

Redox

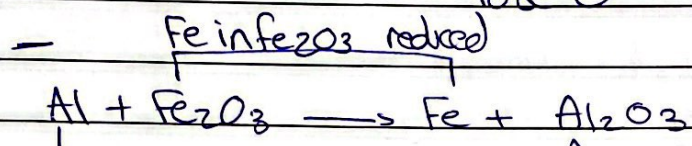
in terms of
oxygen

reduction

oxidation

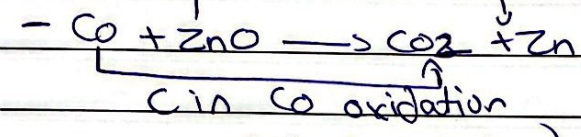
lose O

gain O

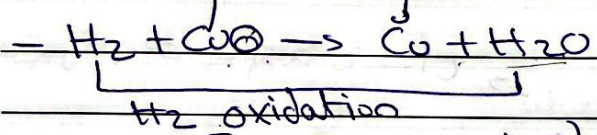


oxidation gain O

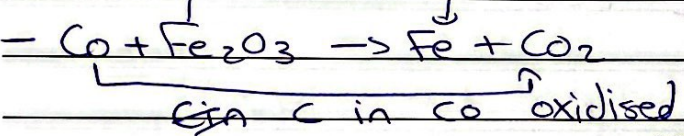
zn in ZnO reduced



cu in CuO reduced



Fe in Fe₂O₃ reduced



Redox

in terms of

oxygen hydrogen

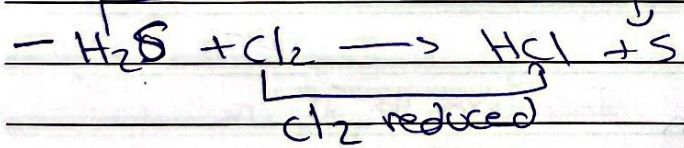
reduction

oxidation

gain H

lose H

oxidation S in H₂S



Redox

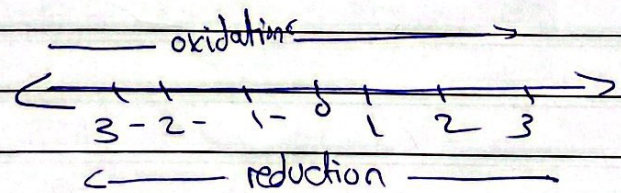
oxidation state

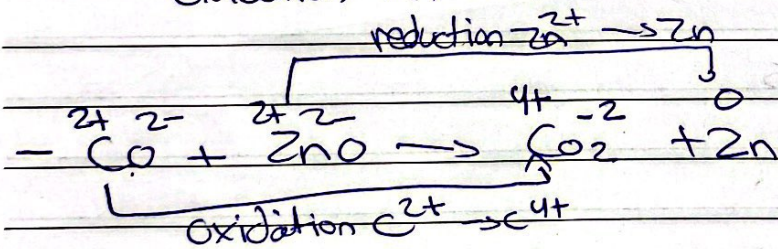
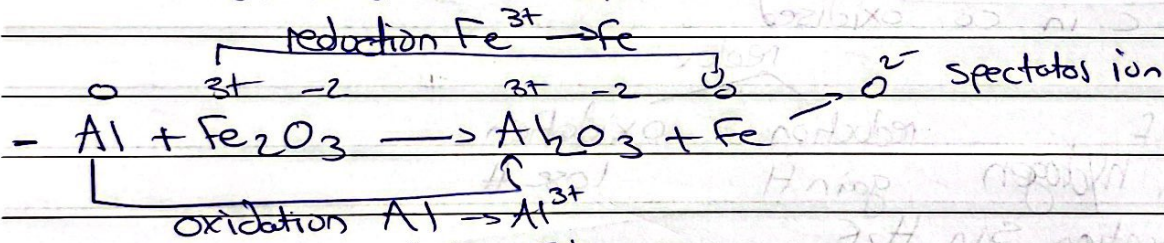
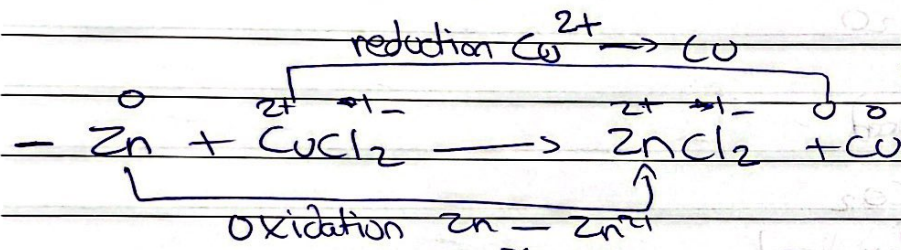
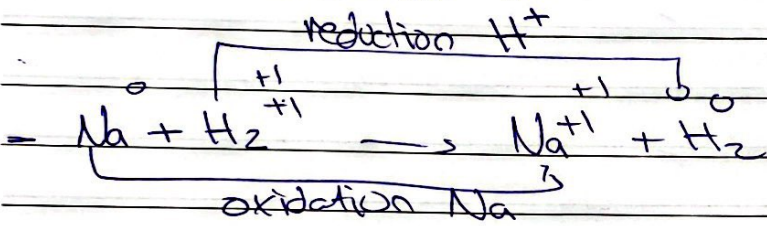
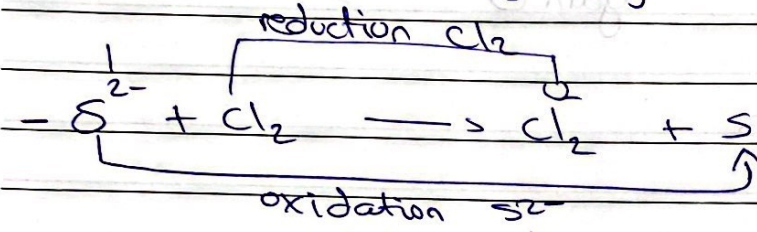
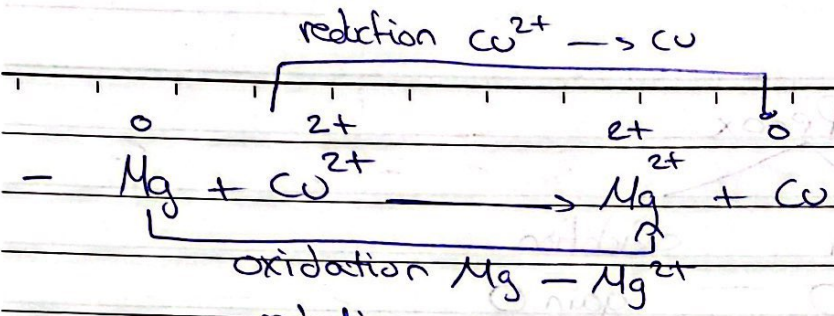
reduction

oxidation

decrease

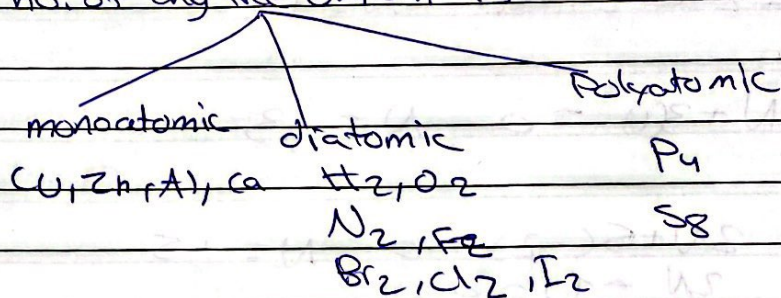
increase





Rules for oxidation

7 the oxidation no. of any free element is zero



- the oxidation no. of any atom in a compound

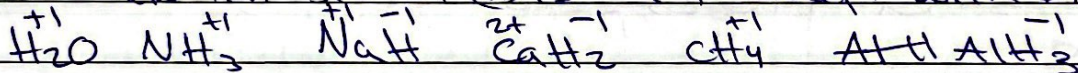
from group I = +1 Li, Na, K, Rb, Cs, Fr

group II = +2 Mg, Ca, Ba, Sr

group III = +3 always only for (Al)

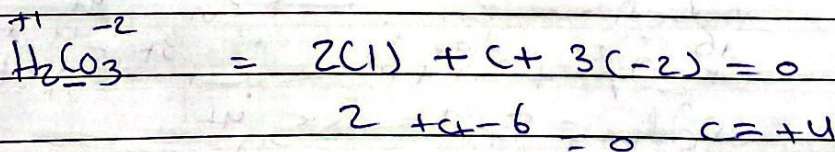
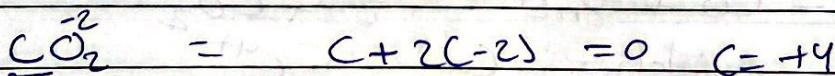
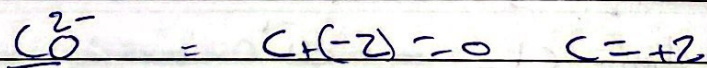
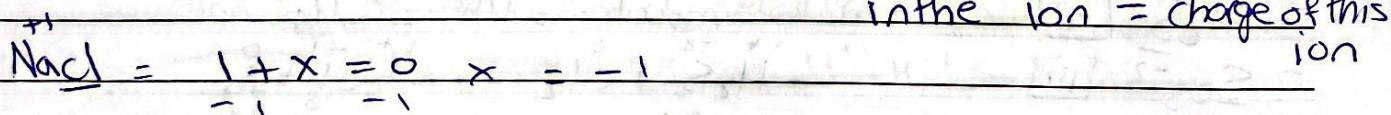
group VII = -1 always for (F)

- the oxidation state of (H) is +1 except with metals (-1)



- the oxidation state of O is (2-) except in peroxide (1-)
 except in OF₂ (2+)

- the sum of all oxid state of all atoms in the compound = zero



+5
+5
0 0

$$\underline{\text{NO}} = N - 2 \cdot 0 = 0 \quad N = +2$$

$$\underline{\text{NO}_2} = N + 2 \cdot (-2) = 0 \quad N = +4$$

$$\underline{\text{NH}_3} = N + 3(0) = 0 \quad N = -3$$

$$\underline{\text{N}_2\text{O}_5} = 2N + 5(-2) = 0 \quad N = +5$$

$$2N + 10 = 0$$

$$\underline{\text{NO}_3^-} = N + 3(-2) = -1$$

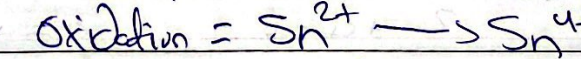
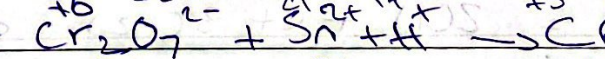
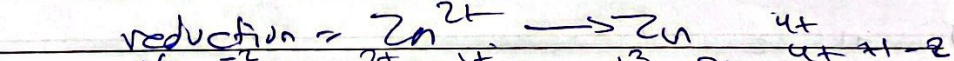
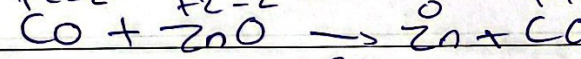
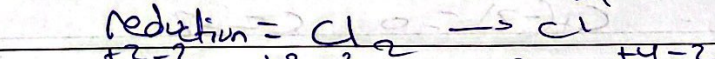
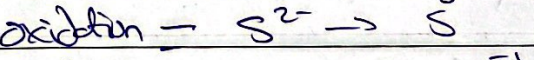
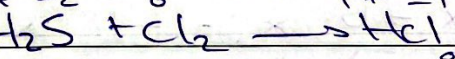
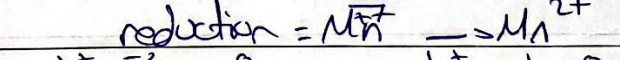
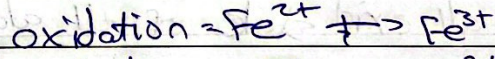
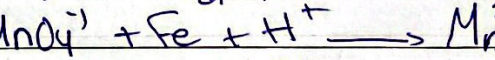
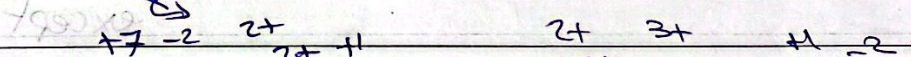
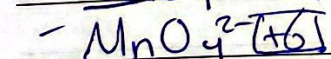
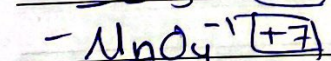
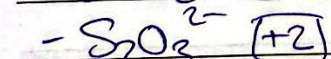
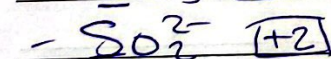
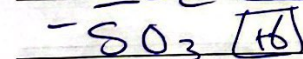
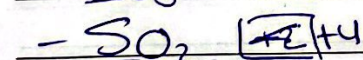
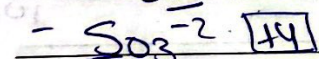
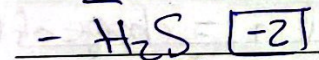
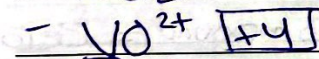
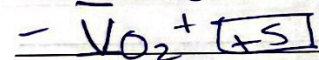
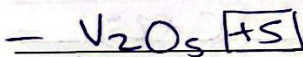
$$N - 6 = -1 \quad N = +5$$

$$\underline{\text{NO}_2^-} = N + 2(-2) = -1 \quad N = +3$$

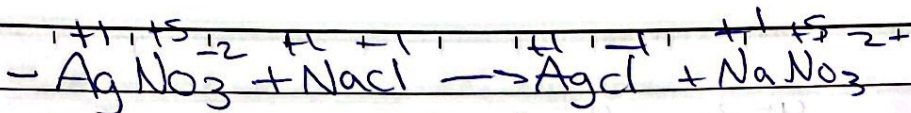
$$\underline{\text{Cr}_2\text{O}_7^{2-}} = 2\text{Cr} + 7(-2) = -2 \quad 2\text{Cr} - 14 = -2 \quad \text{Cr} = +6$$

$$\underline{\text{CrO}_4^{2-}} = \text{Cr} + 4(-2) = -2 \quad \text{Cr} = +6$$

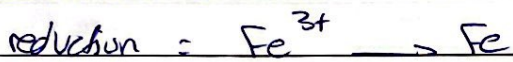
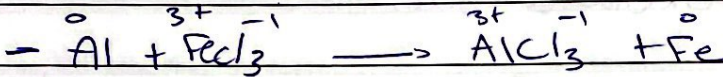
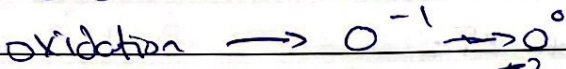
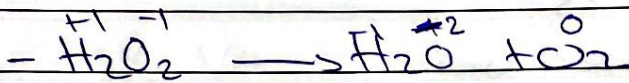
find the oxidation state of all underlined atoms



~~41~~ 9



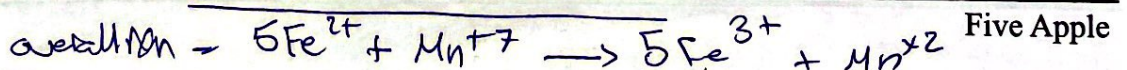
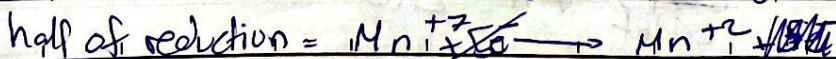
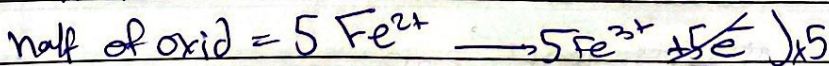
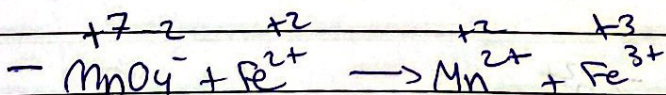
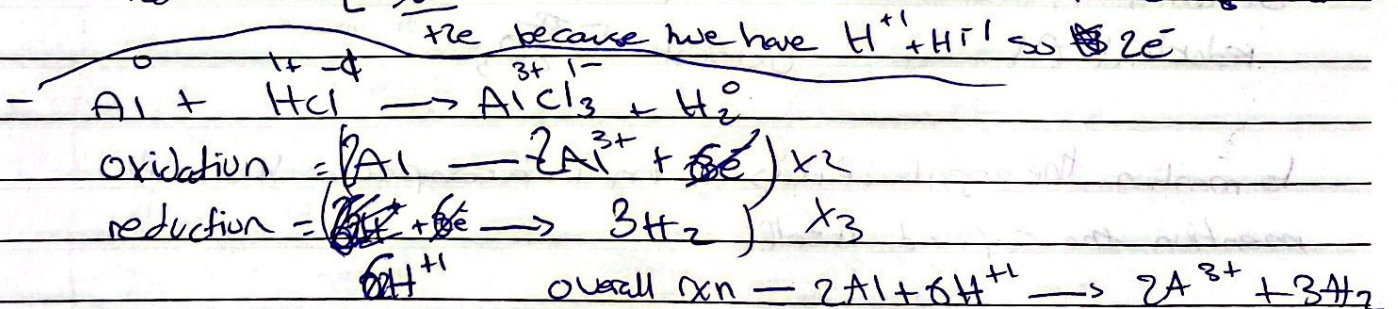
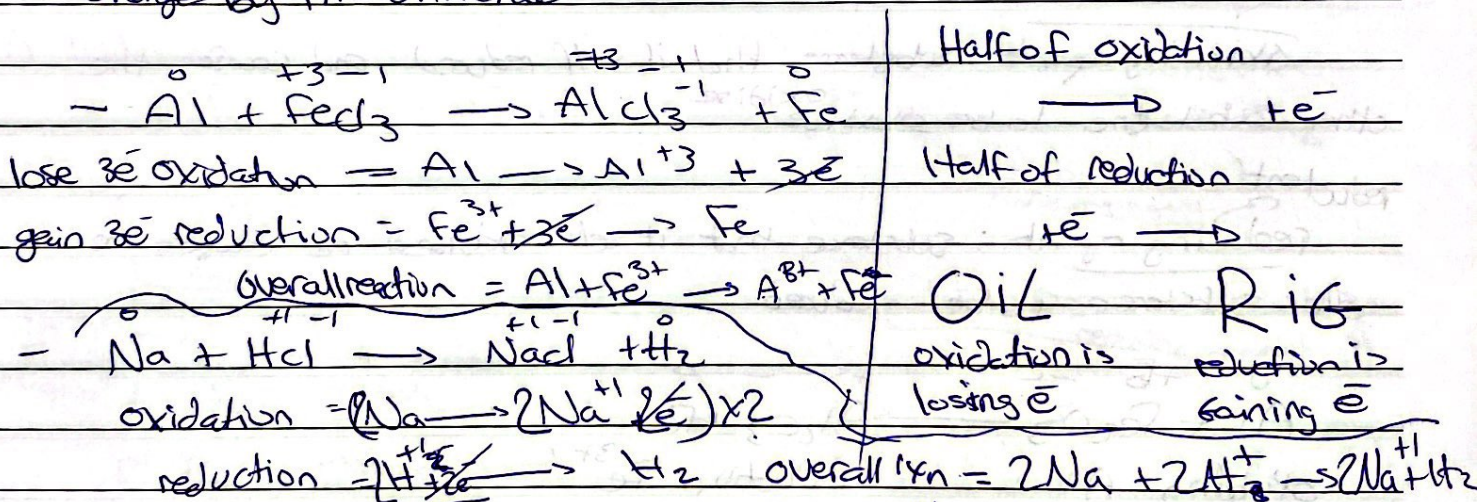
not redox

