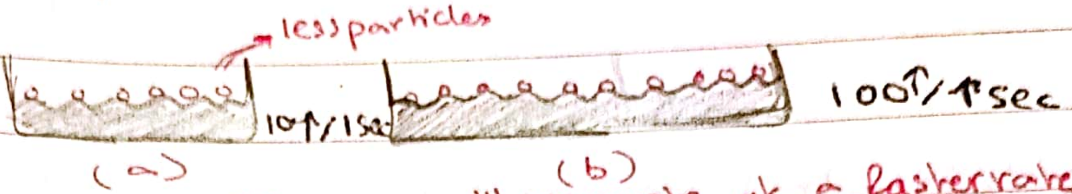
Rate of reaction:



~~[illegible]~~

will evaporate at a faster rate.

$$\text{Rate} = \frac{\text{change in a quantity}}{\text{change in time.}}$$

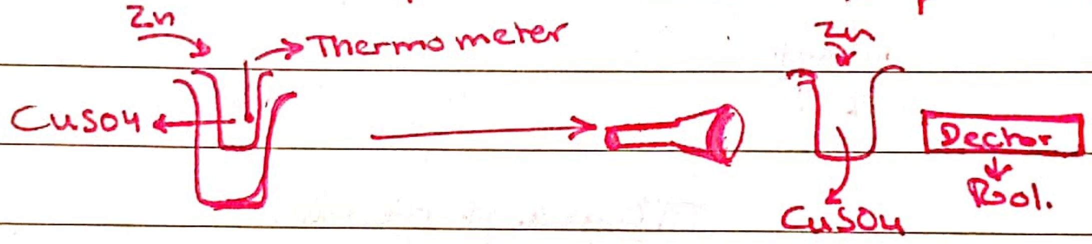
→ Volume
→ Mass
→ Electrical conduct.
→ height
→ Tempritue.

Example:

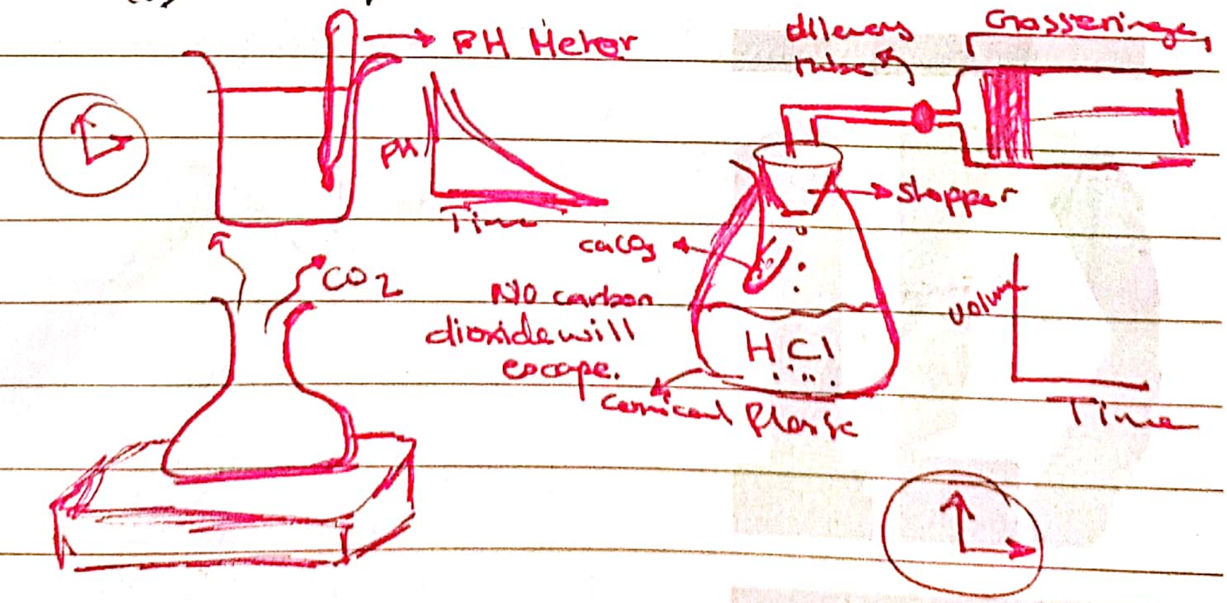
$$\frac{\Delta \text{Mass}}{\Delta \text{Time}} \quad \frac{\Delta \text{Volume}}{\Delta \text{Time}} \quad \frac{\Delta \text{Electrical conductivity}}{\Delta \text{Time.}}$$

$$\frac{\Delta \text{Temp.}}{\Delta \text{Time}} \quad \frac{\Delta \text{height}}{\Delta \text{Time}} \quad \frac{\Delta \text{Color}}{\Delta \text{Time}} \quad \frac{\Delta \text{PH}}{\Delta \text{Time.}}$$

$$\underset{}{Zn_{(s)}} + \overset{\text{Blue}}{CuSO_4{}_{(aq)}} \longrightarrow \overset{\text{Colorless}}{ZnSO_4{}_{(aq)}}\ Cu_{(s)}$$

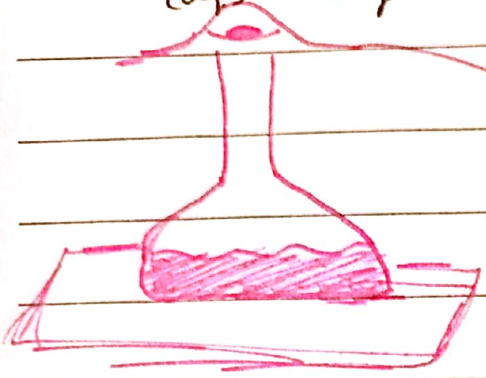


$$CaCO_3{}_{(s)} + 2HCl_{(aq)} \longrightarrow CaCl_2 + H_2O + CO_2$$



$AgNo_{3(aq)} + NaCl_{(aq)} \longrightarrow AgCl_{(s)} + NaNO_{3(aq)}$

$Na_2S_2O_{3(aq)} + 2HCl_{(aq)} \longrightarrow NaCl_{(aq)} + S_{(s)} + SO_{2(aq)} + H_2O_{(l)}$



$\frac{\Delta Mass}{\Delta Time} = g/s$ $\frac{\Delta Volume}{\Delta Time}$ cm^3/s $\frac{\Delta light\ intensity}{\Delta Time}$ $1/s$

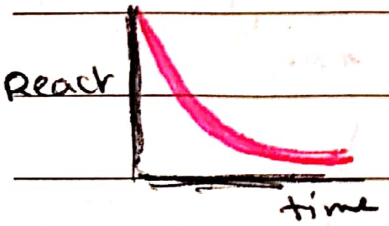
$\frac{\Delta PH}{\Delta Time}$ $1/s$ $\frac{\Delta Electrical\ conductivity}{\Delta Time}$ $1/s$

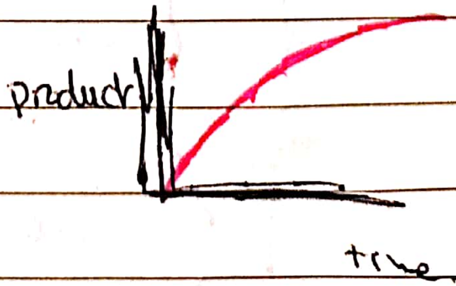
$\frac{\Delta Temp}{\Delta Time}$ $1/s$

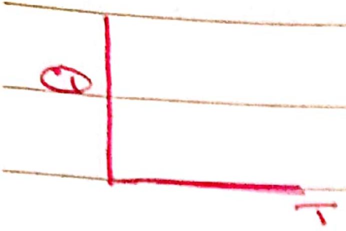
To measure the rate of reaction.

How fast the Reactants consumed per unit time

How fast the products produced per unit time.





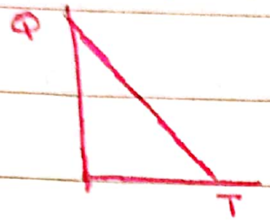


$$R = \frac{\Delta Q}{\Delta T} = \frac{Q_2 - Q_1}{T_2 - T_1}$$

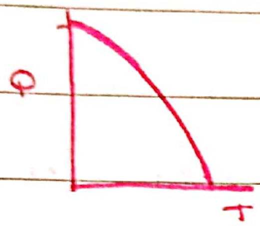
$$\text{Gradient} = \frac{\Delta y}{\Delta x}$$

Types:

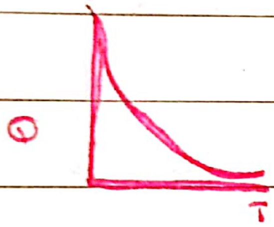
a)



Steepness is constant

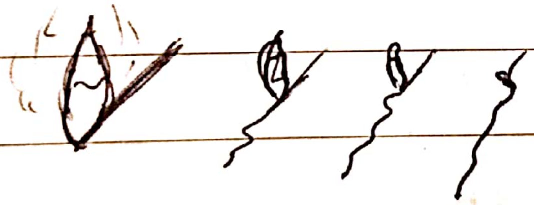


increase in Gradient.



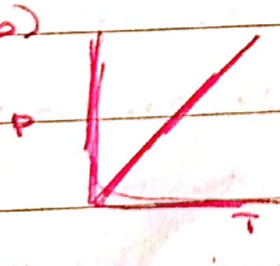
Decrease in Gradient.

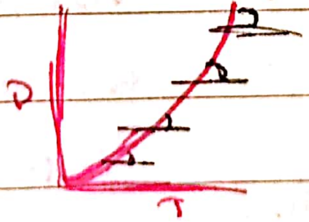
Example:



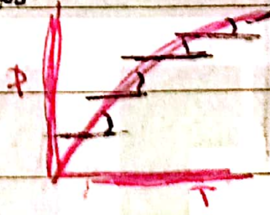
Decreases during time

b)





→ Angle is increasing

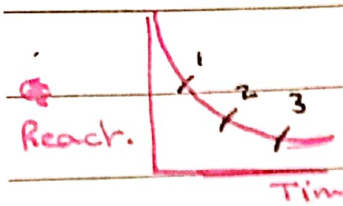


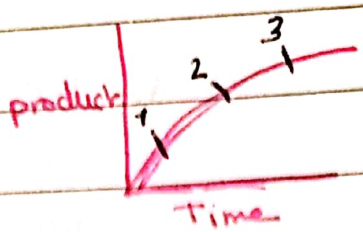
Angle is Decreasing

Steepness is constant

increase in Grandent.

Decrease in Gradient.



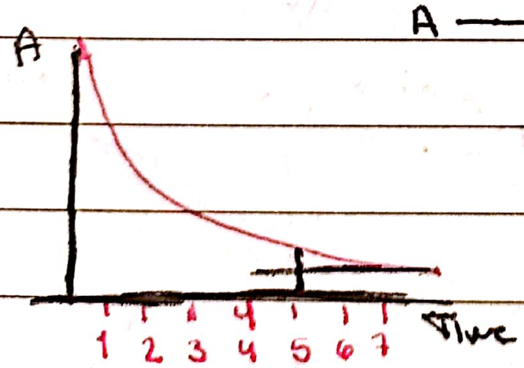


Region (1) is the fastest from the curve Because it is the steepest curve greatest gradient. More reactant so more particles so more effective collisions so faster rate of reaction.

Region (2) slower rate from the graph beause it is was steep less gradient, less reactant less particles so less effective collision for unit time so slower rate of reaction.

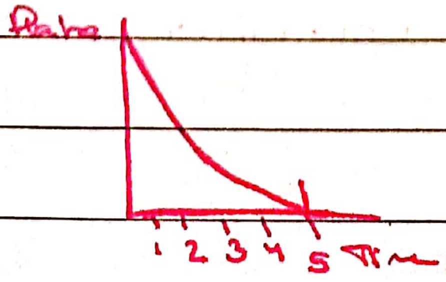
Region (3) reaction is over from the graph because it gradient = 0 horizontal line, No more limiting reagent so no more effective collision so the reaction is stopped.

$A \longrightarrow B$

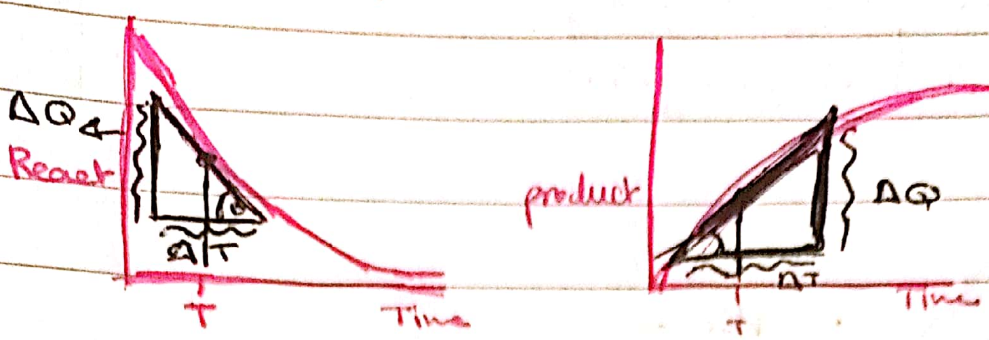


• Draw the graph for Rate vs Time for this reaction.

