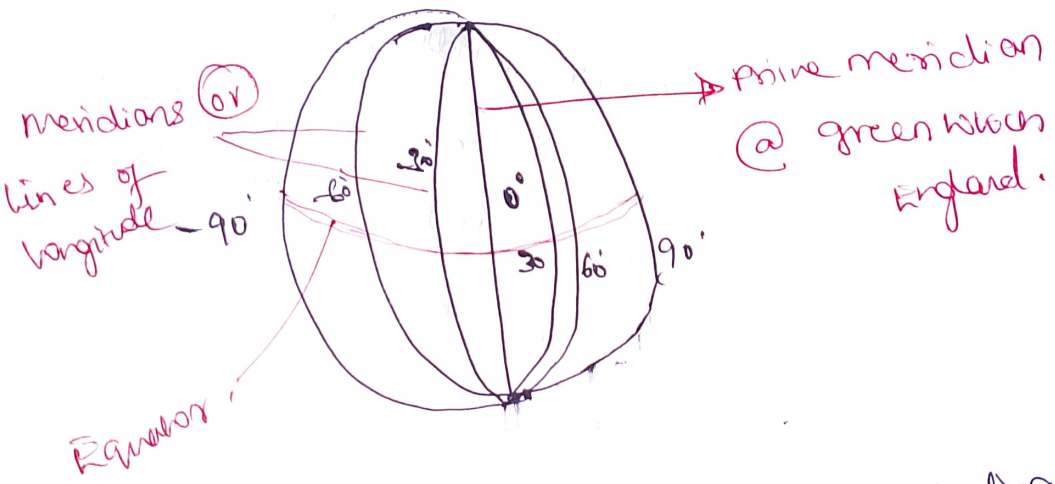
Latitude: The geographic co-ordinates that indicate the distance of a location north-south of the equator are referred as Latitude

Longitudes: Longitudes refers to a geographic co-ordinate that indicates a point's east-west distance from the prime meridian.



Note: India has a vast longitudinal extent, the standard meridian of India lies 82.5° E of the green which meridian.

RENEWABLE ENERGY

Renewable energy is energy that is collected from renewable resources, which are naturally replenished on a human time scale, such as sun-light, wind, rain, tides, wave and geothermal heat.

Based on REN 21's report (2017) renewable contributed 19.3% to humans' global energy consumption and 24.5% to their generation of electricity in 2015 and 2016 respectively.

(Replenished :- to fill (or) complete gain)

Renewable and Non-renewable Energy sources

Non-Renewable energy resources like coal, Nuclear, Oil and natural gas are available in limited supplies. This is usually due to the long time it takes for them to be replenished.

Renewable energy :- There are many forms of renewable energy. Most of these renewable energies depend in one way (or) another on sunlight.

* solar
* wind power
* Hydroelectric energy
* Geo-thermal power.
* Bio-mass is the term of energy from plants
* Hydrogen and fuel cell.

Renewable resources

(1) solar energy
(2) wind energy
(3) Geo-thermal energy
(4) water
(5) Air
(6) soil
(7) cultivated plants
(8) Bio-mass
(9) Bio-fuels
(10) Animals

Non-Renewable resources:

(1) coal
(2) Oil
(3) Peat: peat, commonly found in UK, Ireland (or) Finland.
peat is a soft organic material consisting of partly decayed plant matter together
(4) Uranium (since it is a radioactive element found in ~~tree~~ low amounts within all rocks on earth. It is a Non-renewable resource because of its cosmic origin. The isotopes of uranium were found 6.6 billion years ago in supernovas and do not naturally regenerate

FORMULAE

Note: FOR Problems on Module-I (Conversion II)

15

Indian standard time: I.S.T

Day of the year, n.

n varies from 1 to 365

Example: Jan 1st; n=1, and so on

Declination angle.

$$\delta = 23.45 \sin\left[\frac{360}{365}(284+n)\right]$$

(VTU) point out the Renewable Energy scenario in India.

Ans (as on 2021)

AS on 31 DEC 2021

→ wind power → 40.08 GW

→ solar power → 49.34 GW

→ Bio-power → 10.61 GW

→ Small Hydro power → 4.83 GW.

→ Large Hydro → 46.51 G.W.

45 solar parks of aggregate capacity of 37GW approved by Govt. of India

solarparks in Pavagada (2 G.W), (in Karnataka)

KURNOOL (AP) → (1 GW)

Bhadla-II (Rajasthan) 648 W.

World's largest renewable energy park
≥30 GW capacity solar-wind hybrid.
project is under installation in
Gujrat.

Various Renewable Energy sources (RES)

1) Solar power on the surface of the earth is 10^{16} W where as the total world wide power demand for all civilization is 10^{13} W.

