

Redox Reactions

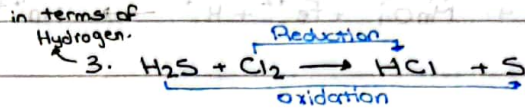
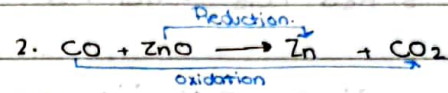
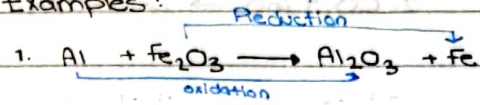
in terms of **Redox**

1. Oxygen loses Gains

2. Hydrogen Gains loses

3. Oxidation State \leftarrow oxidation \rightarrow
 \leftarrow Reduction \rightarrow
 -2 -1 0 1 2

Examples:



Rules of Oxidation State:

1. the oxidation for any free element = 0

2. the oxidation number of any atomic in a compound form:

Group 1: +1 \rightarrow Li, Na, Rb, K, Cs, F.

Group 2: +2 \rightarrow Mg, Ca, Sr, Ba.

Group 3: +3 \rightarrow ONLY for Aluminium.

Group 7: -1 \rightarrow ONLY for Fluorine.

3. Oxidation number of Hydrogen: +1 EXCEPT with metal hydride (-1).

4. Oxidation number of Oxygen: -2 EXCEPT in peroxide (-1) & in OF_2 (+2)

5. The sum of all Oxidation state in a compound is equal to zero and in an ion it is equal to the charge of the ion.

Monatomic: Na, K, Li, Ca, Cu
 Diatomic: H_2, O_2, N_2, F_2
 Polyatomic: P_4, S_8

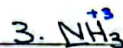
Solving:



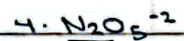
$1 + x = 0 \quad Cl = -1$



$1 + x = 0 \quad Cl = -1$



$N = -3$



$2x + (-10) = -2 \quad x = 4$



$N + (-6) = -1$

$N = 5$



$2x + (-14) = -2$

$Cr = 6$



$x = 3$

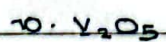


$x = 2$



$S - 8 = -2$

$S = +6$



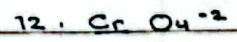
$2V + -10 = 0$

$2V = 10 \quad V = +5$



$P - 8 = -3$

$P = +5$



$Cr - 8 = -2$

$Cr = +6$



$C = +2$

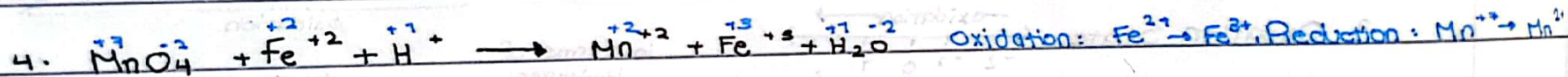
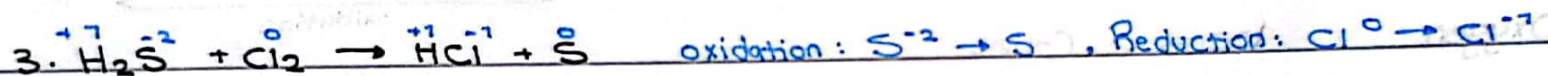
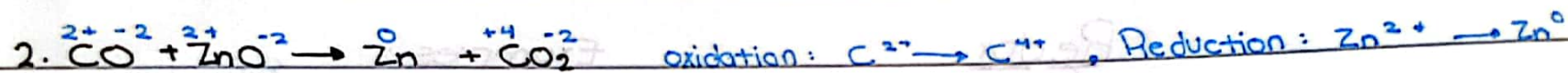
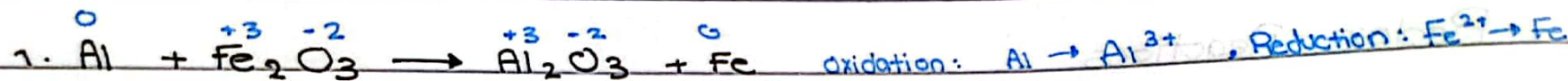


$C = +4$



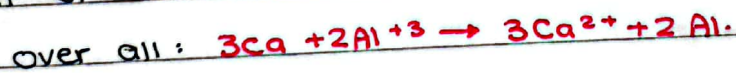
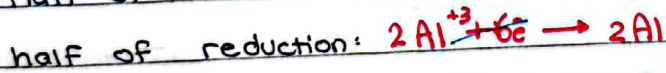
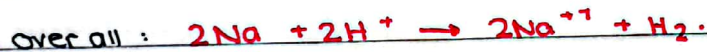
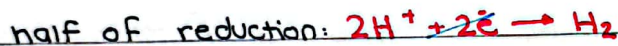
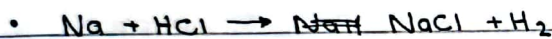
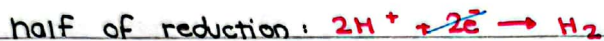
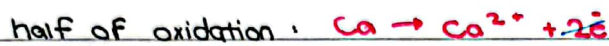
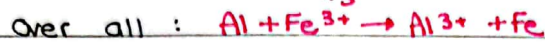
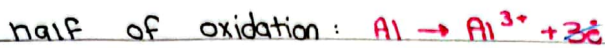
$C = +4$

$C = +4$



Balancing

3.9.2022



notes:

Reduction (+e) is

written before

(→) and in

oxidation after (→)

OILRIG

o x s o e s g

i s d i

d e v n

a e

t t

i i

e e

n n

Oxidising agent and Reducing agent.

6.9.2022

Oxidising agent = **oxidant**

reducing agent = **reductant**.

- the substance that itself reduced and causes other substances to oxidise.
meaning it is reduced.

- the substance that itself oxidised and causes the other substance to be reduced.
meaning it is oxidises.

* important note: if the substance is an ion in the compound the agent is the compound itself.

Examples:



Reducing agent / oxidation : Al

Oxidising agent / reduction : Fe₂O₃

Most common

oxidising agent

reducing agent

1. Oxygen
2. Acidify potassium Manganate.
3. Acidify potassium Dichromate.
4. Halogens (+ 2e⁻)



1. Hydrogen

2. Carbon and carbon monoxide

3. Iodide $2\text{I}^- \rightarrow \text{I}_2 + 2\text{e}^-$

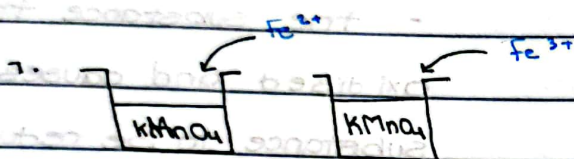
colorless

→ red brown

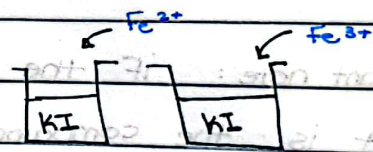
Q: Fe^{2+} is a reducing agent.

Fe^{3+} is an oxidising agent.

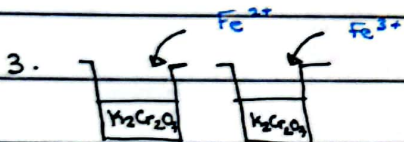
Record the observation in each of the following reaction.



Change color Stays the same.
purple \rightarrow colorless.




no change colorless \rightarrow red brown



change from no change
orange \rightarrow green.

Reactivity Series



K	Potassium	(most reactive) (strongest reductant / weakest oxidant).
Na	Sodium	
Li	Lithium	
Ca	Calcium	metal more reactive, more ^{likely} reactive
Mg	Magnesium	to lose e^- , more likely to oxidise,
Al	Aluminium	more likely to be a reducing agent
C, Co	Carbon	meaning ...
Zn	Zinc	if the metal is a good reactor
Fe	Iron	it is most likely to oxidise.
Pb	Lead	
H	Hydrogen	
Cu	Copper	
Ag	Silver	(least reactive) (weakest reductant / strongest oxidant).