* To measure the rate
↓
Find the gradient



How to find the gradient:

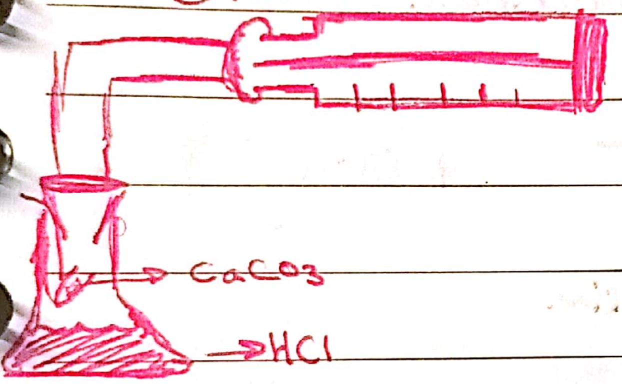


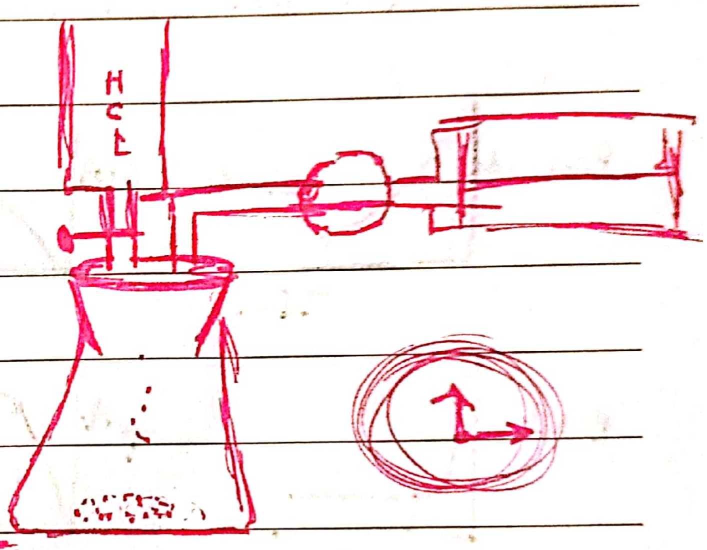
$$Rate = \frac{\Delta Q}{\Delta T}$$

To measure the rate of reaction:

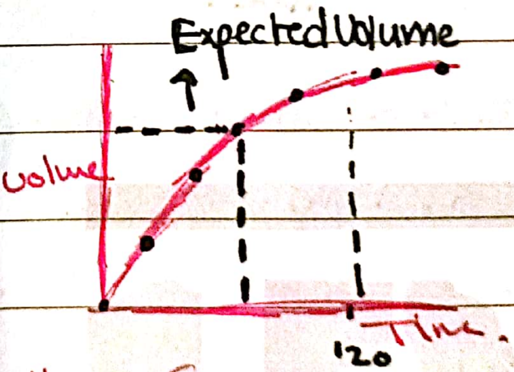
$CaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$

① Find volume

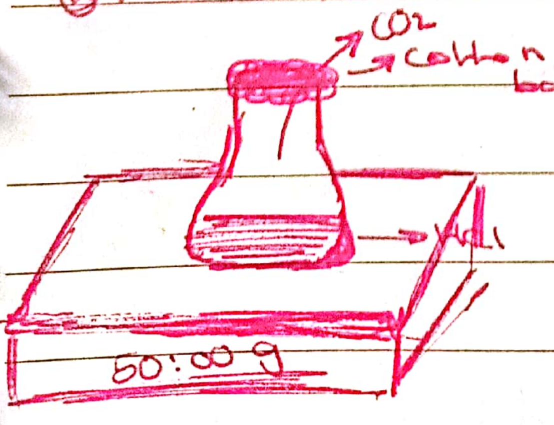




Time	0	30	60	90	120	150
Volume	0	20	30	33	34	34



② Find the mass:

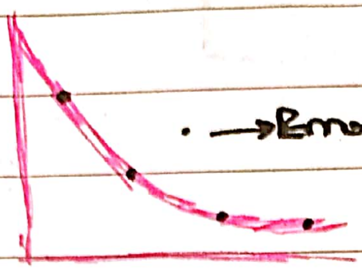


→ To allow CO2 to escape & prevent splashing

* why did the mass decrease.

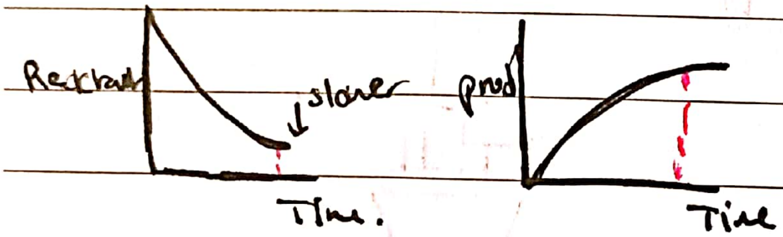
Because CO2 escaped.

Time	0	30	60	90	120	180
volume	50	45	41	40	39.5	39.5

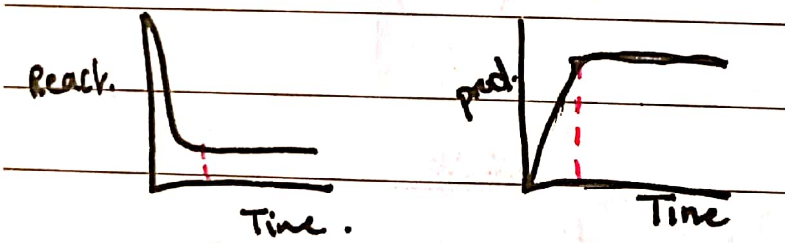


Faster rate of reaction:

-More product per the same unit time the same product with less time. (Steaper curve).



★Wrong



★ Right

Factors affect the rate of reaction:

1) Temp
2) Surface area
3) Concentration
4) Pressure
5) Light intensity
6) Catalyst.

1) Temprature:

Q1) State how the temprature affects the rate of reaction:

As the temp ↑ the rote of reaction ↑. (Less time)

Q2) Explain how the Temp affects the rate of reaction (3marks)

As temp increases the particles gain kenetic energy, So they move faster. More particles will have energy equal to or greater than Activation energy.
More effection collisions per unit time so faster rate of reaction.

Q3) plan an experiment to show that ① temp affects the rate of reaction.

$CaCO_3(\overset{s}{\cancel{aq}}) + 2HCl(aq) \longrightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$

Exp1: Mass: $CaCO_3$ = 2g (Lumps)

Volume: HCl = $\overset{0.1}{\cancel{1}}$ dm^3 (Concentration)

HCl = 1 ml/dm^3 (Temp = 25°C)

1) Measure volume

2) Measure Mass

3) Repeate with higher temp.

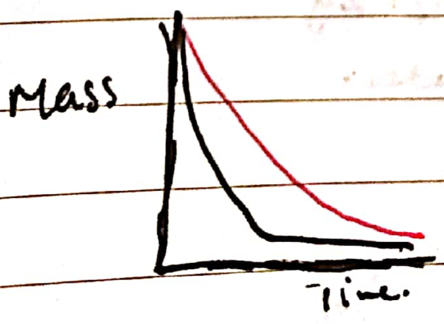
Exp2: Mass: $CaCO_3$ = 2g (Lumps)

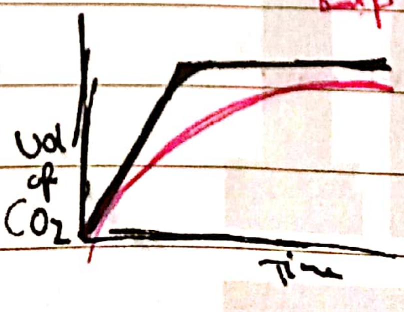
Volume: HCl = 0.1 dm^3

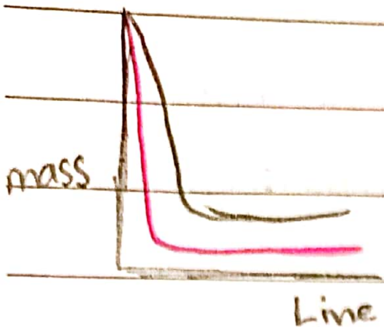
HCl = 1 ml/dm^3

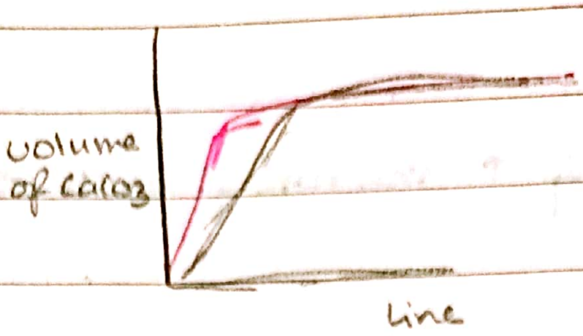
Temp = 50°C.

Exp 1 , Exp2









② Surface area:

· State how the surface area effect the rate of Reaction?

As the surface area ↑ the rate of reaction ↑

By crushing using Mortar & pastile (Particles smaller)

· Explain how the surface area effect the rate of reaction

As the surface area ↑ more particles exposed to the reaction. So more effective collisions per unit time, so faster rate of reaction.

· Plan an Exp. to show how the surface area affect the rate: $CaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$ ↑g

Exp1: $CaCO_3$ = 2g

lumps

Temp: 25°

~~Exp2~~: VHCl: 0.1dm^3

MHCl: 1 mol/dm^3

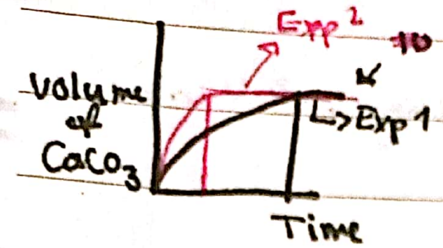
Exp2: VHCl: 0.1dm^3

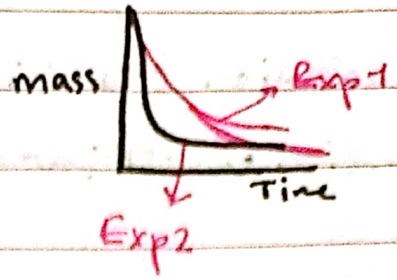
MHCl: 1mol/dm^3

Temp: 25°

$CaCO_3$: 2g

powder.





③ Concentration (ammount) "IMP very"

- State how the concentration affect the rate of reaction

~~Explain~~

As the concentration ↑ the rate of reaction ↑

- Explain how the concentration affect the rate of reaction.

As the concentration of reactant ↑, more particles, so more effective collision per unit time, so faster rate of reaction.

- Plan an exp to show the conc. affect the rate of reaction

added 0.02, 0.01

Excess ← $\frac{CaCO_3(s)}{0.005} + \frac{2HCl(aq)}{0.04} \longrightarrow CaCl_2(aq) + H_2O(L) + CO_2(g)$

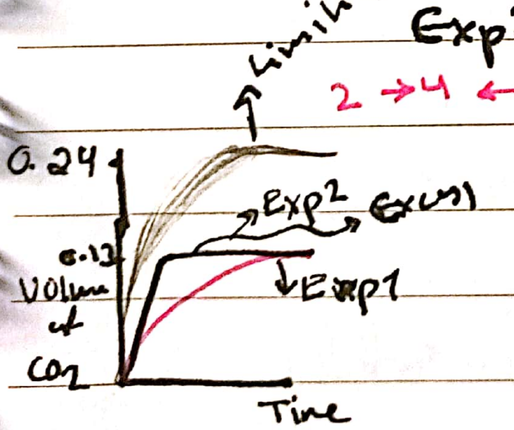
Exp1: M 20g, Lumps, MR=100 — V 0.1 dm³, 1 mol dm³

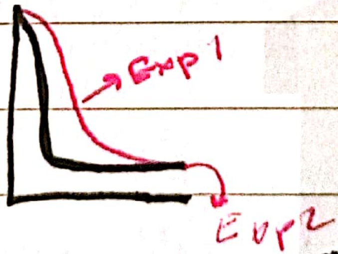
Exp2: M 2.0g, Lumps — V 0.1 dm³, 2 mol/dm³

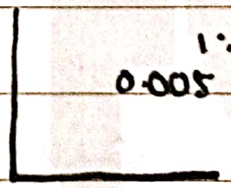
1→2

Exp3: M 4.0g ← 2→4, Lump — V 0.1 dm³, 1 mol/dm³

Balanced equation CaCO3 : HCl
1 : 2
0.02 : 0.04

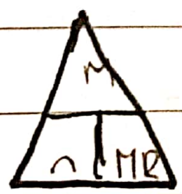


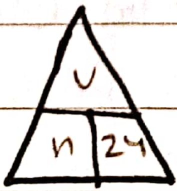




1 : 2
0.005 : 0.01

n = 0.005
V = 0.12





Gas

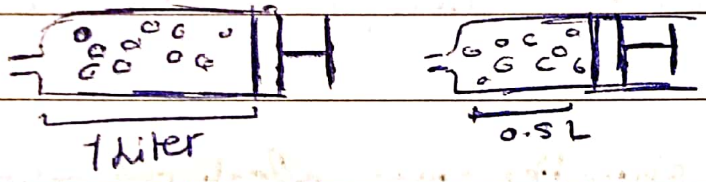
A ①

- If the concentration of the limiting reagent ↑ then both the rate & the final result increases.

- If the con. of the excess reagent ↑ Only the rate ↑

4) Pressure : "only affect the gas"

- by increasing the pressure (by reducing the volume) more particles per unit volume, more effective collisions per unit time so faster rate of reaction.



$\frac{10 \text{ particles}}{1L} = 10$ $\frac{10 \text{ particles}}{0.5 L} = 20$

5) light "only for photochemical reaction"
↓
reactions that need light to occur

a) Photo synthysis:

$6Co_2 6+H_20 \xrightarrow[\text{CHorophyl}]{\text{light}} C_6H_{12}O_6+6O_2$

b) photographic films (not included)

$AgCl_{(s)} \xrightarrow{\text{light}} \underset{\text{black}}{Ag} + Cl_2$

$AgBr_{(s)} \xrightarrow{\text{light}} Ag + Br_2$

6) Catalyst:

Chemical substance that speeds up the rate of chemical reaction without being used up.

How?

provides an alternative pathway with lower activatio energy (EA)

↓EA = ↑ Reaction
slower/faster
↑EA = ↓ Reactio

↳ Ammount of energy to start the reaction.

More particles will have energy equal to greater than EA

So more effective collisions per unit time

faster rate of reaction.

