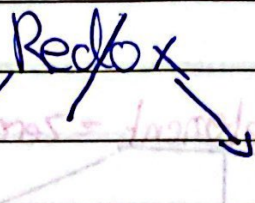


6/6/23



③ Hydrogen

Reduction
gain H

Oxidation
lose H

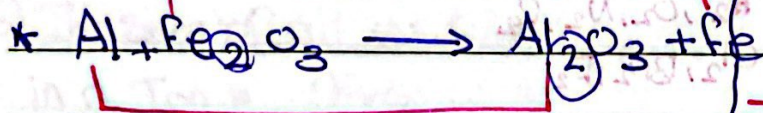
① Reduction

② Oxidation

in term of Lose O
oxygen
*3rd oxygen
decrease*

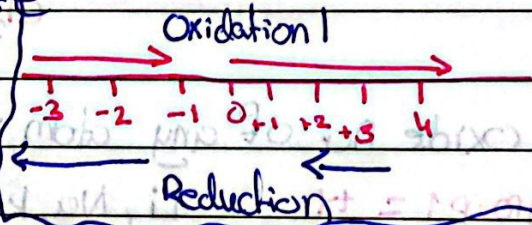
gain O
*increase
oxygen*

Reduction of Fe in Fe₂O₃

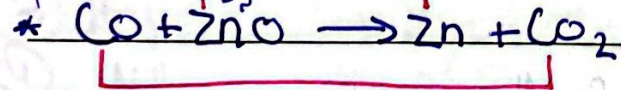


oxidation: Al

③ Oxidation State

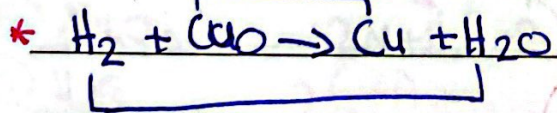


Reduction of Zn in ZnO



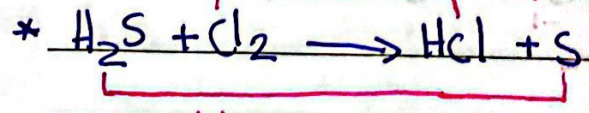
oxidation in CO

reduction of Cu in CuO



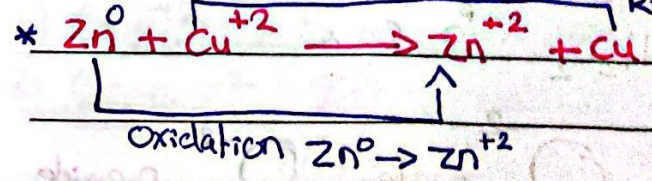
oxidation of H₂

Reduction of Cl₂



oxidation of S in H₂S

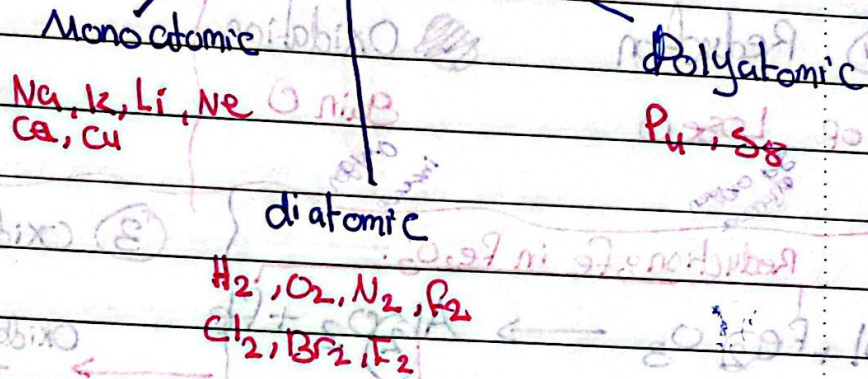
Reduction (Cu⁺² → Cu)



oxidation Zn⁰ → Zn⁺²

Rules of oxidation state :-

1) The oxidation state for any free element = zero



2) The oxide no. of any atom in a compound from

Group 1 = +1 Li, Na, K, Rb, Cs, Fr

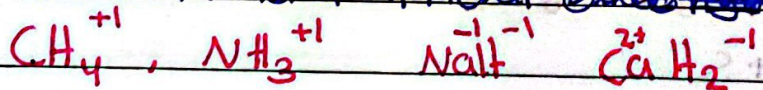
Group 2 = +2 Mg, Ca, Sr, Ba

Group 3 = +3 always +3 only for Al

Group 7 = -1 always -1 only for F

3) The oxidation no. of Hydrogen (+1)

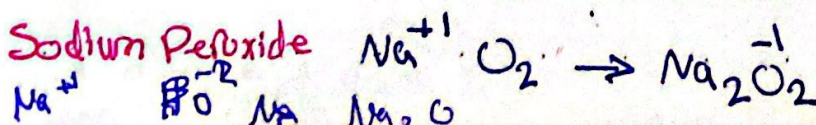
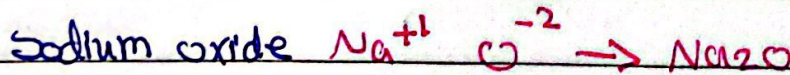
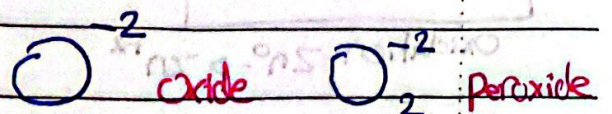
except with metal in metal hydride (-1)

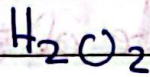
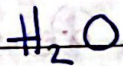
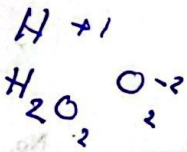


4) The oxidation states of oxygen (-2)

except in Peroxide (-1) H_2O_2

except in OF_2 (+2)



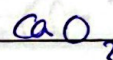
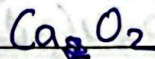
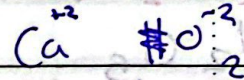
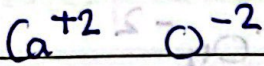


Water

Hydrogen Peroxide

Calcium oxide

Calcium Peroxide



5) The sum of all oxidation state in a compound = 0
 in a Ion = Charge of this ion

1) $NaCl$ $+1 + x = 0$ $x = -1$

2) $HClO^{-2}$ $+1 + x - 2 = 0$ $x = +1$

3) $HClO_2$ $+1 + x + 2(-2) = 0$ $x = +3$

4) NH_3 $N + 3(+1) = 0$ $N = -3$

5) NO $N + (-2) = 0$ $N = +2$

6) N_2O_5 $2N + 5(-2) = 0$ $N = +5$

7) H_2S $2(+1) + S = 0$ $S = -2$

8) H_2SO_4 $2(+1) + S + 4(-2) = 0$ $S = +6$

9) SO_3 $S + 3(-2) = 0$ $S = +6$

10) NO_3^{-1} $N + 3(-2) = -1$ $N = +5$

11) MnO_4^{-1} $Mn - 8 = -1$ $Mn = +7$

12) SO_3^{-2} $S + 3(-2) = -2$ $S = +4$

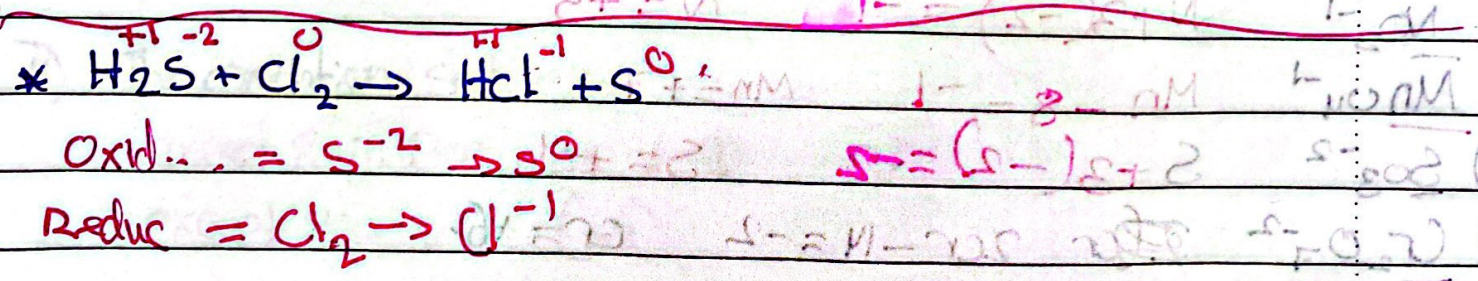
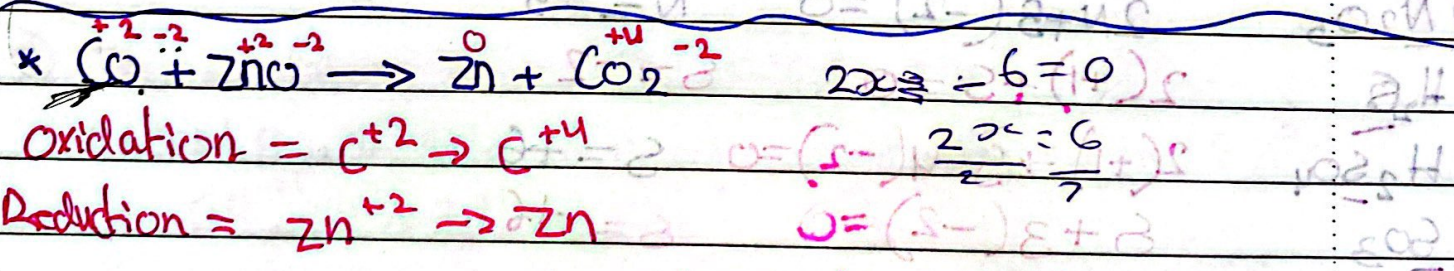
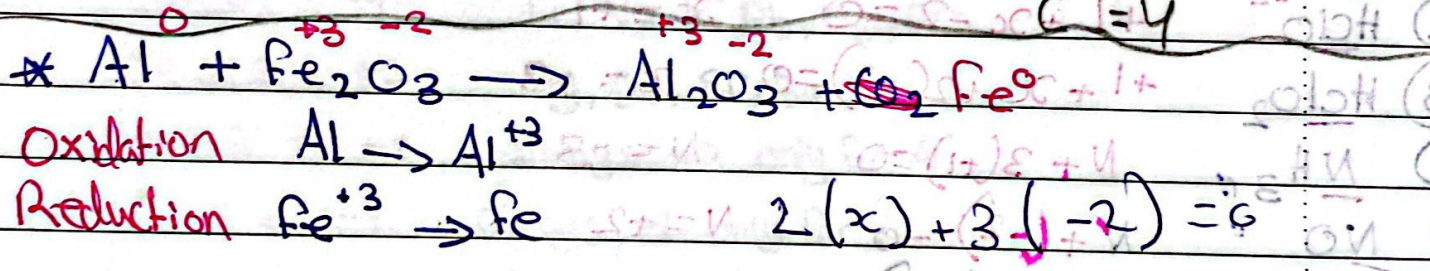
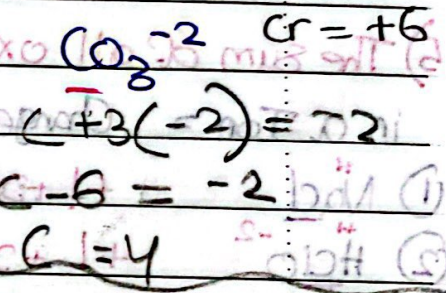
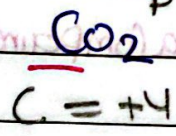
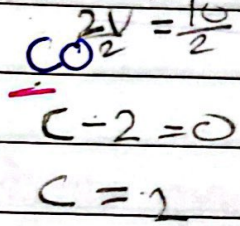
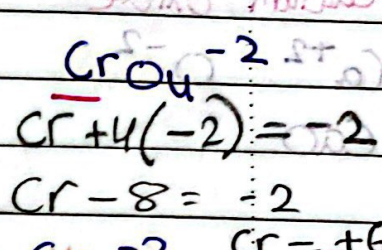
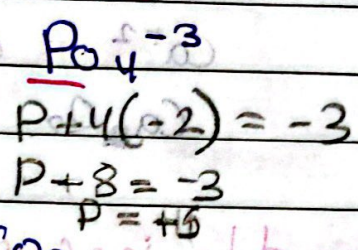
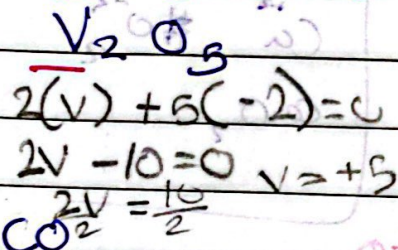
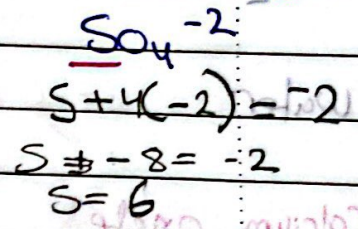
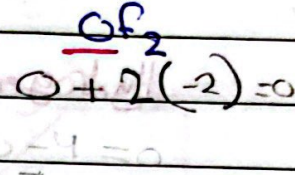
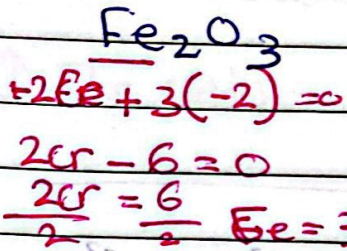
13) $Cr_2O_7^{-2}$ $2Cr - 14 = -2$ $Cr = +6$

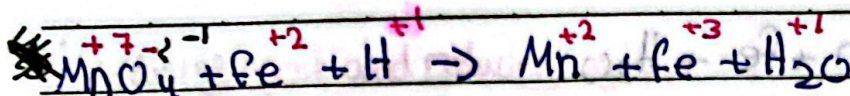
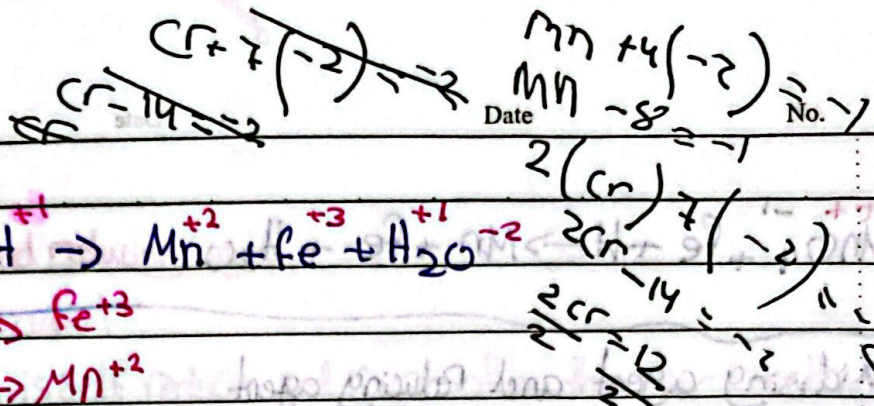
$2(Cr) + 7(-2) = -2$

$2Cr + 14 = 2$

$2Cr = -12$
 $Cr = -6$

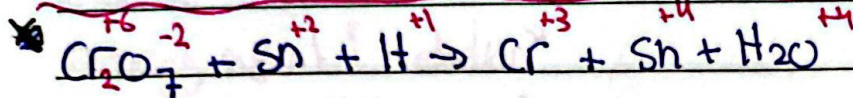
Q or find the oxidation state of ~~state~~ each under lined species.





Oxidation = $\text{Fe}^{+2} \rightarrow \text{Fe}^{+3}$

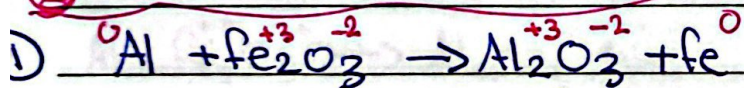
Reduction = $\text{Mn}^{+7} \rightarrow \text{Mn}^{+2}$



A Writing a balanced half Ionic equation

1) Atoms

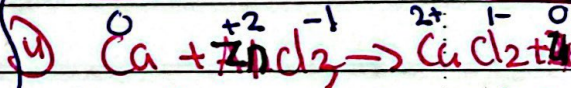
2) The charge by adding e^- to the side with greater charge by the difference.



Half oxidation $\text{Al} \rightarrow \text{Al}^{+3} + 3e^-$

Half of reduction $\text{Fe}^{+3} \rightarrow \text{Fe}$

Overall
$$\text{Al} + \text{Fe}^{+3} \rightarrow \text{Al}^{+3} + \text{Fe}$$



H.O.O $(\text{Ca} \rightarrow \text{Ca}^{+2} + 2e^-) \times 3$

H.O.R $(\text{Zn}^{+2} \rightarrow \text{Zn}) \times 2$

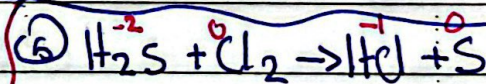
$$3\text{Ca} + 2\text{Zn}^{+2} \rightarrow 3\text{Ca}^{+2} + 2\text{Zn}$$



H.O.O $\text{Ca} \rightarrow \text{Ca}^{+2} + 2e^-$

H.O.R $\text{Zn}^{+2} + 2e^- \rightarrow \text{Zn}$

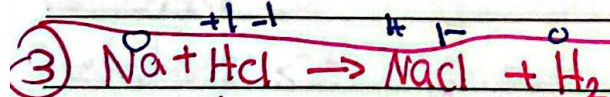
Overall Reaction
$$\text{Ca} + \text{Zn}^{+2} \rightarrow \text{Ca}^{+2} + \text{Zn}$$



H.O.O $\text{S}^{-2} \rightarrow \text{S} + 2e^-$

H.O.R $\text{Cl}_2 + 2e^- \rightarrow 2\text{Cl}^-$

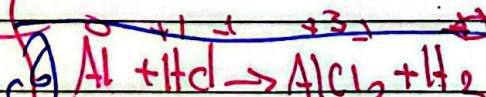
$$\text{S}^{-2} + \text{Cl}_2 \rightarrow \text{S} + 2\text{Cl}^-$$



H.O.O $(\text{Na} \rightarrow \text{Na}^{+1} + 1e^-) \times 2$

H.O.R $2\text{H}^{+1} + 2e^- \rightarrow \text{H}_2$

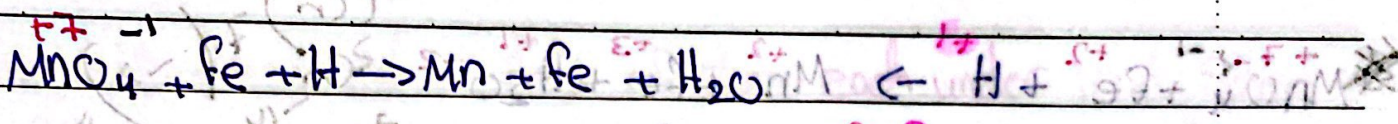
$$2\text{Na} + 2\text{H}^{+1} \rightarrow 2\text{Na}^{+1} + \text{H}_2$$



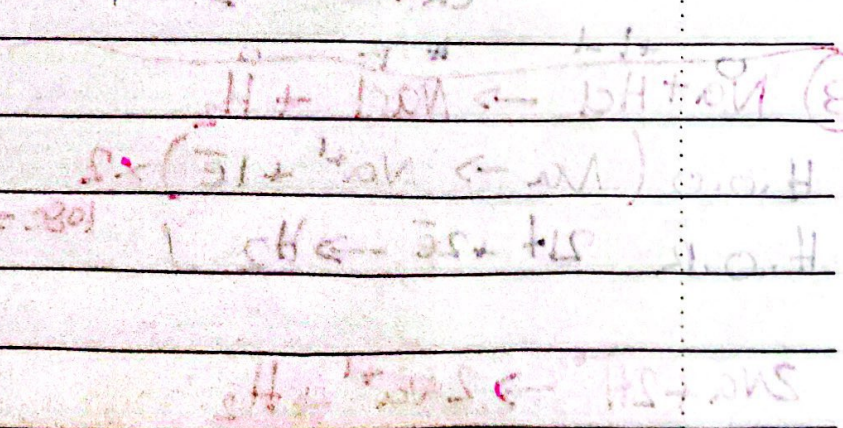
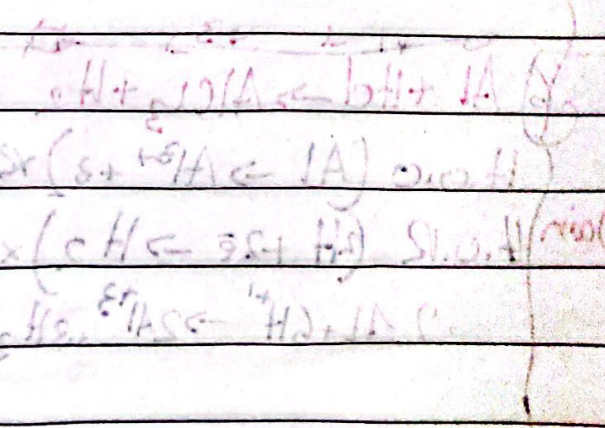
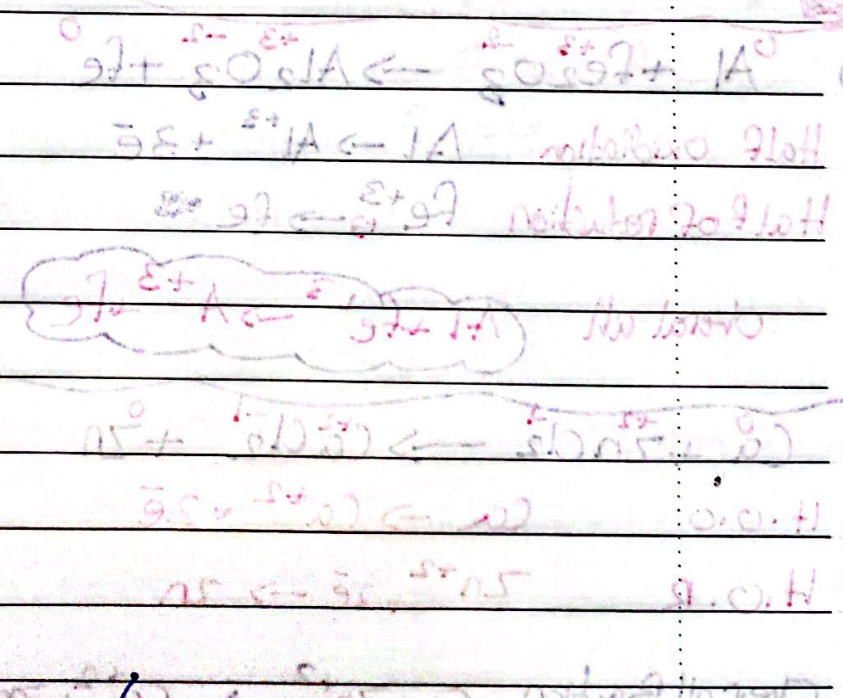
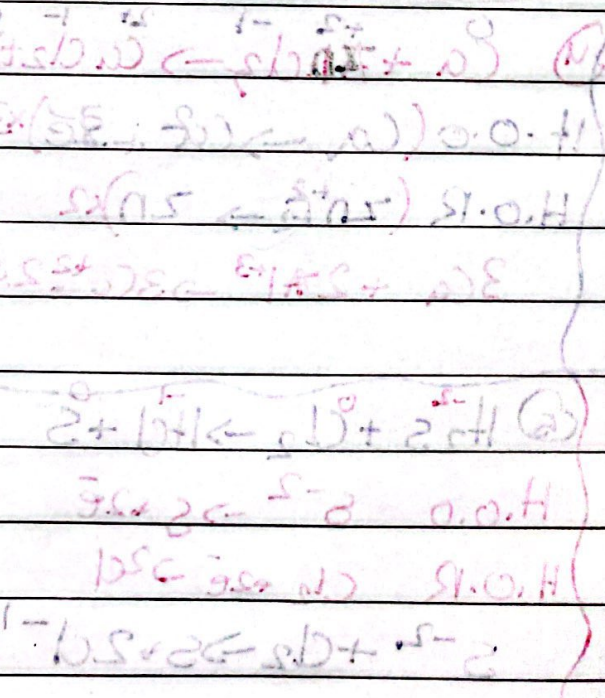
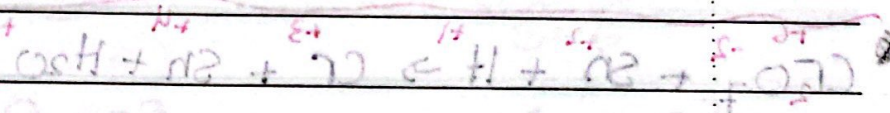
H.O.O $(\text{Al} \rightarrow \text{Al}^{+3} + 3e^-) \times 2$

H.O.R $(2\text{H}^{+1} + 2e^- \rightarrow \text{H}_2) \times 3$

$$2\text{Al} + 6\text{H}^{+1} \rightarrow 2\text{Al}^{+3} + 3\text{H}_2$$



Oxidising agent and Reducing agent
 Oxidising agent "Oxidant"



$Mn^{4/}$

$$S = (S) + (2)S$$

Subject

Date

No.