Sun gives 1000 times more power than actually needed.

2) Wind power

Installed capacity as on
2018 → 34,293 MW
target for 2022
60,000 MW (wind power based Electricity)

3) Bio-Energy :- Bio-mass is a resource of renewable energy that is derived from carbonaceous waste of human & natural activities.

Bio-Energy encompasses bio-mass power, Bagasse co-generation, waste to energy, biomass gasifier, bio ethenol, bio-diesel etc.,

Biomass Energy in India
16,000 MW from biomass energy
3500 MW from Bagasse co-generation.

Seconds to decimal (Conversion 16

D° M' S'' → Degrees

Note: 1hr → 1Degree

60 min = 1hr

3600 sec = 1hr.

Convert $45^\circ\ 28'\ 32'' = 45^\circ + \frac{28}{60} + \frac{32}{3600}$

$= 45.4756^\circ$

Determine the LAT corresponding to 14:30h @ mumbai (19° 07'N, 72° 51'E) on July 1, in india, Std time is based on 82.5°E

$E = 9.87 \sin 2B - 7.53 \cos B - 1.5 \sin B.$

$B = (n-81)\left(\frac{360}{364}\right)$,

$LAT = IST - 4(L_{std} - L_L) + E$

$n = 182, \quad B = 99.89$

$E = -3.54.$

$LAT = 14.30h - 4(82.50 - 72.85)\ min + (-3.524)\ min$

$= 14.30h - 42.1\ min$

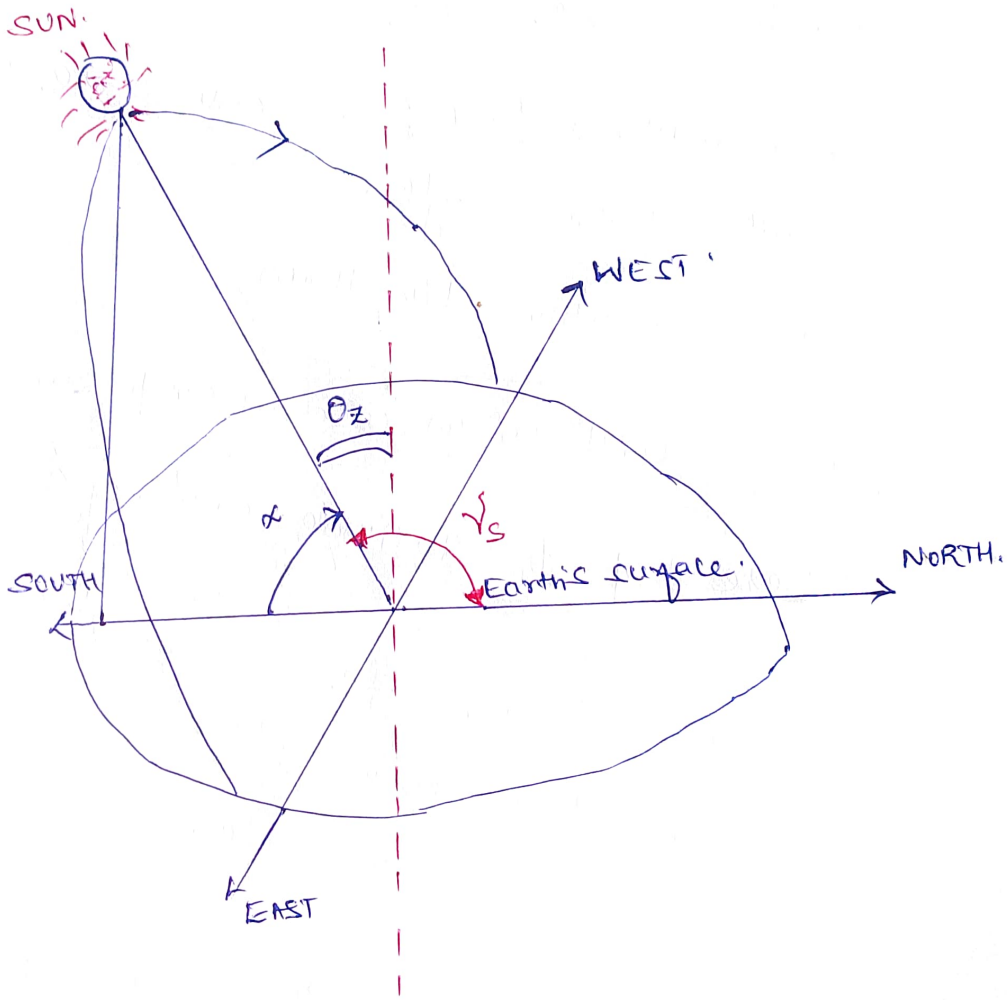
$= 13hr\ 47.9\ min$ //

Note:

Earth rotates 1° longitude every 4 minutes.
(4 minutes | degree)

in other words (1 degree = 4 minutes in GMT)

Altitude angle (α): It is the vertical angle between the projection of the sun's rays on the horizontal plane and the direction of suns rays (passing through the point).



