Residence Time → Time spend in the reservior.

$RT = \frac{\text{Content}}{\text{Flux.}}$

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Hydrological Cycle

Precipitation ↓ Evaporation ↑

Surface of Earth.

RT of water in Earth Atmosphere.

Liquid converted into the ppt

2.5 cm depth

Average ppt = 1 mt/year = 1 meter/year

Global Average

$$RT = \frac{\text{Content}}{\text{Flux}}$$

$$= \frac{2.5\,cm}{100\,cm/year}$$

$$= 0.025\,years$$

$$= 0.025 \times 365$$

$$\boxed{RT = 9\,days}$$

(2)

Residence Time of Water in Ocean.

$$RT = \frac{\text{Content}}{\text{Flux}}$$

Ave. depth = 5 km

= 5000 mt

$$= \frac{5000\,mt}{1\,mt/year} = 5000.$$

$$\boxed{RT = 5000 \text{ Years}}$$

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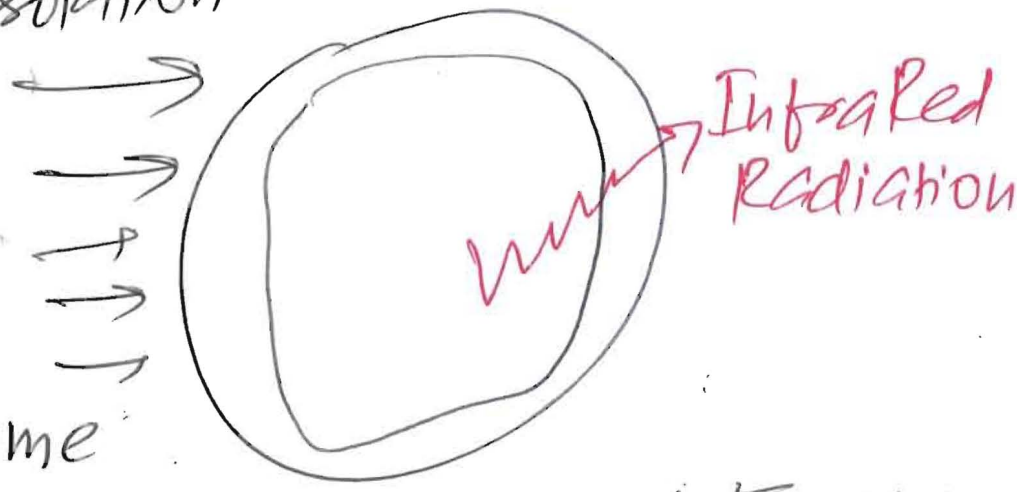
Energy Budget of Earth and Green House Cases.

(8)

