

Day / Date

"Chemistry"

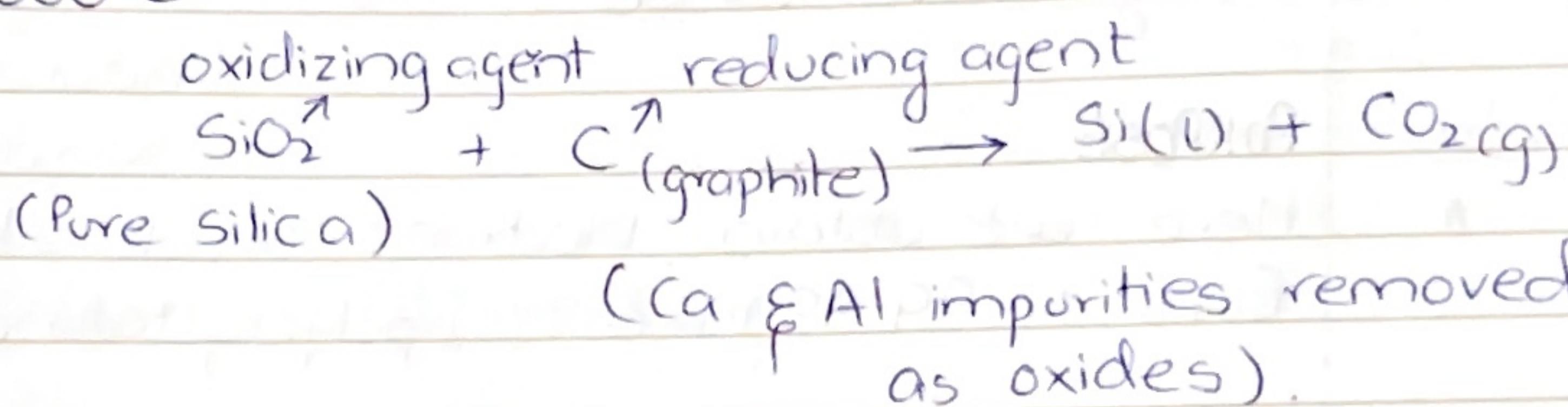
Abundance pie chart
(earth's crust).

- Melting point of silicon is 1414°C at only 25% and Oxygen in Earth's crust is 49.5%.

Silicon Purification Process.

Electric Arc Furnace.

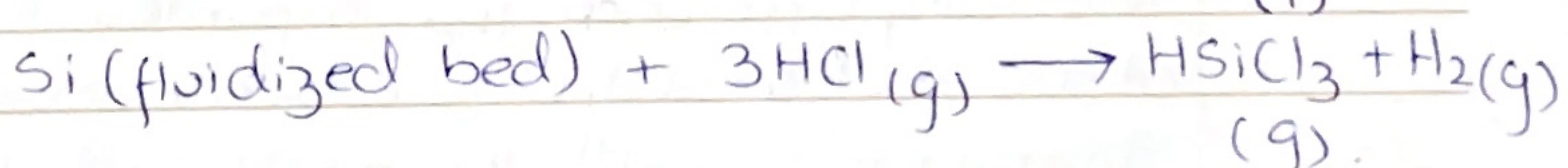
- Best grade Silica is acquired by quarrying. Pure Silica is reduced in electric arc furnace above 2000°C .



The silicon obtained is Metallurgical Grade Silicon (MGS) - 99% pure.

FLUIDIZED BED REACTOR:-

Now MGS i.e 99% pure is powdered to react with HCl in a fluidized Bed Reactor at 300°C to get Trichlorosilane. (HSiCl_3)



- * The Trichlorosilane has chlorides of Fe, Al, B & P formed with $\therefore \text{HSiCl}_3$ is fractionally distilled.

SIEMEN'S PROCESS:-

Vapourization of HSiCl_3 into Si (vapours).

RNX:-

The purified HSiCl_3 is vapourized and reacted with H_2 at 1100°C .



REQUIRED SUBSTANCES:-

- * An inert gas is used to carry the reactants.
- * Silicon vapours are collected on the substrate that is already silicon to attract it.

(near the heat source)

PURPOSE

Here we obtain Electronic Grade Silicon EGs i.e 99.99996% (polycrystalline).

ZONE REFINING:-

PURPOSE:-

This process is used to obtain 99.999996%.

EGs which is again polycrystalline.

RNX:-

- * Here a coil is heated and moved slowly through the tube containing silicon. Due to density difference the impurities concentrate at the molten section which is moved downwards with the motion of the coil.

leaving behind ultrapure silicon.

Galaxy

REQUIRED



CZOCHRALSKI METHOD

PURPOSE:-

It is used to obtain a single / non - mono - crystalline silicon to make a wafer of (300mm x 0.77mm)

REQUIRED SUBSTANCES:-

- Required substance: Poly
- (i) Fused / molten crystalline EGs (ultrapure)
- (ii) Seed of EGs (ultra pure)
- (iii) 1500°C Argon gas.

RNX:-

- (i) Ultra pure Si powder and transferred in a chamber of molten silica crucible
- Chamber is evacuated to be filled with Argon gas 1500°C . (an apparatus used to handle minerals in RNX)
- (ii) A seed crystal & ultra pure Si is dipped into molten mass.

Galaxy

Day / Date

* Diameter of the monocrystalline is obtained by temperature from withdrawal is accounted by rotation.

The crucible speed is rotated in the opposite direction (this is done to get the perfect required shape) and the seed crystal is withdrawn slowly i.e. about 1mm/hour, to make a "Monocrystalline ingot".

Similarly other shapes are obtained by other different methods.

(Multi-crystalline block)

(ii) **Bridgeman method.** (Multi-crystalline growth.)

(Monocrystalline cylinder growing.)

NOTE:-

Doping increases electric conductivity of silicon.

If one out of 10 million atoms of silicon are replaced with doping the conductivity increases 100,000 times.

* Doping modifies band gap between conduction and valence band changing electronic properties.

QUESTION:-

Why is there a need of slicing up a wafer?

NOTE:-

Q. Why silicon dioxide is not used to make wafer?
(i) Purity of Silicon is compromised.
(ii) Polycrystalline Nature.

Integrated Circuits are approx linear which is to say that they're formed on the surface of the silicon.

More than 10Billion electronics can be arranged.

To maximize the surface area of silicon, available for making chips, the boule is sliced up into discs, called wafers.

CONSTRUCTION OF A SILICON SAW & USAGE:-

The wafers are just thick enough to allow them to be handled safely during semiconductor fabrication. 300mm wafers are typically 0.775mm thick.

Sawing is carried out by a wire saw that cuts multiple slices simultaneously, in the same way, that some kitchen gadgets cut an egg.

However the silicon saw differs that they these kitchen tools as the wire is constantly moving and also carries with it a slurry of silicon carbide, the same abrasive material that forms the surface of 'wet dry' sandpaper. The edges of the wafer are then sanded off to above chirping off at later processes.

silicon into

Q. 1 ton of Bituminous Coal Yield ...?

- (i) 12500 cubic foot gas. (Natural gas).
- (ii) 50 kg tar (when distilled gives 35kg pitch).
- (iii) Ammonical liquid (yields 3kg Ammonia)
- (iv) Gives 65-70% coke (700-800 kg).

Rxn 2 :-

Temp is fixed at 1000°C . Now the red hot coal will react with steam to produce $\text{CO} \& \text{H}_2$. Now, this is the endothermic which acquires energy from the red hot coal.



$\xrightarrow{\text{Synthesis Gas:-}}$ 41% H_2 , $(\text{CO}_2 \& \text{N}_2, 4:1)$

- (i) Composed of $\text{CO}_2 \& \text{H}_2$; ($\text{CO}_2 \& \text{N}_2, 4:1$)
- (ii) It is used in gas/steam turbines.
- (iii) Fertilizer production.
- (iv) Pharmaceutical use.
- (v) Production of Natural gas.

"SHIFT REACTION":- (Temp drops!)

If we want to acquire more hydrogen except major components of Synthesis gas.

In addition to rxn 2, we can use its $\text{CO} \downarrow$ with (H_2O) steam; (separated)



* Drawn on page 111

Q. What are the by-products of coal gasification?

Coal gasification
↓
Synthetic Gas.

$\text{C} + \text{O}_2 \text{ (air)} \longrightarrow \text{CO}_2 + \text{Heat}$
keep close to 1000°C

Ammonia Melting electricity
Fertilizer Diesel; Naptha; Waxes; Steam
Galaxy



WHY COAL IS A DIRTY FUEL?

WHY COAL IS A DIRTY FUEL?

(iii) STAGED BURNING:-

- (i) Dusty mining & handling.
- (ii) Emission of Hg & Nitrogen (acid rain)
- (iii) Oxidized Sulphur & (global warming)
- (iv) Oxides of Carbon by green house effect.

