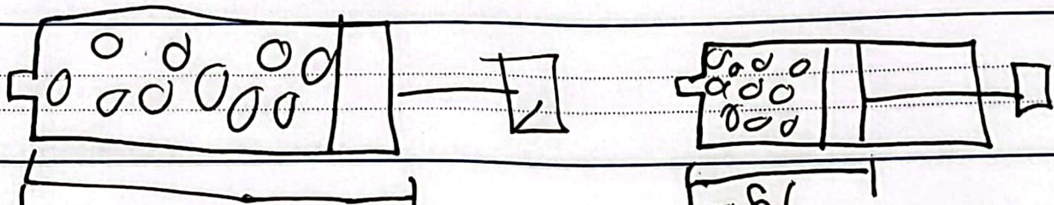
Day : .... Date : ....

4) pressure only for gas

explain how the 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



1 litre

$\frac{10 \text{ particles}}{1 \text{ litre}} = 10$

0.5 L

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

5) light for photochemical rxn

- photosynthesis

$$6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{light}} C_6H_{12}O_6 + 6O_2$$

6) Catalyst: chemical substance that speeds up the rate of a chemical reaction

Enzyme: Biological catalyst

Day : .... Date : ....

How?

it provides an alternative pathway with lower activation energy, so more particles will have energy equal to or greater than Ea, so more effective collisions per unit time, so faster reaction

Ea: the min amount of energy needed to start the rxn
↑Ea . slower rate
↓Ea higher rate

$H_2O_2 \xrightarrow[\text{or } MnO_2]{CuO} H_2O + O_2$

Q1 Plan an exp to show that CuO is a catalyst for this rxn

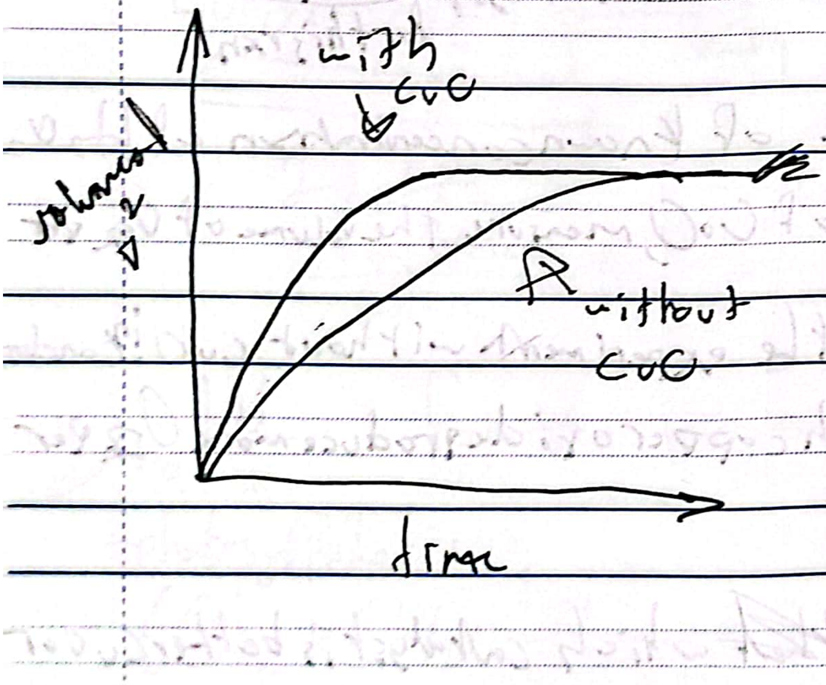
take known volume of known concentration of H_2O_2 and a known mass of CuO, measure the volume of O_2 per unit time. repeat the experiment without CuO. in conclusion the experiment with copper oxide produce more O_2 per the same unit time

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

take known volume of known concentration of H_2O_2 at known mass of CuO, measure the volume of O_2 per unit time, repeat with MnO_2 (same mass), in conclusion, the exp that produces 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 r

add a known mass of CuO to H_2O_2 until no more bubbles of O_2, filter the mixture, dry in oven, remeasure the mass, inco the mass will not change.



Day : .... Date : ....