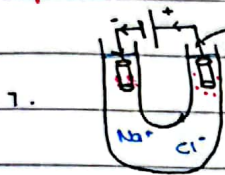
Electrolysis

7.9.2022

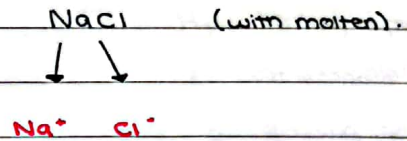
Electro → stands for electricity
 ysis → stands for analysis (breaking down).

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

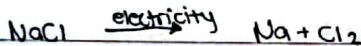
* **Electrolyte:** chemical compound that conducts electricity when molten or aqueous.



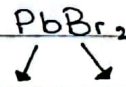
electrons lost from Cl passes through the battery and to the cathode and to Na to discharge it.



cathode deposit of metal anode green yellow gas.



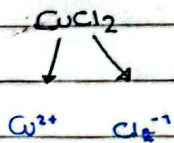
2. PbBr₂



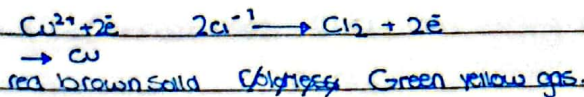
cathode deposit of metal anode bubbles of red brown gas

Solve:

Q1. CuCl₂(l) | Graphite

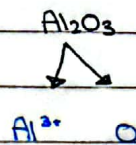


cathode anode

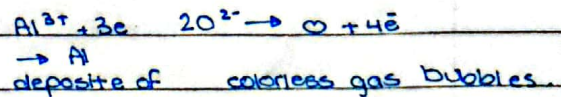


electrolyte consumed.

Q2. Al₂O₃ | Graphite

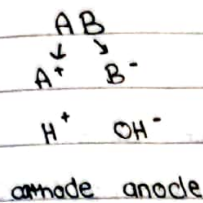


cathode anode



electrolyte consumed.

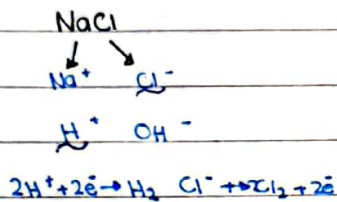
* Electrolysis of aqueous electrolyte using inert.



At the ...
cathode:
 less reactive more likely to discharge and more reactive stays in electrolyte.

anode:
 always OH^- except concentrated halides (Cl^-, I^-, Br^-)
 OH^- is observed as colourless gas

* e.x. concentrated NaCl(aq) using graphite.



O-level Gas test:

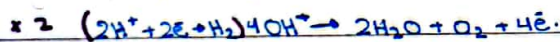
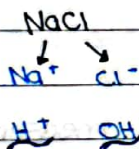
H_2 lighting splint test.
 you hear a popping sound.

O_2 glowing splint test.
 the splint relights.

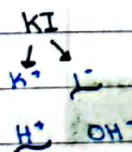
Cl_2 damp litmus paper test.

bleaches red litmus paper

* e.x. dilute NaCl(aq) using graphite:

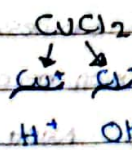


* e.x. Concentrated KI(aq) using graphite:



colourless gas bubbles. red brown solid

* e.x. Concentrated CuCl₂(aq) using graphite:

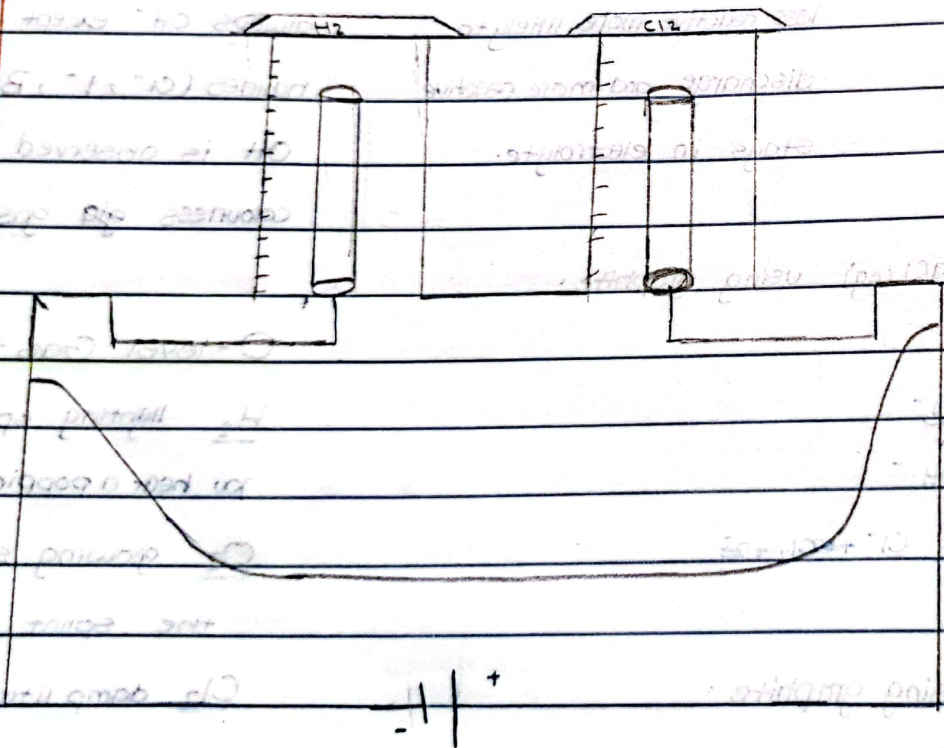


deposit of red brown solid green-yellow gas bubbles.

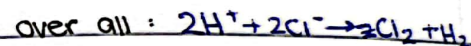
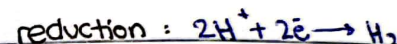
Questions:

Concentrated Sodium chloride (NaCl) is called Brine Solution.

Q₁: Plan an experiment to collect and measure the volume of H₂ and Cl₂ produced.



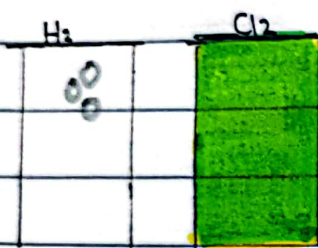
Half of ...



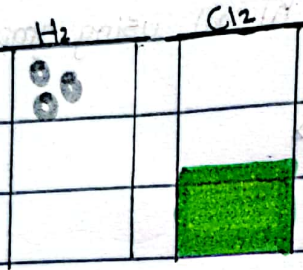
Q₂: The final appearance of the 2 measuring cylinders:

Q2. The final appearance of the 2 measuring cylinders:

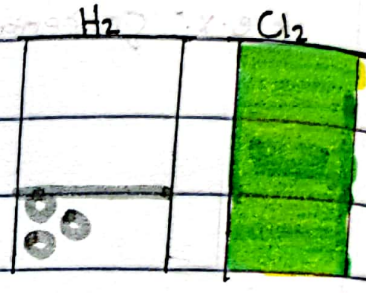
a) is answer.