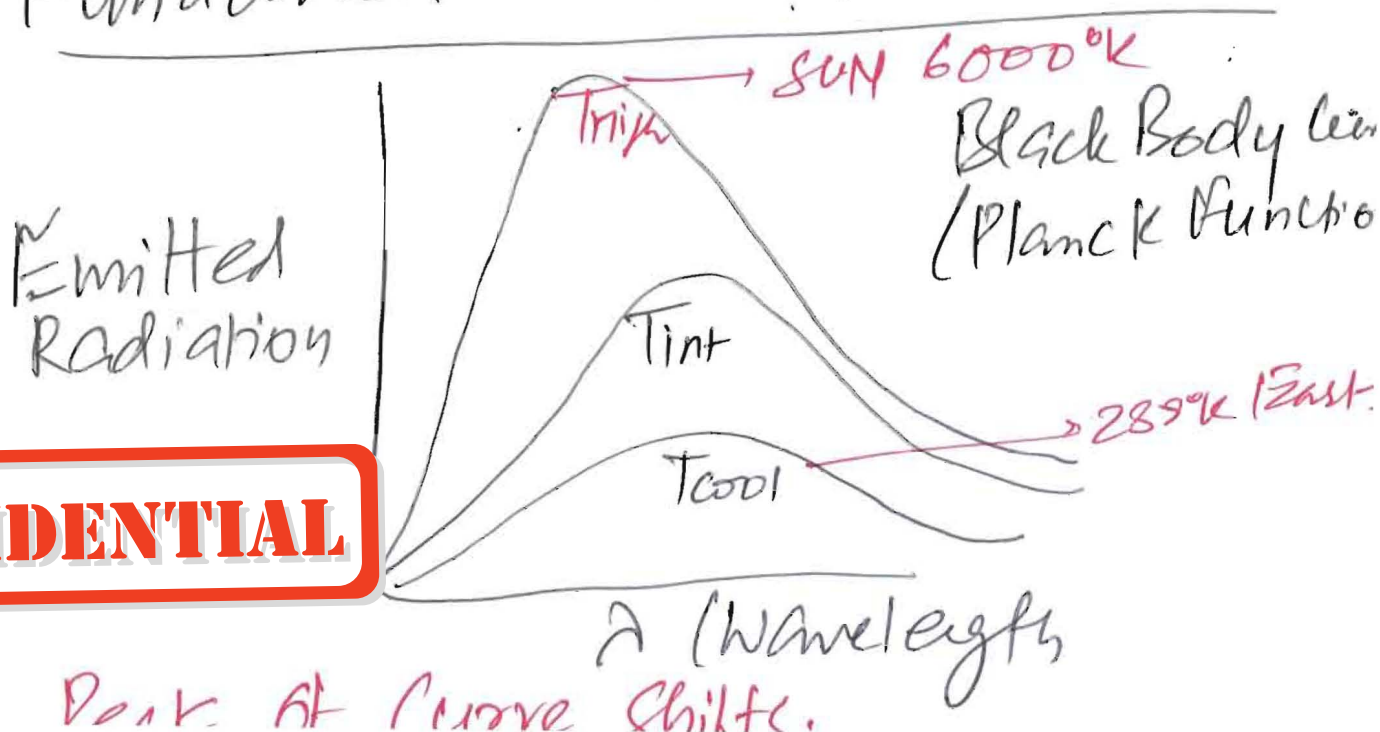
Insolation.



Assume

1) Neglect Geothermal Energy
2) Assumption Uniform Temperature
3) Steady State Condition.

Fundamental Laws of Radiation



Peak of Curve Shifts.

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Colour of the Radiation changes as the temperature changes. (Obje
Area increases also increases.
Shift in the peak Refers to Wien's Law.

(4)

$$\lambda_{max} = \frac{2897}{T(K)}$$

1 micron = 10^{-6}m.

Electromagnetic Spectrum

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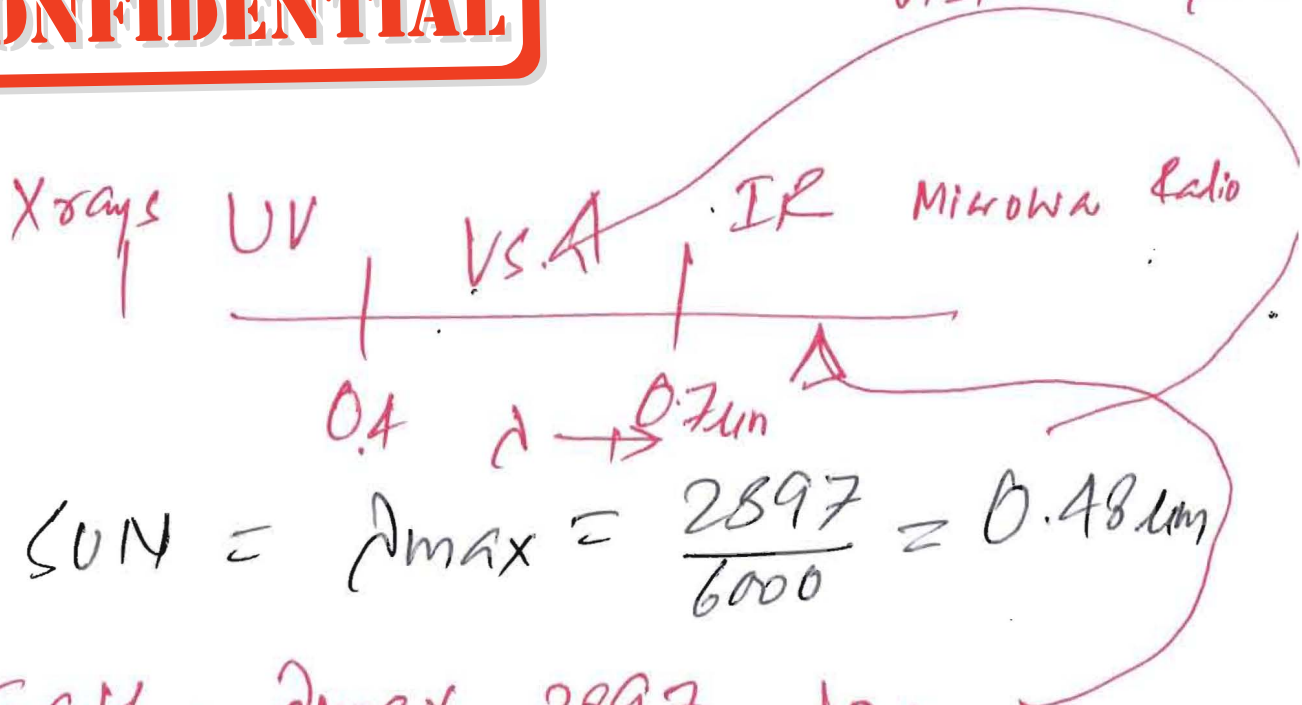