Example : in taj mall on thursday a ticket's price is 8 JDs meanwhile on monday it's 4 JDs meening that more people wanted come. the catalys is the same as more particles will be included in the reaction when the EA is lowered.

Q) Decomposition of hydrogen peroxide:

$$2H_2O_2(aq) \xrightarrow[MnO_2]{CuO} 2H_2O_{(l)} + O_2(g)$$

① plan an experement to show that CuO is a catalyst for this reaction:

- Take a known volume with a known temp & concentration of H_2O_2.

- Measure the volume of O_2 produced per unit time
- Reparte the exp with CuO
- Conclusion: the exp with CuO produce more O_2 per same unit time

② plan an exp to show which catalyst CuO or MnO_2 is better.

Same Q

- The same mass of CuO & MnO_2

2 diff test tubes.

- Take a known volume with a known temp & concentration of H_2O_2
- Add a known mass of CuO
- Measure the volume of O_2 produced unit time
- Repeat the ~~mass~~ experement using MnO_2
- Conclusion: the exp that produce more O_2 per the same unit time use the better catalyst.

③ plan an exp to show that CuO not used up during the reaction.

- Take a known maso of ~~copp~~ CuO
- do the experement until no more bubbles of O_2
- filter the mixture
- ~~Wait the dry~~ dry in oven → wet can't measure

Reversable reaction

Types of reaction:

① One way

Reactant → products

② both ways

$\text{Reactant} \underset{\text{backward}}{\overset{\text{Forward}}{\rightleftharpoons}} \text{product}$

- Bothways:

☆ $NH_4Cl_{(s)} \overset{\text{heating}}{\rightleftharpoons} NH_{3(g)} + HCl_{(g)}$ → hydrogen chloride, only named in gas state.

- Oneway:

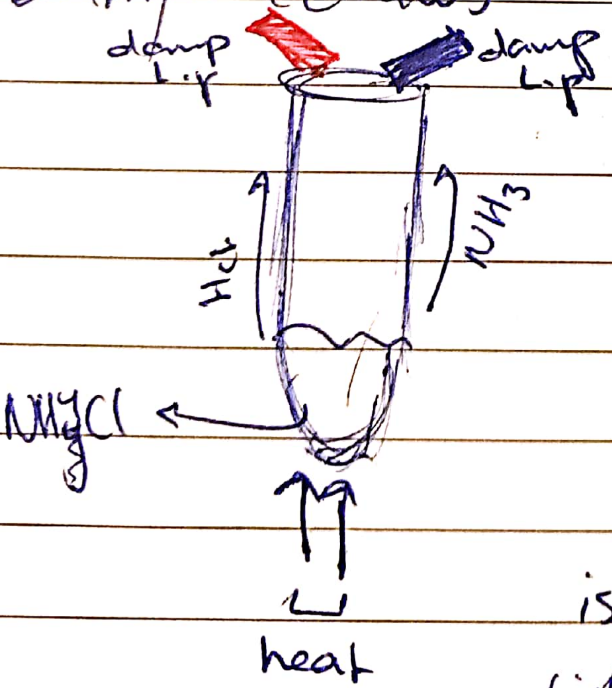
$CaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$

why can't some reactions not reversable:

1) No chemistry
2) Reactivity series
3) Products not suitable to react.

Ex☆: Ammonium chloride $\xrightarrow{\Delta}$ Ammonia + Hydrogen chloride.

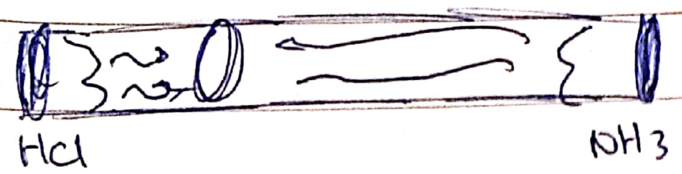
Example (draw):



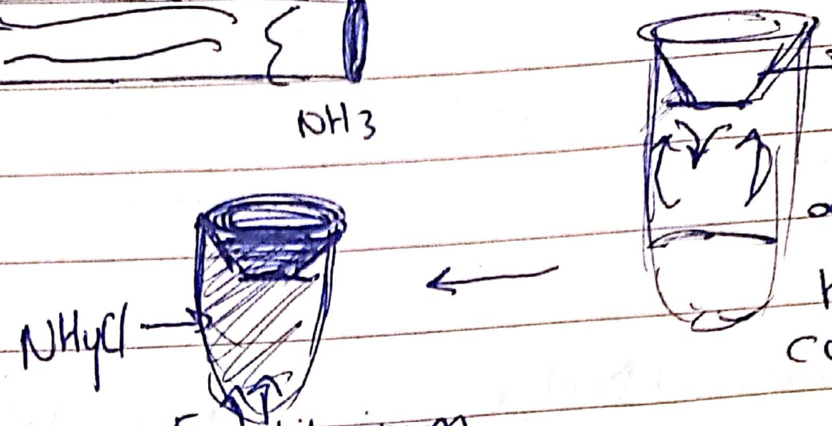
- which damp litmus paper change it's color first, why?

- The damp Red litmus paper change it's color first bcs NH_3 is a Basic gas & is lighter than HCl which is an acidic gas.

$NH_{3(g)} + HCl_{(g)} \longrightarrow NH_4Cl_{(s)}$



solution:



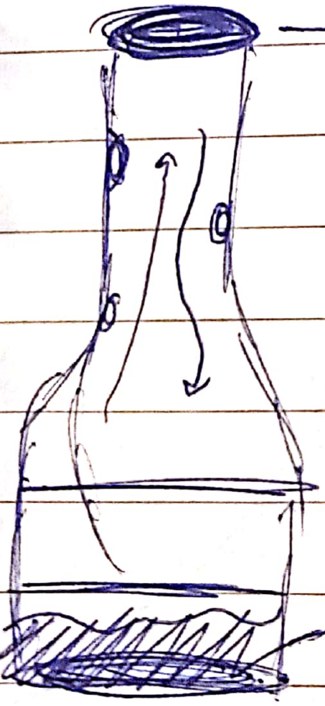
add sto
to let th
colide.

Always ← Equilibrium
dynamic   reaction

Example: Dynamic Equilibreium

→ evaporation

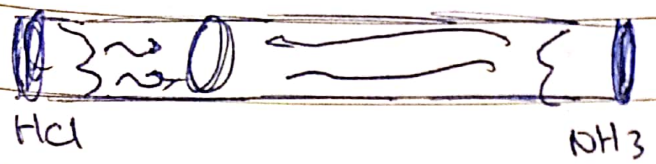
Condensation ~~back~~ occurs but the rate is slower than evaporation



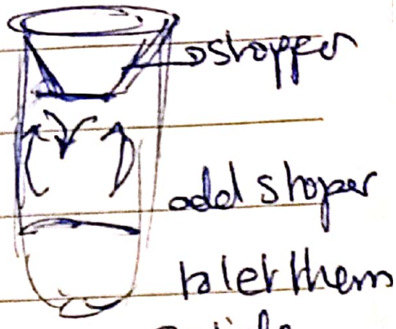
↓

Condensation ratee is equal to the rate of evaporation.

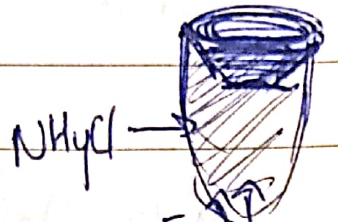
$NH_3(g) + HCl(g) \longrightarrow NH_4Cl(s)$



solution :



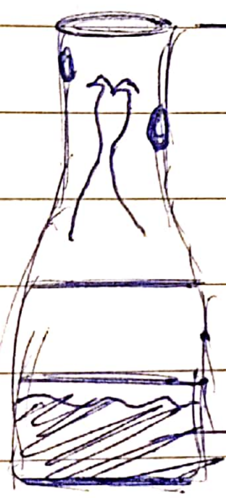
add stoper to let them colide.



Equilibrium reaction

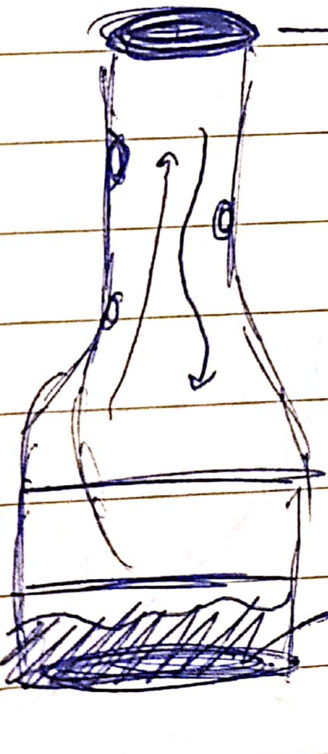
Always dynamic ←

Example: Dinamic Equilibreium



~~evaporation~~

condensation occurs but the rate is slower than evaporation

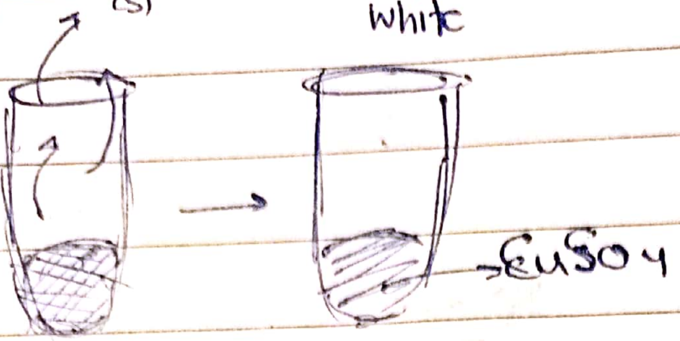


Condensation ratee is equal to the rate of evaporation.

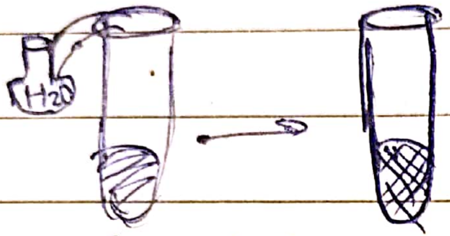
Blue $\xrightarrow{\text{Color}}$ white

$CuSO_4 5H_2O_{(s)} \xrightarrow{\Delta} CuSO_{4(s)} + SH2O$

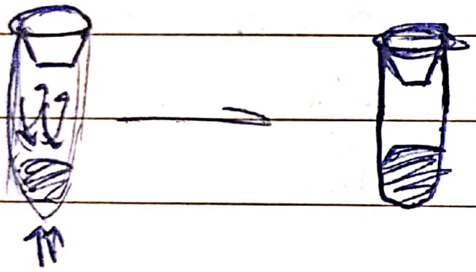
white



$CuSO_4(s) + 5H_2O \longrightarrow CuSO_4 sH_2O$



$CuSO_4 \overset{\Delta}{\rightleftharpoons} CuSO_4 + SH_2O$



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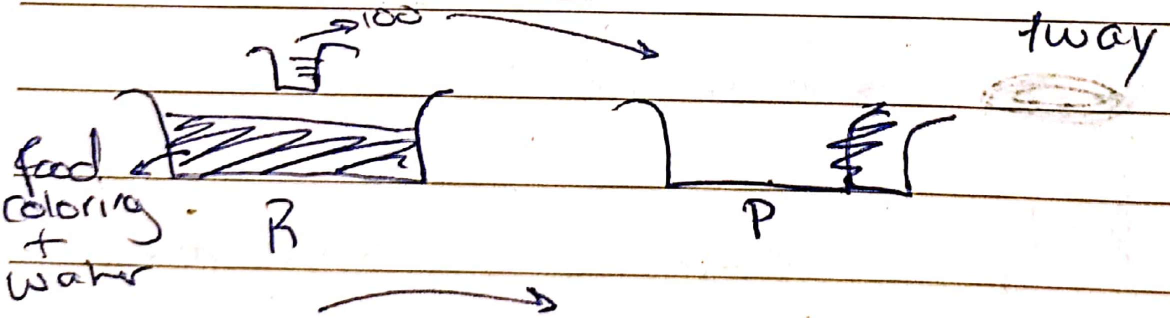
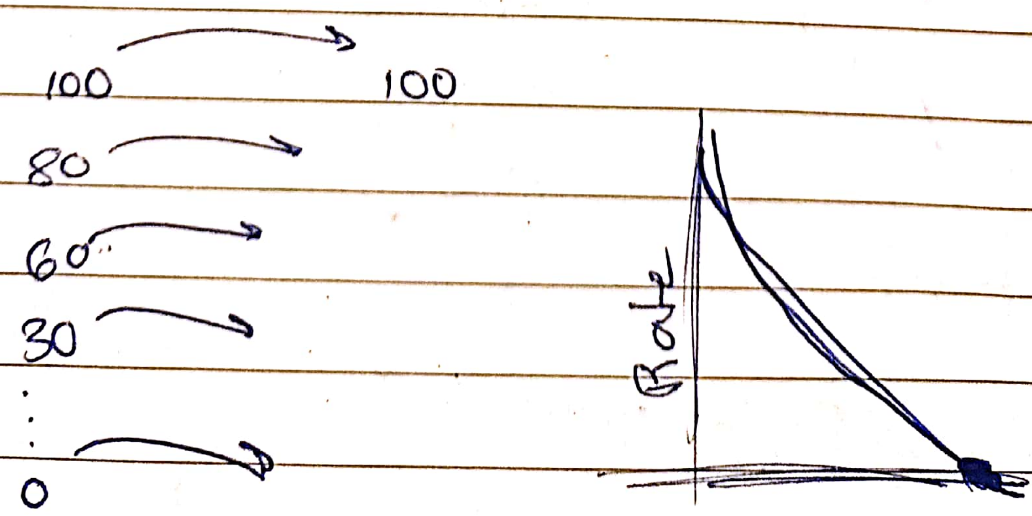
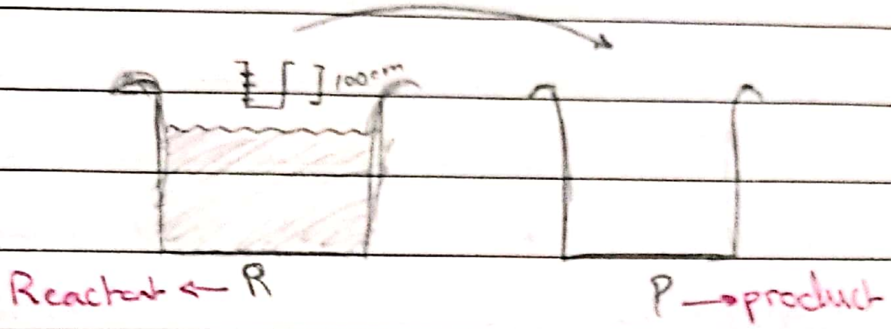
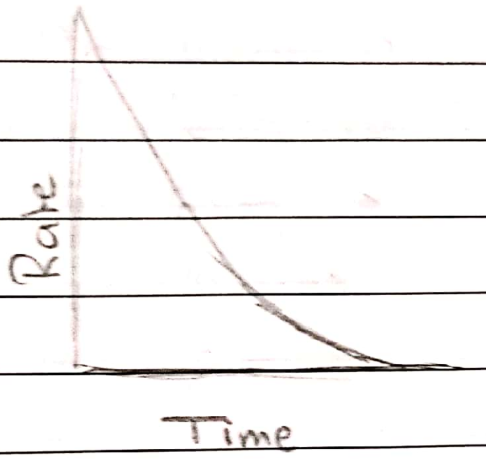




