ESIC01 Assignment - 1.

Name : Priyanshu Mahato.
Roll No. : pm21ms002.

Q1. Explain the thermal variation of the atmosphere as a func^n of altitude.

ans. Based on the altitude, the atmosphere can be broadly classified into four subzones, namely Troposphere, Stratosphere, Mesosphere, Thermosphere. The thermal variation amongst the different subzones of the atmosphere is as follows :-

→ The 'Troposphere' goes upto 15km in altitude and being the lowest layer, the Troposphere absorbs heat from the bottom. This happens mainly because the bottom surface is better at absorbing solar radiation with lower frequencies. Most of these radiations filter down through air to the surface. This process of convection continues and half of the heat incurred due to radiations is absorbed and radiated once again to space

as IR radiations which is absorbed by certain Greenhouse Gases (eg. CO_2 & O_3) and clouds. To conclude, troposphere has a linear dependency on altitude in terms of variation; it decreases linearly with altitude.

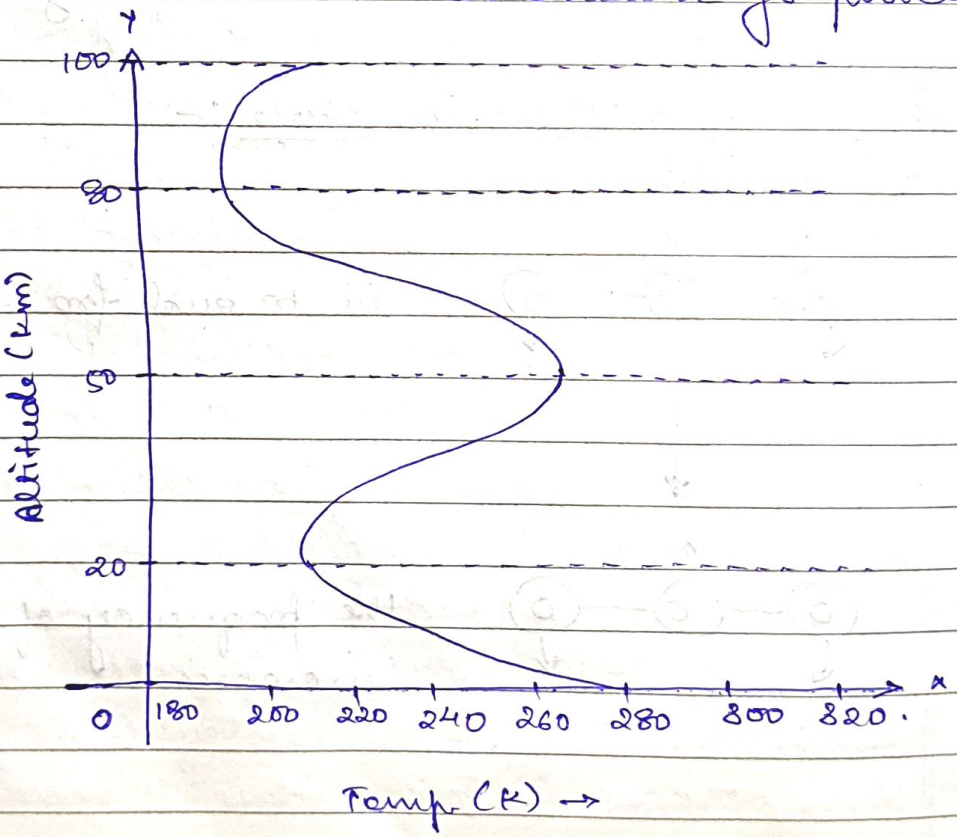
→ Now, coming onto 'Stratosphere', there is a rapid increase in temperature with altitude, this primarily happens because ozone is abundantly present in the Stratosphere which absorbes UV radiation resulting in energy rise, due to this, temperature also rises. Stratosphere ranges till an altitude of 50 km but we see a decrease in the concentration of ozone after 30 km. This is observed due to the upcoming UV radiations, ozone incurs sufficient concentration to absorb most of these radiations resulting in rise of energy pertaining to temperature rise.