- (v) Ashes & Carbon by green house effect.
- (vi) Particulate Matter (smog) residue in fly ash and Particulate Matter (smog) residue in slag.
- (vii) Oxides of Carbonate residue in furnace.

"CLEAN COAL TECHNOLOGY"

FUELE GAS DESULFURIZATION / SCRUBBING:-

- (i) Coal pulverization.
- Coal pulverization. This removes water washed coal ; This removes inorganic S(60%) and organic S(40%) removed by sprinkling aqueous CaCO_3 . $\text{CaO} + \text{SO}_2 \rightarrow \text{CaSO}_3$.
- on fly gas

(ii) FLUIDIZED BED BOILER:-

- (i) Powdered Coal/Limestone tumbled by air jets in a fluidized bed. S removed
- (ii) Heat transfer to form steam is efficient we burn in low temp (about 750°C) to reduce NO_x formation.

Ques

Ans

We set the air fuel ratio with high fuel to air ratio to reduce NO_x formation. \rightarrow (high fuel to air).

IGCC:-

- (i) Coal gas is produced purified and then burnt.
- (ii) Gas turbine, (iii) Steam turbine

~ "Syn gas is used" here to generate electricity."

- (ii) Syn gas to make useful chemicals.
- (iii) IGCC efficiency is 50%, whereas conventional burning is 30%.

* Check diagram from slides.

Natural Gas Purification:-

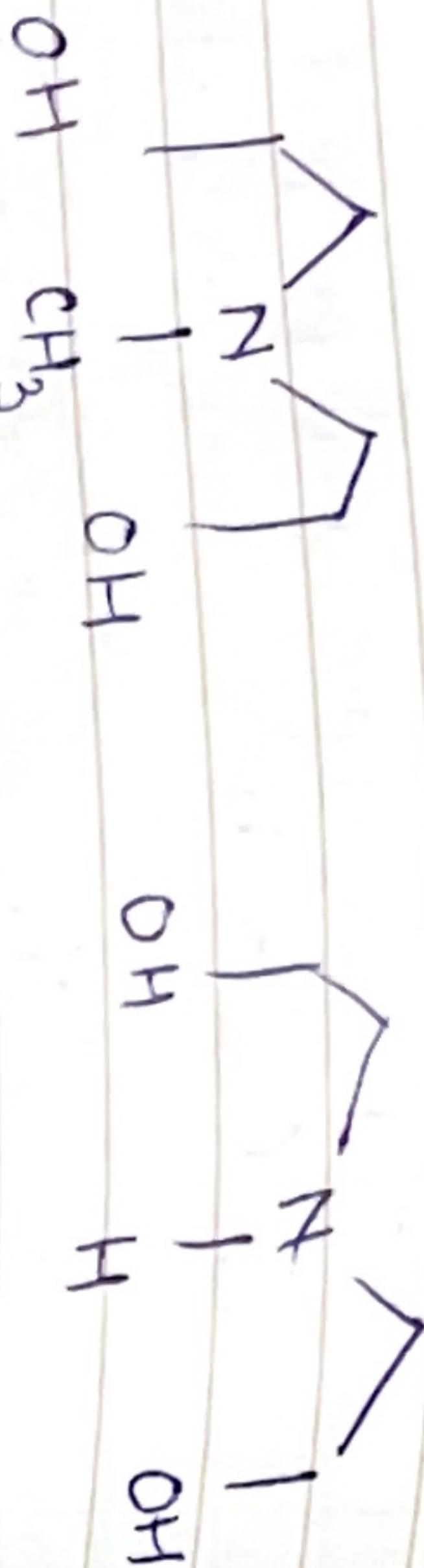
aim To get only methane.

iii) Now Removing moisture.

(i) Removal of sulphur & CO content

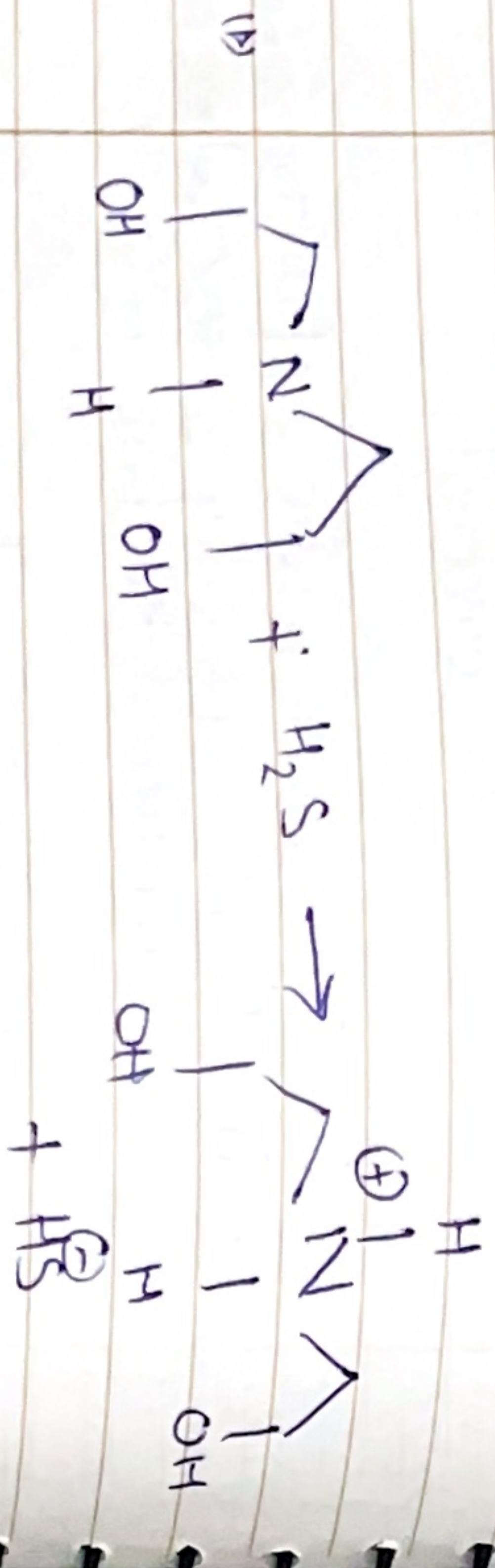
present as H_2S present as H_2O

* Using Diethanolamine MDEA. or DEA



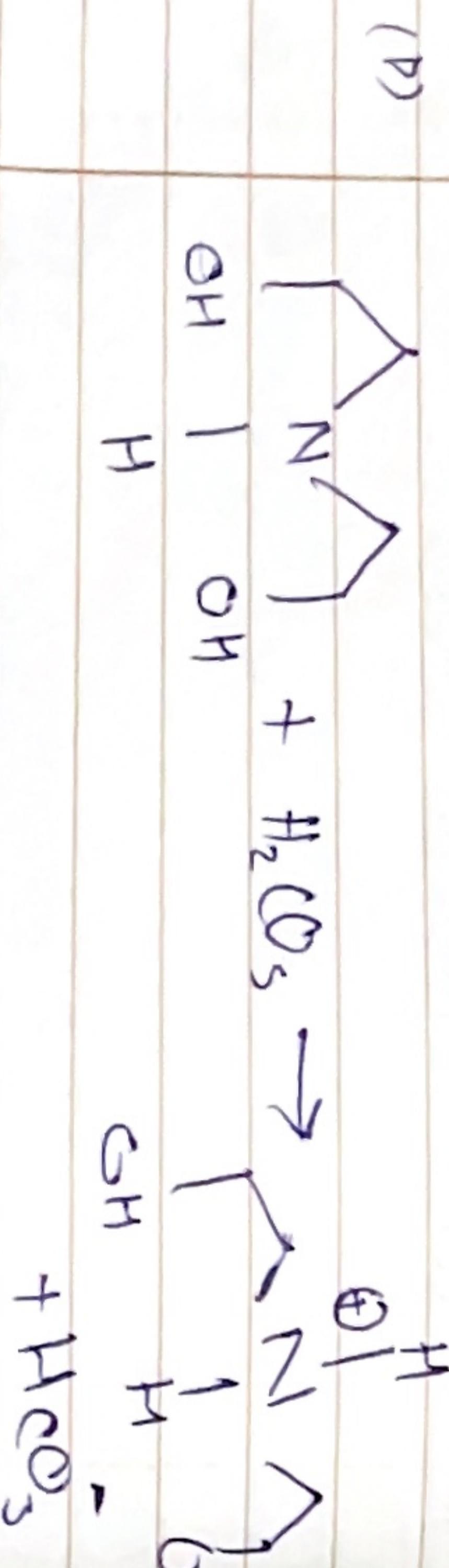
(ii) Removing higher alkanes!

Using hexane, which is oil absorber of higher alkanes.



(iv) The fractional distillation of oil to recover hexane and propane, n-ethane, isol-n-butane is done.

CHECK SLIDES TOO!



PETROLEUM:-

if it has high S \rightarrow sour
if it has low S \rightarrow sweet.