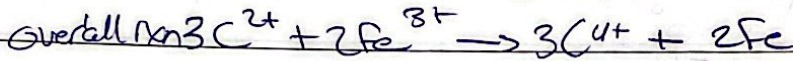
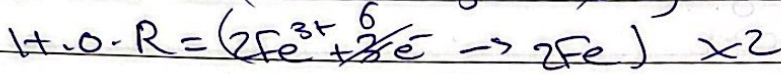
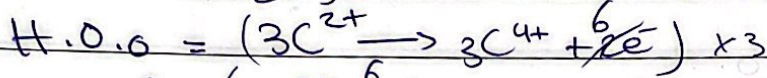
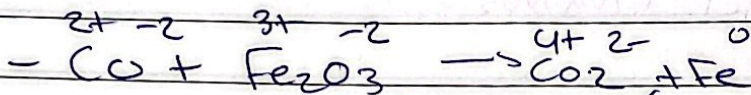


Writing Half Ionic equation "Balanced"

1) Balance the atoms

2) Balance the charge by adding e^- 's to the side that has greater charge by the difference





- to Identify which species oxidise or reduce

oxidation state

↑ oxidation

↓ reduction

- to define the oxidation and reduction

Oil Rig

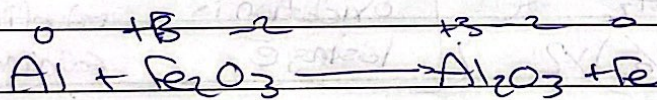
oxidising and reducing agents

oxidant

oxidising agent: substance that it self reduced and causes the other substance to be oxidise

reductant

reducing agent: substance that it self oxidise and causes the other substance to be reduced



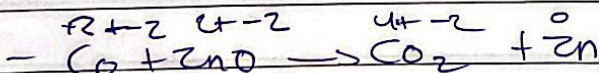
oxidation Al

reduction Fe³⁺

reductant Al

oxidant Fe₂O₃

- to mention the agent if it is an ion in a compound you must mention the compound itself.



oxidation C²⁺

reduction Zn²⁺

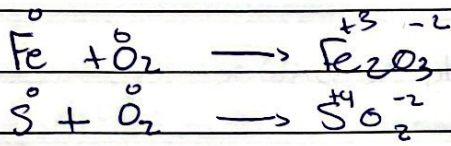
reducing agent = Co

oxidant ZnO

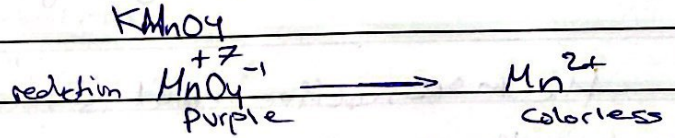
reducing agent

oxidant

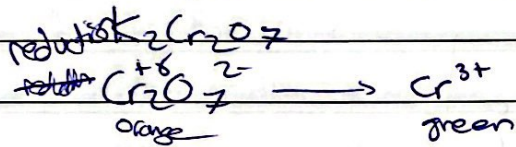
most common oxidising agent :-



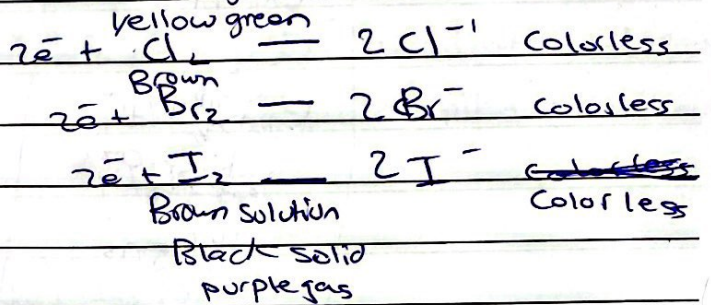
2) Acidify potassium manganate



3) acidify potassium dichromate



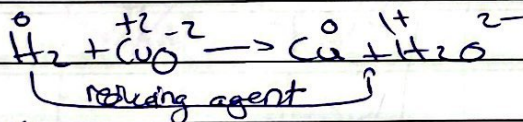
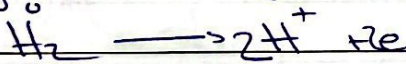
4) Halogens reduction



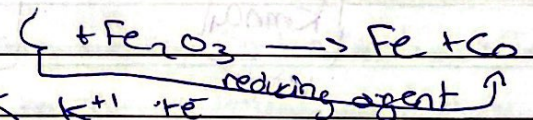
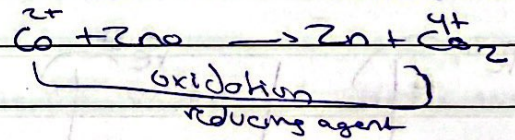
most common reducing agent :-

2) metals

1) Hydrogen



2) carbon / carbon monoxide



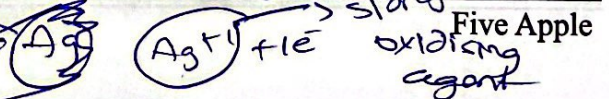
strongest reducing agent

- (K) most reactive metals
- Na
- Li more able to lose e⁻
- Ca
- Mg more able to oxidise
- Al more able to be reducing agent
- C, Co
- Zn
- Fe
- Pb
- H
- Cu

- K $\text{K}^{+1} + 1\text{e}^-$
- Na $\text{Na}^{+1} + 1\text{e}^-$
- Li $\text{Li}^{+1} + 1\text{e}^-$
- Ca $\text{Ca}^{+2} + 2\text{e}^-$
- Mg $\text{Mg}^{+2} + 2\text{e}^-$
- Al $\text{Al}^{+3} + 3\text{e}^-$
- C, Co
- Zn $\text{Zn}^{2+} + 2\text{e}^-$
- Fe $\text{Fe}^{2+} + 2\text{e}^-$
- Pb $\text{Pb}^{+2} + 2\text{e}^-$
- H
- Cu $\text{Cu}^{2+} + 2\text{e}^-$

weakest reducing agent

strongest oxidising agent



Five Apple

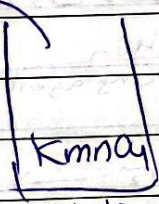
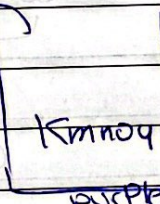
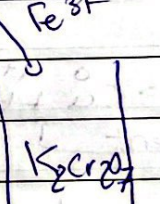
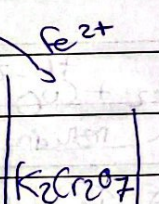
the less reactive ion is more likely to reduce
the less to be oxidising agent


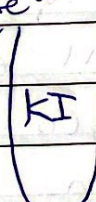
the more reactive metal is more likely to oxidise
the more to be reducing agent.

oxidant	reductant
O_2	H_2
$KMnO_4/H^+$	C, Co
$K_2Cr_2O_7/H^+$	metals
Halogens	Iodide

Q Fe^{2+} is reducing agent
 Fe^{3+} is oxidising agent

write observation in each of the following

Fe^{2+}  purple from purple to colorless $MnO_4^- \rightarrow Mn^{2+}$	Fe^{3+}  purple stays same	Fe^{3+}  stays orange	Fe^{2+}  from orange to green
--	--	---	---

Fe^{2+}  colorless stays colorless	Fe^{3+}  colorless change to red-brown $2I^- \rightarrow I_2 + 2e^-$
--	---

ice doesn't dissolve it melts
 (aq) is a solution that its physical state liquid
 contains things

Electrolysis

Electricity

Analysis

"Breaking down"
from solid

Electrolysis: Breaking down Ionic compound, "molten or aqueous" by passing electricity

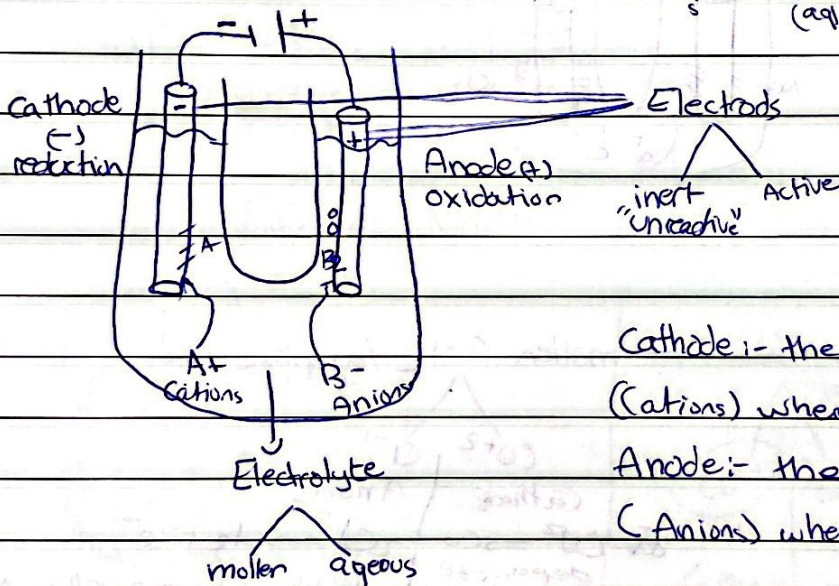
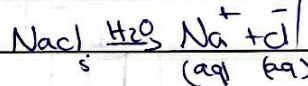
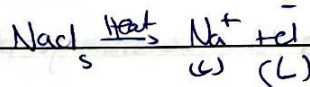
Q why the solid Ionic compound don't conduct electricity?

- ions are not free to move

Q why the ionic compounds conduct electricity when molten or dissolved in water?

- the ions are free to move

Electrolyte: the chemical compound that conduct electricity when molten or aqueous



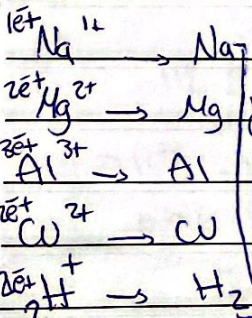
Cathode: - the -ve rod that attracts +ve Ions (Cations) where the reduction takes place

Anode: - the +ve rod that attracts -ve Ions (Anions) where the oxidation takes place.

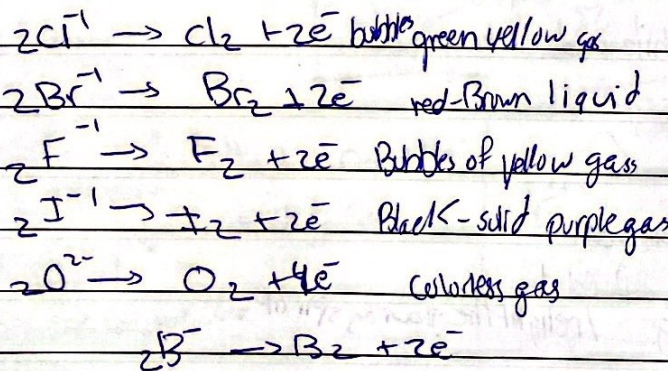
Electrolysis = discharging } Ion → element

Cations

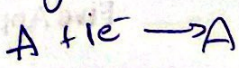
Anions



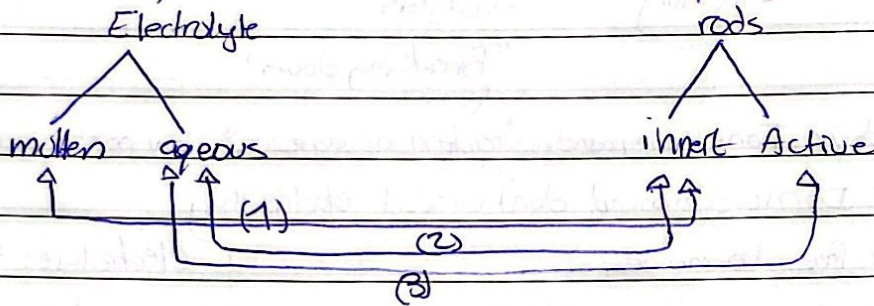
deposit of metals



Bubble of colorless gas

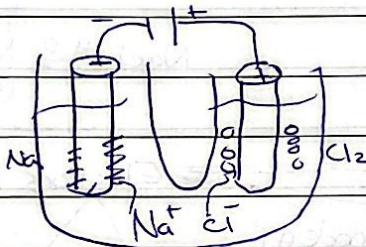
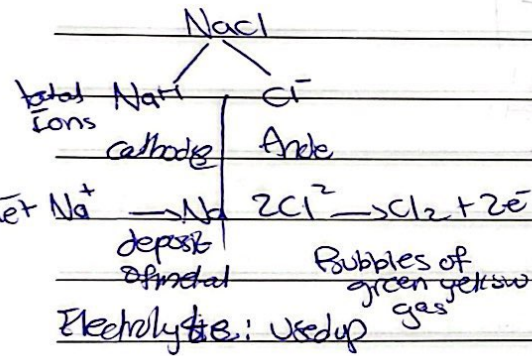


Electrolysis



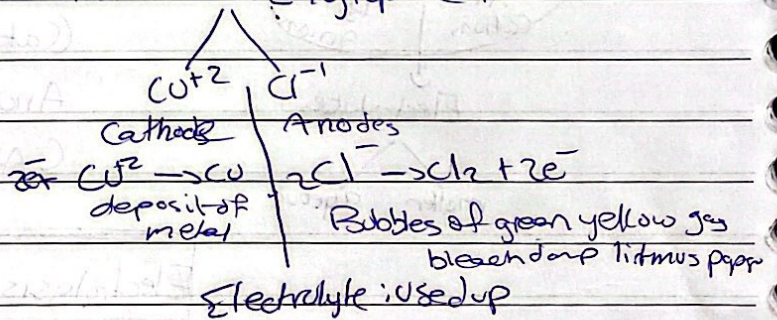
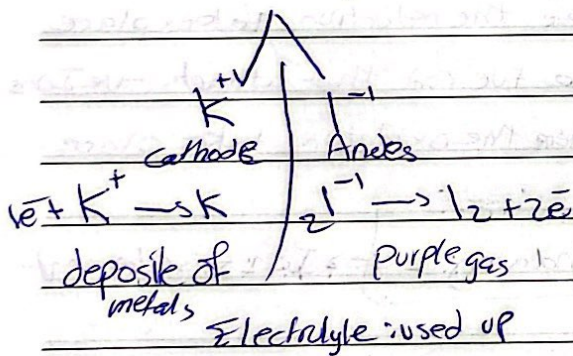
- molten using inert rod

- Electrolysis for molten NaCl using graphite

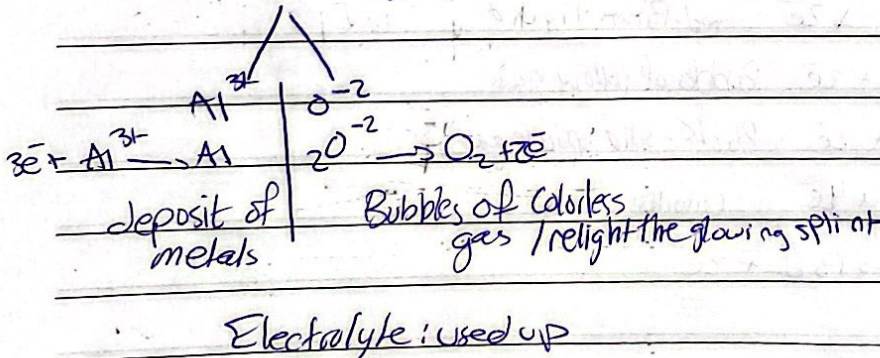


- molten KI / graphite rod

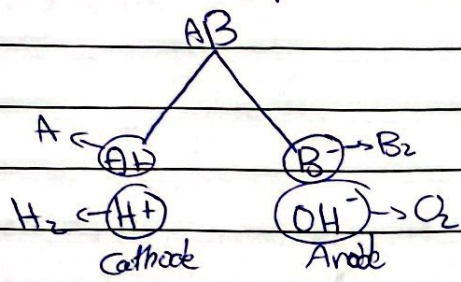
- molten CuCl_2 / graphite rod



- molten Al_2O_3 / graphite rod



- Electrolysis for aqueous electrolyte.

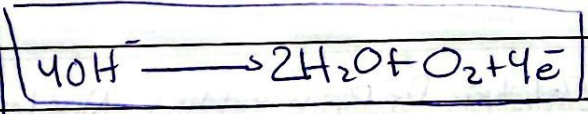
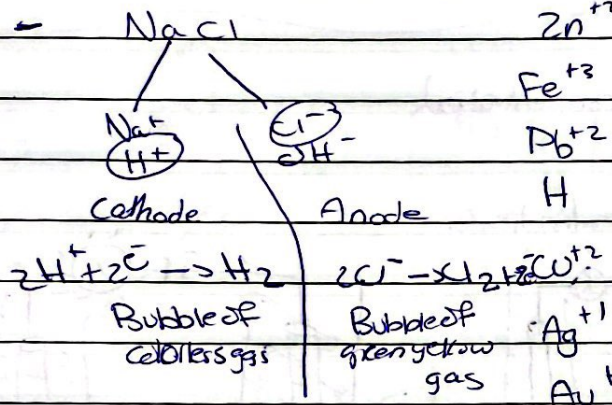


at cathode
 K^+ the less reactive ion is more likely to reduce

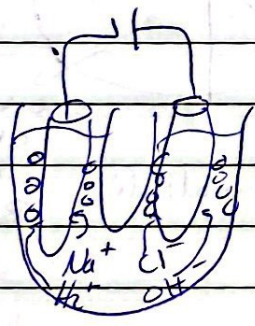
at Anode
 only concentrated halides are more likely to oxidise
 if not concentrated halide the OH^- will oxidise