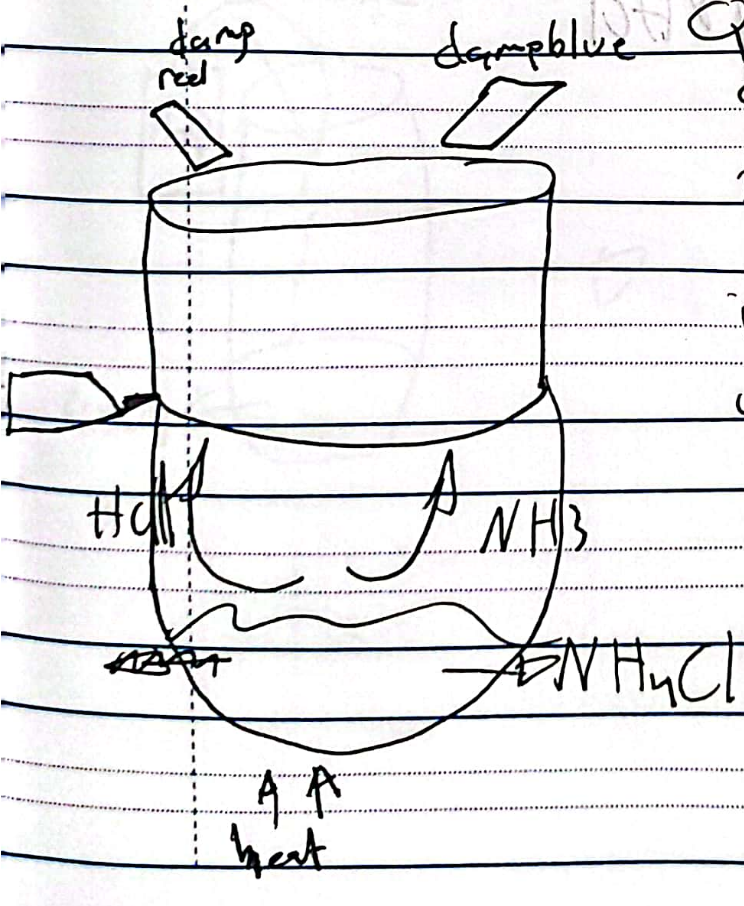
reversible reactions

Chemical reactions

one way	both ways
reactants $\xrightarrow{Forward}$ products	reactants $\underset{backward}{\overset{forward}{\rightleftharpoons}}$ products
$Mg + HCl \rightarrow MgCl_2 + H_2$	$3H_2 + N_2 \rightleftharpoons 2NH_3$
$CaCO_3 + HNO_3 \rightarrow Ca(NO_3)_2 + H_2O + CO_2$	$2SO_2 + O_2 \rightleftharpoons 2SO_3$
	$NH_4Cl \rightleftharpoons NH_3 + HCl$
	$2NO_2 \rightleftharpoons N_2O_4$

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

ammonium chloride — ammonia — hydrogen chloride

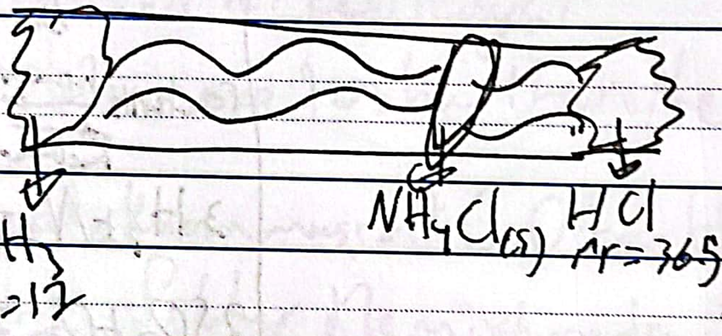


Q which damp litmus paper will change its color first, explain your answer?