SUN = $\lambda_{max} = \frac{2897}{6000} = 0.48\mu m$

Earth = $\lambda_{max} = \frac{2897}{300} = 10\mu m$ = IR spectrum

Thermal IR region.

Radiation coming from SUN in one range and outgoing in the different Range. (5)

→ Key to understand GHG Concept

Stefan Boltzmann Law

Total Power area under curve

$$\frac{\text{Power}}{\text{Area}} = \sigma T^4$$

σ → Stefan Boltzmann Constant

$= 5.735 \times 10^{-8}$ Watt/m²/K⁴

Sense of Both the Laws.

Double the temperature then the energy increased 4 times x4 times = 16 times

→ White light sum of all spectrum.

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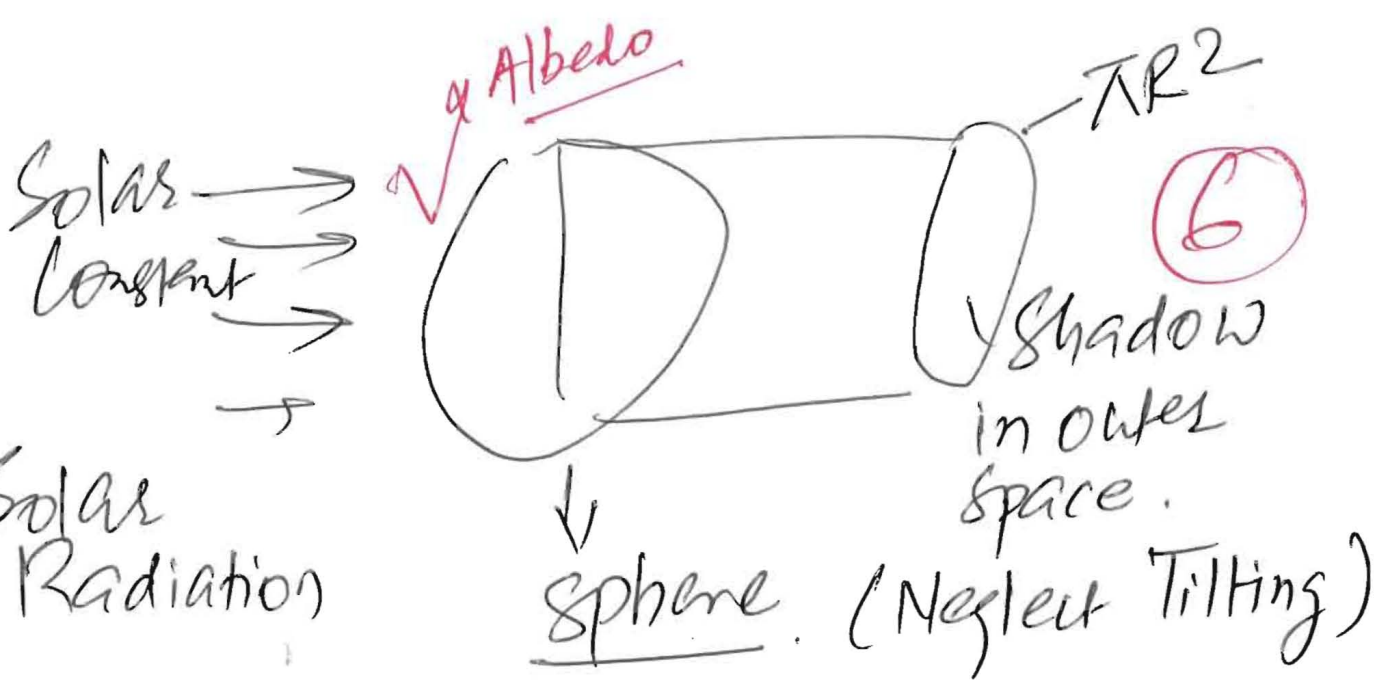