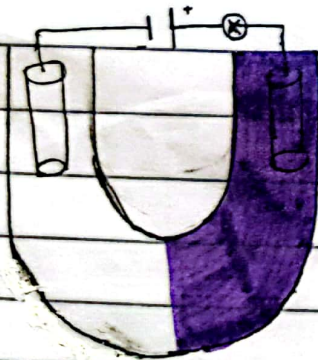
b)



c)



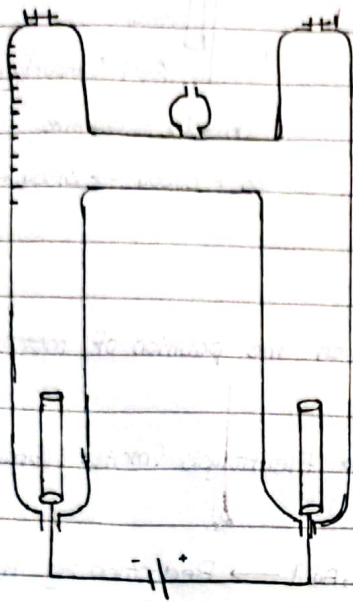
Q3: Brine with universal indicator:



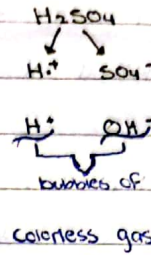
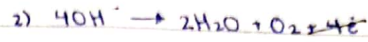
Observations:

- 1) bulb will light up.
- 2) green yellow gas on anode (due to oxidation of Cl^-)
- 3) bubbles of colourless gas on cathode (reduction of H^+)
- 4) The solution becomes purple around cathode because NaOH is an alkaline.
- 5) Chlorine bleaches the solution around the anode that is why Cl_2 is colorless. (This does not show directly as some Cl_2 dissolves).

* Electrolysis for $H_2SO_4(aq)$ / Hoff-man device.



final appearance:



Q. the final appearance:



* Applications of electrolysis:

1) extraction of metal

↓
molten / inert.

2) prepare solution

↓
aqueous / inert.

3) aq. electroplating /

purifying metal → aqueous / active.

* Electroplating:

- coating a metal with another metal using electrolysis.

why? 1) to prevent rusting 2) more attractive.

* Electroplating a metal spoon with silver:

1) Clean the spoon from any impurities of oxide layer with sand paper to ensure good sticking.

2) make the spoon the cathode (-ve rod).

3) The anode must be Ag.

4) electrolyte must contain Ag^+ eg.: $AgNO_3$.

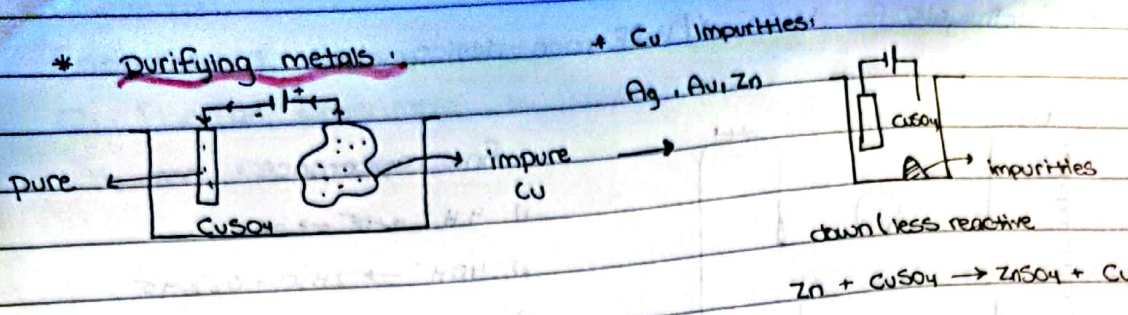
5) turn on circuit - "spoon must be fully immersed in the electrolyte".

6) Rotate the spoon to ensure equal distribution.

7) Rinse with distilled water.

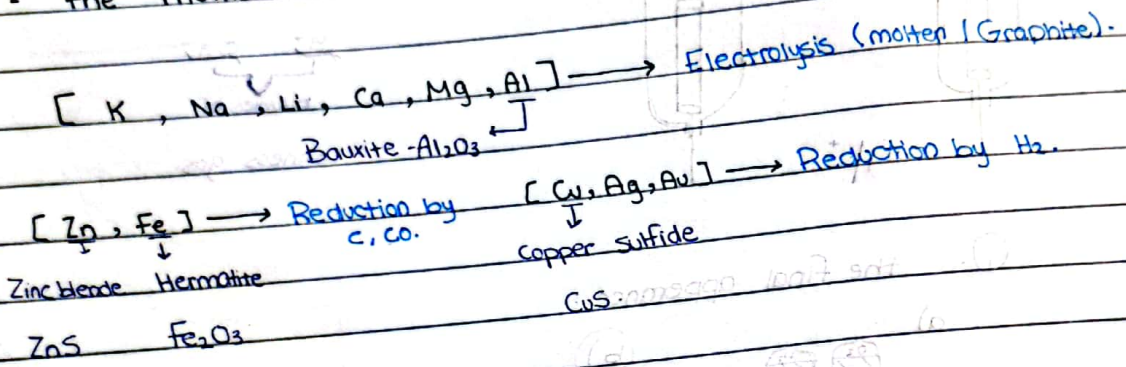
8) Dry in oven. →

* Purifying metals:



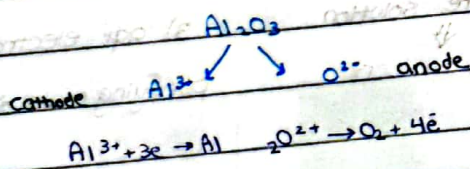
* Extraction of metals from their ores:

- the method of extraction depends on the position of metals in the reactivity series.

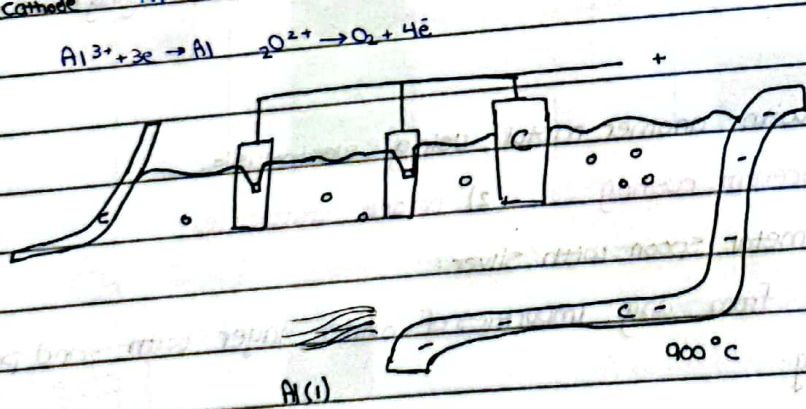


• Extraction of Aluminium from Bauxite (Al₂O₃):

1) method: electrolysis using molten / Graphite.
 2) m.p of Al is about 2000°C.
 so we dissolve Al₂O₃ in a molten Graphite Na₃AlF₆ to lower the m.p to 900°C ∴ ∴ ∴



- less expensive - increases electrical conductivity.

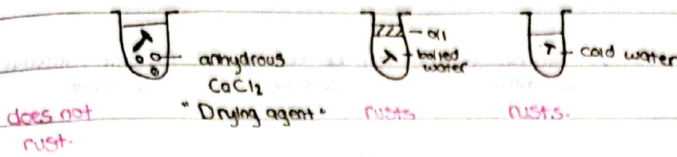


- Gases produced at anode -
- 1) O₂
 - 2) CO₂
 - 3) CO
- reaction of rods with O₂ so we must replace them regularly.

Property:	Use:
1) low density	Aircraft bodies
2) ductile	electrical wires
3) malleable	window frames / cooking utensils.
4) conduct electricity	wires
5) non-toxic oxide byer formed	food cans.

* Rusting: slow reaction (6-7 days).

reaction of iron (Fe) with both O_2 and H_2



Question:

Plan an experiment to show which rust prevention solution is better.

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

Put them in a known volume of water for 1 week. Dry them and measure the mass again. Repeat the experiment with solution 2.

* Results:- the exp. which causes more increase in mass, is the worst solution.