- Electrolysis for concentration

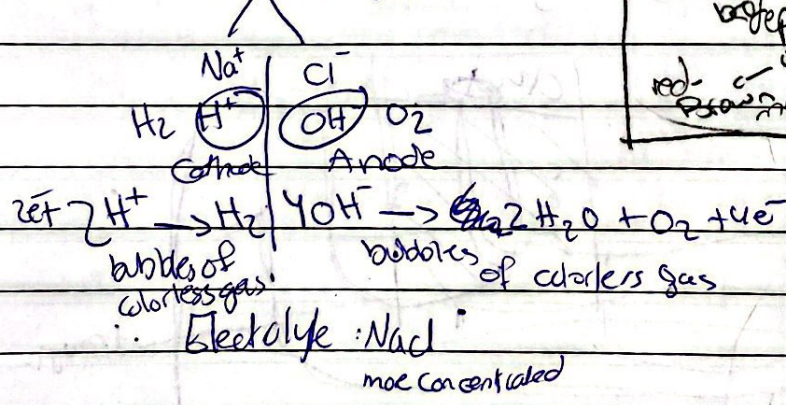
aqueous sodium chloride "Brine" Al^{+3}



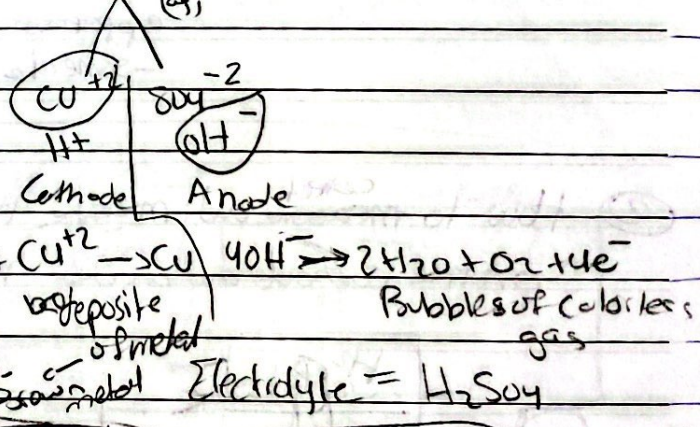
Electrolyte: $NaOH$



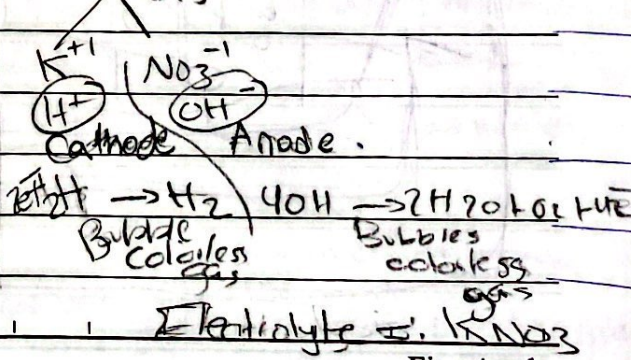
- dilute $NaCl$ / graphite



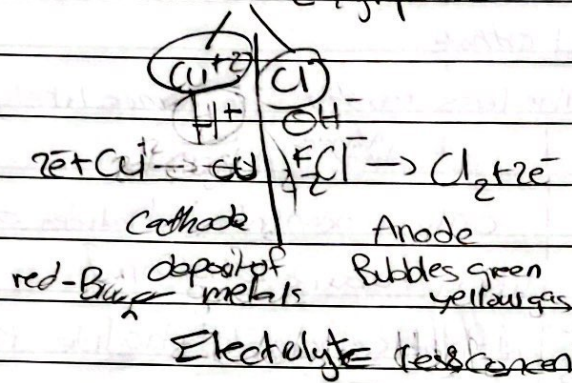
- $CuSO_4$ / graphite



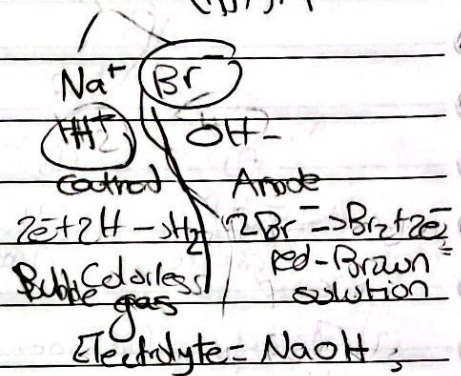
- KNO_3 / graphite



- concentrated CuCl_2 / graphite



- concentrated NaBr / graphite

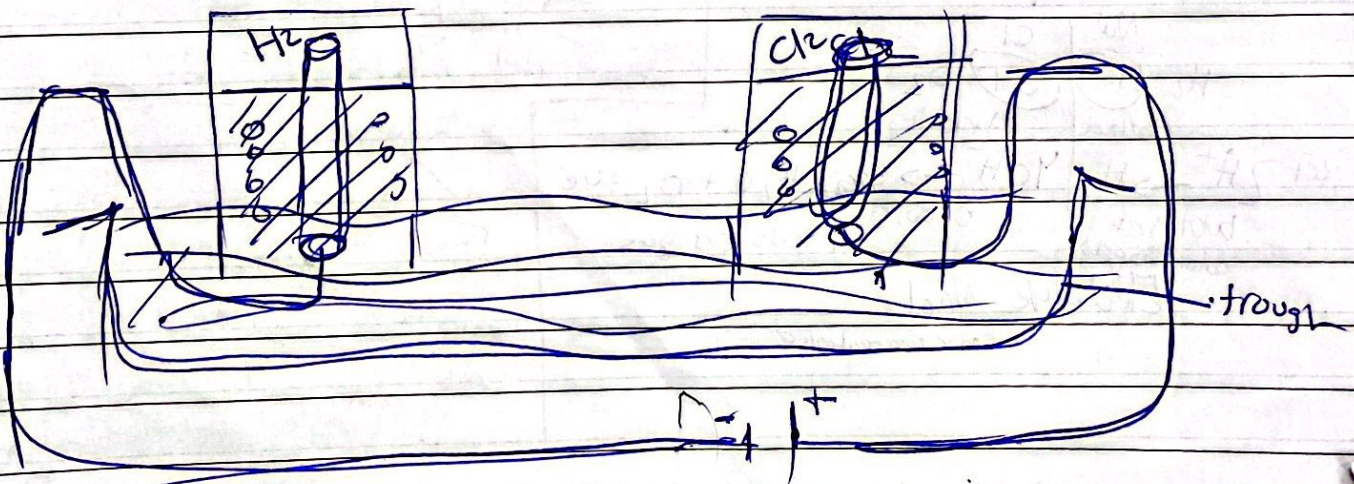


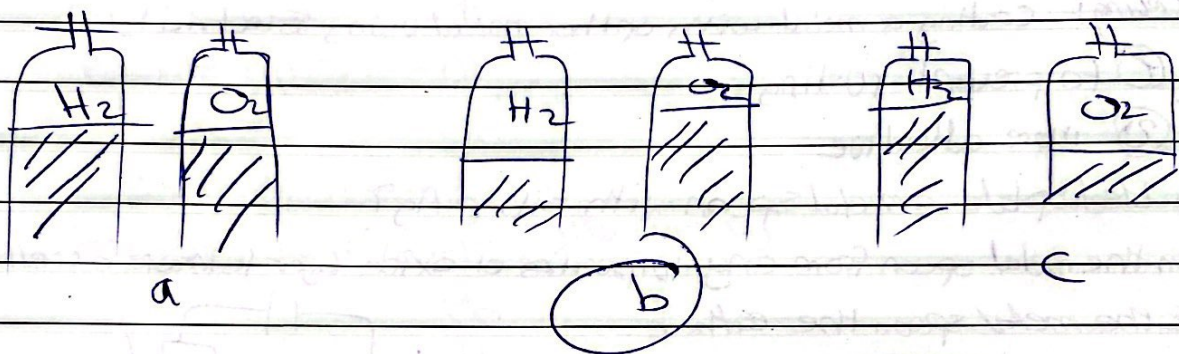
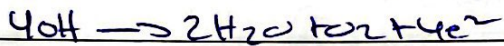
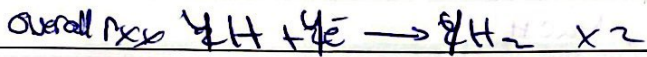
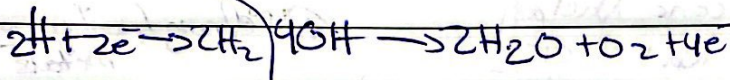
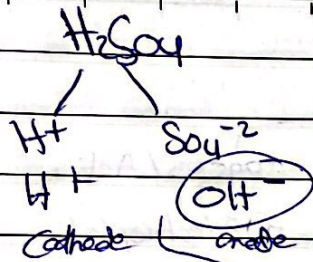
Electrolysis for Brine solution NaCl / concentrated

NaCl
 Na^+ Cl^-
 H^+ OH^-
 $2\text{e}^- + 2\text{H}^+ \rightarrow \text{H}_2$ $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$
 Bubbles of colorless gas Bubbles of green yellow gas
 Electrolyte = NaOH

① Brine + universal indicator

② How to ^{collect} measure and measure their volume the two gases H_2 - Cl_2 on the cathode and anode by using inverted measuring





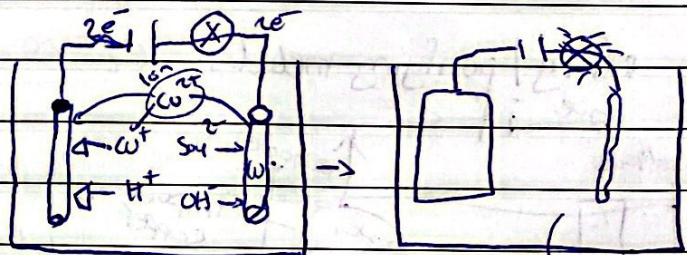
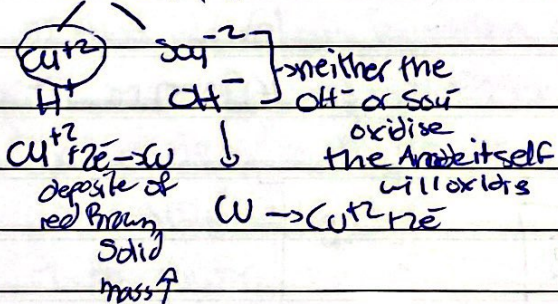
Electrolysis for aqueous electrolyte using active rod

the active rod made from the same metal ion in the electrolyte

$CuSO_4(aq)$ using Cu rod

$AgNO_3(aq)$ using Ag rod

$CuSO_4(aq)$



to Cathode through electrolyte

to anode through wire

$Cu^{2+} + 2e^-$

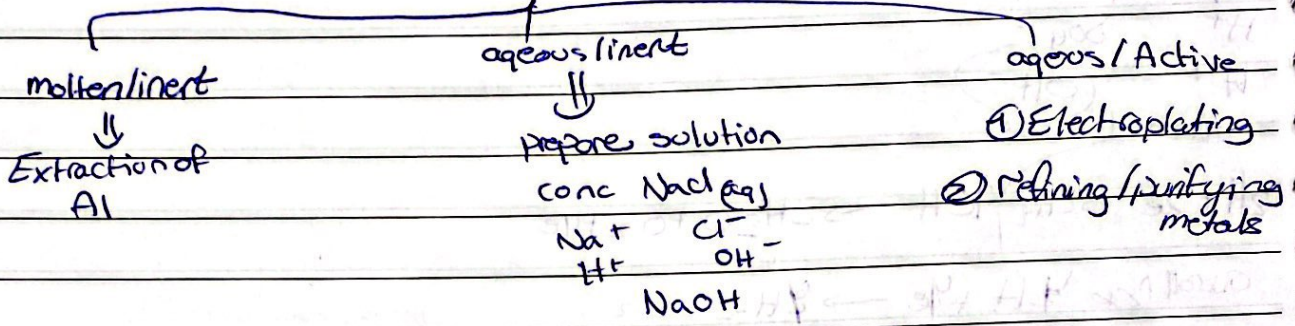
Cathode it's mass increase
Cu²⁺ reduced as Cu deposit

Anode it's mass decrease
oxidise and lose e⁻

important

It's the same because the anode oxidise and replace the Cu^{2+} in the electrolyte
Five Apple with the same rate

application on Electrolysis

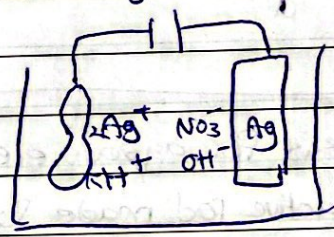


Electroplating:- coating a metal with another metal using Electricity

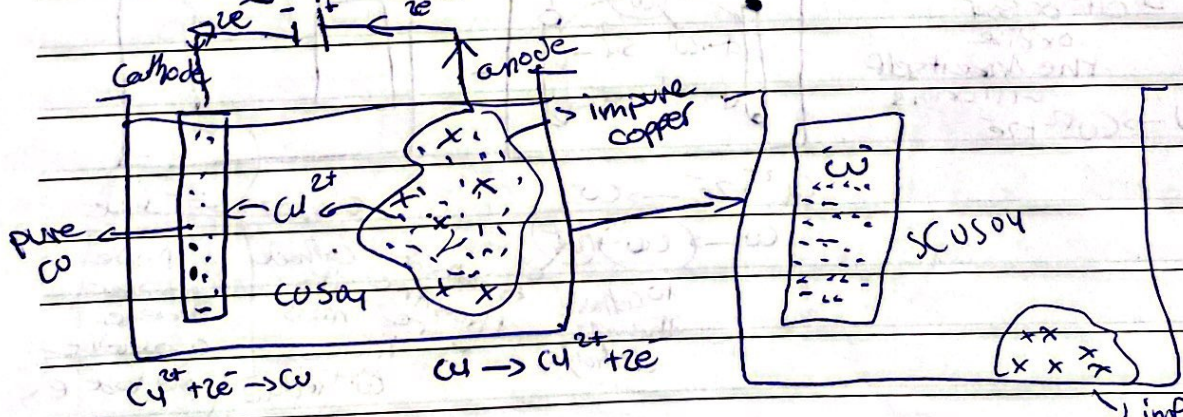
- why? ① to prevent rusting -
 ② more attractive

How to Electroplate a metal spoon with silver Ag?

- ① Clean the metal spoon from any impurities or oxide layer to insure a well stick
- ② make the metal spoon the cathode
- ③ the anode must be silver
- ④ the Electrolyte must has Ag^+ e.g $AgNO_3$
- ⑤ Switch on the ~~switch~~ circuit
- ⑥ rotate the metal spoon to insure an equal distribution
- ⑦ rinsed with distilled water
- ⑧ dry in oven



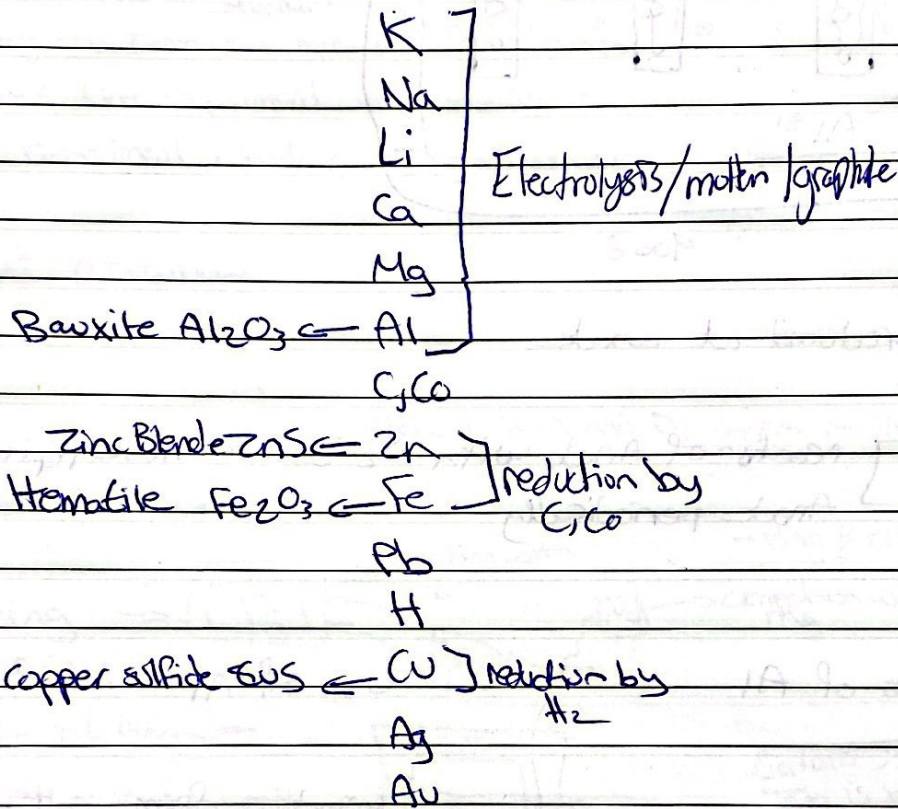
refining/purifying metals



impurities → they are less reactive than Cu
 Ag, Au: settle down
 Zn: displacement replace Cu from $CuSO_4$

Extraction of metals

the method of extraction the metal from its ore depends on the position of this metal in the reactivity series



Extraction of aluminium Al

ore: Bauxite Al_2O_3

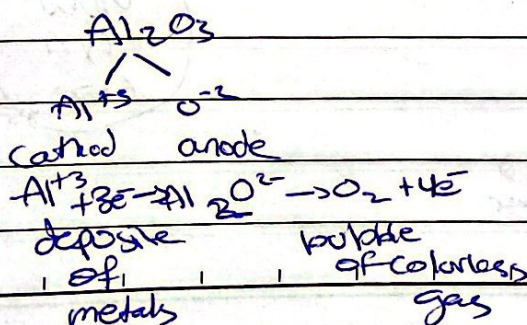
method: Electrolysis for molten ore using graphite

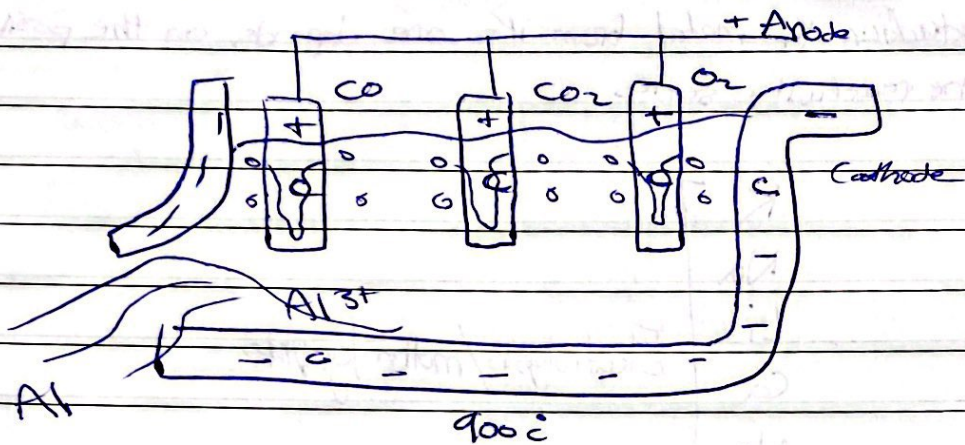
the m.p of Al_2O_3 is 2000°

So we dissolve Al_2O_3 in molten cryolite

Na_3AlF_6 why?