→ Next, we move on to 'Mesosphere', where rapid decrease in temperature is observed due to the lowering of ozone (O_3) concentration resulting in the decrease in heating rate. Mesosphere ranges from 50 to 85 km (approx).

in this region a rapid decrease in temperature is noticed, O_2 absorbs the intermediate wavelength UV rays.

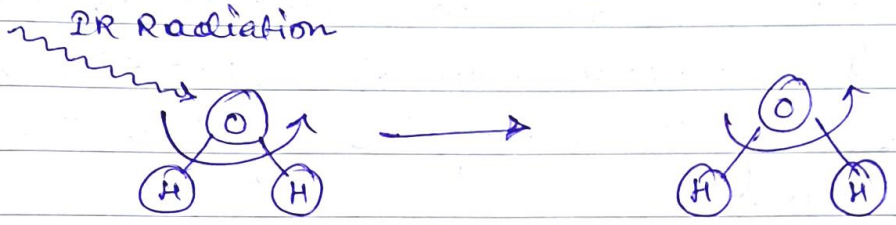
→ The last region in discussion 'Thermosphere', ranges from 83km to about 100 km (approx), the temperature now rises steadily and is caused by the absorption of short wavelength UV rays.

→ To conclude, the variation of temperature with altitude can be shown graphically as,



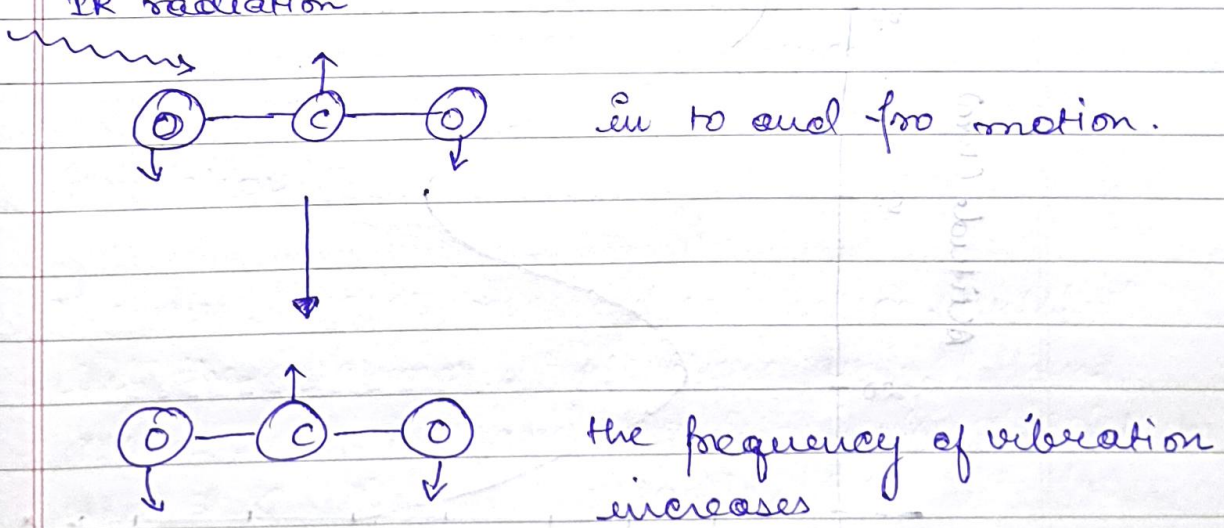
Q2. Identify two physical processes by which gases can absorb infrared radiation. Give examples of each process.

ans. (1) Rotation state change :-



The molecule spins faster. This is rotation state change.