Ways to prevent rusting:-

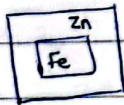
- 1) painting
 - 2) oiling
 - 3) Greasing
 - 4) Cover with plastic
- to prevent O_2 and H_2O from reaching the iron.

Rusting Prevention.



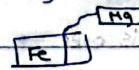
* 1) Galvanizing :

Coating Fe with Zn



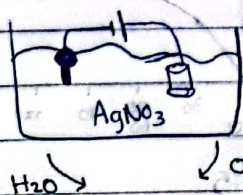
* 2) Sacrificial Protection:

Connecting Fe with Mg

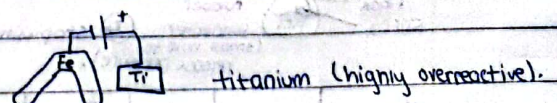


* Zn and Mg are more reactive than Fe so they are more likely to oxidise, more likely to lose e^- , so Fe is likely to rust.

* 3) Electroplating:



* 4) Cathodic Protection:



Rate of reaction ::

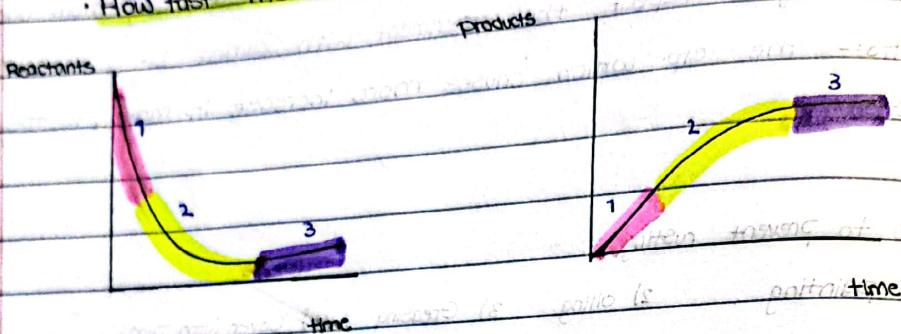
Rate = $\frac{\Delta \text{Quantity}}{\Delta \text{Time}}$ ($\frac{\Delta Q}{\Delta T}$)

Quantities include:

- 1) $\frac{\Delta \text{mass}}{\Delta \text{time}}$
- 2) $\frac{\Delta \text{temp.}}{\Delta \text{time}}$
- 3) $\frac{\Delta \text{volume of gas}}{\Delta \text{time}}$
- 4) $\frac{\Delta \text{conc.}}{\Delta \text{time}}$
- 5) $\frac{\Delta \text{light intensity}}{\Delta \text{time}}$
- 6) $\frac{\Delta \text{height of precipitate}}{\Delta \text{time}}$
- 7) $\frac{\Delta \text{PH}}{\Delta \text{time}}$

* Measuring the rate of reaction:

How fast the reactants consumed per unit time :-



Region (1):

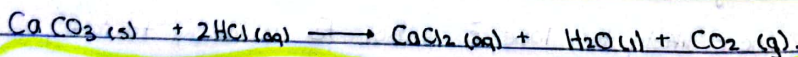
- 1) fastest rate \rightarrow steepest
- 2) more amount of reactants
- 3) more particles
- 4) more effective collisions per unit time.

Region (2):

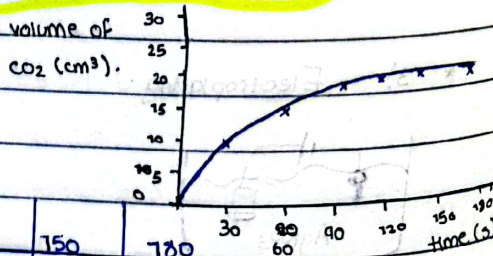
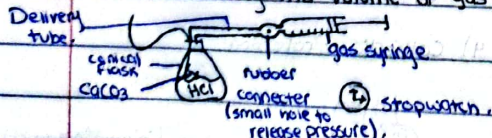
- 1) slower rate \rightarrow less steep.
- 2) less number of particles
- 3) less effective collisions per unit time.

Region (3):

- 1) Reaction is over \rightarrow horizontal (zero gradient).
- 2) less/number no more limiting factor.
- 3) no more effective collisions.



1) measuring the volume of gas.



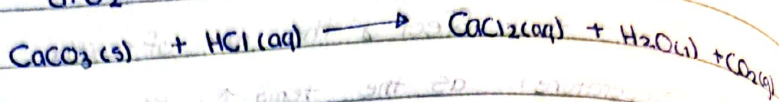
Time (sec.)	0	30	60	90	120	150	180
Volume of CO ₂ (cm ³)	0	7.5	15	17.5	19.5	21.5	22.5

3) Concentration: as the conc. ↑ the rate of reaction ↑. more effective collisions → faster rate of reaction.

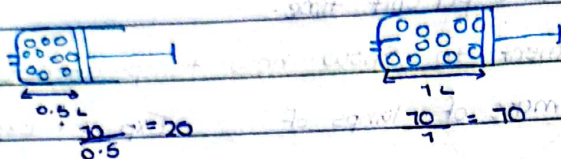
* Plan an experiment

exp. 1: 0.005 + 0.04

exp. 2: 0.02 + 0.1 → higher rate.



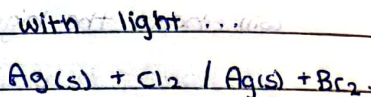
4) Pressure: (only on gases) as the pressure ↑ the rate of reaction ↑. more particles so more effective collisions.



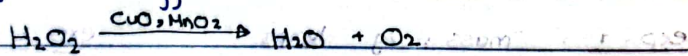
5) light: (only for photochemical reactions).

like photosynthesis: $6\text{CO}_2 + 6\text{H}_2\text{O} \xrightarrow{\text{light}} \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$

Photographic films are coated with AgCl (silver chloride) or AgBr (silver bromide).



6) Catalyst: a chemical substance that speeds up the rate of reaction without being used up. It provides an alternative by lowering the Ea so more particles with greater energy → more effective collisions.



Plan... to show that CuO is the catalyst.

- 1) known volume, known concentration of H_2O_2 at a known temp.
- 2) measure volume of O_2 produced.
- 3) Repeat exper. using CuO → more O_2 produced with CuO.

Plan... to show which catalyst is better.

- 1) "
- 2) " with MnO_2
- 3) Repeat with CuO → CuO produces more O_2 .

Reversible reactions:

types of chemical reactions.

- 1) One way: reactants \rightarrow products
- 2) Two way: reactants \rightleftharpoons products.

Dynamic equilibrium def.

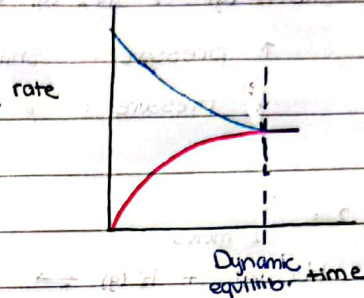
when the rate of forward equals the rate of backward and when products and reactants are constant.

Dynamic equilibrium in terms of ...

1) Rate:

rate of reaction \downarrow , less reactants, less particles, less effective collisions per unit time.

- forward - backward



2) Concentration:

* Le Chatelier principle

if the system is at equilibrium \rightleftharpoons and any external factors disturb the eq. the eq. can shift either (forward \rightarrow) or (backward \leftarrow) to return back to the equilibrium.

* factors that affect the position of equilibrium:

1) Temperature

* temp. \uparrow

$\uparrow\uparrow$ rate of endo.

\uparrow rate of exo.

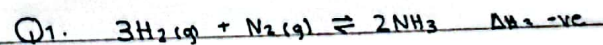
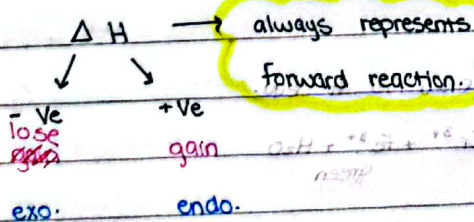
endo: increases

more shifts to endo.