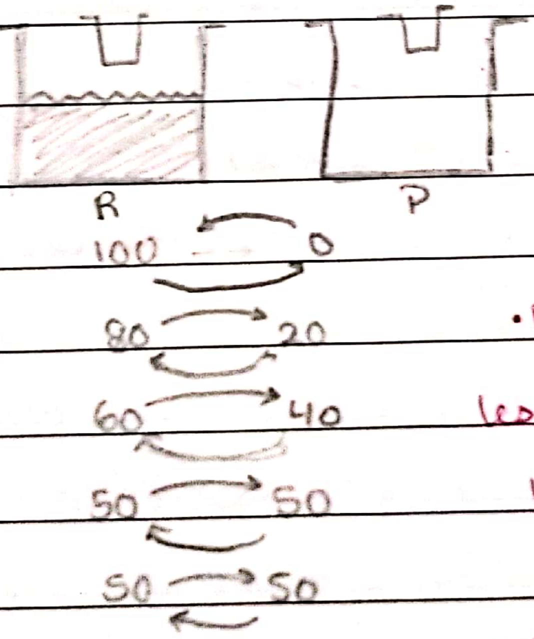
Dynamic equilibrium:

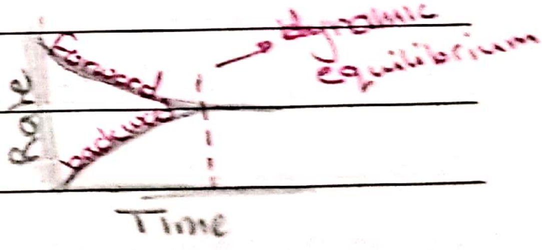




100 →
80 →
60 →
40 →
20 →

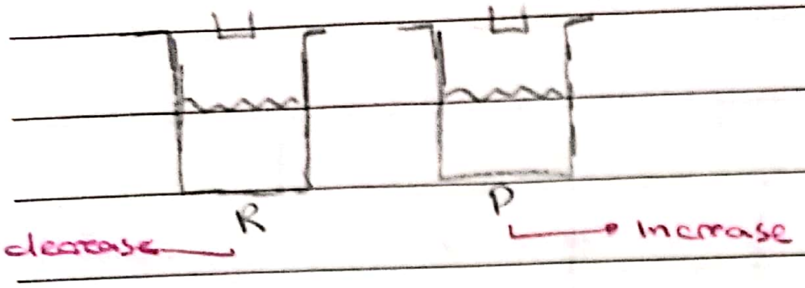
Rate ↓ with time the reactants consumed so less particles so less effective collisions

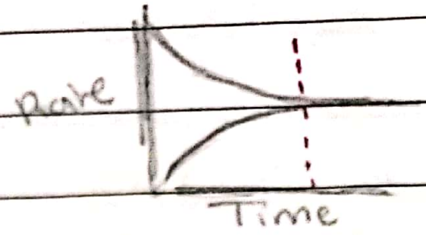




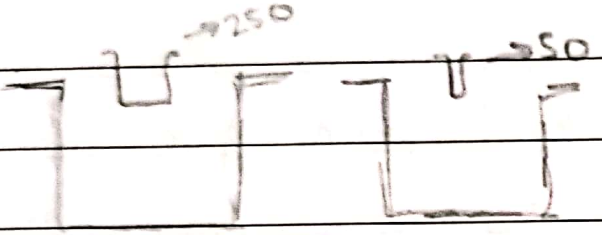
- Rate of forward decrease with time less reactants so less particles so less effective collisions per unit time.
- Go to the worksheet for backward.

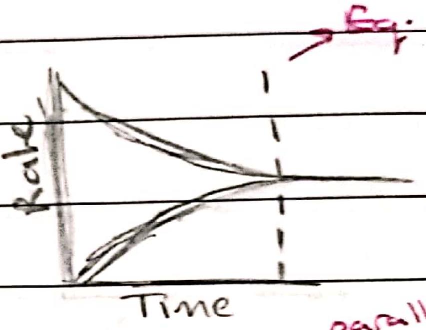
> Dynamic equilibrium in terms of rate: when the rate of forward & backward reaction is equal/same.

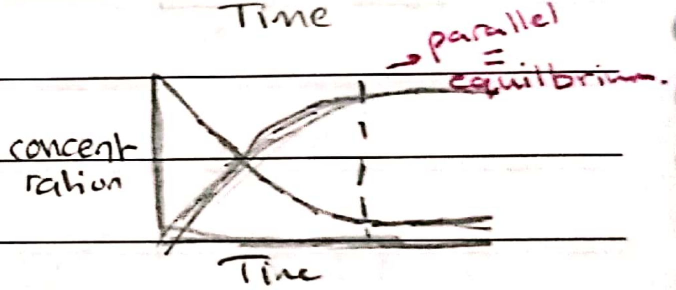




Dynamic equilibrium in terms of concentration: when the concentration of reactant & product are constant.







• Le Chatlier principle: Equal rate ↑

if the system at equilibrium ⇌

& any external factor disrupt this equilibrium

the system can shift itself either to the forward ⇌ → forward faster

or to the backward ⇌ to return back to ~~elig~~ eliquilibrium.

↳ shift backward.

what are the 3 factors that affect the position of equilibrium:

1) Temprature 2) pressure 3) concentration.

↑ temp shift to endothermic

↓ temp shift to exothermic

① Temprature:

- ↑ temp : shift to endothermic
- ↓ temp : shift to exothermic

higher rate ← ↑↑ Rate of endo

Lower rate ← ↓↑ Rate of exo

lower rate ← ↓↓ " of endothermic.

higher rate ← ↑↓ Rate of exothermic

★ The sign of ΔH (energy changes) always represents the forward side

ΔH

\+ endo

Gain energy.

− exo

lose ~~Gain~~ energy

- $A + B \underset{exo}{\overset{endo}{\rightleftharpoons}} C + D$ endo; $\Delta H = +ve$

↑ temp   shift forward to endoside   ↓A ↓B ↑C ↑D

↓ temp   shift backward to exoside   ↑A ↑B ↓C ↓D

- $x + w \underset{endo}{\overset{exo}{\rightleftharpoons}} y + z$ exo $\Delta H = -ve$

↓ temp   shift forward to exoside   ↓w ↓x ↑y ↑z

↑ temp   shift backword to endoside   ↑w ↑x ↓y ↑z

- $N_2(g) + 3H_2(g) \underset{endo}{\overset{exo}{\rightleftharpoons}} 2NH_3(g)$ exo $\Delta H = -ve$

> To obtain high yeild of NH_3, in terms of Temp we use (high/low) temp. & why?

to favor the exothermic side which is the forward rxn.

· Temp for haber process (400-450°c)

- $2SO_2(g) + O_2(g) \underset{endo}{\overset{exo}{\rightleftharpoons}} 2SO_3(g)$ $\Delta H = \overset{exo}{-ve}$

	Rate of forward	Rate of backward	Yeild of SO_3
↑temp	↑	↑	↓
↓temp	↓	↓	↑

Q: Sealed tube contains mixture of equil.

$2NO_2(g) \rightleftharpoons N_2O_4(g)$

dark brown Palebrown

if this tube is cooled to a cold water bath the mixture becomes paler explane why?

the forward reaction is exothermic favored by low temp.

② pressure "only for gases"

↑pressure to the side with less pressure

less gas moles

↓pressure shift to the side with greater p.

more gas moles.

$$\overbrace{N_2(g) + 3H_2(g)}^{4} \rightleftharpoons \overbrace{2NH_3(g)}^{2}$$

↑ pressure : shift forward to side with less gas.

↓ pressure : shift backward " " with more gas.

$$\overbrace{H_2CO_3(aq)}^{0 \longrightarrow B\ cs(aq)} \rightleftharpoons \overbrace{H_2O_{(l)} + CO_2(g)}^{\textcircled{1}}$$

↑ pressure = shift backward : less gas

↓ pressure " forward " " " more gas.

$$\overbrace{H_{2(g)} + I_{2(g)}}^{2} \longrightarrow \overbrace{2HI(g)}^{2}$$

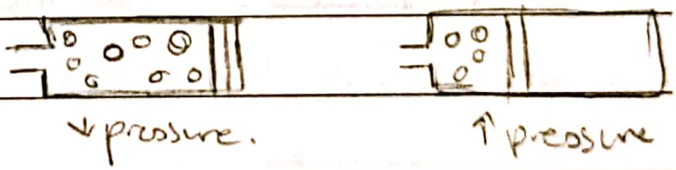
purple colorless

- Why increasing the pressure has no effect on the position of the equilibrium?

Because both side has the same number of gas moles

- Why by ↑ing pressure the mixture becomes more purple?

The I_2 molecules become closes together and the colorbecomes more dense.



• Sealed tube contains NO_2 & N_2O_4 at equilibrium.

$$- \underset{\text{dark brown}}{2NO_2(g)} \rightleftharpoons \underset{\text{pale brown}}{N_2O_4(g)}$$

when the pressure of the system ↑ the color of the mixture will.

a) Becomes paler then goes darker

[✓ b)] " darker " " Paler.

c) " darker " stays darker

d) " Paller thenstays darkr.

③ Concentration:

Reactant(s) $\rightleftharpoons$ products.

↑ Reactant] Forward   Backward [↓ Reactant
↓ Product   ↑ Product

• $A+B \rightleftharpoons C+D$

↑(A) shift to forward ↓(B) ↑(C) ↑(D)
↓(B) shift to backward ↑(A) ↓(C) ↓(D)
↑(C) shift to backward ↑(A) ↑(B) ↓(D)
↓(D) shift to forward ↓(A) ↓(B) ↑(C)

• Indicator:

$\underset{red}{HIn_{(aq)}} \rightleftharpoons \underset{yellow}{H^+_{(aq)} + In^-_{(aq)}}$

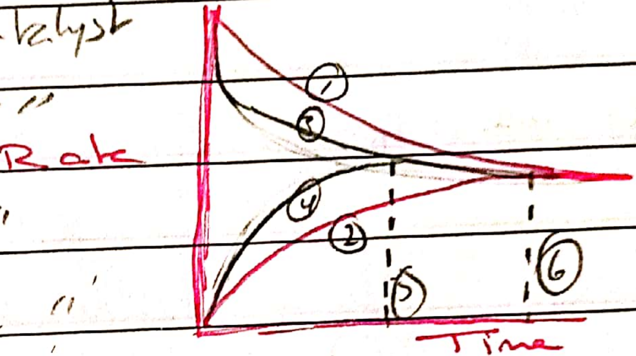
- When we add $\underset{\longrightarrow Acid}{HCl}$ ↑H^+ it will shift forward
  ↑HIn more red color
  ↓In^- less yellow color
- When we add $\underset{\longrightarrow Base}{NaOH}$ ↓H^+ shift forward (proton acceptor)
  ↑In^- more yellow color
  ↓HIn^- less red color.
- The $Cr_2O_7^{-2}$ & Cr^{3+} Ions are →In equilibrium.

$\underbrace{Fe^{2+} + H^+ + Cr_2O_7^{-2}}_{orange} \rightleftharpoons \underbrace{Cr^{3+} + Fe^{3+} + H_2O}_{green}$

Why by adding HCl to equilibrium the color of the system have a green color?

Forward, Because the H^+ is on the reactant, Adding HCl will ↑ the amount of H^+ so the equilibrium shifts forward to the side so more Cr^{3+} (more green) & less $Cr_2O_7^{2-}$ (less orange).

* Catalyst has no effect on the position of the equilibrium. But it will speed up the rate of forward & backward reaction. So less time taken to reach equilibrium.