ZENITH ANGLE: Zenith angle (θ_z) is the vertical angle b/w the suns rays and a line perpendicular to the horizontal plane through the point. * It is the angle b/w the beam

from the sun and the vertical otherwise.

Zenith angle (θ_z) is the complimentary of sun's altitude angle.

$$\theta_z = \frac{\pi}{2} - \alpha$$

{Note: mathematically two angles are complementary when they add upto 90°.}

Altitude angle (α), zenith angle θ_z and Solar azimuth angle (γ_s) hour angle (ω) are all basic angles.

The relation btw them.

$$\cos\theta_z = \cos\phi \cos\omega \cos\delta + \sin\phi \sin\delta$$

Where $\phi = \phi_L$ = latitude angle of the location.

θ_z = zenith angle.

ω = hour angle

δ = declination angle.

also

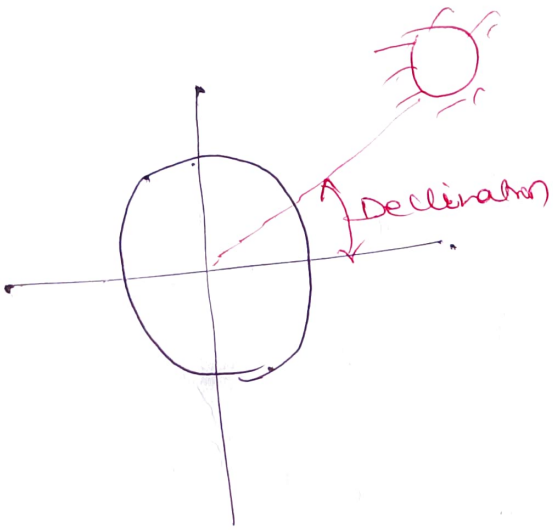
$$\delta = 23.45 \sin\left[\frac{360}{365}(284+n)\right]$$

(in degrees)

$$t_d = \frac{2}{15}\cos^{-1}(-\tan\phi\tan\delta). \quad \text{(A)}$$

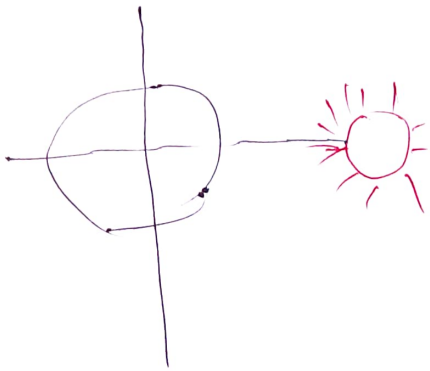
from equation 'A' we note that length of the day (t_d) (or) DAY length is the function of latitude and solar declination.

Declination angle



δ = +ve

Summer solstice in Northern hemisphere

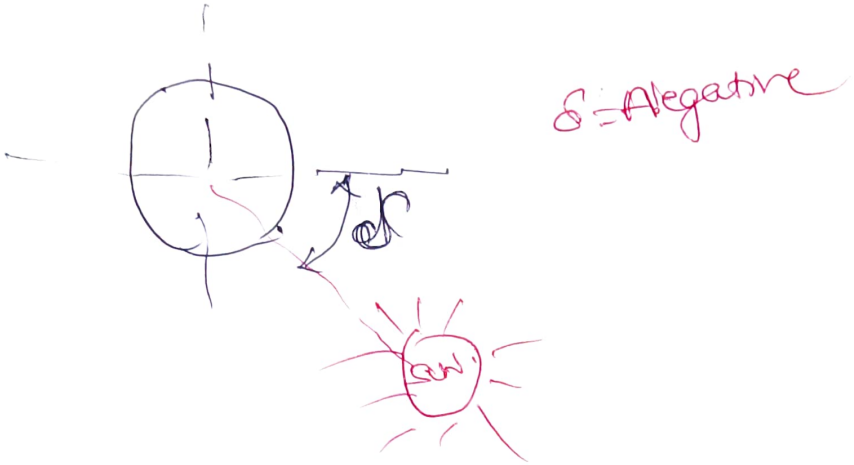


Equinox.

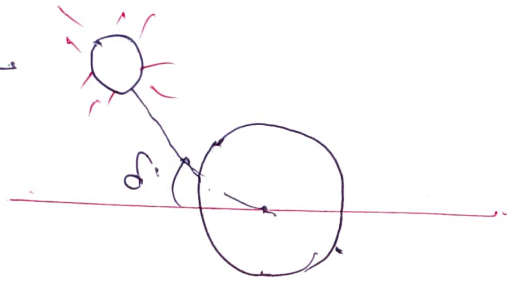
equinox days.