* temp. \downarrow

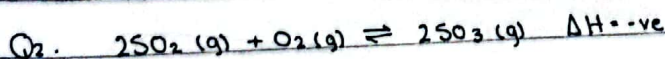
$\downarrow\downarrow$ rate of endo. endo. decreases more

\downarrow rate of exo. so shifts to exo.



use low temp. to favor forward reaction (exo.)

to increase NH_3 yield.

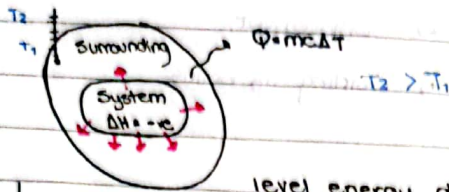


	rate of forward	rate of backward	% SO_3
\uparrow temp.	Increase	Increase	decrease
\downarrow temp.	decrease	decrease.	Increase

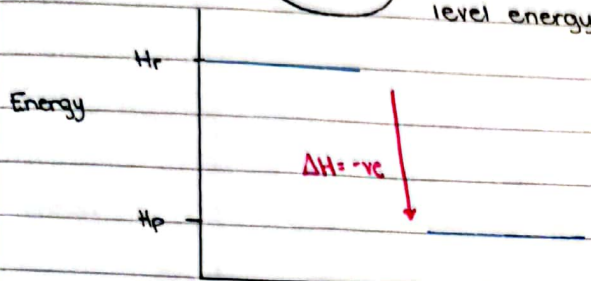
Exothermic

3.11.2022

Defenition: Reactions that give out (Release) energy to the surrounding.

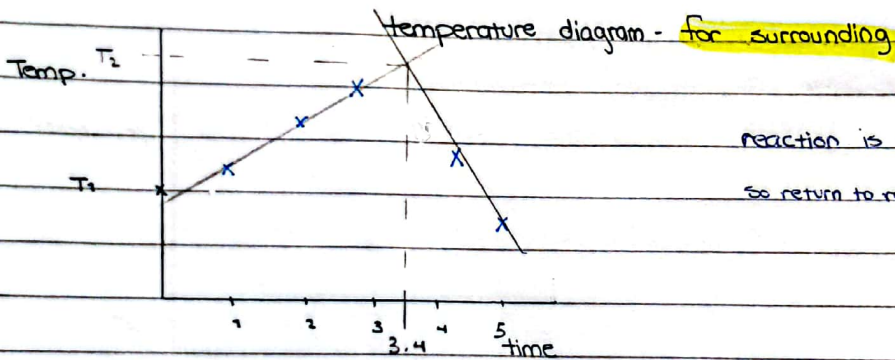


level energy diagram - for system.



Enthalpy: Heat contents "stored energy"
 Hr: enthalpy of reactants.
 Hp: enthalpy of products.

Reaction progress.



reaction is over
 so return to room temp.

↑ Q, more exo.

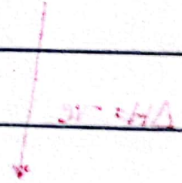
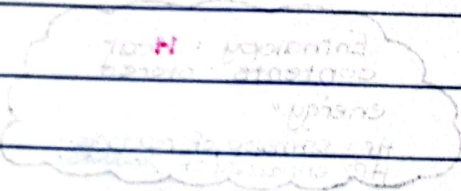
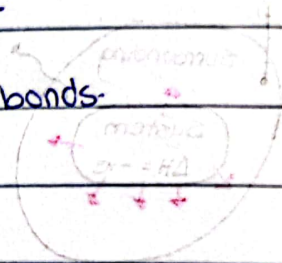
How to express exothermic reaction:

- 1] Reactants → products $\Delta H = -ve$
- 2] Reactant → product + Energy output > input.
- 3] Profile Diagram:



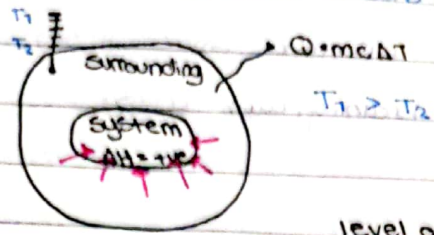
Examples of exothermic:

- 1) Freezing / condensation
- 2) Respiration
- 3) Combustion
- 4) Neutralization
- 5) Voltaic cell (battery)
- 6) Displacement
- 7) Building up bonds

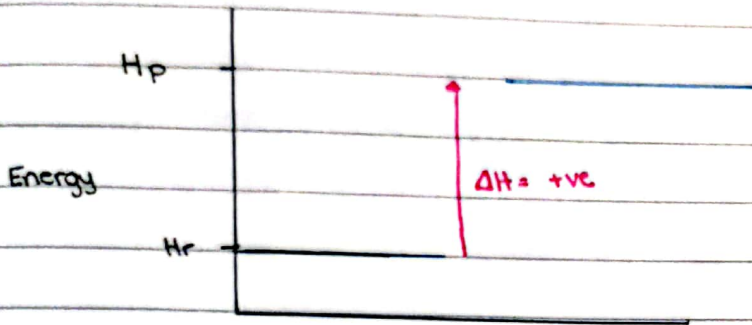


Endothermic

Definition: Reactions that absorb (take in) energy from the surrounding.



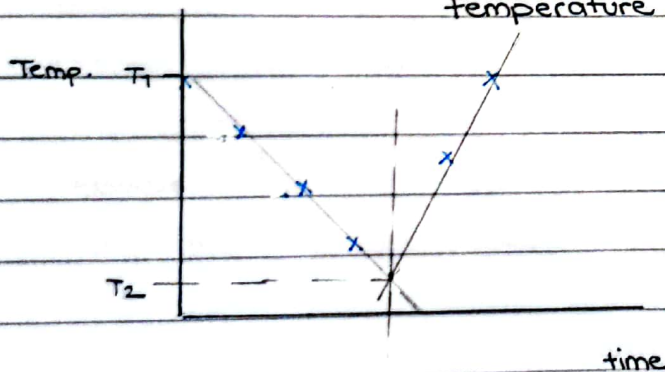
level of energy diagram - for system



Enthalpy: Heat contents + stored energy.
 Hr: enthalpy for reactants
 Hp: enthalpy for products

level of energy

temperature diagram - for surrounding



↑ Q, ↑ ΔT
 more endo.

How to express endothermic:

1) Reactants → Product ΔH = +ve

2) Reactants + energy → Product.

3) Profile diagram



input > output

Examples of endothermic.

1) Boiling, melting

2) Photosynthesis

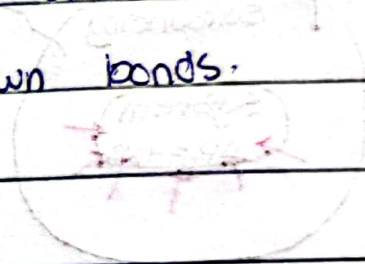
3) Thermal decomposition

4) electrolysis

5) Photographic films,

6) dissolving ammonium salts

7) breaking down bonds.



$\Delta H = +ve$

Measuring ΔH reaction

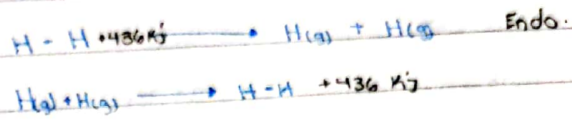
theoretical

Using bond energy.

ΔH reaction using bond energy

- Bond energy:
- 1. the amount of energy needed to break 1 mol in gas state.
 - 2. the amount of energy released to build 1 mol in gas state.

Bond	bond energy KJ/mol
H-H	436



$\Delta H_{\text{reaction}} = \sum \text{input} - \sum \text{output}$
 to break down bonds in reaction (input) vs to build up bonds in products (output)

endo. exo.

input > output input < output.