① Rate of forward without catalyst
② " " Backward " ""
③ " " forward with "
④ " " Backward with "
⑤ Time taken to reach equil with catalyst
⑥ " " " """"""" " " without"

Energetics:

- What is energy?:

= Input > Output

= Output ≥ input

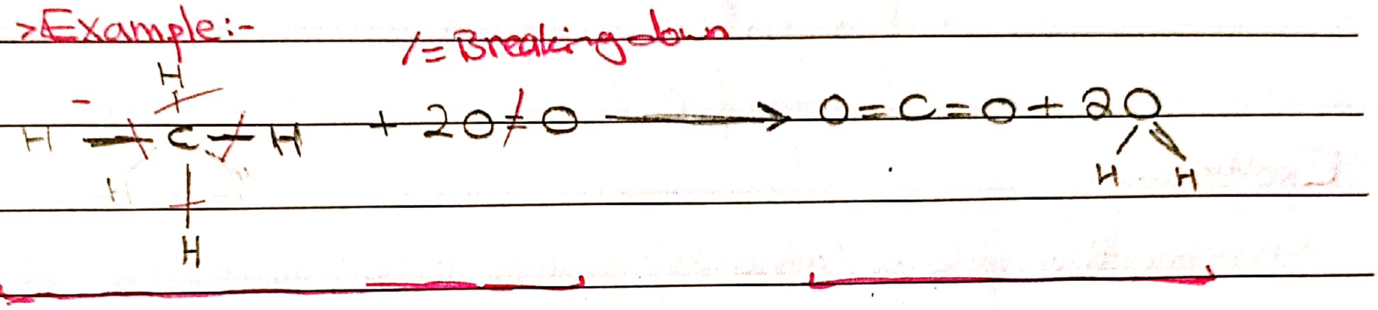
The ability to do work (Joule)

Work in Chemical reaction

Breaking down bonds of reactants] endothermic

exothermic [Building up bonds in products

>Example:-

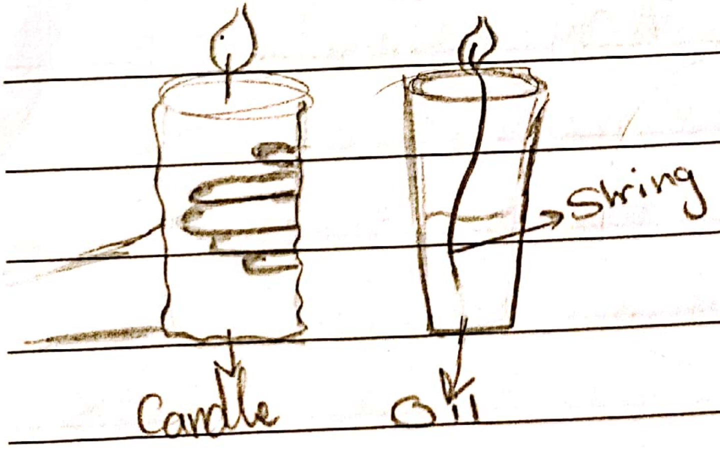


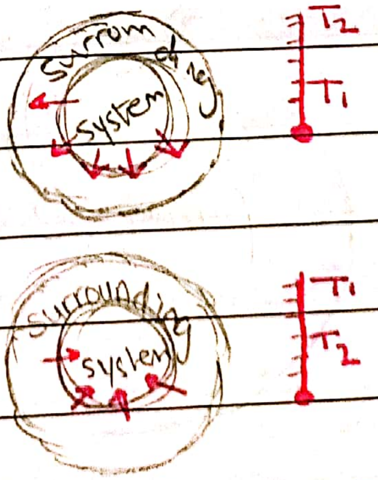
Breaking down | Building up

• Since this reaction is exothermic:

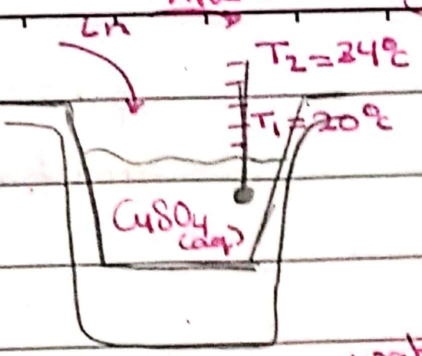
The ammount of energy released by building up bonds in product > The ammount of energy absorbed by breaking down bonds in reactant.

Chemical energy: Enthalpy : Heat energy (Stored energy)



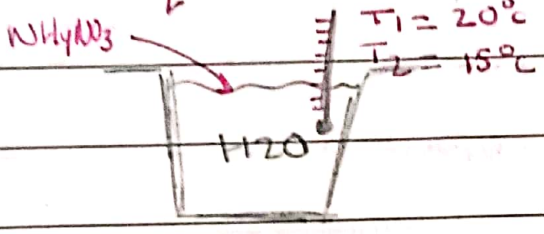


After adding:



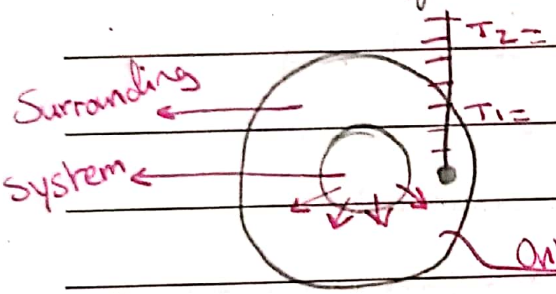
$Zn_{(s)} + CuSO_{4(aq)} \rightarrow ZnSO_{4(aq)} + Cu_{(s)}$

- $NH_4NO_{3(s)} + aq \xrightarrow{water} NH_4^{+}{}_{(aq)} + NO_3^{-1}{}_{(aq)}$



Exothermic:

> Reaction that gives out (releases) energy to the surrounding



Water (H_2O) ← 4.2 J/g.c°

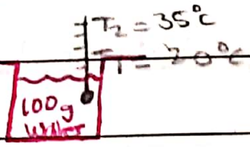
↑

Specific heat capacity

Only surrounding $Q = M\ C\ \Delta T$

Energy Transfer ↑ Q, mass(g) ↑ M, Specific heat capacity ↑ C, change in temp. ↗ ΔT

$T_2 > T_1$



- Find the ammount of energy transfer?

$Q = m \times C \times \Delta T$

$Q = 100 \times 4.2 \times (35-20)$

$Q = 100 \times 4.2 \times 15$

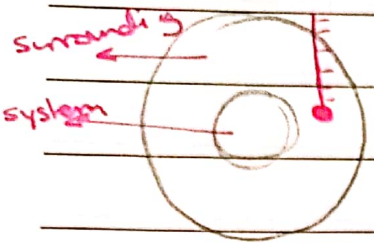
$Q = 6300 J$

$Q = 6.3 kj$

☆ Only measure the temp of the surrounding not the system.

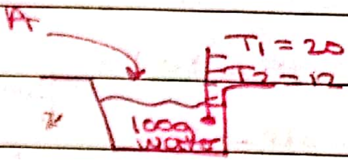
Endothermic:

Reaction that absorb (take in) energy from the surrounding



$Q = M \times C \times \Delta T$

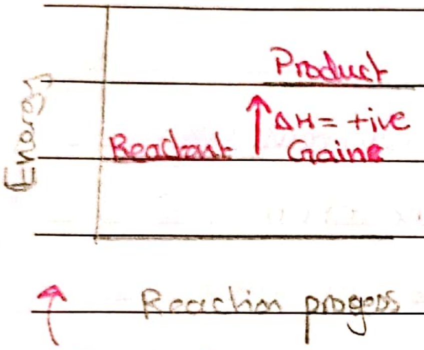
Find Q =



$Q = 100 \times 4.2 \times 8$

$Q = 3360j$

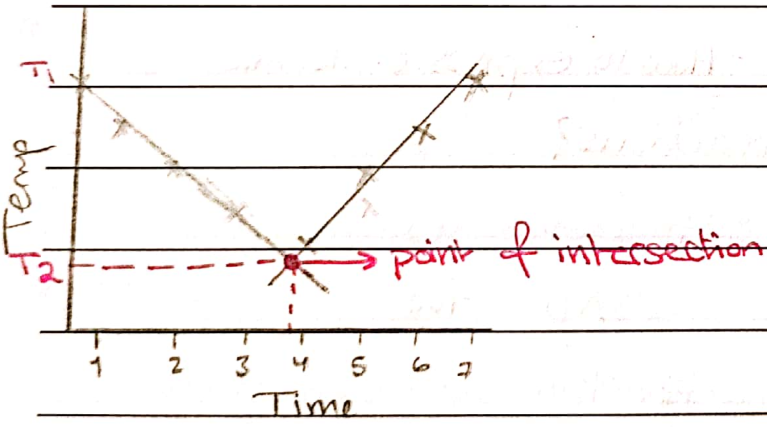
$Q = 3.36 kj$



- Examples on endothermic:

1) Photosynthesis
2) Photographic films
3) Electrolysis
4) Boiling, melting
5) Breaking down bonds
6) Thermal decomposition.

· For System "Energy level" diagram.

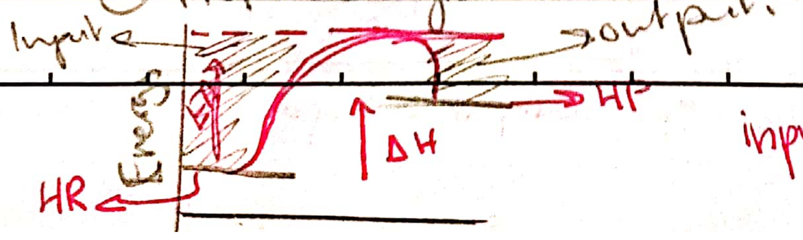


· How to express endothermic reactions?

① Reactants ⟶ products ΔH = +ive

② Reactant + energy ⟶ product.

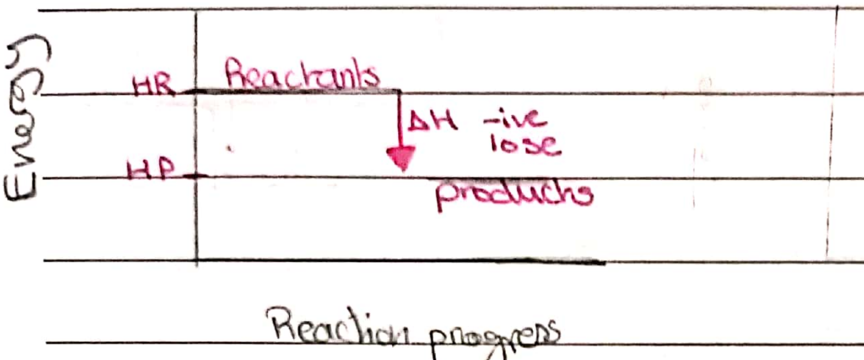
③ Profile diagram.



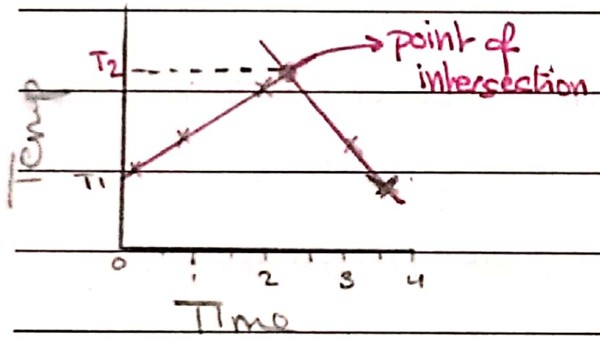
input > output

Exothermic reaction 2:

For system "Energy level diagram"



For Surrounding "Temp diagram"



why did the temp decrease?

Reaction is over return back to room temprature

You can measure avey 30 sec to make the result more reliable

- Examples on exothermic:
  1) Combustion
  2) neutralization
  3) displacment
  4) Voltaic cell
  5) freezing & Condensing
  6) building up bonds
  7) Resperation

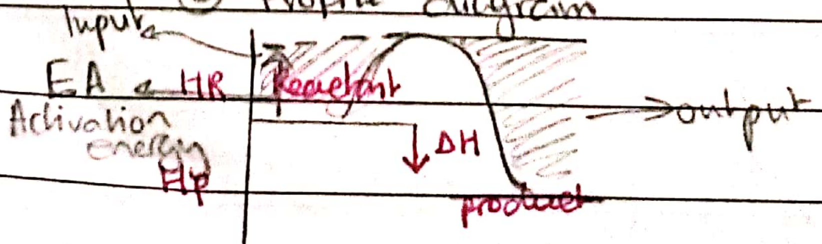
· How to express exothermic reactions?

① Reactant gives out product

$\Delta H = -ive$

② Reactant ⟶ products + energy

③ Profile diagram



- Measuring ΔH

1) Theoritical

using bond energy

2) practical

1) neutralization

2) Displacment

3)

Bond energy:-

- The ammount of energy needed to break 1mol of a bond in a gaseous state.

- The ammount of energy released to build 1 mol of a bond in a gaseous state.

kj/mol

Bond	Bond energy
H — H	436

> $H-H_{(g)}$ + 436kj/mol ⟶ H(g) + H(g)

> H(g) + H(g) ⟶ H-H(g) + 436 kj/mol

★ ΔH = $\sum$ input − $\sum$ output

Sum

To break down bonds in reactants

To build up bonds in product

ΔH

input > output
+
Endo

input < output
−
Exo

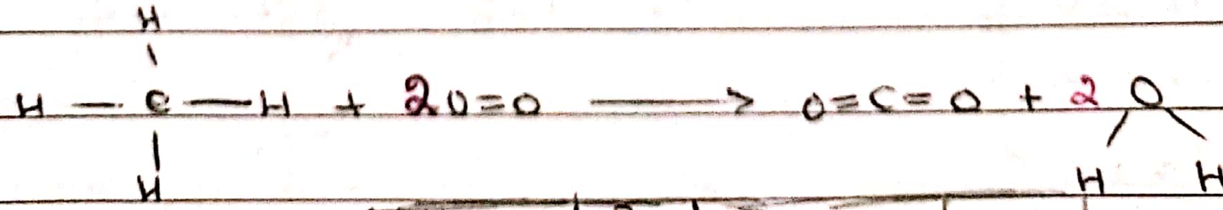
- To use this equation:

1) Balanced equation

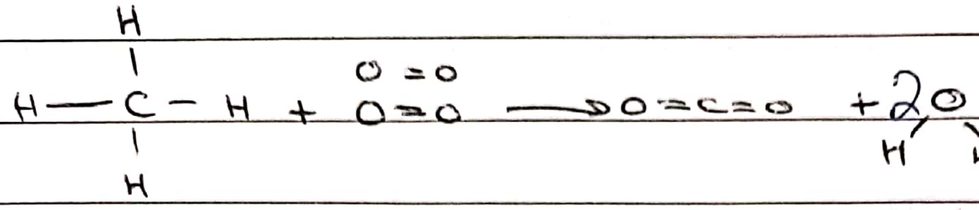
2) Covalent structure

3) Bond energy.