Fractional distillation products

gasoline 8

Naphtha 8

Residual gas 80

Diesel 16

Kerosine 12

Lubricating Oil 36

Gas Oil 44

(C₅-C₁₂)

* The gasoline is about 20 - 25% in petroleum we usually increase this quantity and also quality.

OCTANE NO. (Quality measure of gaso)

* It the measure of n-heptane & iso octane mixture of gasoline to a corresponding known scale to test the quality of gasoline.

* High quality \Rightarrow \uparrow Octane no.

(and vice versa)

also

iso Octane = Octane no. 100.

n-heptane = Octane no. 0.

ENHANCING OCTANE NO.:-

► ADDITIVES:-

i) Ethyl fluid or
tetraethyl lead.

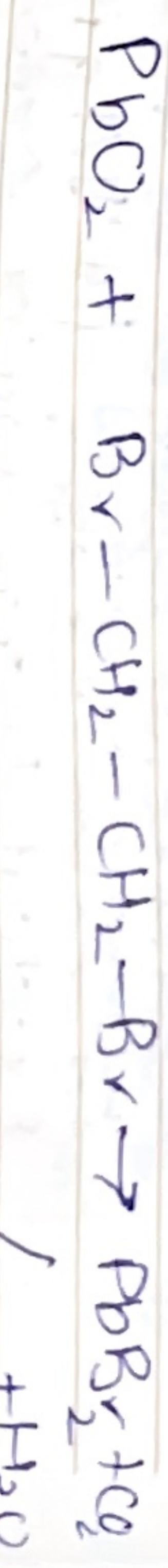
comp:-

- 1. Pb(Et)₄
- 2. Br-CH₂-CH₂-Br
- 3. Cl-CH₂-CH₂-Cl
- 4. Dye.

draw back is the production of PbO₂ that is nonvolatile and accumulates.



also:



* Lead also destroys the

3 major catalysts found in atmosphere in exhaust pipes.



(Very toxic materials)

~~GASOLINE~~
~~alcohol~~
~~gasoline~~

(i) + -butyl Alcohol (7%)
(ii) 50:50 +butyl Alcohol &
methyl alcohol.
(iii) Ethyl alcohol. (E-10/E-20)

N.G \rightarrow [deasphalting] $\xrightarrow{\text{skid}} \text{Primary reformed}$ N.G (CH₄) $\downarrow \text{Steam}$

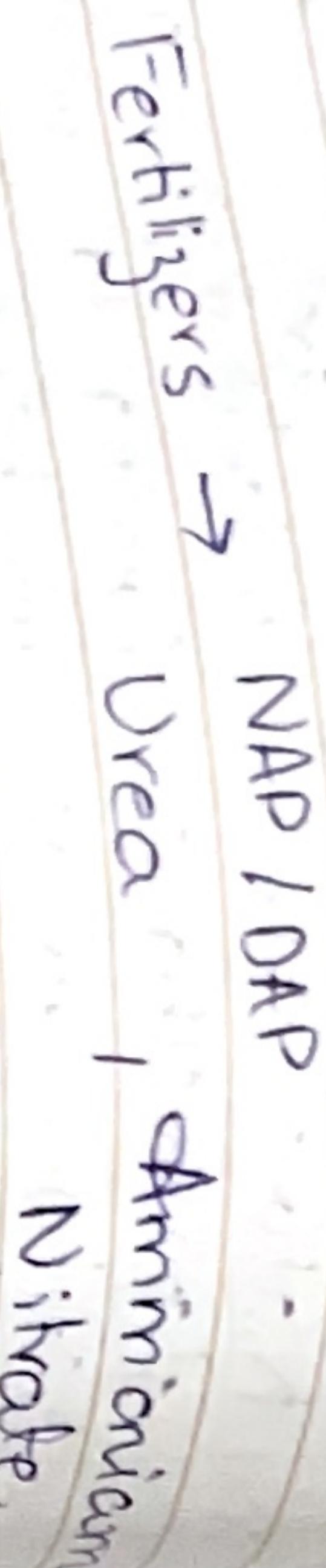
[secondary reform] $\xrightarrow{\text{Steam}}$ syngas

CO₂ removal

(iv) AMMONIA SYNTHESIS. (STEPS / DETAIL)

STEAM METANE REFORMING:-
Aim :- PRODUCTION H₂ FOR EN₂ NH₃

① Desulphurization:- Natural gas contains sulphur which is removed by using ZnO.

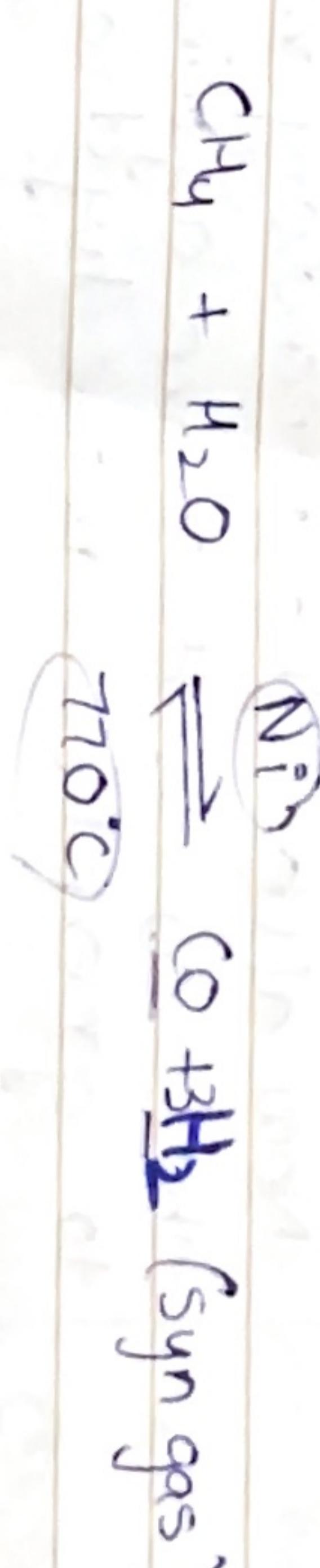


after this process the natural gas has less than 0.1 ppm of sulphur

AMMONIA PRODUCTION:-

NH₃ is the second highest chemical demanded in the world (160 Megaton)

② Primary Reforming :- The updated CH₄ is reacted with steam



we use the 'CO' generated with steam i.e. shift rxn. (+ to generate more H₂).



These steps will convert only 65% conversion of CH₄ to H₂.

Both

Nitrogen obtained from air & Hydrogen extracted from natural gas reforming.

Nitrogen obtained from air & Hydrogen extracted from natural gas reforming.

Galaxy

Now to convert the remaining 35% of CH₄ into H₂. (ie now 95% conversion)

$\xrightarrow{\Delta N}$ **secondary reforming.** \rightarrow Syngas (CO₂, H₂O, N₂ from N.G.)

The H₂ can also be generated more by shift rxn.



Water-gas shift Rxn:- (CO is only 0.21 left after this)

Now after the secondary reforming the CO & H₂O are again reacted to generate more hydrogen.



$\xrightarrow{5}$ **Absorption.**

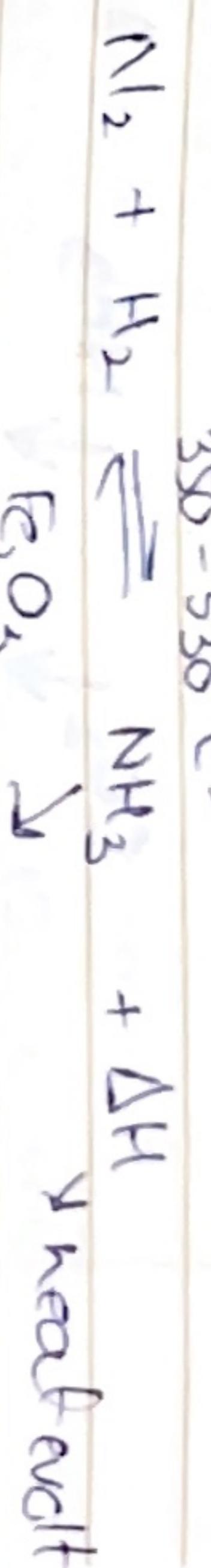
$\xrightarrow{6}$ **Removal of CO₂ by methanation:-**

CO & CO₂ (i.e oxygen containing carbons) are undesirable in the synthesis of ammonia which are removed by

(i) 'First' Absorption.

- (ii) 'Second' Methanation.
- high temp / high pressure
- $$CO_2 + H_2 \rightarrow CH_4 + H_2O$$
- at this step the CO₂ is now < 10 ppm.

⑦ Ammonia Synthesis.