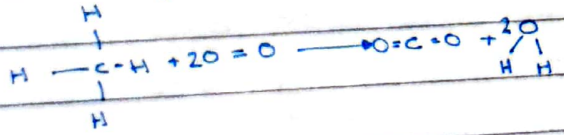
to use this equation:

1. balanced equation
2. covalent structure
3. bond energy.

example:



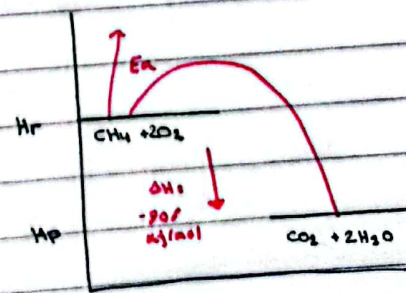
balanced covalent bond energy



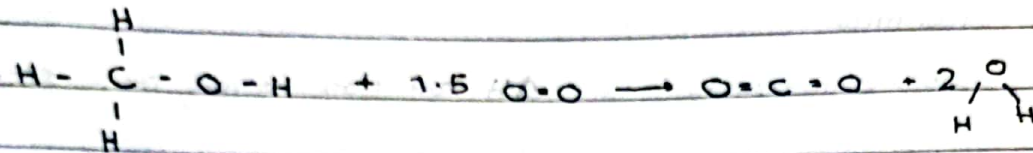
Bond broken	Bond Formed
- 4 x C-H	- 2 x C=O
4 x 413 = 1652	2 x 799 = 1598
- 2 x O=O	- 4 x O-H
2 x 495 = 990	4 x 463 = 1852
$\Sigma = 2642 \text{ KJ}$	$\Sigma = 3450 \text{ KJ}$

bond	bond energy
1. C-H	413
2. O=O	495
3. C=O	799
4. O-H	463

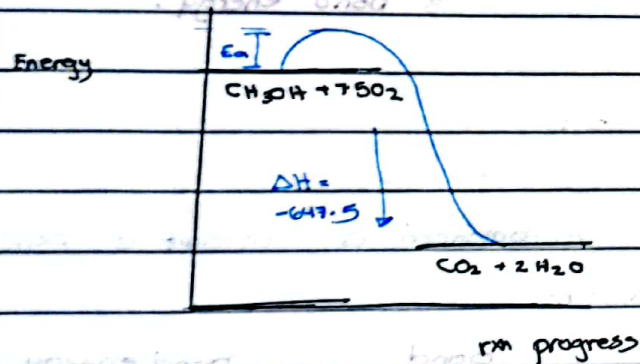
$\Delta H = \sum \text{input} - \sum \text{output}$
 $= 2642 - 3450 = -808 \text{ KJ}$
 exo.



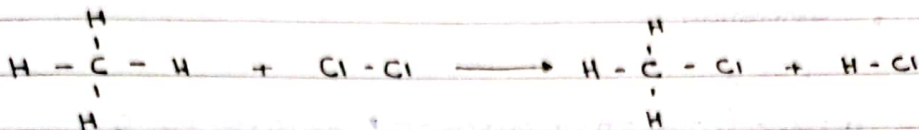
Example 2:



Bond broken	Bond built	bond	bond energy
- 3 x C-H	- 2 x C=O	C-H	413
3 x 413 = 1239	2 x 799 = 1598	O=O	495
- 7 x C-O	- 4 x O-H	C-O	358
7 x 358 = 2506	4 x 463 = 1852	C-O	358
- 1 x O-H	3450 KJ	O-H	463
1 x 463 = 463			
- 1.5 x O=O	$\Sigma = \Sigma \text{input} - \Sigma \text{output}$		
1.5 x 495 = 742.5	$= 2802.5 - 3450$		
2802.5 KJ	$= -647.5 \text{ KJ/mol}$		



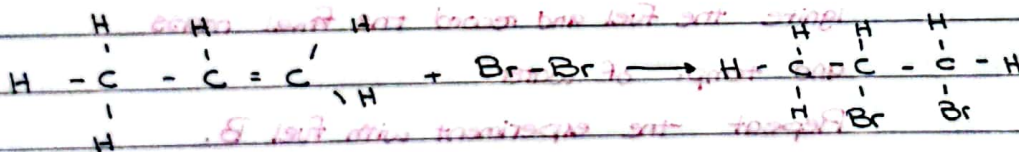
Example 3:



Bond broken	Bond formed	Bond	Bond Energy
7 x Cl-Cl	7 x C-Cl	C-H	413
7 x 242 = 242	7 x 328 = 328	Cl-Cl	242
7 x C-H	7 x H-Cl	H-Cl	431
7 x 413 = 413	7 x 431 = 431	C-Cl	328
655 KJ	759 KJ		

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

Example 4:

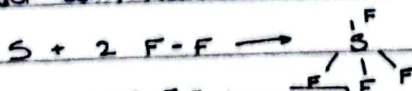


Bond broken	Bond formed	Bond	Bond Energy
Br-Br	2 x C-Br	C-H	413
C=C	C-C	C-C	348
614	900	C=C	614
807 KJ		Br-Br	193
		C-Br	276

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

Example 5:

When sulfur react with Fluorine the reaction gives 780 KJ/mol.



If the bond energy of F-F is 157 KJ/mol

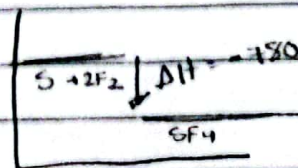
- 1) Draw an energy level diagram.
- 2) Find the bond energy of S-F.

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

$$-780 = 2 \times 157 - 4 \times \text{S-F}$$

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

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



Finding ΔH (energy change) practically.

Combustion:

$$\begin{array}{c}
 \text{H} \quad \text{H} \\
 | \quad | \\
 \text{H} - \text{C} - \text{C} - \text{O} - \text{H} + 3\text{O} = \text{O} \longrightarrow 2\text{O} = \text{C} = \text{O} + 3 \begin{array}{c} \text{O} \\ | \\ \text{H} - \text{H} \end{array} \\
 | \quad | \\
 \text{H} \quad \text{H}
 \end{array}$$

for surrounding:

$Q = mc \Delta t \longrightarrow 100 \times 4.2 \times 10$
 $= 4200 \text{ J} \longrightarrow 4.2 \text{ KJ}$

↓
subject

$4.2 \longrightarrow 2\text{g}$

$96.6 \text{ kJ/mol} \longrightarrow 46$

100g H₂O

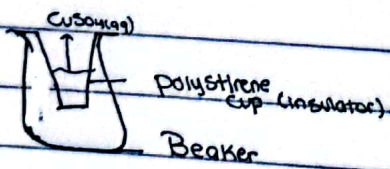
$m_1 = 200$
 $m_2 = 198\text{g}$

Q. two fuels A & B.

Plan an investigation to show which one produce more energy.

- take a known mass of water with a known initial Temp. in a copper can.
- take a known mass of fuel A.
- ignite the fuel and record the final mass and temp. of water.
- Repeat the experiment with fuel B.
- the fuel which cause more temp. rise per gram of fuel produce more energy.

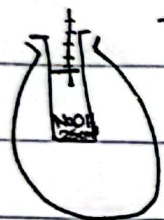
displacement.



Why do we put a beaker below polystyrene cup?

- more insulation
- more stable

Neutrization.