Oxidising agent and reducing agent

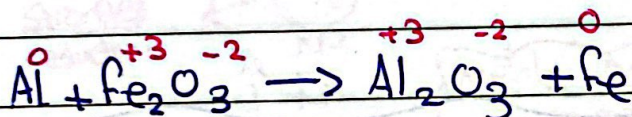
Oxidising agent "oxidant"

↳ The substance that is self reduce and cause other the other substance to oxidise.

Reducing agent "Reduction"

The substance that is self oxidised and causes the other substance to be reduced.

if the substance is anion in a compound the agent is the compound itself



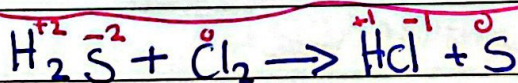
Oxidation: Al Reducing agent: Al

Reduction: Fe^{+3} Oxidation agent: Fe_2O_3



Oxidation: C⁺² Oxidating agent: ZnO

Reduction: Zn⁺² Reducing agent: CO



Oxidation: Cl_2 Reductant: H_2S

Reduction: S^{-2}



Oxidising agent: MnO_4^{-1} reductant: Fe^{+2}

Oxidation: Fe^{+2} Reduction: Mn^{+7}

$$2Cr + 7(-2) = -2$$

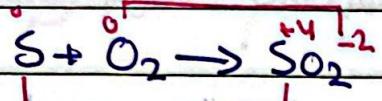
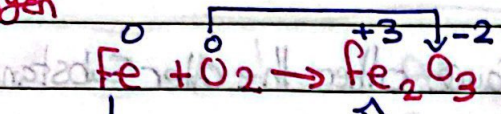
$$2Cr - 14 = -2$$

$$2Cr = -2$$

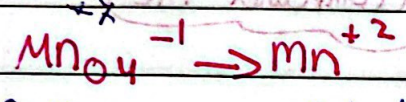
$$Cr = -1$$

* Most Common oxidising agent (Reduction)

① Oxygen



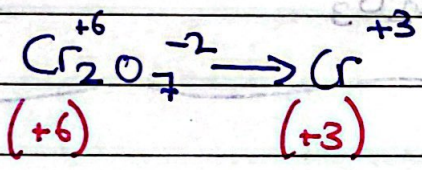
② Acidity Potassium manganate



Purple

Colorless

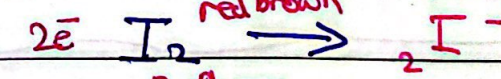
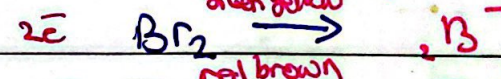
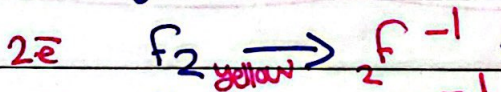
③ Acidify Potassium dichromate / H^+



Orange

Green

④ Halogens



Purple gas

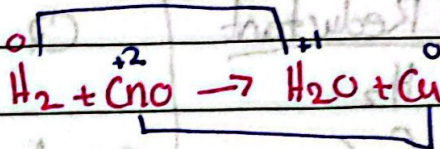
black solid

red brown solution

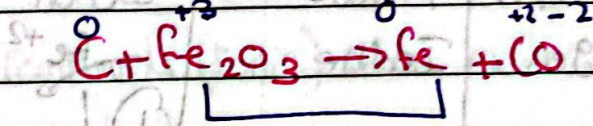
colorless

Most Common reducing agent

① Hydrogen



② Carbon and Carbon monoxide



③ Iodide $2I^- \rightarrow I_2 + 2e^-$

colorless

red brown.

④ Metals

Strongest reductant

(K)

Weak oxidant.

- Na
- Li
- Ca
- Mg
- Al
- C, CO
- Zn
- Fe
- Pb
- Cu

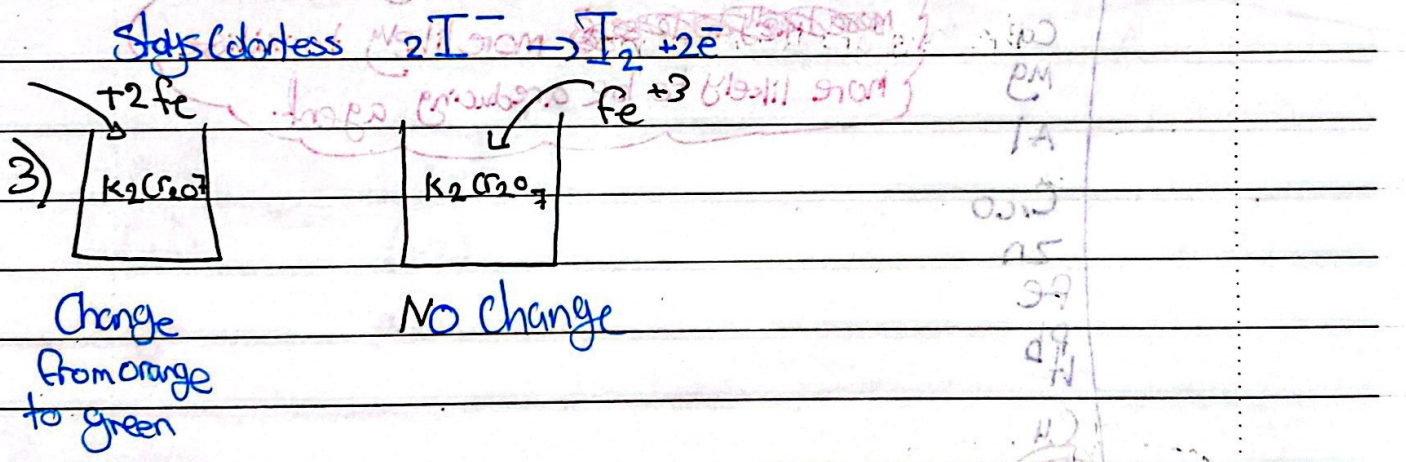
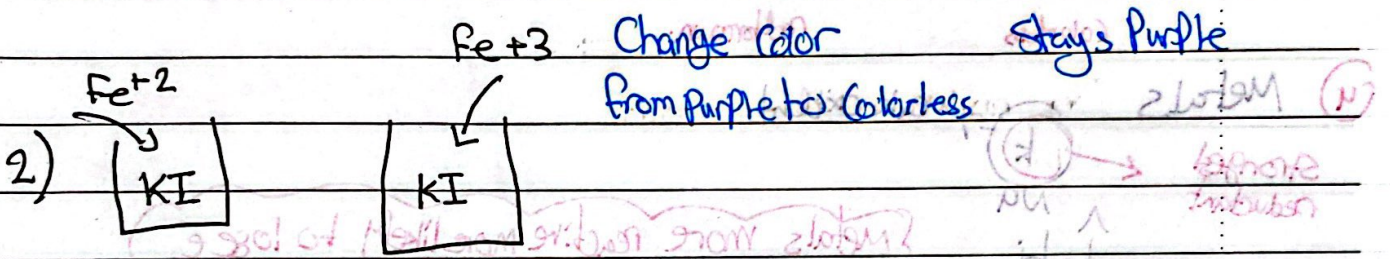
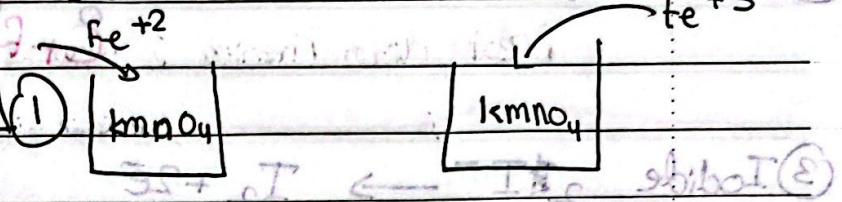
Weakest reductant.

(Ag)

Strongest oxidant.

Metals more reactive more likely to lose e⁻
~~more likely to be oxidised~~ more likely to oxidise
 more likely to be a reducing agent.

Reduction	Oxidation	
Oxidant	Reductant	Q. Fe^{+2} is reducing agent
O_2	H_2	Fe^{+3} is an oxidising agent
$KMnO_4$	C, Co	record the observation in each of the following reaction
$K_2Cr_2O_7/H^+$	Metals	
Halogen	Iodine	



Electrolysis

Electricity

Analysis

"breaking down"

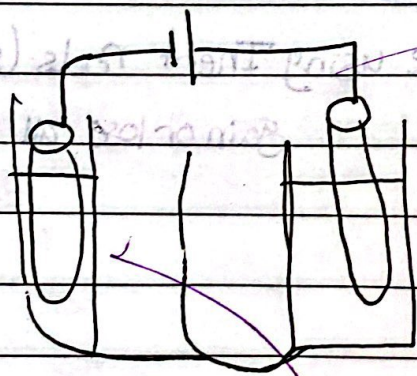
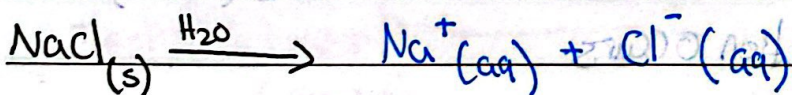
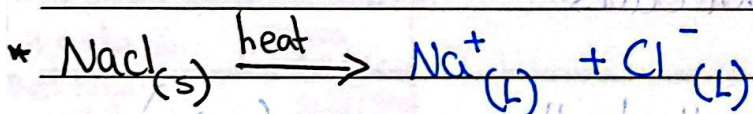
Electrolysis: Break down chemical compounds (ionic) when molten or aqueous by passing electricity.

Why the ionic compound don't conduct electricity when solid? or aqueous

The ions are free to move.

Why the ionic compounds conduct electricity when dissolved in water or being molten?

The ions are free to move.



Cation +

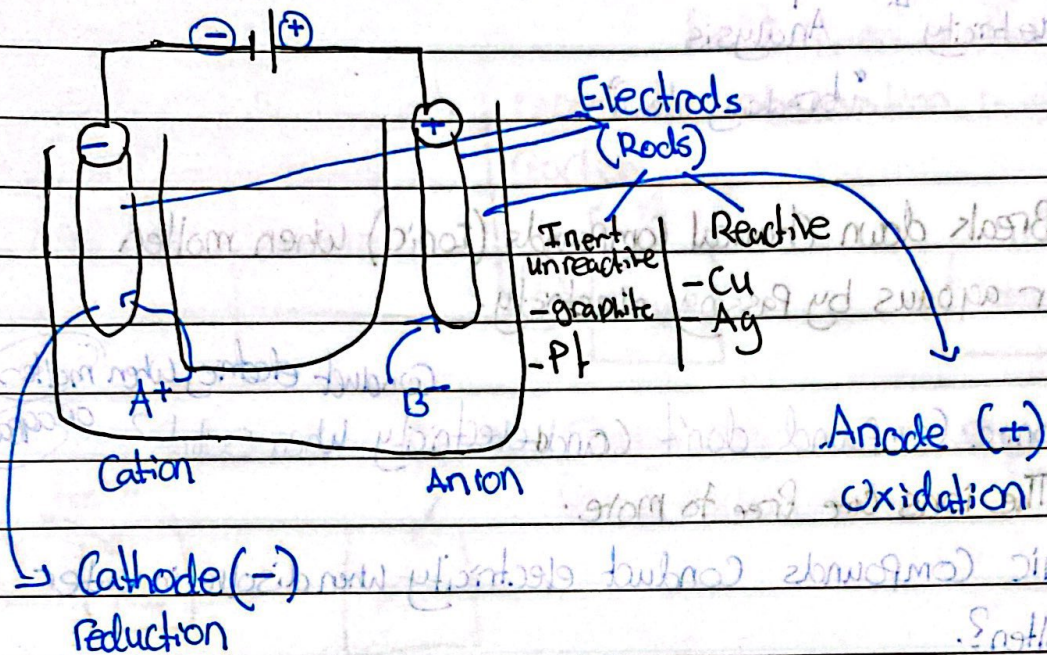
Anions -

Subject

Date

No.

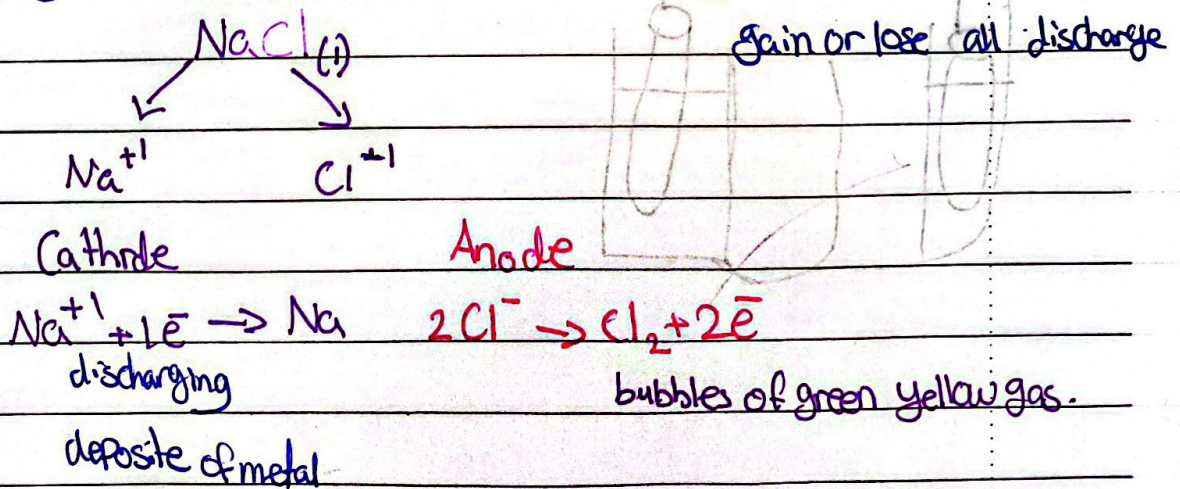
Electrolysis Cell



* Cathode: The -ve rod that attracts the +ve ions (cation) where the reduction occurs.

* Anode: The +ve rod that attracts the -ve ions (anion) where the oxidation occurs.

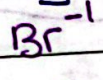
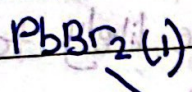
* Electrolysis for molten electrolyte using Inert rods (graphite)



Electrolyte & use up

Subject

Molten lead(II) Bromide



Cathode

Anode

$F_2 \rightarrow$ yellow gas

$Cl_2 \rightarrow$ green yellow gas

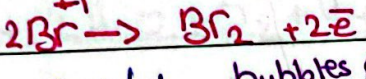
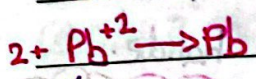
$Br_2 \rightarrow$ red brown gas and

Liquid

$I_2 \rightarrow$ black solid

Purple gas

Red brown soln



deposit of metal

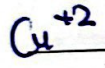
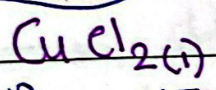
bubbles of red brown gas

$Cu \rightarrow$ Red brown

$Na \rightarrow$ deposit of metal

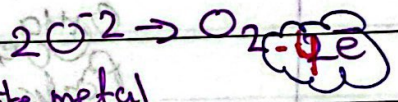
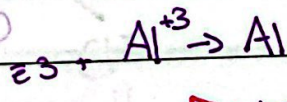
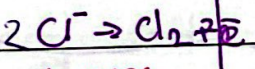
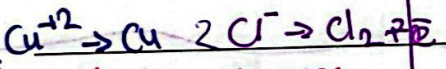
$O \rightarrow$ colorless gas

Electrolyte is used up



Cathode

Anode



deposit of Red brown solid

bubbles of green yellow gas

deposit metal

bubbles of colorless gas

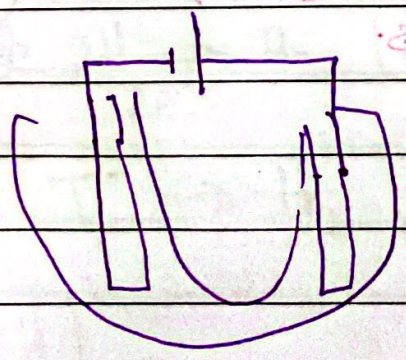
Electrolyte is used up (consumed)

* Electrolysis of aqueous Electrolyte using



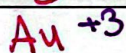
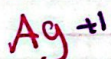
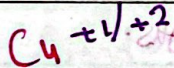
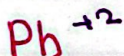
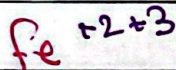
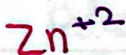
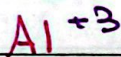
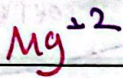
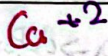
Cathode

Anode



* At the Cathode

The less reactive ion is more likely to reduce and the more reactive stays in the electrolyte.

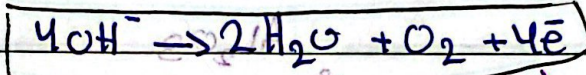


* At the anode always OH^- expect concentrated

when the halide oxidise



when OH^- oxidise



Oxygen Produced

bubbles of colorless gas.

Concentrated NaCl / graphite



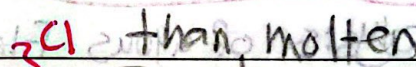
Cathode

Anode

Concentrated rather

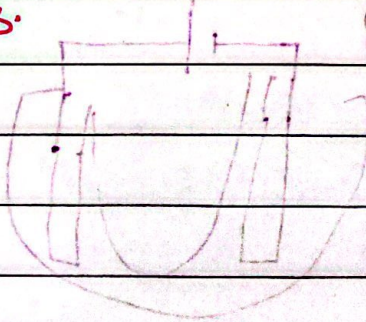


bubbles colorless gas.

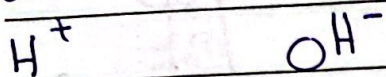


1) bubble is bigger

2) rate of bubble



$\text{CuSO}_4(\text{aq})$ / graphite

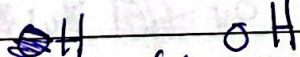
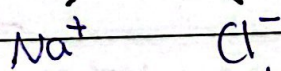


Cathode: $2\text{e}^- + \text{Cu}^{+2} \rightarrow \text{Cu}$ \Rightarrow deposit of red-brown solid.

Anode: $4\text{H}^+ \rightarrow 2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^- \Rightarrow$ bubbles of colorless gas.

* electrolyte: H_2SO_4

diluted $\text{NaCl}(\text{aq})$ / graphite

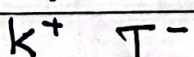
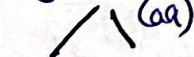


Cathode: $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$ (bubbles of colorless gas)

Anode: $4\text{OH}^- \rightarrow 2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^-$ (bubbles of colorless gas)

* electrolyte: NaCl

conc KI / graphite

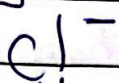
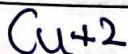


Cathode: $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$ (bubbles of colorless gas)

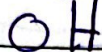
Anode: $2\text{I}^- \rightarrow \text{I}_2 + 2\text{e}^-$ (Red brown)

KOH

Conc. $CuCl_2$ / graphite



less concentrated ($CuCl_2$)

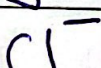
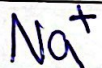


Cathode $Cu^{+2} \rightarrow Cu^0$ (deposits of red-brown solid)

Anode $Cl^- \rightarrow Cl_2$ (\rightarrow bubbles of green-yellow gas)

* Concentrated Sodium Chloride called Brine Solution.

