \sec\theta_z$

$m = \sec\theta_z = \text{cosec}\,\alpha$

$= \text{cosec}\,\theta_z$

$m = 0$:- On Extra-Terrestrial Region

$m = 1$:- It means sun is overhead.

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