$T_1 = 22^\circ\text{C}$



$T_2 = 28^\circ\text{C}$

Specific heat capacity = 4.2

density = 1 g/cm³

$$Q = mc\Delta T$$

$$\Delta T = 28 - 22 = 6^\circ\text{C} \quad D = m/V \quad 1 = m/25$$

$$C = 4.2$$

$$m = 25$$

$$m_{\text{tot}} = 25 + 25 = \underline{\underline{50}}$$

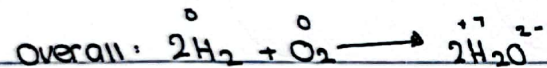
$$50 \times 4.2 \times 6 \rightarrow 1260 \text{ J}$$

13.11.2022

Alternative resources of energy

- Hydrogen Fuel cell.

memorise



Advantages:

- 1) no CO₂
- 2) produce high amount of energy
- 3) Generate electricity.

test for water:

Physical test: 100°C

Chemical test:

1. Cobalt chloride: blue → pink

2. CuSO₄: white → blue

Disadvantages:

- 1) expensive
- 2) hard to store and transport.
- 3) Risk of explosion.

Industrial Chemistry

1. Dealing with Gases

- Dry
- Collect

2. Industry of ...

- NH_3 : Haber process
- H_2SO_4 : Contact process
- CO_2 : Carbonate cycle

3. Extraction of metals

- Al
- Fe
- Zn
- Cu

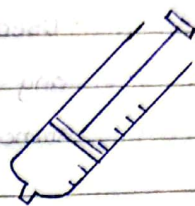
* Dealing with Gases:

Reaction → Gas → Dry → Collect

- Collecting gases

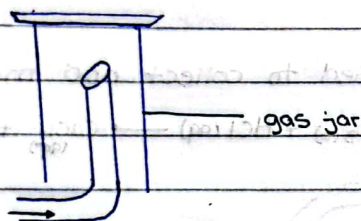
1. Gas syringe:

- used to collect and measure the volume of any gas.
- no mixing of gases.



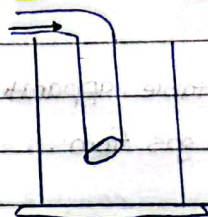
2. Delivery tubing:

i. upward delivery:



less dense than air

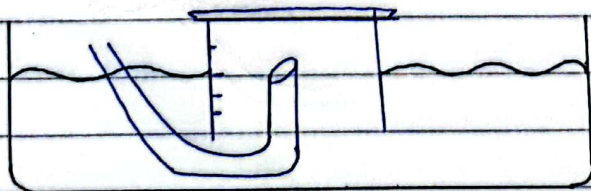
ii. downward delivery:



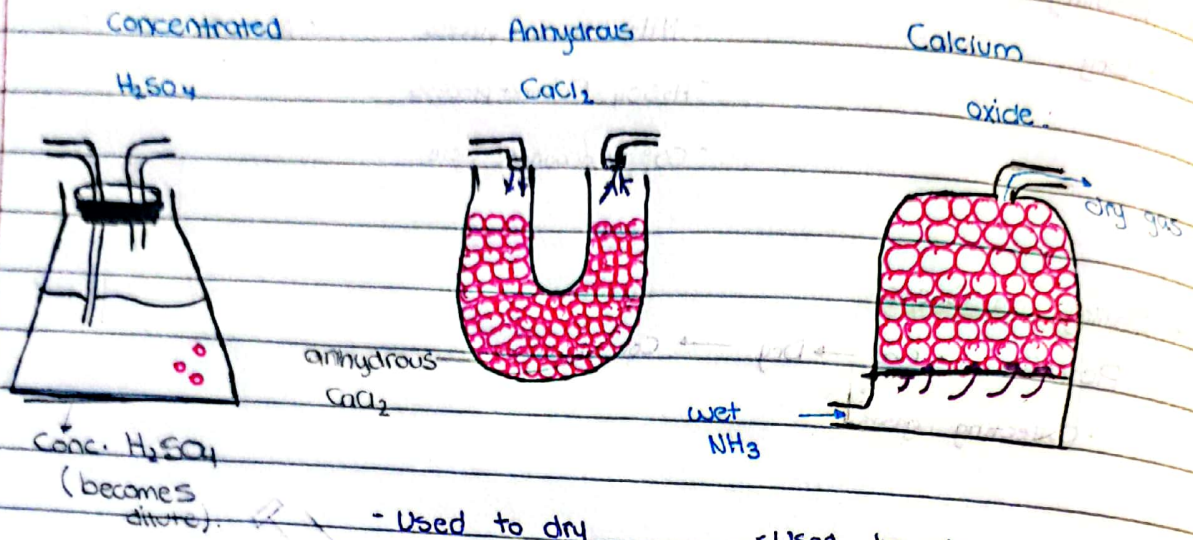
more dense than air

3. Overwater:

- only for insoluble gases.



Drying Gases



Conc. H_2SO_4
(becomes dilute).

anhydrous $CaCl_2$

wet NH_3

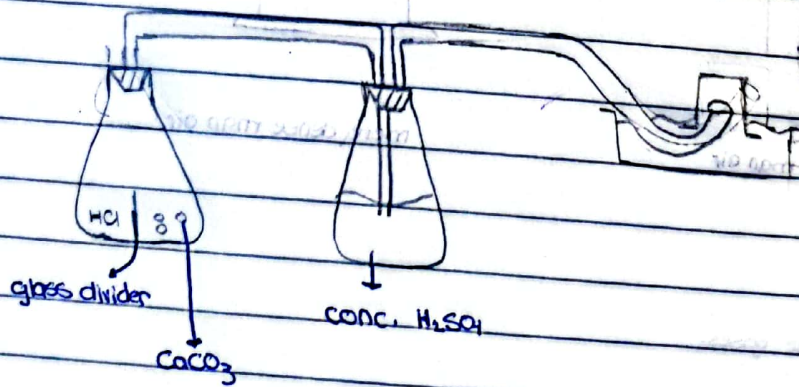
- used to dry any gas except NH_3 . (it neutralizes H_2SO_4).

- Used to dry any gas except ammonia.

- Used to dry only ammonia.



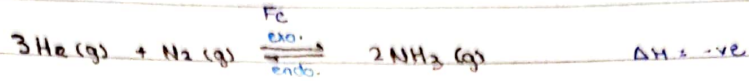
* Q. Draw a suitable apparatus used to collect and measure the volume of CO_2 gas from ...
 $CaCO_3(s) + HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$



Industry of Ammonia: (Haber Process).

uses of Ammonia ..

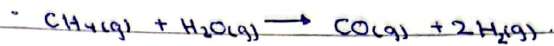
1. Smelling salts
2. Cleaning detergent
3. prepare fertilizers (main use).



How to obtain 8

1) Nitrogen: Fractional distillation of liquid air
 ↓
 different b.p ↓
 cooling under high pressure.

2) Hydrogen: cracking of Alkalines (organic).



Essential ~~pre~~ conditions for haber process 8

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

adv.

less than 400°C

dis.

more than 450°C

adv.

dis.

- higher yield of NH_3

- slower rate,

- faster rate

- less yield.

- shift forward to

particle lose kinetic

- shift backward

exo. side

energy so less

to endo. side.

effective collisions

per unit time.

- Add excess H_2 and N_2

to return back to container.

2) Pressure: 200 atm

over 200 atm .

adv.

dis.

- Remove NH_3 immediately

- more yield of NH_3

- risk of explosion

How? by cooling.

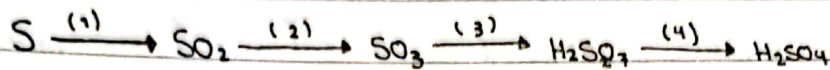
shift forward to side

- expensive

with fewer gas moles

- faster rate

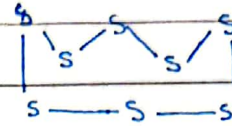
Industry of H₂SO₄ : (contact process).