$NaCl$

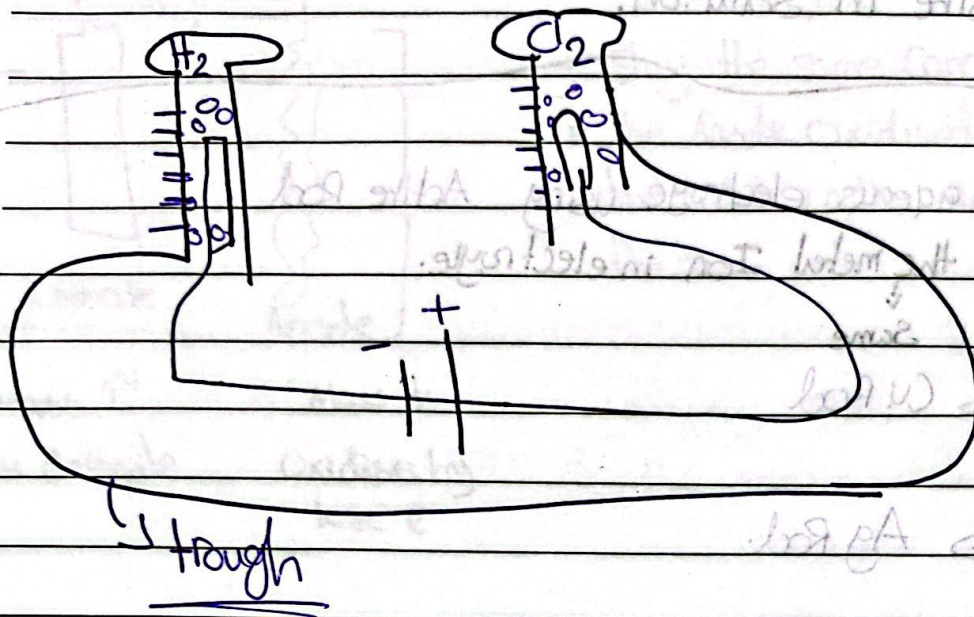


Cathode $H \rightarrow H_2$

electrolyte of $NaOH$

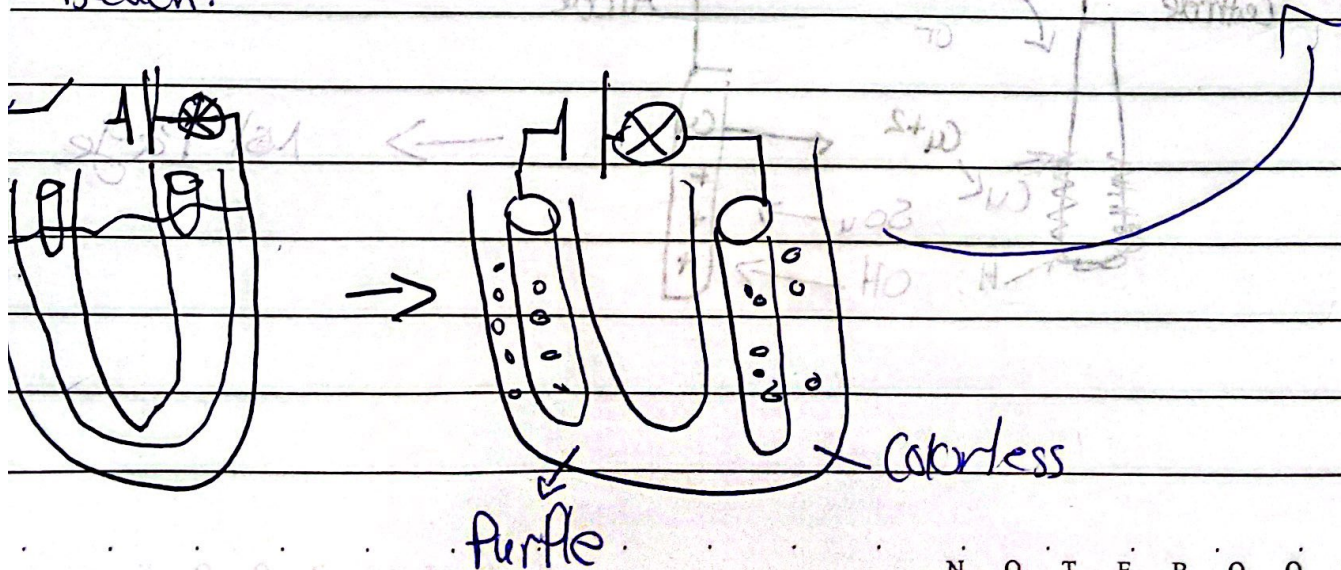
Anode $2Cl \rightarrow Cl_2$

Q1 Plan an experiment to collect and measure the volume



Observation :-

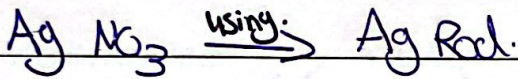
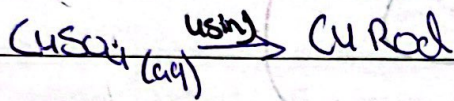
1. The bulb will light up
2. bubbles of green yellow gas on anode (oxidation of Cl^-)
3. bubbles of colorless gas on the cathode (reduction of H^+)
4. Around the cathode the solution becomes purple because $NaOH$ is an alkali
5. Around the anode the solution becomes colorless since Cl_2 bleach.



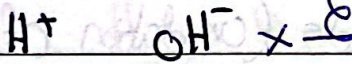
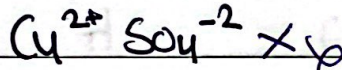
* The Cl_2 not immediately appear as H_2 produce?
Some Cl_2 dissolve in solution.

Electrolysis for aqueous electrolyte using Active Rod

* The rod must be the metal Ion in electrolyte.

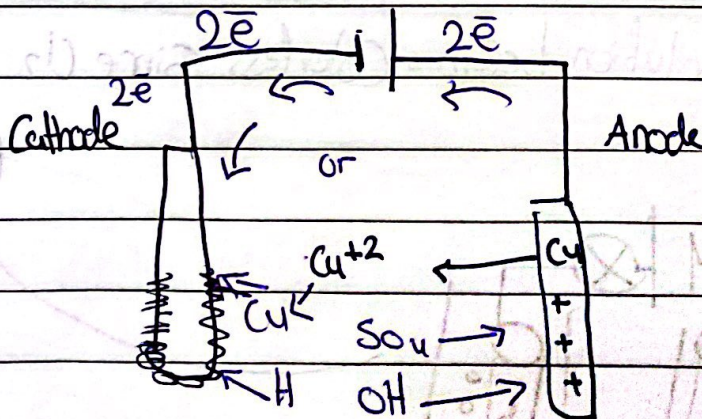
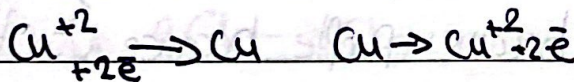


Electrolysis from aqueous $CuSO_4$ using Cu Rod



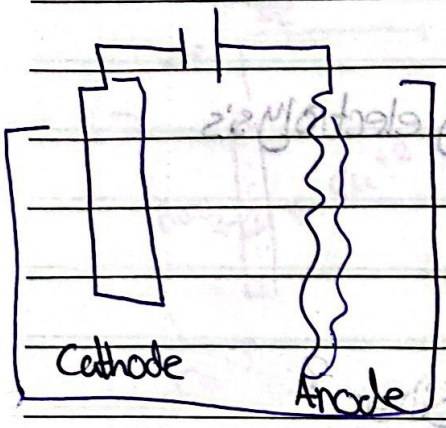
The anode itself oxidise

Cathode Anode



Not Page

② Refining metals / Refining copper



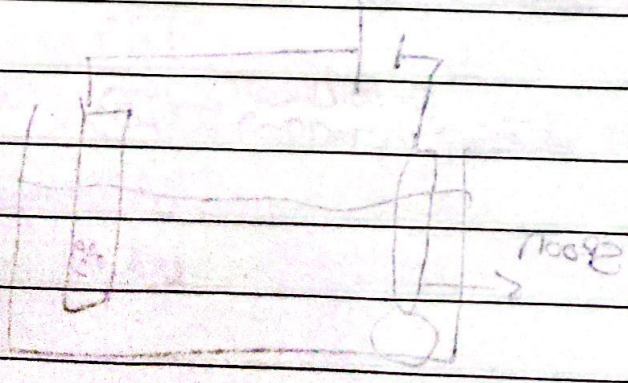
Electrolyte

- Stay the same concentration
- * the Anode Oxidised and replace the Cu^{+2} in the electrolyte with the same rate.

Mass ↑
Cu deposit

Mass ↓
Oxidise by
lose e

- ① Clean the surface from any impurities
- ② Turn on the current before the setup is fully immersed in the electrolyte
- ③ Rotate the setup to ensure an even distribution in the electrolyte
- ④ Use a distilled water
- ⑤ Use a low current
- ⑥ The voltage must be low
- ⑦ Make the area of the cathode



electroplating

Coating a metal with another metal using electrolysis

Why??

① to Prevent rusting

② More reactive

* How to electroplate a metal spoon with silver?

① Clean the spoon from any impurities or oxide layer using sand paper to ensure a good sticking.

② Make the spoon the cathode

③ The anode must be Ag

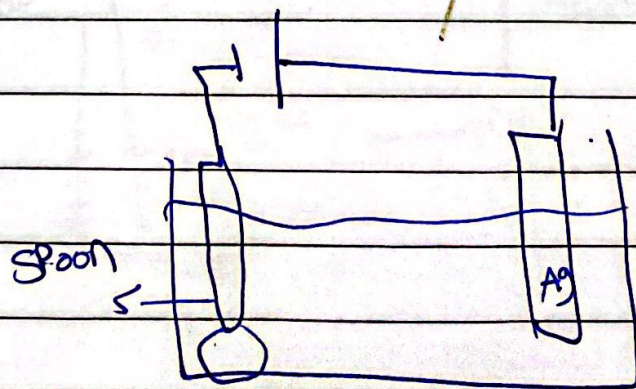
④ The electrolyte must contain Ag eg. AgNO_3 .

⑤ Turn on the circuit be sure that the spoon is fully immersed in the electrolyte.

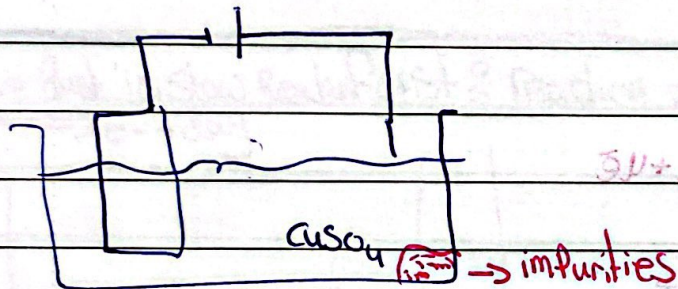
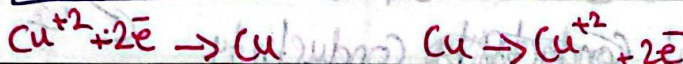
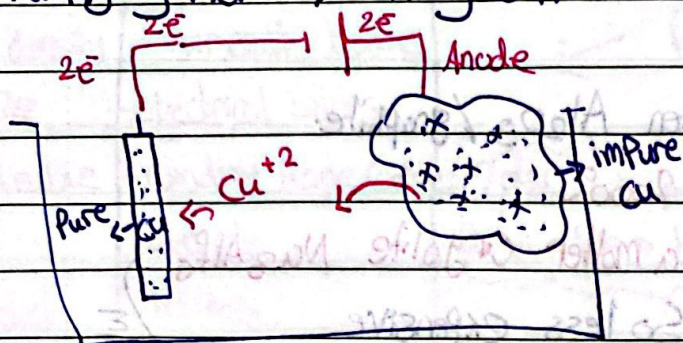
⑥ rotate the spoon to ensure an equal distribution

⑦ Rinse with distilled water

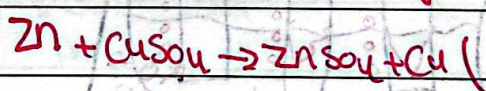
⑧ dry in oven.



② Purifying metals / Refining Copper:



Au, Ag → settle down (less reactive)



Extraction of metal from their ores:

• The method of extraction depends on the position of metal in reactivity

~~Series~~ Series.

K, Na, Li, Ca, Mg, Al, Zn, Fe, Pb, H, Cu, Ag, Au
 Reduction by H → Copper (in) Sulphide CuS
 Electrolysis (Molten / graphite) ←
 Bauxite Al_2O_3 ←
 Reduction by C, CO →
 zincblende ZnS
 Hematite

Extraction of Aluminium

Ore:- Al_2O_3 Bauxite

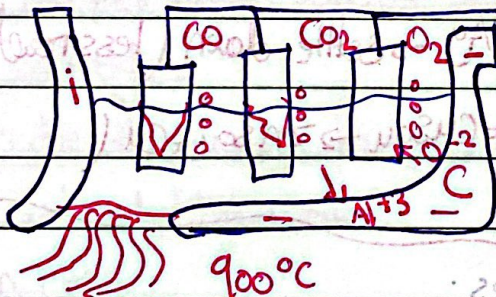
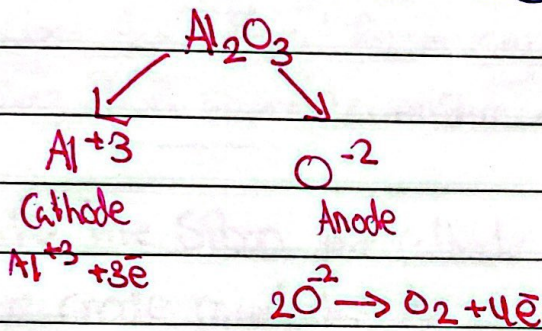
Method:- Electrolysis for molten Al_2O_3 / graphite.

* M.P of Al_2O_3 is about $2000^\circ C$

So we dissolve Al_2O_3 in a molten Cryolite Na_3AlF_6

- To lower the m.p $900^\circ C$ So less expensive

- To increase the electrical ~~conductivity~~ conductivity.



Gases Produced at Anode

1- O_2

2- CO_2

3- CO

Reaction of Rods with O_2

So we must replace them Periodically.

find notes in it

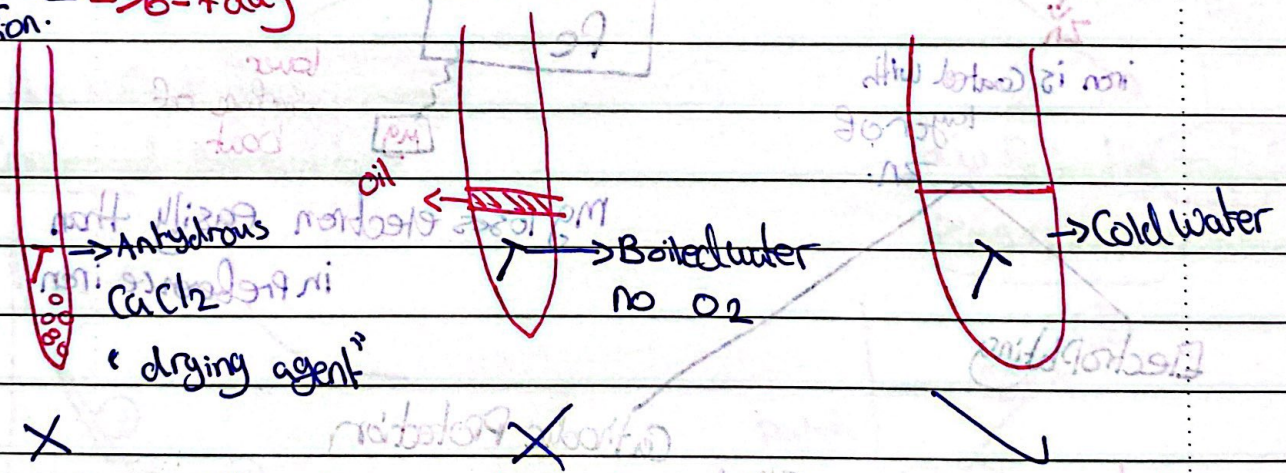
← For Aluminium (Al)

Property	Use
- Low density	- Aircraft bodies
- ductile	- electrical wires
- Malleable	- window frame cooking utensils
- Conduct electricity	- Wires
- Form an oxide layer which is not toxic.	- Food cans.

ductile → low
malleable → bends

* Rust is slow reaction. Rust is reaction of iron with both O_2 and H_2O
 ⇒ 6-7 day

Post Paper Question.



* Plan an exp to show which rust prevention solution is better

Take a known mass of iron nail apply a known volume of the first solution.

Put them in a known volume of water for 1 week.

dry them and measure the mass again. Repeat the exp with 2 solution.

Conclusion of the exp which cause more increase mass worse solution.

How to prevent rusting

- Painting
- Oiling
- Greasing
- Cover with Plastic

Prevent the air reaching the

"to prevent O_2 and H_2O from reacting the iron"

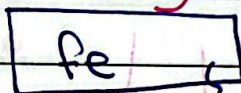
Galvanizing Coating



iron is coated with layer of Zn.

Sacrificial Protection

Connecting

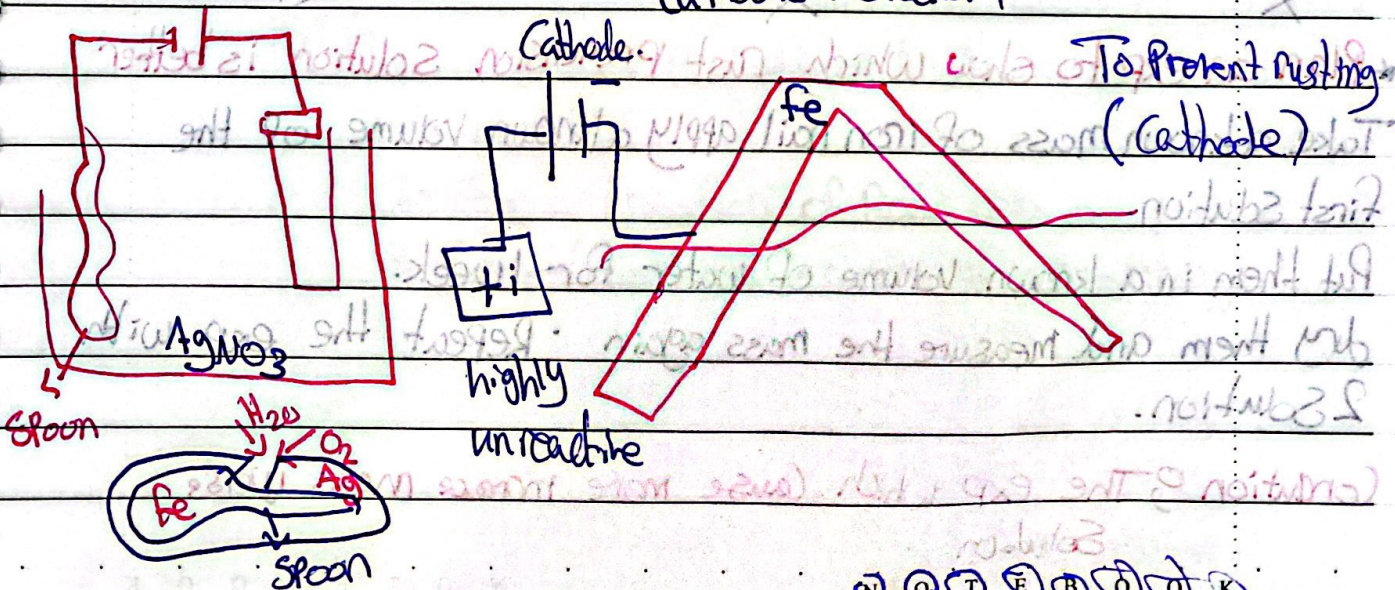


lower surface of boat.

Mg loses electron easily than in preference iron.

Electroplating

Cathodic Protection



NOT A BOOK

Rate of Reaction

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

$$\frac{\Delta \text{Mass}}{\Delta \text{time}}$$

Δ height of ppt

Δ time

$$\frac{\Delta \text{PH}}{\Delta \text{Time}}$$

Δ light Intense

$$\frac{\Delta \text{Volume}}{\Delta \text{time}}$$

Δ time

$$\frac{\Delta \text{temp}}{\Delta \text{time}}$$

Time (t)

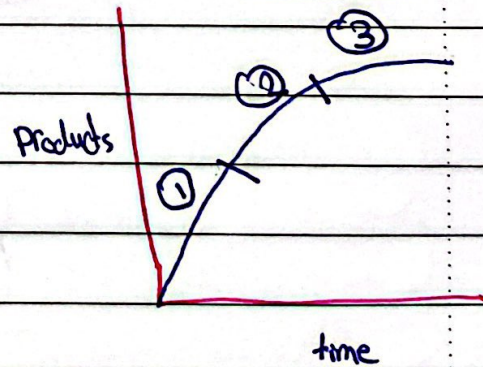
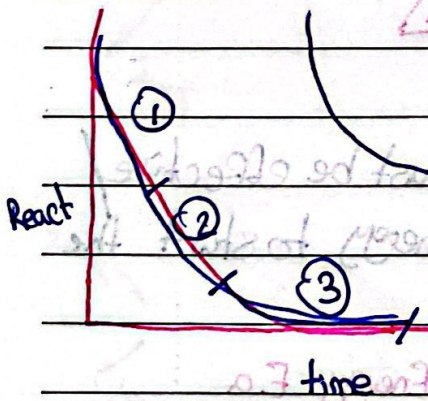
Measure the rate of reaction

How fast the reactants

Consumed Per unit time

How fast the products

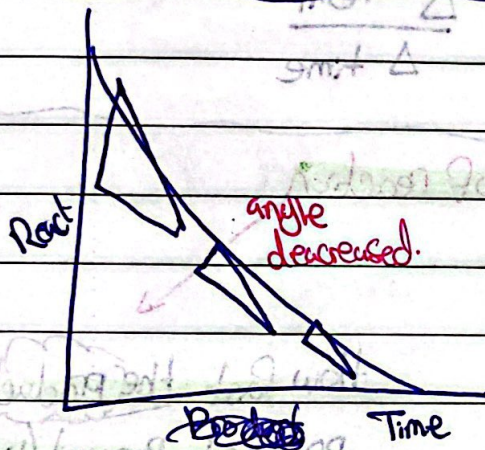
Produced per unit (time)



Region ① \rightarrow Fastest Rate \rightarrow from the graph steepest more amount of reactants more particles more effective collision per unit time.