- $CH_3 + 2O_2 \longrightarrow CO_2 + 2H_2O$



Bond	Bond energy	Bond	Bond energy
C − H	413	C = O	799
O = O	458	O − H	463



$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

Bond broken:

4x C—H = 4x413 +

2x O=O = 2x458

2568 kj

Bond built:

2x C=O = 2x 799

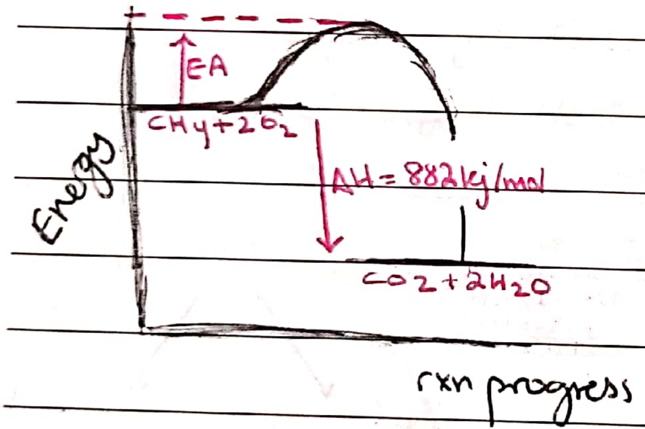
4x O—H 4x463 +

3450 kj

Exo

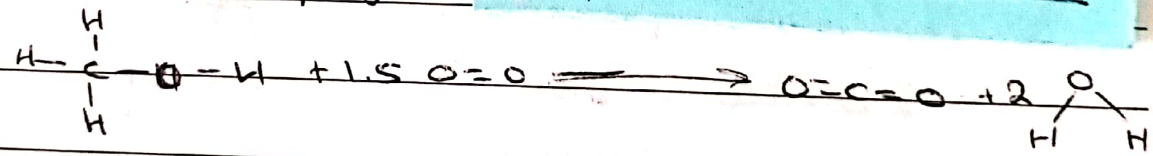
ΔH= 2568 − 3450 = −882 kj/mol

Profile diagram:



Bond	Bond energy
C−H	413
C−O	358
O−H	463
O=O	458
C=O	799

Rev Hmi

[redacted] 

$$CH_3OH + 1.5\,O_2 \rightarrow CO_2 + 2H_2O$$

Bond broken,

3x C—H

1x C—O

1x O—H

1.5 x O=O

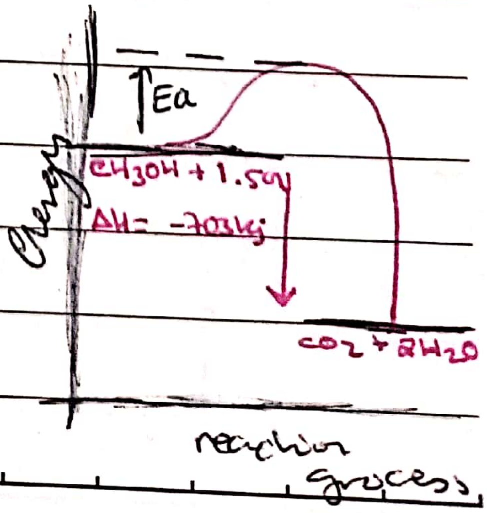
2747

Bond build:

2x C=O

4x O—H

3450

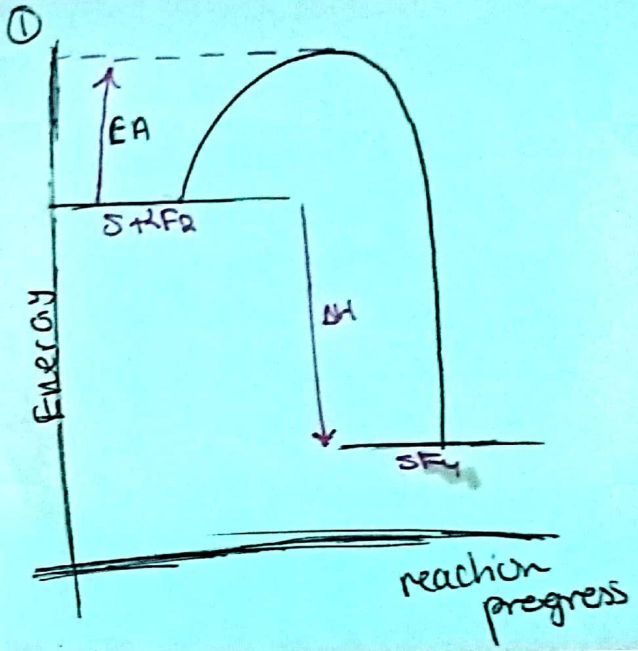


exo

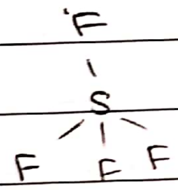
ΔH = 2747 − 3450 = −703 kj/mol

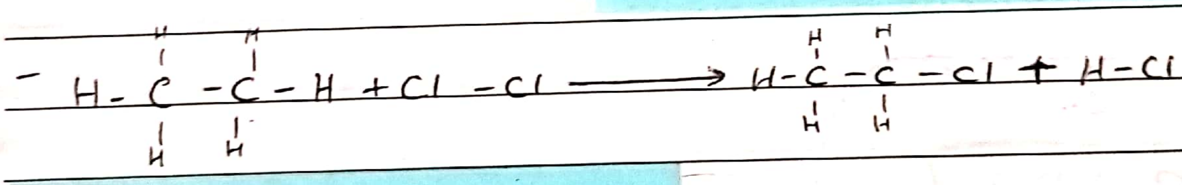
- The reaction between Sulfur & Flourine gives out 780 kj/mol.
if the bond energy F-F is 160 kj/mol
1) Draw a profile diagram for the reaction.
2) Find the bond energy for S-F

2) $\Delta H = \Sigma input - \Sigma output$
$-780 = (2\times160) - (4\times S-F)$
$-780 = 320 - 4\times S-F$
S-F = 275 kj/mol



S + 2F-F =





$$- H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-H + Cl-Cl \longrightarrow H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-Cl + H-Cl$$

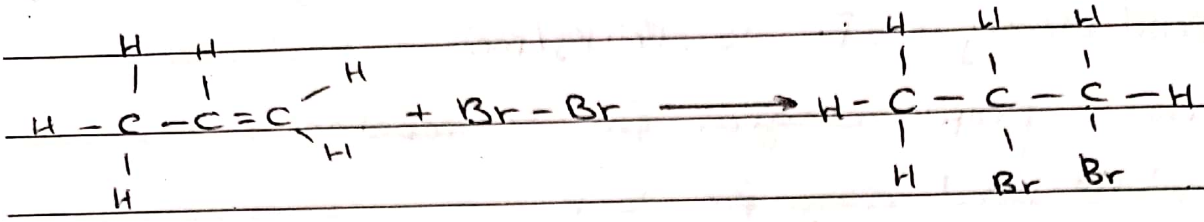
Bond	Bond energy
C-H	413
C-C	348
Cl-Cl	242
C-Cl	328
H-Cl	431

Bond broken:
C-H ×1 = 413
Cl-CL×1 = 242
655 kj/mol

Bond build:
C-Cl×1 = 328
H-Cl ×1 = 431
759 kj/mol

ΔH = 655 - 759 = -104

Calculate ΔH reaction & deduce if the reaction is exo or endo.



Bond broken:

$C=C = 614$] 807 kj/mol

$Br-Br = 193$

Bond built:

$C-C$] 900 kj/mol

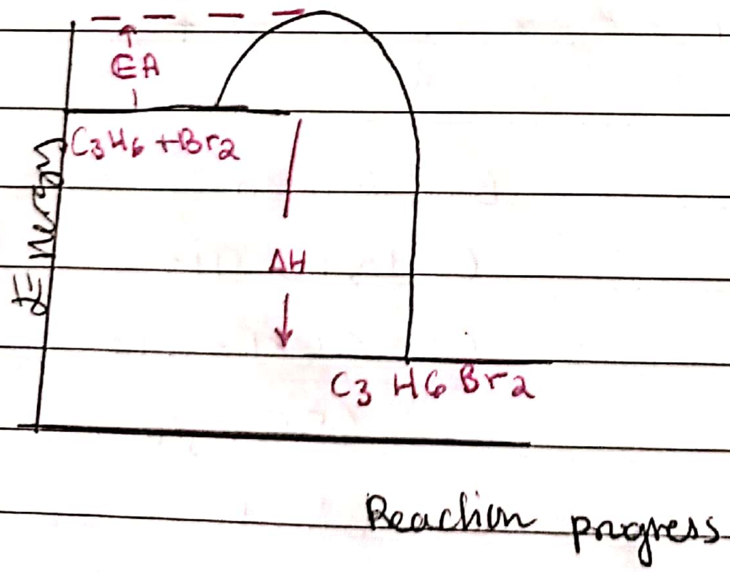
$2 \times C-Br$

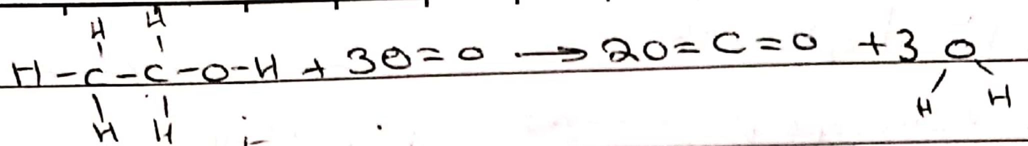
$\Delta H = \Sigma input - \Sigma output$

$807 - 900 = 93$ kj/mol

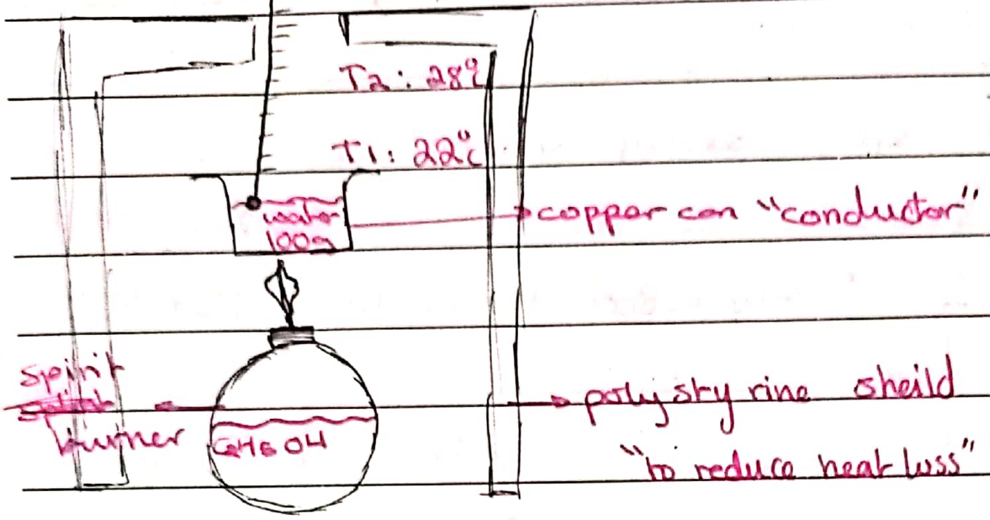
Bond	Bond energy
C-H	413
C-C	348
C=C	614
Br-Br	194
C-Br	276

Draw a profile:





$$H-C(H_2)-C(H_2)-O-H + 3O=O \rightarrow 2O=C=O + 3\,H-O-H$$



$M_1 = 200g$

$M_2 = 198g$

$$Q = mc\Delta T$$

$$= 100 \times 4.2 \times 6 = 2520J \rightarrow 2.52kj$$

$$2.52kj \xrightarrow[\text{burning}]{\text{Released by}} 2g\ C_2H_5OH$$

$$\Delta H \longleftarrow Mr = 1mol\ C_2H_5OH = 46g$$

$$\Delta H = \frac{46 \times 2.52}{2} = -57.96\ kj/mol$$

$$Mr\ C_2H_5OH = 2(12) + 5(1) + 1(16) + 1(1) = 46$$

2 fuels A&B. Plan an exp to show which fuel produces more energy:

1) Take a known mass of water with a known inetial temp

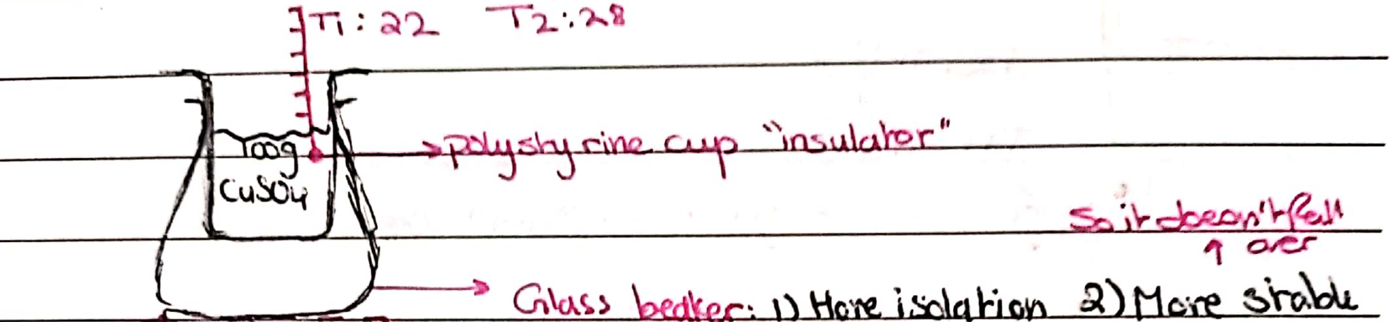
2) take known mass of fuel A. 3) Ignite the fuel & measure fin
new mass & ~~mass~~ temp of water. 4) repeat with fuel B.

