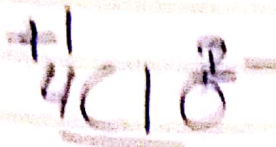
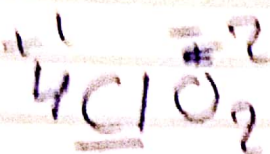


$$\begin{aligned} +1 + x &= 0 \\ x &= -1 \end{aligned}$$



$$\begin{aligned} +1 + x - 2 &= 0 \\ x - 1 &= 0 \end{aligned}$$

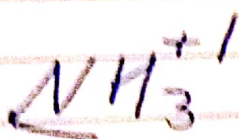
$$x = +1$$



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

$$+1 + x - 4 = 0$$

$$x = +3$$



$$N + 3(+1) = 0$$

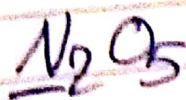
$$N + 3 = 0$$

$$N = -3$$



$$N + (-2) = 0$$

$$N = +2$$

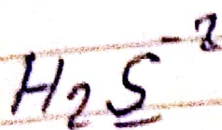


$$2N + 5(-2) = 0$$

$$2N - 10 = 0$$

$$2N = 10$$

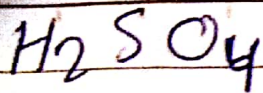
$$N = +5$$



$$2(+1) + S = 0$$

$$2 + S = 0$$

$$S = -2$$

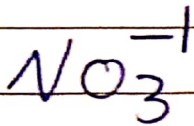


$$2(+1) + S + 4(-2) = 0$$

$$2 + S + 8 = 0$$

$$S - 6 = 0$$

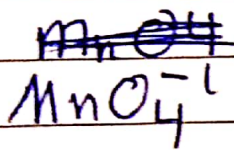
$$S = +6$$



$$N + 3(-2) = -1$$

$$N - 6 = -1$$

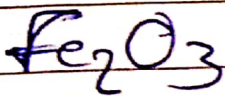
$$N = +5$$



$$\text{Mn} - 8 = -1$$

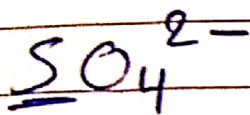
$$+8 \quad +8$$

$$\text{Mn} = +7$$



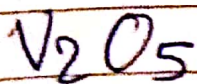
$$2\text{Fe} - 6 = 0$$

$$\text{Fe} = +3$$



$$S - 8 = -2$$

$$S = +6$$



$$2V + 5(-2) = 0$$

$$2V = +10$$

$$V = +5$$



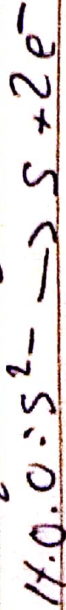
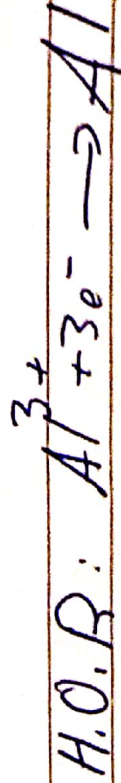
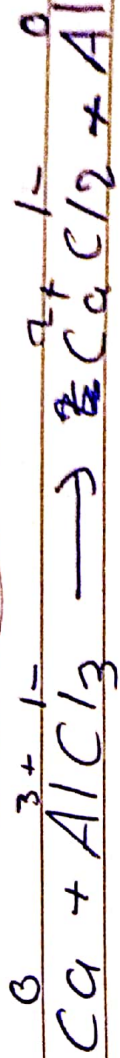
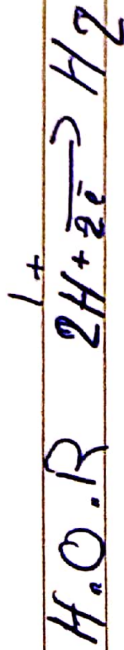
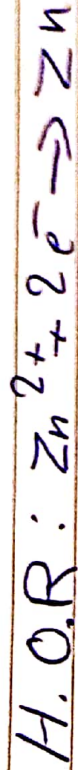
Oxidation = $\text{Al} \rightarrow \text{Al}^{3+}$

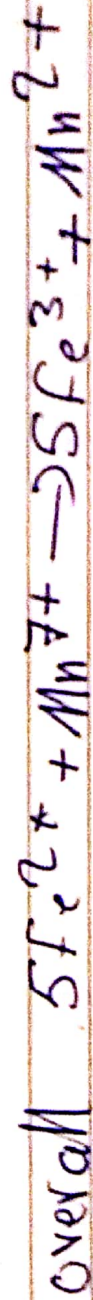
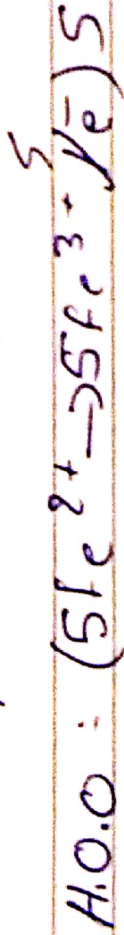
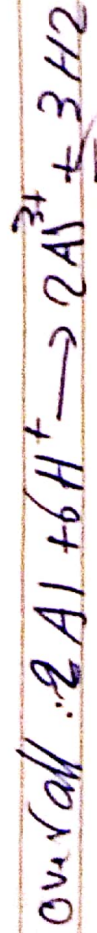
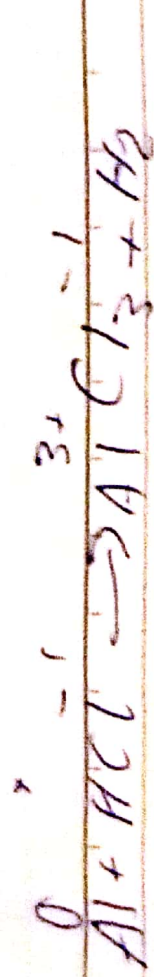
reduction $\text{Fe}^{3+} \rightarrow \text{Fe}$

~~Half~~ writing balanced half ionic equation in

1) ~~atoms~~ Atoms

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





oxidising agent and reducing agents

~~oxidising agent "oxidant"~~

reducing agent oxidising agent
oxidation reduction

O gain O loss O

H lose H gain H

Oxidation state \uparrow \downarrow

e^- transfer lose e^- gain e^-

oxidising agent "oxidant"

the substance that itself reduced and causes the other substance to be oxidised.

~~reducing agent~~

reducing agent "reductant"

the substance that it self oxidised and causes the other substance to be reduced

if the substance is an ion or compound, the agent is the compound itself



oxidation: Al reducing agent: Al

reduction: Fe^{3+} oxidising agent: Fe_2O_3



oxidation: C^{2+}

oxidising agent: ZnO

reduction: Zn^{2+}

reducing agent: CO



oxidation: Cl_2 reduction: H_2S



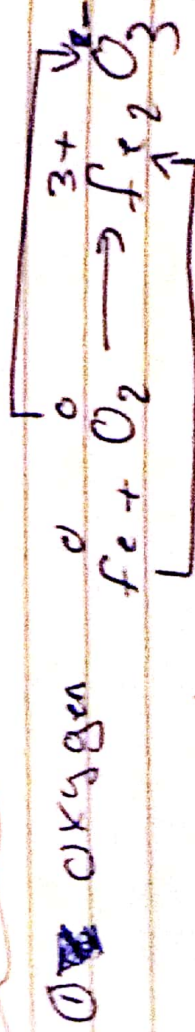
oxidising agent: MnO_4^-

reduction: Fe^{2+}

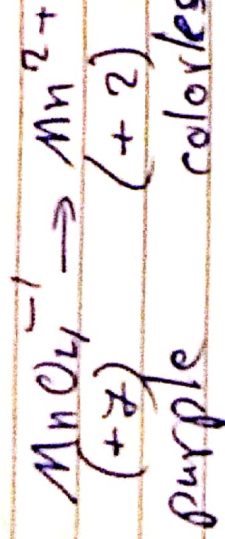
oxidation: Fe^{2+}

reduction: Mn^{7+}

most common oxidising agent



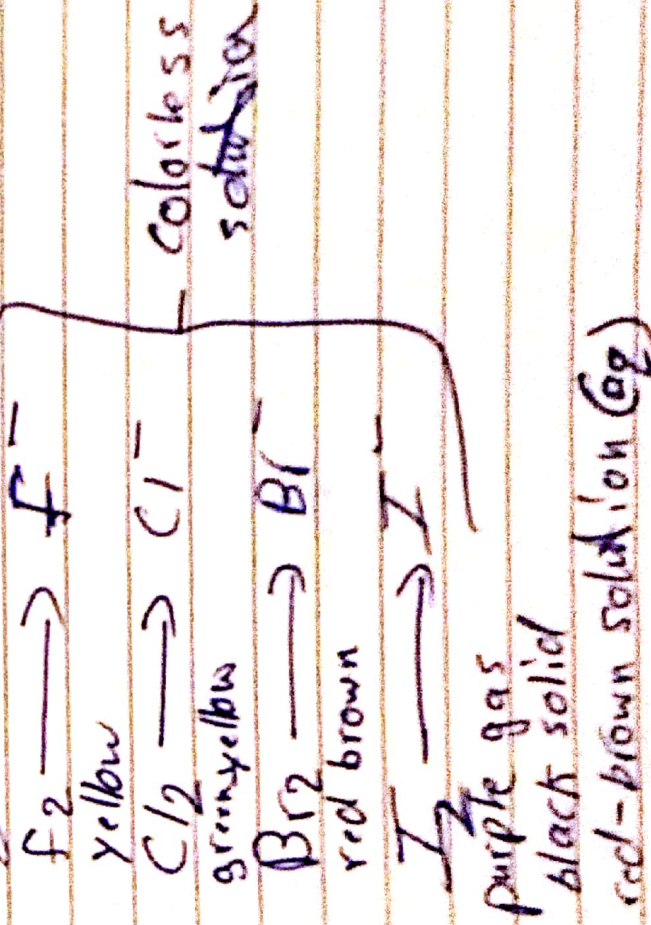
① Acidity potassium manganate $KMnO_4/H^+$



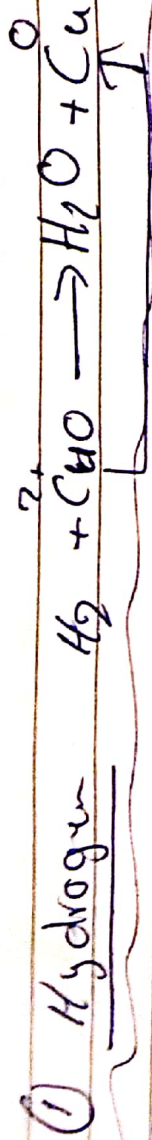
③ Acidity potassium dichromate $K_2Cr_2O_7/H^+$



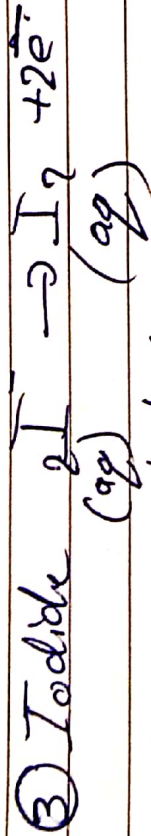
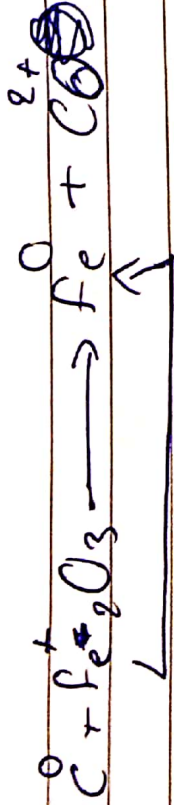
④ Halogens Example:



most common reducing agents

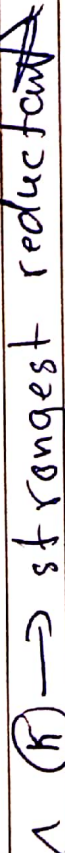


② carbon and carbon monoxide



~~red~~ red brown

④ metals



metal more Na

reaction Li

more likely Ca

to lose Mg

e^- Al

more likely CuCO

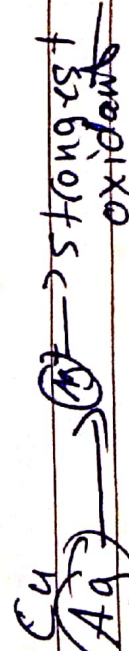
to oxidise Zn

more likely Fe

to be Pb

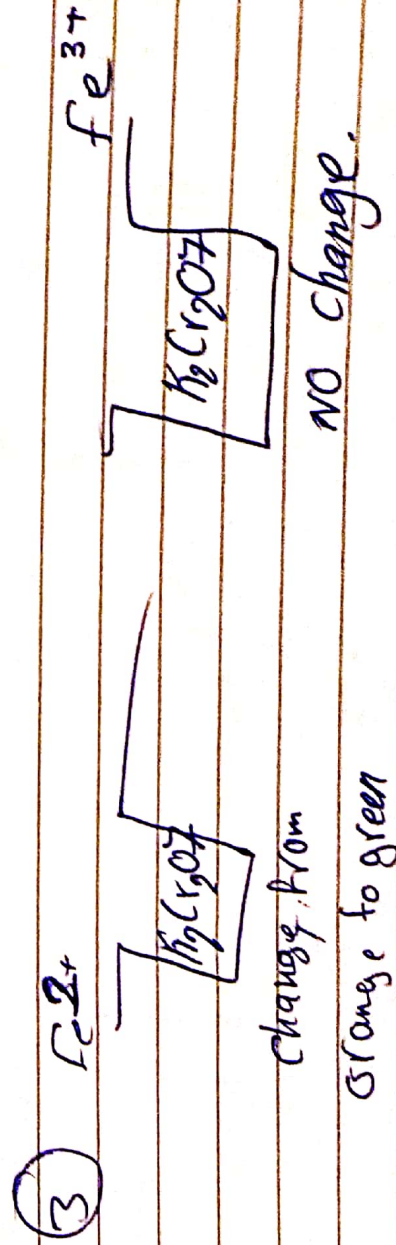
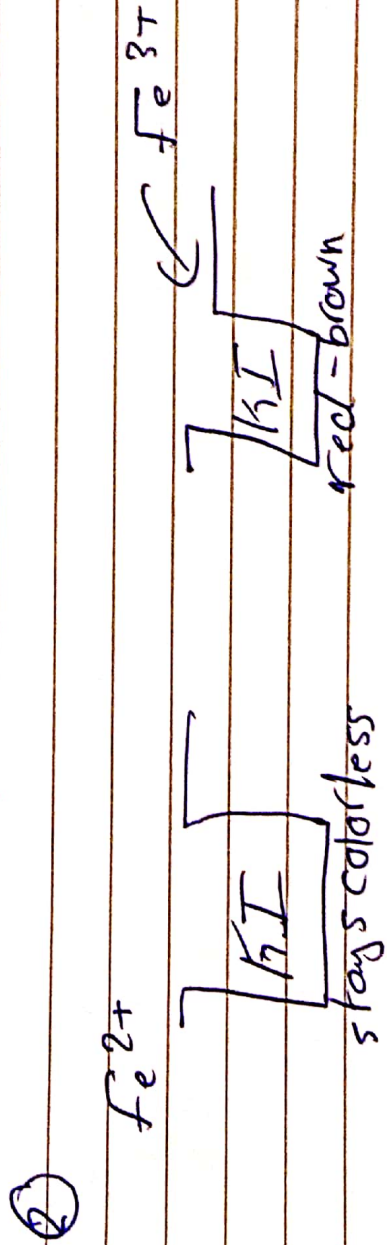
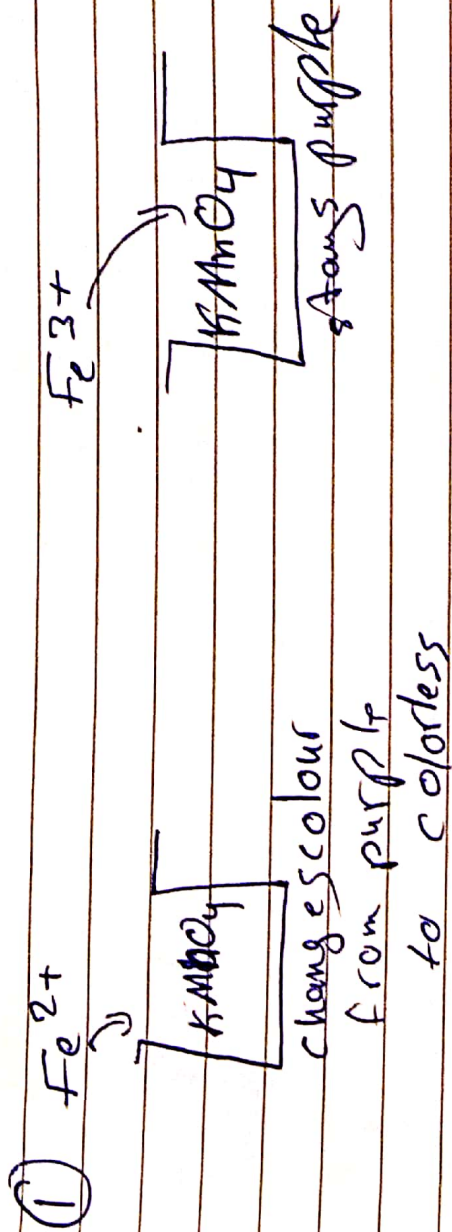
reducing H

agent



weakest reductant

Q: Fe^{2+} is a reducing agent
 Fe^{3+} is an oxidising agent
record the observation in each of the following reaction



Electrolysis

Electricity Analysis

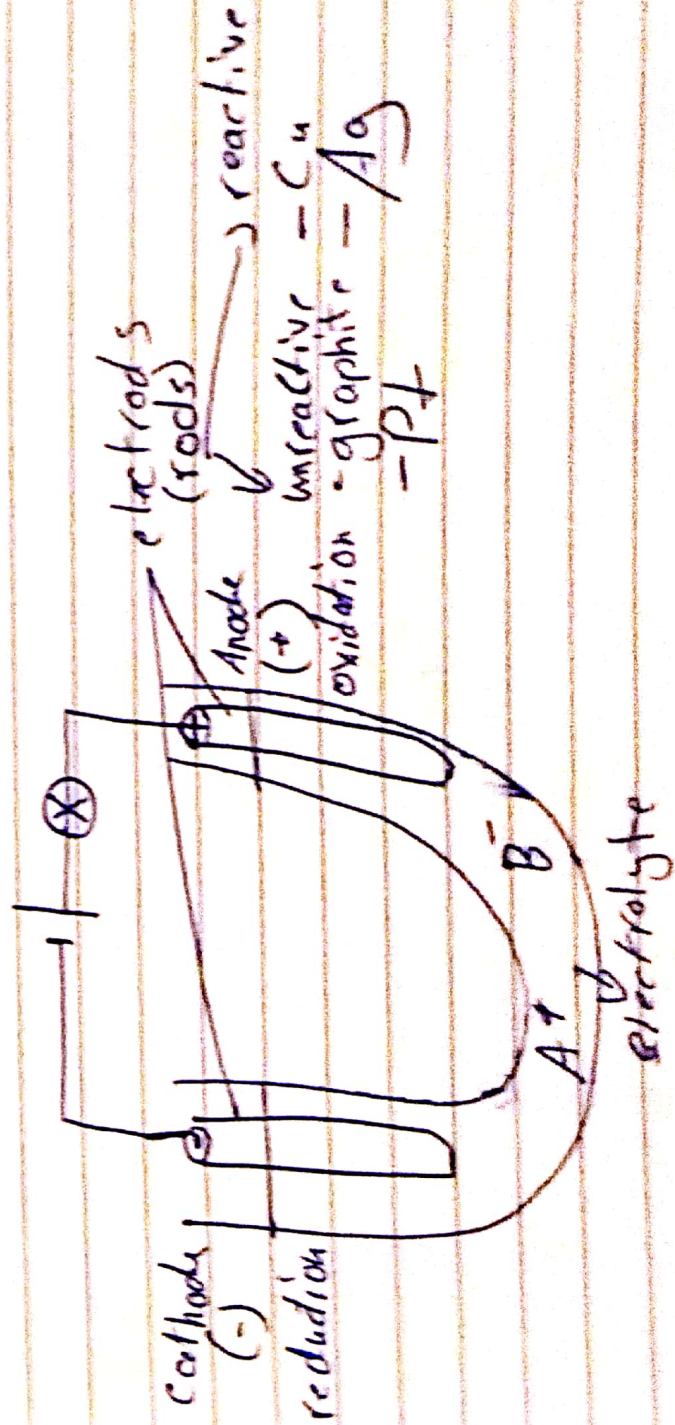
"Breaking down"

Electrolysis: Breaking down chemical compounds (Ionic) when molten or aqueous by passing electricity

Electrolyte: Chemical compound that conduct electricity when molten or aqueous.

Why M ionic compounds don't conduct electricity when solid? - the ions are not free to move.

Why M ionic compound conduct electricity when dissolved in water or being molten? - the ions are free to move.



~~Electrolysis~~

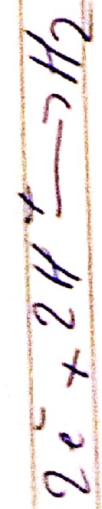
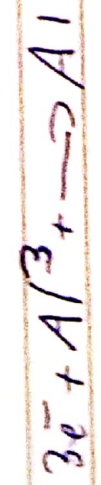
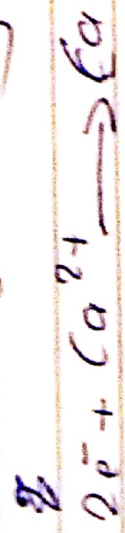
~~Cathode:~~ The -ve rod that attracts the +ve ions (cations) where the reduction occurs.