1. to lower the m.p to 900° so less cost
2. to increase the ~~Electric~~ Electrical conductivity





gases produced at anode

- 1 - O_2
 - 2 - CO_2
 - 3 - CO
- Reaction of Anode with O_2 so we must replace the Anode periodically

properties of Al

- malleable
- low density
- form non-toxic oxide layer
- conduct electricity
- ductile

Use of Al

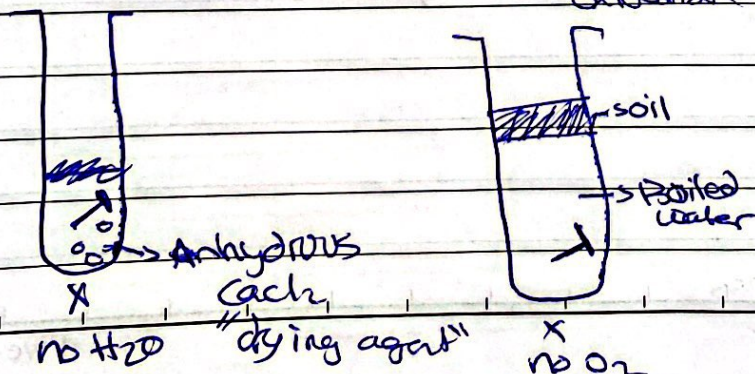
- Window frame, cutting utensils
- Air craft bodies
- Food cans
- electrical wire

- rusting

- the reaction of Iron with both H_2O and O_2



oxidation reaction



Two rust prevention solution A & B Plan an exp to show which is better (6pt)

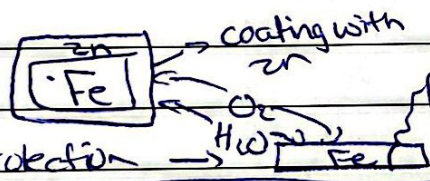
- take a known mass of Iron nail
- apply a known volume of solution A
- and then to a known volume of water for one week
- ~~the~~ dry the Iron nail measure the mass
- repeat the experiment using solution B
- the experiment which caused less increase in mass is the better solution

Rust prevention

- paint
- oiling
- greasing
- cover with Plastic

-> prevent H₂O and O₂ from reaching Fe

- Galvanizing ->



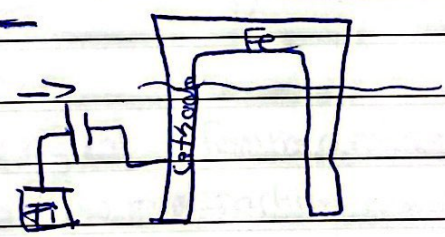
- Sacrificial protection ->



- Mg & Zn are more reactive than Fe more likely to oxidise so Fe is less likely to rust

- Electroplating ->

- Cathodic protection ->



Galvanizing Zn is better than Electroplating

Rate of Reaction

$$\text{rate} = \frac{\text{Change in Quantity}}{\text{change in time}} = \frac{\Delta Q}{\Delta t}$$

$$\frac{\Delta \text{ph}}{\Delta \text{time}} = \frac{1}{s}$$

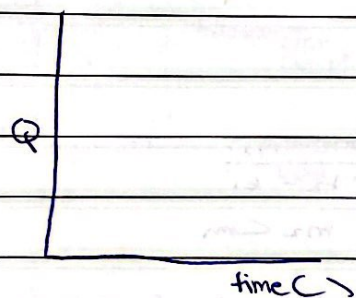
$$\frac{\Delta \text{mass}}{\Delta \text{time}} = \frac{g}{s}$$

$$\frac{\Delta \text{light intensity}}{\Delta \text{time}} = \frac{1}{s}$$

$$\frac{\Delta \text{temp}}{\text{time}} = \frac{^{\circ}\text{C}}{s}$$

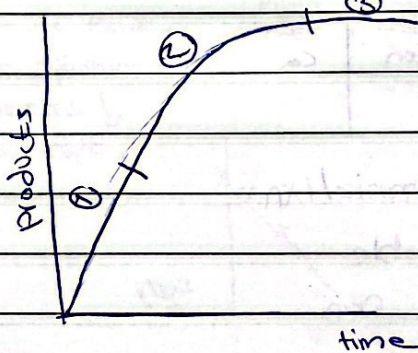
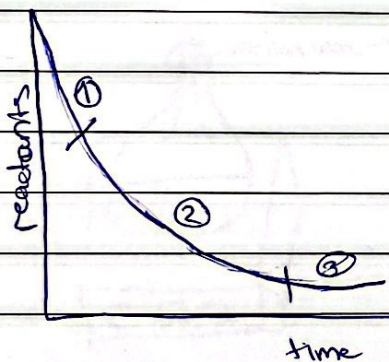
$$\frac{\Delta \text{Volume of gas}}{\Delta \text{time}} = \frac{\text{cm}^3}{s}$$

$$\frac{\Delta \text{Electrical conductivity}}{\Delta \text{time}} = \frac{1}{s}$$



- to measure the rate of Reaction

- measure how fast the reactant consumed Per unit time
- measure how fast the product^{produced} per Unit time



region (1) = the rate is the highest \Rightarrow from the curve: steepest ^{high} gradient

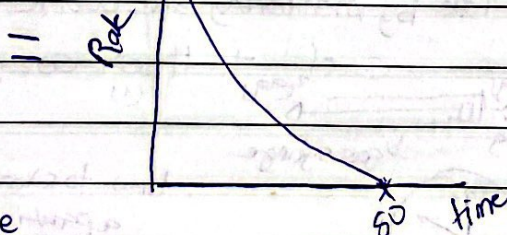
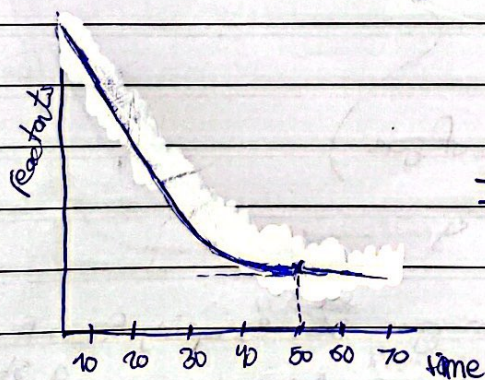
more reactant so more particles so more effective collisions per unit time

Region (2) = the rate is slower \Rightarrow from the curve: less steep / lower gradient

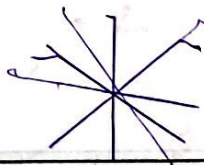
less reactant so less particles so less effective collisions per unit time

region (3) = the reaction is over \Rightarrow from the curve: horizontal line gradient = 0

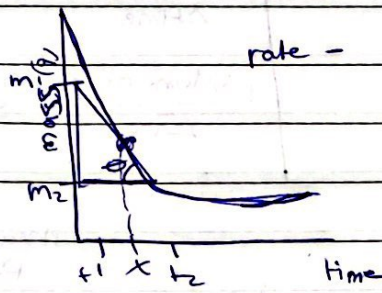
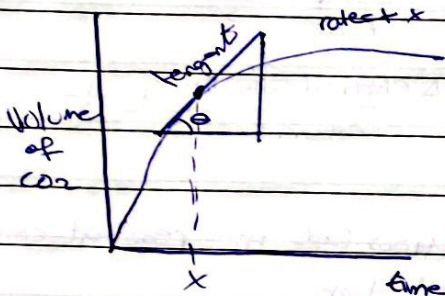
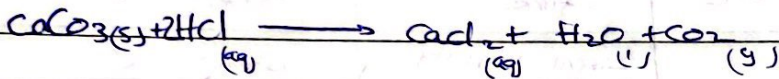
no more limiting reagent no more effective collisions per unit time



with a ruler

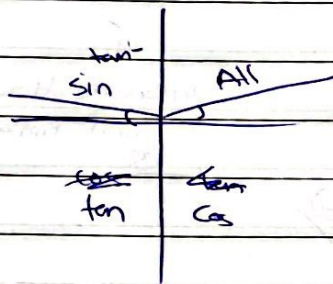


from the graph how to measure the rate \rightarrow find the gradient



$$\text{rate} = \frac{\Delta m}{\Delta t} = \frac{m_2 - m_1}{t_2 - t_1}$$

$m_2 < m_1$

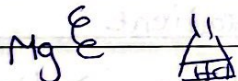


3 main conditions for any chemical rxn:

① the reactant must be suitable



② the reactant must collide



no more limiting factor

③ the collision must be effective

the particles have minimum amount of energy needed to start the reaction

time (s)	0	10	20	30	40	50	60
vol (cm ³)	0	8	13	15	16	16	

8 + 5 = 13
13 + 2 = 15
15 + 1 = 16

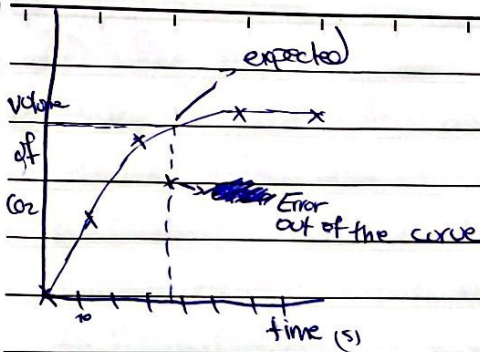
Activation energy E_a

① measuring the rate by monitoring the volume of gas

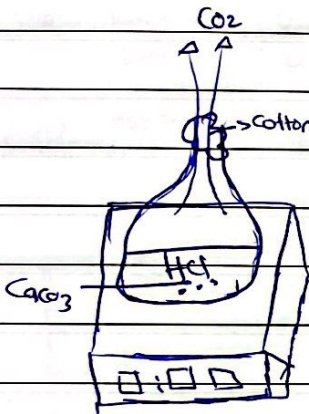
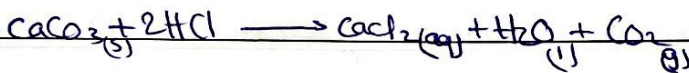


How to stop gas escaping from the apparatus using small test tube with a string inside the conical flask

rate decreases with time

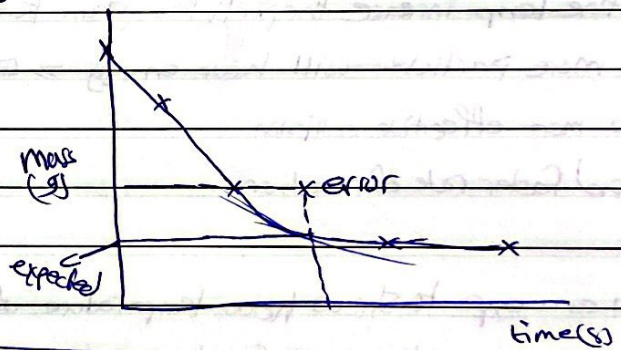


② measuring the Rate by monitoring the change in mass of conical flask + contents per unit time



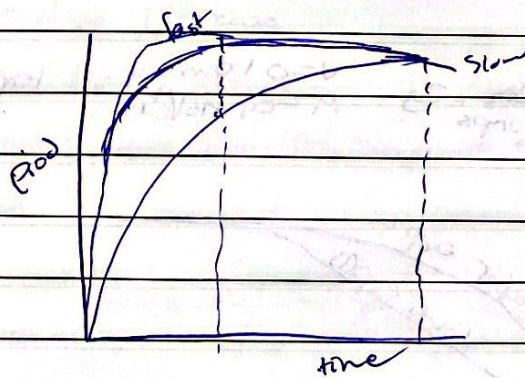
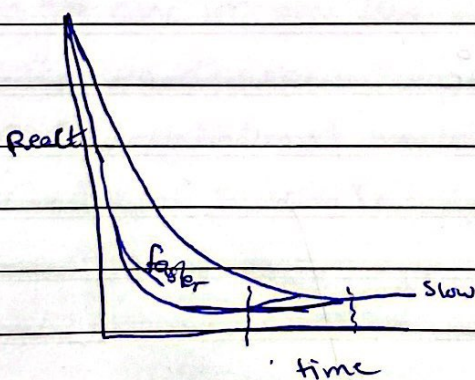
cotton wool → to allow CO₂ to escape and prevent splashing
? why the mass ↓
CO₂ escape

time(s)	0	10	20	30	40	50
mass (g)	50	49.5	42	41	40.5	40.5
		-0.5	-7	-1	-0.5	



Increasing the Rate of Reaction

Same product with less time
or more product per the same time



they end together

Factors affect the rate of reaction

- ① temperature
- ② surface area
- ③ concentration
- ④ pressure (only for gases)
- ⑤ light
- ⑥ catalyst

temperature

- state how the temperature affect the rate of RXN?

as the temperature increase the rate of reaction increase

- explain how the temp affect the rate of rxn?

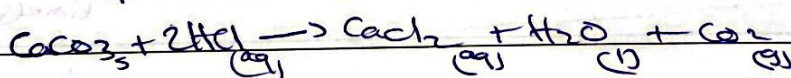
as the temp increase the particles gain K.E so move faster

so more particle will have energy $\geq E_a$

so more effective collision

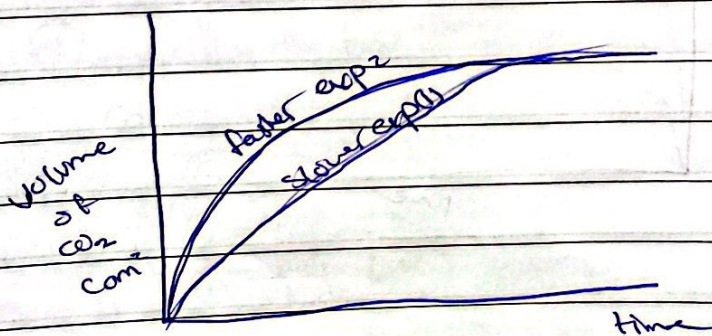
and faster rate of reaction

- plan an exp to show how temperature affect the rate of rxn?



exp₁ = m CaCO₃ = 2g lumps V = 0.1 dm³ temp = 25°C
M = 0.1 mol/dm³

exp₂ = m CaCO₃ = 2g lumps V = 0.1 dm³ temp = 50°C
M = 0.1 mol/dm³



② Surface area

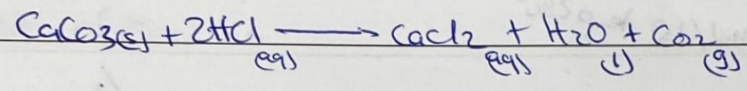
- State how the surface area affect the rate of reaction

as the surface area increases ~~the rate of~~ ^{by reducing} the particle size / crushing using mortar and pestle, the rate of reaction increase

- Explain how the surface area affect the rate of reaction

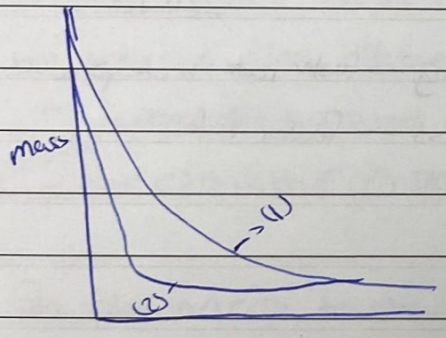
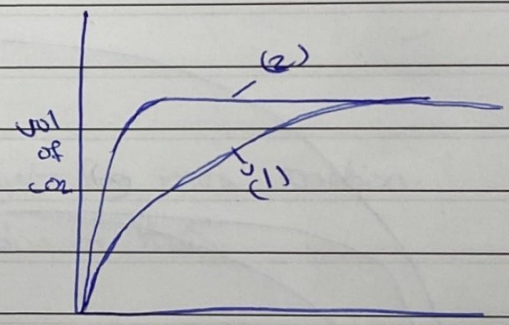
as the surface area increase more particles exposed to the reaction so more effective collisions per unit time so faster rate of reaction

- plan an exp to show how the surface area affect the rate of reaction



exp 1 mass = 2g lumps $V_{\text{HCl}} = 0.1\text{dm}^3$
 $M_{\text{HCl}} = 1\text{mol/dm}^3$ temp = 25°C

exp 2 mass = 2g powder $V_{\text{HCl}} = 0.1\text{dm}^3$
 $M_{\text{HCl}} = 1\text{mol/dm}^3$ temp = 25°C



③ Concentration gradient "amount"

- State how concentration affect the rate of reaction

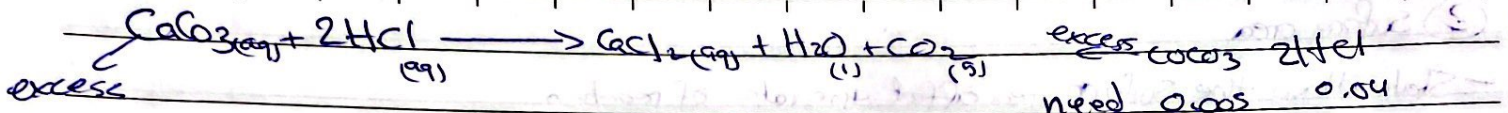
as the conc. increase the rate of reaction increase

- explain how the concentration affect rate of reaction

as the concentration of reactant increases more particles so more effective collisions per unit time so faster rate of reaction

next question next page ->

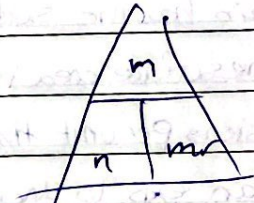
Plan exp to show concentration gradient affect rate of reaction



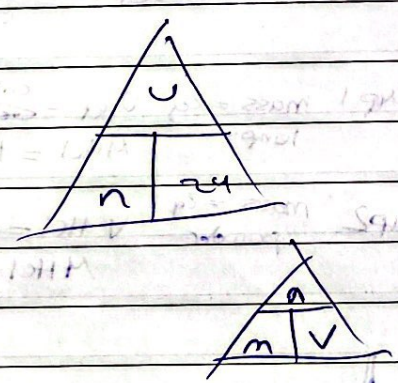
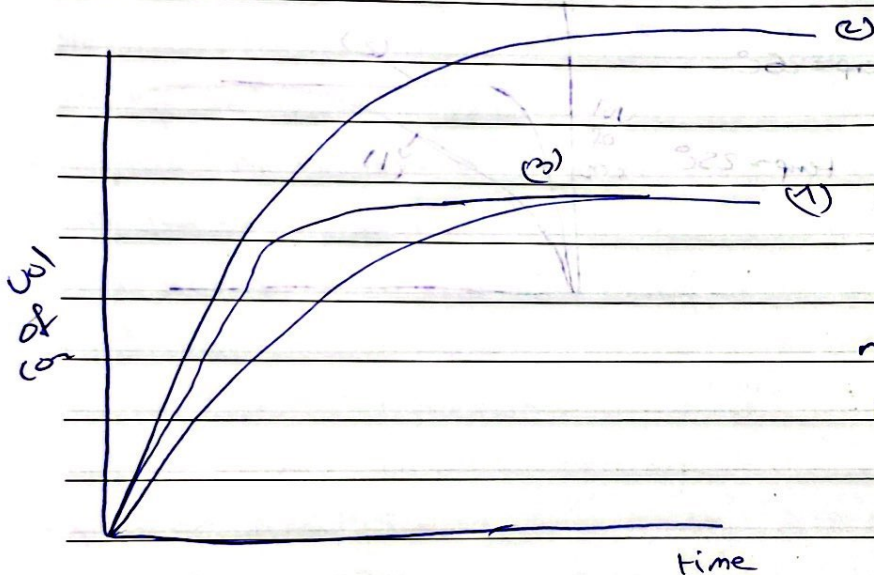
exp 1 mass 2.0g lumps $V_{\text{HCl}} = 0.1 \text{ dm}^3$ $M_{\text{HCl}} = 0.1 \text{ mol/dm}^3$ temp 25°C
 $M_r = 100$

need 0.005 0.02 0.01

exp 2 mass 2.0g lumps $V_{\text{HCl}} = 0.1 \text{ dm}^3$ $M_{\text{HCl}} = 0.2 \text{ mol/dm}^3$ temp 25°C



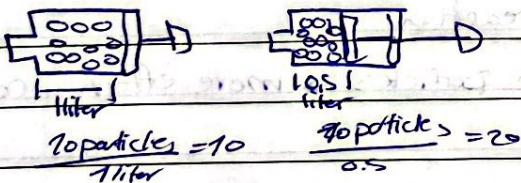
exp 3 mass 4.0g lumps $V_{\text{HCl}} = 1 \text{ dm}^3$ $M_{\text{HCl}} = 0.1 \text{ mol/dm}^3$ temp 28°C



more limiting \rightarrow faster rate more product
 more excess \rightarrow faster rate

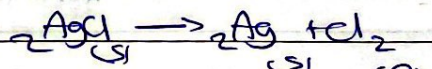
Pressure: "only for gas"

explain how pressure affect the rate of reaction?
 as the pressure increase (by lowering the volume) more particles per unit volume so more effective collisions per unit time so faster rate of reaction.

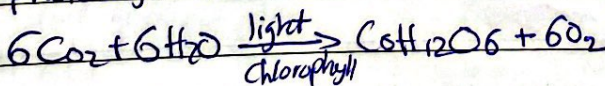
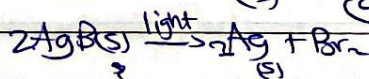


photographic film "out of syl"

light for photochemical rxn



photosynthesis



6) catalyst

Catalyst: substances that speed up the rate of reaction without being used up.