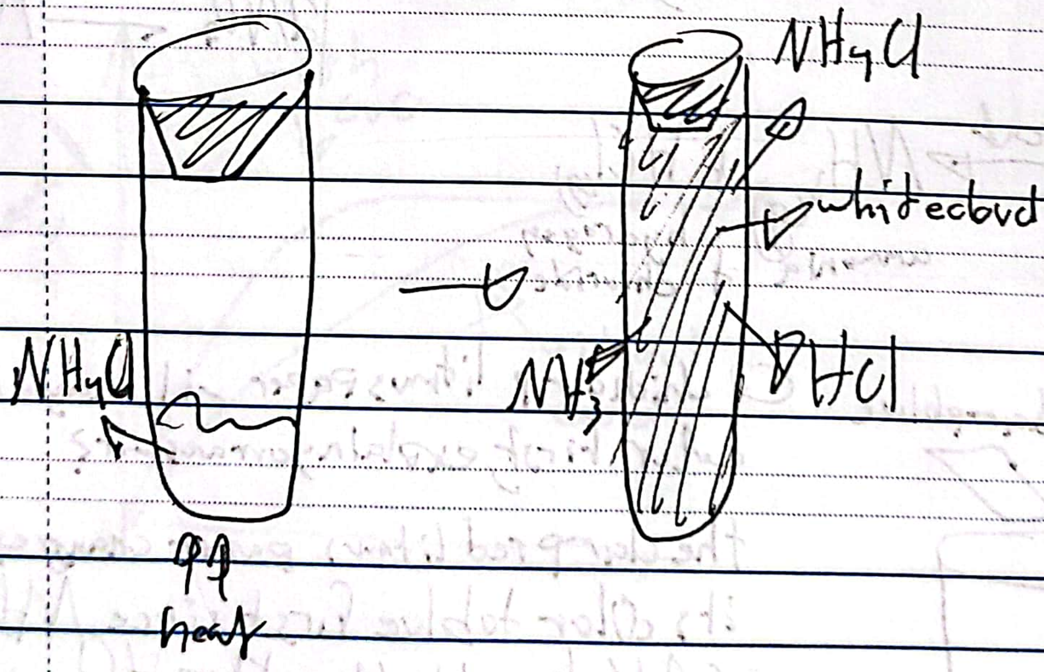
the damp red litmus paper changes its color to blue first since $NH_{3(g)}$ is Alkali and lighter than $HCl_{(g)}$ which is acidic

Day : .... Date : ....

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



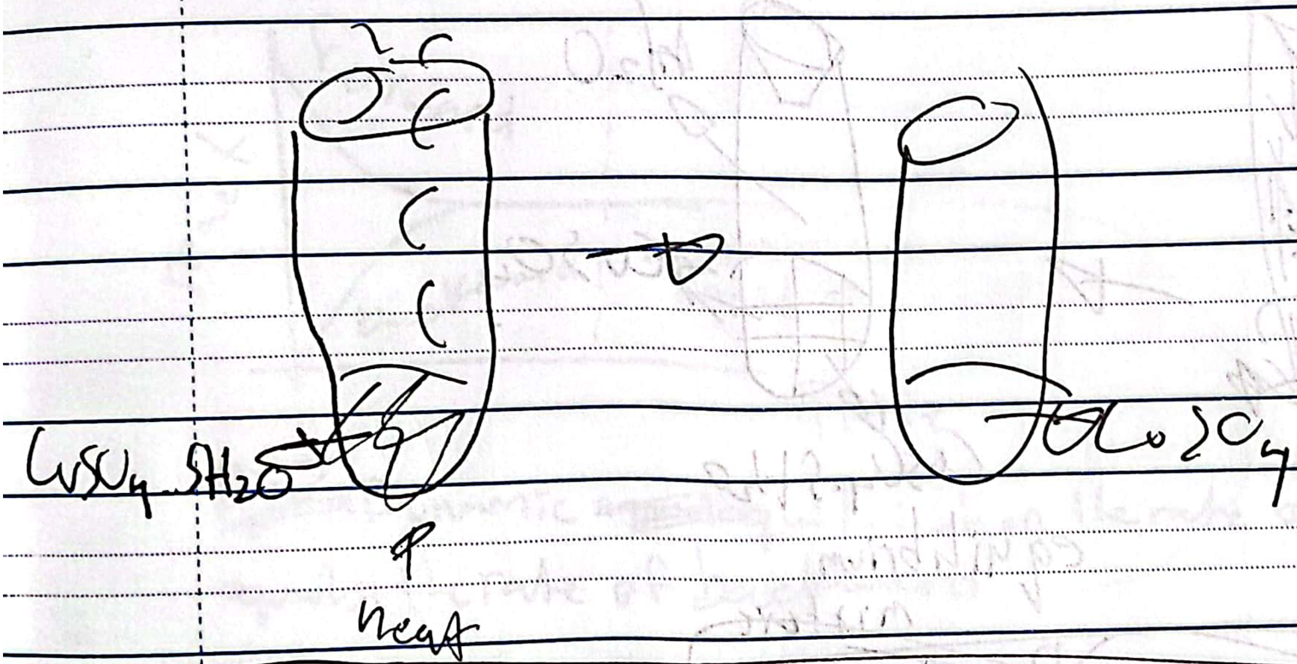
$NH_4Cl_{(s)} \rightleftharpoons NH_{3(g)} + HCl_{(g)}$



Day : .... Date : ....