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

Electrolysis = Discharging

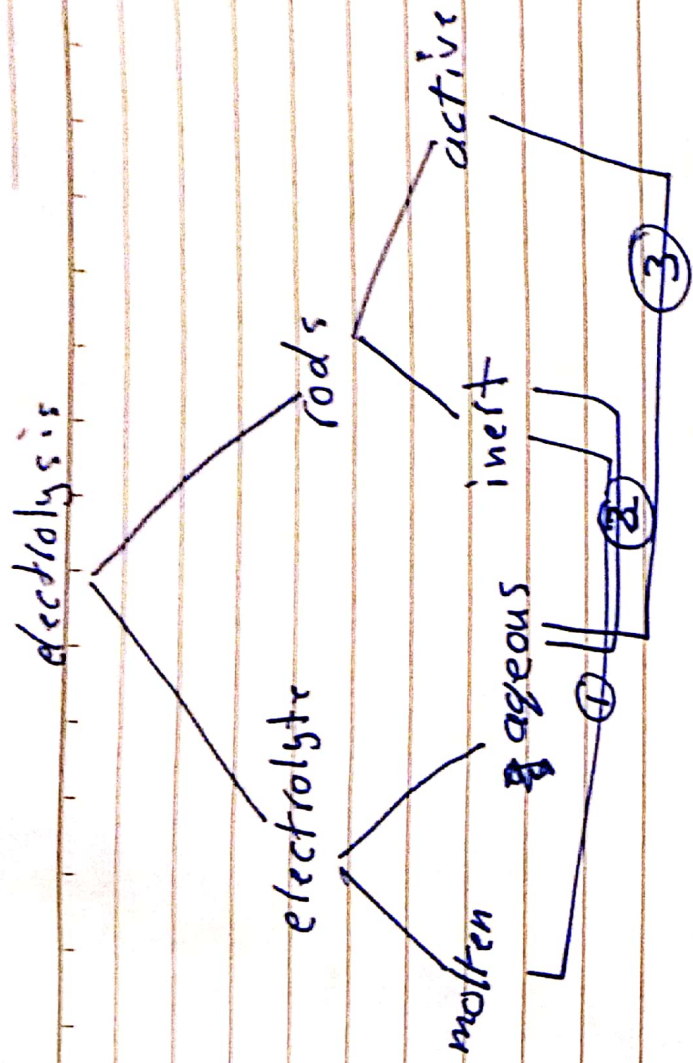
Ion \rightarrow element

Cations

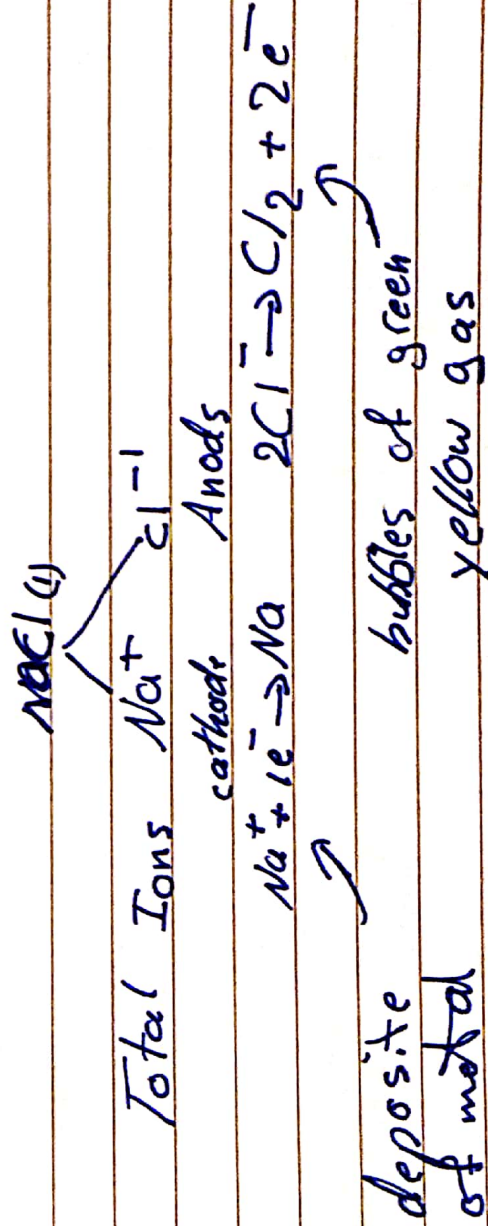


Anions

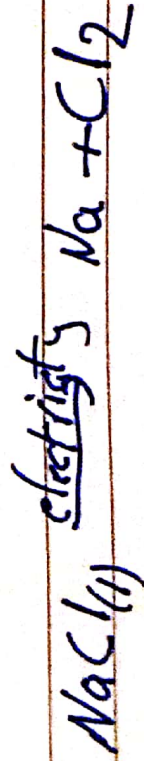




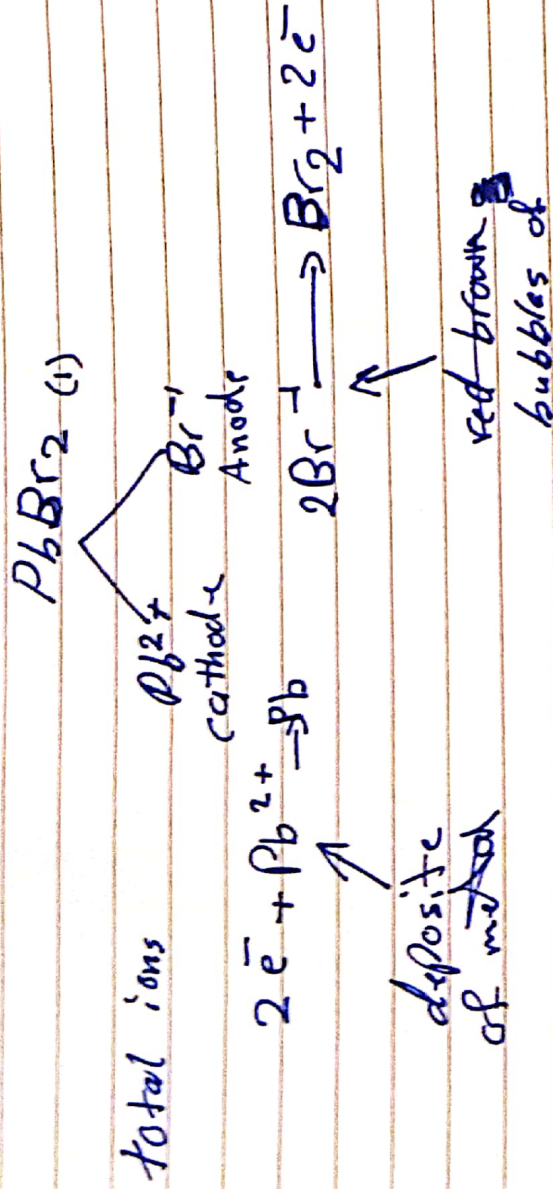
Electrolysis for molten electrolyte using Inert rods (graphite)



Electrolyte: used cup



molten lead (I) bromide

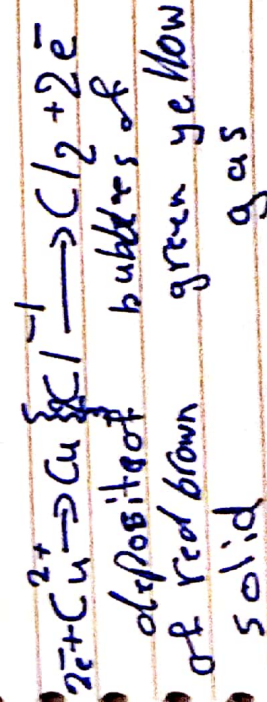
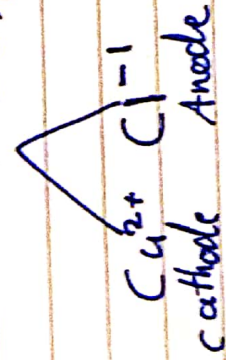


Electrolyte: used up

~~bulb~~ bulb lights

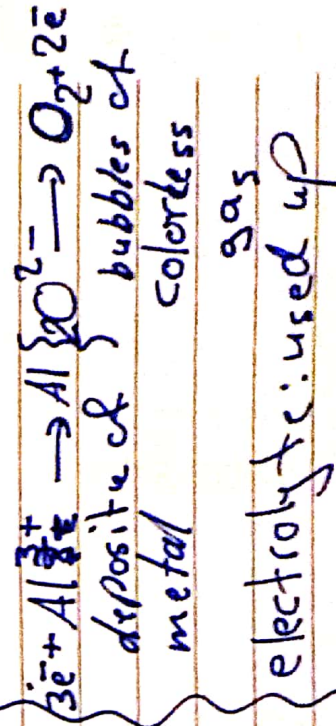
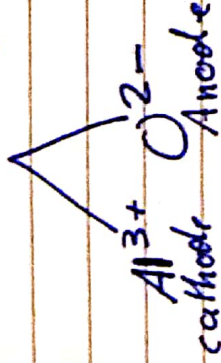
ON

$CuCl_2 (l)$ / graphite



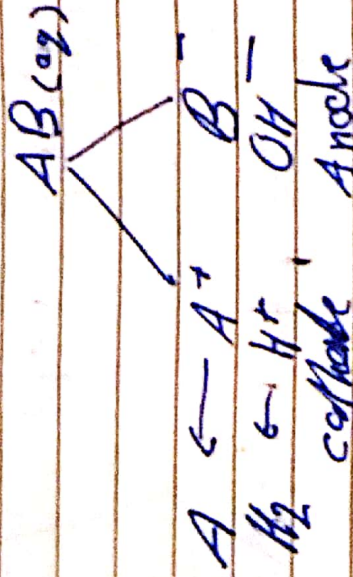
Electrolyte: used up

Al_2O_3 / graphite



Electrolyte: used up

Electrolysis of aqueous



At the cathode

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

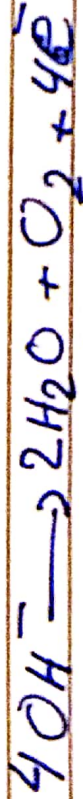
At the Anode

always OH^- except concentrated halides: Cl^-, Br^-, I^-

When the halide oxidise



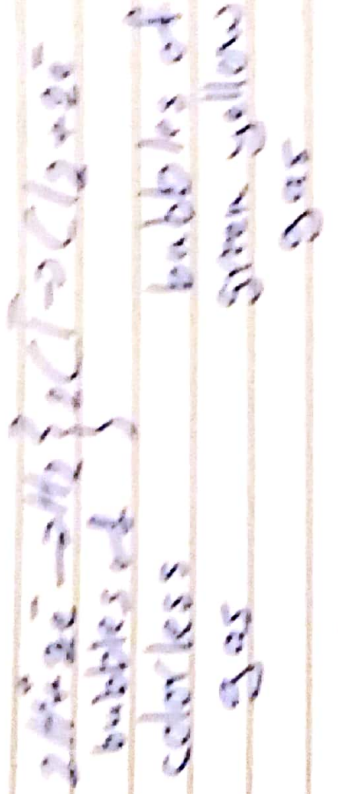
When OH^- oxidise



bubbles of
colorless gas

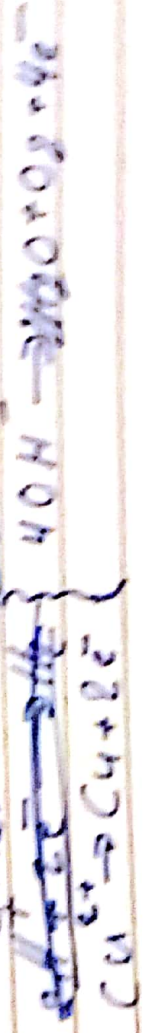
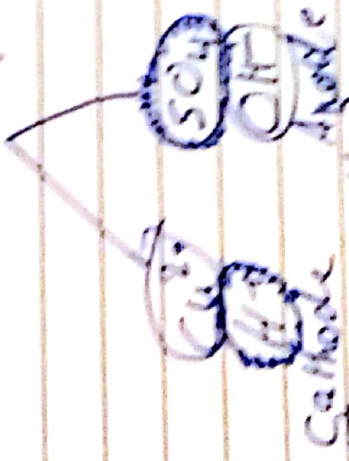
concentrated NaCl(aq)

NaCl



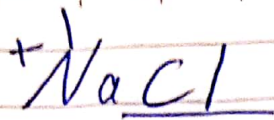
Electrolytes NaOH

CuSO₄ (aq)

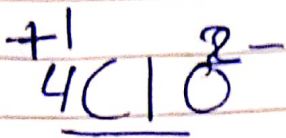


electrolyte: H₂SO₄

chem

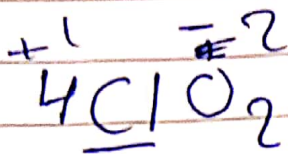


$$\begin{aligned} +1 + x &= 0 \\ \boxed{x = -1} \end{aligned}$$



$$\begin{aligned} +1 + x - 2 &= 0 \\ x - 1 &= 0 \end{aligned}$$

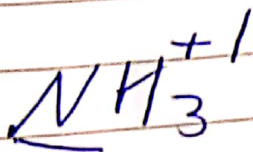
$$\boxed{x = +1}$$



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

$$+1 + x - 4 = 0$$

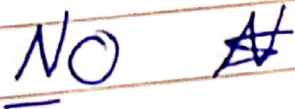
$$\boxed{x = +3}$$



$$N + 3(+1) = 0$$

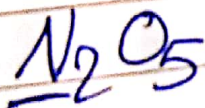
$$N + 3 = 0$$

$$N = -3$$



$$N + (-2) = 0$$

$$N = +2$$

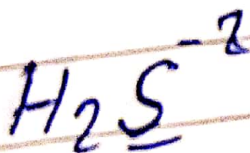


$$2N + 5(-2) = 0$$

$$2N - 10 = 0$$

$$2N = 10$$

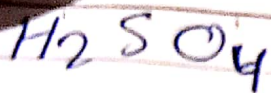
$$N = +5$$



$$2(+1) + S = 0$$

$$2 + S = 0$$

$$S = -2$$



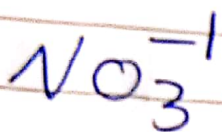
~~ClF₂~~

$$2(+1) + S + 4(-2) = 0$$

$$2 + S + 8 = 0$$

$$S - 6 = 0$$

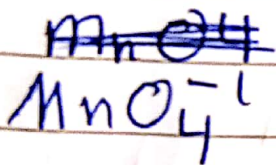
$$S = +6$$



$$N + 3(-2) = -1$$

$$N - 6 = -1$$

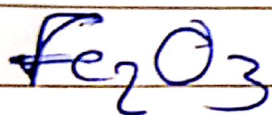
$$N = +5$$



$$\text{Mn} - 8 = -1$$

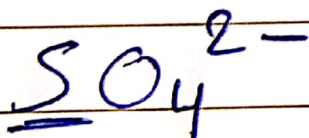
$$+8 \quad +8$$

$$\text{Mn} = +7$$



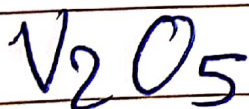
$$2\text{Fe} - 6 = 0$$

$$\text{Fe} = +3$$



$$S - 8 = -2$$

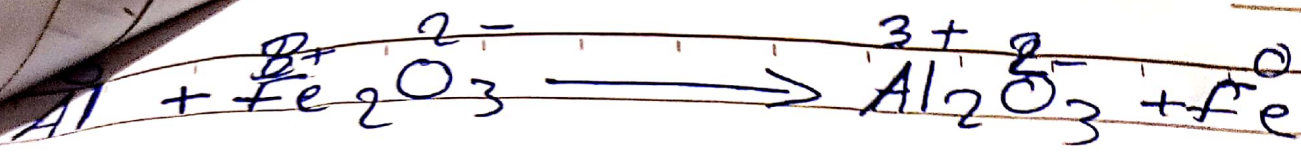
$$S = +6$$



$$2V + 5(+2) = 0$$

$$2V = +10$$

$$V = +5$$



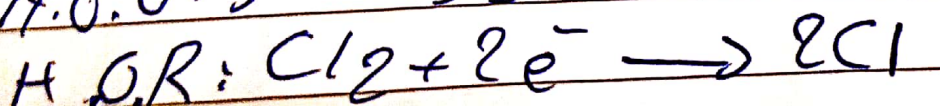
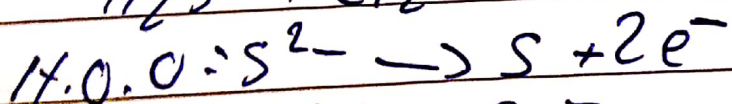
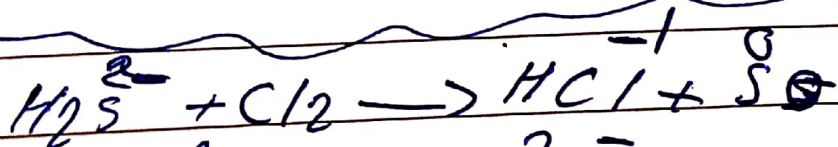
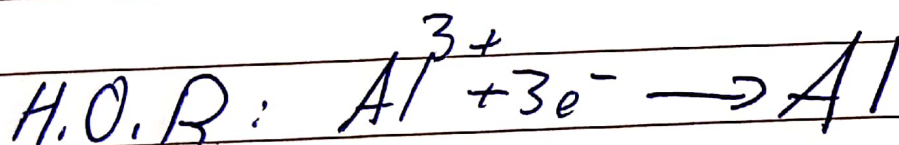
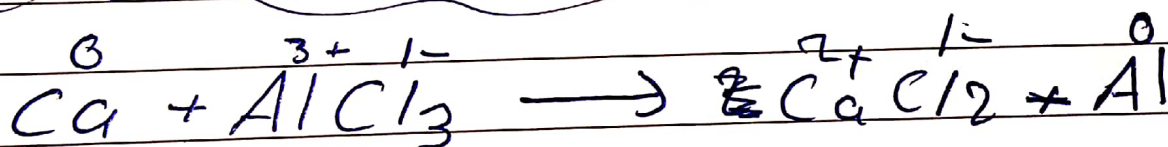
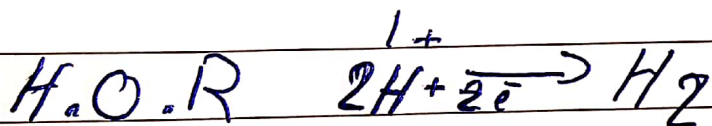
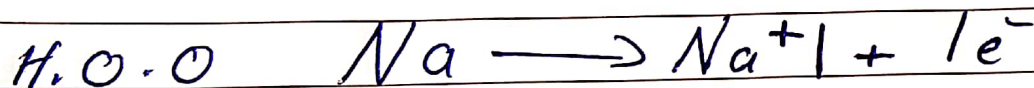
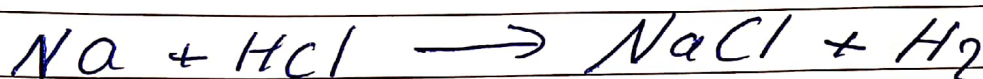
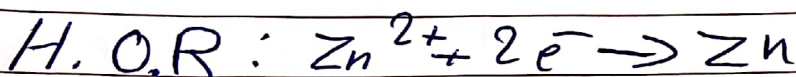
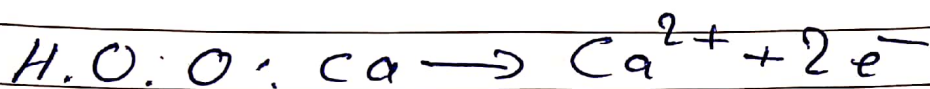
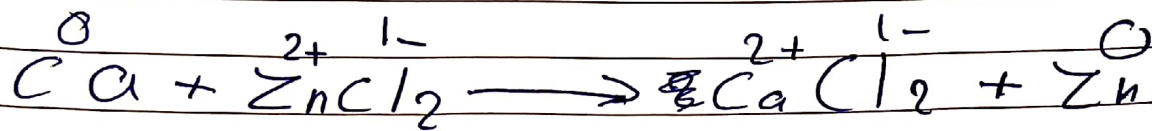
oxidation = $\text{Al} \rightarrow \text{Al}^{3+}$

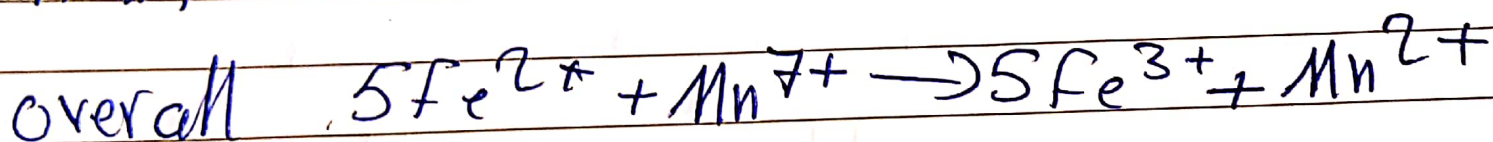
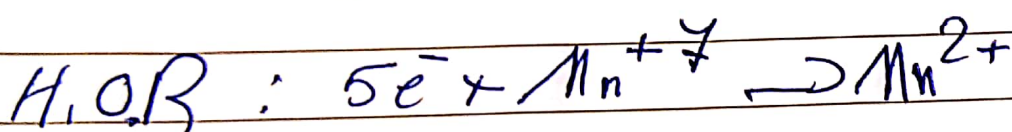
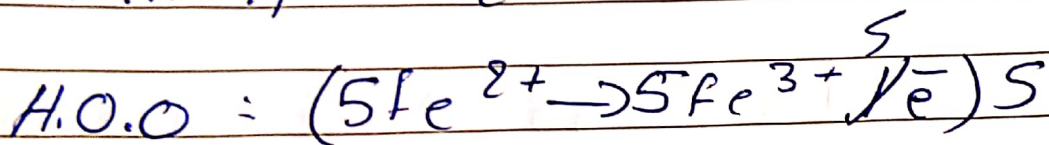
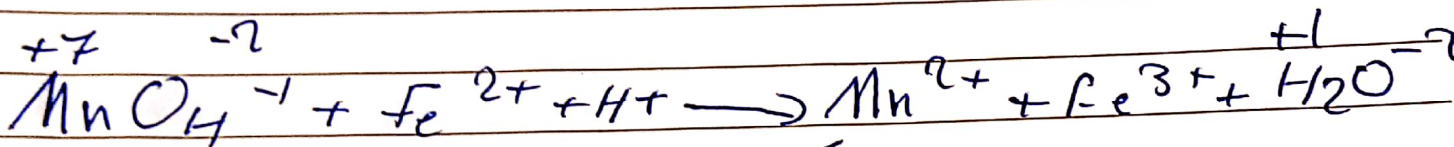
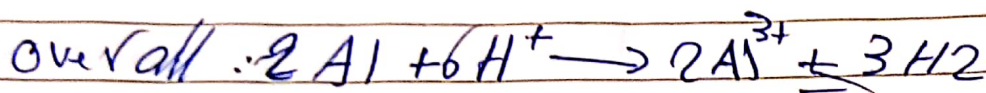
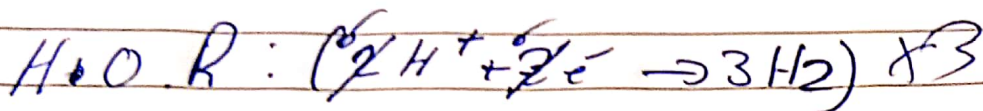
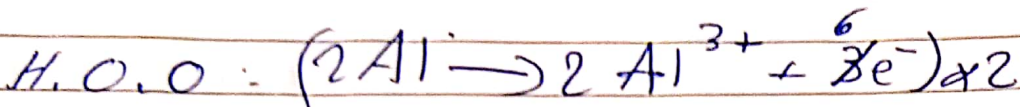
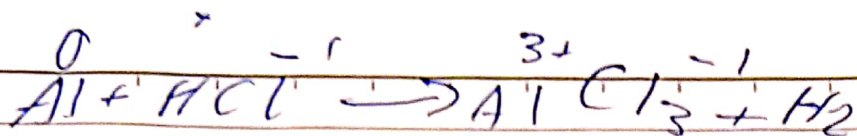
reduction $\text{Fe}^{3+} \rightarrow \text{Fe}$

writing balanced half Ionic equation

1) ~~atoms~~ Atoms

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





Oxidising agent and reducing agent

~~Oxidising agent "oxidant"~~

reducing agent
oxidation

oxidising agent
reduction

O

gain O

loss O

H

lose H

gain H

oxidation state \uparrow

\downarrow

e^- transfer

lose e^-

gain e^-

~~oxidising agent "oxidant"~~

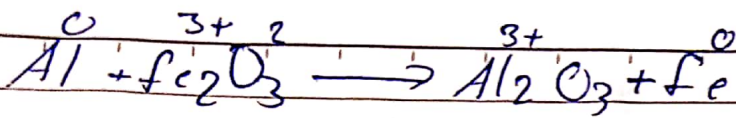
the substance that itself reduced and causes the other substance to be oxidised.