Enzymes: biological catalysts

How?

E_a : the min amount of energy needed to start the reaction

it provides an alternative path way with

lower ^{E_a} activation energy so more particles will

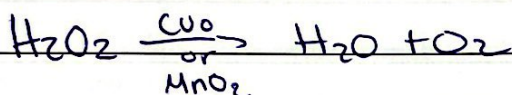
have energy equal to or greater than E_a

↑ E_a slower rate

So more effective collisions per unit time so

↓ E_a faster rate

Faster rate of reaction



Q1 plan an exp to show that CuO is catalyst for this reaction.

- Same known volume of known concentration of H_2O_2

- add a known mass of CuO

- measure the volume of O_2 per unit time

- repeat the experiment without CuO

Conclusion

- the exp with CuO produce more O_2 per the same unit time

Q2 plan an exp to show which catalyst is better CuO or MnO_2

- take known volume of known conc. of H_2O_2

- add known mass of CuO

- measure the volume of O_2 per unit time

- repeat with MnO_2 (same mass)

Conclusion

- the exp that produce more O_2 per the same unit time is the better catalyst

Q3 plan an exp to show that the CuO not used up during the exp

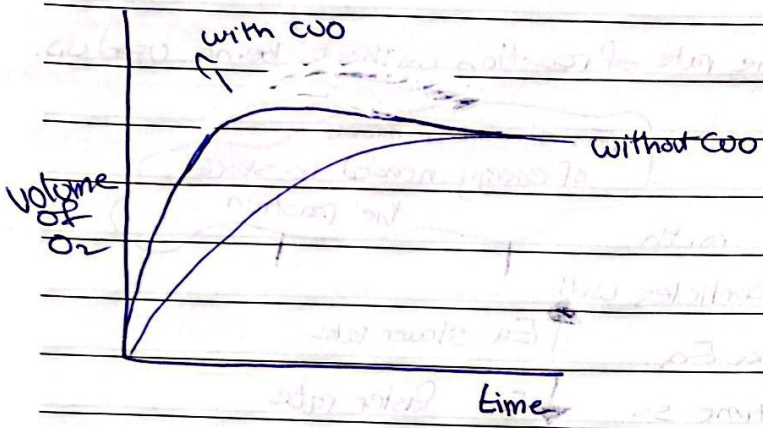
- known mass of CuO to H_2O_2 until no more bubbles of O_2

- Filter the mixture

dry in oven, remeasure the mass

Conclusion

- the mass will not change



The graph shows the volume of gas produced over time for two different conditions: 'without CO₂' and 'with CO₂'. The 'with CO₂' condition shows a faster rate of gas production, reaching a higher final volume compared to the 'without CO₂' condition.

The experiment was conducted to determine the effect of CO₂ on the rate of reaction. The following steps were followed:

- 1. Measure the volume of gas produced over time.
- 2. Record the volume of gas produced at regular intervals.
- 3. Plot a graph of volume of gas against time.
- 4. Compare the two graphs to see the effect of CO₂.
- 5. The graph shows that the rate of reaction is faster when CO₂ is present.

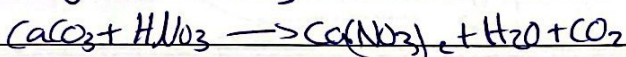
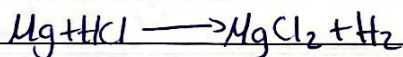
The reason for this is that CO₂ acts as a catalyst, increasing the rate of reaction without being consumed in the process.

Reversible Reaction

Chemical Reaction

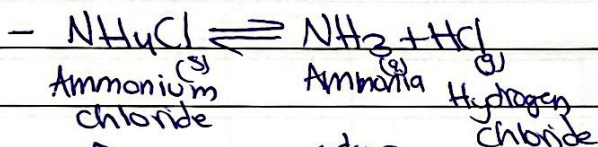
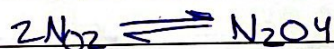
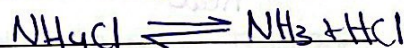
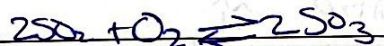
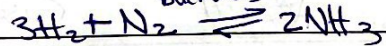
one way

Reactant $\xrightarrow{\text{forward}}$ products



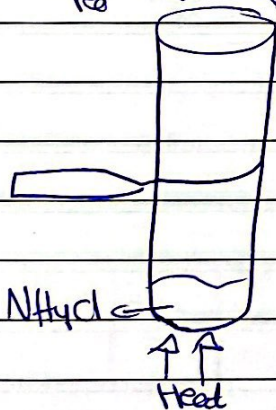
Both way

Reactant $\xrightleftharpoons[\text{backwards}]{\text{forward}}$ product

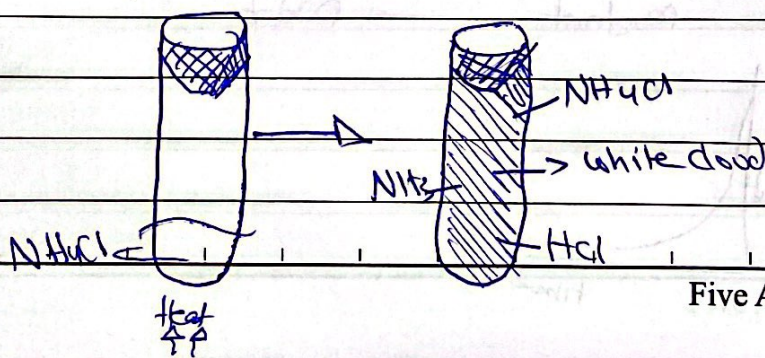
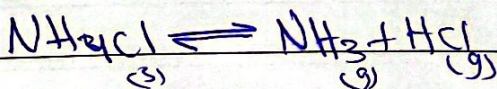
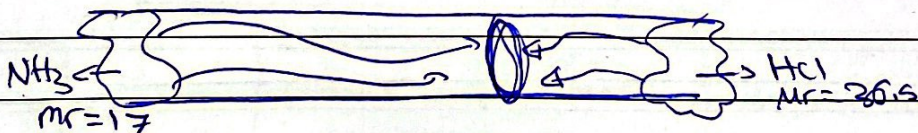
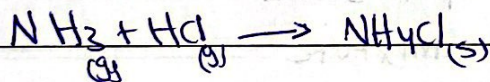


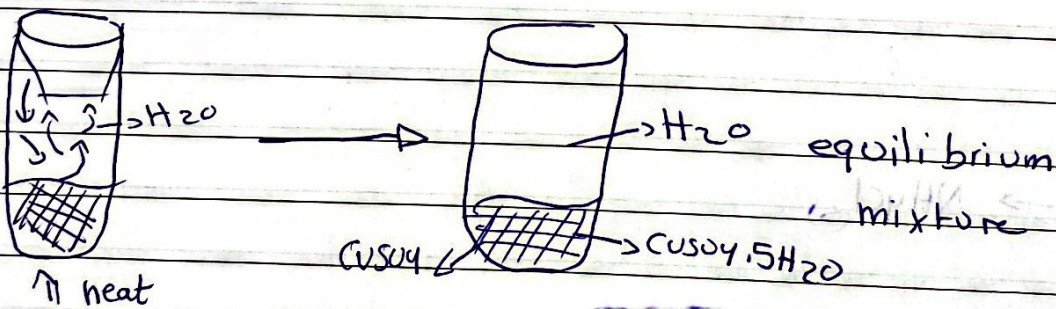
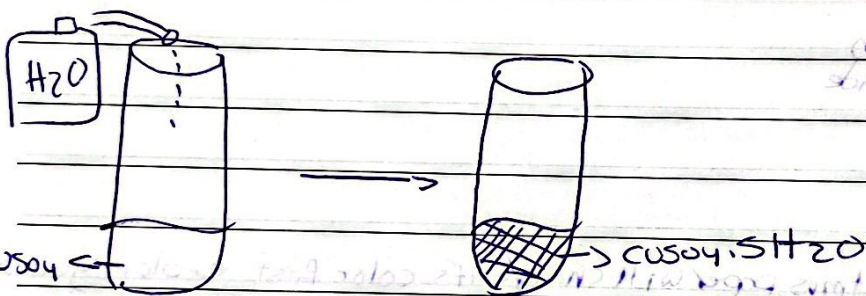
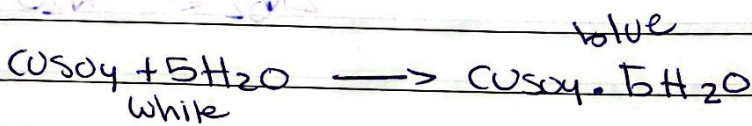
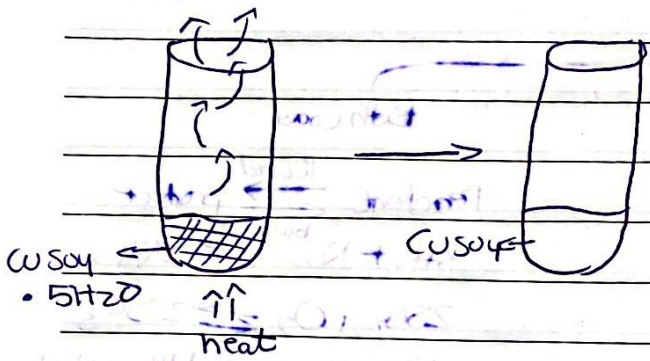
damp red

damp blue



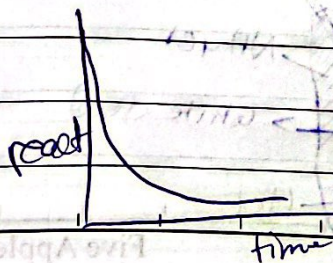
Q which damp litmus paper will change its color first explain your answer?
 - the damp red litmus paper changes its color to blue first since NH_3 is alkali and lighter than HCl , which is acidic.





One way

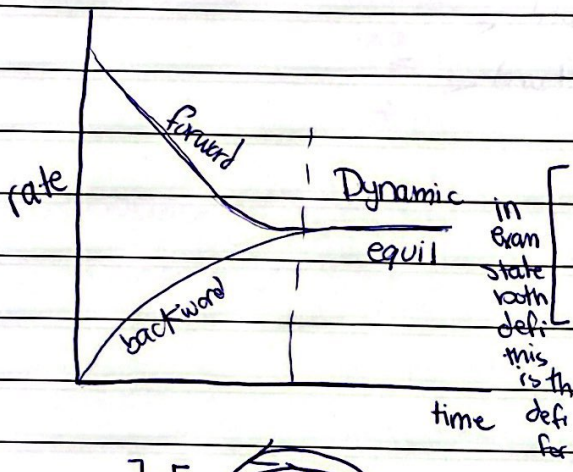
reactant \longrightarrow product



YASSI
NOOO!
OKAY!

equilibrium
doesn't end

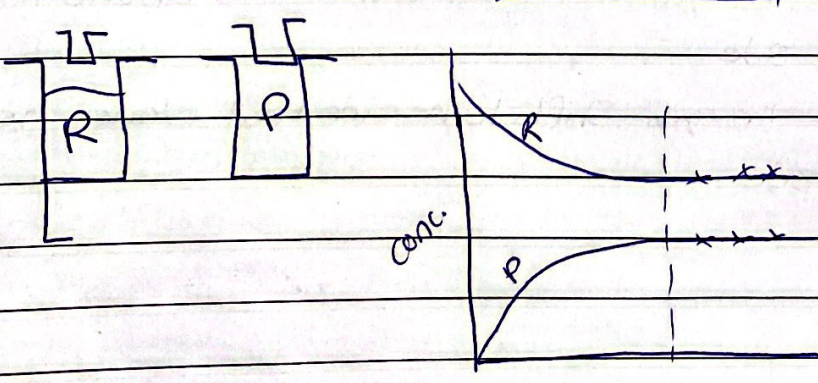
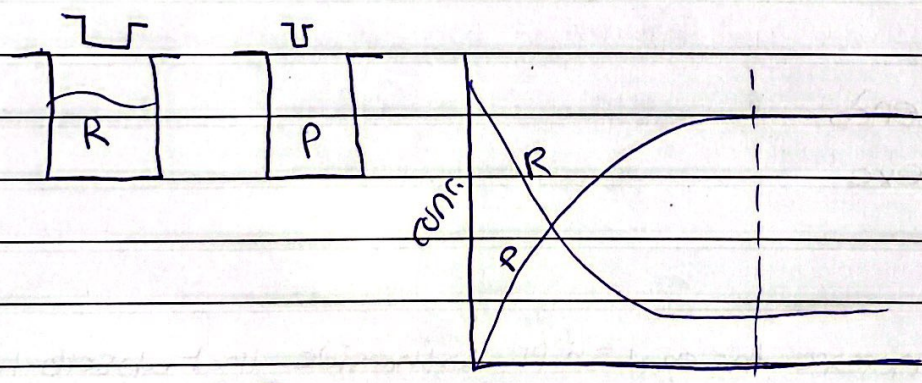
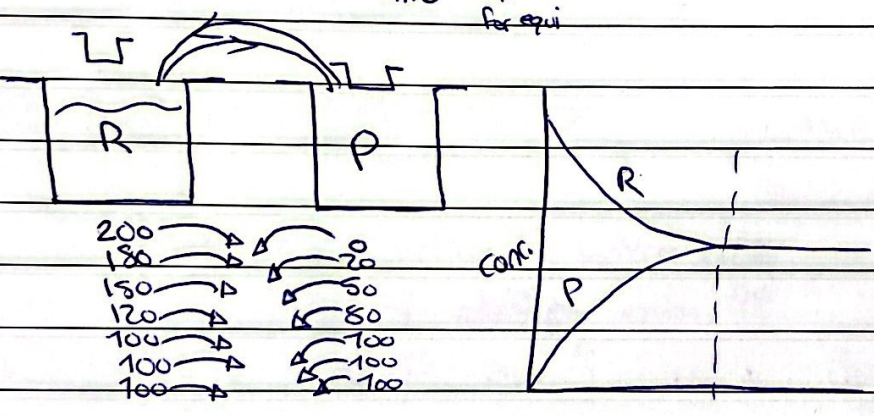
Dynamic equilibrium



Dynamic equilibrium: When the rate of forward equals the rate of Backwards.

in terms of concentration: when the concentration of reactants & products are constant

in gram state both defi this is the time defi for equi



Le Chatelier principle

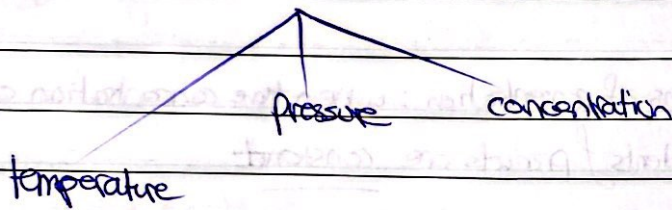
if the system at equilibrium \rightleftharpoons

and any external factor disturb the equil

the equil shift it self either to the forward \rightarrow

or to the backward \leftarrow

to return back to the equil



Endothermic $\%$ absorb
 $\Delta H = +ve$

Exothermic $\%$ Release
 $\Delta H = -ve$

Temperature:

\rightarrow endo $\&$ exo

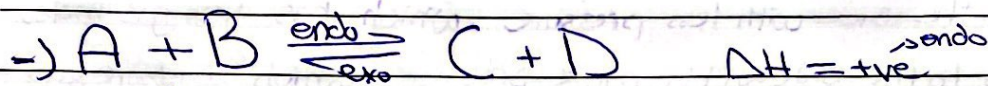
\uparrow Temp shift to endo

\downarrow Temp shift to exo

- as the temperature increase the equil shifts to the side that absorb heat which is the endothermic side

- as the temperature decrease the equil shifts to the side that releases heat which is the exothermic side

the sign of ΔH is always represented as the forward reaction



\uparrow temp \rightarrow shifts to the endo side (forward)

$\uparrow\uparrow$ rate of endo / forward

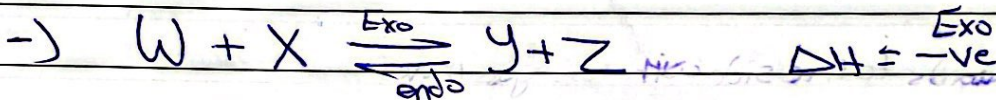
$\downarrow A \downarrow B \uparrow C \uparrow D$

\uparrow rate of exo / backward

\downarrow temp \rightarrow shift to the exo side (backward)

$\downarrow\downarrow$ rate of forward

\downarrow rate of backwards $\uparrow A \uparrow B \downarrow C \downarrow D$



\uparrow temp shift backwards to the endo

rate of ~~endo~~ endo $\uparrow\uparrow$

rate of exo \uparrow

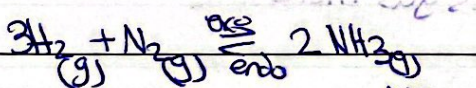
$\uparrow W \uparrow X \downarrow Y \downarrow Z$

\downarrow temp shift forward to the exo

rate of endo $\downarrow\downarrow$

rate of exo \downarrow

$\downarrow W \downarrow X \uparrow Y \uparrow Z$



temp \uparrow

rate of reaction increase

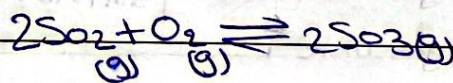
rate of backwards increase

they yield of NH_3 , why?

it will decrease, increase in

temp shifts to equl to the

backwards to the endo



the yield of SO_3 increase
by cooling explain why

the forward reaction is

exothermic favoured

by cooling

Sealed tube contains NO_2

and N_2O_4 at equil



dark brown pale brown

if we put this tube in cold

water bath - the color becomes

paler explain why?

Since forward reaction is

exothermic favoured by

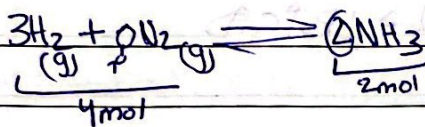
Cooling.

Five Apple

Pressure

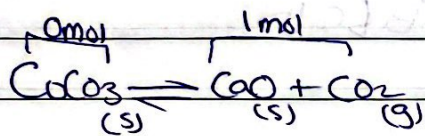
↑ pressure ⇒ shifts to the side with less pressure which has less gas moles

↓ pressure ⇒ shifts to the side with more pressure which has more gas moles



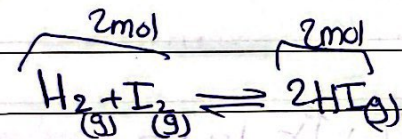
↑ pressure : shifts forward to the side with less gas mole

↓ pressure : shifts backward to the side with more gas mole



↑ pressure : shifts backward to the side with less gas mole

↓ pressure : shifts forward to the side with more gas mole



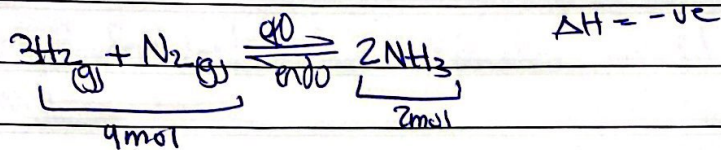
↑ pressure : has no effect on the position of equilibrium

↓ pressure : they have the same n of gas mole

↑ pressure rate of less gas mole ↑↑
rate of more gas mole ↑ } shifts to less gas mole

↓ pressure rate of less gas mole ↓↓
rate of more gas mole ↓↓ } shifts to more gas moles

Complete the table



effect	rate of forward	rate of Backwards	yield of NH_3
\uparrow temp	increase	increase	decrease
\uparrow pressure	increase	increase	increase
\downarrow pressure	decrease	decrease	decrease

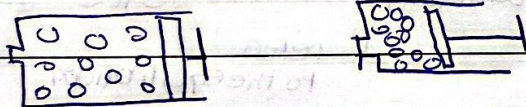
Q the reaction $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$ at equilibrium why by increasing the pressure the position of equilibrium does not change?