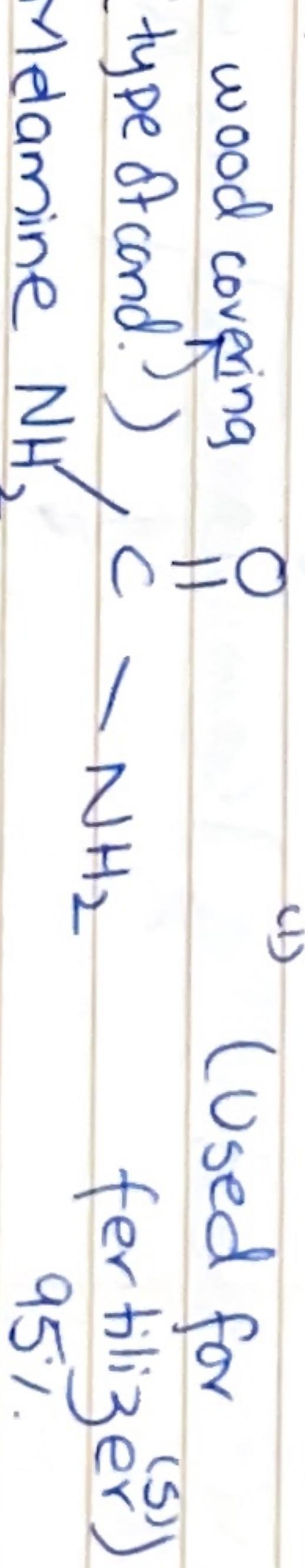


anhydrous ammonia.

This process is slower however increased by high temp & pressure with catalysts to increase the speed of rxn; however the net conversion in NH₃ is still low which is promoted by sending N₂ & H₂ again into the reactor.

Read text or how to produce ammonia (slides).

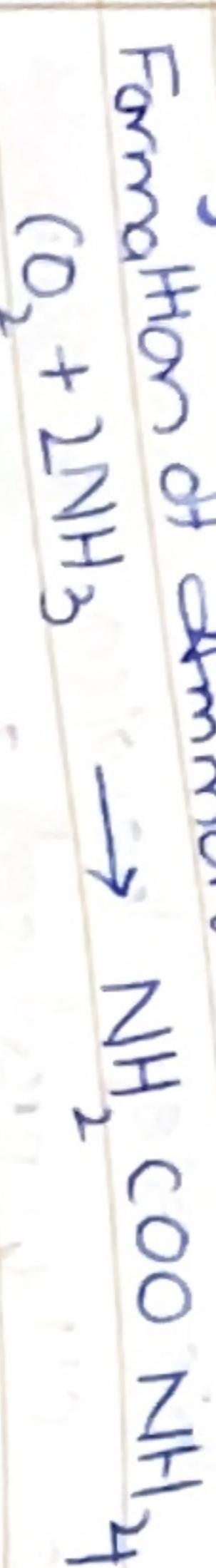
UREA:-



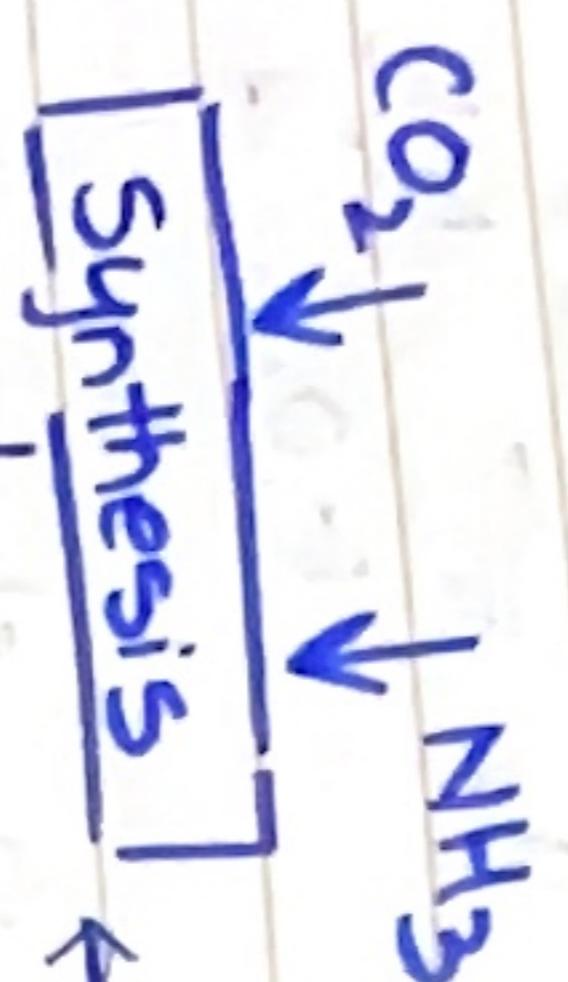
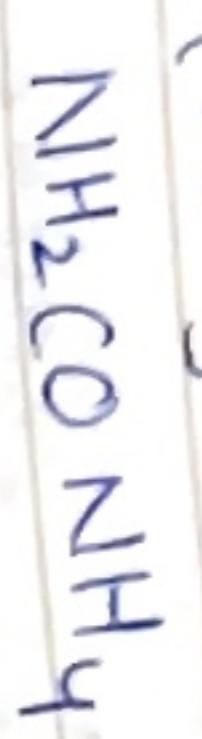
- (ii) 31. Melamine NH₂
- (iii) 11. cattle feed
- (iv) 11. other uses.

Ques/Ans

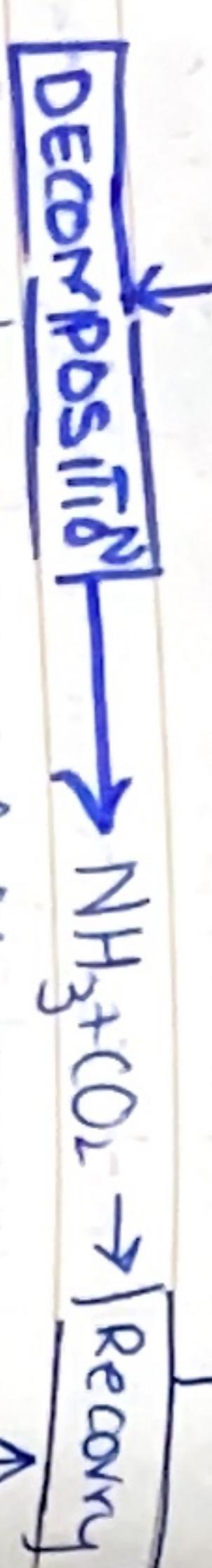
Synthesis of Urea :- Carbamate:-



Decomposition
(Dehydration).



Synthesis



Leftover



$$\text{Pressure} = \frac{\text{Force}}{\text{Area}} = \frac{ma}{A}$$

as the pressure
acted
on Earth.

$$m = \frac{PA}{a}$$

(Let $a = g$)