Region 2 Slower Rate \Rightarrow from the graph. Less steep $\frac{\Delta y}{\Delta x}$
 Less Number of Particles
 So less number of effective collision per unit time

Region 3 reaction is over \Rightarrow gradient = 0 (horizontal)
 no more limiting nit
 no more effective collision

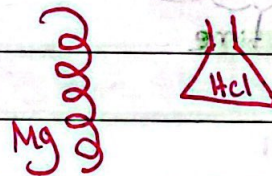


For any chemical reaction there are three main condition

① the reactants must be suitable

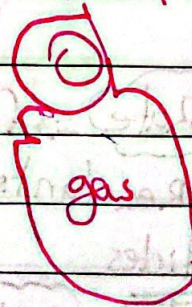


② The reactants must ~~be~~ collide



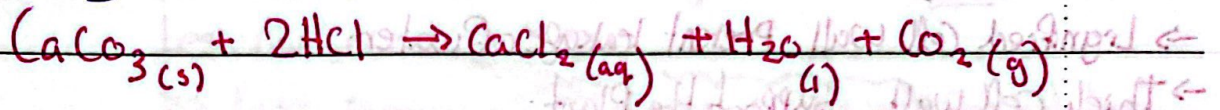
③ The collision must be effective/
 min amount of energy to start the
 Reaction EA

Activation Energy E_a

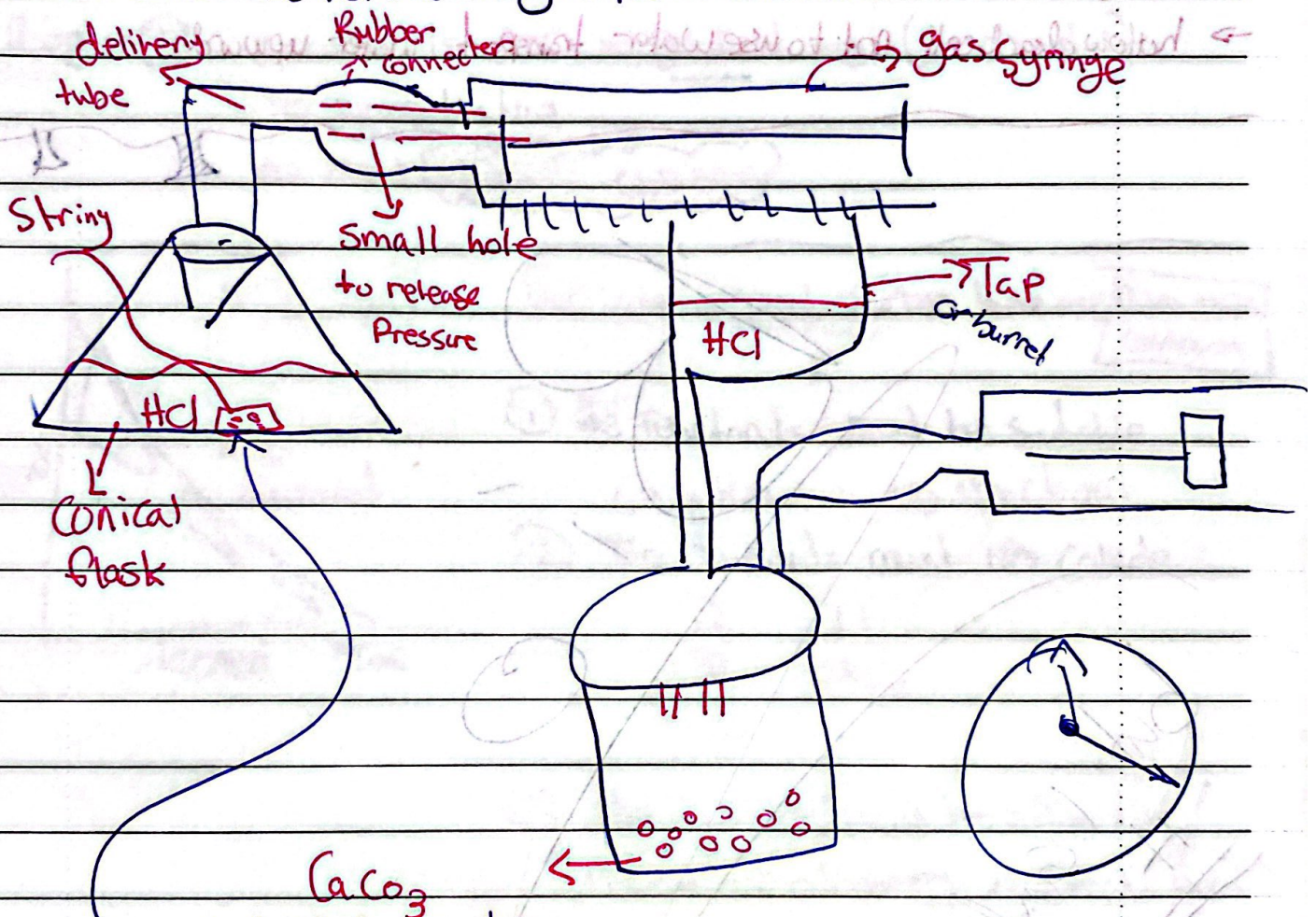


or propane

Measuring the rate of reaction:-



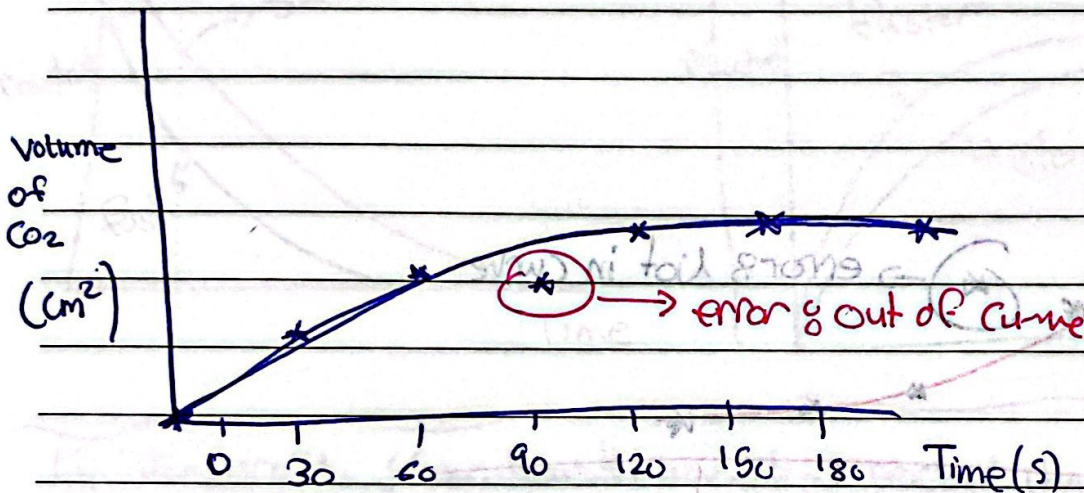
① Measure the volume of gas per unit time.



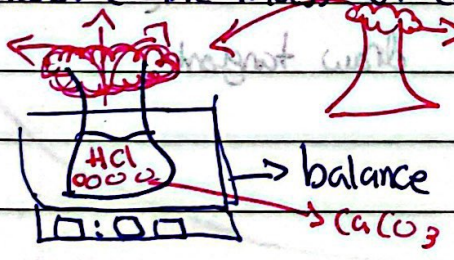
Mount the test tube
 once we turn on the stop watch we start the timer
 (More accurate)

So no gas will escape out of the test tube.

Time	0	30	60	90	120	150	180
Volume of CO_2	0	10	15	17	17.5	17.5	17.5
		+10	+5	+2	+0.5	+0	+0



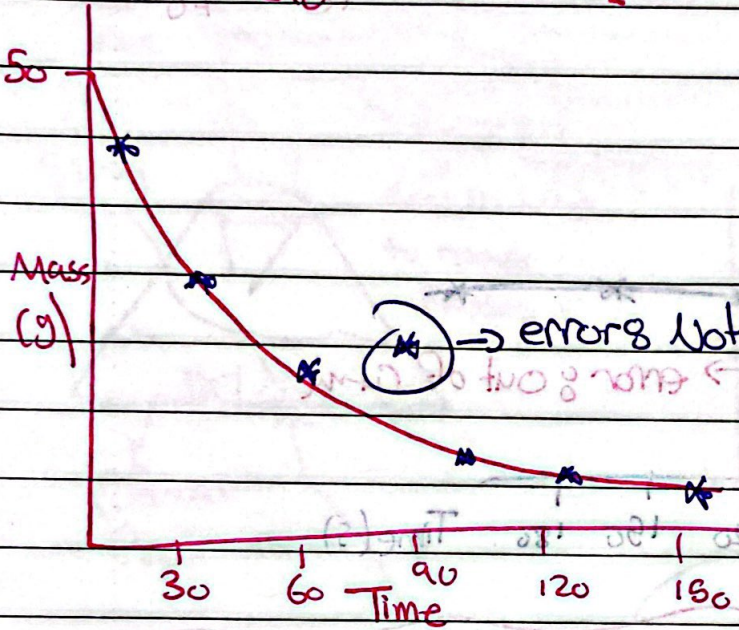
② measure the mass of conical flask + contents per unit time



Cotton wool to allow CO_2 to escape and prevent splashing.

* The mass decrease because CO_2 escape.

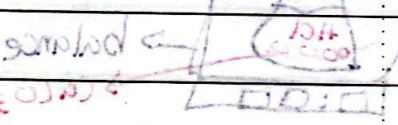
Time (s)	0	30	60	90	120	150	180
Mass (g)	50	40	39	33	32.5	32.5	32.5
		-10	-5	-2	-0.5	-0.5	-



* to find the rate at

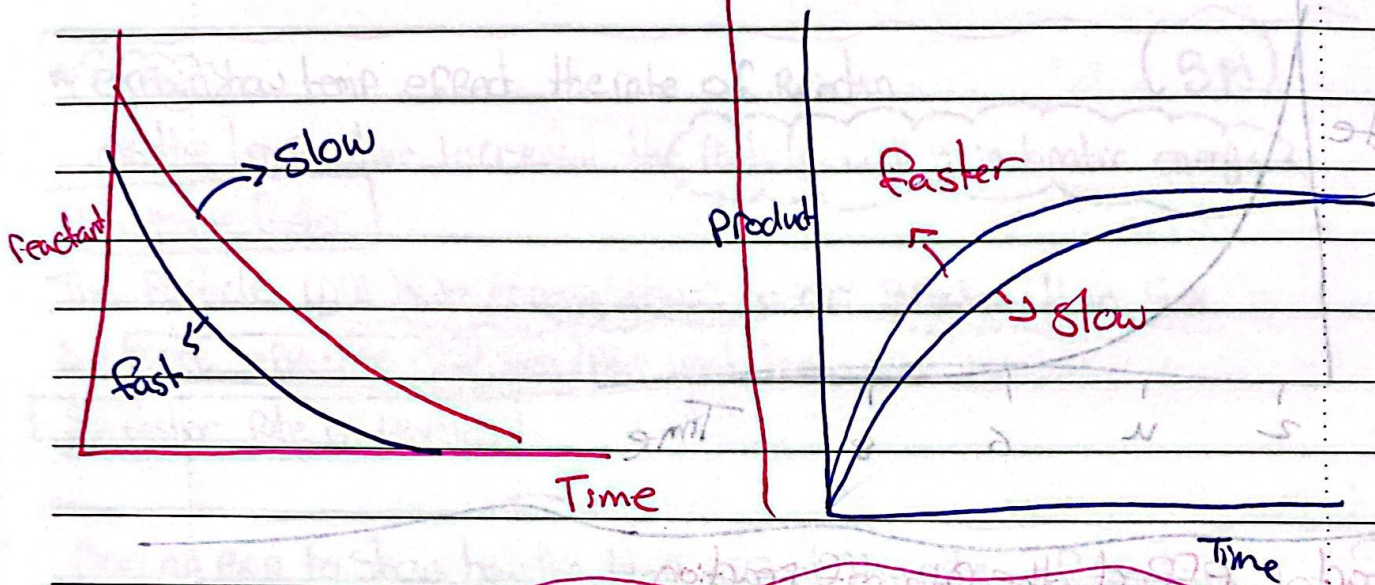
Specific time - at = 80

draw tangent

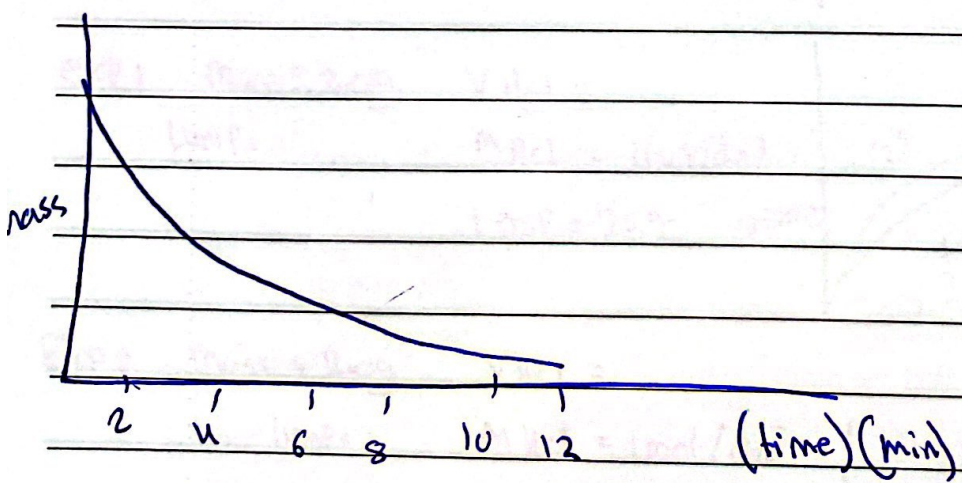


Increasing the rate of reaction

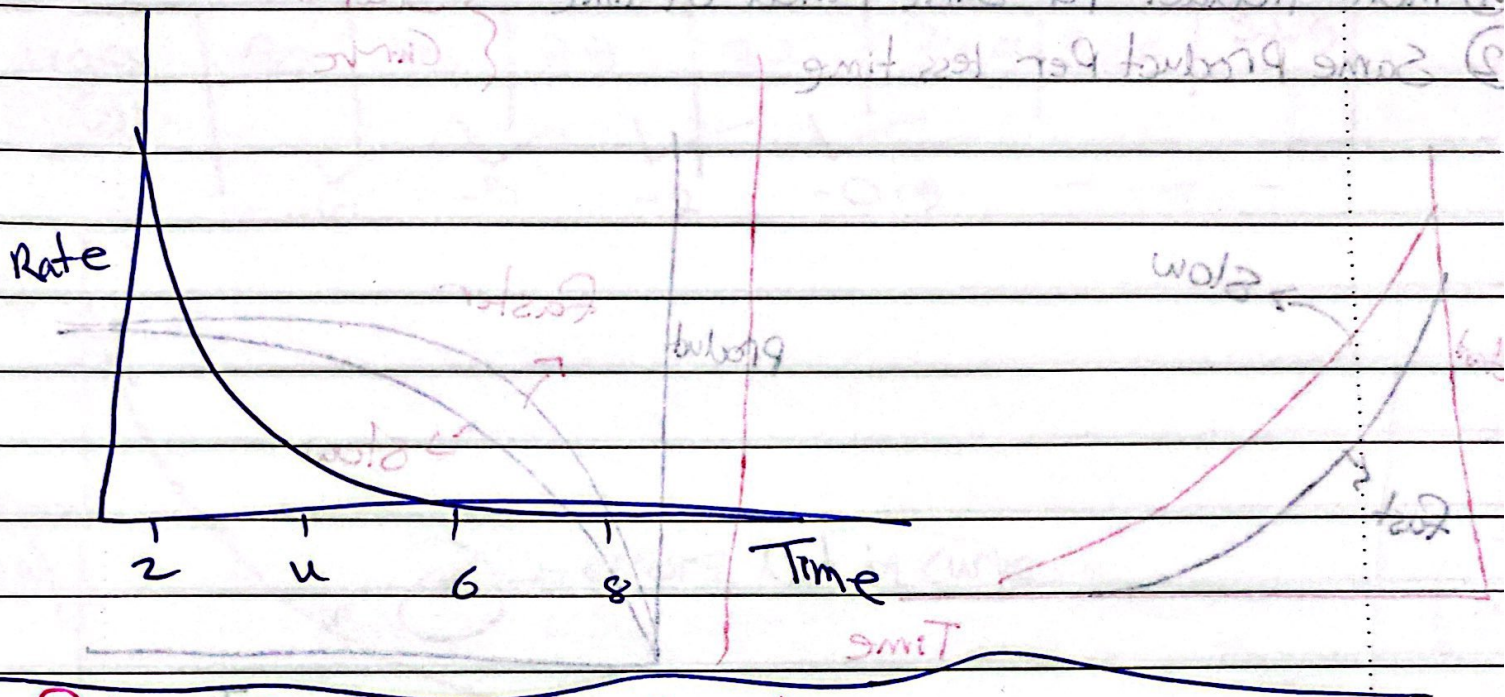
- ① more product per same period of time
 - ② same product per less time
- } Steeper Curve



Q The graph show how the amount of reactant changes with time



Draw Rate vs time graph for this reaction



Factor effect the rate of reaction

- ① Temperature
- ② Surface area
- ③ Concentration / amount
- ④ Pressure
- ⑤ Light Intensity
- ⑥ Catalyst.

① Temperature

* State how temperature affect the rate of reaction.

As the temperature increase the rate of reaction increase.

* explain how temp effect the rate of Reaction (3 Pt)

As the temperature increase the Particle will gain kinetic energy

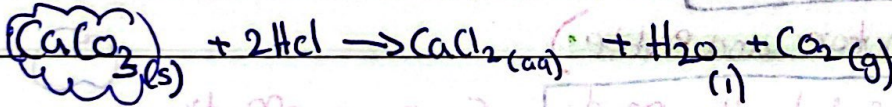
So more faster.

The Particle will have energy equal to or greater than E_a

So more effective Collision Per unit time.

So faster rate of reaction.

Plan an exp to show how the temp affect the rate of reaction



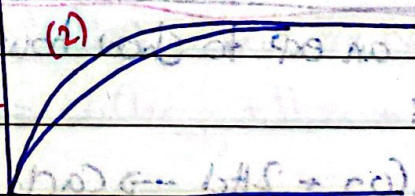
Exp 1 Mass = 2.0g V HCl =

lumps

M HCl = 1 mol/dm³

temp = 25°C

Volume



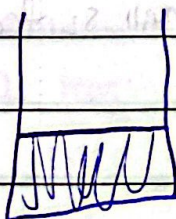
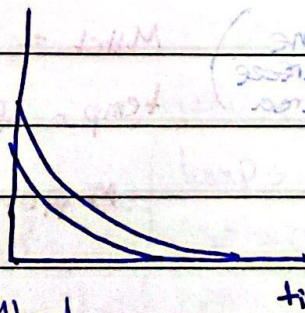
Exp 2 Mass = 2.0g V HCl =

lumps

M HCl = 1 mol/dm³

temp = 50°C

mass



Constant

① Mass of CaCO₃

② Concentration of HCl

different

temperature

Take a known mass of temp CaCO_3 and them to a known Volume of known Concentration HCl at 23°C measure the Volume of CO_2 Produced using a gas Syringe Per unit time. Repeat the experiment at 50°C . The exp at 50°C produce CO_2 at less time.

② Surface area.

State how surface area effect the rate of reaction.

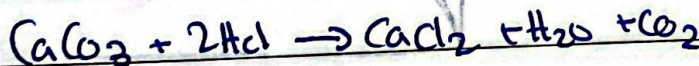
As the surface area increase the rate of reaction increase.

Explain the surface area effect the rate of reaction

As the surface area increase (decrease the Particle Size by crushing using mortar and pestle)

more Particles exposed to the reaction So more effective Collision Per unit time So faster rate.

Explain an exp to show how surface area affect the rate of reaction?



exp 1 mass 2

$\text{V HCl} =$

① Same mass of CaCO_3

② Same temp

lumps (same surface area)

$M_{\text{HCl}} = 1 \text{ mol/dm}^3$

different

temp = 25°C

① lumps Powder

② small surface area

exp 2 mass 2

$M_{\text{HCl}} = 1 \text{ mol/dm}^3$

Powder

temp 25°C

③ Concentration "Amount"

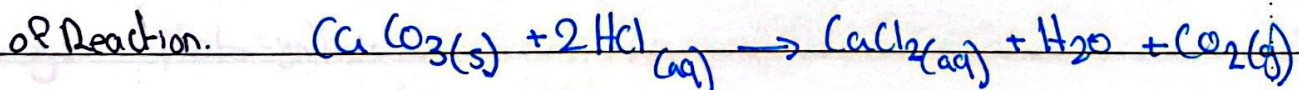
State how the concentration affect the rate of Reaction.

As the concentration \uparrow The Rate of Reaction.

* Explain how the concentration affect rate of reaction.

As the concentration increase more particles
So more effective collision per unit time
So faster rate of reaction.

Plan an experiment to show how concentration affect the rate of Reaction.



Exp 1 mass

$$V = 0.1 \text{ dm}^3$$

CaCO_3

$$M_{\text{HCl}} = 0.1 \text{ mol/dm}^3$$

lumps

$$\text{temp} = 25^\circ\text{C}$$

Exp 3

mass

$$\text{CaCO}_3 = 4\text{g}$$

lumps

$$V = 0.1 \text{ dm}^3$$

$$M = 0.1 \text{ mol/dm}^3$$

$$\text{Temp} = 25^\circ$$

Exp 2 mass

$$V = 0.1 \text{ dm}^3$$

$$\text{CaCO}_3 = 2\text{g}$$

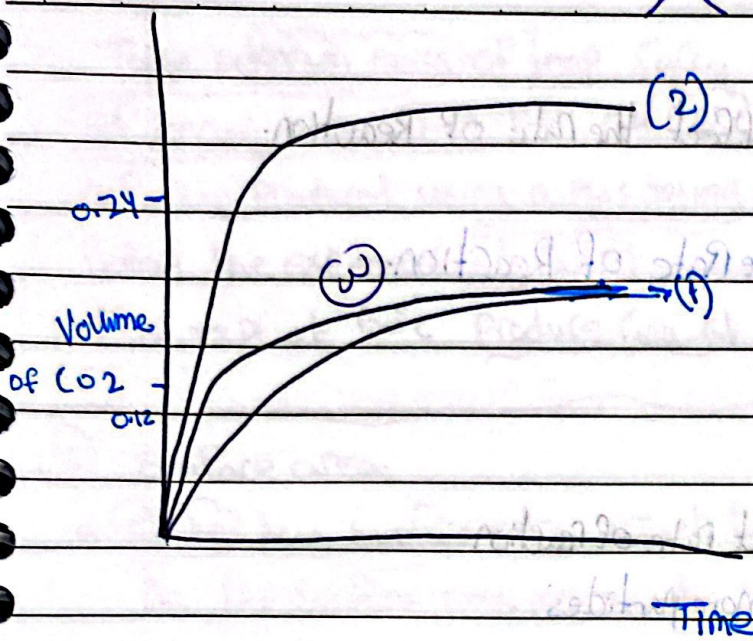
$$M = 0.2 \text{ mol/dm}^3$$

lumps

$$\text{temp} = 25^\circ\text{C}$$

* Same mass
of CaCO_3
* Same Temp

* different concentration
of HCl



more limiting → faster rate
more product

more excess → faster rate

And an experiment to show how concentration affects the rate of reaction:

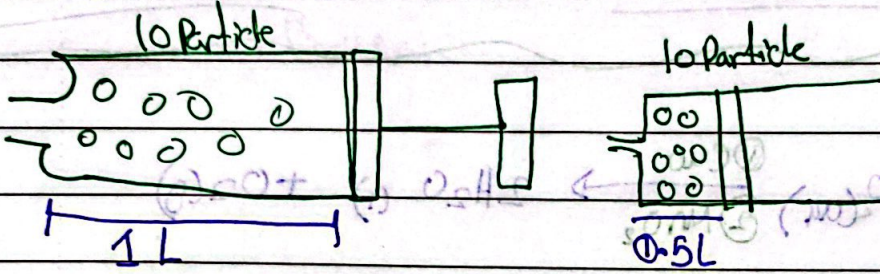
$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

Exp	Mass	Temp	Time	Volume of CO ₂
1	1.0g	20°C	10s	0.1g
2	1.0g	30°C	10s	0.2g
3	1.0g	40°C	10s	0.3g

④ Pressure :- "only affect the gas"

explain how the pressure affect the rate of reaction.