- because both sides of the reaction have the same number of gas moles

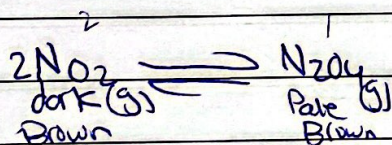
why by increasing the pressure the mixture becomes more purple

because the gas particles of I_2 become closer together and the color appears more

condense



Q mixture of NO_2 and N_2O_4 at equil in a sealed tube (multiple choice)



by increasing the pressure the mixture

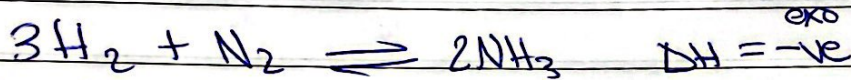
- a) becomes darker and stays darker
- b) becomes darker and goes paler
- c) becomes paler and stays paler
- d) becomes paler and goes darker

Concentration



↑ [A] shift forward
↓ [B] ↑ [C] ↑ [D]

↑ [C] ↓ shifts backward
↑ [A] ↑ [B] ↓ [D]

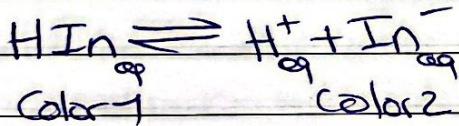


temp: 400-450°C

pressure: 200 atm

Concentration: add excess H_2 and N_2 remove NH_3 immediately (condensation)

Indicator



more H_2 & N_2 will react → it will shift to the forward side to return to the equilibrium

Add HCl

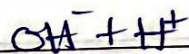
acid

proton donor

↑ [H⁺] shifts ~~backward~~ ^{forward}
more HIn more color (2)
less In⁻ less color (1)

add NaOH

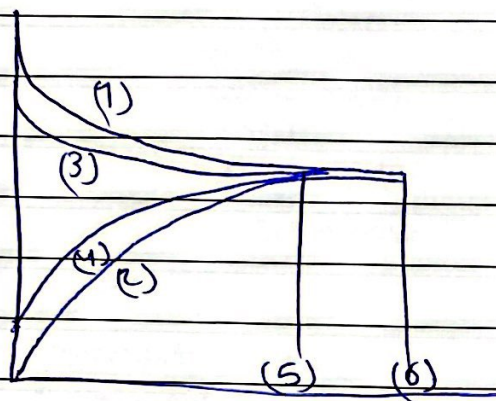
proton acceptor



shifts backward
↓ [H⁺] → more In⁻ more color (1)
less HIn less color (2)

Catalyst :

has no effect on the position of equilibrium because it speeds up the rate of forward and backward reactions so it causes the equilibrium to occur with less time.



- 1) rate of forward without catalyst
- 2) rate of backward without catalyst
- 3) rate of forward with catalyst
- 4) rate of backward with catalyst
- 5) time taken to reach equilibrium with catalyst
- 6) time taken to reach equilibrium without catalyst

Energetics

(Energy in chemical reaction)

Energy: the ability to do work
in chemical reaction

to break down
bonds in
REACTANTS
input
absorb, take
in
Endothermic

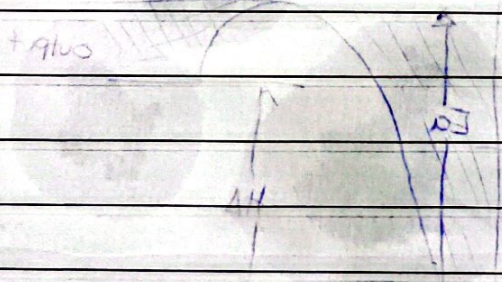
to build up
bonds in the
PRODUCTS
output
release give out
Exothermic

input > output
Endothermic

output > input
Exothermic

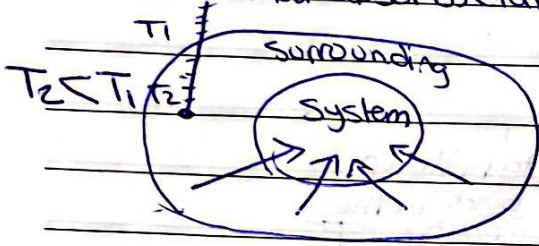
Enthalpy: heat contents

stored energy in bonds



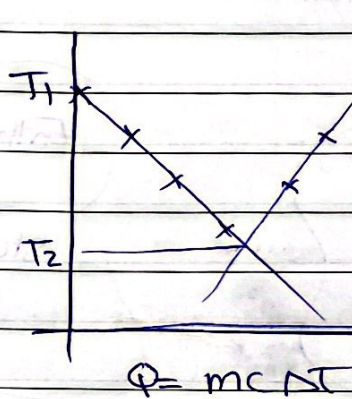
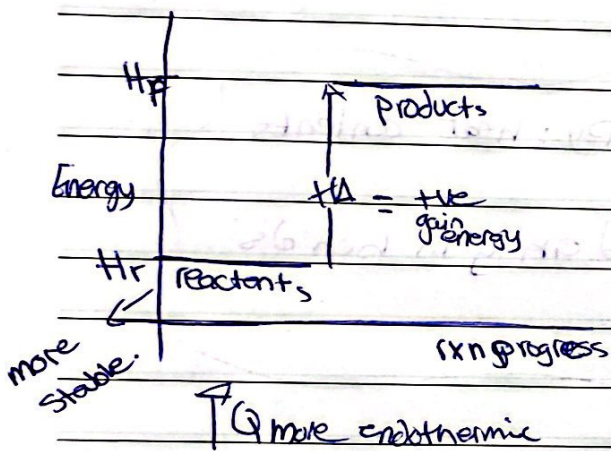
Endothermic :-

Reaction that absorbs (take in) energy from the surrounding when they take place



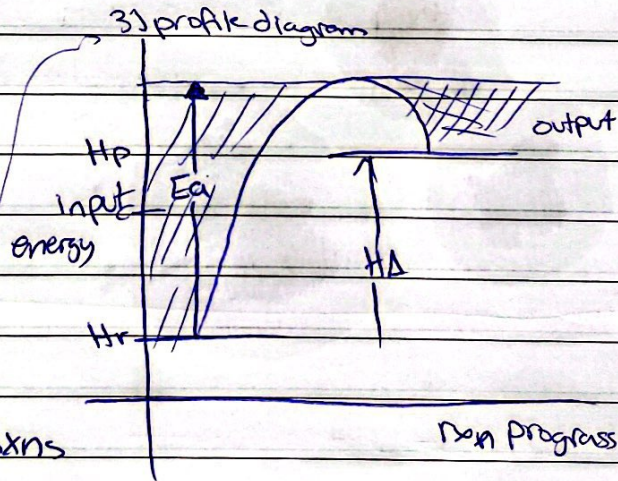
for system
Energy level diagram

for surrounding
Temp diagram

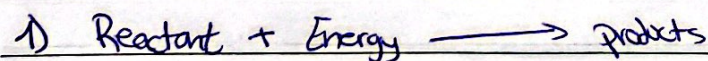


Examples

- 1) photosynthesis
- 2) photographic films
- 3) Thermal decomposition
- 4) Electrolysis
- 5) boiling / melting
- 6) Breaking down bonds



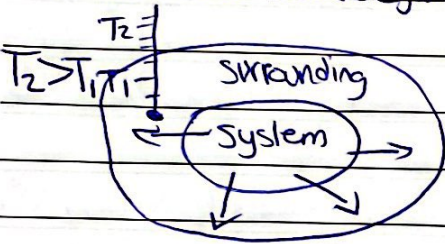
How to express Endothermic Rxns



3) profile diagram

Exothermic

reaction that releases (give out) energy to the surrounding when they take place

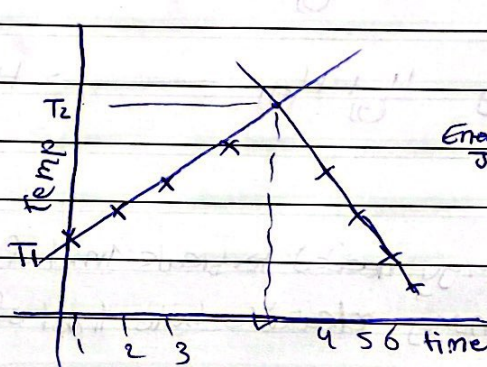
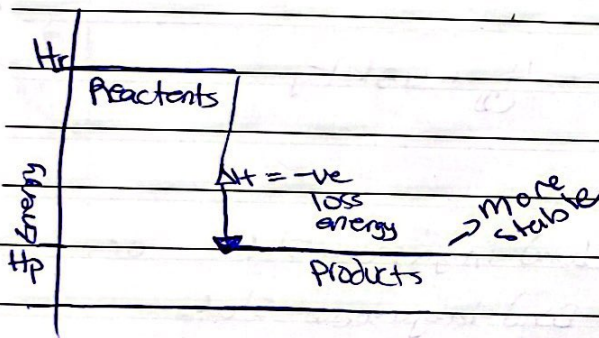


for system

for surroundings

Energy level diagram

Temp diagram



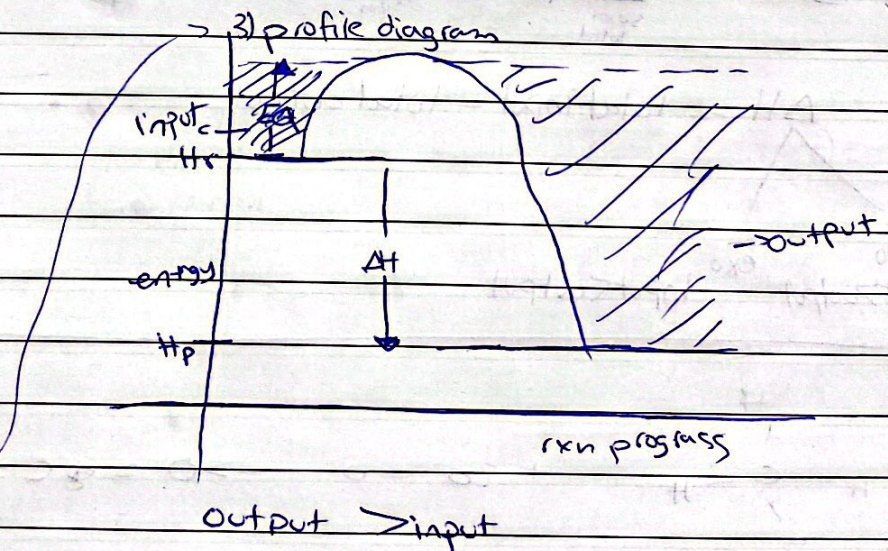
$$Q = m C \Delta T$$

Energy
mass (g)
specific heat capacity
change in temp
 $c_{\text{water}} = 4.2 \text{ J/g}^\circ\text{C}$

↑ more exothermic

Examples

- 1) combustion
- 2) displacement
- 3) neutralization
- 4) respiration
- 5) freezing, condensation
- 6) Voltaic cell
- 7) building up bonds

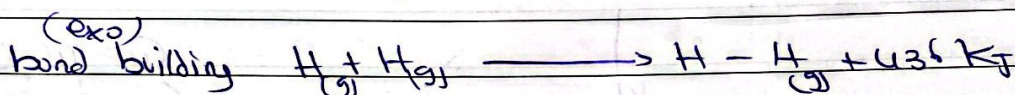
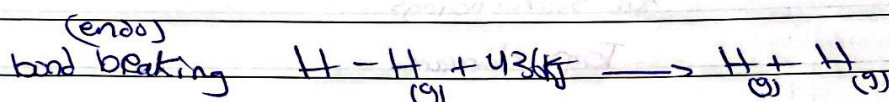


How to express exothermic rxns

- 1) Reactants \longrightarrow products + energy
- 2) Reactants \longrightarrow products $\Delta H = -ve$
- 3) profile diagram

measuring ΔH rxn using Bond energies

bond	bond energy KJ/mol
H-H	436

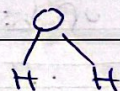
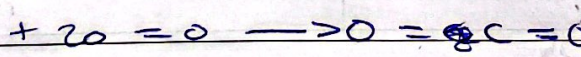
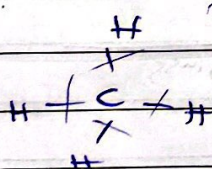
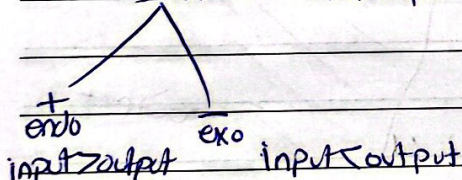


Bonding energy:

the amount of energy needed to break 1mol of bond in gaseous state or the amount of energy released to build 1mol of bond in gaseous state

$$\Delta H_{\text{rxn}} = \sum_{\text{sum total}} \text{input} - \sum_{\text{sum}} \text{output}$$

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



bond	bond energy KJ/mol
C-H	413
O-H	463
O=O	496
C=O	799

bond Broken: $4 \times \text{C-H} = 4 \times 413$
 $2 \times \text{O} = \text{O} = 2 \times 496$
 total input: 2644 KJ

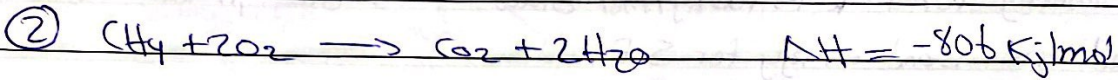
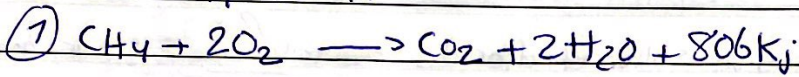
bond build: $2 \times \text{C} = \text{O}$
 $4 \times \text{O-H}$
 $= 3450 \text{ KJ}$

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

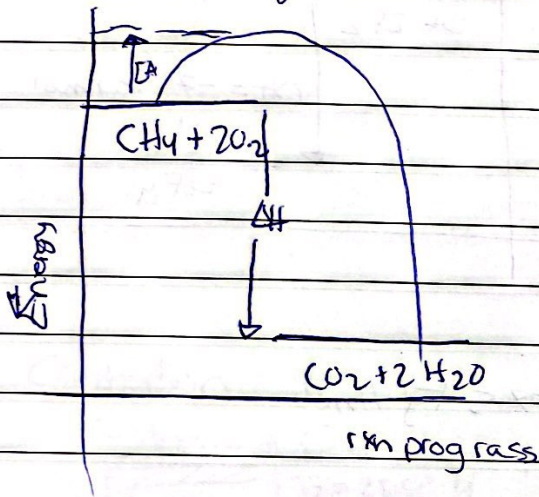
$$2644 - 3450 = -806 \text{ KJ/mol}$$

exo

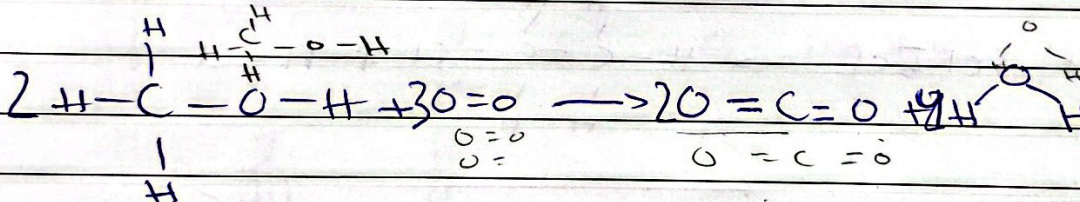
How to express it



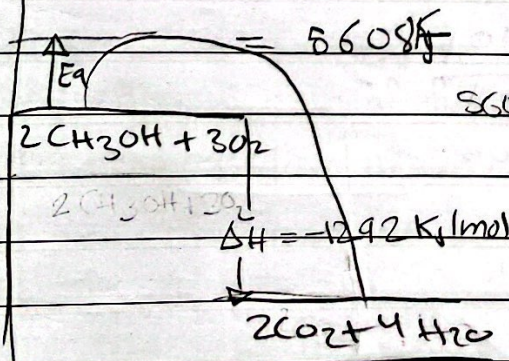
③ profile diagram



ΔH is always for one mole



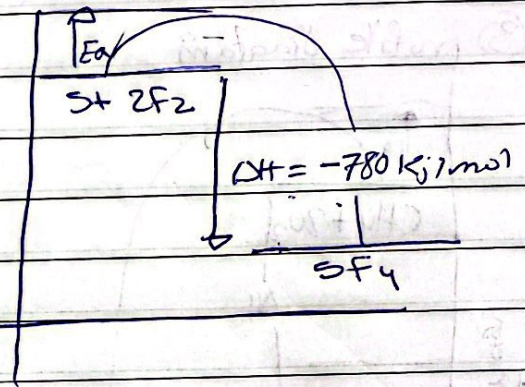
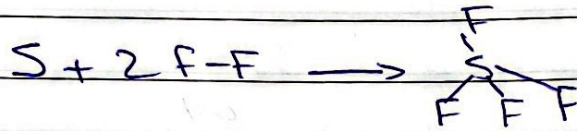
bond broken	bond build	bond	bond energy Kj/mol
$6 \times \text{C}-\text{H} = 413 \times 6$	$4 \times \text{C}=\text{O} = 799 \times 4$	$\text{C}-\text{H}$	413
$2 \times \text{C}-\text{O} = 358 \times 2$	$8 \times \text{O}-\text{H} = 8 \times 463$	$\text{C}=\text{O}$	799
$2 \times \text{O}-\text{H} = 463 \times 2$		$\text{O}-\text{H}$	463
$3 \times \text{O}=\text{O} = 496 \times 3$		$\text{C}-\text{O}$	358



$5608 - 6900 = -1292 \text{Kj/mol}$
exo

$$\Delta H = -780$$

sulfur react with fluorine to give sulfur tetrafluoride and release 780 kJ/mol
 if the bond energy for F-F is 160 kJ/mol draw a profile diagram for this
 reaction find the bond energy for S-F



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

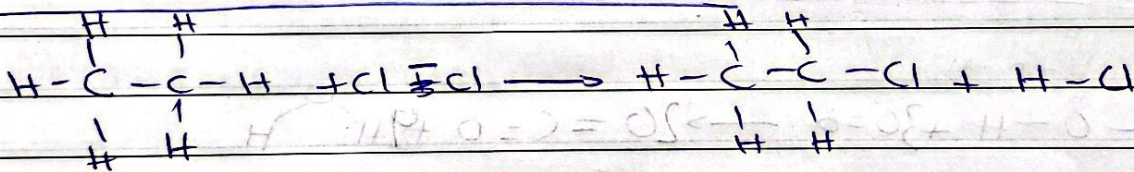
$$-780 = (2 \times 160) - 4 \times S-F$$

$$-780 = 320 - 4S-F$$

$$-320 = -4S-F$$

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

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



bond	bond energy (kJ/mol)
Cl-Cl	242
H-Cl	
C-H	413
C-C	328

find the bond energy of H-Cl if the amount of energy released is 104 kJ/mol

$$C-H = 413$$

$$C-Cl$$

$$242$$

$$328 + H-Cl$$

$$-104 = (413 + 242) - (X + 328)$$

$$-104 = 655 - 328 + H-Cl$$

$$\frac{-x}{-1} = \frac{-431}{-1}$$

$$x = 431 \text{ kJ/mol}$$

measuring the amount of energy transfer

always for surrounding

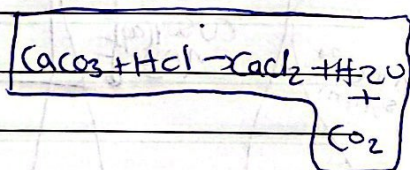
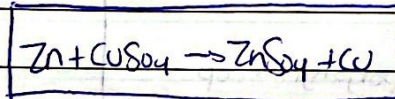
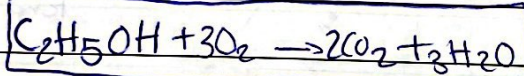
$$Q = m c \Delta T$$