6

Solar Constant 1380 W/m²

Area = πR^2

= R Radius of Planet.

Intercepted Radiation

$= S\pi R^2$

S = Solar Constant.

Albedo = Average Reflectivity of Planet

Earth = 0.33 or 33% = a

Absorbed Radiation

$S\pi R^2 (1-a)$

$= S\pi R^2 (1-0.33)$

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Emitted Radiation

Actual surface area of sphere

$= 4\pi R^2$

Emitted Radiation

$= 4\pi R^2 \times T^4$

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Steady state Assumption

$$S\pi R^2(1-a) = 4\pi R^2 \sigma T^4$$

$$S\pi R^2(1-a) = 4\pi R^2 \sigma T^4$$

→ No direct impact of Radius of the planet.

$$T^4 = \frac{S(1-a)}{4\sigma}$$

$$T_k = \left[\frac{S(1-a)}{4\sigma}\right]^{1/4}$$

$$T°K = \left[\frac{1380(1-0.33)}{4\times(5.73\times10^{-8})}\right]^{1/4}$$

$T_k = 252°K$

= Predicted Temperature for Earth.

(8)

$T = 252°K$

$T° = -21°C$

Predicted or Calculated

$T°_{Actual} = 288°K$

$= 15°C$

The temperature increased or conducive to survive because of Green House Gases.

GHG = CO_2, H_2O, CH_4, NO_2

Blanket of Earth is atmosphere and GHG present in that.

UV, Vis.