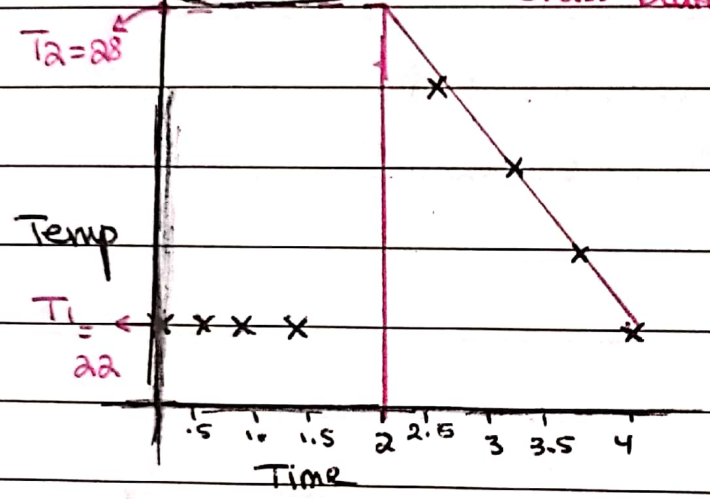
Conclusion:

The fuel which cause more temp change is the one that produce more energy.

ΔH reaction for displacment:

$$Zn_{(s)} + CuSO_{4\,(aq)} \longrightarrow ZnSO_{4\,(aq)} + Cu_{(s)}$$





★ Don't measure the first 1.5 sec to make sure the temprature is stable. (No heat transfer)

$$Q = M \times C \times \Delta T$$

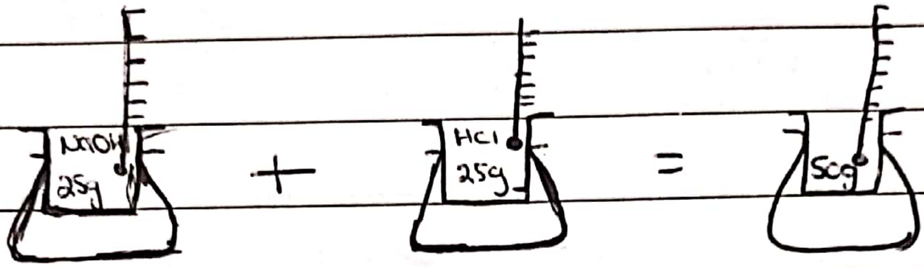
$$= 100 \times 4.2 \times (28 - 22)$$

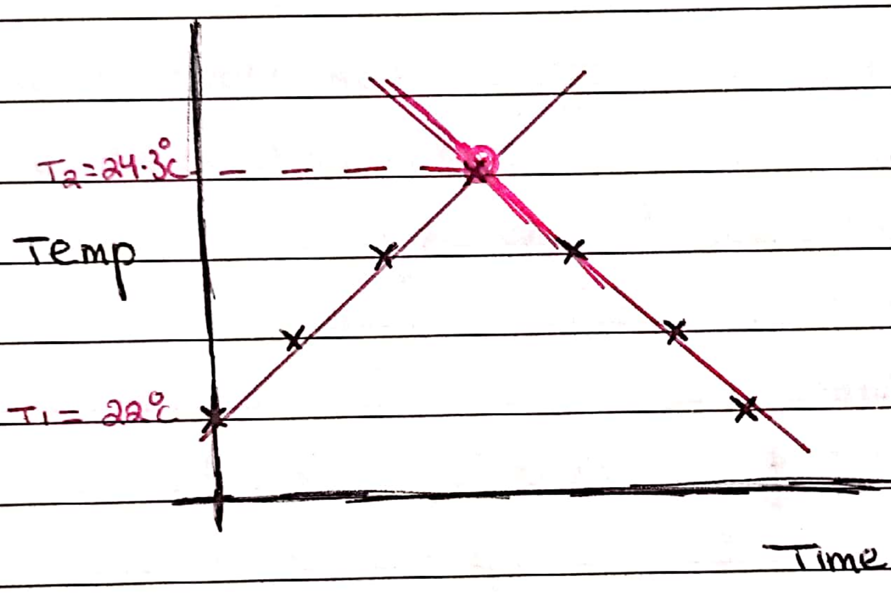
$$= 100 \times 4.2 \times 6$$

$$= \boxed{2520\,J}$$

Neautralization:

$NaOH_{(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$





$Q = M \times C * \Delta T$

$= 50 \times 4.2 \times 2.5$

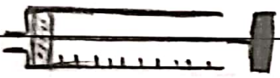
$= 525\ J$

Industrial Chemistry

- Dealing with gases
  - Collect gas
  - Dry
- Industrial
  - NH_3 Haber process
  - H_2SO_4 Contract process
  - CO_3^{-2} carbonate cycle
- Extraction of metals
  - Al, Fe
  - Zn, Cu – old sylabus

- Dealing with gas:
  - H_2: $Mg_{(s)} + HCl_{(aq)} \longrightarrow MgCl_{2(aq)} + H_{2(g)}$
  - O_2: $2H_2O_{2(aq)} \xrightarrow{CuO} 2H_2O_{(l)} + O_{2(g)}$ CuO → catalyst
  - CO_2: $CaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$
  - NH_3: $NH_4Cl_{(aq)} + NaOH_{(aq)} \xrightarrow{\Delta} NaCl_{(aq)} + H_2O_{(l)} + NH_{3(g)}$ Δ → Heat
  - SO_2: $Na_2SO_{3(aq)} + HCl_{(aq)} \xrightarrow{\Delta} NaCl_{(aq)} + SO_{2(g)} + H_2O_{(l)}$
- Ways of collecting gas:-

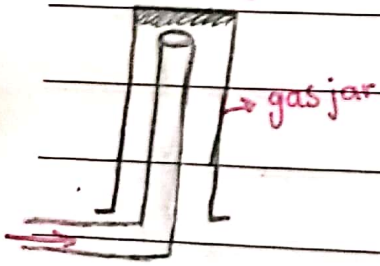
①: Gas syringe:



*works on all types of gases (Dense & low dense).

②: Delivery tube:

Upward delivery



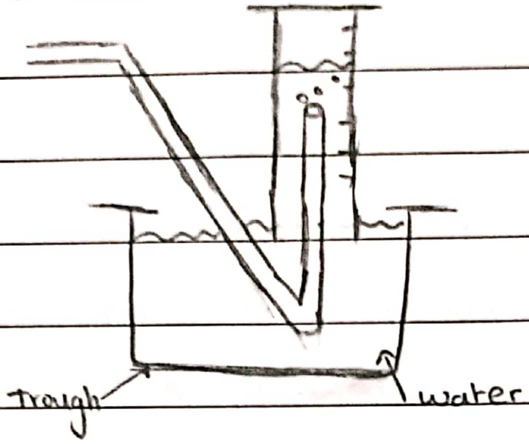
To collect less dense gas than air

Downward delivery.

To collect more dense gas than air

Disadvantages:
1) Mix with other gases (air)
2) Gas might escape

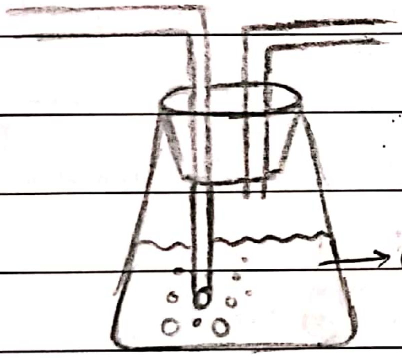
③: Over water:



★ This method is used only for insoluble gases in water(H_2O)

• Drying Gases:

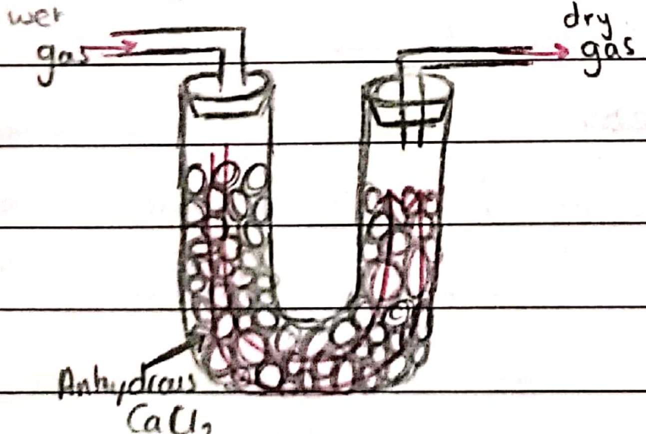
① Concentrated H_2SO_4:



★ Used to dry any gas except NH_3 → Base] which will form a salt
since it will react with H_2SO_4. → Acid

→ Concentrated H_2SO_4 (Becomes dilute)

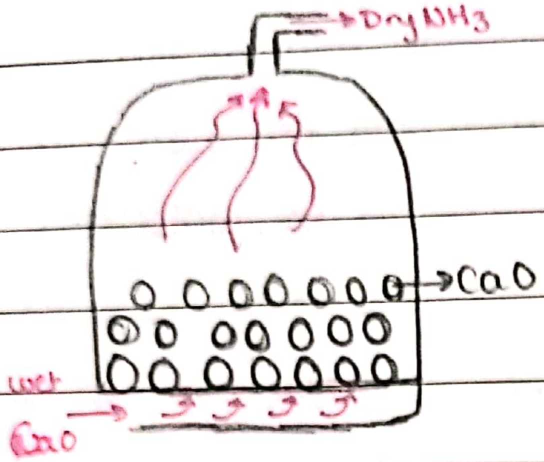
② Anhydrous $CaCl_2$:



(Becomes hydrated)

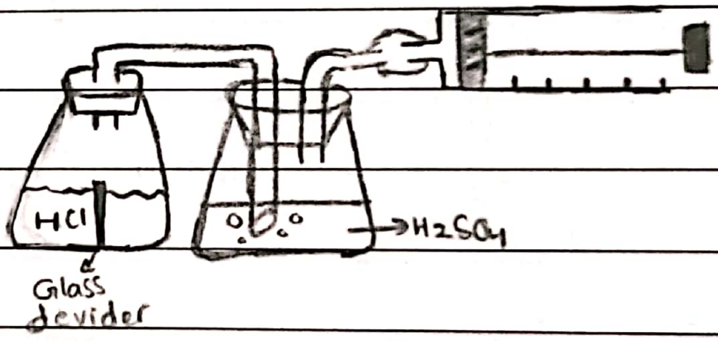
★ Used to dry any gas except NH_3

③ CaO (Base):



• Draw a suitable apparatus to collect & measure the volume of dry CO_2 from this reaction. "insoluble in water"

$CaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$



Industry of Ammonia (NH_3) Harber Process

Fe → catalyst

$\underbrace{3H_{2(g)} + N_{2(g)}}_{4} \xrightleftharpoons{Fe} \underbrace{2NH_{3(g)}}_{2}$ Δ = –ive (exothermic)

Temprature: 400-450°C → optimum temp.

Preasure: 200 atm * ↑ pressure will ↑ temp.

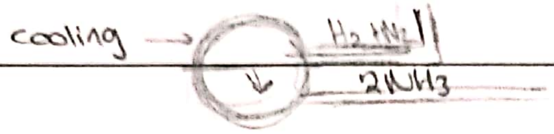
Catalyst : Fe (iron)

* Uses: Cleaning detergent, smelling salt, fertelizers.

To enhance the forward reaction:

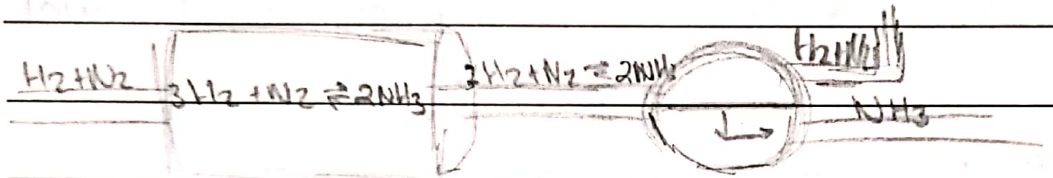
① Add excess H_2 & N_2?

Return back to converter



② Remove NH_3 instantly? and how?

Cooling the NH_3 in the cooling chamber



- How to obtain N_2?

Fractional distilation of liquid air (cooling under high pressure)

- How to obtain H_2?

① cracking of alkalines (organic chemistry)

② $CH_4(g) + H_2O(g) \longrightarrow CO + 3H_2$ (At 500 °C)

- Why is ammonia hard to make?

Because it is a reversable reaction meaning if you add heat more than needed then it will favor backward

- The ratio needed is 1 volume of nitrogen to 3 x hydrogen volume.

why?

$$\overset{3}{3H_2} \; : \; \overset{1}{+N_2} \rightleftharpoons 2NH_3$$

6 hydrogen
2 nitrogen

6 hydrogen
2 nitrogen

Temprature : 400 — 450 °c

less than 400	More than 450
1) Adv:	1) Adv:
a) More NH_3 shift forward to exo side	faster rate
2) Dis:	2) Dis
Slow rate of reaction	less yeild of NH_3 shift Backward to endo side

Preassure : 200 atm

- high preassure

1) Adv:

a) More yeild: Shift forward to less gas mole.

b) Faster rate

2) Dis:

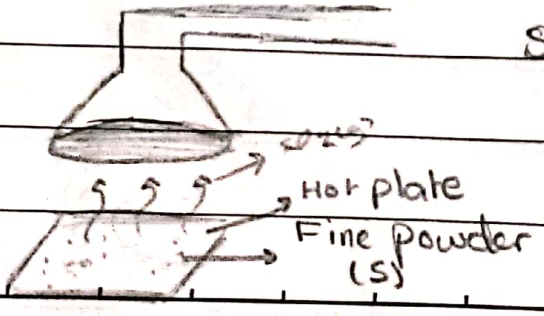
a) Risk of explosion

b) Expensive

§ Industry of sulfuric acid.