As the pressure increases (by reducing the volume) so more particles per unit volume, so more effective collision per unit time so faster rate of reaction.



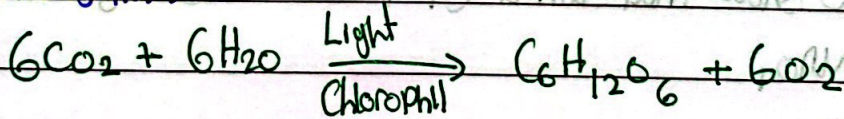
$$\frac{10 \text{ Particle}}{1 \text{ L}} = 10 \quad \frac{10}{0.5} = 20$$

(For example X-Ray)

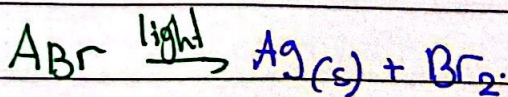
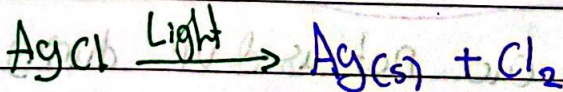
⑤ Lights - "only for photochemical reaction"

Reaction that need light to occur.

eg:- Photosynthesis



Photographic films Films coated with AgCl or AgBr



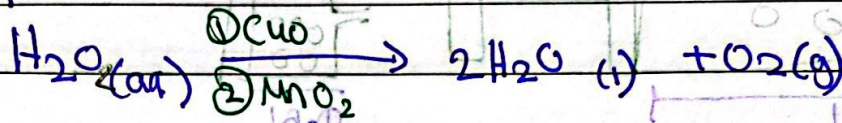
⑥ Catalyst is Chemical Substance that speeds up the reaction without being used up.

How? it provides an Alternative way with lower E_a .

So more particles will have energy equal to or more than E_a .

So more effective collision per unit time so faster rate of rxn.

The Reaction



① Plan an exp to show that CuO is a catalyst for this reaction.

take a known Volume with a known conc of H_2O_2 measure the volume of O_2 produced per unit time. Repeat the experiment using CuO

The exp using CuO will produce more O_2 per the same unit time.

② Plan an exp to show that which of the two catalyst is

better CuO or MnO_2

Same as Q1

Same mass of catalyst

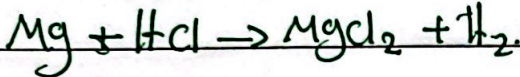
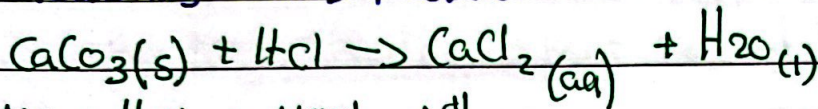
③ Plan an exp to show that CuO not used up during the reaction.

Reversible Reaction.

types of chemical

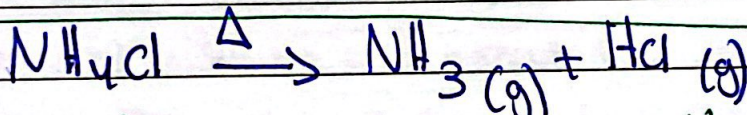
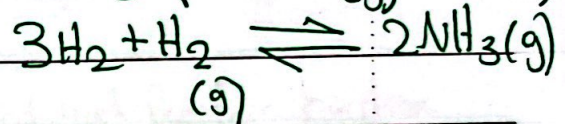
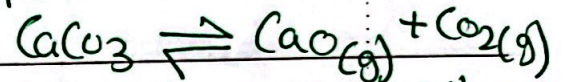
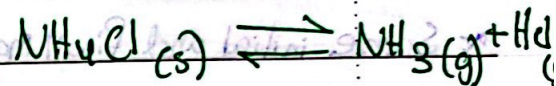
one way

Reactants $\xrightarrow{\text{forward}}$ Products



both ways

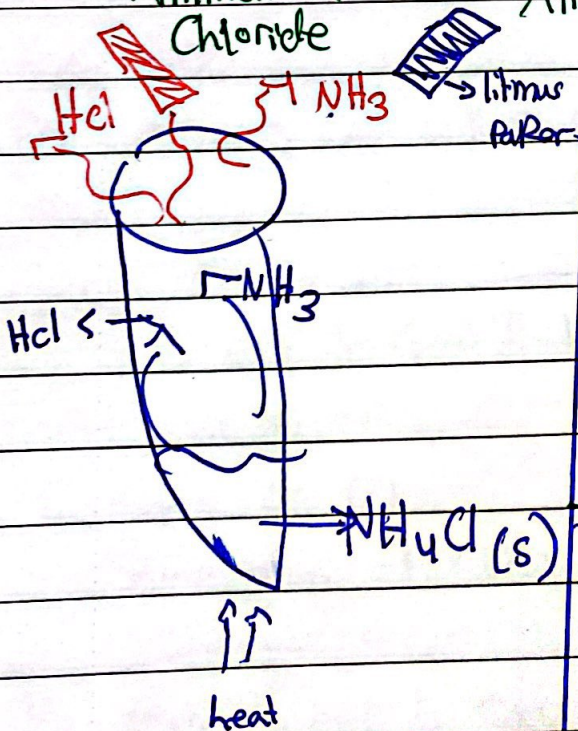
Reactants $\xrightleftharpoons[\text{backward}]{\text{forward}}$ Products



Ammonium Chloride

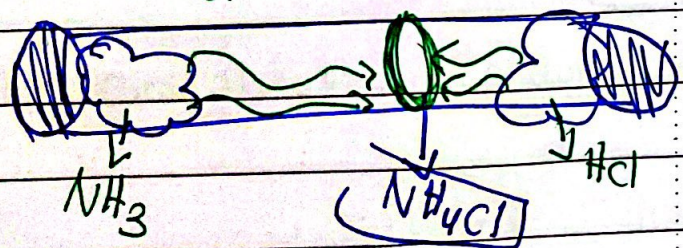
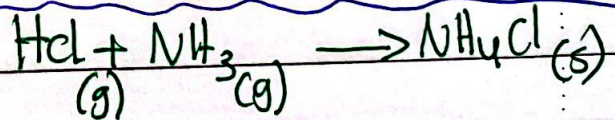
Ammonia

Hydrogen Chloride



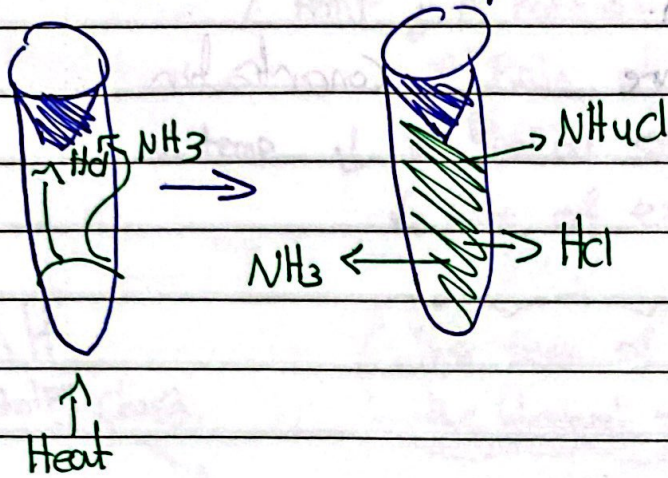
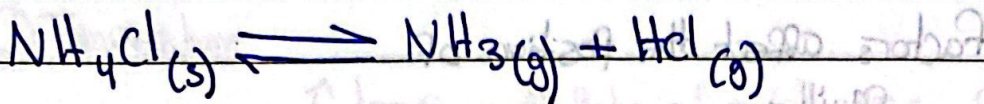
Q) Which damp litmus paper will change its color first; why

The damp red litmus paper changes to blue first because NH_3 is alkali and lighter than HCl which is acidic

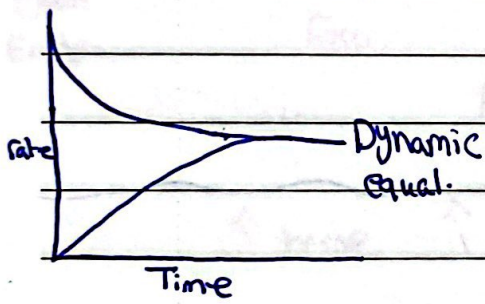


litmus

more



in terms of Rate



The rate of forward ↓

Less reactants so less particles

So less effective collisions (Per unit)

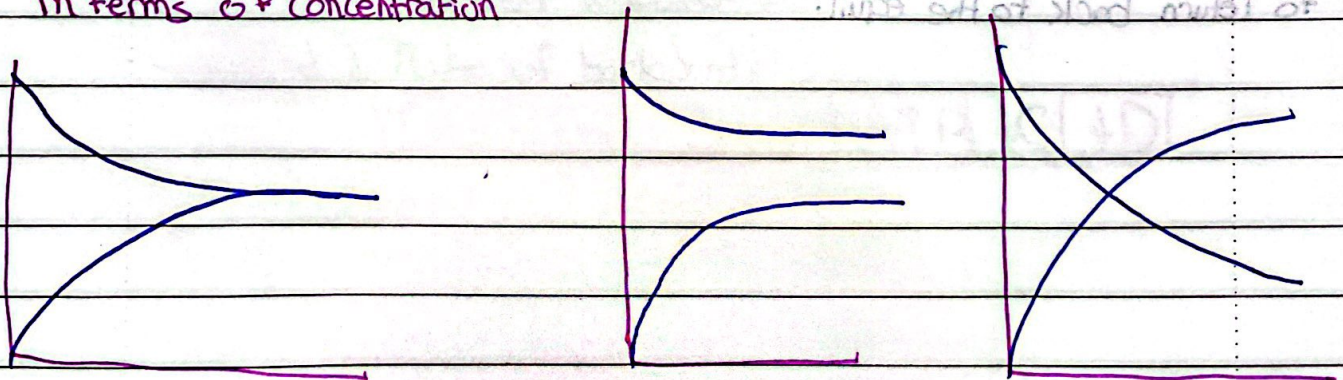
the rate of backward ↑

More particles

More product

More effective collisions

in terms of concentration



Factors affect the position of equilibrium.

temp
 ↘ --- endo foxo
 ↑ temp shift to endo
 ↓ temp shift to exo

Pressure

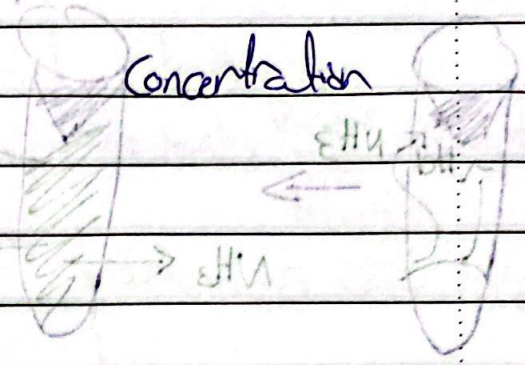
Concentration

↓ $[A]$

← $[B]$

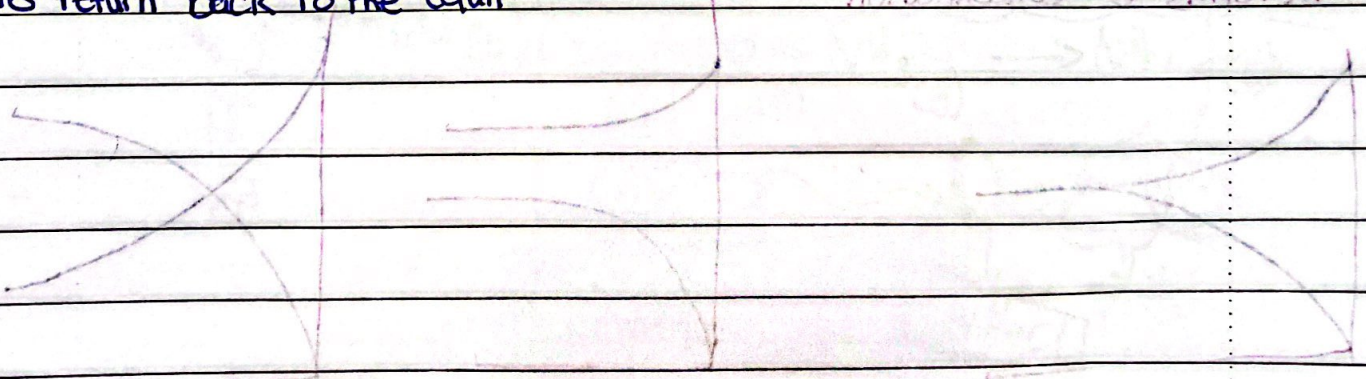
↓ $[C]$

→ $[D]$



Le Chatelier Principle

If the system at equil \rightleftharpoons
 and any external factor disrupt the equil
 the equil can shift itself either to the forward \rightleftharpoons
 or the backwards \leftleftharpoons
 to return back to the equil.



① Temperature

↑ temp ↓ ↑ Rate of endothermic

Shift to endo

↑ Rate of exothermic

↓ temp ↓ ↓ Rate of endothermic

Shift to exo

↓ Rate of exothermic

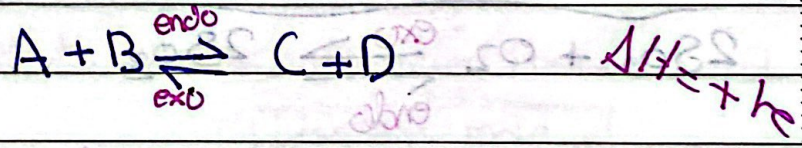
ΔH

Enthalpy change

The sign of ΔH is always represent the forward reaction

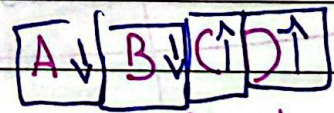
+ve
Gain
Endo

-ve
Lose
Exo



↑ temp ↑ ↑ Rate of forward

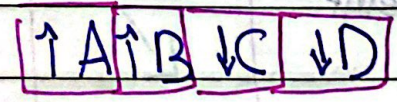
↑ Rate of backwards

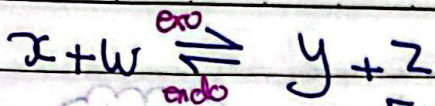


Shift forward to the endo

↓ temp ↓ ↓ Rate of forward

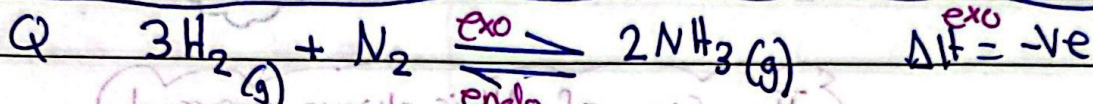
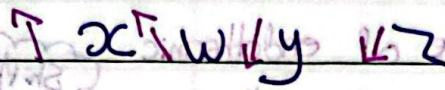
↓ ↓ Rate of backwards





$$\Delta H = -ve$$

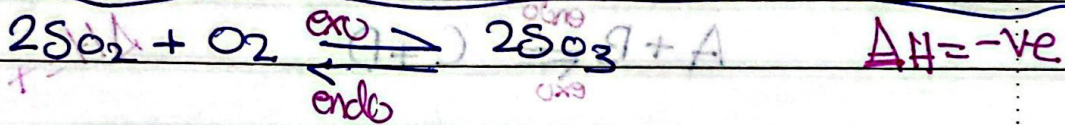
↑ Temp → ↑ rate of forward
 ↑ Temp → ↑ rate of backward } Shift to endo



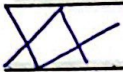
To produce more yield

We must use low temp

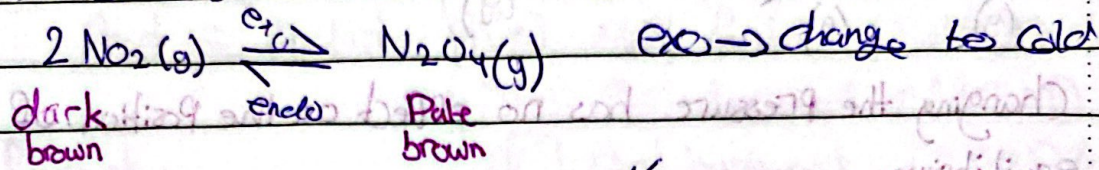
to favour the forward reaction which is exothermic



	Rate of Forward	Rate of backward	% SO ₃
↑ temp	↑	↑	decrease
↓ temp	↓	↓	increase



Mixture of NO_2 and N_2O_4 at equil in a sealed tube



if we put this sealed tube in a cold water bath the mixture becomes paler?

because the forward reaction is exothermic enhanced

by Cooling

② Pressure

As the Pressure increase

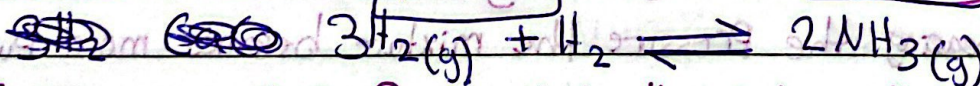
The equil shift to the side with Less Pressure

Less gas mole

As the Pressure decreased

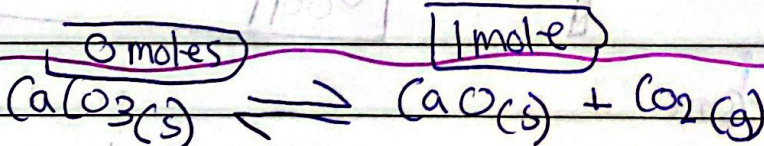
More Particles

More gas mole



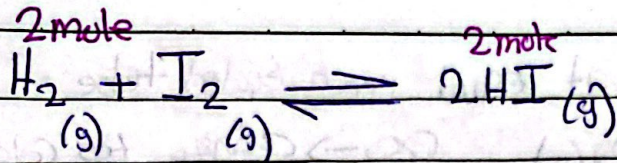
↑ Pressure Shift forward to the side with less

Gas moles ↑ % NH_3



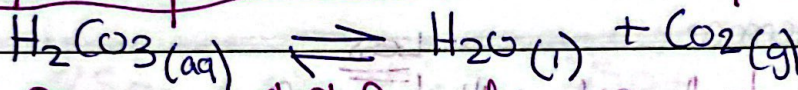
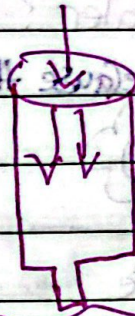
↓ Pressure Shift ~~backward~~ ^{forwards} to side with more gas mole

↑ Pressure Shift backwards to side with less gas mole



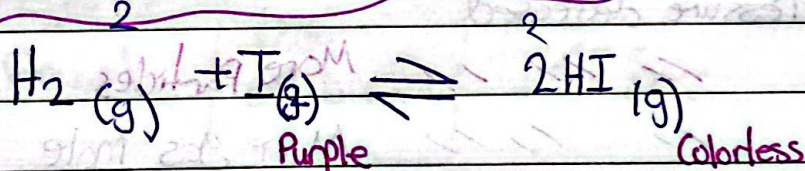
Changing the pressure has no effect on the position of equilibrium

Since both side has the same no. of gas mole



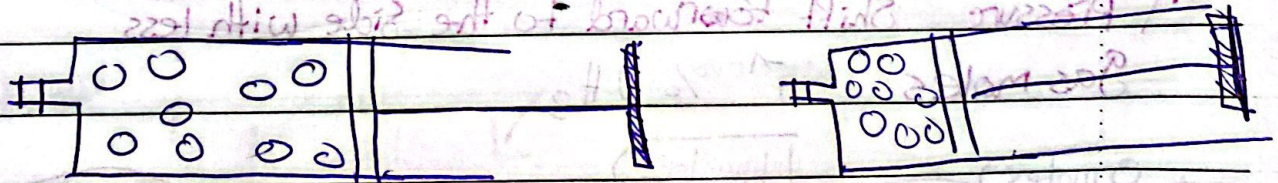
↓ Pressure Shift Forward

to the side more gas mole



The equil doesn't affect by increasing the pressure

Why by increasing the pressure the mixture becomes more Purple?