(moment in time when Sun crosses the earth's equator.

(March 23 & September



In general



$$LST = LT + 4(\text{Standtime longitude} - LSTM) + EOT$$

LST = local solar time

LT = local time

4 = Earth rotate 1 degree longitude every 4 minutes. (4 minutes/degree)

~~LSTM~~ = (Stand time longitude

LSTM = local standard time meridian.

R.E.S
(NAGESH)

EEE563.

Renewable Energy sources. (1)

Renewable energy is energy generated from natural resources - such as sunlight, wind, rain tides and geothermal heat - which are renewable (naturally replenished)

Renewable energy sources.

* Biofuel
* Biomass
* Solar
* Hydropower
* Geothermal
* TIDAL
* WAVE & WIND.

Hydropower — A power source that is clean and renewable - it doesn't pollute the air because no fuels are burned and it's renewable because it uses the Earth's water cycle to generate electricity (Assuming global rainfall - constant) Hydropower is renewable.

Geothermal energy is heat energy generated and stored in the earth. The thermal energy is the energy that determines the temperature of matter.

Geothermal energy of the Earth's crust originates

R.E.S in India.

Renewable energy in India comes under purview of the ministry of new and Renewable Energy (M.N.R.E).

Standard definations:-

Renewable energy: Energy obtained from natural & persistent flows of energy occurring in the immediate environment An obvious example is solar (Sun-shine) energy.

Non-Renewable energy:- Energy obtained from static stores of energy that remain underground unless released by human Interaction fuels, Example:- Nuclear, fossil fuels of coal Oil, natural gas.

Environmental energy

Total solar flux absorbed at sea level is about 1.2×10^{17} W.

Thus solar flux reaching the Earth's surface is ~ 20MW per person

Solar → solar radiation absorbed by the earth and its atmosphere is 3.8×10^{24} J/yr.

Form of Energy → low temp heat.

Wind: The kinetic energy available in the atmosphere circulation is 7.5×10^{20} J.

Form of ~~heat~~ Energy → Electricity.

Biomass :- Total solar radiation absorbed by plants is 1.3×10^{21} J/year.

Form of Energy → High temperature heat

World's standing biomass has energy content of about 1.5×10^{22} J.

Form of Energy → Bio-gas (cooking mechanical power)

Geothermal :- The heat flux from the earth's interior through the surface is 9.5×10^{20}

Form of Energy → low temperature heat.

Total amount of heat stored in water stream to a depth 10 km is estimated to be 4×10^{21} J; that stored in the first 10km of dry rock is around 10^{27}

(or)

Tidal.

Energy dissipated in connection with slowing down the rotation of the earth as a result of tidal action is around 10^{26} J.

Form of energy → Electricity.

Large tidal barrage is in operation - La Rance in France.

Total installed capacity is about 240 MW.

Wave:

The amount of energy stored as kinetic energy in waves is order of 10^{18} J.

Form of Energy → Electricity.

Hydro :- The annual precipitation land amounts to 1.1×10^{17} kg of water. Taking average elevation of land area as 840m, the annually accumulated potential energy would be 9×10^{20} J.

Form of Energy → Electricity.

World's Hydroscheme → 40% of Electricity → 363 GW.

Biomass and Biogas.

Bio-mass is produced in nature through photosynthesis achieved by solar energy conversion.

Biomass ⟹ organic matter.

Bio-mass resources fall into 3 categories.

1) Bio-mass in non-traditional solid mass (wood and agricultural residue)
2) Biomass in non-traditional form (converted into liquid fuels).

First category is to burn the biomass directly and get the energy.

In the second category the bio-mass is converted into ethanol and methanol to be used as liquid fuels in engines.

(3) The third category is to ferment the bio-mass anaerobically to obtain a gaseous fuel called biogas.

Bio-GAS → 55% to 65% Methane
30% to 40% CO_2
+ impurities H_2, H_2S and N_2.

Bio-mass resources include

(a) concentrated - waste - municipal so
sewage, wood products, Industria
wastage.

(b) disposed manure, crop residue etc.

BIO-GAS! :- The main source for producn of Bio-gas is wet - cowdung (or) wet live stock (human).

In India cattle population is 250 million so the main source for bio-gas is cowdung.

Sewage! — Sewage water contains 84% methane → could be effectively used to run engines to drive ellric generator.

SOLAR - RADIATION AND ITS MEASUREMENT

Sun is a large sphere of very hot gases, the heat being generated by various kinds of fusion reactions.

sun's diameter = 1.39×10^6 km.