$$m = \frac{PA}{g} \Rightarrow (10^5 \text{ Pa}) (4\pi R^2) / (6.8)$$

$$m = 5.2 \times 10^{18} \text{ kg.}$$

Urea granules

Ques/Ans

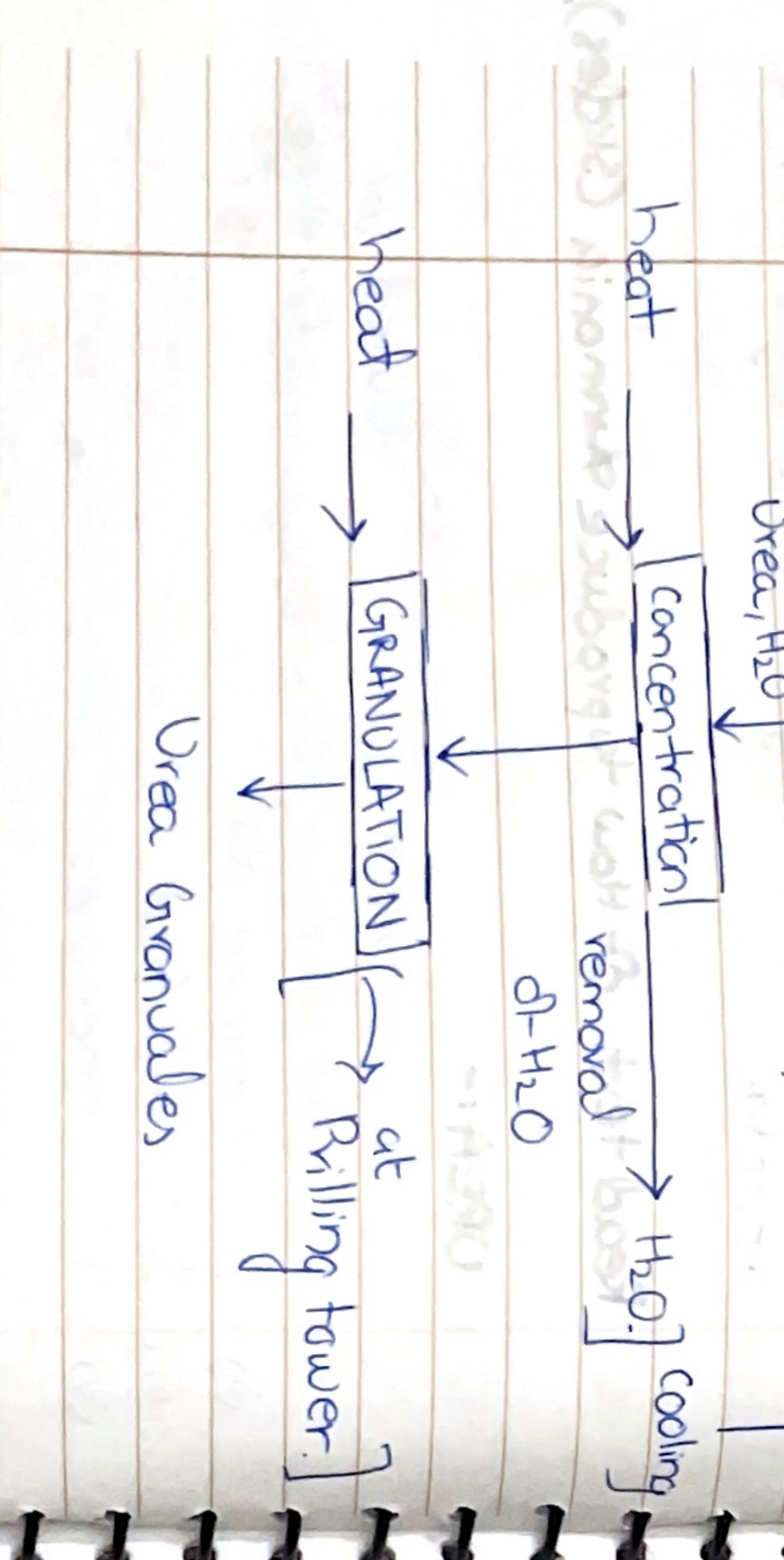
TOPIC :- ENVIRONMENTAL CHEMISTRY

Layers of atmosphere :-

- (i) Troposphere. (9-12 km)
- (ii) Stratosphere. (12-50 km)
- (iii) Mesosphere. (50-80 km)
- (iv) Thermosphere. (80-700 km)
- (v) Exosphere. (700 - 10,000 km)

* Pluto's atmosphere, 130 km thick.

The atmospheric mass :-



Chemistry of Air Pollution.

Atmospheric Pressure. ($P = P^0 e^{-\frac{Mgh}{RT}}$)

$$P = P^0 e^{-\frac{Mgh}{RT}}$$

(9.8 m/s^2) = gravitational acceleration.

d = gas const. (8.314 J/Kmol) would be given \uparrow in K

T = absolute temp

P^0 = atmospheric pressure at sea level.

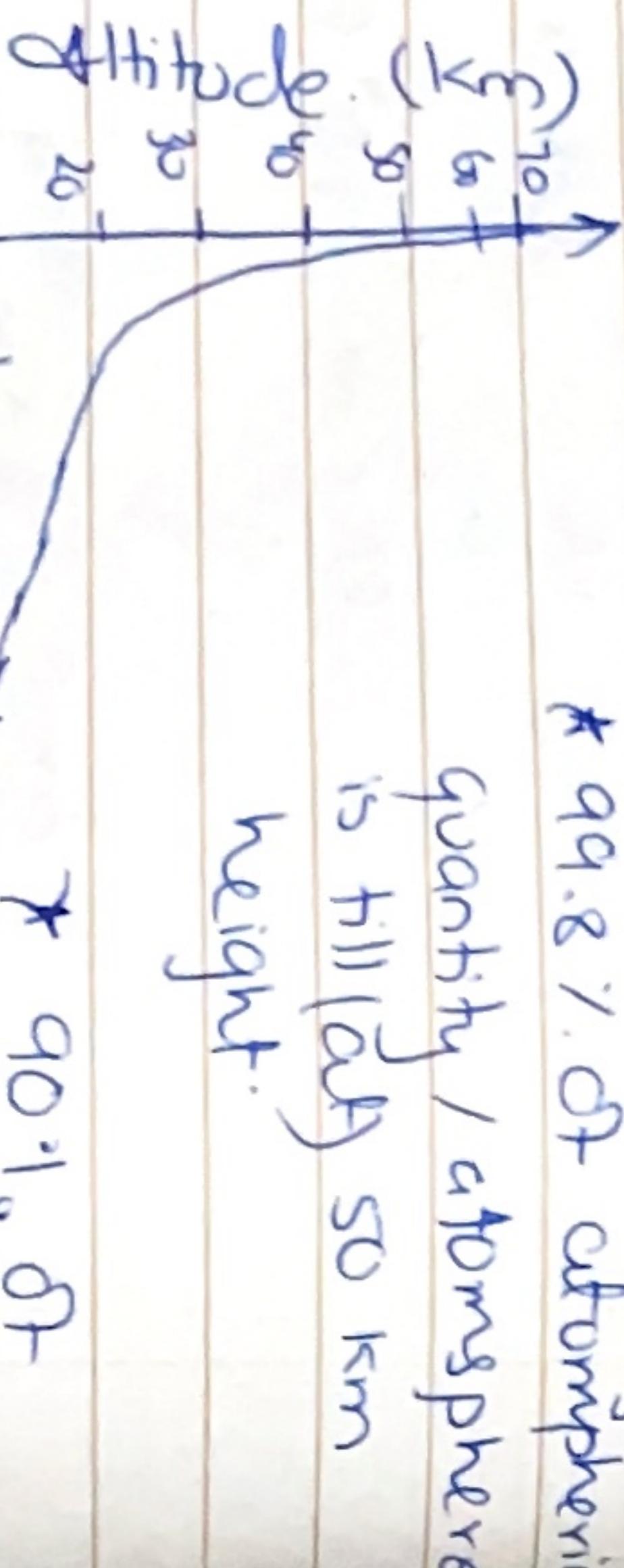
P = Pressure at a given height.

h = altitude (given..)

M = Molar mass of Earth's air. (28.4 g/mol) $\approx 29 \text{ g/mol}$

* as the altitude increases, the pressure decreases.

* 99.8% of atmospheric quantity / atmosphere is till (at) 50 km height.

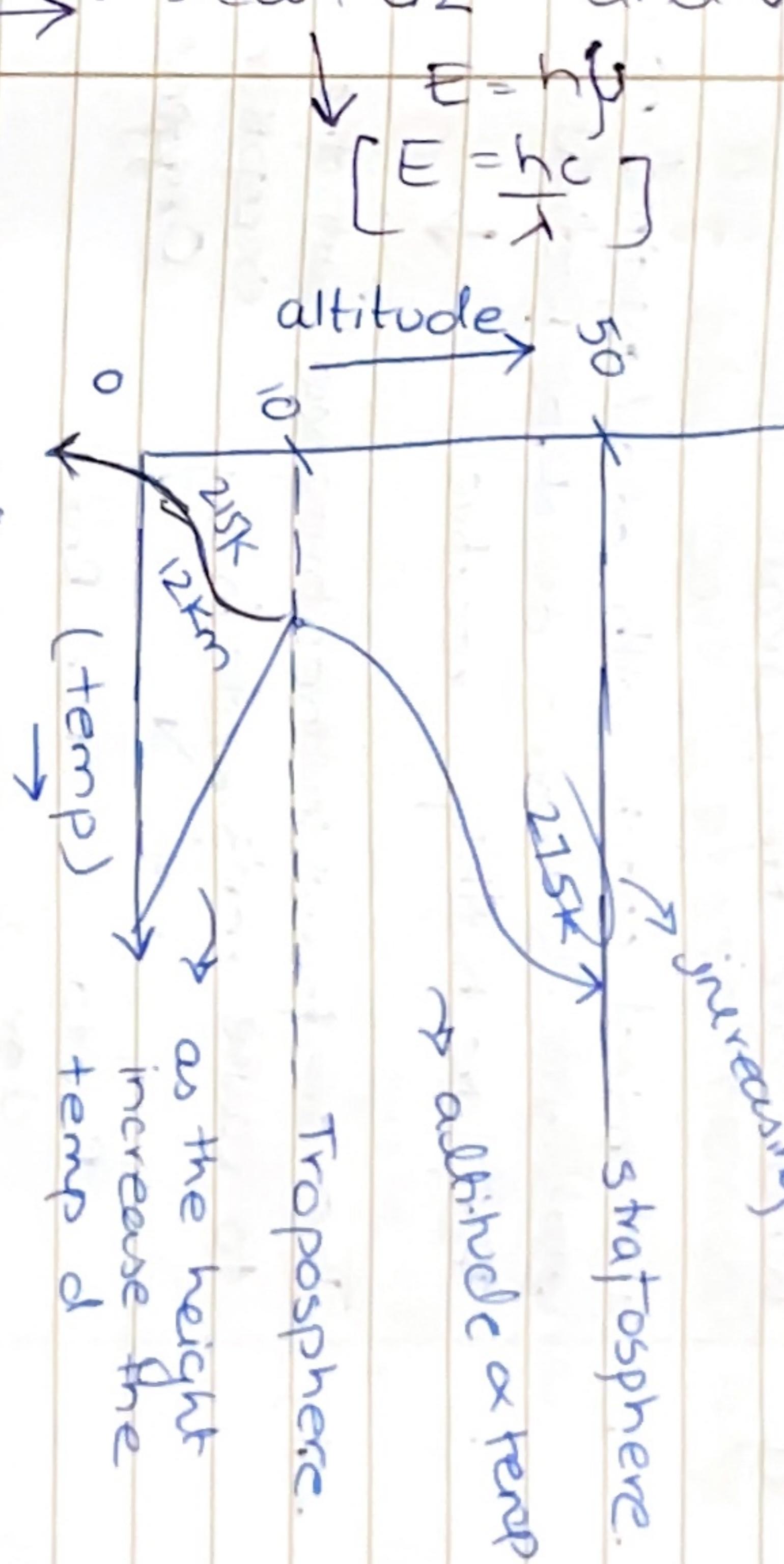


* 90% of atmosphere is below 16 km .