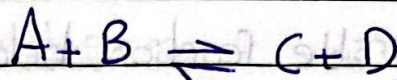


The I₂ molecules become

closer to each other so the color seems to be darker

③ Concentration

React \rightleftharpoons Products



$\uparrow [A]$ Shift Forward $\downarrow [B]$ $\uparrow [C]$ $\downarrow [D]$

$\uparrow [B]$ Shift backward $\uparrow [A]$ $\downarrow [C]$ $\downarrow [D]$

$\uparrow [C]$ Shift backward $\uparrow [A]$ $\uparrow [B]$ $\downarrow [D]$

$\uparrow [D]$ Shift backward $\uparrow [A]$ $\uparrow [B]$ $\downarrow [C]$

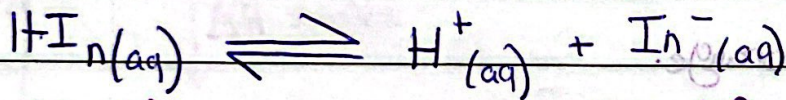
\uparrow Reactants

\downarrow Product. $\left\{ \begin{array}{l} \text{Shift Forward} \end{array} \right.$

\downarrow Reactants

\uparrow Product $\left\{ \begin{array}{l} \text{Shift backwards} \end{array} \right.$

Indicator



Color (1)
Red

Color (2) Methyl orange
Yellow

add HCl: proton donor $\uparrow H^+$ Shift backward

More HIn More color (1)

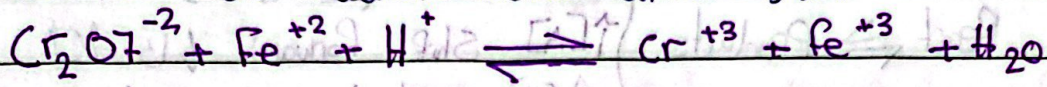
Less In^- Less color (2)

add NaOH: Proton acceptor $\downarrow H^+$ Shift Forward

More In^- More color (2)

Less HIn Less color (1)

Q. The reversible reaction below at equilibrium



(1) Orange green

Explain why by adding HCl to the reaction mixture the color of the mixture become green?

HCl is an acid (proton donor)

More H^+

Shift forward

More Shift Forward

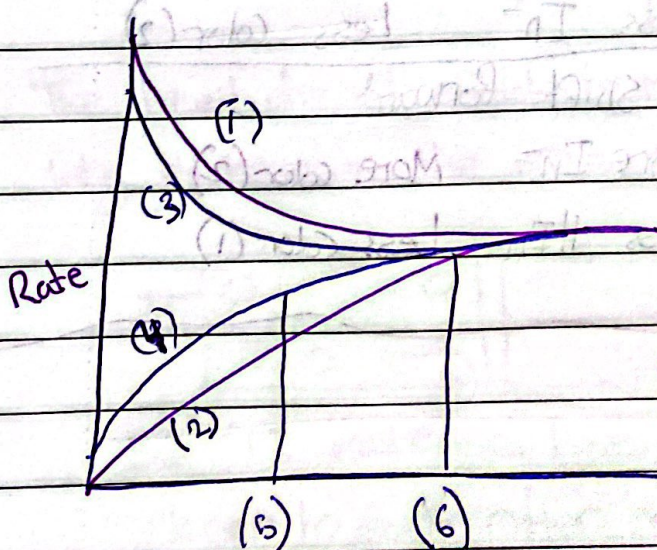
More Cr^{3+} More green

Less $\text{Cr}_2\text{O}_7^{2-}$ Less orange.

* Catalyst

has no effect on the position of equilibrium

Since it speeds up the rate of forward and backward



(1) → Rate of forward reaction without catalyst

(2) → " " " backward

(3) Rate " forward " with "

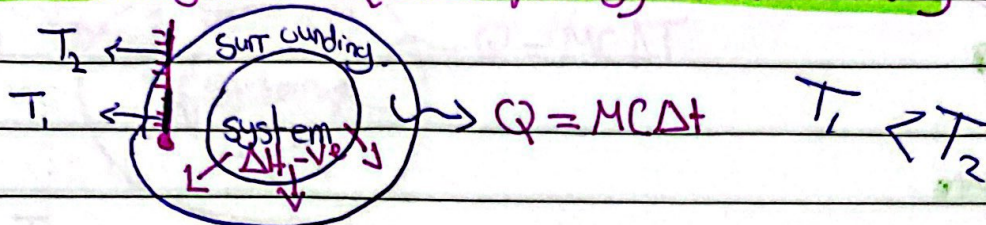
(4) " " backward " " "

(5) time taken to reach equil with catalyst

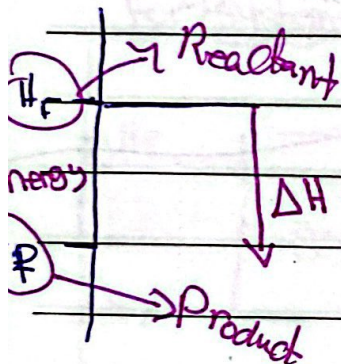
(6) " " " " without.

Exothermic

Reaction that give out (Release) energy to the surrounding



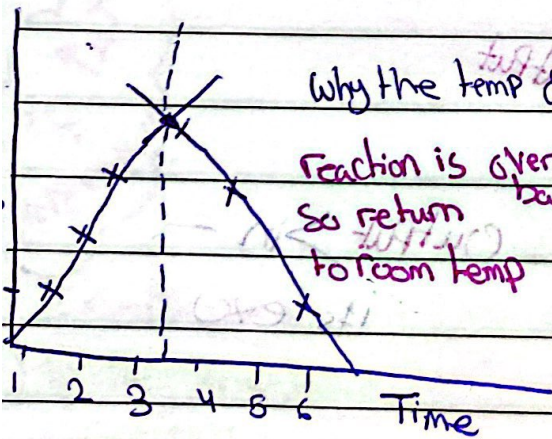
For system (level Energy diagram)



Enthalpy of Heat Contents "stored energy"

Enthalpy Reactant H_r Enthalpy of Products H_p

For Surrounding (temp diagram)



Why the temp decrease in more time?

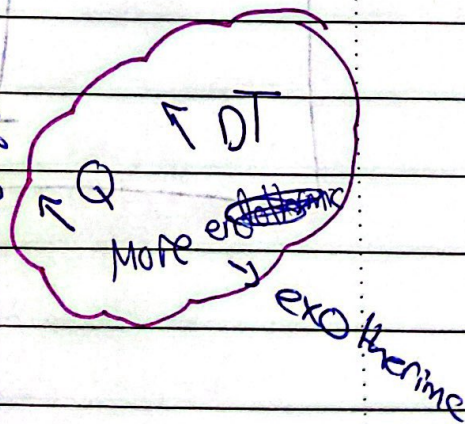
Reaction is over back so return to room temp

(To know when the reaction) if over draw an intersection lines

$Q = mc\Delta T$

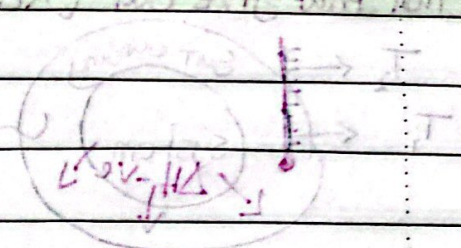
Energy transfer Q Mass m Change in temp ΔT

(4.2 J/g°C) Specific heat capacity c



Example on exo :-

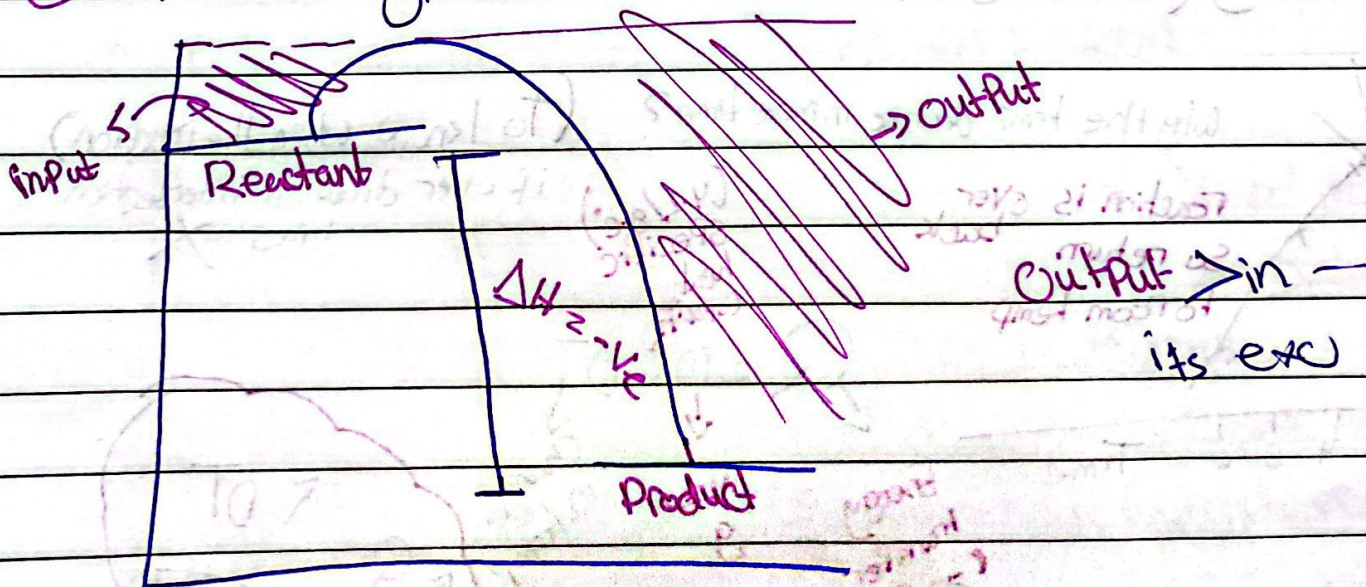
- 1- Freezing, condensation
- 2- Respiration
- 3- Combustion
- 4- Neutralization
- 5- displacement $Zn + CuSO_4(aq)$
- 6- Voltage Cells
- 7 - building up bonds.



How to express exo rxn

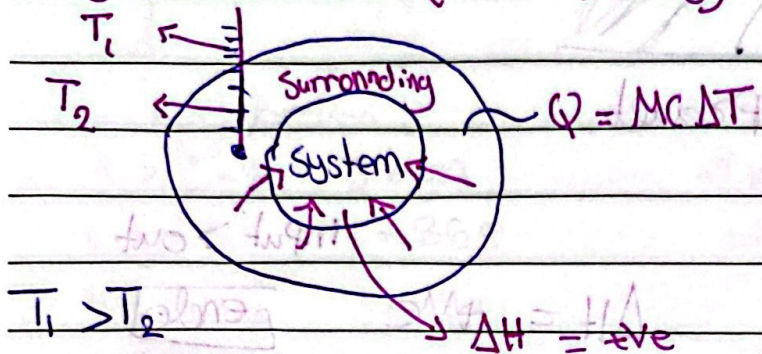
- ① Reactant \rightarrow Product $\Delta H = -ve$
- ② Reactant \rightarrow Product + energy

③ Profile diagram



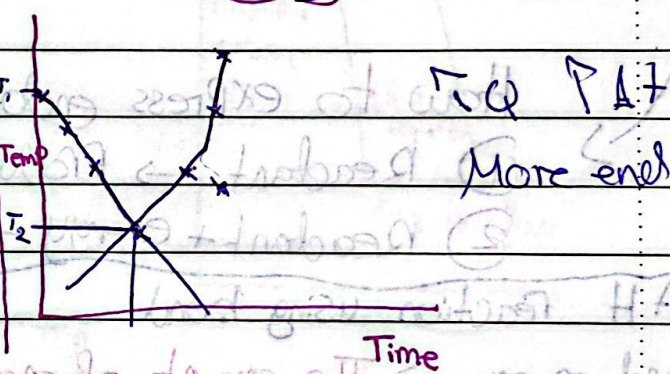
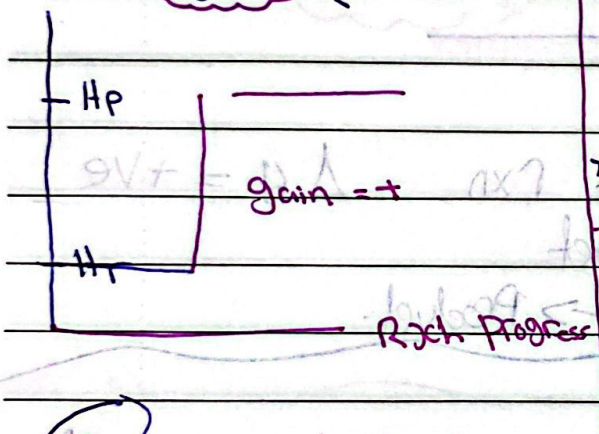
Endothermic.

Reaction that absorb (take in) energy from the surrounding.



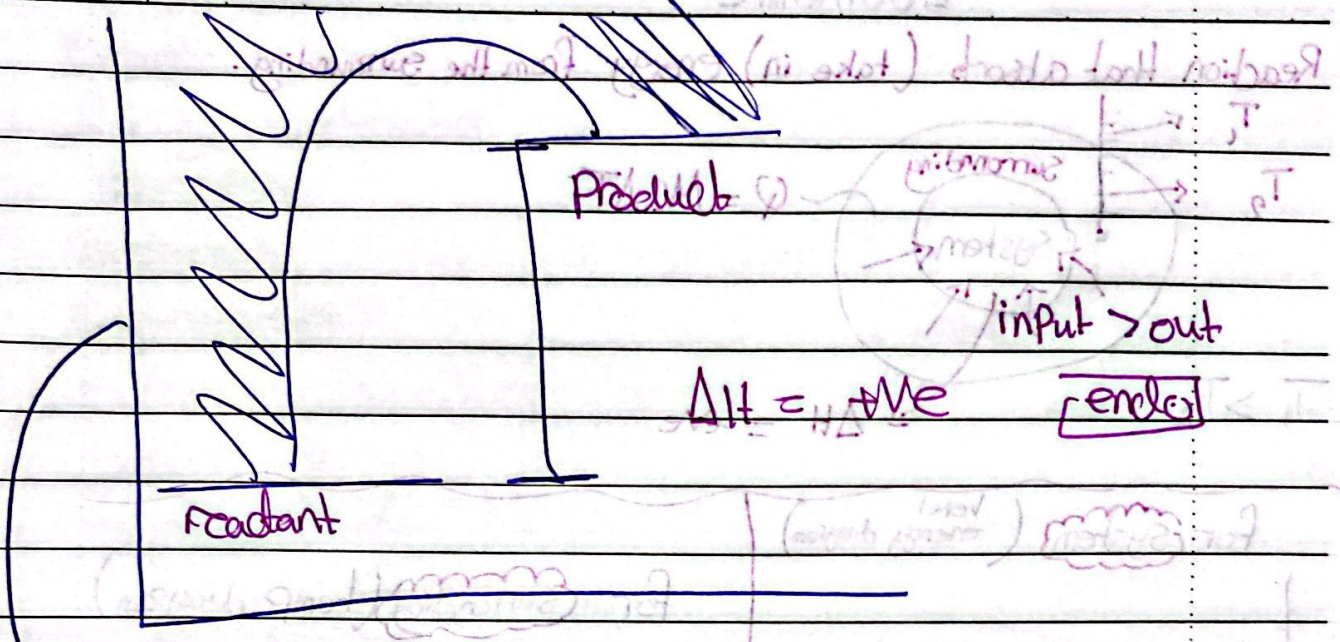
For System (level energy diagram)

For Surrounding (temp diagram)



Examples of Endothermic

- 1) Boiling, melting
- 2) photosynthesis
- 3) Thermal decomposition.
- 4) Electrolysis.
- 5 - Photographic Films
- 6) dissolve ammonium salt
- 7) breaking down bonds.

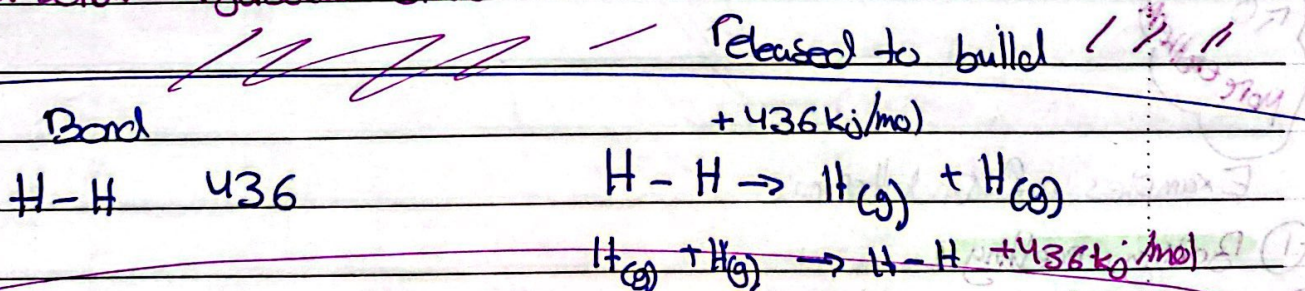


How to express endo rxn $\Delta H = +ve$

- ① Reactant \rightarrow Produkt
- ② Reactant + energy \rightarrow Produkt

ΔH reaction using bond

Bond energy \rightarrow The amount of energy needed to break 1 mol of a bond. in gaseous state



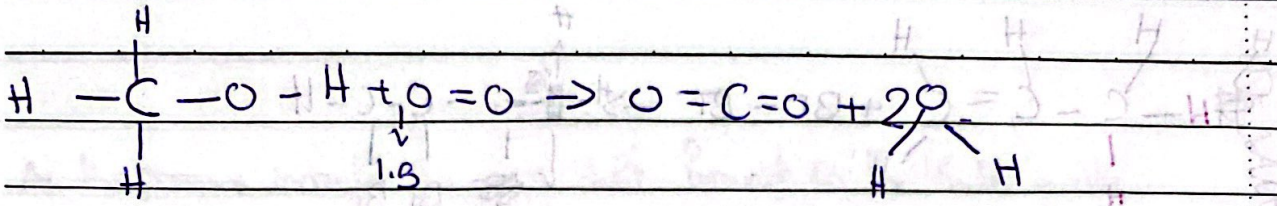
$$\Delta_{\text{Reaction}} = \sum \text{input} - \sum \text{Output}$$

if the input > output \rightarrow endo

if the output > input \rightarrow exo

To use this equation

- ① balance
- ② covalent
- ③ bond energy.

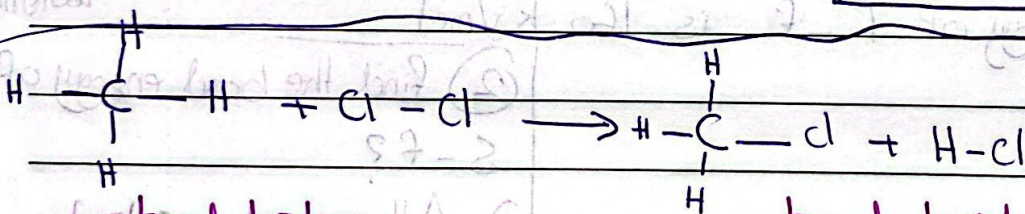
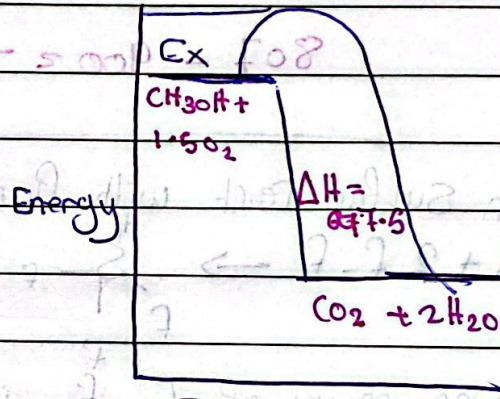


bond broken

bond build

$$\begin{array}{l}
 3 \times \text{C}-\text{H} \quad 3 \times 413 \\
 1 \times \text{C}-\text{O} \quad 1 \times 368 \\
 1 \times \text{O}-\text{H} \quad 1 \times 463 \\
 1.5 \times \text{O}=\text{O} \quad 1.5 \times 495
 \end{array}
 \quad
 \begin{array}{l}
 2 \times \text{C}=\text{O} \quad 2 \times 799 \\
 4 \times \text{O}-\text{H} \quad 4 \times 463 \\
 3495 \text{ kJ}
 \end{array}$$

2802.5 kJ



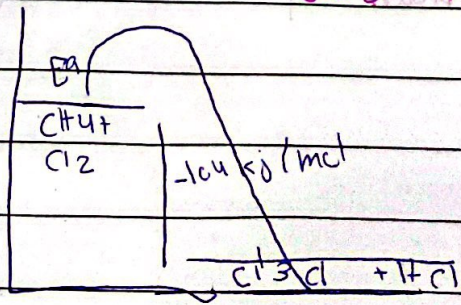
bond broken

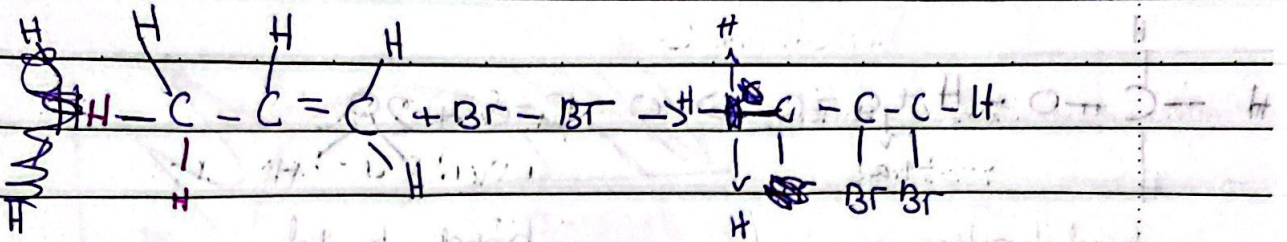
bond build

$$\begin{array}{l}
 1 \times \text{C}-\text{H} \quad 413 \\
 1 \times \text{Cl}-\text{Cl} \quad 242 \\
 655 \text{ kJ}
 \end{array}
 \quad
 \begin{array}{l}
 \text{C}-\text{Cl} \quad 328 \\
 \text{H}-\text{Cl} \quad 431 \\
 759 \text{ kJ}
 \end{array}$$

$$655 - 759 = 104 \text{ kJ}$$

Bond	bond energy kJ/mole
C-H	413
Cl-Cl	242
H-Cl	431
C-Cl	328





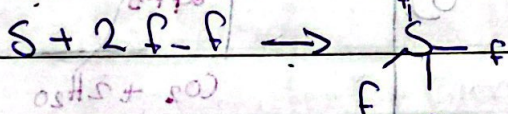
bond broken	bond built	Bond	bond energy
$\text{Br}-\text{Br}$ 1×193	$2 \times \text{C}-\text{Br}$ 2×276	$\text{C}-\text{H}$	4×413
$\text{C}=\text{C}$ 1×614	$\text{C}-\text{C}$ 1×348	$\text{C}-\text{C}$	1×348
		$\text{C}=\text{C}$	1×614
		$\text{Br}-\text{Br}$	1×193
		$\text{C}-\text{Br}$	2×276

807 kJ

900 kJ

$$807 - 900 = -93 \text{ kJ/mole}$$

When sulfur react with fluorine the reaction give -780 kJ/mol



if the bond energy of $\text{F}-\text{F}$ is

160 kJ/mol

1) Draw an energy of $\text{F}-\text{F}$ is 160 kJ/mol

2) Find the bond energy of $\text{S}-\text{F}$?