Earth's diameter = 1.27×10^4 k.m.

Mean distance b/w earth & sun
= 1.50×10^8 k.m.

NASA: National Aeronautics and Space administration.

As per NASA solar constants are as under

⇒ 1.353 Watts per square metre.

⇒ 1165 K cal per sqmetre/hour.

(OR) 1 Langley = 1 cal/cm² of solar radiation received in one day.

116.5 Langleys (calories per sq cm) per hour.

⇒ 429.2 BTU per sq ft per hour.

Note: (1)

Potential Energy:- The energy possessed by a body because of its position relative to others, stresses within itself, electric charge and other factors.

Kinetic energy is energy of an object due to its movement - its motion.

Kinetic energy = $(\frac{1}{2})$ (mass) (velocity)².

Note (2)

1 KW = 3412.142 BTU/hr.

1 BTU/hr = 0.000293071038 KW.

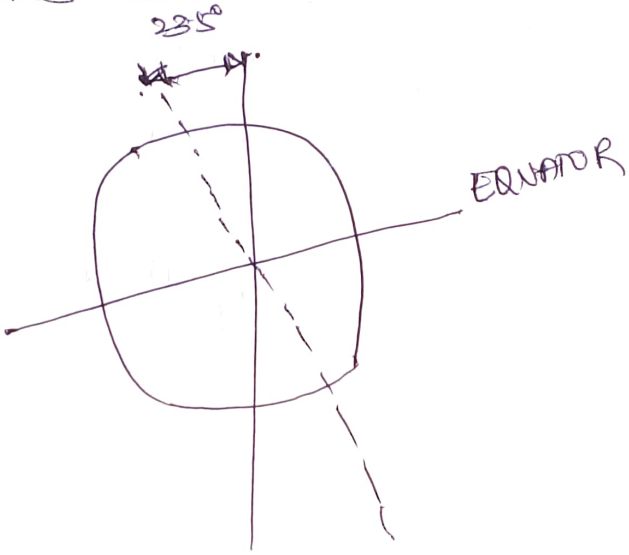
1 KW = 859,845.23 cal/hr.

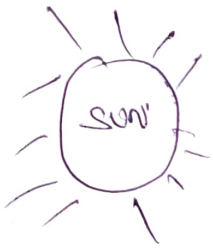
1 cal = 4.1868 Joules

SUN-EARTH RELATIONSHIP.

The earth's axis is inclined 23.5° from vertical.