~~reduction~~

~~reducing agent "reductant"~~

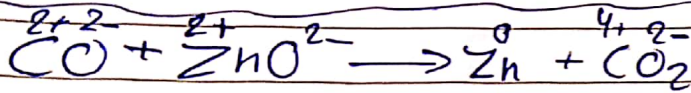
the substance that it self oxidised and causes the other substance to be reduced

if the substance is an ion or compound, the agent is the compound itself



oxidation: Al reducing agent: Al

reduction: Fe³⁺ oxidising agent: Fe₂O₃

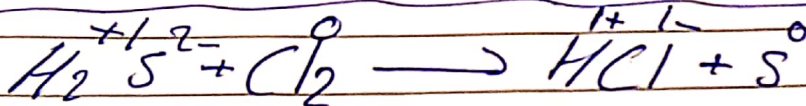


Oxidation: C²⁺

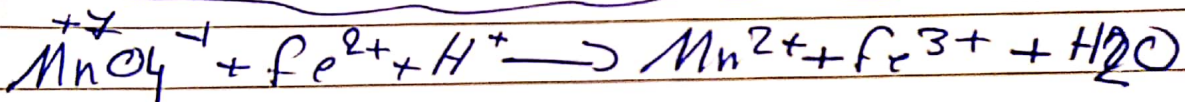
oxidising agent = ZnO

reduction: Zn²⁺

reducing agent: CO



oxidant: Cl₂ reductant: H₂S



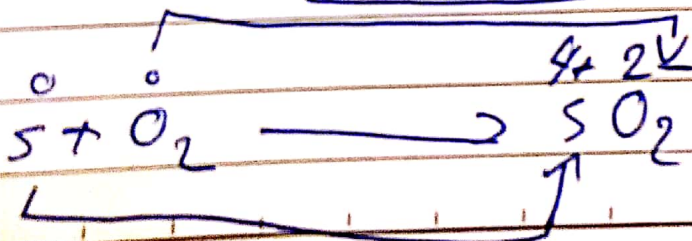
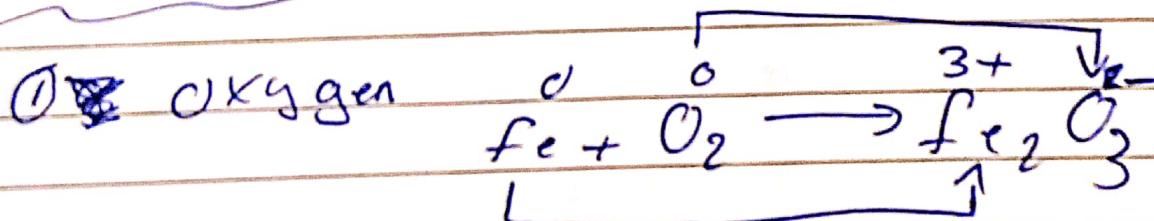
oxidising agent: MnO₄⁻

reductant: Fe²⁺

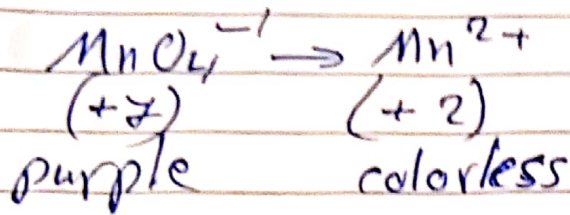
oxidation = Fe²⁺

reduction: Mn⁷⁺

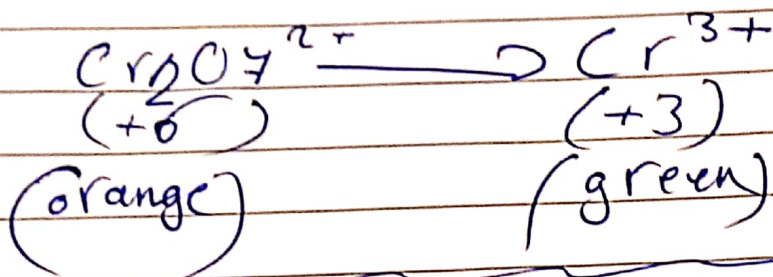
most common oxidising agent



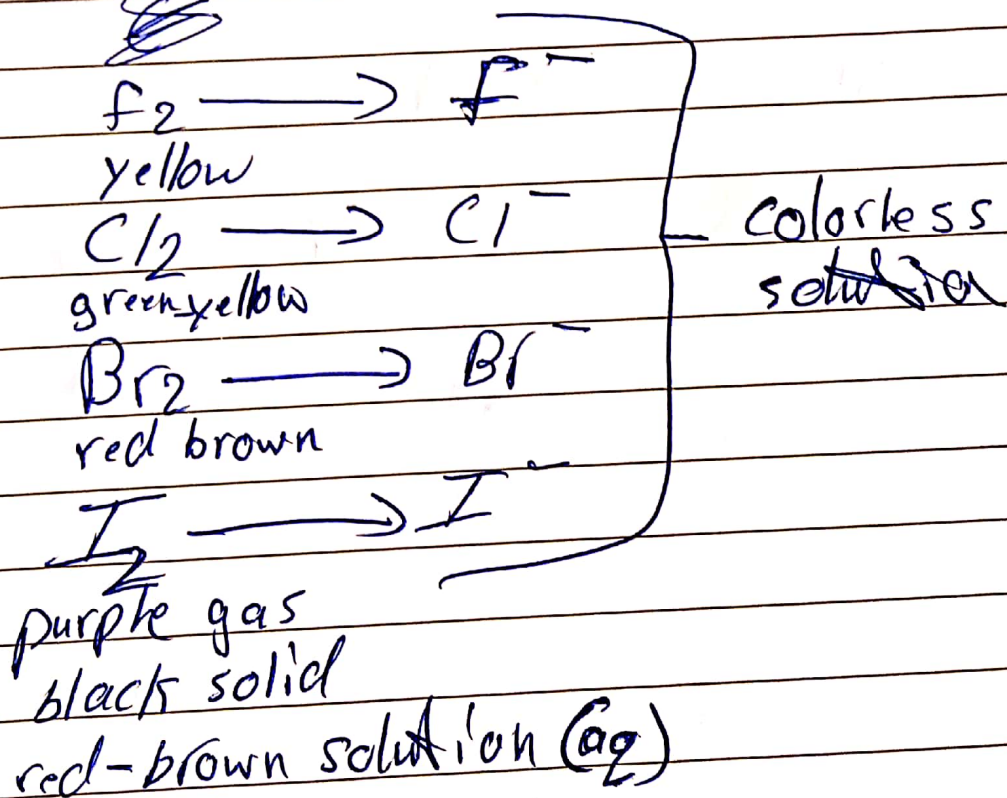
① Acidity potassium manganate $KMnO_4/H^+$



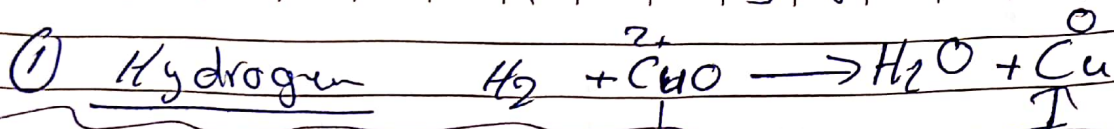
② Acidity potassium dichromate $K_2Cr_2O_7/H^+$



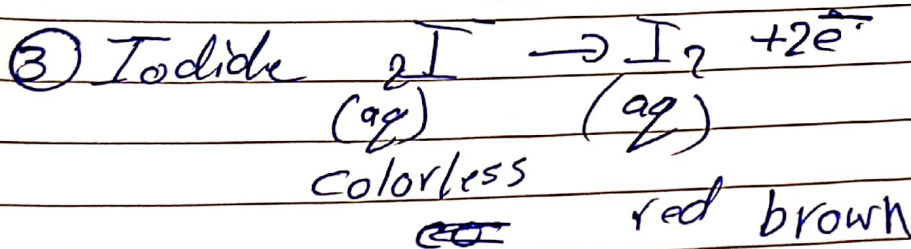
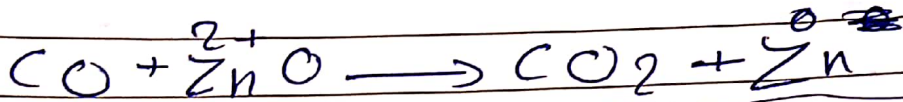
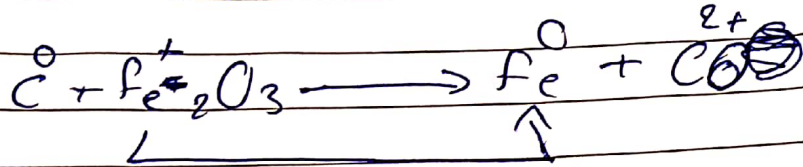
④ Halogens ~~example~~:



most common reducing agent



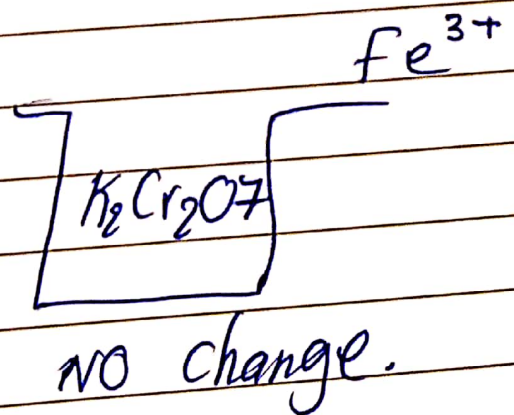
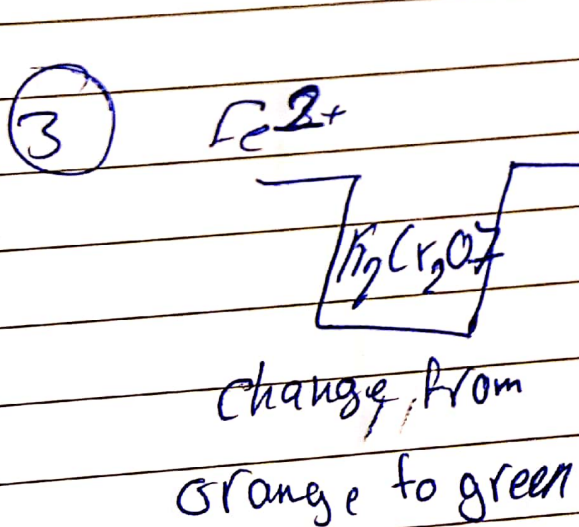
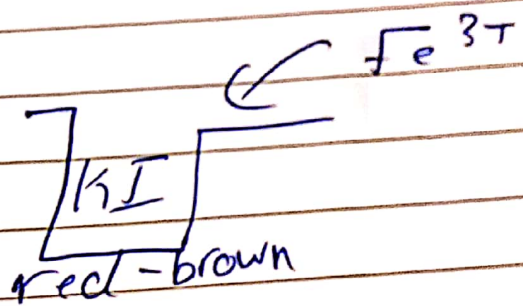
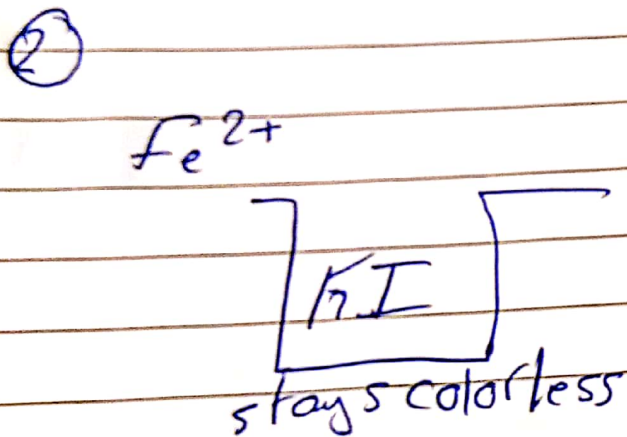
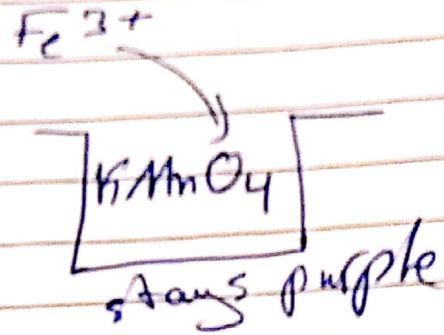
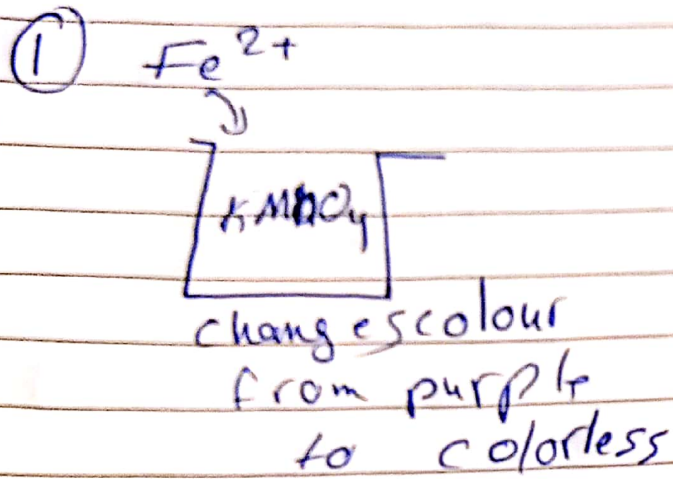
② carbon and carbon monoxide



④ metals

	(K) → strongest reductant
metal more reaction	Na
more likely to lose e^-	Li
	Ca
	Mg
	Al
more likely to oxidise	CuCO
	Zn
more likely to be reducing agent	Fe
	Pb
	H
	Cu
	(Ag) → strongest oxidant
weakest reductant	

Q: Fe^{2+} is a reducing agent
 Fe^{3+} is an oxidising agent
record the observation in each of the following
reaction



Electrolysis

electricity Analysis

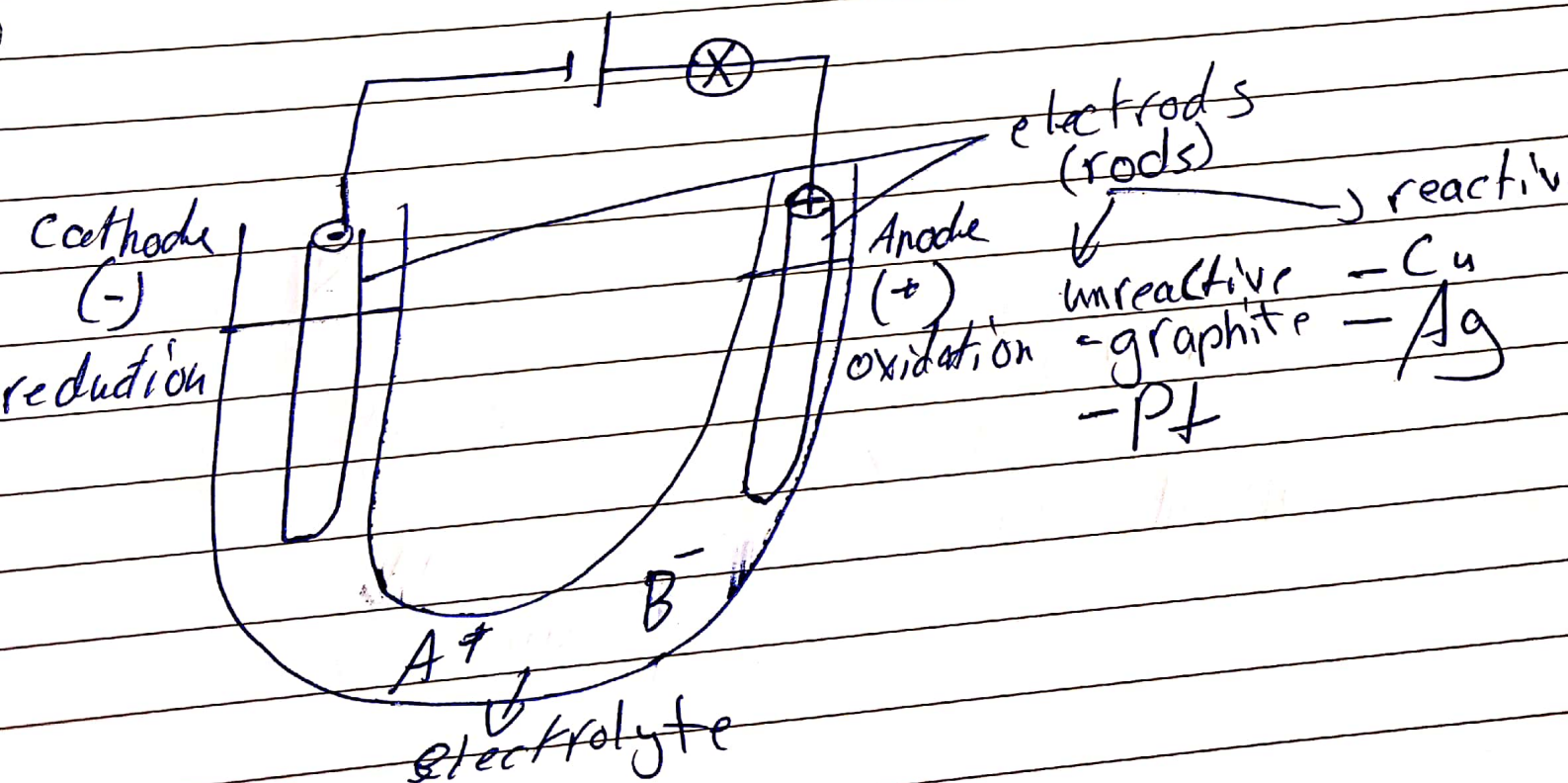
"Breaking down"

Electrolysis: Breaking down chemical compounds (Ionic) when molten or aqueous by passing electricity

* Electrolyte: Chemical compound that conduct electricity when molten or aqueous.

Why do ionic compounds don't conduct electricity when solid? - the ions are ^{not} free to move.

Why do ionic compound conduct electricity when dissolved in water or being molten? - the ions are free to move.



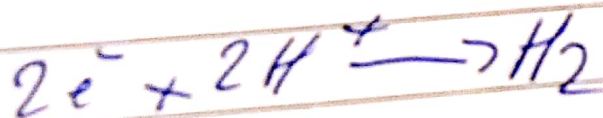
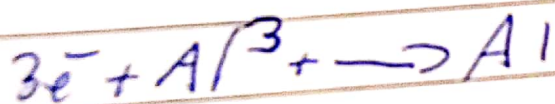
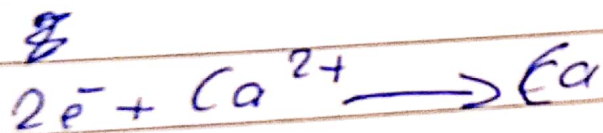
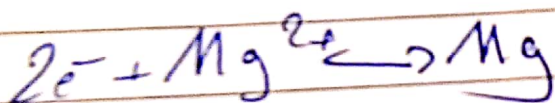
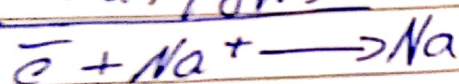


~~At Cathode:~~ the -ve rod that attracts the +ve ions (cations) where the reduction occurs

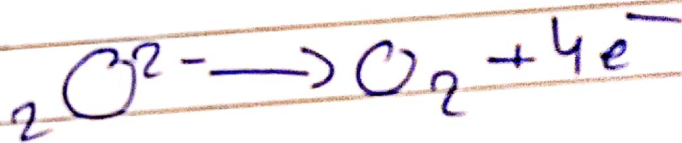
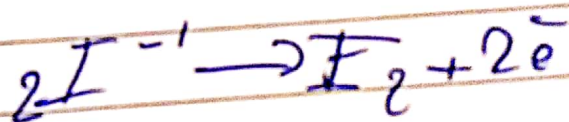
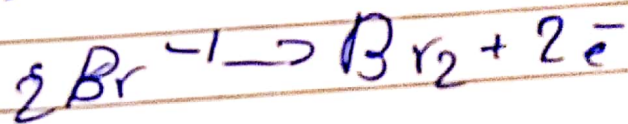
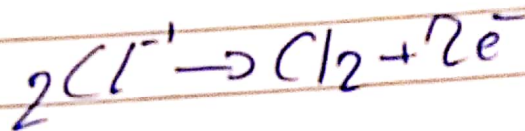
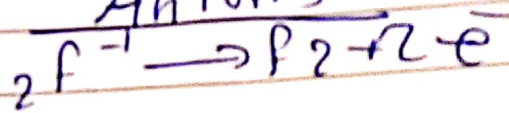
* Anode: the +ve rod that attracts the -ve ions (anions) where the oxidation occurs.

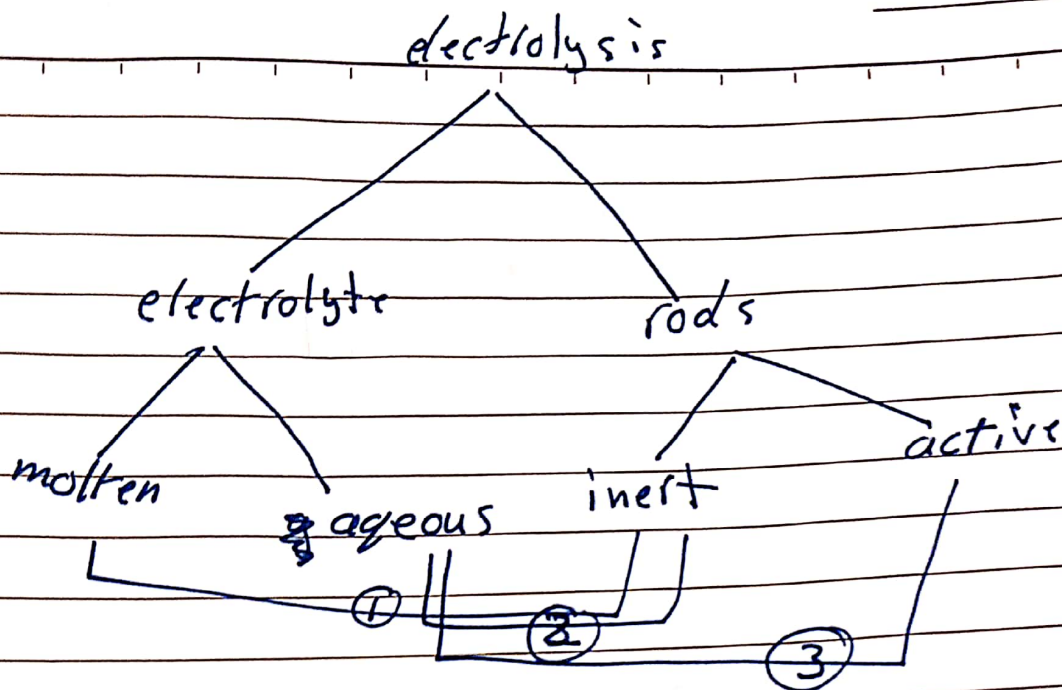
electrolysis = Discharging
 Ion \longrightarrow element

Cations

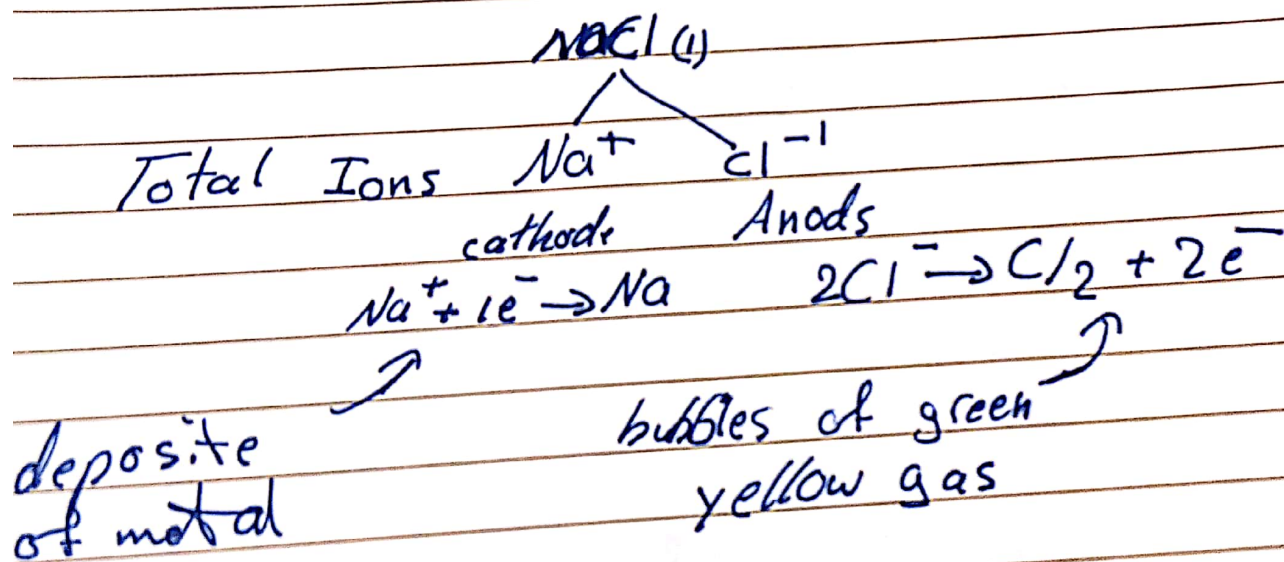


Anions





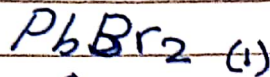
Electrolysis for molten electrolyte using Inert rods (graphite)