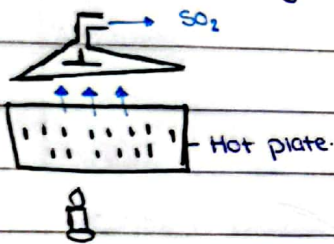
causes acid rain, kills bacteria, bleaching agent.

sulfur:

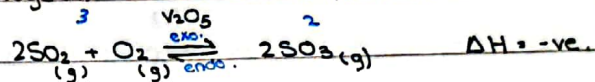
- Group (VI)
- yellow solid
- Valency (2)
- S₈
- uses: medicine, match, rubber.



Stage (1): + O₂ / Roasting.



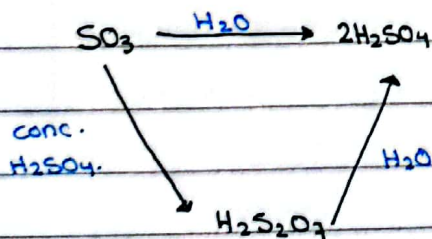
Stage (2): + O₂ / Contact process.



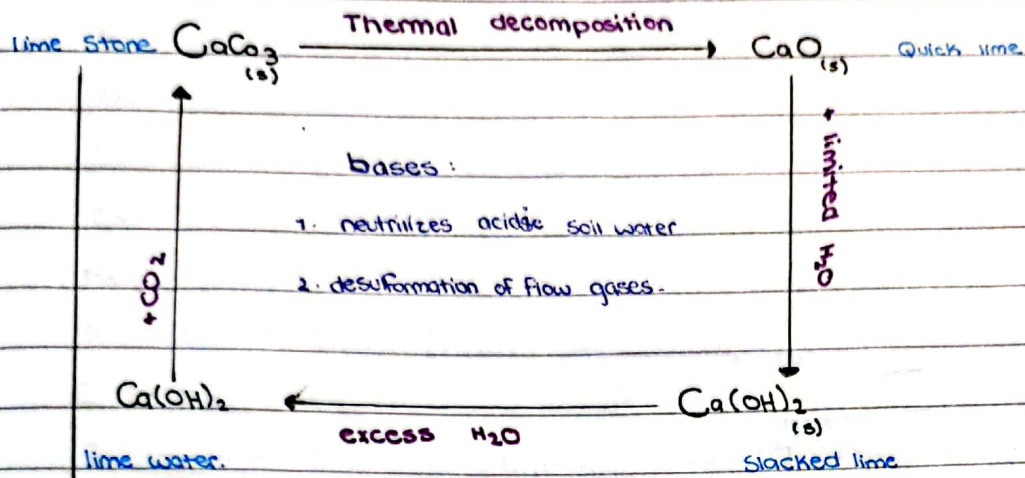
essential conditions:

- 1) Temperature : 400 - 450 °C
- 2) Pressure : 2 atm 'high pressure favour the favoured reaction' 2 atm gives max-yield of SO₃.
- 3) Catalyst : V₂O₅ Vanadium (V) oxide.

Stages (3)(4):



Carbonate cycle

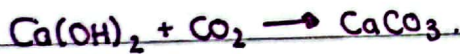
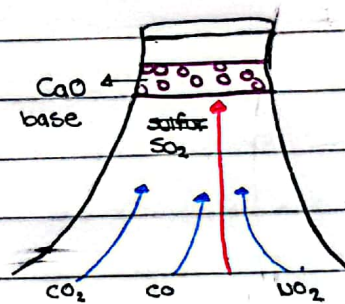


bases :

1. neutralizes acidic soil water
2. desulfurization of flue gases.

uses :

- CaCO_3 : building / extraction of iron.
- CaO : dry ammonia (NH_3).
- Ca(OH)_2 : test CO_2



Extraction of metals

K

Na

Li

Ca

Mg

Al \longrightarrow Bauxite (Al_2O_3) by electrolysis / molten

Cu, CO

Zn \longrightarrow Zinc blend (ZnS) not in ovens } reduction by C and CO

Fe \longrightarrow Hematite (Fe_2O_3) } "blast furnace"

Pb

H

Cu \longrightarrow CuS not in ovens

Ag

Au

Pt

* Extraction of Iron (Fe):

ore: Fe_2O_3 Hematite method: reduction of C and CO

place: blast furnace.

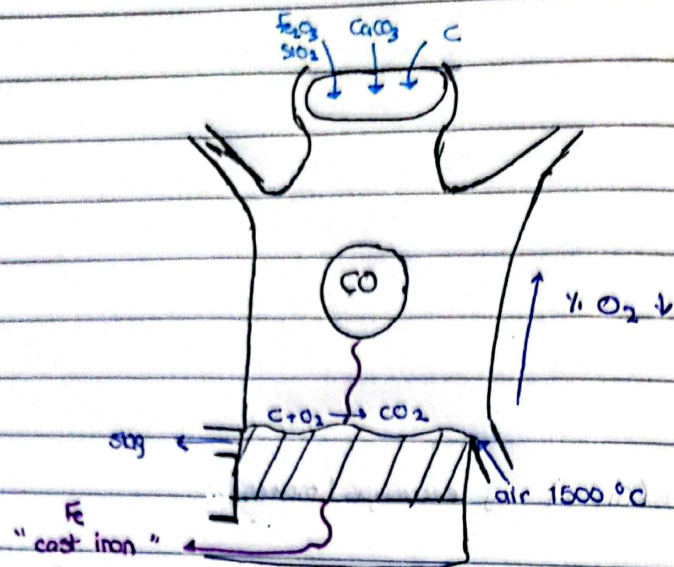
Raw materials: Fe_2O_3 mixed with SiO_2 acidic impurities.

$CaCO_3$ "lime stone"

Coke "Carbon" "pure"

at $1500^\circ C$



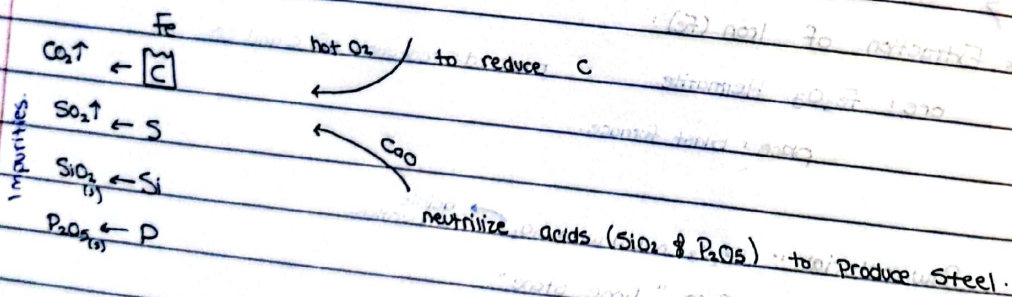


iron leaves min to get because of it's high density.

CO is important so reduction would take place

* slag forms a protective layer that prevent the reaction of Fe and O_2 use & mix with bitumene to make rods.

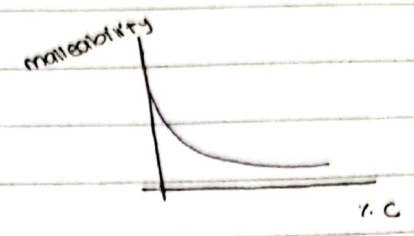
* Steel making "oxygen base process".



Steel (% of C in steel)

- mild steel: 0.03% C (car bodies)
- medium steel: 0.3% C (railways)
- Stainless Steel: 3-5% C (cutters / watches).

As the % of C ↑
 the malleability ↓
 (% C ∝ malleability)



* Alloy is mixture of metal with another metal or semi-metal

Brass Cu, Zn

Bronze Cu, Sn

Steel Fe, C, Ni, Cr

alloys are harder because it has different sizes of particles so harder to slide between each other.

Metal Cu

Brass Cu, Zn



* Extraction of Zinc - Zn

Ore: Zinc blende ZnS method: reduction by C, CO

place: blast furnace.

Step 1: Roast with hot oxygen.

C, CO and H₂ can only reduce the less reactive metal from its oxide only.