The earth's axis tilted to 23.5 degrees



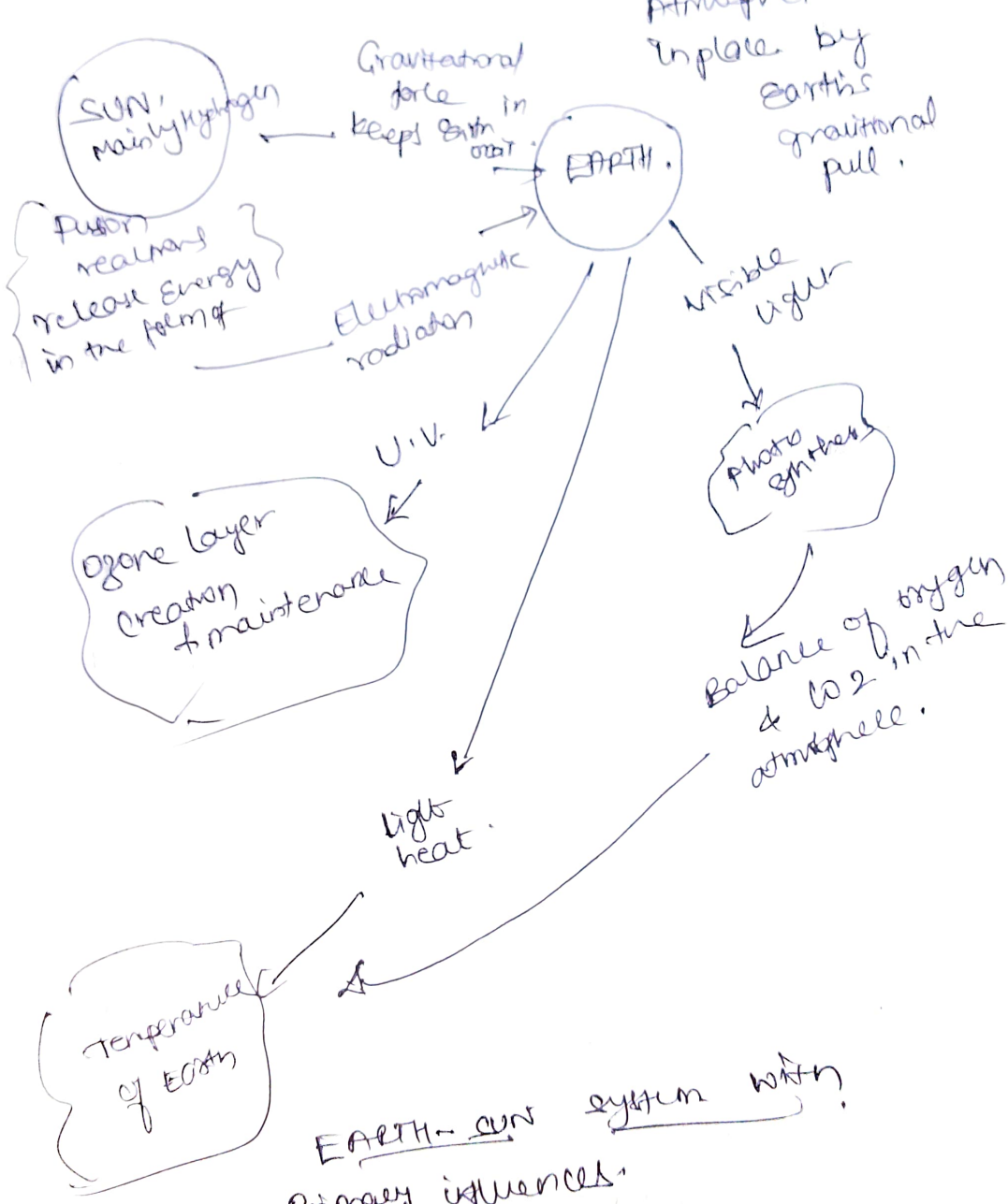


The earth's immediate physical environment is patterned by 3 primary influences

(1) nearness of the sun

(2) The earth's atmosphere, a mixture of gases held in a layer surrounding the earth by the earth's gravitational force. This layer has reached the current and somewhat steady composition of approximately 80% Nitrogen and 20% of oxygen

(2.) The composition of solid rocks of the earth, which gives rise to the material in and on the earth (including water, an essential to our type of life), also resulting from the composition and manner of the origin of the earth is the temperature of the Earth's core.

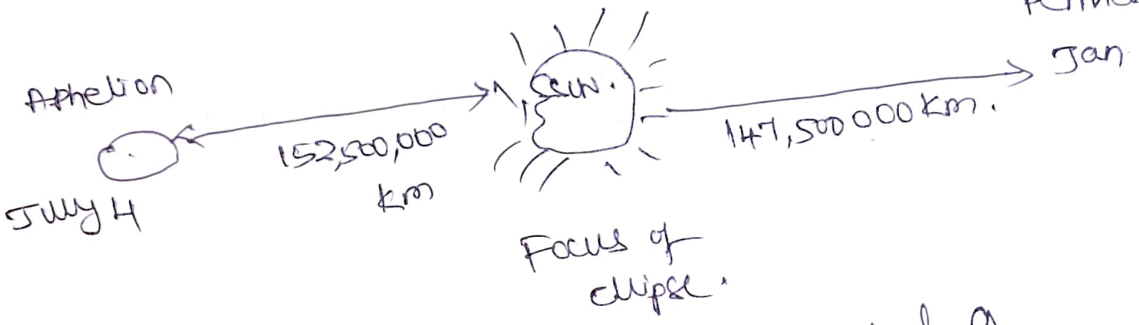


EARTH - SUN system with Primary influences.

Different components of the suns solar spectrum interact with the atmosphere.

Earth rotates about on a tilted plane that is tilted 23.5° w.r.t its vertical axis around the sun. The earth needs 23 hours 56 minutes to complete one true rotation,

Orbit of Earth about the sun is not circular



One orbit around the sun is called a revolution

On revolution takes 365 days (or) one year to complete.

Aphelion distance $= 9.45 \times 10^7$ miles

perhelion distance $= 9.15 \times 10^7$ miles

[1 mile = 1.609 km].

SOLAR ENERGY Reaching earth's surface

Terrestrial radiation is the solar radiation that is reaching the earth's surface and useful on the earth.

Extraterrestrial radiation is the solar radiation that is not reaching the surface of the earth.

Due to the elliptical shape of the earth's orbit around the sun the distance between the earth and sun varies continously throughout the year there will be a variation of terrestrial flux on the earth. The intensity of solar radiation I can be given by

$$\frac{I}{I_{sc}} = 1 + 0.033 \cos\left(\frac{360(n-2)}{365}\right) \quad \text{— (A)}$$

Where I = intensity of solar radiation.