Energy transfer (Joules) mass (g) specific heat for water capacity $4.2 \text{ (J/g}^\circ\text{C)}$ change in temp

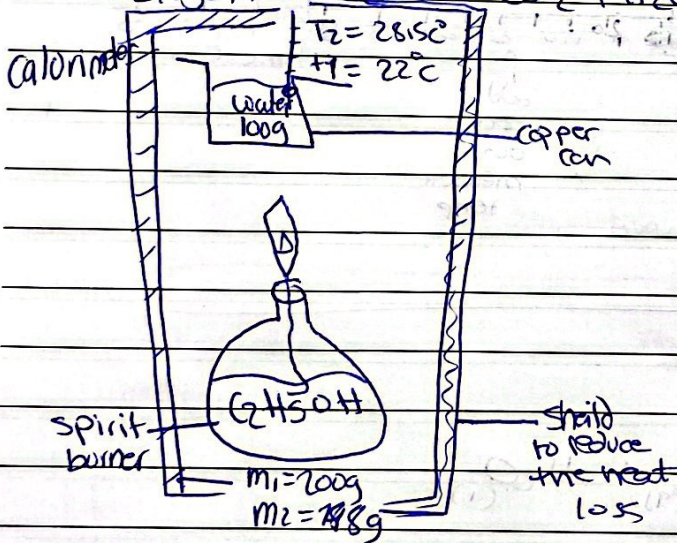
combustion

displacement

neutralization



Combustion



$$c_{\text{water}} = 4.2 \text{ J/g}^\circ\text{C}$$

$$Q = mc\Delta T$$

$$Q = 100 \text{ g} \times 4.2 \times (28.5 - 22) = 2730 \text{ J}$$

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

$$\text{molar mass of C}_2\text{H}_5\text{OH} = 46 \text{ g}$$

$$\frac{2730 \text{ J}}{2 \text{ g C}_2\text{H}_5\text{OH}} \times \frac{46 \text{ g}}{1} = 62790 \text{ J/mol}$$

$$\Delta H = -62.79 \text{ kJ/mol}$$

Two fuels A & B

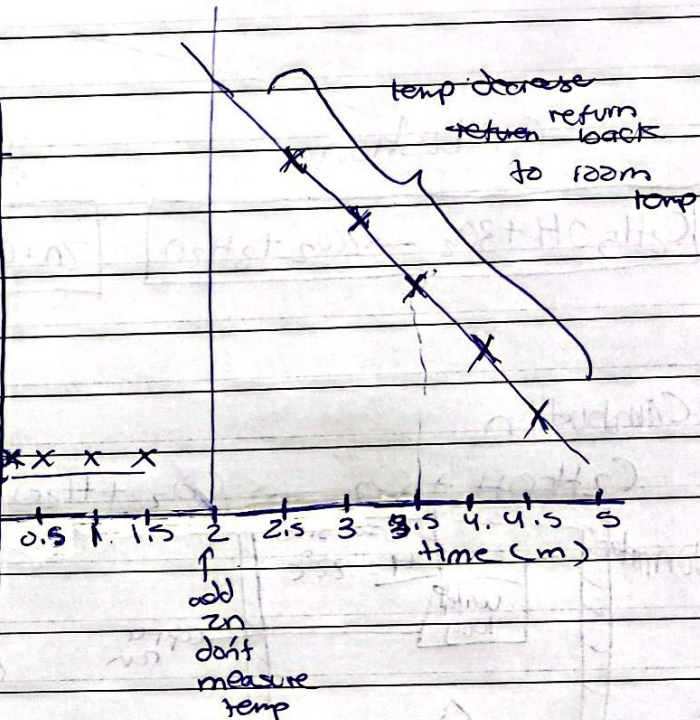
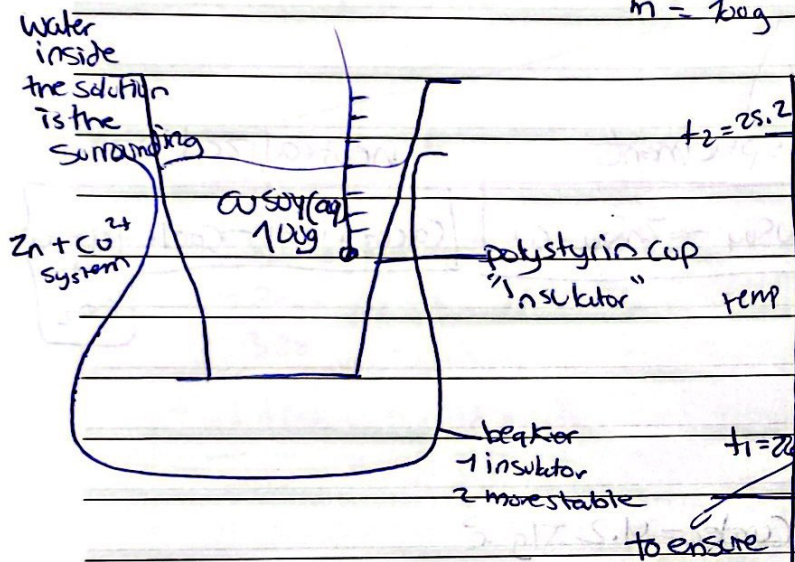
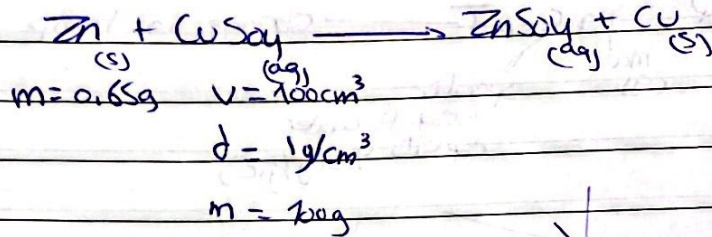
plan an experiment to show which fuel produce more energy?

- take a known mass of fuel A in a spirit burner place a known mass of water in a copper can measure the initial temp of water (T_1) ignite the fuel (A) for ~~some~~ ~~and~~ ~~measure~~ ~~the~~ ~~final~~ ~~temp~~ measure the final temp of water (T_2) repeat the exp using fuel (B) the fuel which cause more temp change is the one that produce more energy.

displacement Reaction

$$d = \frac{m}{V}$$

$$\rho = \frac{m}{V}$$

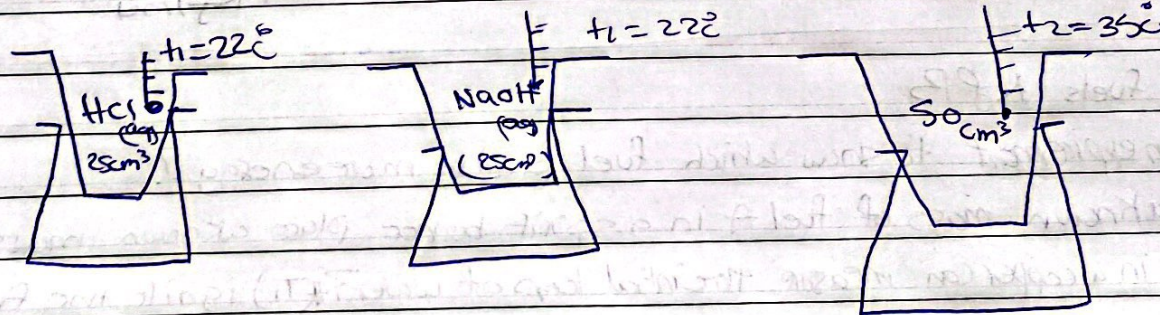
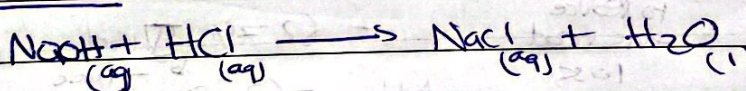


$$Q = m c \Delta T$$

$$100 \times 4.2 \times 3.2$$

$$Q = 1344 \text{ J}$$

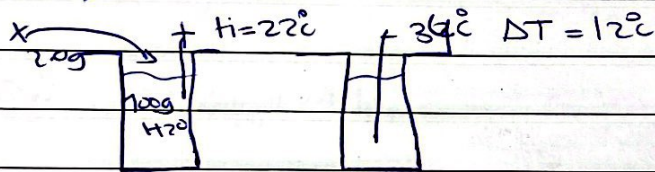
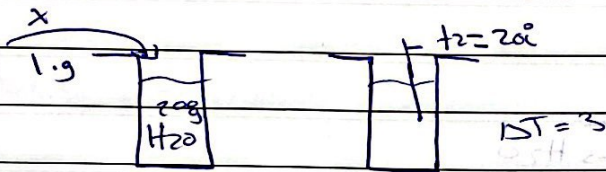
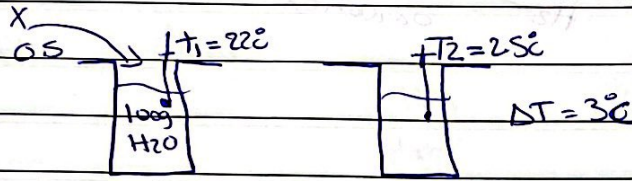
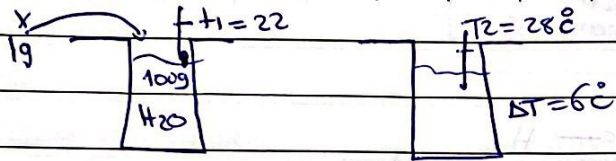
neutralization:



$$Q = m c \Delta T$$

$$(25 + 25) \times (4.2) \times 13 = 2730 \text{ J}$$

limiting

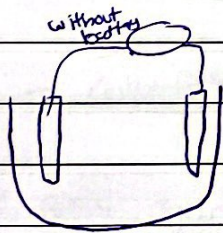


Alternative resources of energy

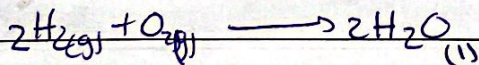
Voltaic cell

Hydrogen fuel cell

Uranium



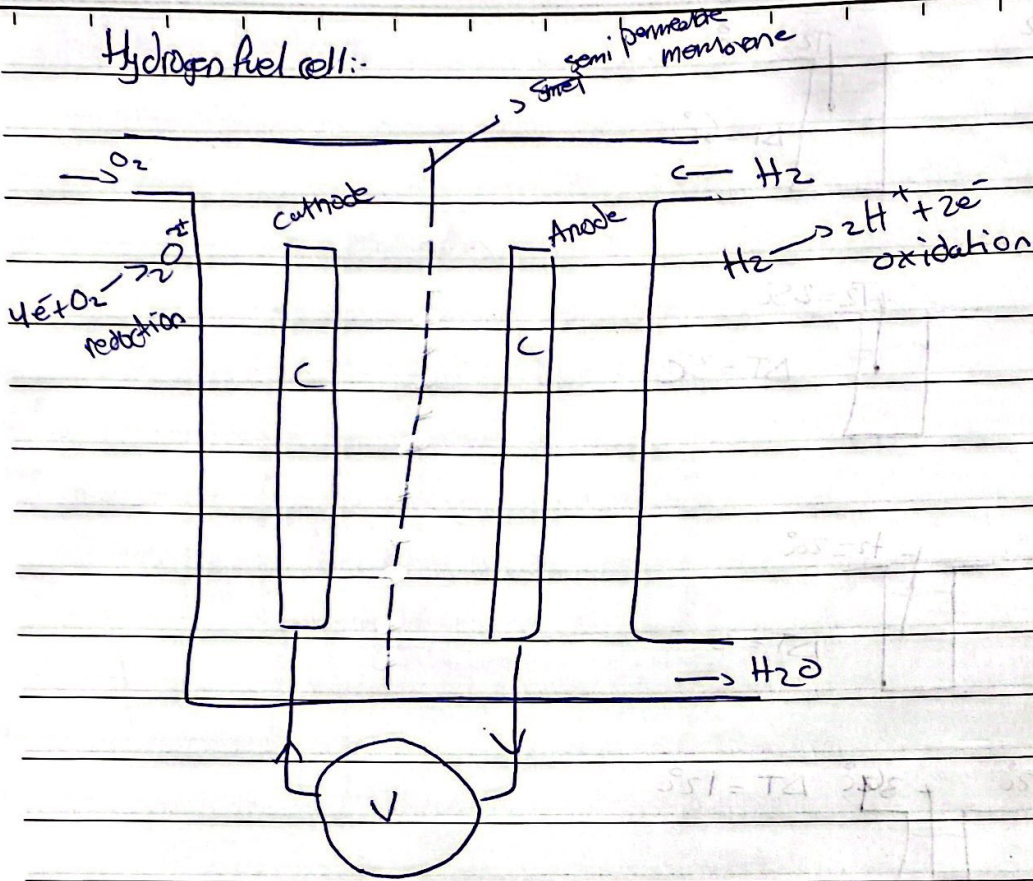
Hydrogen fuel cell



advantages: produce only H_2O as waste product and produce high amount of energy
no CO_2 produced (not pollutant)

disadvantages: hard to store and transport and risk of explosions

Hydrogen fuel cell:



Industrial chemistry

dealing with gases

dry collect

industry

NH_3
Haber process

H_2SO_4
contact process

(CO_3^{2-})

extraction

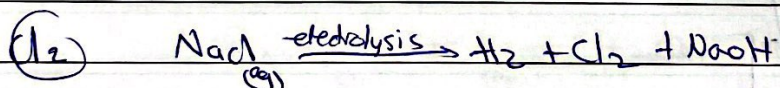
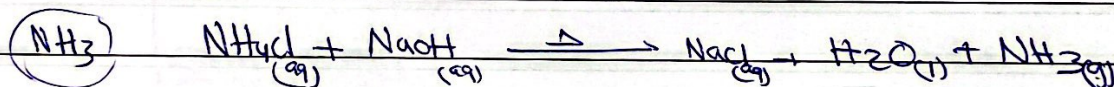
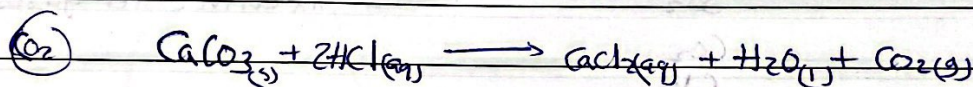
Fe

Zn

Cu

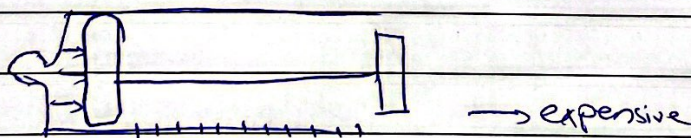
Al

Dealing with gases :-



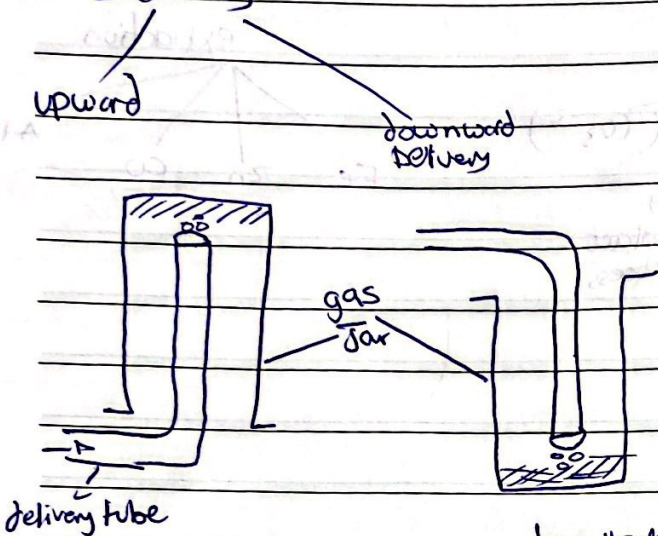
- collect gases

① gas syringe



∴ collect and measure the volume of every gas

② Delivery

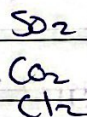


to collect less dense gas than air



to collect more

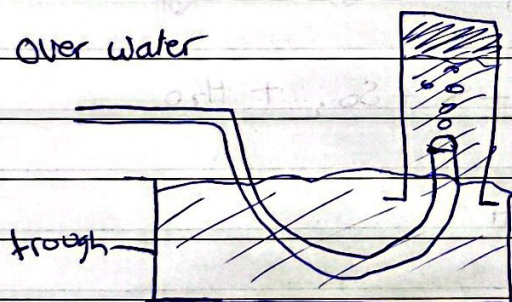
dense gas than air



- some gas might escape

- mix with other gases

③ over water



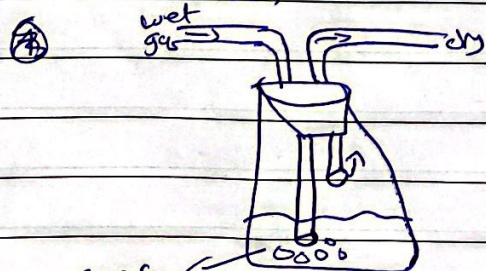
- hard to use

used only for insoluble gas in water

↳ CO_2 slightly soluble in water

- Drying gases

① conc. H_2SO_4

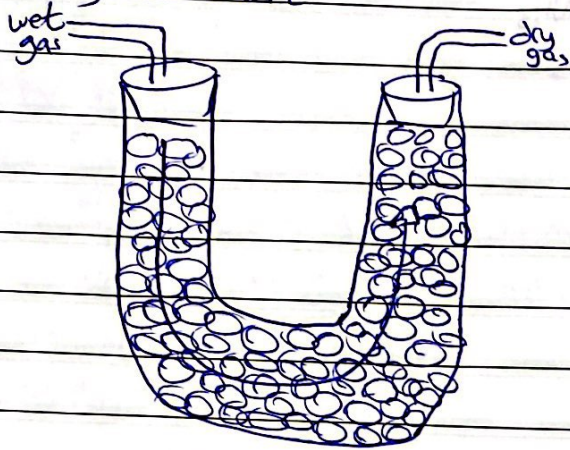


used today only gas except NH_3

conc. H_2SO_4

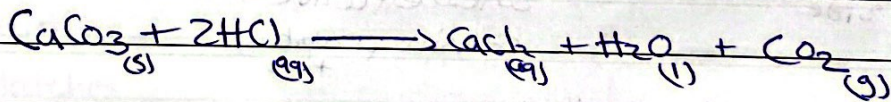
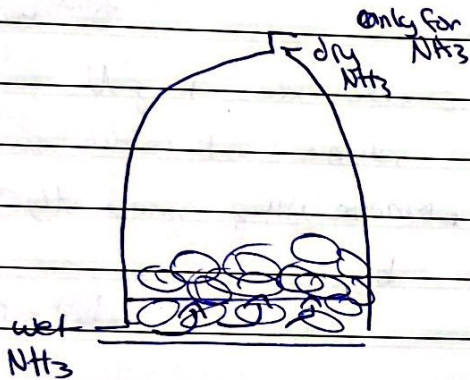
2 and 3 should have spaces between