$S \xrightarrow{①} SO_2 \xrightarrow{②} SO_3 \xrightarrow{③} H_2S_2O_7 \xrightarrow{④} H_2SO_4$

1) From $S \rightarrow SO_2$:



$S + O_2 \longrightarrow SO_2$

★ Method: Roasting

- **Uses**: Fire works, Matches, medicine
- **Ore**: zinc blend (ZnS), Another source: Fossil fuel.

2) From $SO_2 \longrightarrow SO_3$

V_2O_5 → catalyst

$2SO_{2(g)} + O_{2(g)} \underset{endo}{\overset{exo}{\rightleftharpoons}} 2SO_{3(g)}$ ΔH = -ive Method: Contact process

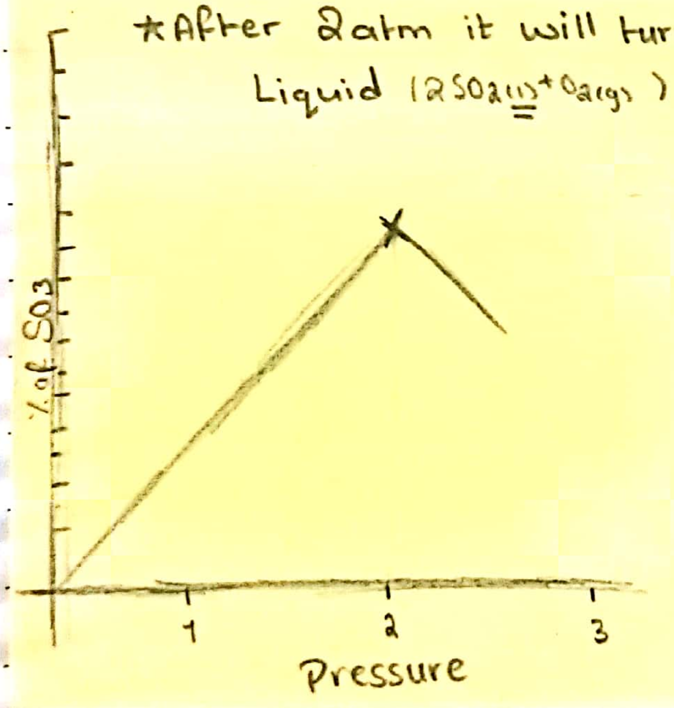
a) Temp 400 – 450°c

b) Pressure: 2 atm (high pressure favors the forward side which has less gas moles) ((Max yeild 98% at 2atm))

Cannot become 100%.

Don't memorize 2

*After 2atm it will turn Liquid ($2SO_{2(l)} + O_{2(g)}$)



c) Catalyist: V_2O_5

Vanadium (V) oxide

- uses:

1) Food preperuative

(Due to it killing bacteria)

2) Paper industry

(Bleaching agent)

3) $SO_3 \longrightarrow H_2S_2O_7$:

$SO_3 \xrightarrow{H_2O} 2H_2SO_4$

conc. H_2SO_4

$H_2S_2O_7$

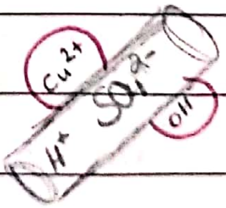
oleum

H_2O

Disadvantage:

1) Highly exothermic (very vigeous)

2) low yeild x.

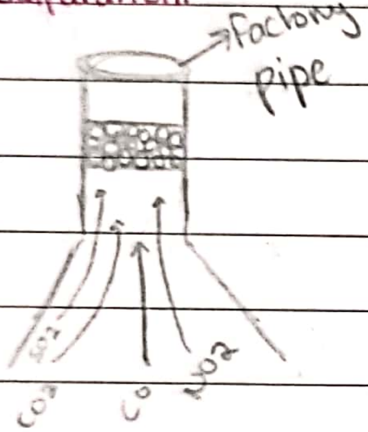


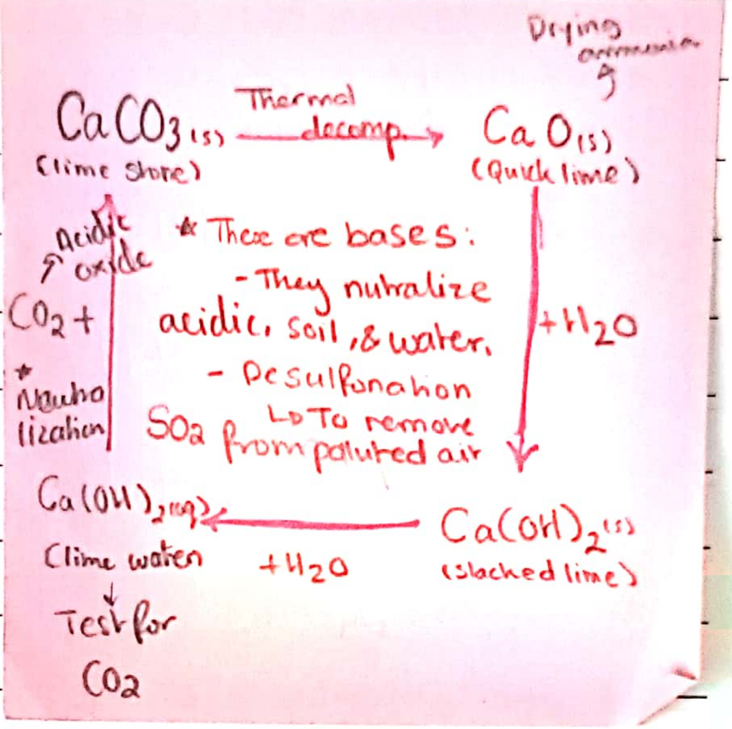
Carbonate cycle:-

• Uses:-

* $CaCO_3$ < lage lumps: Building
Small lumps: neutralisation

-Desulfuration:





* These are bases:
- They nutralize acidic, soil, & water.
- Desulfonation
↳ To remove SO_2 from poluted air

- $CaCO_3 \xrightarrow{\Delta Heat} CaO + CO_{2(g)}$ ↑ evaporates

- $Ca(OH)_{2(aq)} + CO_{2(g)} \longrightarrow CaCO_{3(s)} + H_2O_{(l)}$

Extraction of metals:-

-Depends on where it is on the reactivity series.

↳ Reactivity series:

$\underbrace{K \quad Na \quad Li \quad Ca \quad Mg \quad Al}_{\text{Electrolysis for molten ore}}$ → Al_2O_3 Bauxite

Zinc blend ZnS ← $\underbrace{Zn \quad Fe}_{\text{Reduction by C \& CO "Blast furnace"}}$ Pb → Hematite Fe_2O_3

$\underbrace{Cu}_{\text{Reduction by } H_2}$ Ag Au

Extraction of iron:-

ore: Fe_2O_3 Hematite

method: reduction by C & CO

Place: Blast furnace

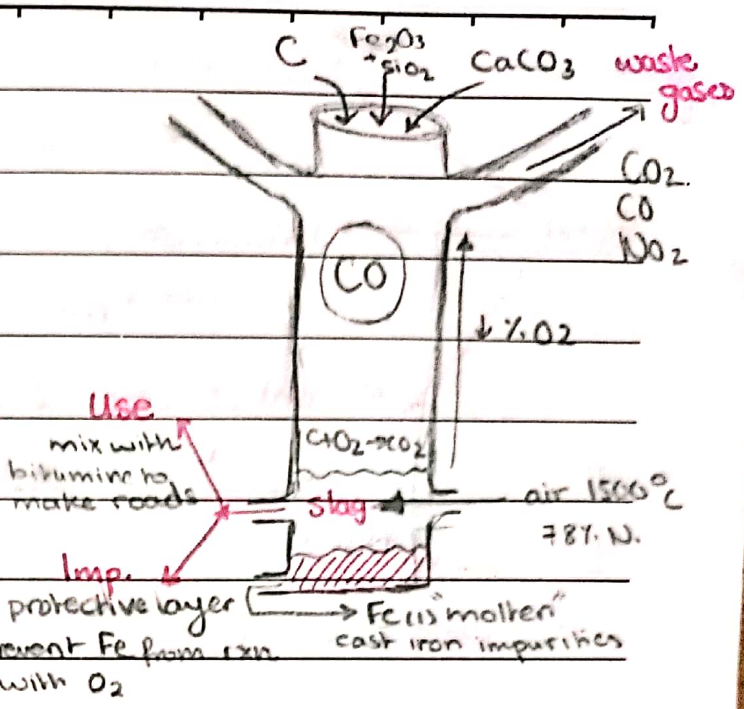
Raw materials:

1) Fe_2O_3 with acidic impurities SiO_2

2) Calcium carbonat $CaCO_3$ "lime stone"

3) Coke (pure carbon) "C"

4) Air 1500 °c



• Why is NO_2 formed?

Because "N" is 78% in air

① Complete combustion:

$$\underbrace{C + O_2 \longrightarrow CO_2}_{\text{produces energy}} \text{ (Redox)}$$

② Incomplete combustion:

$$2C + O_2 \longrightarrow 2CO \text{ (Redox)}$$

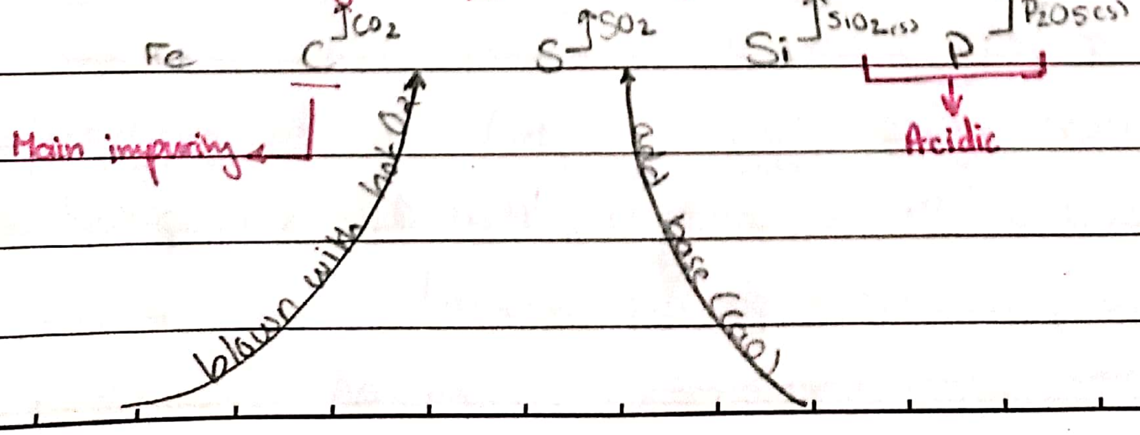
③ $CO_2 + C \longrightarrow 2CO$ (Redox)

④ $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$ (Redox)

⑤ $CaCO_3 \xrightarrow{Heat} CaO + CO_2$ (thermal decomposition)

⑥ $\underbrace{CaO}_{\text{Base}} + \underbrace{SiO_2}_{\text{acid}} \longrightarrow \underbrace{CaSiO_3}_{\text{Slag}}$ (neutralization)

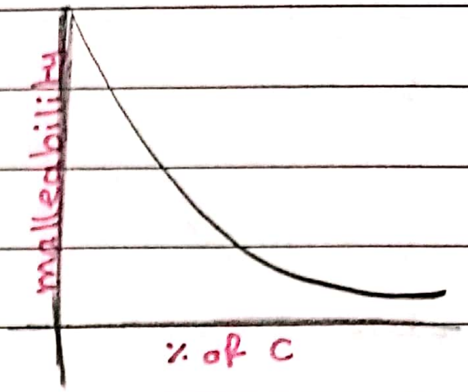
- Steel making: "oxygen-base process"



Steel → Mild Steel 0.03 % C
└use → Car bodies

Steel → Medium steel 0.3% C
└use → Railway

Steel → Stainless steel 3-5% C
└use → Watch cutlers



Extraction of zinc:

ore: Zinc blend

Formula: ZnS

Method: Reduction by C, CO

Place: blast furnace

★ C, CO, H_2 can reduce the less reactive metal only from their OXIDE

- Step 1: Roasting with O_2:

$$ZnS + O_2 \longrightarrow ZnO + SO_2$$

- Step 2: blast furnace:

$$C + O_2 \longrightarrow CO_2$$

$$2C + O_2 \longrightarrow 2CO_2$$

$$CO_2 + C \longrightarrow 2CO$$

$$CO + ZnO \longrightarrow Zn + CO_2$$

└→ produced Zn is 100% pure

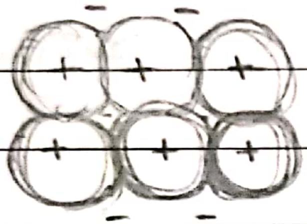
Why is Zn pure?:

The temprature inside, the furnace is 1500°c, the boiling point of zinc is 907°c, meaning that the zinc produced as gas leaving the other impurities behind

Alloy:

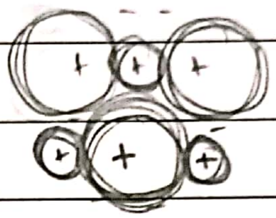
- Mixture of metal with another metal or semi-metal
  - Brass: Cu, Zn → zinc
  - Bronze: Cu, Sn → tin
  - Steel: Fe, C, Cr, Ni

Cu



Same size of atoms
so easier to slide

Brass



Two diffrent side
so harder to slide.