(2) Changing Vibration State :-



Q3. Given that a 300 K blackbody radiates its peak energy at the wavelength of about 10 μm, at what wavelength would a 900 K blackbody radiate its peak energy?

ans. The wavelength at which the black body emits peak energy $\lambda_p \propto \frac{1}{T}$ (Wien's Law)

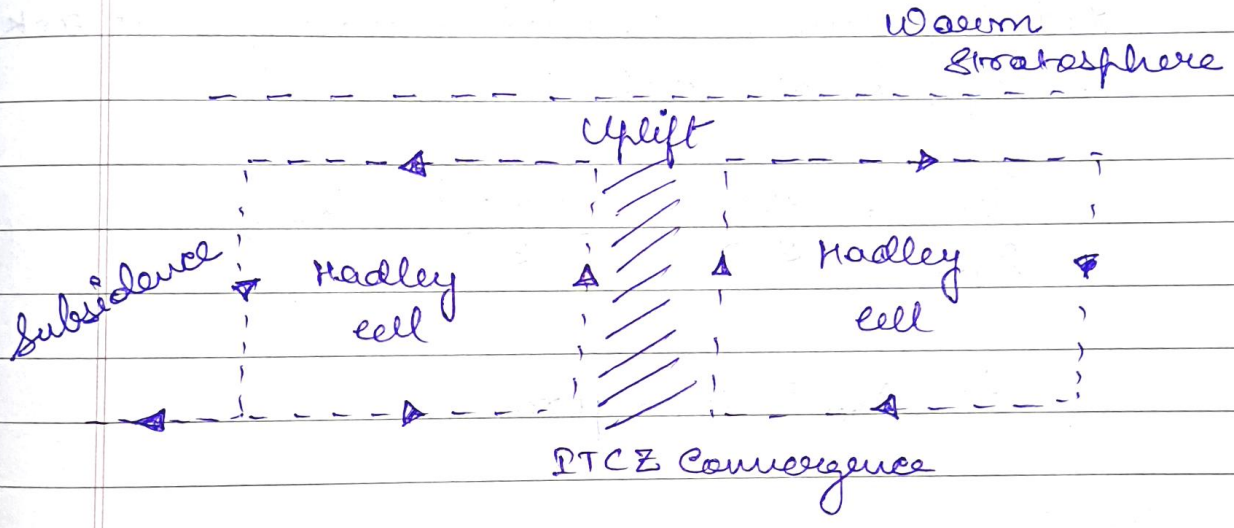
Let λ_{300} denote required wavelength at 300 K. & λ_{900} be at 900 K.

$$\frac{\lambda_{300}}{\lambda_{900}} = \frac{900}{300} \Rightarrow \frac{10 \times 10^{-6}}{3} = \lambda_{300}$$

$$\therefore \lambda_{900} = 3.33 \ \mu m.$$

Q4. Explain the formation of Hadley cells and if they are affected by seasonal variations.

ans. The Hadley cells are a type of convection cell that are the dominant mode of circulation of between 30° N and 30° S latitude.



Formation :-

The air in ITCZ rises by convection, until it hits the warmer stratosphere air. It then moves laterally and starts to sink at 30° N and 30° S. This is the Hadley cell. At the descending arms of the Hadley cell, precipitation is low & deserts occur.

Seasonal Variation :-

The Hadley cells do vary seasonally. As uplift varies over a season (there is more hot air in April, May & June in Northern Hemisphere), the circulation shifts to the Northern Hemisphere and similarly shifts south in December and January as it sees summer.

Qs. Briefly explain the formation of jet streams.

ans. Jet streams are produced by the interplay of 3 factors. The low pressure system at equator due to ~~excessing~~ excessive heating and a high pressure system at poles due to cooling and the Coriolis Effect.

The Horizontal Pressure Gradient between poles and equator drives the colder air to equator, while the warmer air rises & flows towards the poles. This rising air rises to the tropopause; and as it goes to the planet's poles, the Coriolis Effect acts on it deflecting it to the right and creating

Westerly winds. At their maximum speeds, they form Jet Streams b/w 30° & 60° latitude.