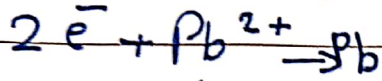
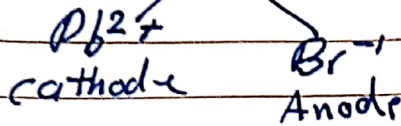
Electrolyte: used up



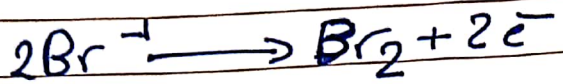
molten lead (I) bromide



total ions



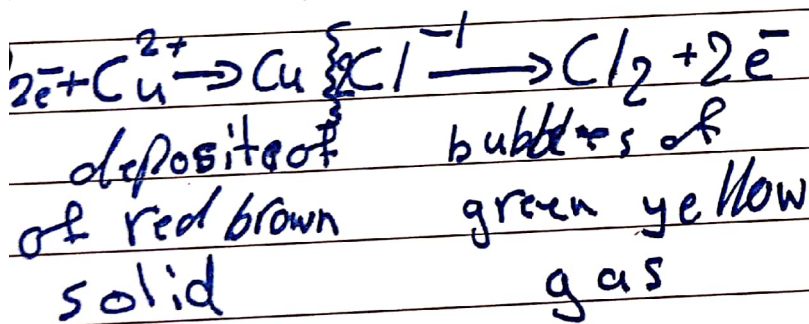
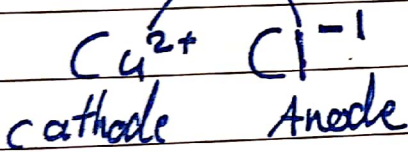
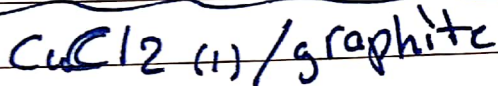
deposit of metal



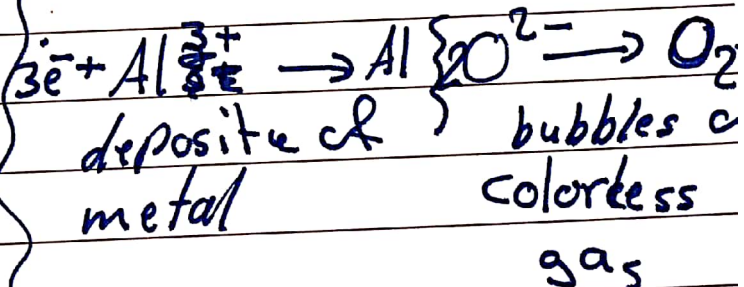
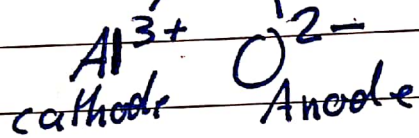
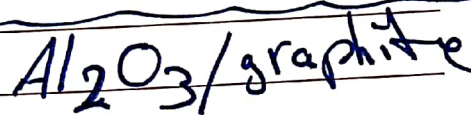
red brown bubbles of red brown gas

Electrolyte: used up

bulb lights on

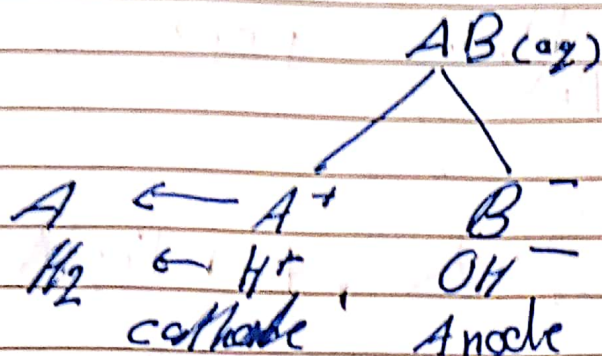


Electrolyte: used up



electrolyte: used up

Electrolysis of aqueous



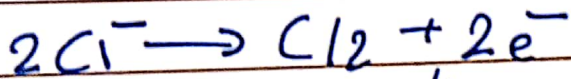
At the cathode

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

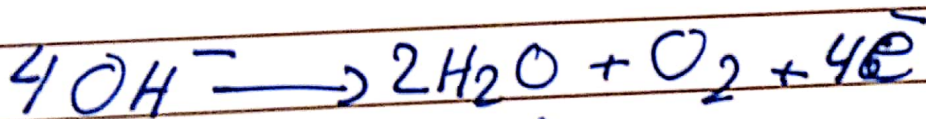
At the Anode

always OH^- except concentrated halide: Cl^- , Br^- , I^-

when the halide oxidise

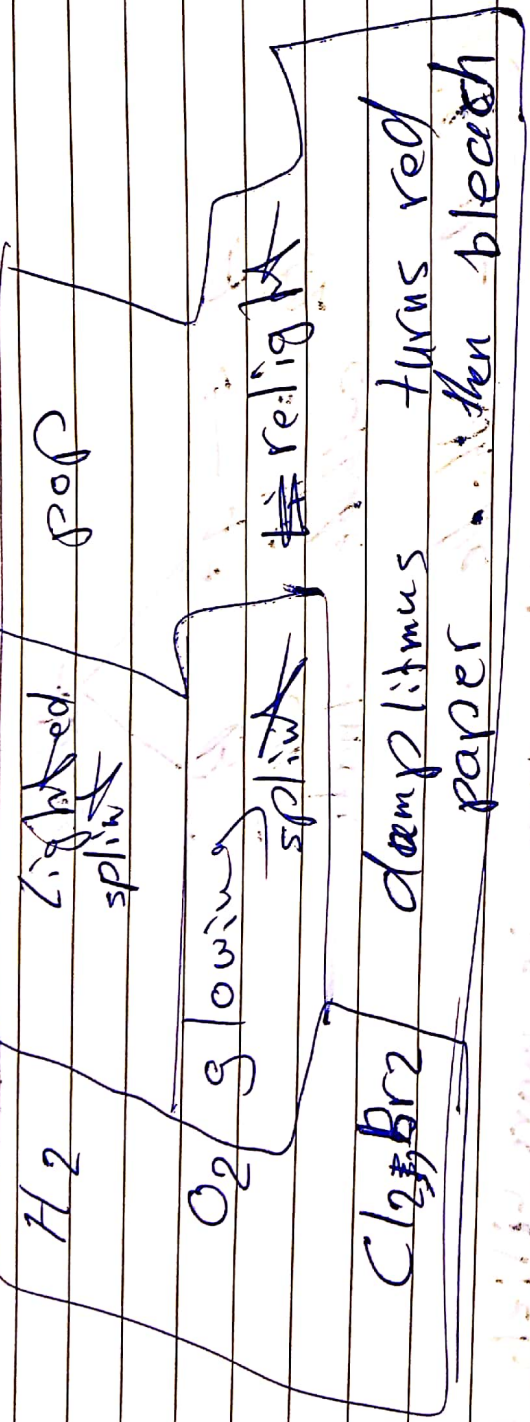


when OH^- oxidise

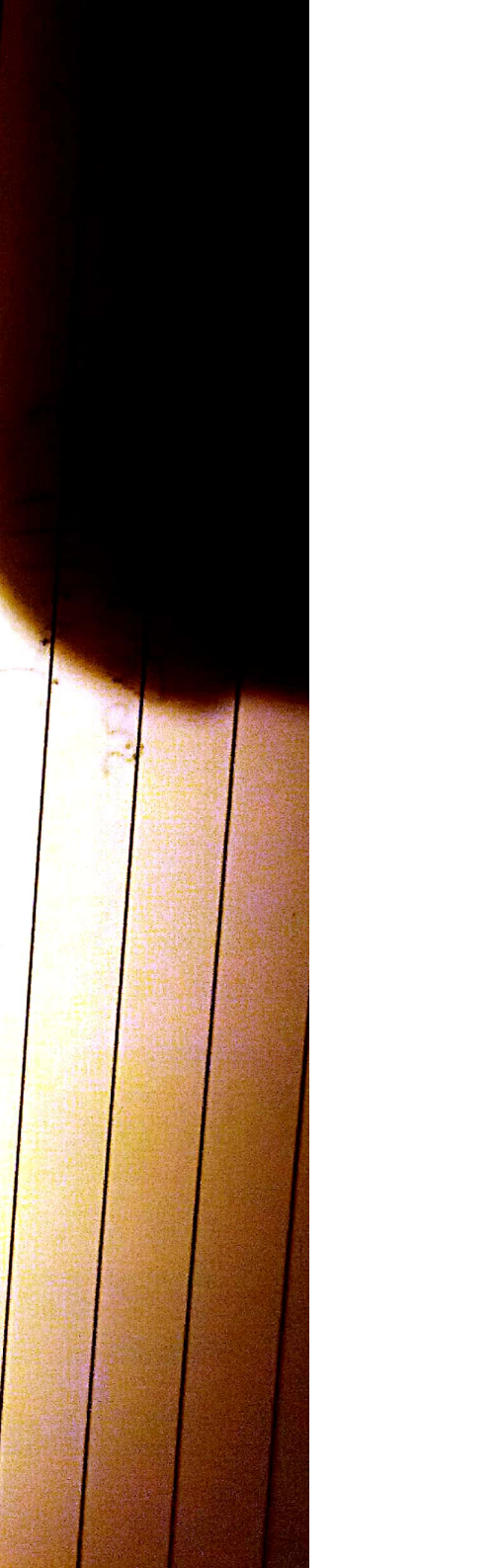


bubbles of
colorless gas

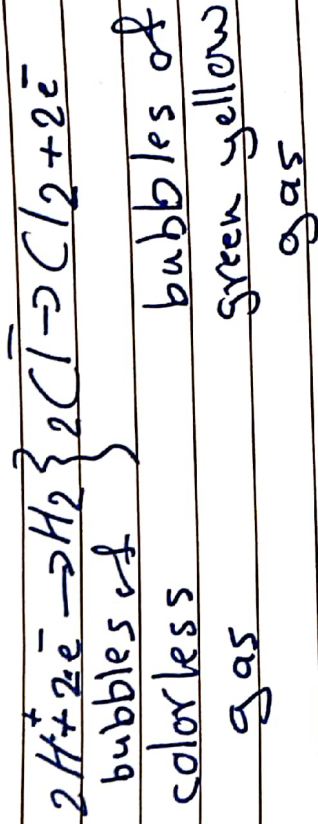
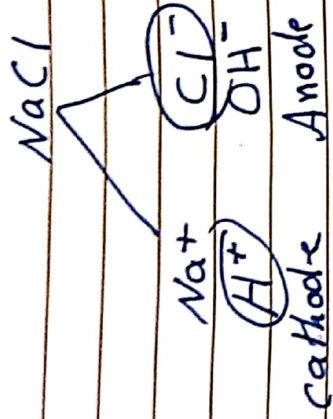
gas test results



Cl₂ / Br₂ damp litmus paper turns red when bleached

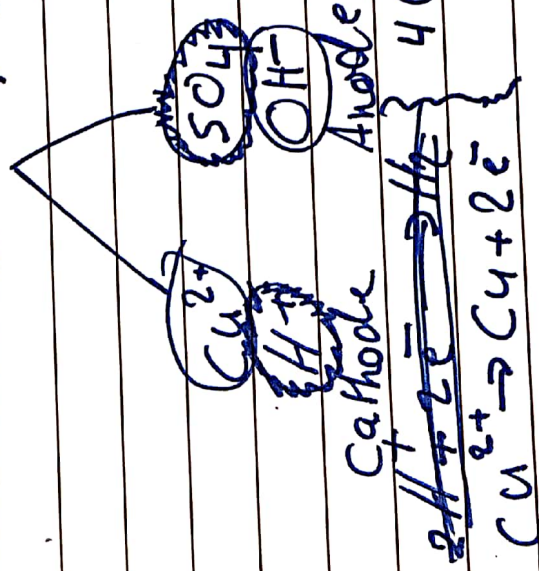


concentrated NaCl (aq)



Electrolyte: NaOH

CuSO_4 (aq)



electrolyte: H_2SO_4

dilute NaCl (aq)

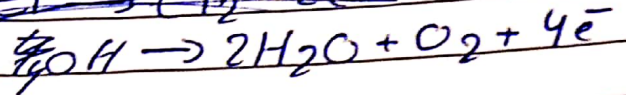
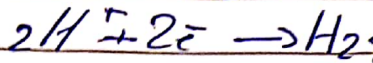
Na⁺



cathode



Anode



bubbles
of colorless
gas

bubbles
of
colorless
gas

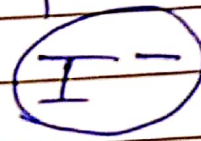
electrolyte = NaCl

concentrated KI (aq)

K⁺

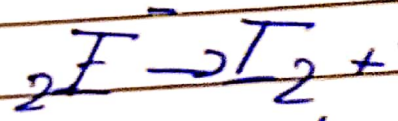
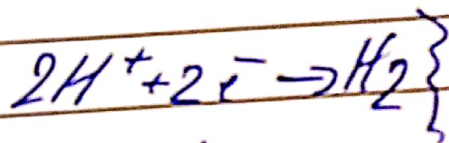


cathode



OH

Anode

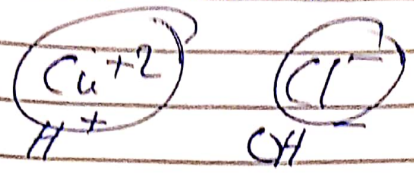


bubbles
of colorless
gas

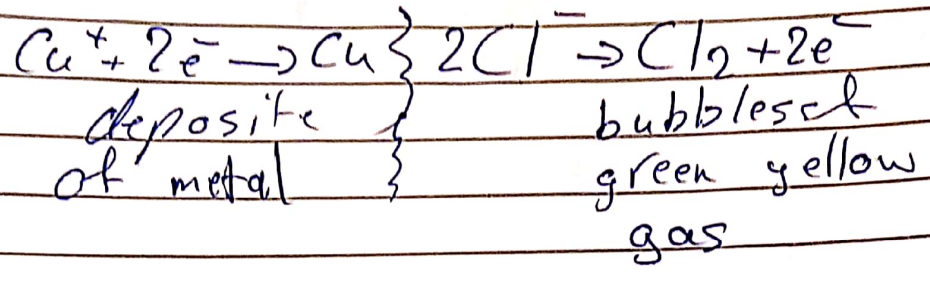
red
brown

electrolyte: KOH

Concentrated $\text{CuCl}_2(\text{aq})$



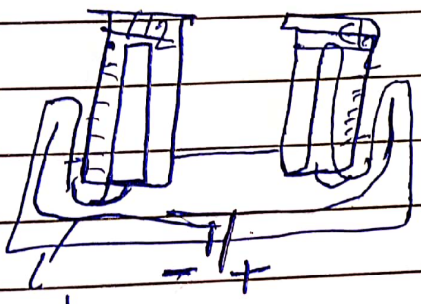
Cathode Anode



~~Set~~
 Electrolyte: less concentrated CuCl_2

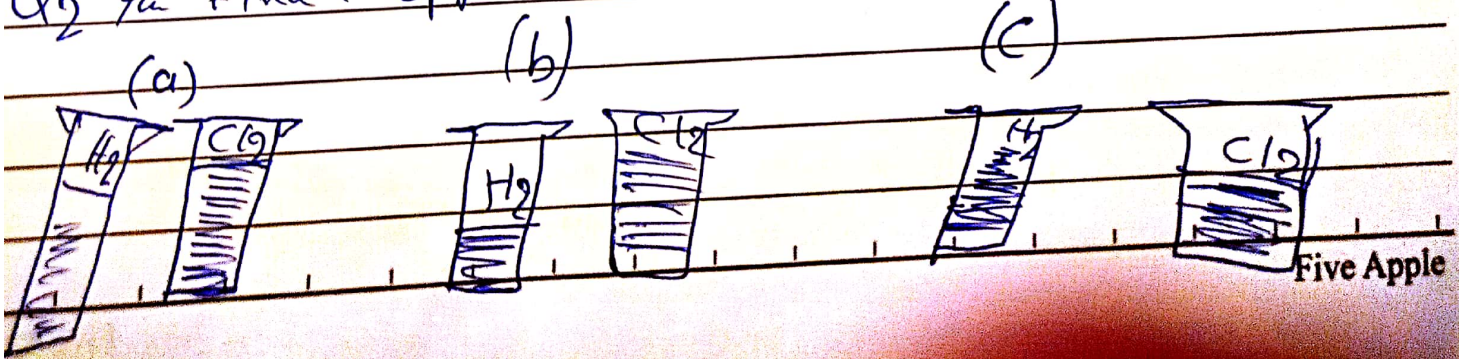
concentrated ~~AA~~ $\text{NaCl}(\text{aq})$ called Brine solution

Q1 = plan an exp to collect and measure the volume of H_2 and Cl_2 produced?



tough

Q2 the final appearance of the two measuring cylinders



Q3) Brine with universal indicator
observation:

1- ~~the~~ light bulb will light up

2- bubbles of green yellow gas on the
Anode

3- bubbles of colorless ~~gas~~ gas on the
cathode

4- around the cathode the solution becomes purple
because NaOH is an alkali.

5- around the Anode the solution becomes colorless
~~because NaOH is an alkali~~ since Cl_2 bleaches
the color

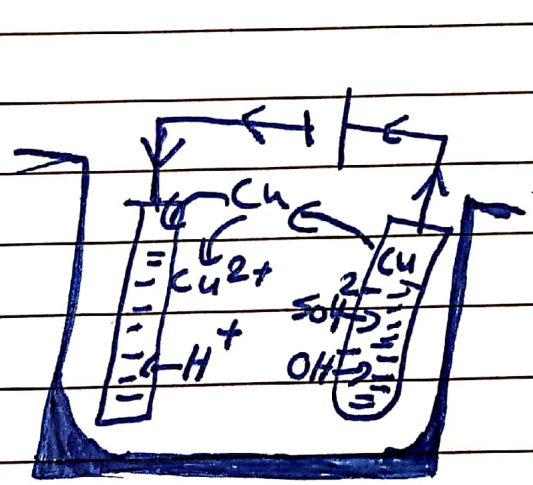
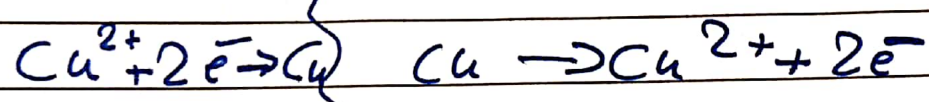
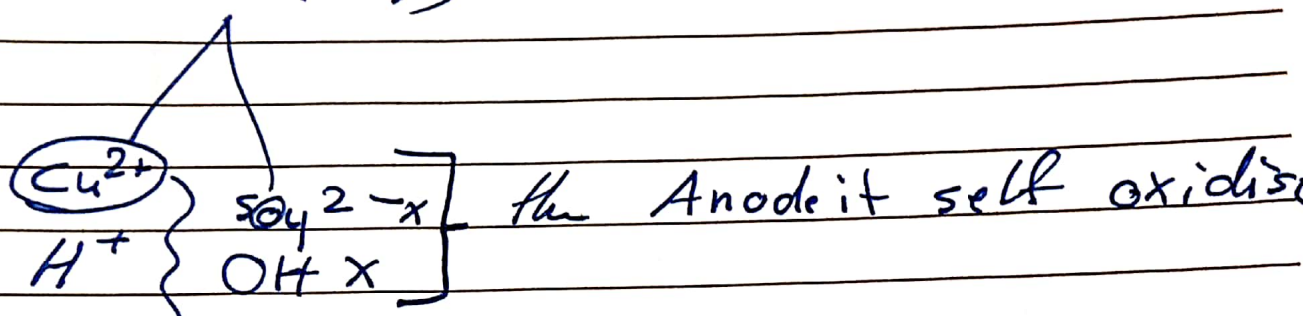
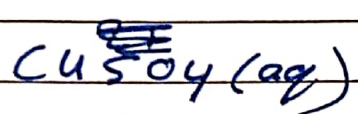
Active rod

Electrolysis: for aqueous electrolyte using the rod must be the same metal ion in the electrolyte.

$CuSO_4(aq)$ using Cu rod

$AgNO_3(aq)$ using Ag rod

electrolysis for (aq) $CuSO_4$ using Cu rod

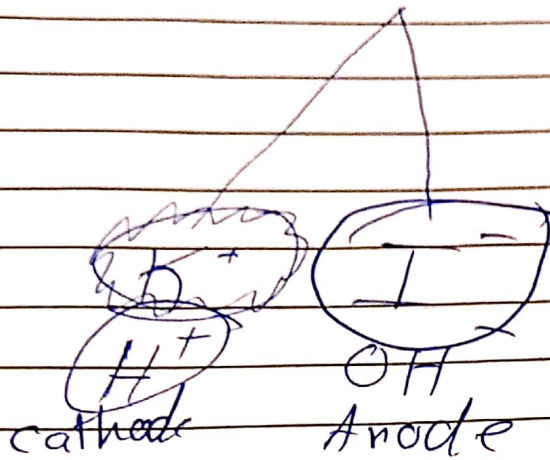


cathode	Anode
↑ mass	↓ mass
Cu deposit	oxidised
	lose e^-

electrolyte

- stays in same concentration
- the Anode oxidised and re-enters the Cu^{2+} in the electrolyte at the same rate.

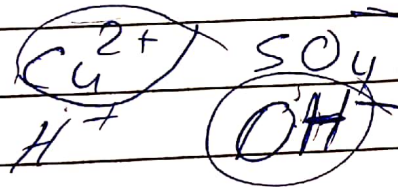
can (KI (aq))



~~H₂~~ H₂

} I₂

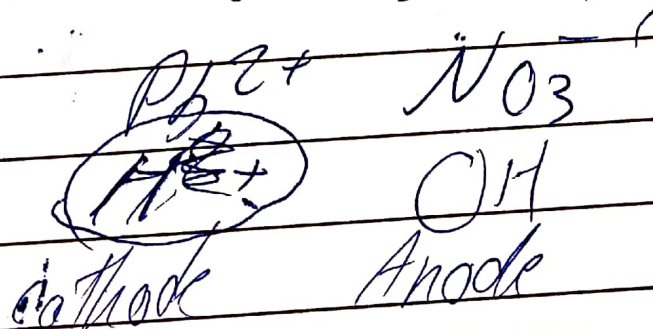
CuSO₄



Cu } O₂

H₂SO₄

Pb(NO₃)₂



Electroplating

definition: coating a metal with another ~~metal~~ metal using electrolysis

why 1) to prevent rusting.
2) more ~~see~~ attractive.