The atmospheric $T' \epsilon' P'$

Temperature limit.

if $\lambda > 242 \text{ nm}$ then it will not break O_2 and vice versa



Wavelength & Frequency Calculation:-

Given that Bond dissociation energy of $O_2 \Rightarrow 495 \text{ kJ/mol}$

Einstein's Eqn:- $E = h\nu$

convert 15 J/mol $\rightarrow \text{J/molecule}$.

$$495 \text{ kJ/mol} \Rightarrow 495 \times 10^3 \text{ J} \times \frac{1 \text{ mol}}{\text{mol}} \times \frac{6.022 \times 10^{23}}{1 \text{ molecule}}$$

$$E = h\nu \Rightarrow 8.22 \times 10^{-19} \text{ J} \Rightarrow 1.24 \times 10^{15} \text{ s}^{-1}$$

My/Date

$f(a)$ = converging
 $f(b)$ = diverging

$|f(b)|$ = converging



Q. What are Free radicals:-

- (i) A chemical species with odd/unpaired no. of electrons is known as Free Radicals.
- (ii) They are highly reactive.

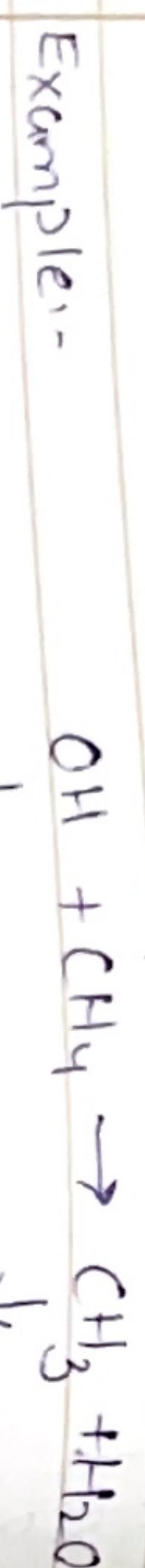


(iii) They are found in the atmosphere "with the exception of oxygen" to cause rads made in/by oxygen

Photo Dark Rnx

chemical

Example



(OH is obtained from nature; highly reactive & makes more free radicals)

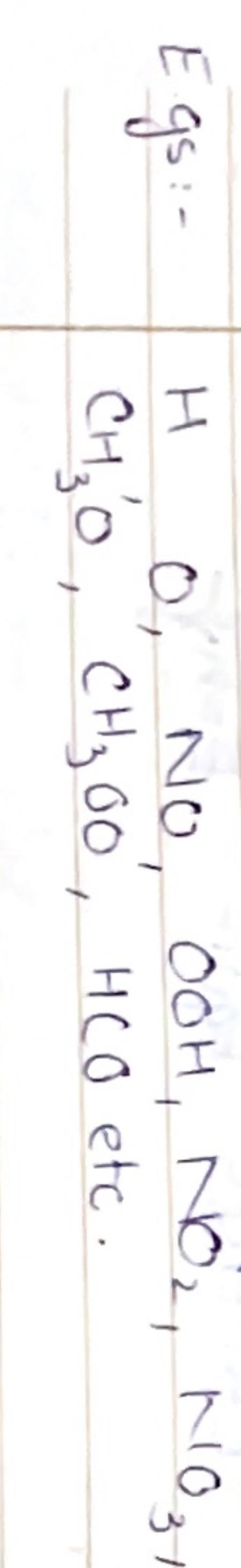
(Example)

Troposphere (Lysening CO - 12 km).

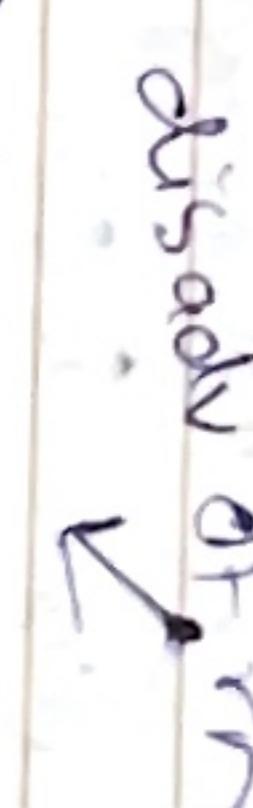
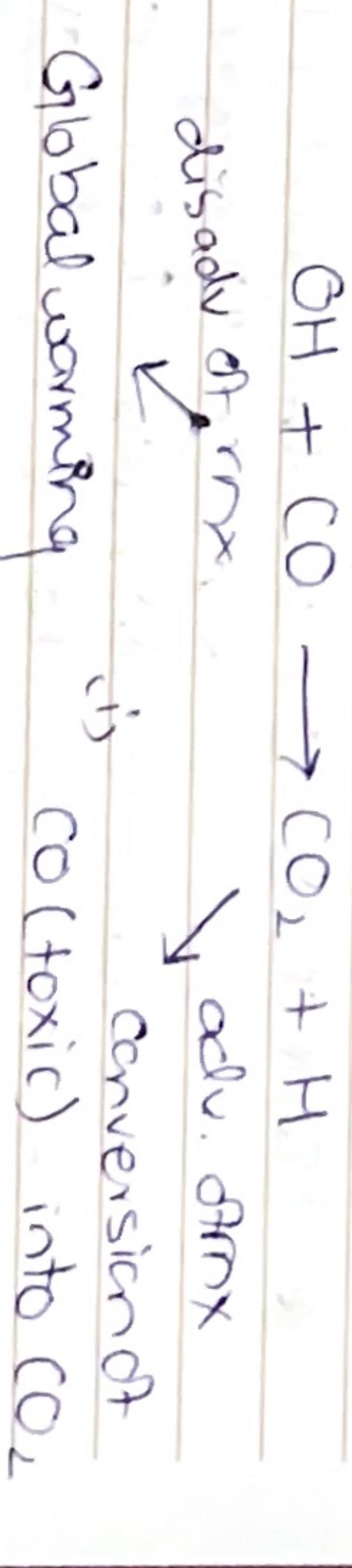
Method: Mechanism

(i) washing with rain (settling of particulate matter)

(ii) chemical rnx.

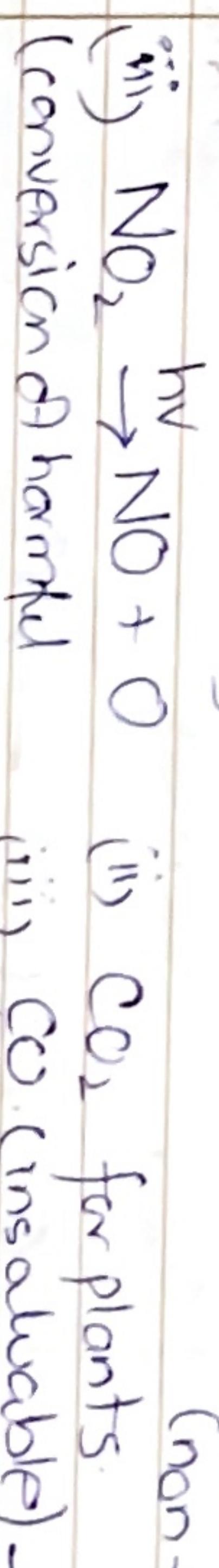


* Concentration of free radicals is only 10 ppb in atmosphere



conversion of

Global warming \rightarrow CO (toxic) into CO₂ (non-toxic)



(ii) CO₂ for plants

Q. Diff b/w Dark & photochemical Rnx.

Dark chemical Rnx

Photochemical Rnx.

- (i) Do not require photons
- (ii) To carry out the reaction require photons to carry out the reaction.

* NO; apw

Dry/Particulate

(a) dry deposition on surfaces
(settling of dust).

Vacuum cleaner:- (of nature).

$\text{[OH]} \text{ CH}_4, \text{NO}_2, \text{SO}_2$.