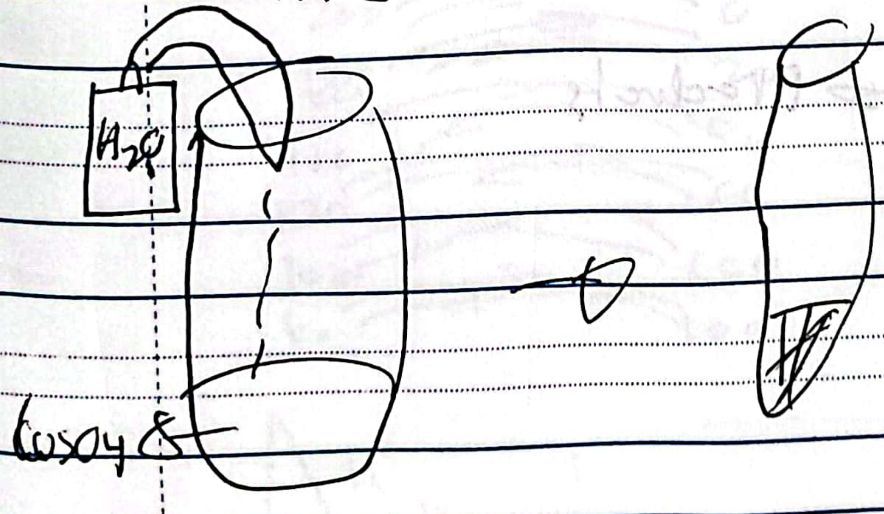
$CuSO_4 \cdot 5H_2O_{(s)} \xrightarrow{heat} CuSO_{4(s)} + 5H_2O$

blue   white



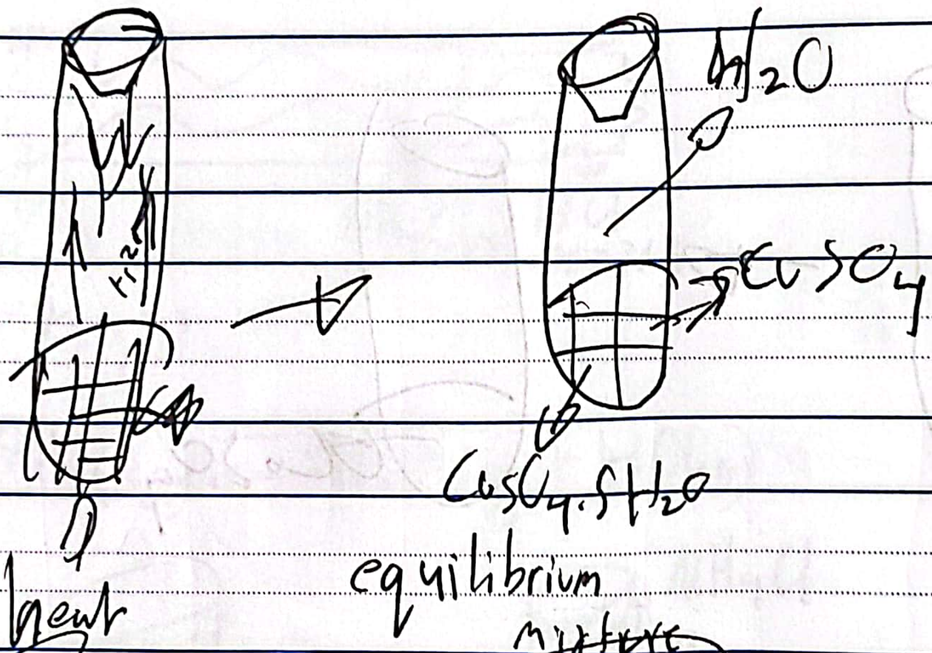
$CuSO_{4(s)} + 5H_2O \rightarrow CuSO_4 \cdot 5H_2O$

white



Day : .... Date : ....