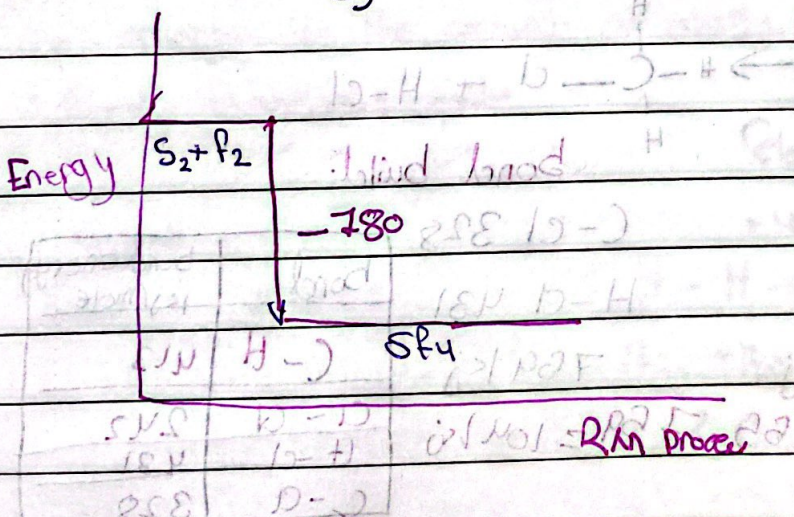
$$\Delta H = \text{input} - \text{output}$$

$$-780 = (2 \times 160) - 4 \times \text{S}-\text{F}$$

$$\text{S}-\text{F} = 276 \text{ kJ/mol}$$

$$-1100 = -4 \times \text{S}-\text{F}$$

$$\text{S}-\text{F} = 275 \text{ kJ/mol}$$



Measuring ΔH Combustion for ethanol



$$Q = mc\Delta T \Rightarrow \Delta T = \frac{Q}{mc}$$

$$\text{Energy transfer} = 100 \times 4.2 \times 10$$

$$= 4200 \text{ J} \approx 4.2 \text{ kJ}$$

4.2 kJ Produced from 2g C_2H_5OH



$$m_1 = 200 \text{ g}$$

$$m_2 = 198 \text{ g}$$

ΔH

$$96.6 \text{ kJ/mol}$$

1 mole

$$46 \text{ g } C_2H_5OH$$

$$\Delta H = -96.6 \text{ kJ/mol}$$

Two fuels A and B Plan an exp to show which one produce more energy?

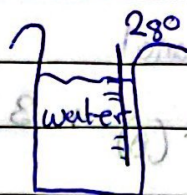
Take a known mass of water with known initial temp in a

Copper Can

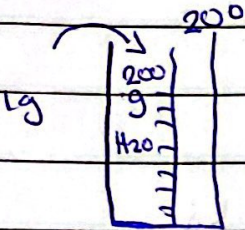
Take a known mass of fuel A (ignite the fuel) and record the final mass and final temp of water

- Repeat with using fuel B

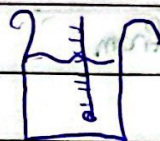
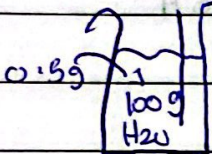
the fuel which cause more temp to rise per gram of fuel produce more energy



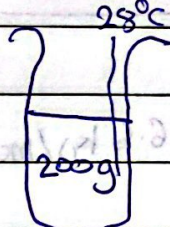
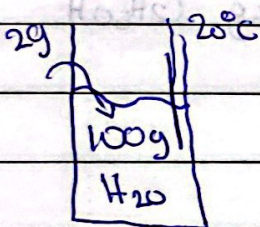
$\Delta t = 8^\circ$



temp? $\Delta t = 4^\circ C$

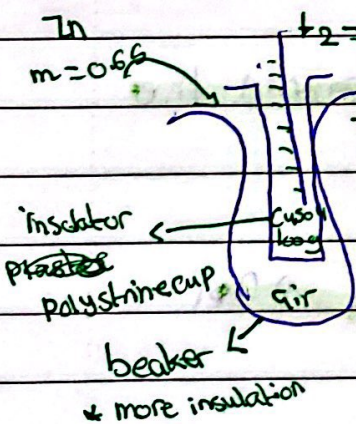


$\Delta t = 4^\circ C$

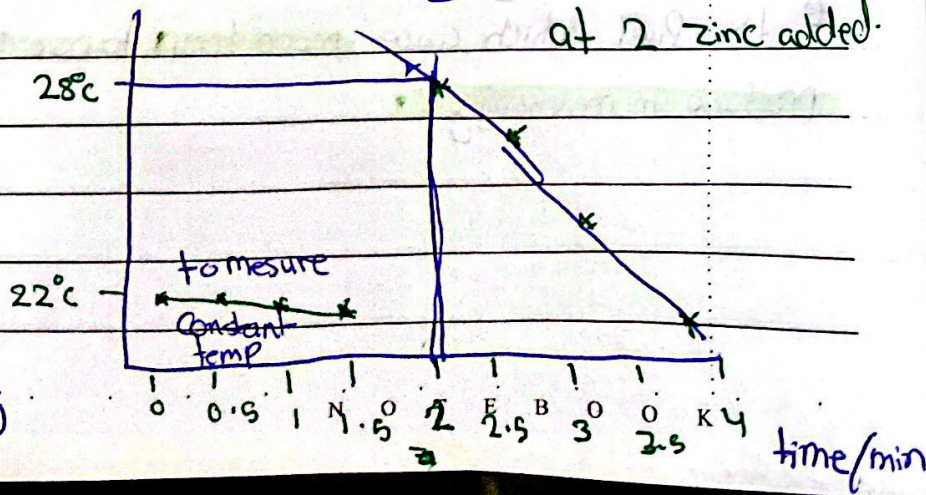


$\Delta t = 8^\circ C$

Measuring displacement



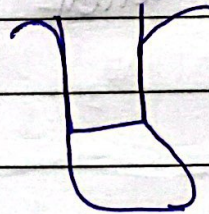
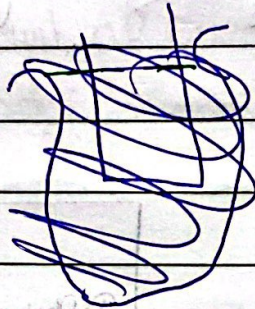
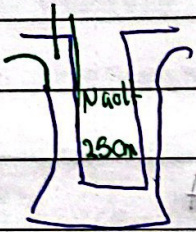
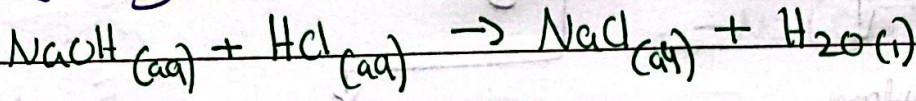
$T_1 = 22^\circ C$
 $T_2 = 28^\circ C$
 Stir with thermometer to disperse heat equally
 (slowly to)
 avoid over heating



$Q = mc\Delta t$
 $100 \times 4.2 \times 6$

$2620 J = 2.62 kJ$

Measuring ΔH Neutralization



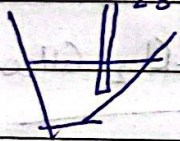
NaOH 25cm³

HCl 25cm³

+ 22°C

22°C

28°C

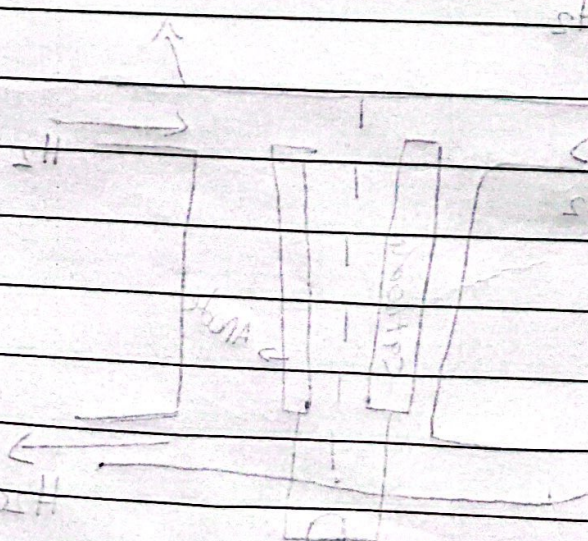
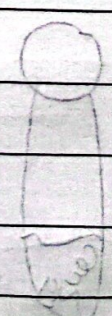


$$Q = M \times 4.2 \times \frac{28 - 22}{25 + 25} \times 6$$

1260 J

90
H₂O ←

H₂O ← NaOH + HCl



Alternative Resources of energy

Voltaic Cell

Hydrogen fuel cell

Uranium

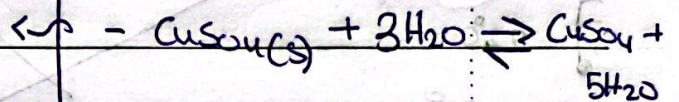
old syl

Water test

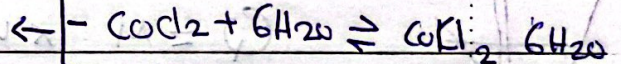
① Physical test: B.P = 100°C

② Chemical test.

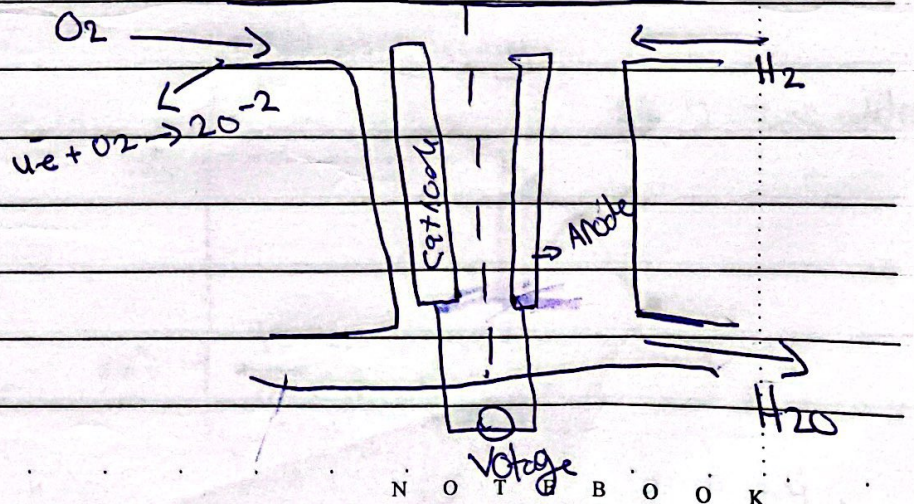
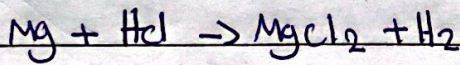
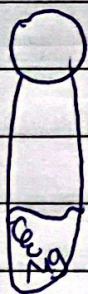
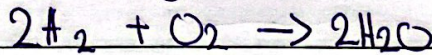
white to blue



blue to pink



Hydrogen fuel cell



N O T B O O K

Advantage & only one waste Product (H₂O)

↓ - NO (CO₂)

(15)

- NO CO₂

- Produce high amount of energy

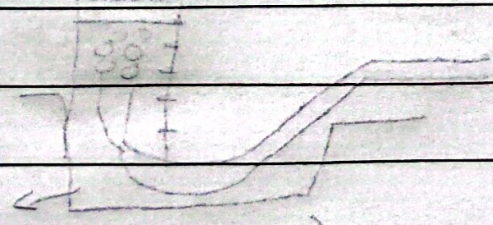
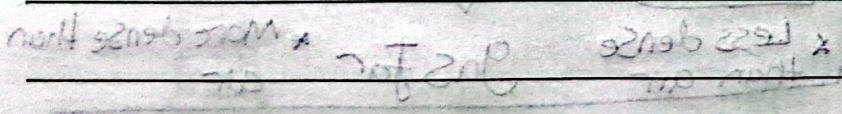
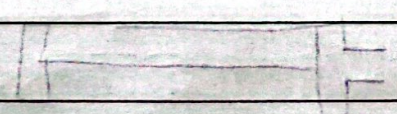
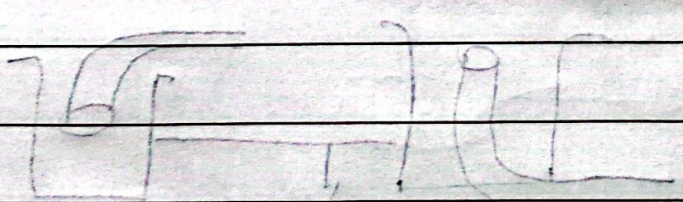
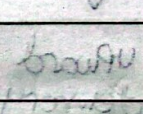
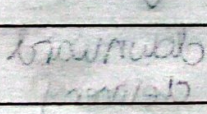
- generate electricity

Disadvantages

- Expensive

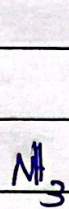
- Hard to store and transport

- Risk of explosion

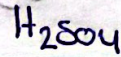


Industrial Chemistry

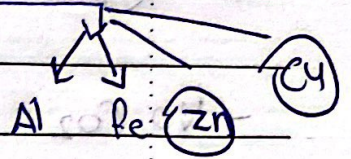
↓
Dealing
with gases



Industry



Carbonate
cycle



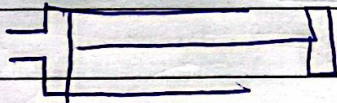
Dealing with gas

Rxn → wet gas → dry → collect

* Collect gas

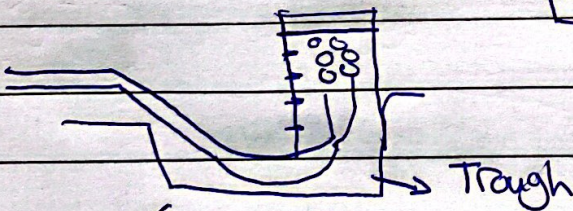
* No mixing
with other
gases.

① gas syringe



use to collect and measure the
volume of any gas

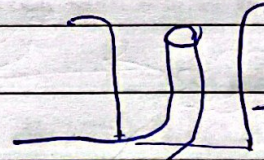
③ over water



only for insoluble gases

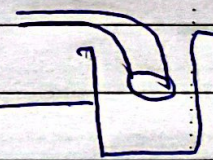
② Delivery tube

upward
delivery



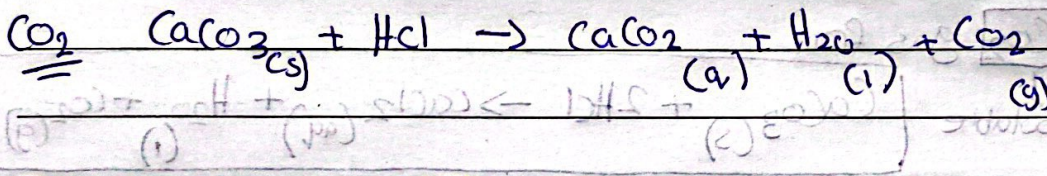
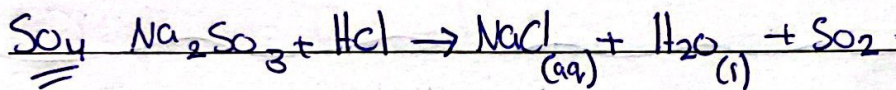
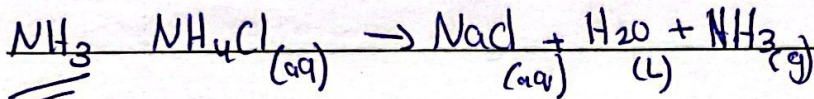
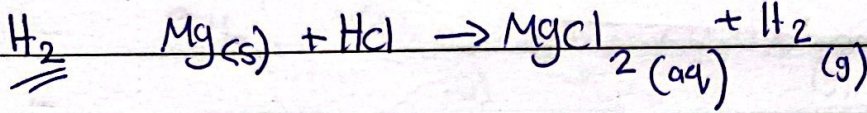
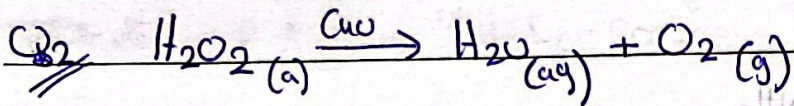
* Less dense
than air

downward
delivery



* More dense than
air

* Mix with air
* can escape



* Dry gases → ① Concentrated H₂SO₄ ② Anhydrous CaCl₂ ③ Calcium oxide

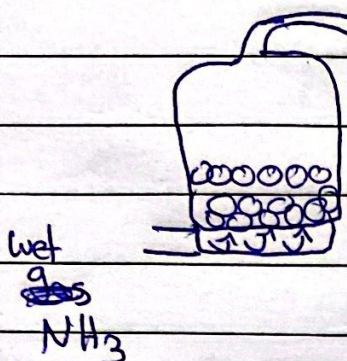
① Concentrated (H₂SO₄) *wet gases* → *dry the gas* → H₂SO₄ (become diluted) *dry any gas included*

used to dry any gas *gas included*
 except NH₃ Chlorine, hydrogen chloride
 if neutralize the H₂SO₄
 $NH_3 + H_2SO_4 \rightarrow NH_4 SO_4$

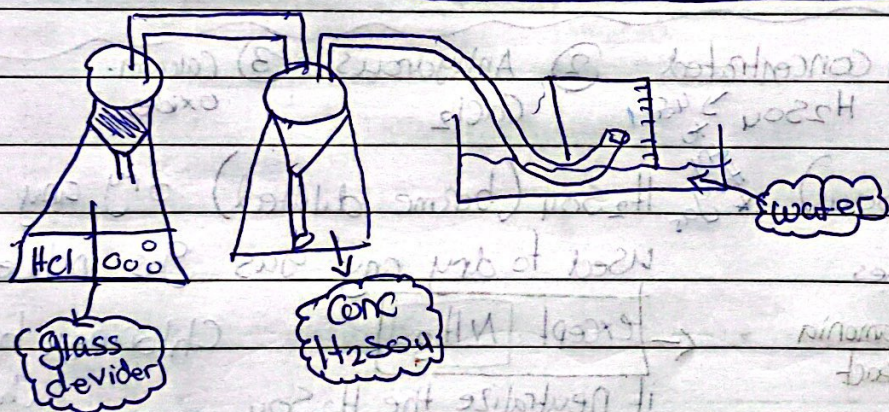
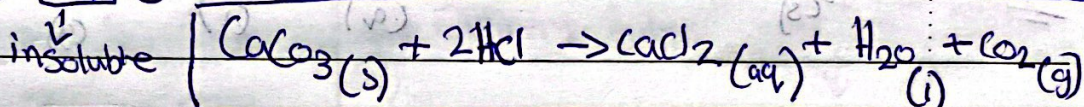
② Anhydrous (CaCl₂)

Moist gas → *dry gas* * use to dry any gas except NH₃

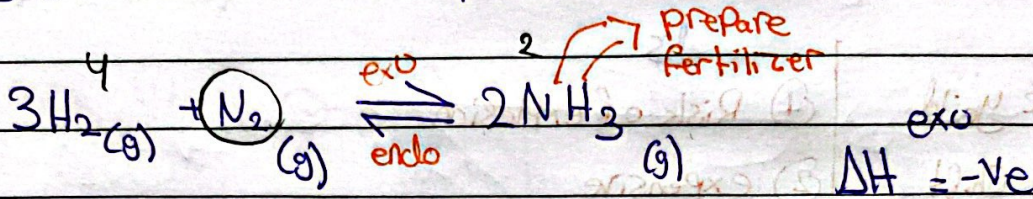
③ Calcium oxide CaO
dry NH_3



Draw a suitable apparatus used to collect and measure volume of dry CO_2 gas from

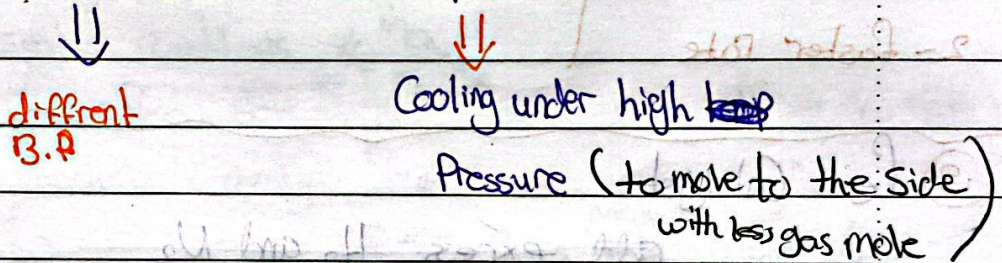


Industry of Ammonia "Haber process"

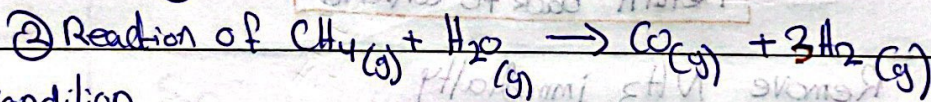


How to obtain.