How to electroplate a metal spoon, with silver?

step 1 - clean the spoon from any impurities as oxide layers, using sand paper to ensure a good sticking.

step 2 - make the spoon the cathode (-ve)

step 3 - the anode must be Ag

step 4 - electrolyte must contain Ag^+ AgNO_3

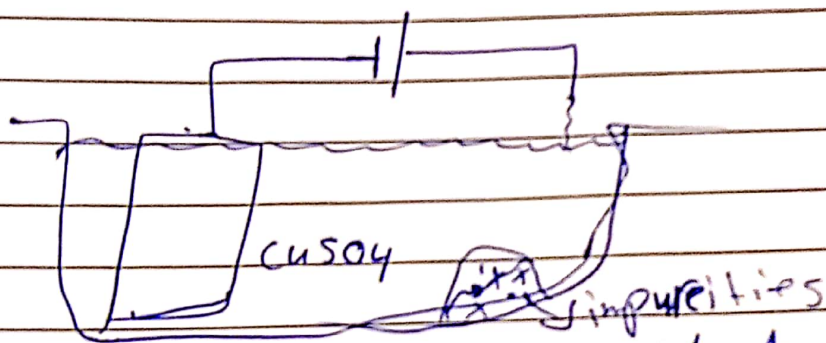
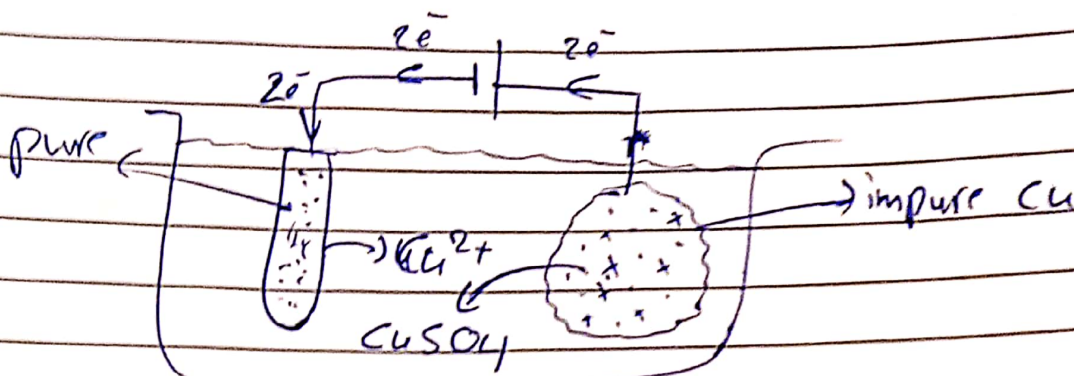
step 5 - turn ~~off~~ on the circuit be sure that the spoon is fully immersed in the electrolyte

step 6 - rotate the spoon to ensure an equal distribution

step 7 - rinse with distilled water

step 8 - dry in oven.

② purifying metals



Au, Ag settle down (less reactive)
 $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

Extraction of molten from their ores:

* The method of extraction depends on the position of metal in reactivity series:

	Na	} electrolysis / molten molten / graphite.
	Li	
	Ca	
	Mg	
	Al	
Bauxite Al_2O_3	C, CO	} reduction by C/CO
Zinc blende ZnS	Zn	
Hematite Fe_2O_3	Fe	
copper sulphide Cu_2S	Pb	} reduction by H_2
	Cu	

Extraction of aluminium

ore: Al_2O_3 Bauxite.

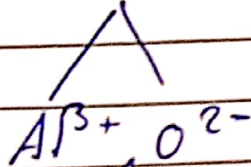
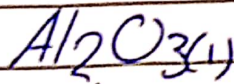
method: electrolysis for molten Al_2O_3 / graphite

M.p of Al_2O_3 is about 2000°C

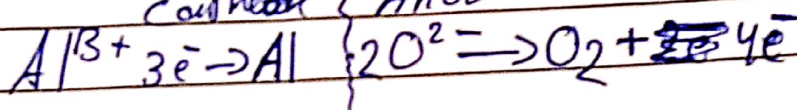
so we dissolve Al_2O_3 in a molten cryolite Na_3AlF_6

— to lower m.p to 900°C so less cost.

— to increase the electrical conductivity



cathode { Anode



gases produced at Anode

1- O_2

2- CO_2] reaction of rods with O_2

3- CO] so we must ~~replace~~ replace them periodically

property

— low density

— ductile

— malleable

— conduct electricity

— form an oxide layer which is non-toxic.

use

— Air ~~etc~~ craft bottles

— electrical wires

— window frame / cooking utensils,

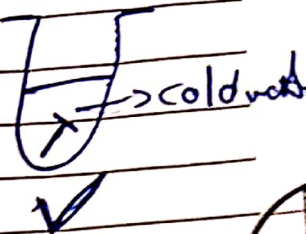
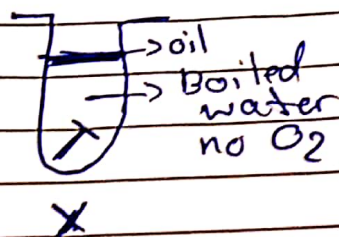
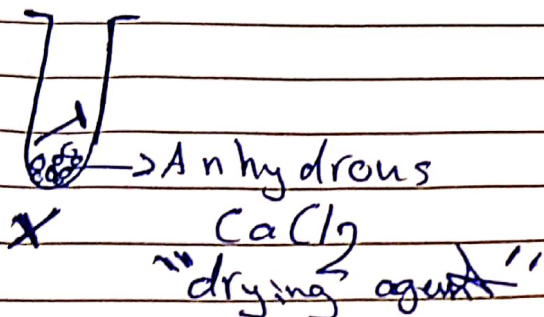
— wires

— food cans

Rust

reaction of Iron with Both O_2 and H_2O

slow reaction \rightarrow 6-7 days



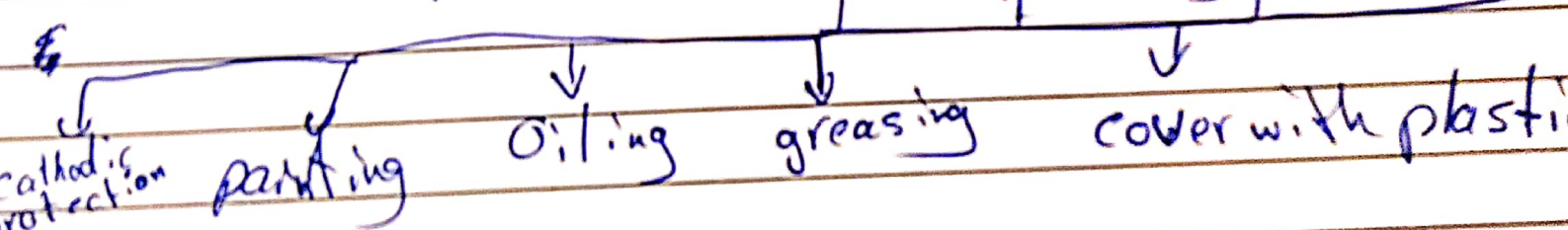
plan an exp to show - which rust prevention solution is better.

steps

1. take a known mass of Iron nail
2. apply a known volume of the first solution
3. put them in a known volume of water for 1 week
4. dry them and measure the mass again
5. repeat the exp with the 2nd solution

Conclusion: the exp which cause more increase in mass is the worst solution.

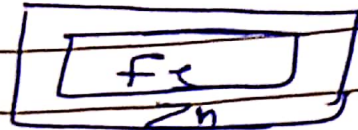
How to prevent rusting



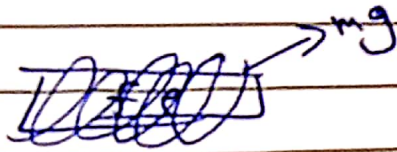
to prevent O_2 and H_2O from reaching the iron!!

Galvanizing: coating with Zn

↑
↓ very similar ↑

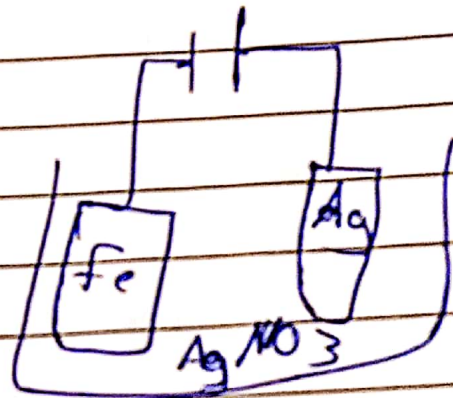
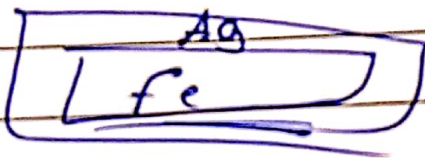


sacrificial protection: connecting with mg

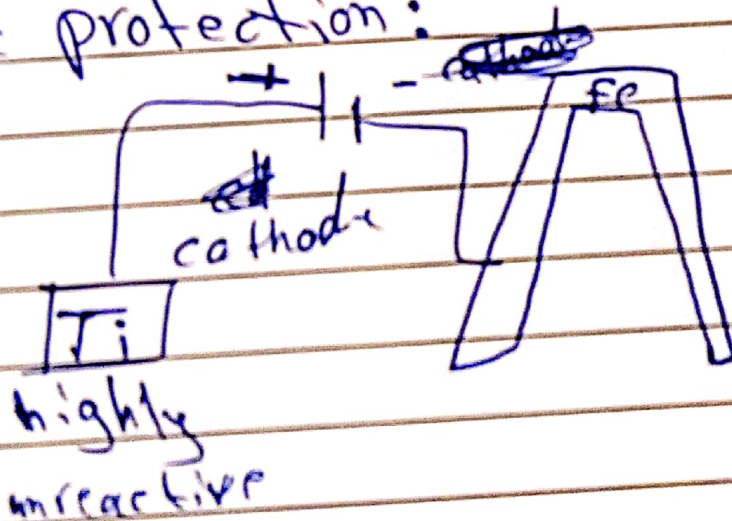


Zn and mg are more reactive than Fe
more likely to oxidise
more likely to lose e^-
so Fe is less likely to rust

electroplating:



cathodic protection:



Rate of reaction

Rate = $\frac{\text{change in Quantity}}{\text{change in time}}$

$$\text{Rate} = \frac{\Delta Q}{\Delta T} \qquad \frac{\Delta \text{mass}}{\Delta \text{time}}$$

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

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

$$\frac{\Delta \text{height of ppt}}{\Delta \text{time}}$$

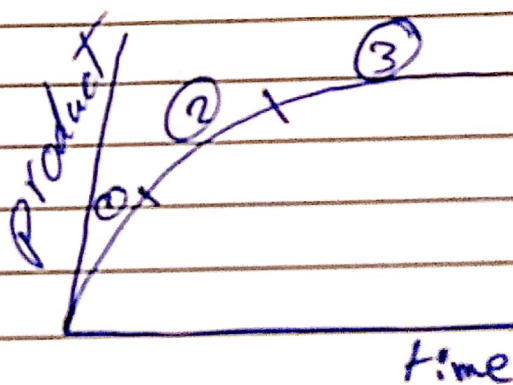
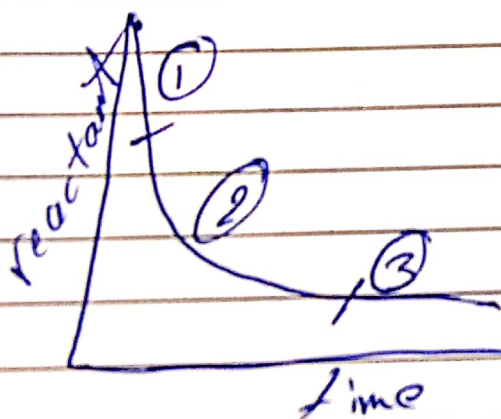
$$\frac{\Delta \text{Light intensity}}{\Delta \text{time}}$$

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

measure the rate of reaction

How fast the reactants
consumed per unit time

How fast the products
produced per unit time



region (1)

more amount of reactants
fastest rate \rightarrow from the graph, steepest

more particles

more effective collisions per unit time

region (2)

- slower rate \rightarrow from 1/2 graph, less steep

- less number of collisions particles

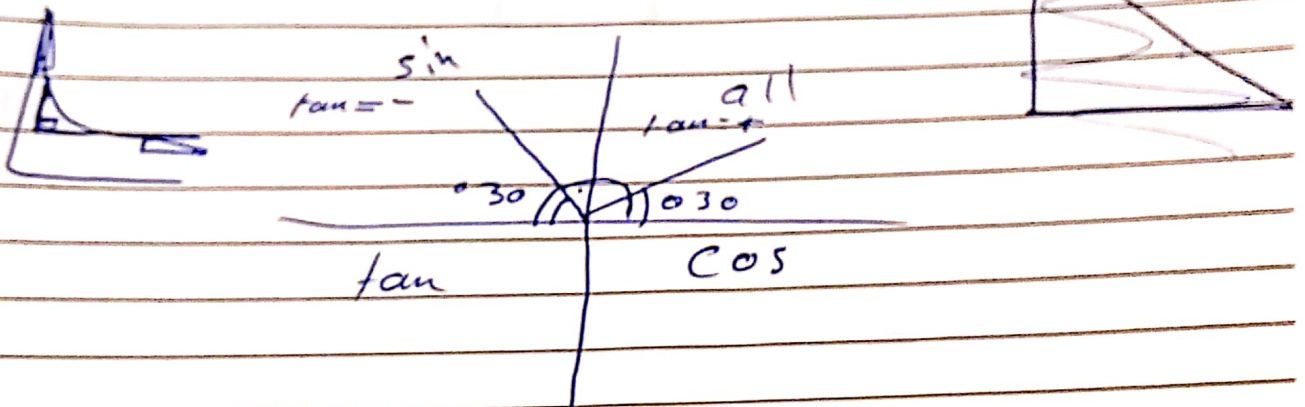
- so less number of effective collisions per unit time.

region (3)

- reaction is over \rightarrow gradient is 0 (flat)

- ~~no~~ no more limiting factor

- ~~no~~ more effective collisions

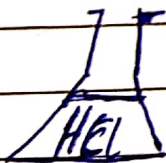


for any chemical reaction there are three main conditions.

① $\text{Cu} + \text{HCl} \rightarrow$ no reaction the reactants must be compatible

② the reactants must come into contact with each other

good mix

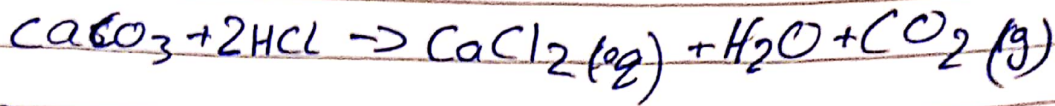


③ the collisions must be effective, minimum amount of energy to start reaction

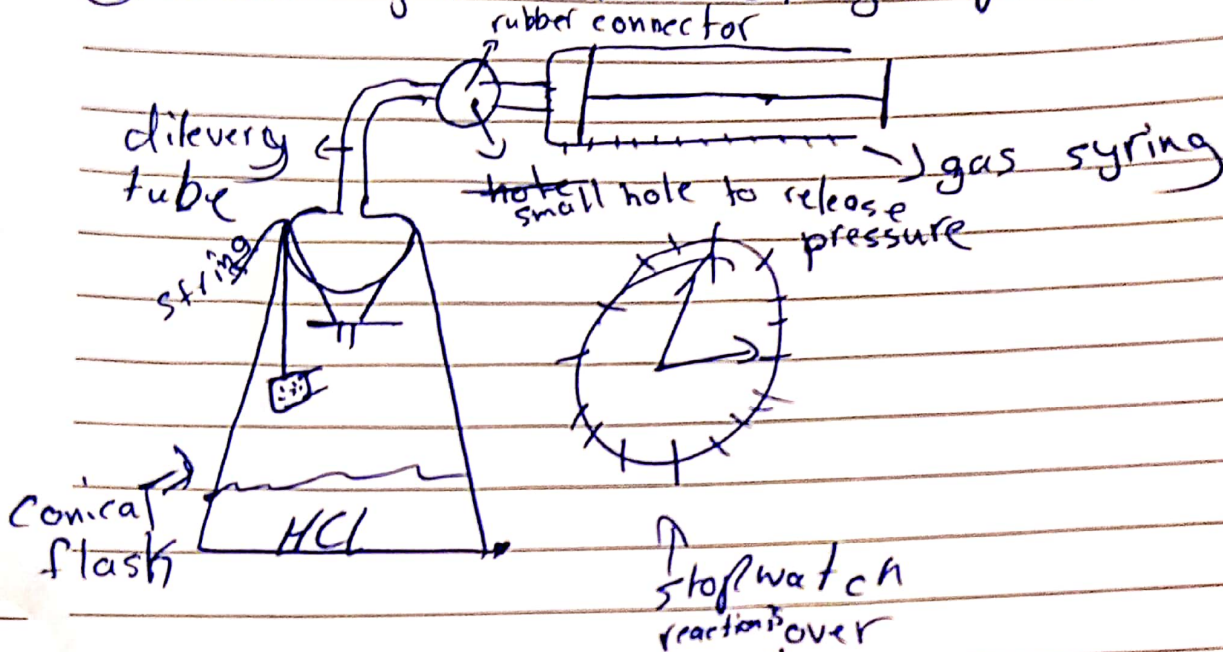
• Activation energy (E_a)

propane

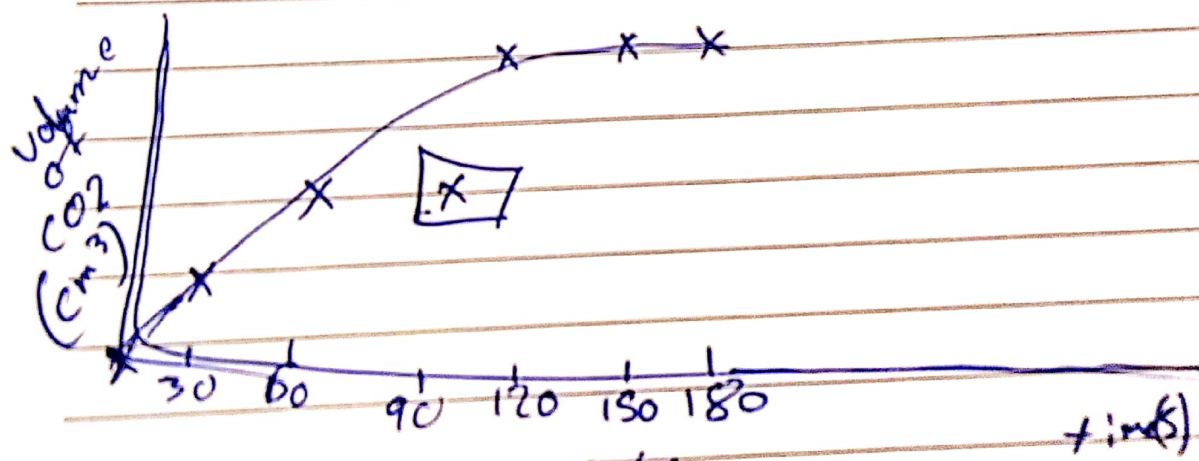
measuring Rate of Reaction



① measuring the volume of gas per unit time.

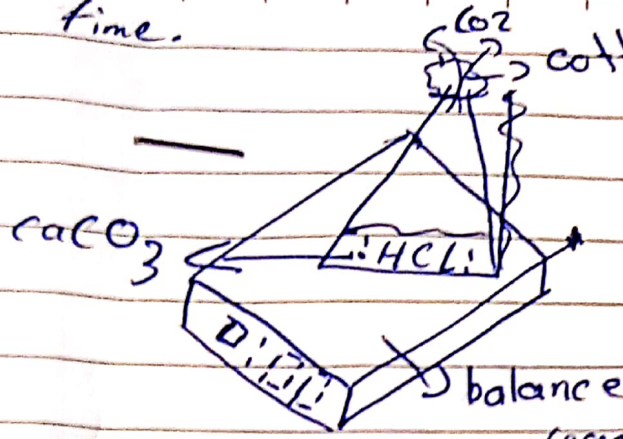


time	0	30	60	90	120	150	180
volume of CO ₂ (cm ³)	0	10	15	17	17.5	17.5	17.5
		+10	+5	+2	+0.5		



error out of the curve

② measure the mass of the conical flask + content per unit time.

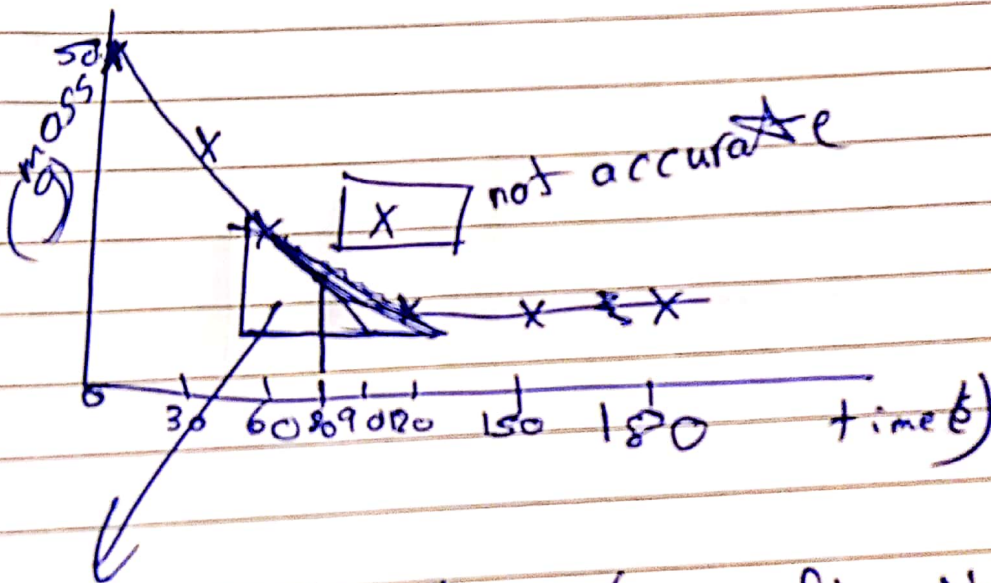


cotton wool
to allow CO_2 to escape and prevent splashing

The mass decreases because CO_2 escape.

reaction is over

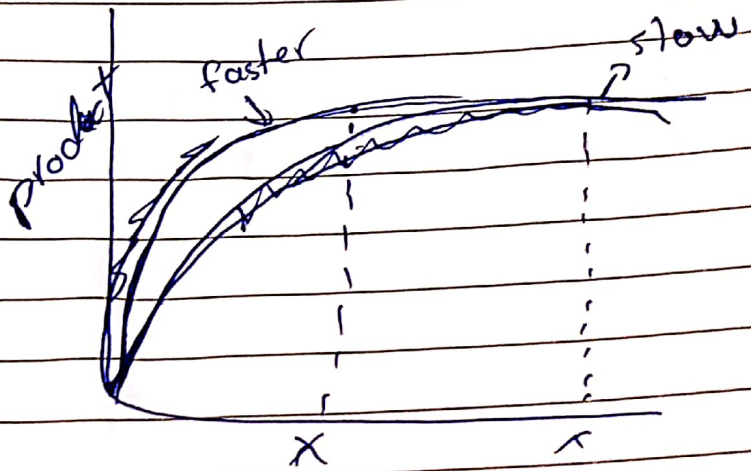
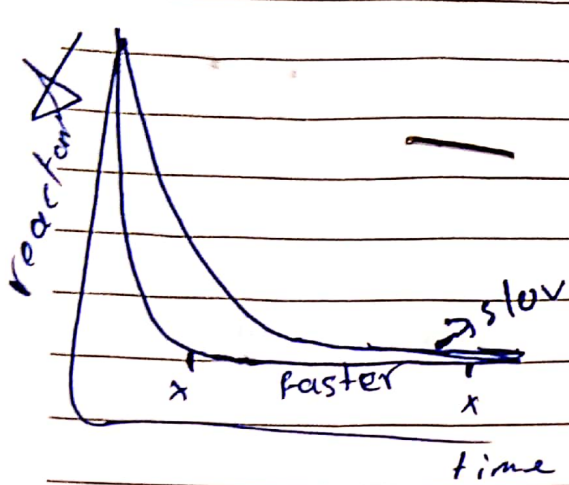
time (s)	0	30	60	90	120	150	180
mass (g)	50	40	35	33	32.5	32.5	32.5
		-10	-5	-2	0.5		



to find the rate at specific time
at $t = 80\text{s}$, draw tangent

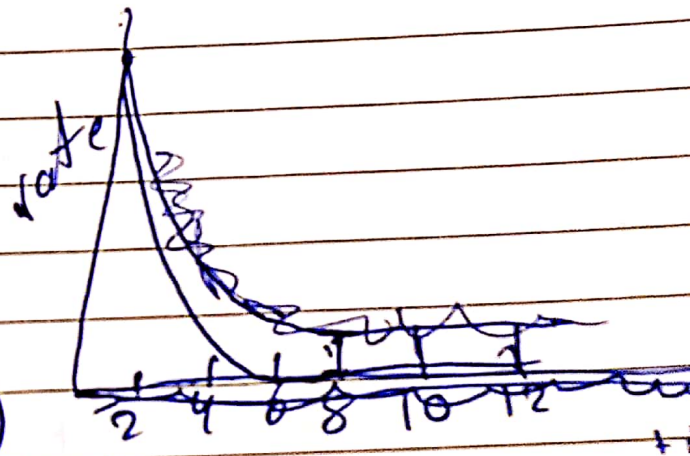
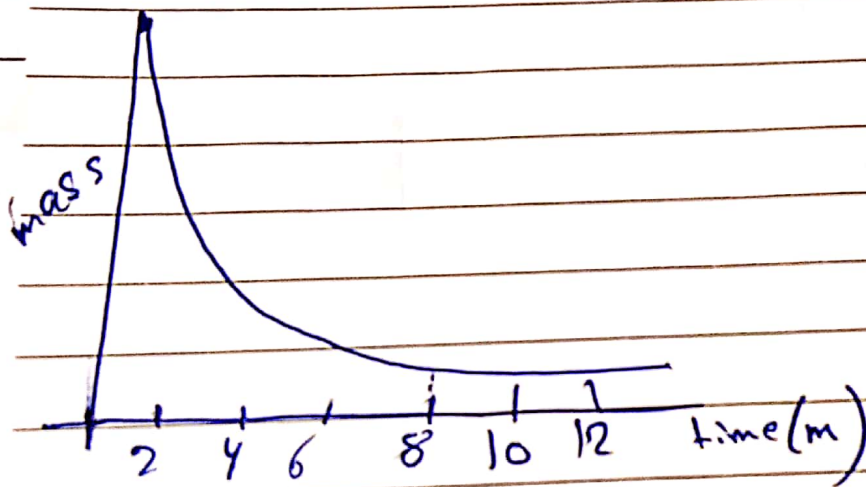
increasing the rate of reaction.

more product per same period of time. or same products per less time.