OH removes all these.

* Removal of CH_4



methoxy.



hydroperoxy radical

SOURCES OF OH in atmosphere.
↳ conc. of OH in troposphere (reacts with O_3 and NO_2)

maximum contribution is 0.05 ppt i.e. OH is given as photolyzed.



Dry/Particulate

→ other contributors are given in the slide.

* NO_2 & O_3 are the major absorbers of solar radiations in troposphere.

Q. \hookrightarrow Formation of O_3 in troposphere?



Energy of the excited released

free oxygen radical after bond formation.

Ozone conc. in atmosphere:-

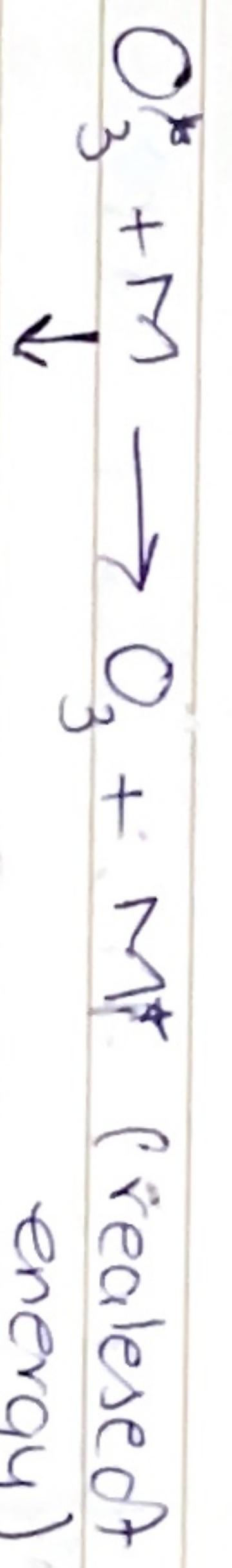
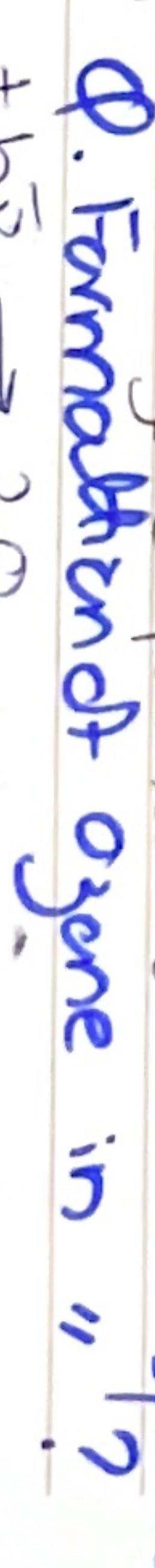


↓

decrease in stratosphere

in troposphere.

Q. Heating mechanism of stratosphere ozone formation: stratosphere!



energy of unstable ozone! [i.e. heating the troposphere]

Galaxy

Overall rxn $\Rightarrow \text{O}_2 + \text{O} + \text{M} \rightarrow \text{O}_3 + \text{M}^*$

Ques.

- * React no 4 is very slow and catalysts such as Cl, NO & C can catalyse it

How the OH & O₃ levels should be maintained in the troposphere.

The conc. of OH in troposphere & the

O₃ should be maintained i.e.

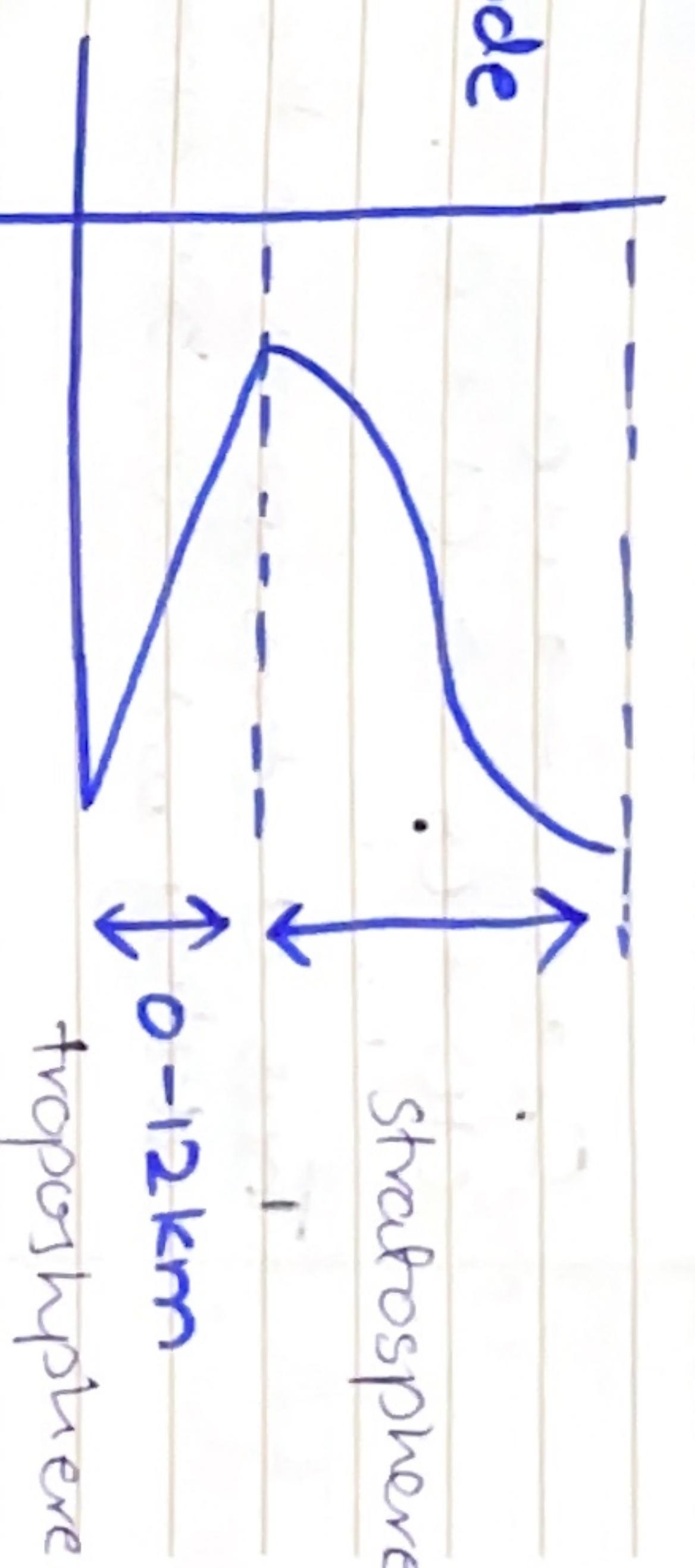
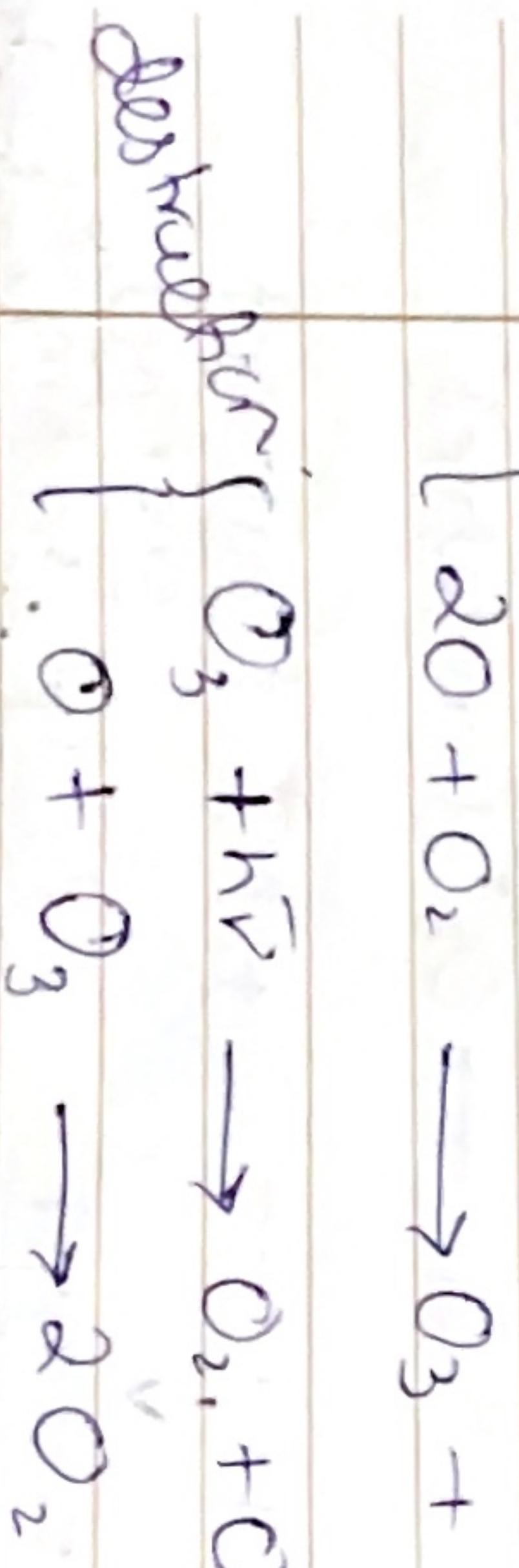
OH conc. ↑ in troposphere.