② Anhydrous CaCl_2

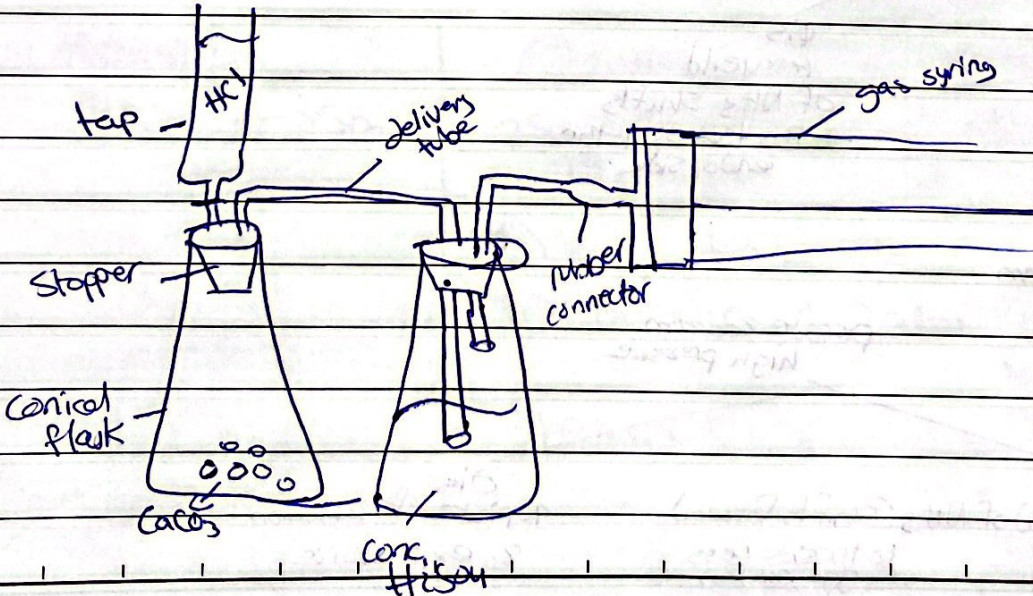


used to dry any gas except NH_3

③ CaO quicklime

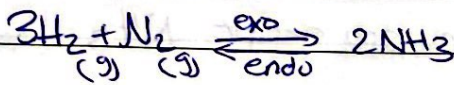


draw an apparatus to collect and measure a dry sample of CO_2

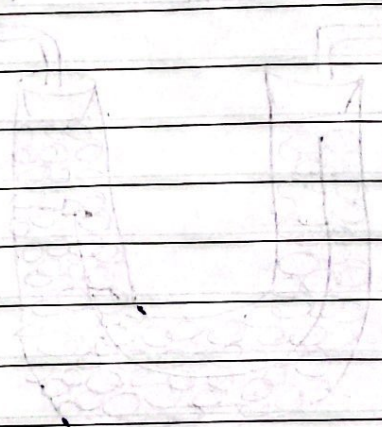


Industry of NH_3

Haber process



$$\Delta H = -ve$$



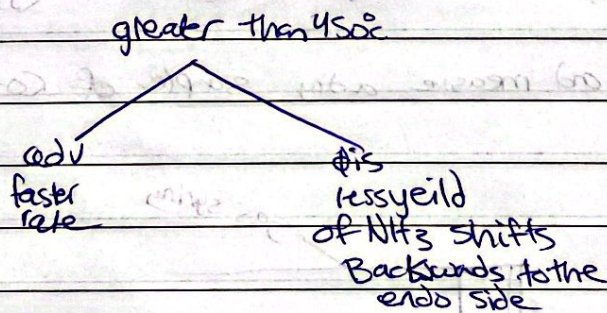
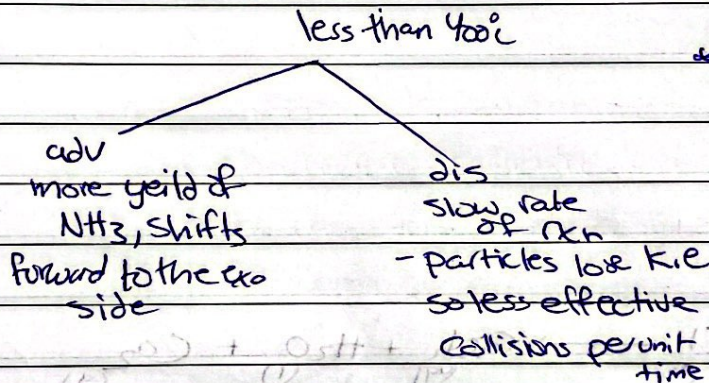
Uses of NH_3

- Fertilizers
- Cleaning detergent
- Smelling salts

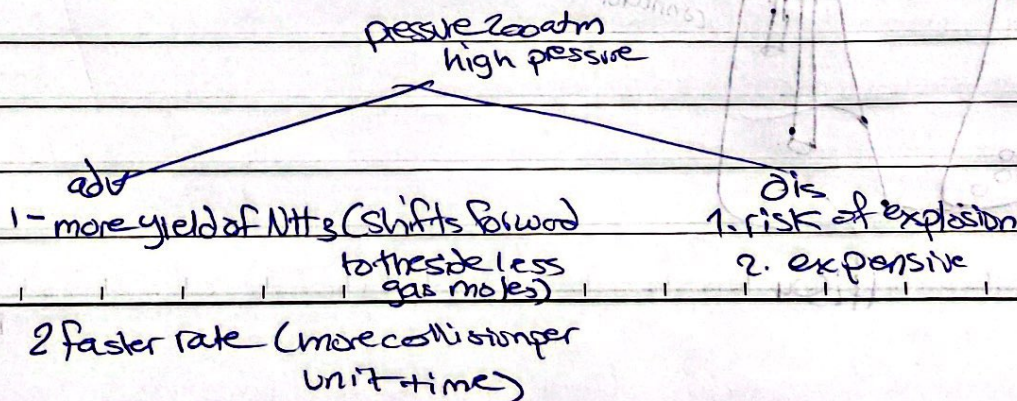
essential conditions

→ temperature $400^\circ\text{C} - 450^\circ\text{C}$

to enhance the forward rxn
 → add excess H_2 & N_2
 → return back to the converter
 → remove NH_3 immediately by cooling down
 NH_3 condense



→ pressure 200 atm

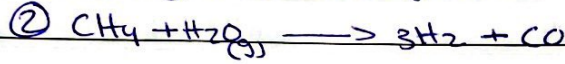


→ catalyst Fe

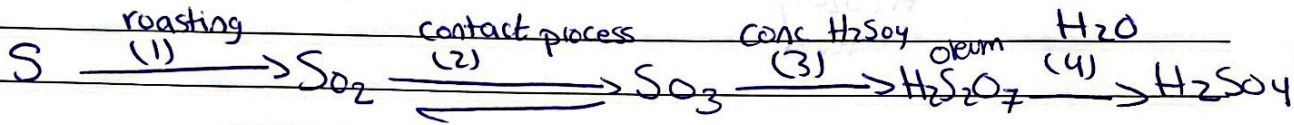
How to obtain

N_2 : fractional distillation of liquid air

H_2 : ① cracking of Alkane (organic)



industry of H_2SO_4



S:-

group VI
yellow solid



ore: Zinc Blend ZnS

source fossil fuel

uses:- medicine

- fireworks

- matches

- rubber

SO_2 :-

choking smell:-

- test SO_2

turns acidify potassium manganate
solution

from purple to colorless

Use:-

- paper industry

↳ Bleaching agent

- food preservative

Kill bacteria

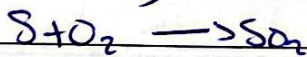
H_2SO_4 :-

oily liquid

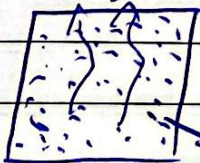
diluted typical acid

conc. dry gas

① Roasting

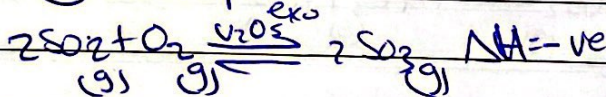


hot plate



S as a fine powder

② contact process



1) temp 400 - 450

2) pressure 1-2 atm "high pressure

favoured the forward

3) catalyst V_2O_5 vanadium

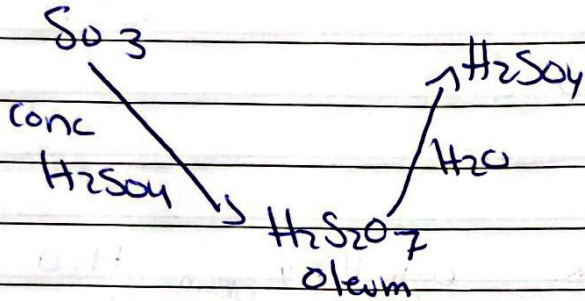
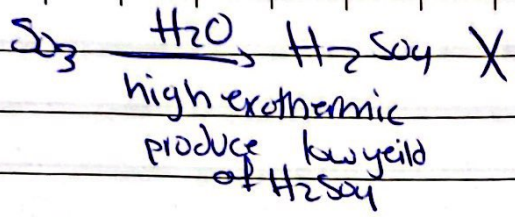
side which has gas less

(V) oxide

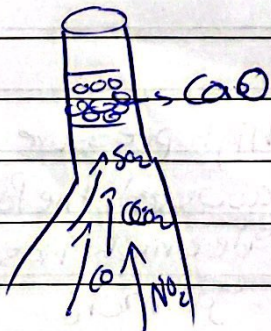
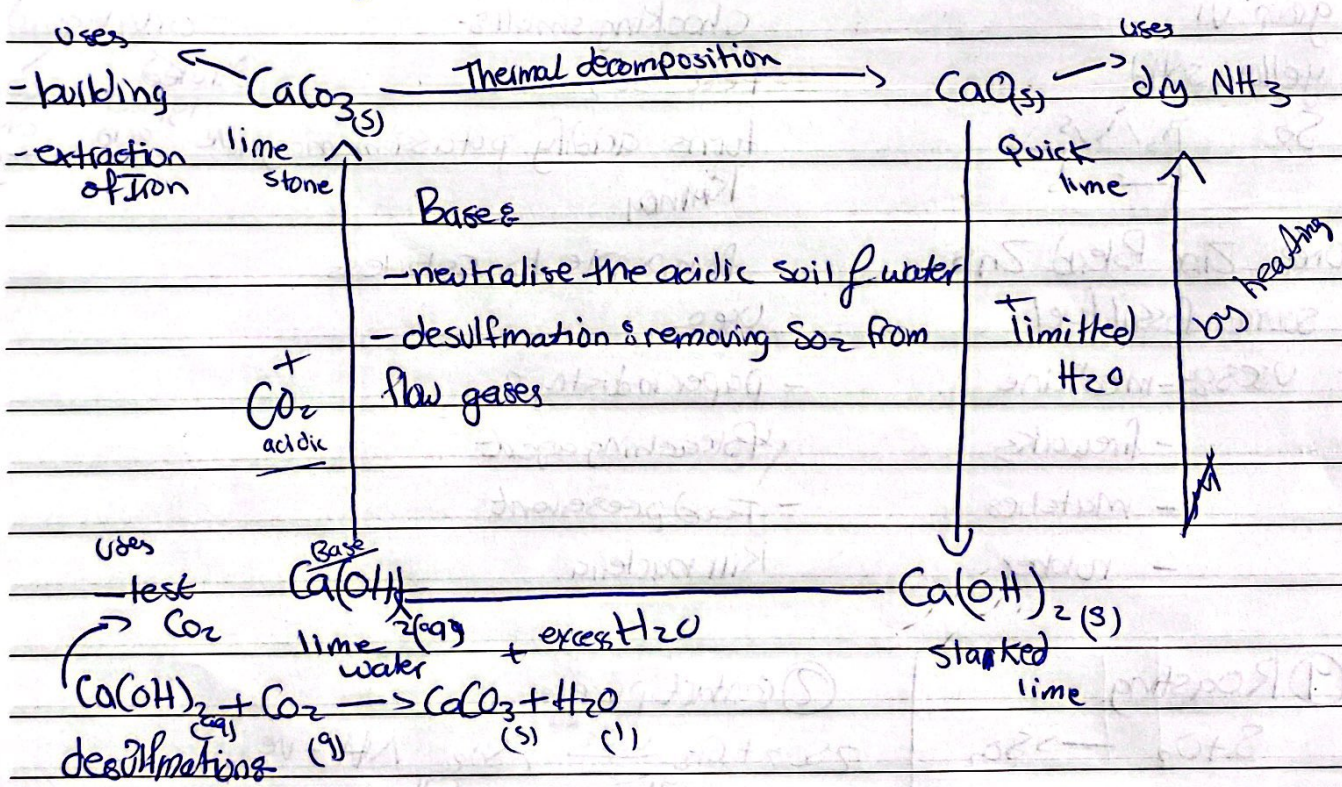
gas mole

max yield at 2 atm

more surface area faster rate of rxn



Carbonate cycle



go back to Electrolysis Chapter to study Al and the other transition metals

Extraction of metals &

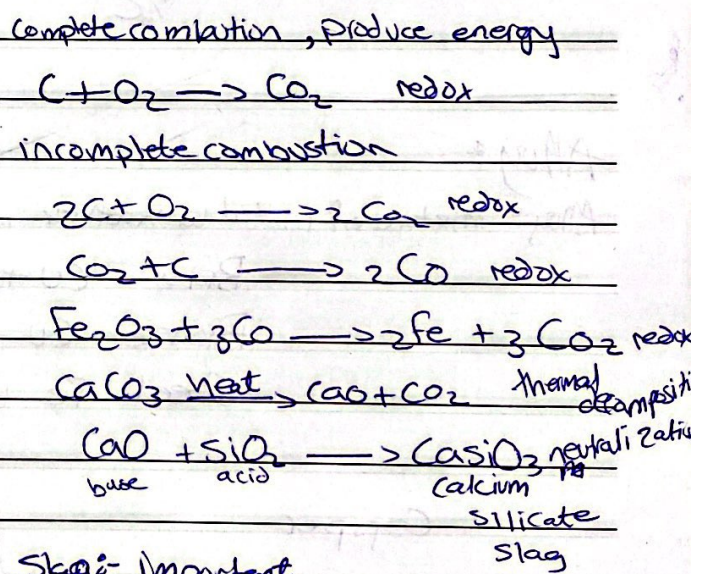
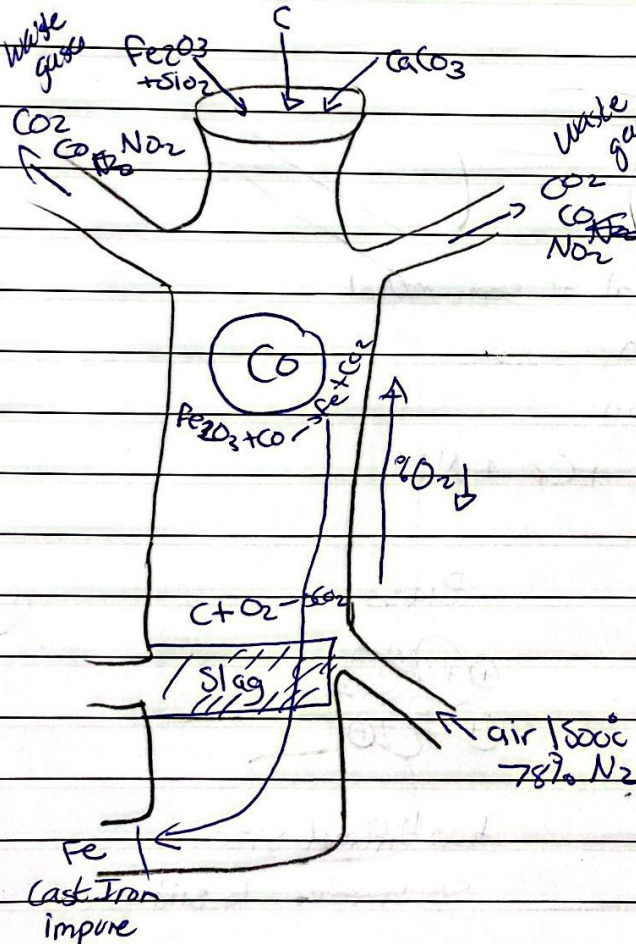
Extraction of Iron

ore: hematite Fe_2O_3

method: reduction by C, CO

place: Blast furnace

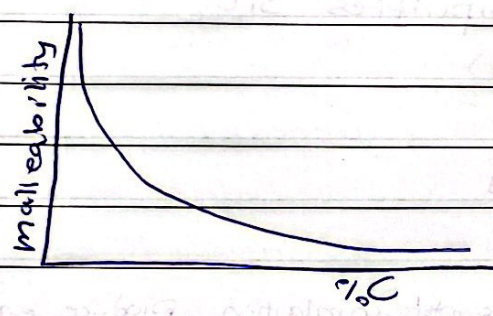
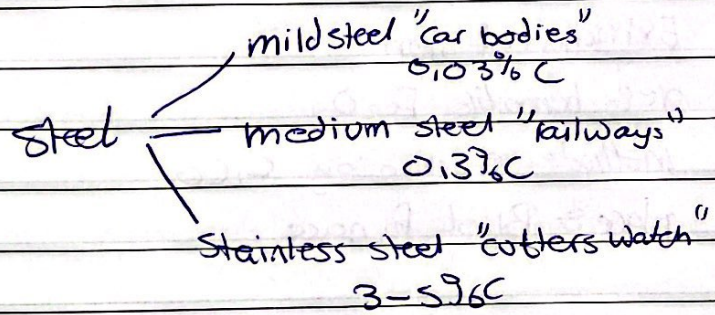
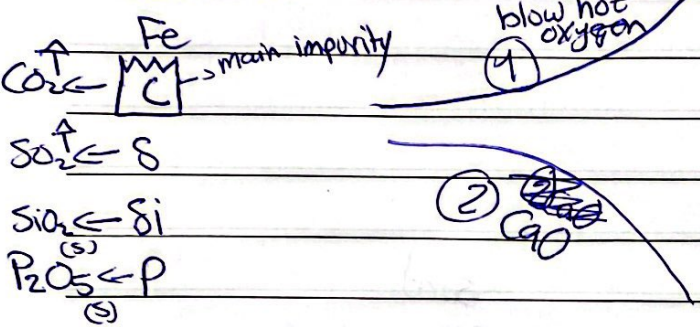
- raw materials: 1) Fe_2O_3 + acidic impurities SiO_2 ^{sand}
 2) $CaCO_3$ (lime stone)
 3) coke (Pure carbon)
 4) air ($T = 1500^\circ C$)



Stage: important
 Protective layer to prevent the rxn of O_2 with Fe
 use: mixed with bitumine to make roads.

Steel making "oxygen-base process"

Cast iron

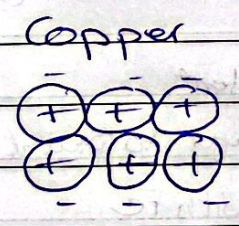


as percentage of C increase
malleability decrease

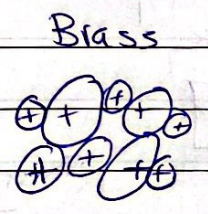
Alloys

Alloy is mixture of metal with other metal or semi-metal

- Brass: Cu + Zn
- Bronze: Cu + Sn
- Steel: Fe + C + Cr + Ni



easier to slide



two different sizes
so harder to slide