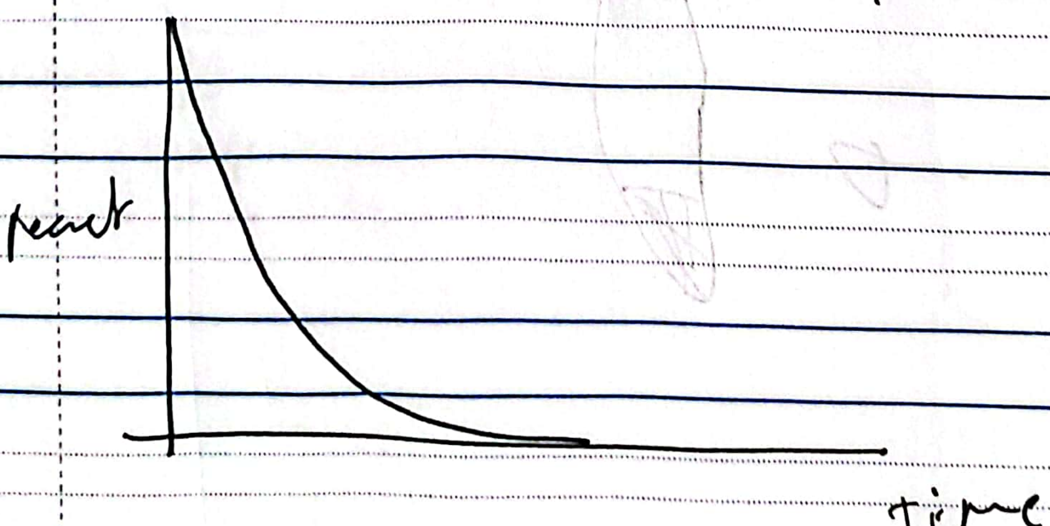
$$CuSO_4 \cdot 5H_2O \rightleftharpoons CuSO_4 + 5H_2O$$



~~Dynamic equilibrium~~

Oneway

reactants ⟶ products

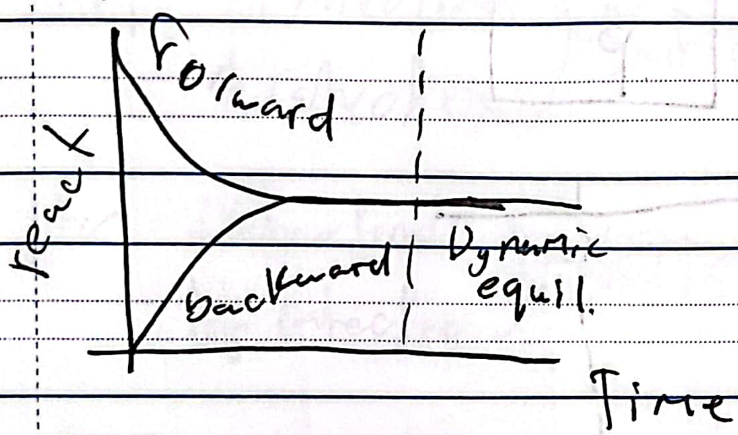


Day : .... Date : ....