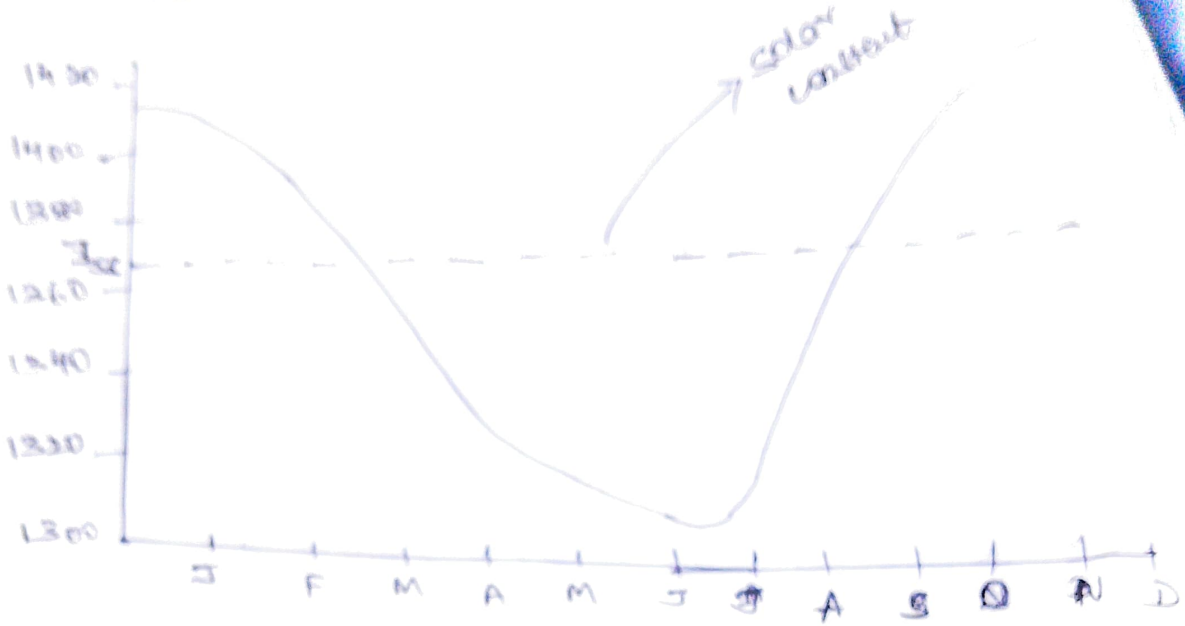
I_{sc} = solar constant. (1.293 kw/m² to 1.412 kw/m²).

n = day of the year. { Eg for Jan 1st n=1 }.

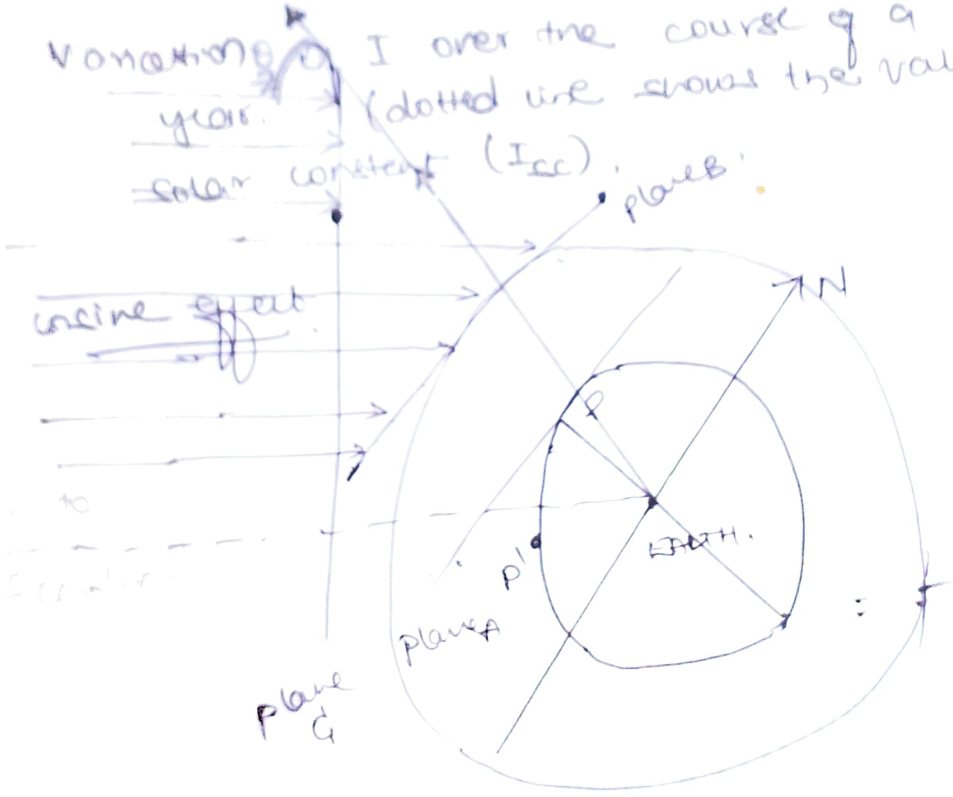
We note that the solar radiation vary with season and regions

The solar radiation intensity falling on a surface is called irradiance (or) Incolation. and is measured by w/m² (or) kw/m².