① the graph below shows how the amount of Reactants changes with time

Draw Rate v. time graph



factors effect the rate of Reaction

① temp ② surface area ③ concentration/amount

④ pressure ⑤ light intensity ⑥ catalyst

①

temp

* state how the temp affect the rate of Reaction
- As the temp increases, the rate of Reaction increases

* Explain how the temp affect the rate of Reaction
- As the temp increases, the particles gain K.E so move faster, the particles will have energy equal to or greater than the E_a , so more effective collisions per unit time.
so faster rate of Reaction. (5pts)

* plan an exp to show how the temp affect the rate of Reaction?
 $CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$

- take a known mass of lumps $CaCO_3$, add them to a known volume of ~~the~~ known concentration of HCl at $25^\circ C$ using gas syringe
measure the volume of CO_2 produced per unit time using a stopwatch, repeat the exp at $50^\circ C$, the exp at $50^\circ C$ produce CO_2 with less time.

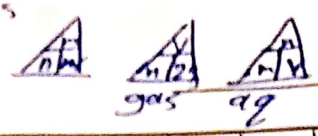
②

surface area

* state how the surface area affect the rate of Reaction? As the surface area ~~affects~~ increases, the rate of Reaction increases.

* Explain how the surface affect the rate of reaction
- As the surface area increases, (decreases the particle size by ^{crushing} using mortar and pestle), more particles exposed to the reaction, more effective collisions per unit time, so faster rate.

moles



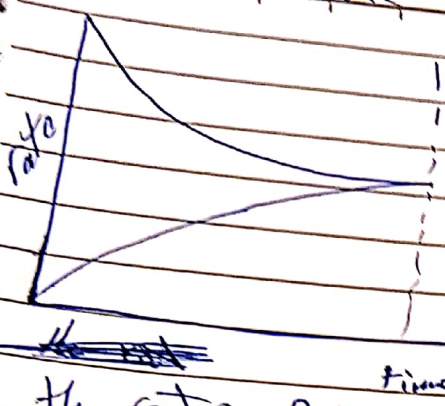
B) Concentration "Amount"

* state how the concentration affect the Rate of Reaction,
As the concentration ↑, the rate of reaction ↑

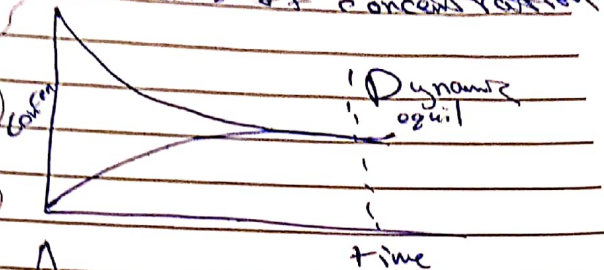
Explain how the concentration affect the rate of Reaction -
As the concentration increase, more particles, so more effective
collisions per unit time, so faster Rate of Reaction
[3pts]

Explain plan an exp. on the effect of concentration ↑

in terms of Rate



in terms of concentration

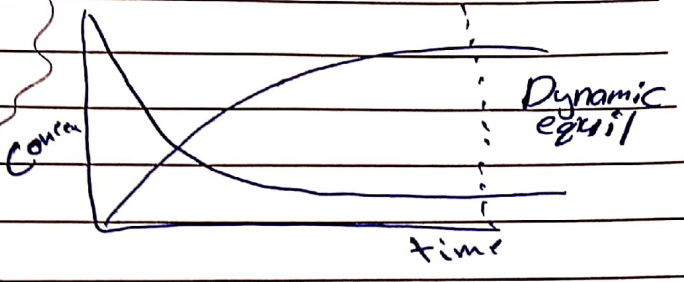
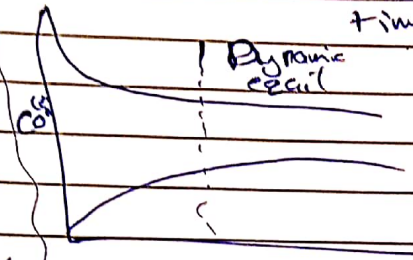


~~the rate of forward~~
the rate of forward

Less Reactants so
Less particles so
Less effective collisions per unit
time.

the rate of backward

more product so
more particles so
more effective collisions



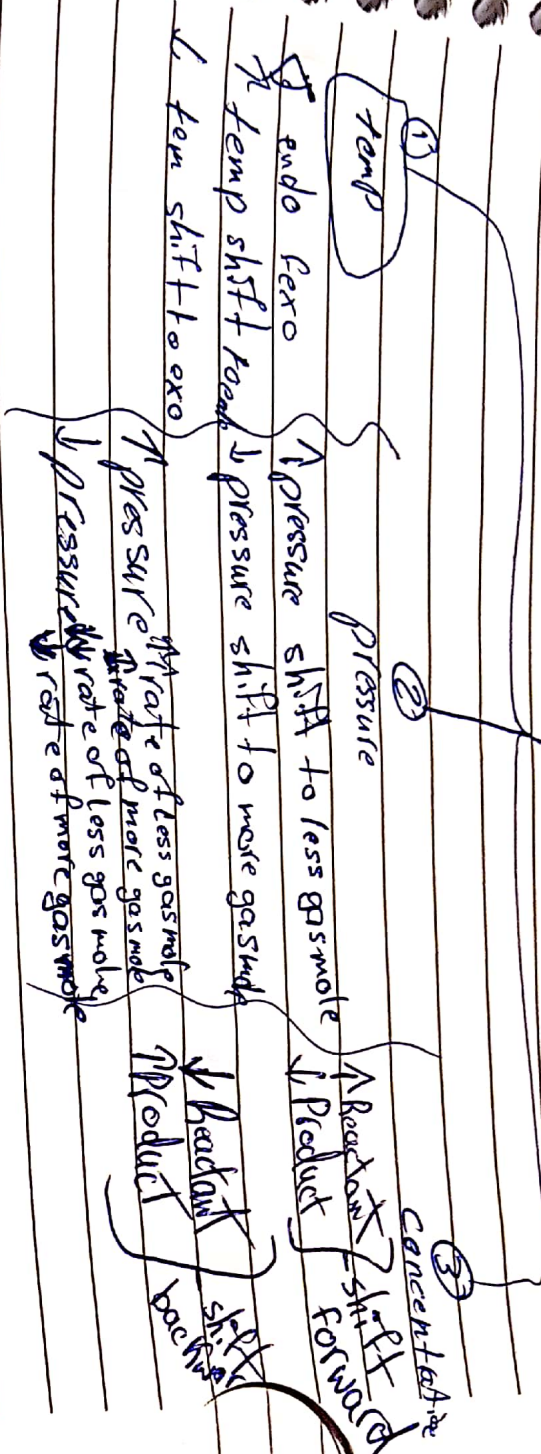
Le chatelier principle

If the system at equilibrium \rightleftharpoons and any external factor disrupt the equilibrium,

the equilibrium can shift itself either to the forward \rightarrow or to the backward \leftarrow

to return back to the equilibrium,

Factors affect the position of equilibrium



1) Temperature:

Temp ↑ rate of endothermic
Temp ↑ rate of exothermic

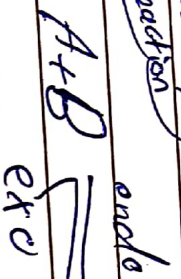
shift to endo

↓ temp ↓ rate of addition
↓ rate of exothermic

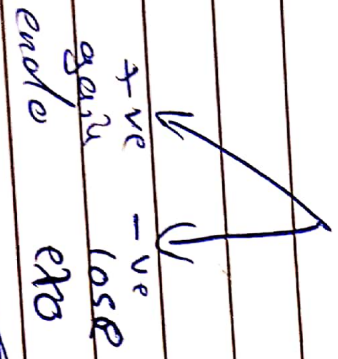
shift to exo

$\Delta H =$

sign of ΔH is always represented in forward reaction



$\Delta H = +ve$



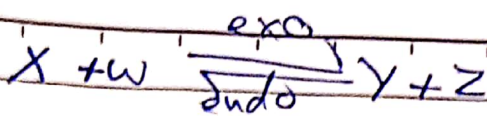
↑ temp ↑ rate of forward
↑ rate of backward

↑ A ↓ B
shift forward to endo

↓ temp ↓ rate of forward
↑ rate of backward

↓ A ↓ B
shift backward to exo

note: exo and endo are flipped in this page

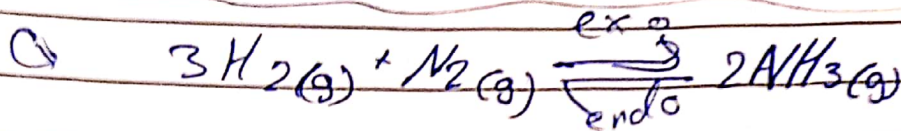


$$\Delta H = -ve$$

exo

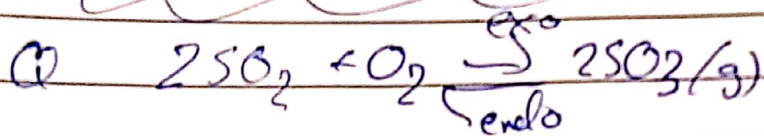
↑ temp } rate of forward } shift to endo
 ↑↑ rate of backward }

↑ x ↑ w ↓ y ↓ z



$$\Delta H = -ve$$

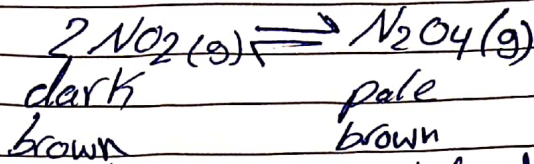
to produce more yield of NH_3
 we must use low temp
 to favour the forward reaction which
 is the exothermic



$$\Delta H = -ve$$

	rate of forward	rate of backward	% SO_3
↑ temp	increase	increase	decrease
↓ temp	decreases	decreases	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 ~~more~~ paler? why?

because the forward reaction is exothermic enhanced by ~~adding~~ cooling.

② pressure

As the pressure increase

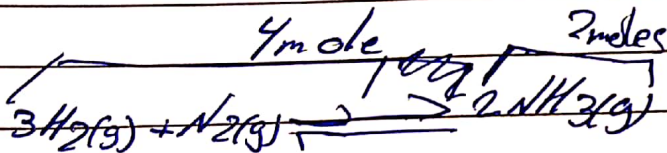
the equil shift to the side with less pressure

the equil shift to the side with less gas moles

As the pressure decrease

the equil shift to the side with more pressure

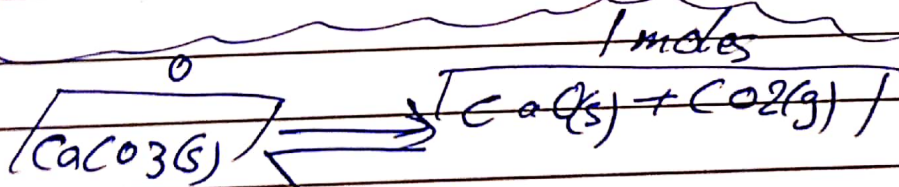
the equil shift to the side with more gas moles.



↑ pressure shift forward to the side with ^{less} gas moles. ~~FAVOR~~

↑ % NH_3

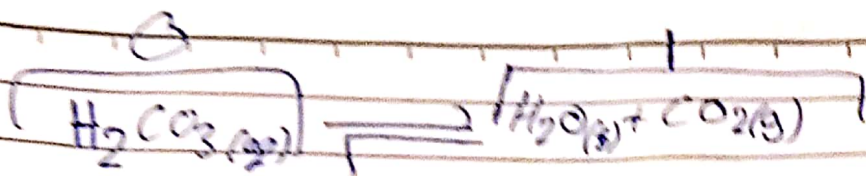
↓ pressure shift backward to the side with more gas moles.



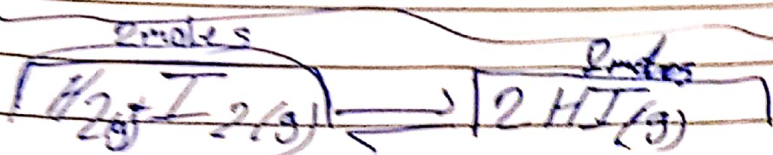
↓ pressure shift forward to the side with more gas moles.

↑ pressure shift backward to the side with less gas moles

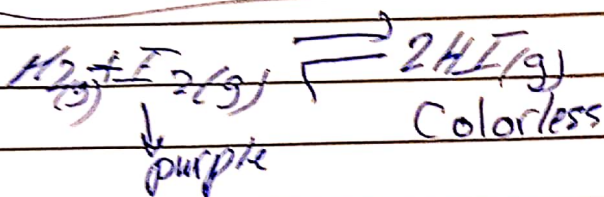
moles



↓ pressure shift forward to the side with more gas moles



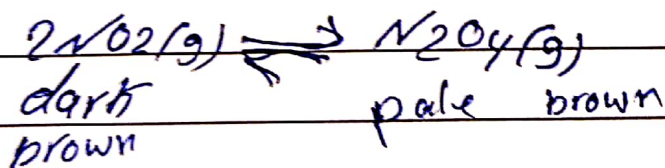
changing the pressure has no effect on the position of equilibrium since both sides have the same number of gas moles.



The equil doesn't affect by increasing the pressure. why by increasing ~~to~~ the pressure the mixture becomes more purple.

I_2 molecules become closer to each other so the color seems ^{to be} darker.

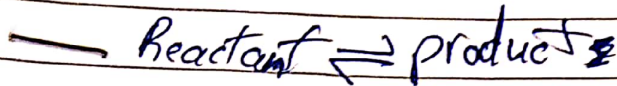
sealed tube contains mixture of $\text{NO}_2(\text{g})$ and $\text{N}_2\text{O}_4(\text{g})$ at equil.



by increasing the pressure the color of the mixture becomes darker, then goes paler.

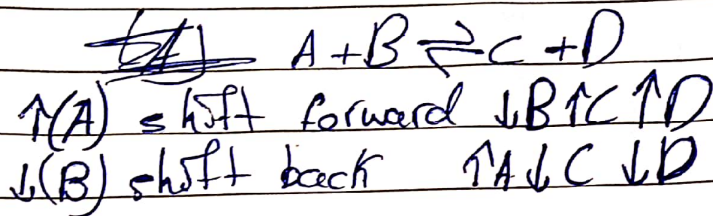
③ concentration

write on table. \rightarrow $\begin{matrix} \uparrow R \\ \downarrow P \end{matrix}$ } shift forward
 $\begin{matrix} \downarrow R \\ \uparrow P \end{matrix}$ } shift backward



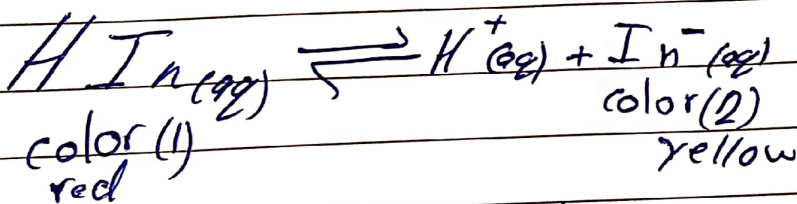
\uparrow Reactant } shift forward
 \downarrow product }

\downarrow Reactant } shift backward
 \uparrow product }



$\uparrow(C)$ shift backward $\uparrow(A)$ $\uparrow(B)$ $\downarrow(D)$

methyl orange indicator



add HCl: proton donor $\uparrow \text{H}^+$ shift backward

more HIn more color (1)

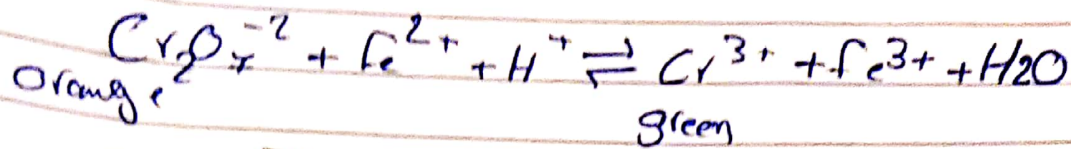
less In⁻ less color (2)

add NaOH: proton acceptor $\downarrow \text{H}^+$ shift forward

more In⁻ more color (2)

less HIn less color (1)

Q1 - the reversible reaction below at equilibrium



Explain why by adding HCl to the reaction the color of the mixture becomes green? (3 pts)

HCl is an acid, (proton donor)

more H^+

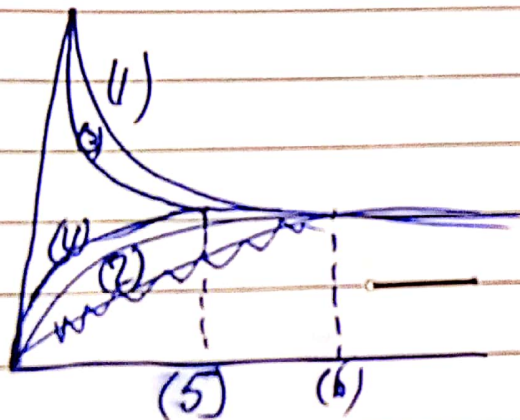
shift forward

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 or backward



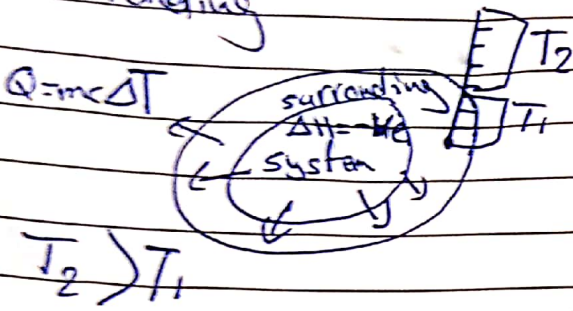
- 1) rate of forward reaction without cat
- 2) " " backward " " "
- 3) " " forward " with "
- 4) " " backward " " "
- 5) time taken to reach equil with cat
- 6) " " " " " without "

the intersection is ~~the~~ where the reaction is over

enthalpy: Heat content's
 H_r = enthalpy of reactants
 H_p = enthalpy of product
 "stored energy"

Energetics

Exothermic: reaction that ~~gives out~~ Release energy to the surrounding

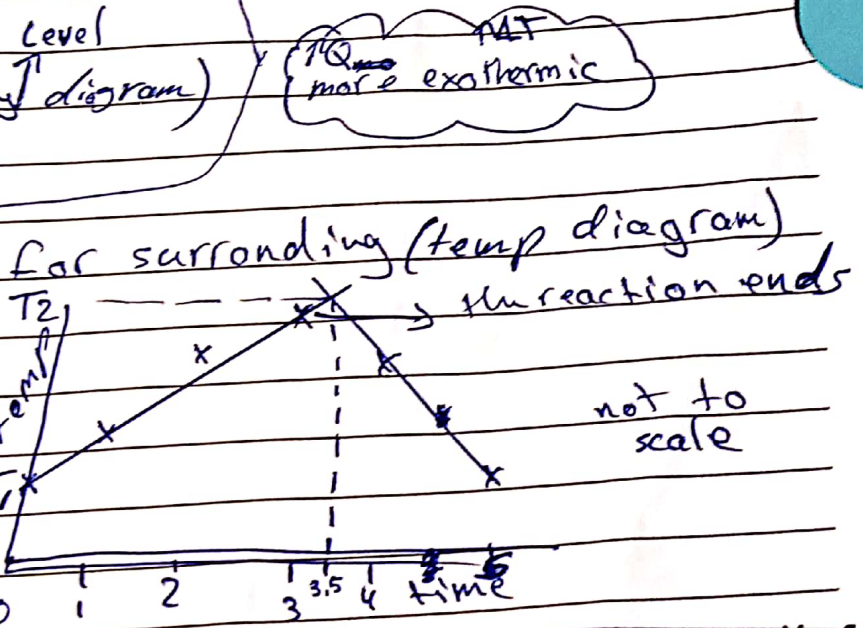
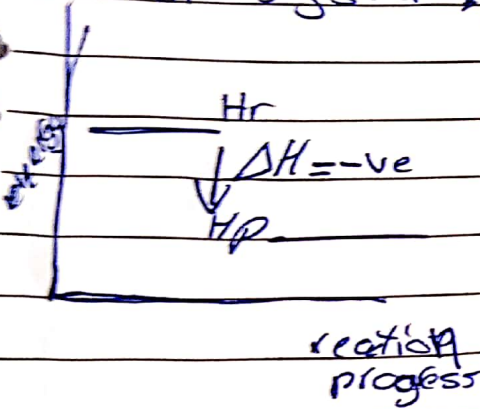


specific heat capacity $4.25 / g \cdot ^\circ C$

$Q = mc\Delta T$ → change in temp

↓ energy transfer unit
 ↓ mass g

for system (energy diagram)