O₃ conc. ↓ in troposphere.

because OH is the natural vacuum cleaner & O₃ is the source of heating in troposphere.

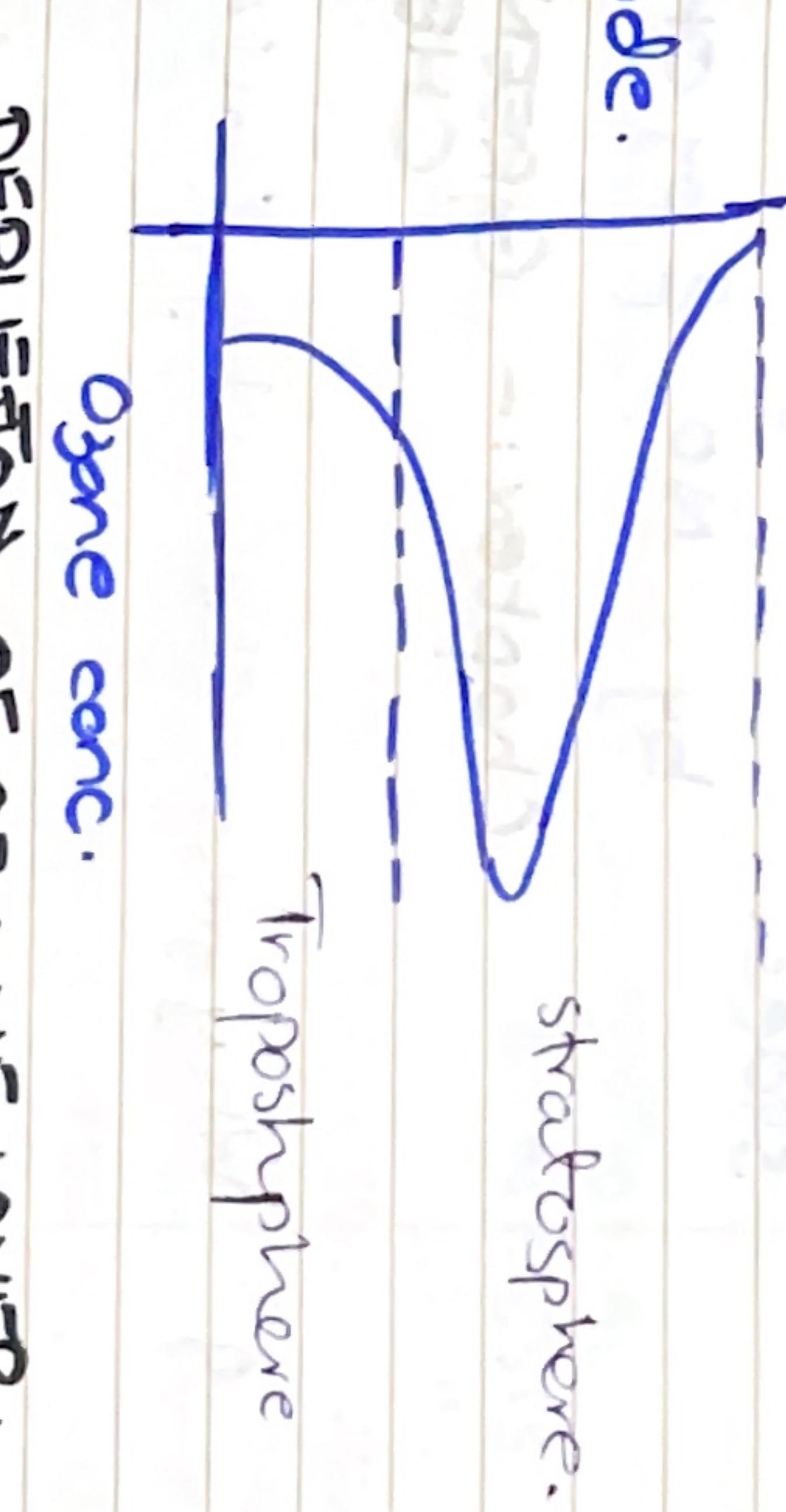
* Ideally the rate of reaction of ozone production and destruction of ozone in the stratosphere should be equal.

Q. Chapman rxn of destruction & production of Ozone.



Altitude.

stratosphere.



Ozone conc.

DEPLETION OF OZONE LAYER:-

(at stratospheric chemistry).

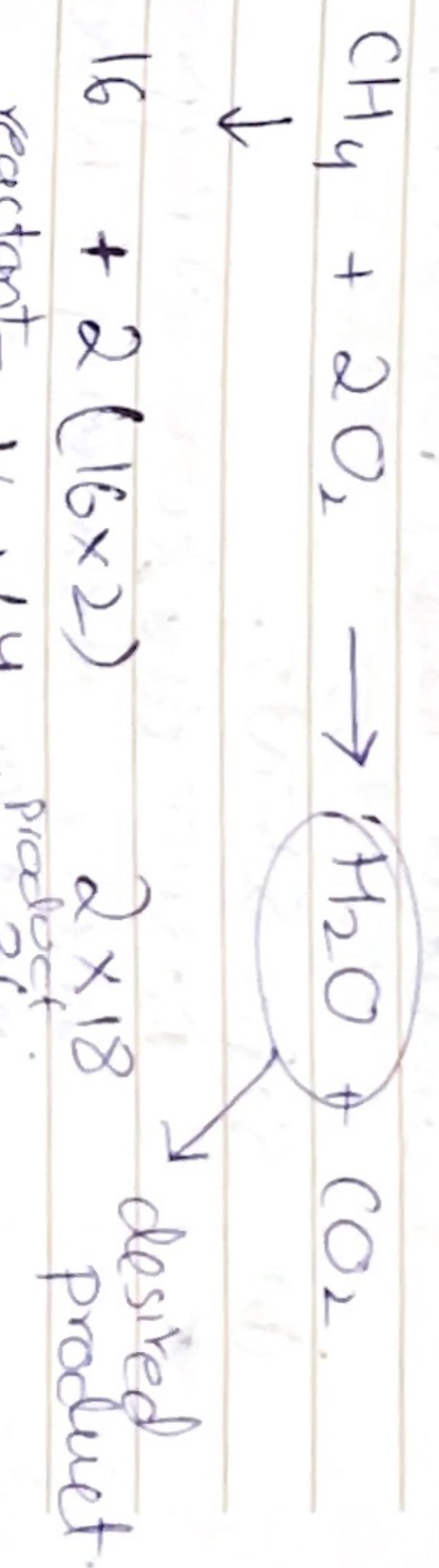


* The Cl atom is produced at stratospheric 30km and acts as a catalyst to speed up the reaction of O + O₃ → 2O₂. (which was originally a slow Galaxy).

Example:-

$O_3 + Cl \rightarrow ClO$
 $ClO + O \rightarrow Cl + O_2$

Thus Cl atom speeds up the rx to destroy upto 100,000 ozone molecules.



- ★ Two more catalytic depletion rxn in slides.

by NO \ddot{F} by OH.

Chapter:- GREEN CHEMISTRY.

GREEN SYNTHESIS

CONVENTIONAL SYNTHESIS.

- (i) environmentally friendly conditional.
- (ii) increase of rate of rx.
- (iii) Reduction of rx time.
- (iv) use of green catalyst

$$= \frac{36}{80} \times 100$$

$$= 45\%$$

- (i) Waste prevention. E-factor = $\frac{kg \text{ of waste}}{kg \text{ of product}}$

- (ii) Atom Economy. ($\frac{\text{less}}{\text{less}}$)

- (iii) less Hazardous chemical synthesis Example.

Production of NaOH.

First ever method \rightarrow Using mercury cell.

(drawback: Hg emissions)

(should be) max can be 100% more

ambient temp (normal range temp).

Chapter:- Water Treatment:-

- * Safer solvents.
- (v) Reduce the conc. of By products, make them easy to handle and non toxic.
- (vi) Renewable sources :- (giving replenishing effect).
- (vii) Catalysis

Based upon :-

- (i) Selectivity (ratio of desired prod to undesired prod)
- (ii) Separation (breakants & products)
- (iii) Products / By products
- (iv) Within too.
- (v) innocuous degradation products (Homless). \Rightarrow Biodegradation, incineration burning in a controlled environment.

BOD should be less in water

- * microorganism degrade the harmful organic matter but require dissolved oxygen, this is known as BOD. (\Rightarrow oxygen requirement)
- If BOD is very great than their is a great requirement of dissolved oxygen.