Variation of I over the course of a year.



Variation of I over the course of a year. (dotted line shows the value of solar constant (I_{sc}).



Limits of Earth's atmosphere.

* Plane A - Horizontal plane at the point P on the earth's surface

* Plane B: surface parallel to plane A on the edge of earth's atmosphere. (Horizontal plane)

* Plane C → surface perpendicular to the sun rays. (normal plane).

Solar constant :- $[I_{sc}]$: It can be defined as total energy received from the sun per unit time on a unit area kept perpendicular to the sun rays at a mean distance from the sun on the earth.

Solar constant is subjected to the variation of ± 4·4% the

Solar const ranges 1·293 KW/m² to 1·412 KW/m².

Solar radiation at earth's surface: (Terrestrial solar radiation)

The solar radiation reaching the earth's surface can be divided into two types

- Beam radiation (Direct radiation).
- Diffuse radiation

Beam or direct radiation: It is the solar radiation received directly from the sun in a single direction.

Beam radiation exists above earth's atmosphere

As soon as sun-radiation enters the earth's atmosphere it is absorbed and scattered by the water vapour and dust in the atmosphere.

The scatted and absorbed solar radiation having less intensity than the beam radiation is called diffuse radiation.

The sum of both the beam and diffuse radiation flux is called total (or) global radiation.

MEASUREMENT OF SOLAR RADIATION

The instruments for solar radiation measurements are * Sunshine Recorder

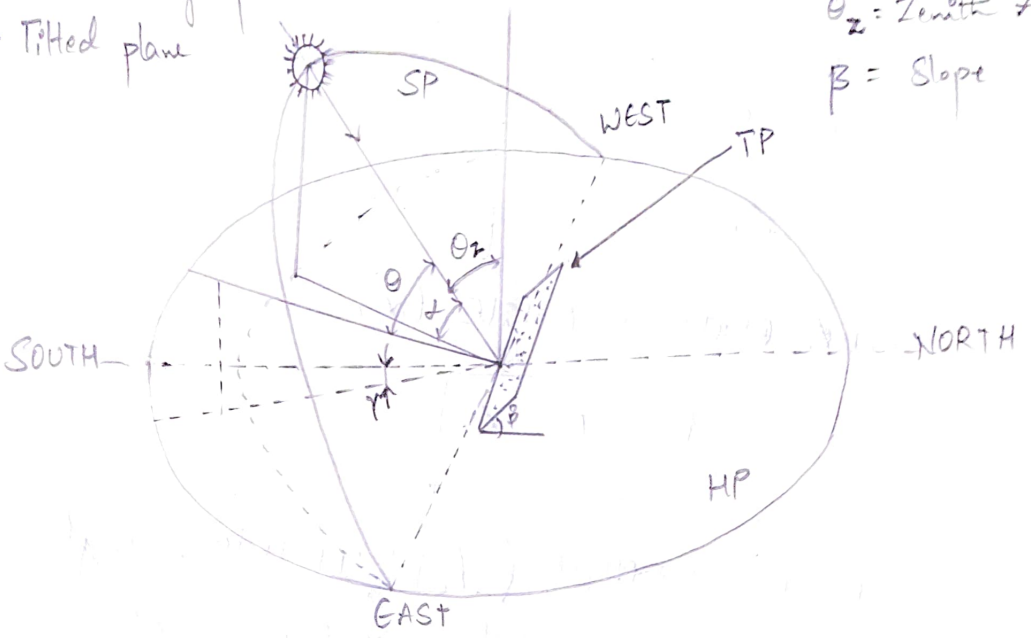
* PYRHELIOMETER.
* PYRANOMETER.

SUN-SHINE RECORDER

Standard definitions. (w.r.t SOLAR RADIATION GEOMETRY)

HP - Horizontal Plane
SP - Sun rays plane
TP - Tilted plane

γ = Solar azimuth angle
α = Altitude Angle
θ = Incident Angle
θ_z = Zenith Angle
β = Slope



SOLAR ANGLES

Incident angle (θ): It is the angle made between the incident beam and the normal to the tilted plane. If I is the intensity of solar radiation, with incident angle θ, then the flux (or) radiation intensity falling normal to the surface is given by, $I \cos\theta$.

Altitude angle (or) solar altitude angle (α). It is the vertical angle made between the projection of the sun's rays on the Horizontal plane, and the direction of sun's rays.