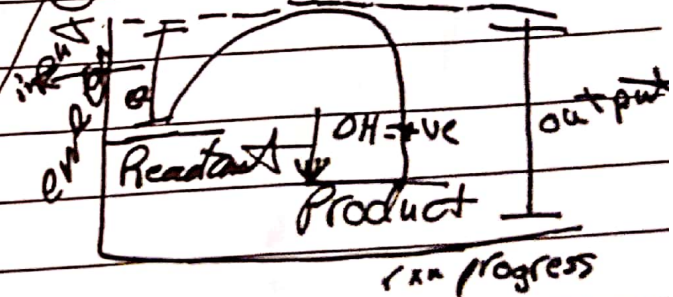
more exothermic

Examples on exo:-

- 1 - Freezing, condensation
- 2 - ~~condensation~~ ~~breathing~~ respiration
- 3 - Combustion
- 4 - neutralization
- 5 - displacement
- 6 - voltaic cell
- 7 - building up bonds

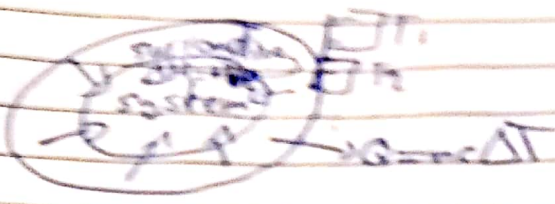
How to express exotherm

- ① reactants → products $\Delta H =$
- ② reactants → products + energy
- ③ Profile diagram



input < output

Endothermic: Reactions that absorb energy from the surrounding



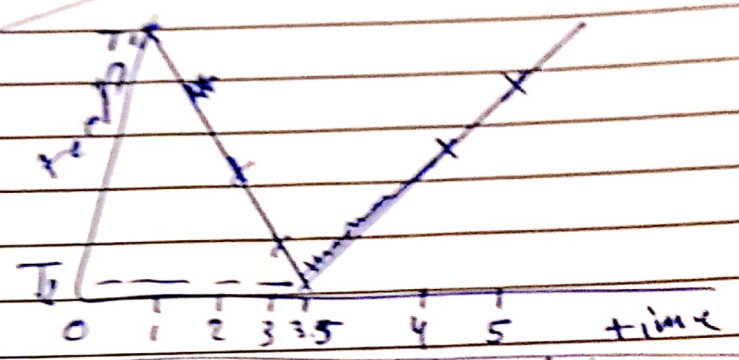
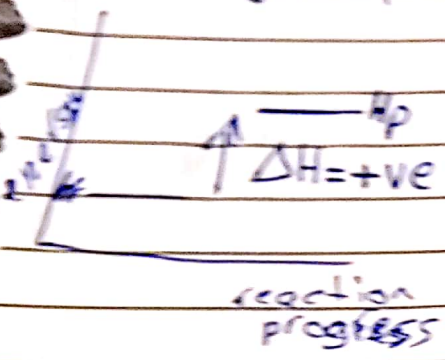
same as the page before
 $Q = mc\Delta T$

more endothermic
 ΔT

$T_2 < T_1$

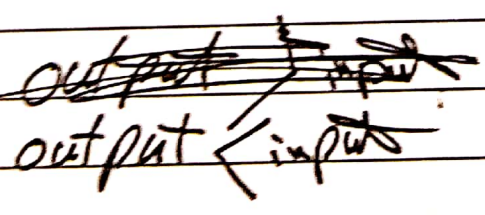
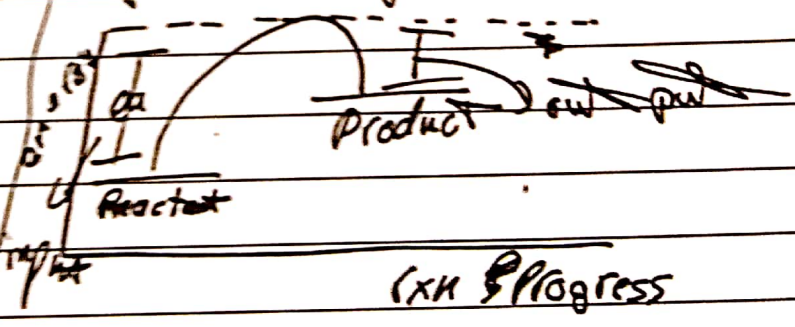
for system (energy level diagram)

for surrounding (temp change)



- examples of endo
- 1- boiling, melting
 - 2- photosynthesis
 - 3- thermal decomposition
 - 4- Electrolysis
 - 5- photographic films
 - 6- dissolve Ammonium salt
 - 7- Breaking down bonds

- How to express endothermic
- ① Reactant \rightarrow Products $\Delta H = +$
 - ② Reactant's energy \rightarrow Product
 - ③ profile diagram



$\Sigma = \text{total}$

measuring ΔH reaction

theoretical
using bond energy

experimental

combustion

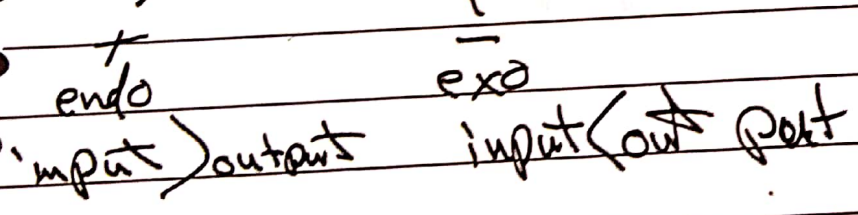
displacement

ΔH reaction using Bond energy:

Bond energy: the amount of energy need to break 1 mole of a bond in a gaseous state.
 or the amount of energy released to build 1 mole of a bond in a gaseous state

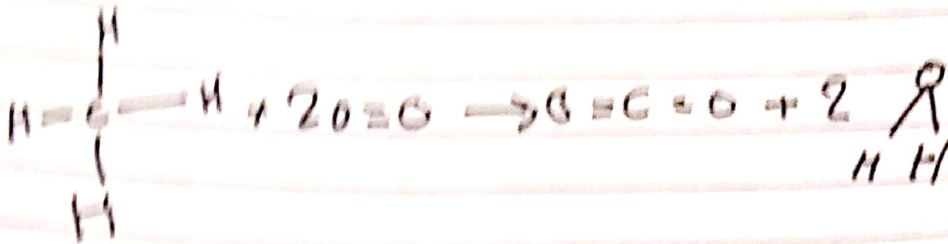
bond	bond energy Kj/mol	
H-H	436 Kj/mol	$H-H + 436 \text{ Kj/mol} \rightarrow H + H$
		$H + H \rightarrow H-H + 436 \text{ Kj/mol}$

$\Delta H \text{ reaction} = \Sigma \text{ input} - \Sigma \text{ output}$
 to break down bond in reactant to build up bonds in product



to use this equation:

- 1) balanced equation
- 2) covalent structure
- 3) bond energy



bond	bond energy
C-H	413
O=O	495
C=O	799
O-H	463
C-O	358

bond broken

$$\begin{aligned} 4 \times \text{C-H} &= 4 \times 413 \\ 2 \times \text{O=O} &= 2 \times 495 \\ \hline &2642 \text{ kJ/mol} \end{aligned}$$

bond formed

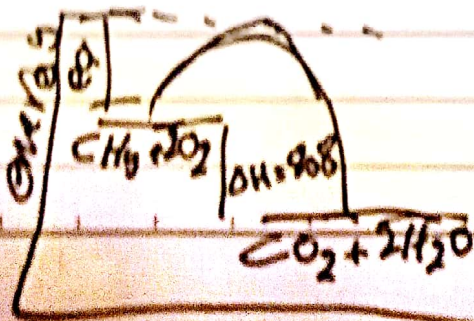
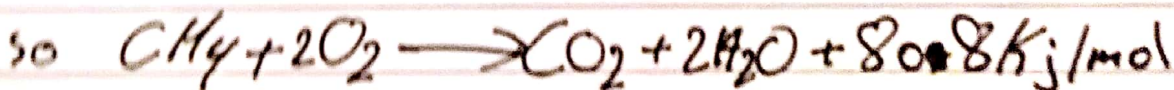
$$\begin{aligned} 2 \times \text{C=O} &= 2 \times 799 \\ 4 \times \text{O-H} &= 4 \times 463 \\ \hline &3450 \text{ kJ/mol} \end{aligned}$$

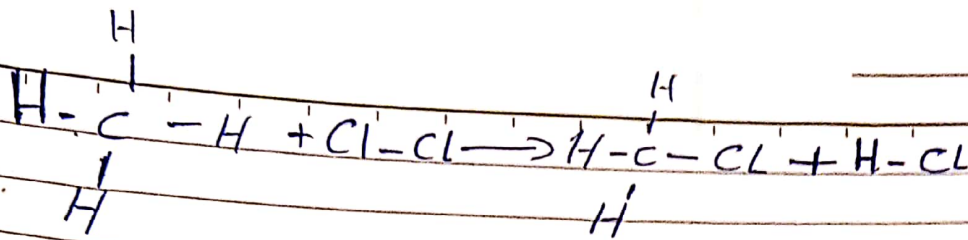
$$\begin{aligned} \Delta H &= \Sigma \text{input} - \Sigma \text{output} \\ &= 2642 \text{ kJ/mol} - 3450 \text{ kJ/mol} \\ &= -808 \text{ kJ/mol} \end{aligned}$$

exo

input < output

$$\Delta H = 808 \text{ kJ/mol}$$





bond broken

$$1 \times \text{C}-\text{H} \quad 413$$

$$1 \times \text{Cl}-\text{Cl} \quad 242$$

$$\underline{655 \text{ kJ/mol}}$$

bond build

$$\text{C}-\text{Cl} \quad 328$$

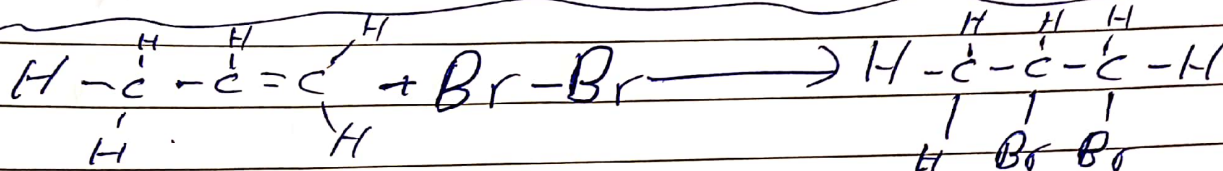
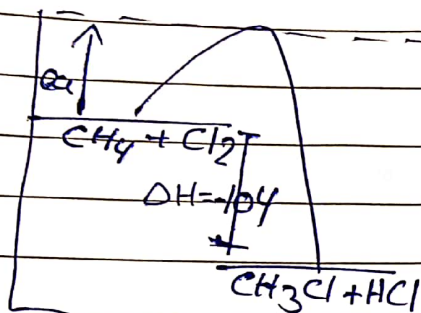
$$\text{H}-\text{Cl} \quad 431$$

$$\underline{759 \text{ kJ/mol}}$$

bond	bond energy
C-H	413
Cl-Cl	242
H-Cl	431
C-Cl	328

$$\Delta H = 655 - 759 = -104 \text{ kJ/mol}$$

exo



Bond broken

$$\text{Br}-\text{Br} \quad 193$$

$$\text{C}=\text{C} \quad 614$$

$$\underline{807 \text{ kJ}}$$

bond build

$$2 \times \text{C}-\text{Br} \quad 2 \times 276$$

$$\text{C}-\text{C} \quad 348$$

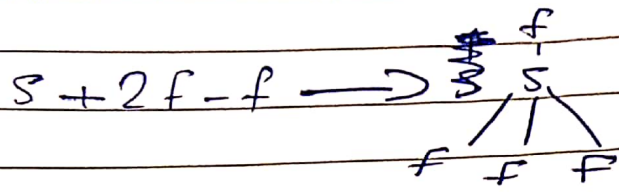
$$\underline{900}$$

$$\Delta H = 807 - 900 = -93 \text{ kJ/mol}$$

exo

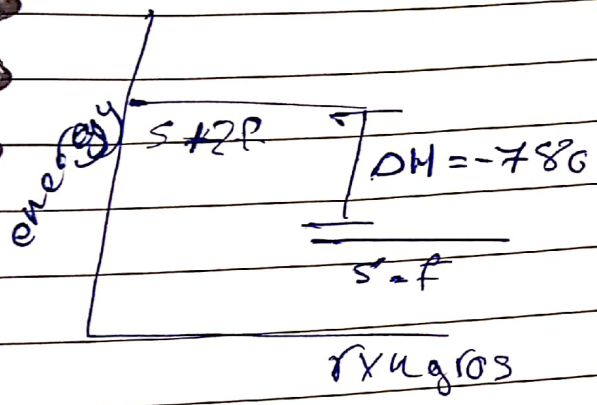
bond	energy
C-H	413
C-C	348
C=C	614
Br-Br	193
C-Br	276

when sulfur react with fluorine the reaction gives -780 kJ/mol



if the bond energy of $F-F$ is 160 kJ/mol
 Find the bond energy of $S-F$?

- 1) draw an energy level diagram?
- 2) Find the bond energy of $S-F$?



$$\Delta H = \text{input} - \text{out put}$$

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

$$\frac{-1100}{4} = \frac{-4S-F}{4}$$

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

note: copper can is more conductive

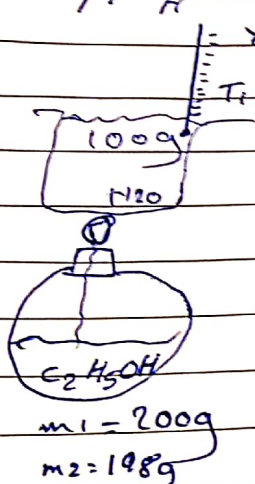
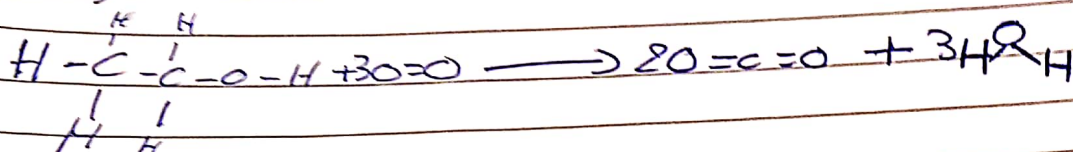
finding ΔH ~~in~~ practically

Combustion

displacement

neutralization

Find ΔH combustion for ethanol



$$Q = mc\Delta T \text{ or } \Delta T = \frac{Q}{mc}$$
$$100 \times 4.2 \times 10$$
$$= 4200 \text{ J} = 4.2 \text{ kJ}$$

4.2 kJ produced \rightarrow 2g $\text{C}_2\text{H}_5\text{OH}$

$$\frac{4.2 \text{ kJ}}{2 \text{ g}} \times 46 \text{ g/mol} = 96.6 \text{ kJ/mol}$$

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

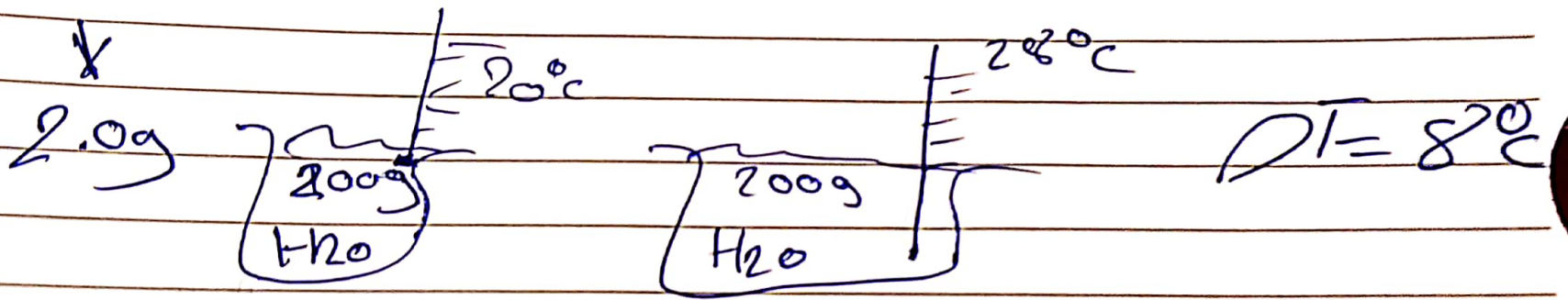
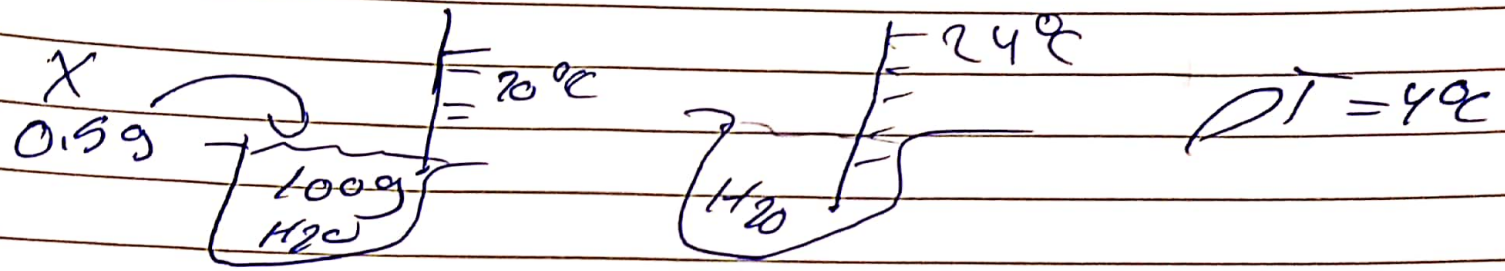
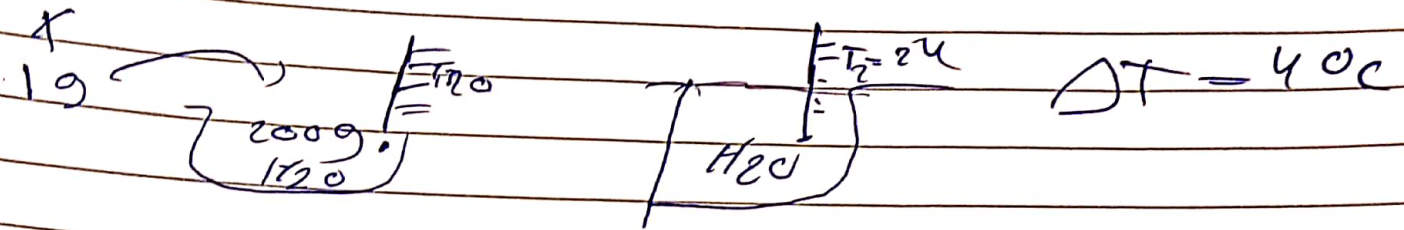
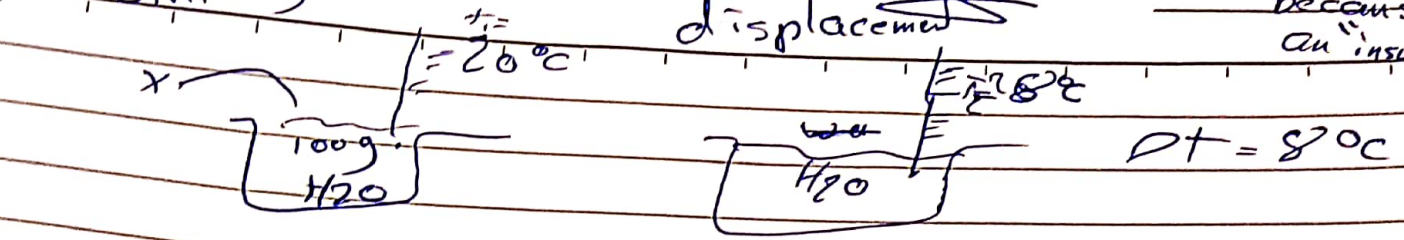
2 Fuels A and B

- plan an experiment to show which fuel produce more energy?
- \rightarrow take a known mass of water with known initial temp in a copper can.
 - \rightarrow take a known mass of fuel A, ignite the fuel and record the final mass and ~~final~~ final temp of water
 - \rightarrow repeat the experiment using fuel B
 - the fuel which causes more ΔH per gram of fuel, produce more energy.

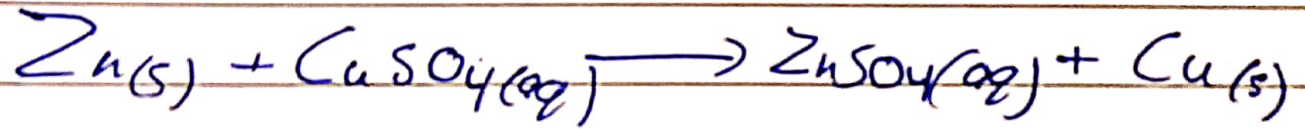
use ~~plastic~~ polystyrene instead of ~~a~~ glass beaker because it's an insulator

Labeling

displacement

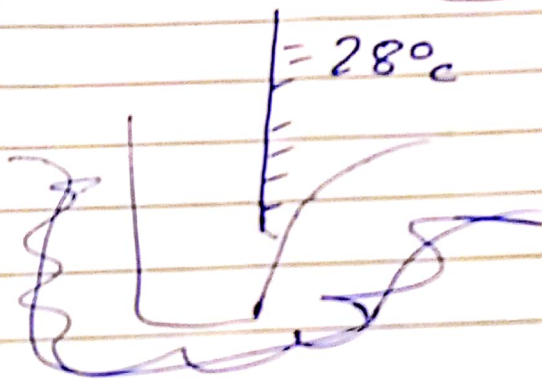
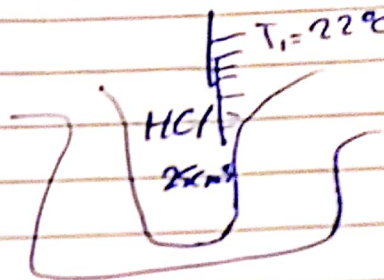
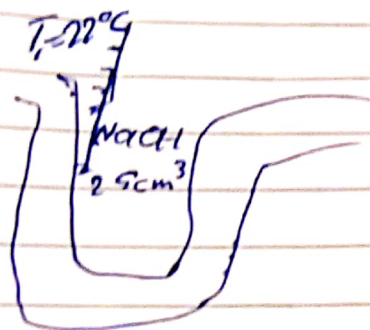


measuring ΔT displacement



neutralization

measuring pH neutralization

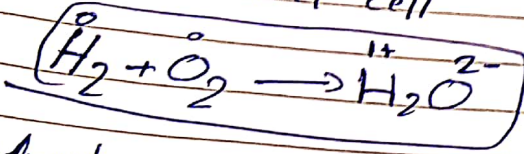


$$\begin{aligned} Q &= mc\Delta T \\ &= 100 \times 4.2 \times 6 \\ &= 1260\text{ J} \\ &= 1.26\text{ kJ/mol} \end{aligned}$$

Alternative Resources
of energy

Physical test: bp = 100°C
Chemical test: $5H_2O \rightleftharpoons CuSO_4 + 5H_2O$ (blue) \rightarrow $K_2CO_3 + 6H_2O \rightleftharpoons K_2CO_3 + 6H_2O$ (pink)
+ test water

Hydrogen Fuel cell



~~memorize all~~

memorize all
this page

advantages of Hydrogen Fuel cell:

- only one waste product
- No CO₂
- produce high amount of energy
- generate electricity

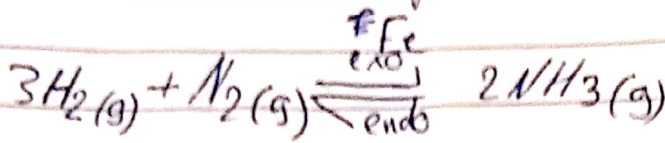
disadvantages of Hydrogen Fuel cell:

- expensive
- hard to store and transport
- Risk of explosion

Note: ~~CH₄~~ CH₄ is methane

air
78% N₂ 0.03% CO₂
21% O₂ 0.01% H₂
0.4% Ar 0.06% other

Industrial Industry of Ammonia "Haber process"



pH = -ve

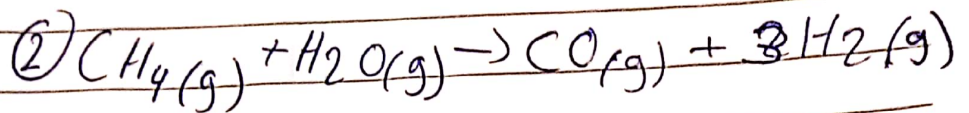
How to obtain:

① Nitrogen: - fractional distillation of liquid air

different B.p

cooling under high pressure

② Hydrogen: ① cracking of Alkanes (organic)



essential conditions

1) temp 400°C - 450°C

less than 400°C

advantages
higher yield of NH₃

disadvantage
slower rate of ~~rate~~ reaction.