① Nitrogen :- fractional distillation of liquid air



② Hydrogen :- ① cracking of Alkanes (organic)



essential condition

1) Temp $400 - 450^\circ\text{C}$

Temp	Adv	More than 450°C	Composition of Air
Less than 400°C	Slower rate	dis	78% N_2
adv	Particle lose	* Less yield	21% O_2
- higher yield of NH_3	KE so less effective	- Shift backward to the endo side	0.9% Ar
- shift forward to the exo thermic side	Collision Per unit time		0.03% CO_2
			0.01% H_2
			0.06% others
			Source of H_2
			Natural air
			air
			air

② Pressure

200 Atm

Adv

1- more yield

of NH_3 - Shift

forward to the

side with fewer

gas mole

2- faster rate

dis
① Risk of explosion

② expensive

③ Fe catalyst

add excess H_2 and N_2

return back to converter

Remove NH_3 immediately

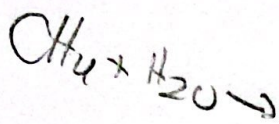
by cooling

* Uses of Ammonia

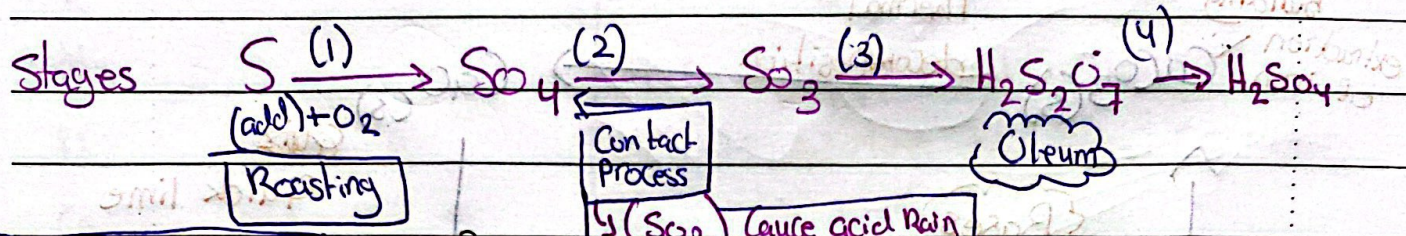
1- Fertilizers

2- Cleaning detergent

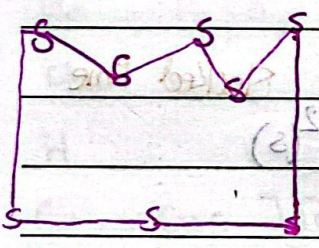
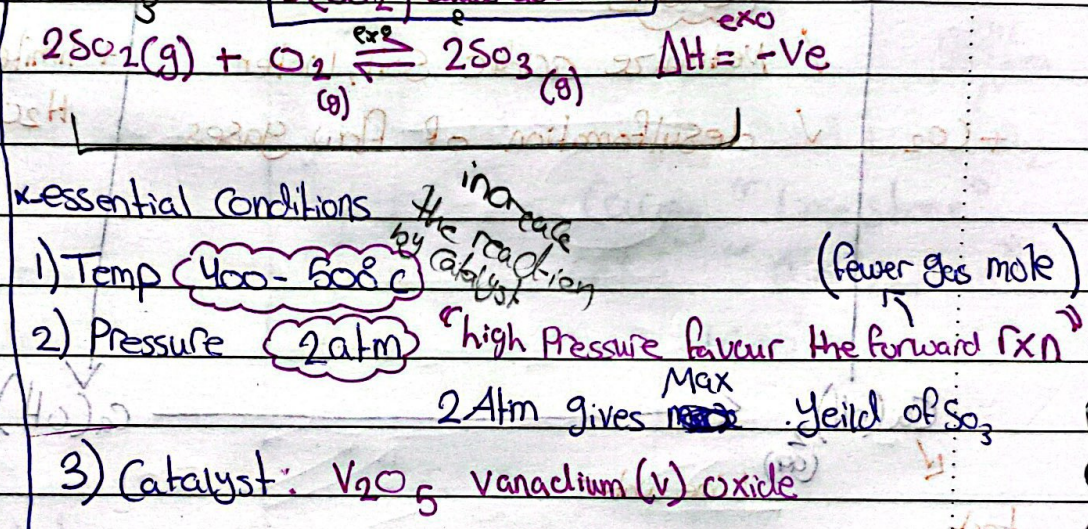
3- Smelling salts



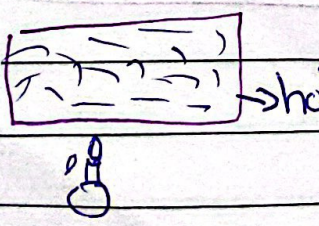
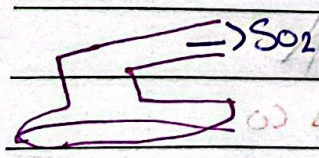
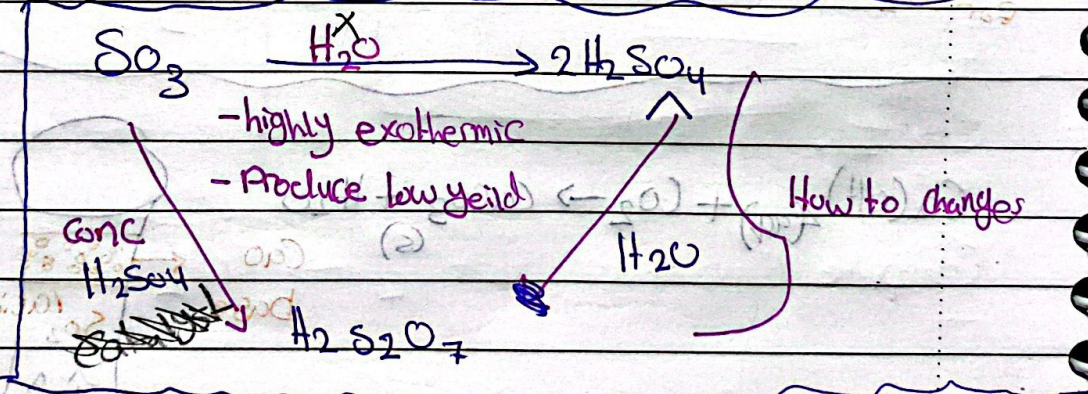
(Industry of H_2SO_4) Contact Process



S (Sulfur)
 - Group (VI)
 - Valency (2)
 - S_8

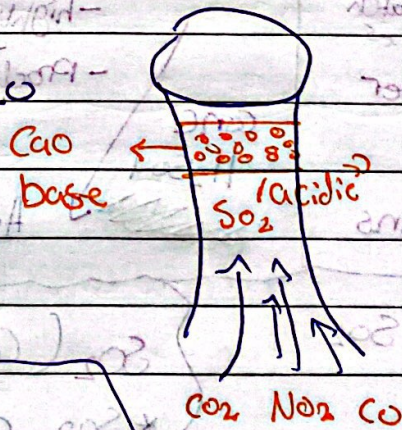
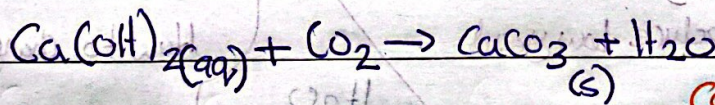
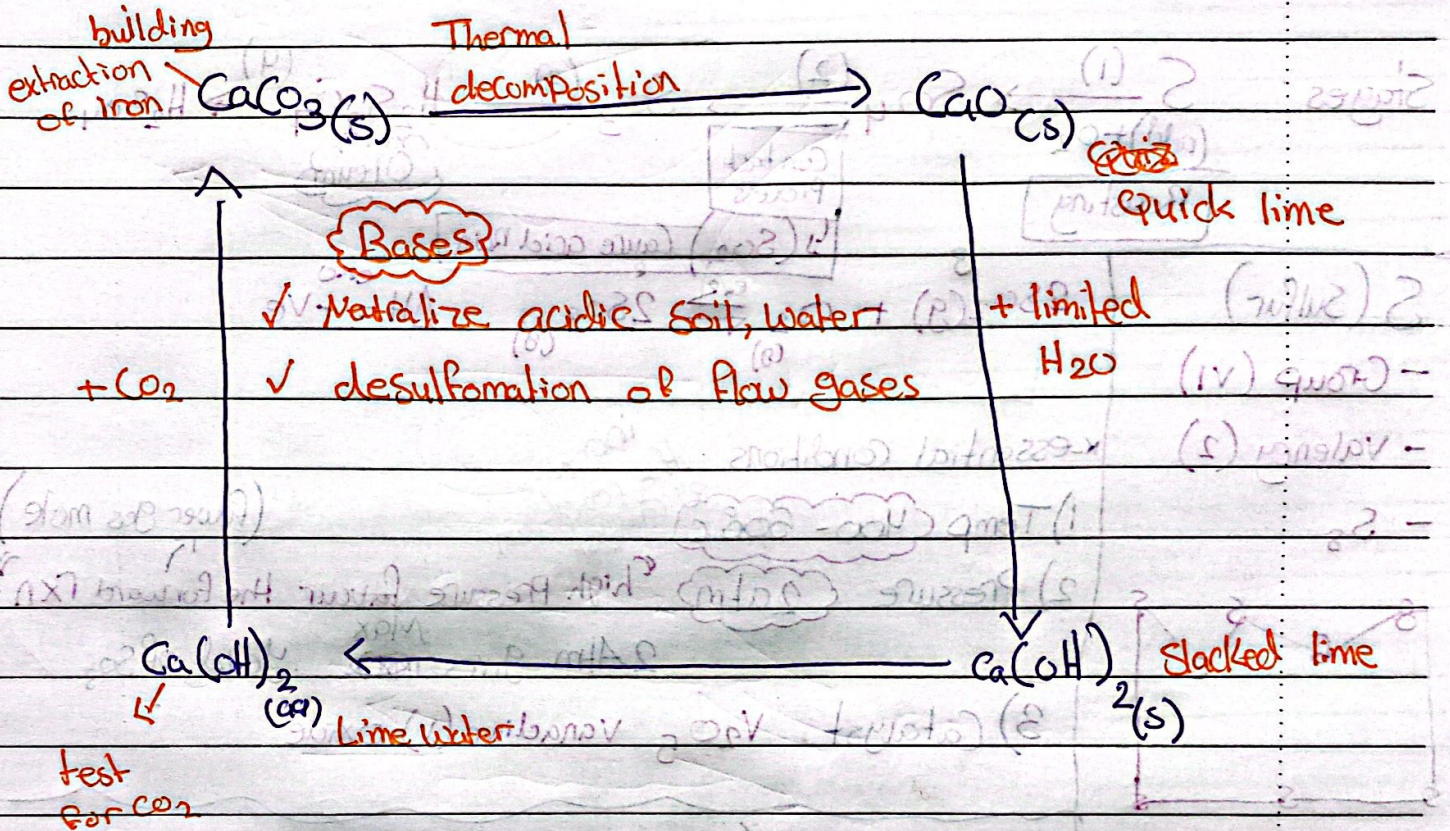


USES:
 * Medicine
 * Match
 * Making rubber
 Ore:
 Zinc blende, ZnS
 from fast fuel



SO_2 (Cause acid rain)
 * SO_2 cause acid rain
 * uses of SO_2
 1) Kill bacteria (sterilization)
 2) Paper industry bleaching agent

Carbonate cycle



uses of limestone

- ① Manufacture of cement
- ② treating alkaline soil

Extraction of metals

Extraction of iron

K

Na

Li

Ca

Mg

Al → bauxite

C, Co

Zn → ZnO zinc blend

Fe → Fe₂O₃ Hematite

Pb

H

Cu → CuS Reduction by H₂

Ag

Au

Pt

Ore: Fe₂O₃ "Hematite"

Method: reduction by C and CO

Place: Blast furnace.

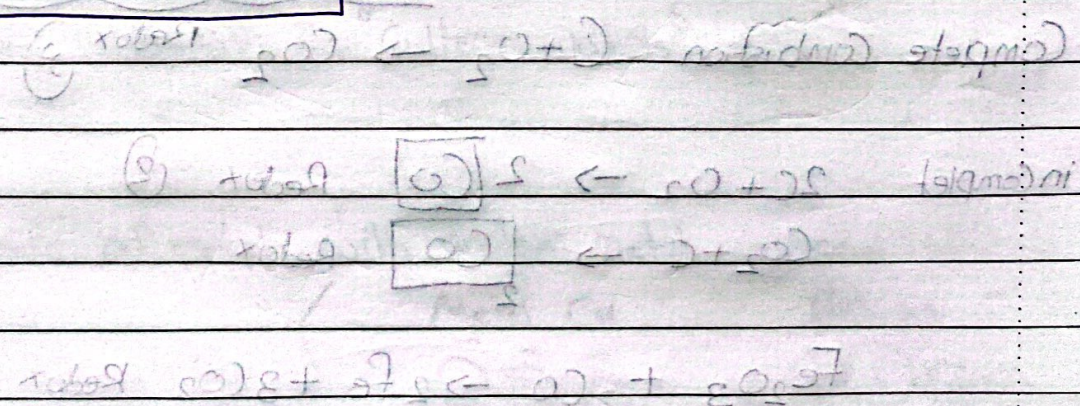
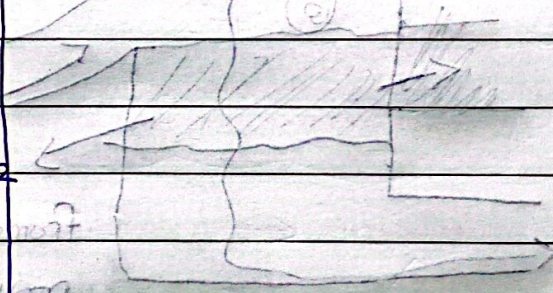
Raw material: Fe₂O₃ mixed with SiO₂

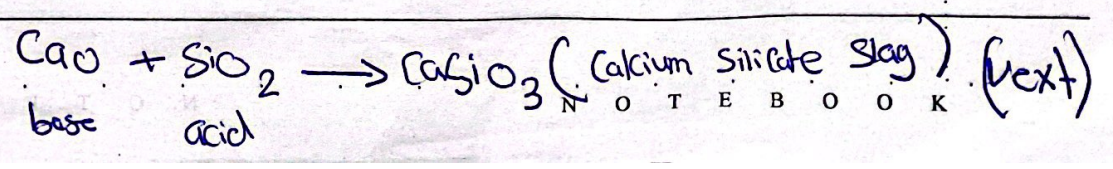
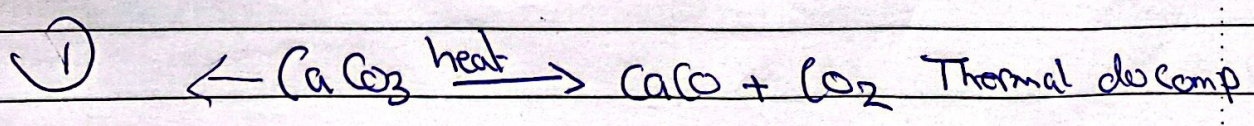
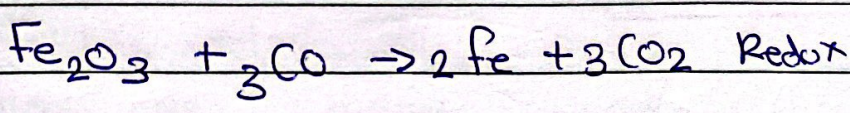
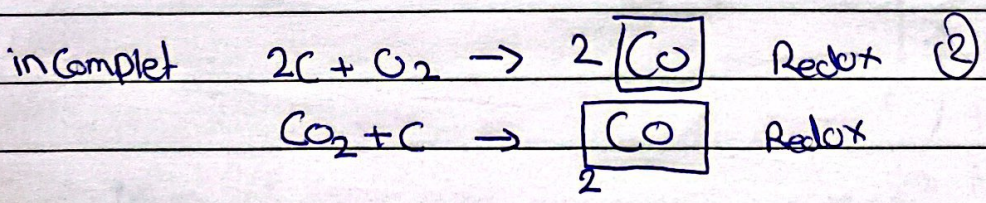
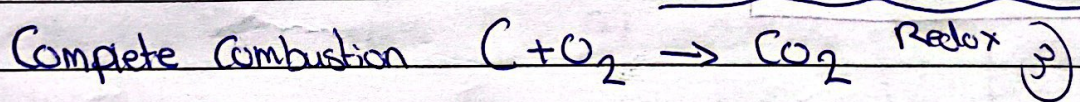
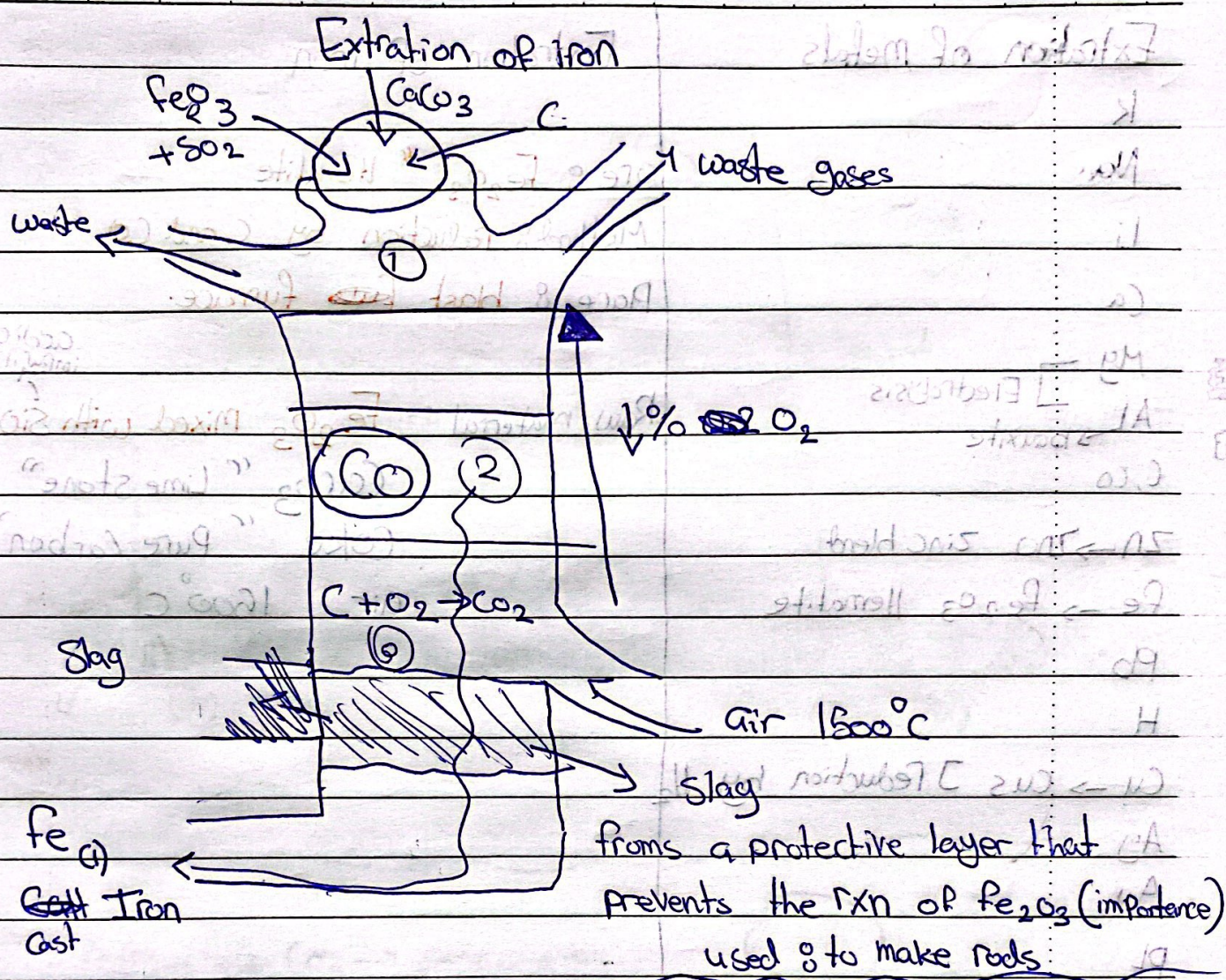
CaCO₃ "Limestone"

Coke "Pure Carbon"

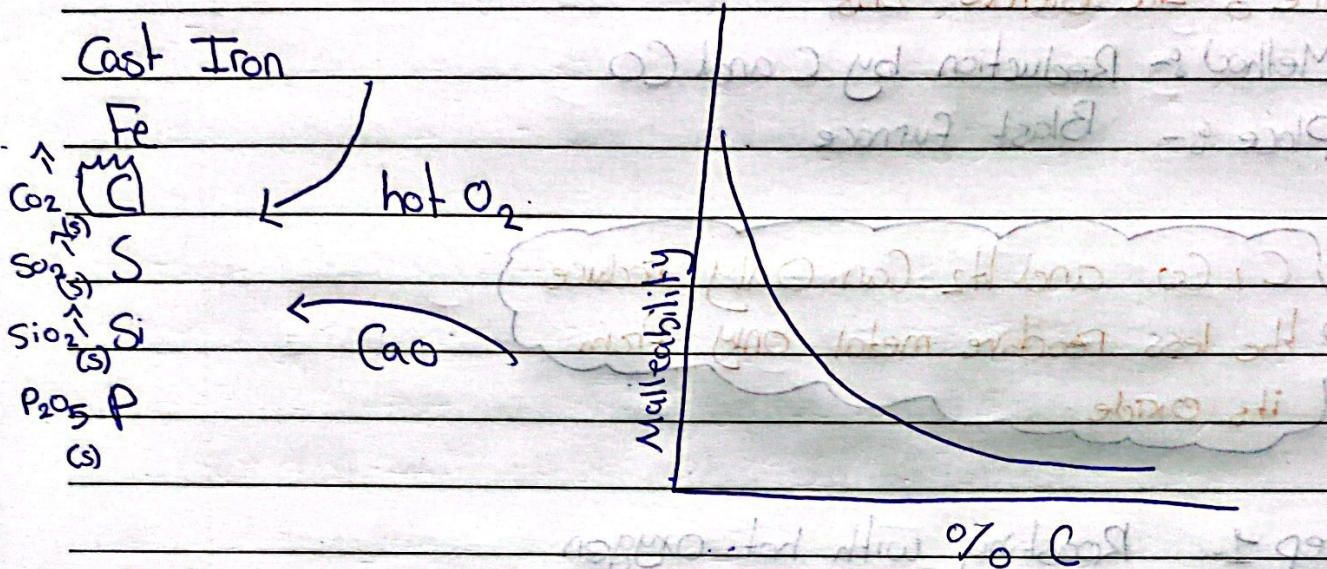
1600°C

acidic impurities





Steel making "Oxygen base process"



Steel %C insteel

3 types

- ① Mild steel 0.03% C "Car bodies"
- ② Medium steel 0.3% C, "Railways"
- ③ Stainless steel 3-5% C, "Cutlery watch"

Alloy

Mixture of metal with another metal or semi metals

Brass	Cu, Zn	} Metal Cu	} Brass
Braze	Cu, Sn		
Steel	Fe, C, Ni, Cr		

harder
different size
of metals

Extraction of zinc

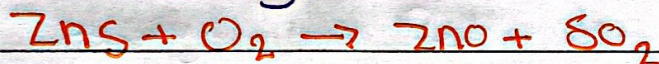
Ore of Zinc Blende ZnS

Method of Reduction by C and CO

Place of - Blast Furnace

C, CO and H_2 can only reduce the less reactive metal only from its oxide

Step 1. Roasting with hot oxygen



Step 2. $C + O_2 \rightarrow CO_2$



The temp inside the furnace $1500^\circ C$

and the b.p of zinc is $907^\circ C$ and

the other impurities since the have of

high b.p in the furn