IR

Absorbs

IR

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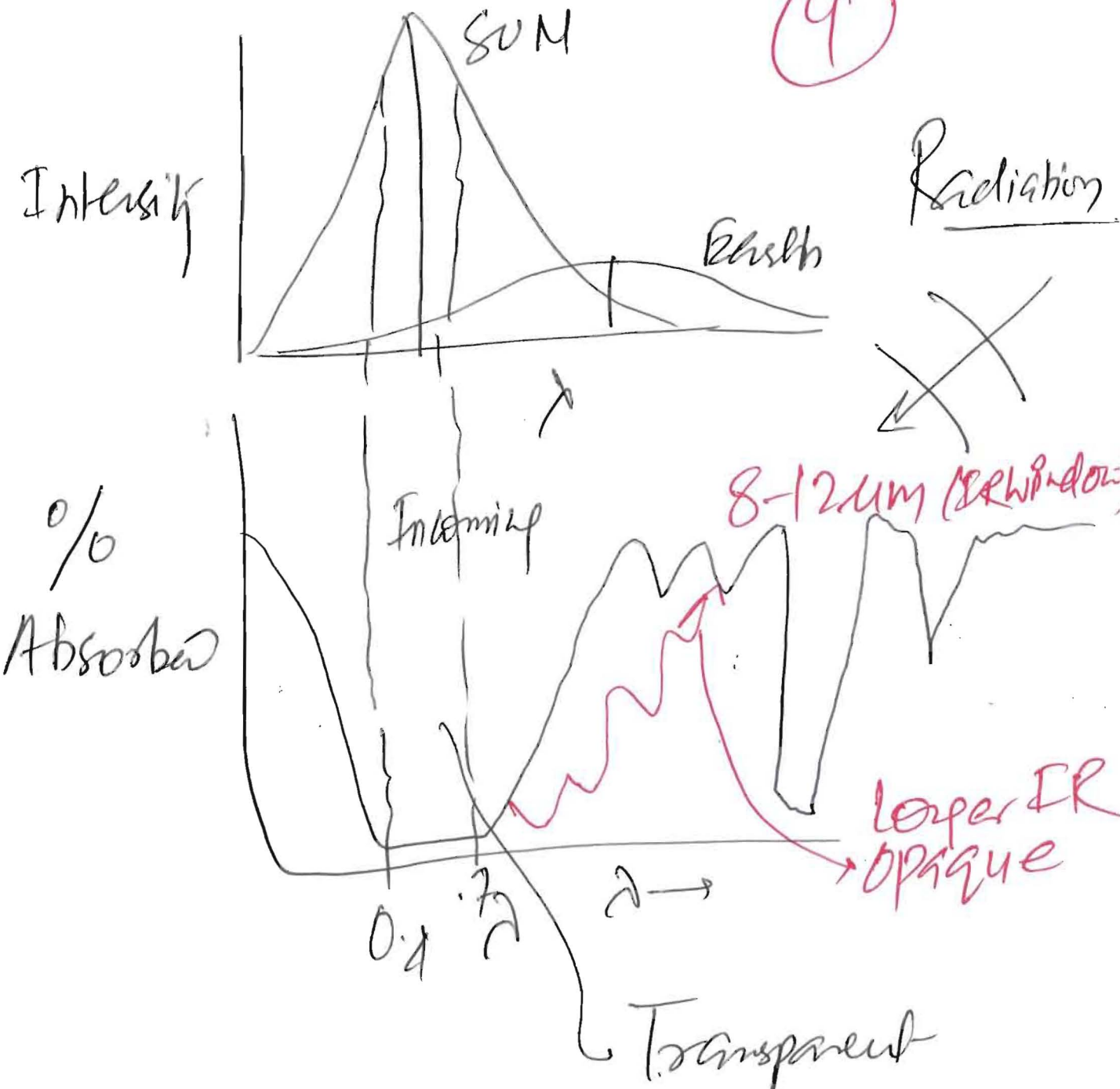
(9)



→ Why N_2 is not GHG 78%.
Why O_2 is not GHG 21%

- Why CO_2 is GHG though less than 0.5%.

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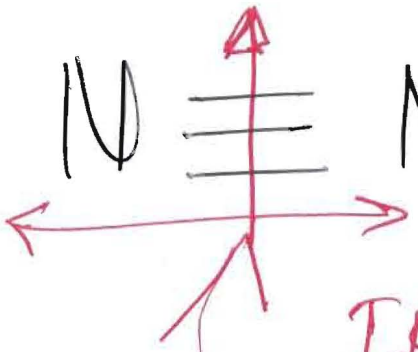
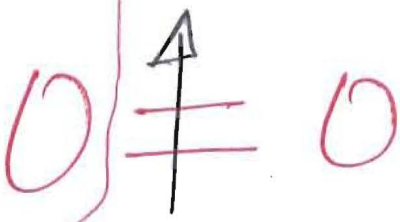


Symmetrical.

IR can pass.



Symmetrical

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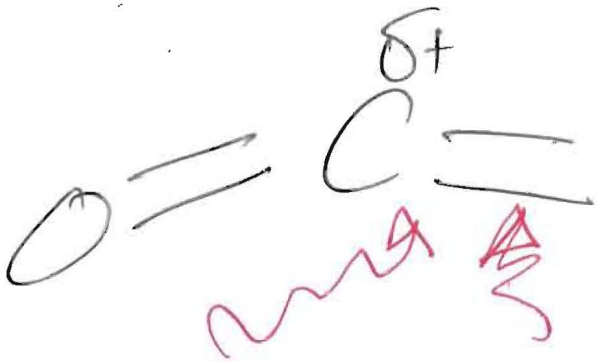
CO_2.



Non Symetrical.

→ Dipole moment present

→ CO_2 traps IR and acts GHG

→  Unsymmetrical

But less RT in atmosphere so cannot act as GHG. Thoye a cloudy day is cool because cloud stops the

Incoming solar radiation and during night it absorbs the outgoing IR and feels warm in night and cool in daytime.

(11)

This is very much basis of the GHG to work principle of radiation.

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