- shift forward
- to the exo side

more than 450°C

advantages
fast rate

disadvantage
less yield of NH₃

② pressure 200 atm

advantage
1. more yield of NH₃
shift forward to ~~exo side~~ side with less gas mole.

disadvantages
1 - risk of explosion
2 - expensive

2 - ~~fast~~ faster rate of reaction

~~uses of NH_3 - Fer~~

③ Fe catalyst

add excess H_2 and N_2
~~return back to convert or~~
~~remove NH_3 immediately~~
~~by cooling~~

Uses of ammonia

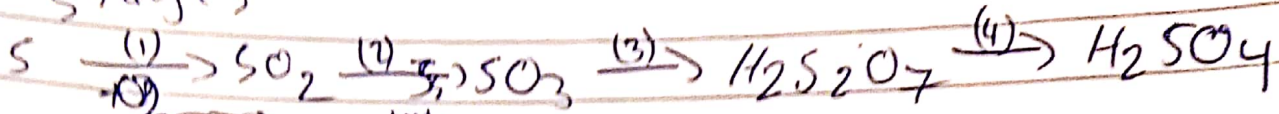
1- fertilizers

2- Cleaning detergents.

3- smelling salts (GYN ~~sett~~ salts)

(Industry of) Contact process

stages



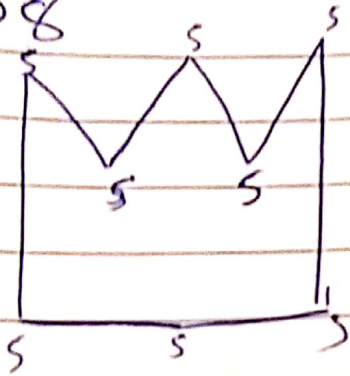
contact process

(1): Roasting
group (VI)

- Valency (2)

- yellow solid

- 5g



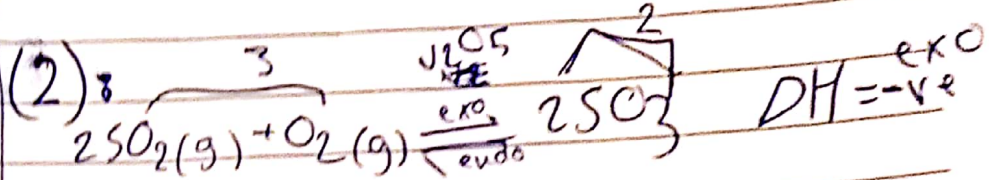
uses: medicine

* ~~match~~ match

* rubber

ore: * zinc blende ZnS

* from fossil fuels



essential conditions

1) temp $400^\circ C - 450^\circ C$

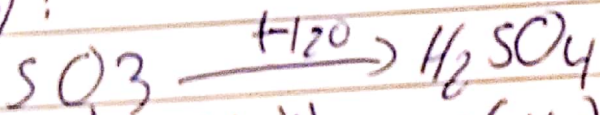
2) pressure 2 atm ~~high pressure~~
 $2 \text{ atm gives max yield of } SO_3$ memorize

3) catalyst V_2O_5
vanadium (V) oxide

note: SO_2 cause acid rain

* uses: ~~at~~ kills bacteria
 * paper and bleaching

(3):



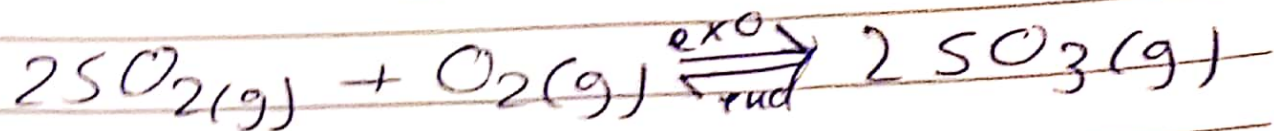
- highly exo (violent)

H_2SO_4 - pr

H_2O

H_2SO_4

a) sulphuric acid is made by the contact process



i) what are the reaction conditions for the contact process?

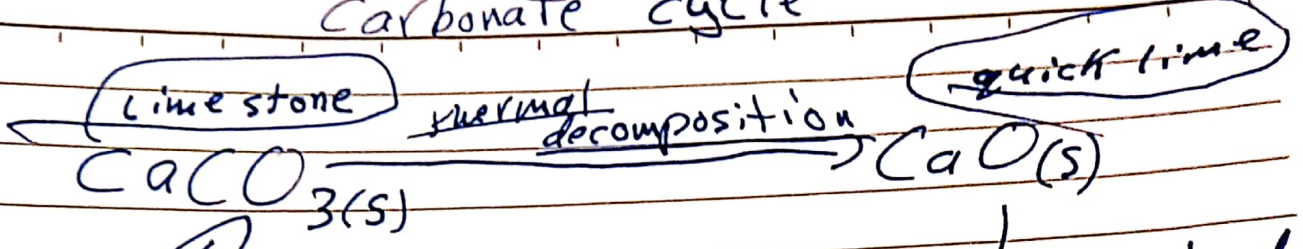
- temp from 400°C to 450°C

- the pressure has to be 2 atm

- catalyst V_2O_5 vanadium (V) oxide

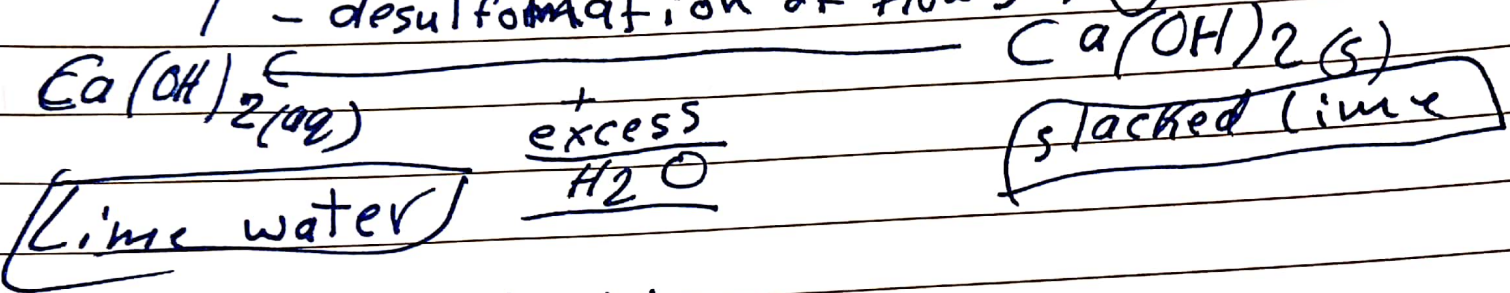
ii) would the yield of sulphur trioxide increase, decrease or stay the same when the temp is increased

Carbonate cycle



+CO₂ \nearrow bases \searrow +limited H₂O

- neutralise acidic soil water
- desulfomation of flow gasses

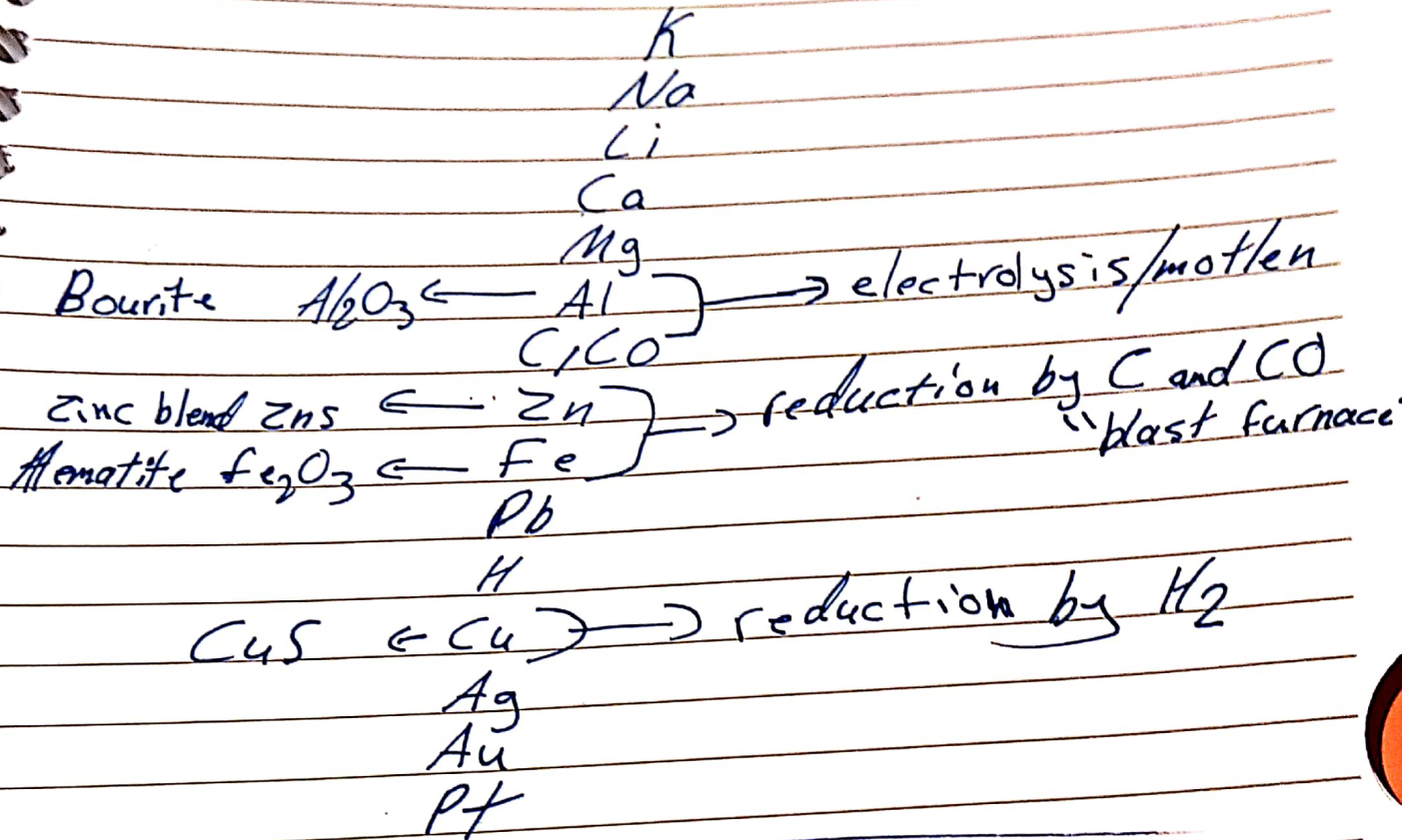


CaCO_3 \leftarrow building extraction of Iron

$\text{CaO} \rightarrow$ dry NH₃

$\text{Ca(OH)}_2 \rightarrow$ test CO₂

Extraction of metals



extraction of Iron:

ore: Fe_2O_3 "Hematite"

method: reduction by C and CO

place: blast furnace

raw materials: - Fe_2O_3 mixed with S, O_2

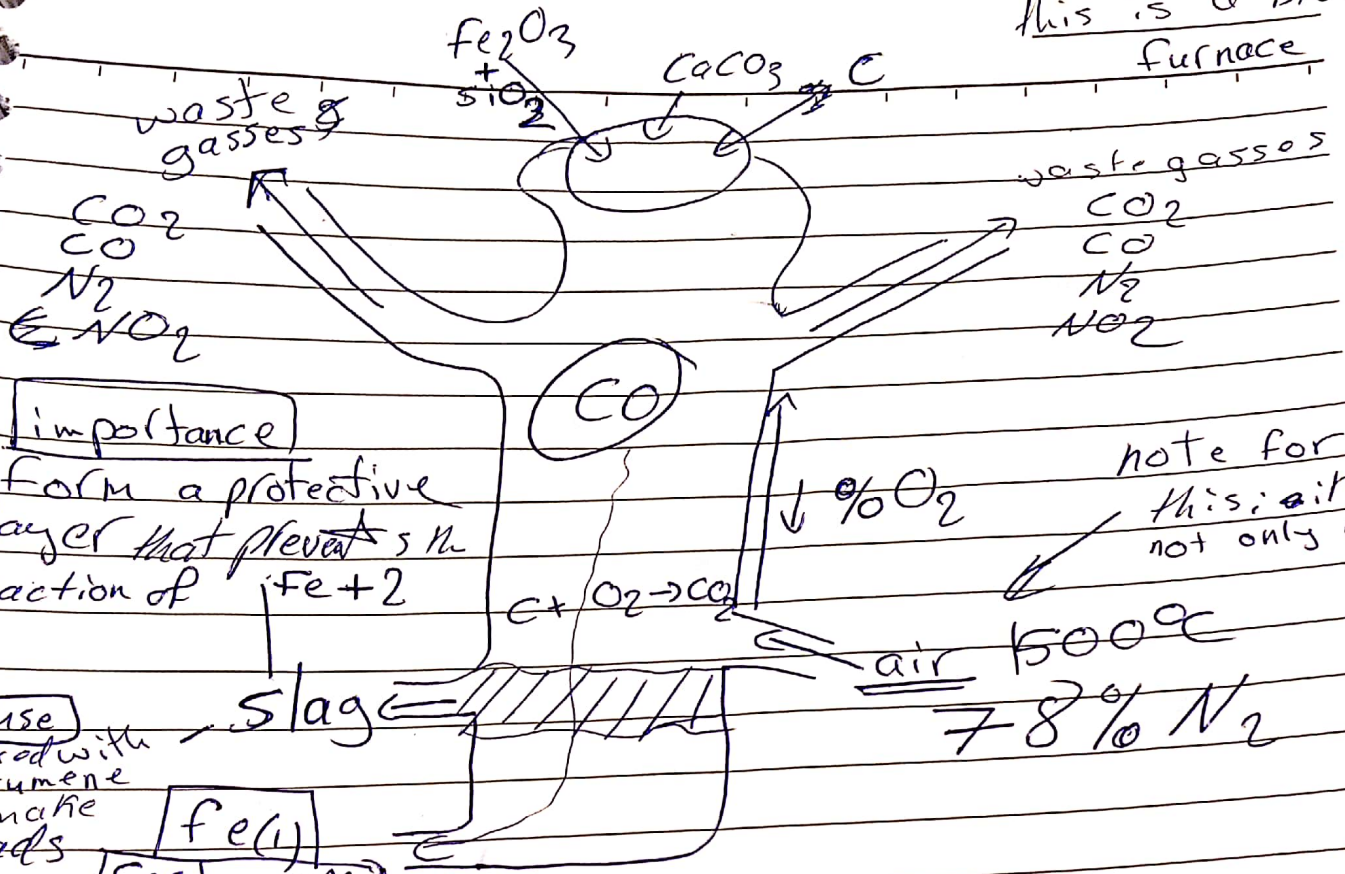
$CaCO_3$ "lime stone"

coke "carbon" "pure"

air $1500^\circ C$

acidic
impurities

this is a blast furnace



importance

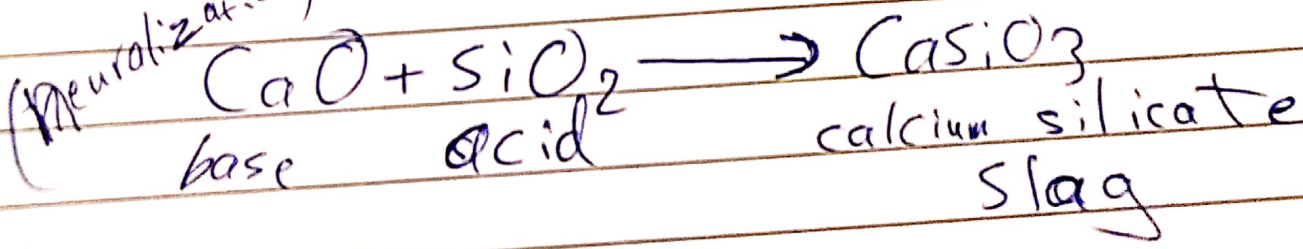
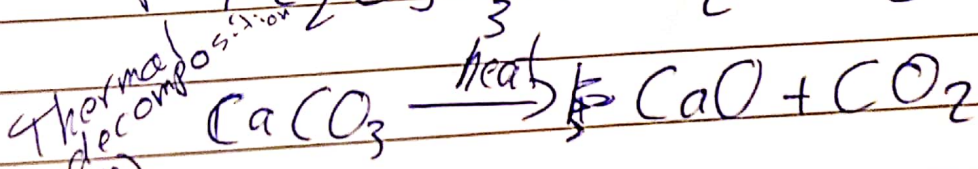
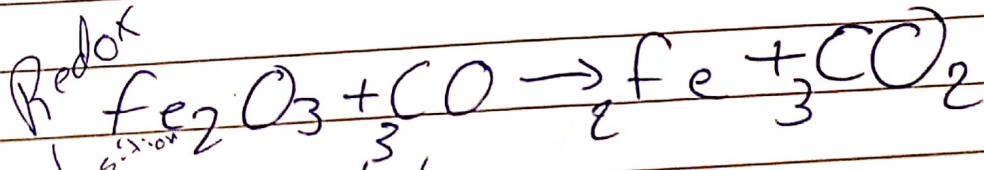
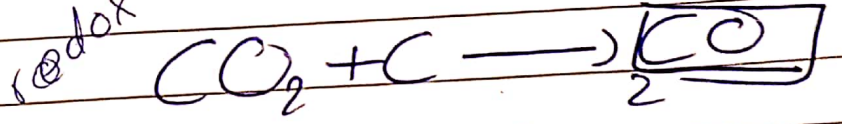
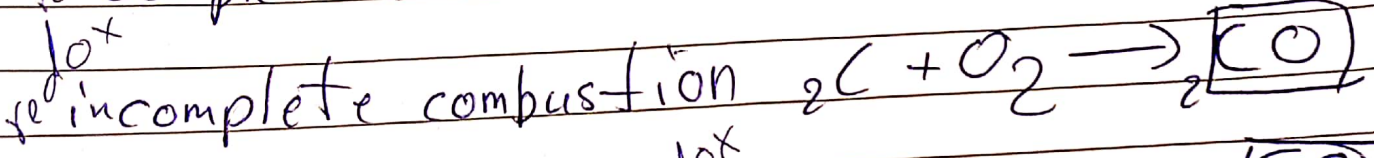
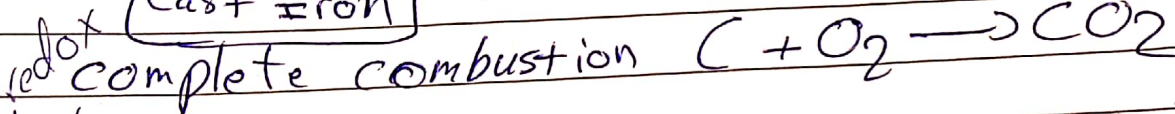
form a protective layer that prevents the reaction of $Fe+2$

note for this: air is air not only O_2

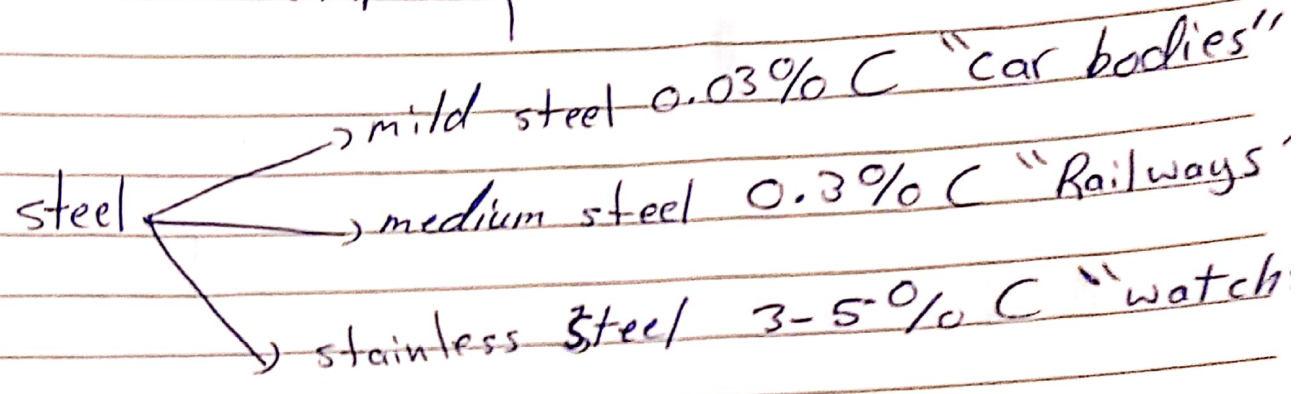
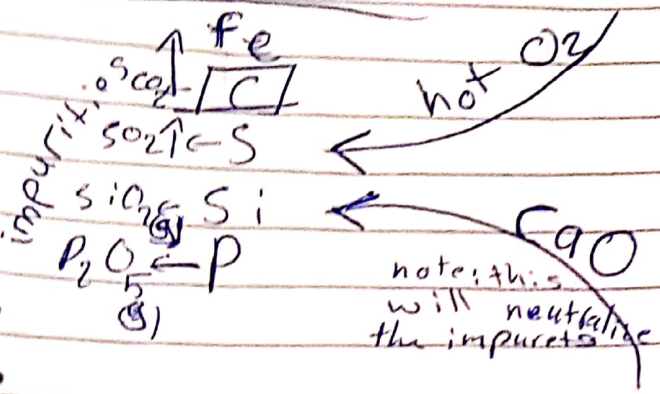
use

mixed with bitumene to make roads

Fe(l)
Cast iron



cast Iron steel making "oxygen base process"



Alloy

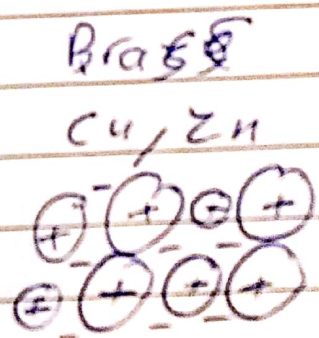
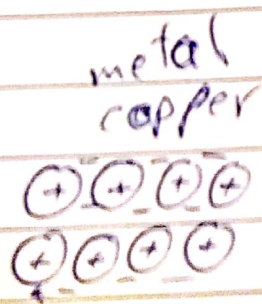
it's a mixture of metal with another metal or semi metals

Brass Cu, Zn

Sn = ten

Bronze Cu, Sn

steel Fe, C, Ni, Cr



same size

harder than pure metal
different size of metals

extraction of zinc

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

Ore: Zinc blende ZnS

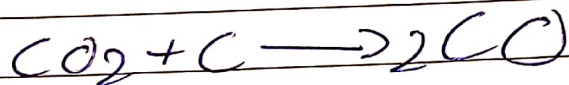
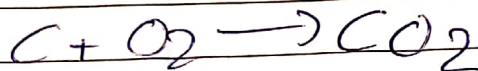
method: reduction by C and CO

place: Blast furnace

step 1: Roasting with hot oxygen



step 2:



The temp inside the furnace is $1500^\circ C$ and the boiling point is ~~$907^\circ C$~~ $907^\circ C$, so it's produced as a pure gas must condense, and the other impurities ~~since~~ ~~the~~ have high boiling points stay in furnace.