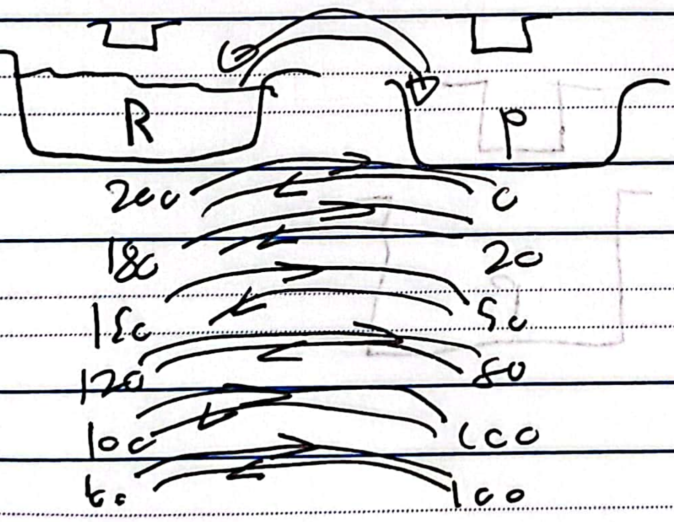
Dynamic equilibrium

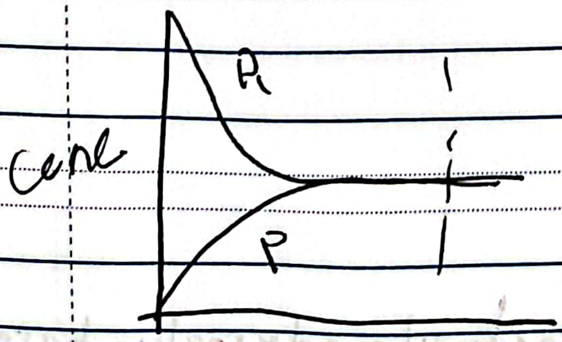
~~Reactant product~~

reactant ⇌ product



~~Dyna~~ Dynamic ~~equi~~ equil. : when the rate of forward equals the rate of backward





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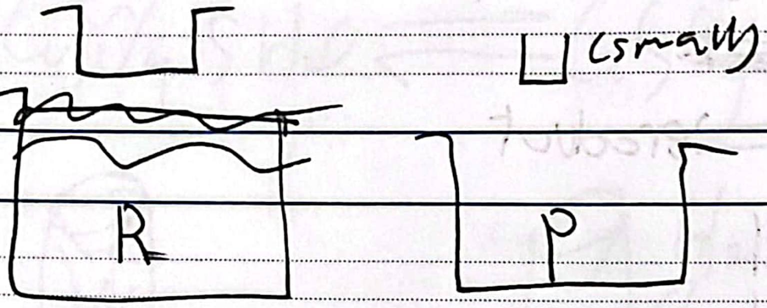
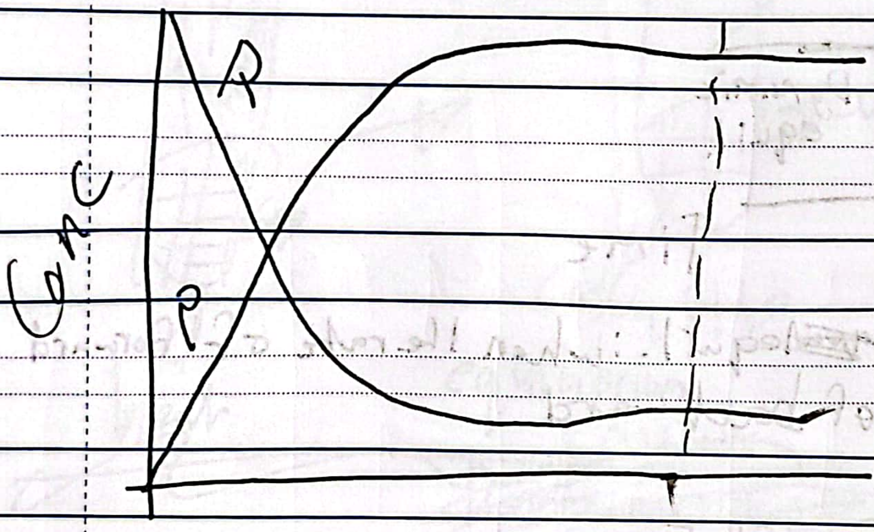
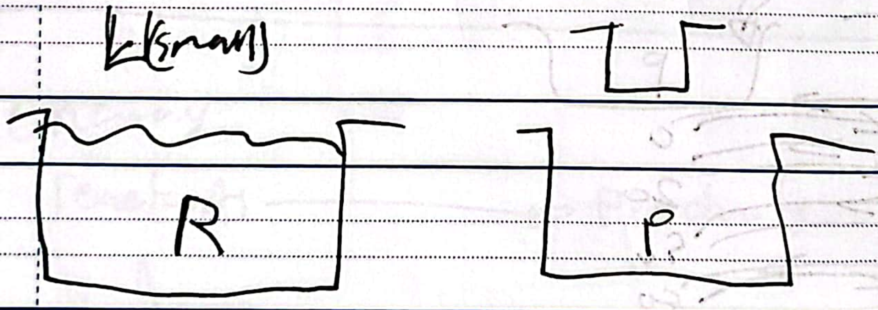
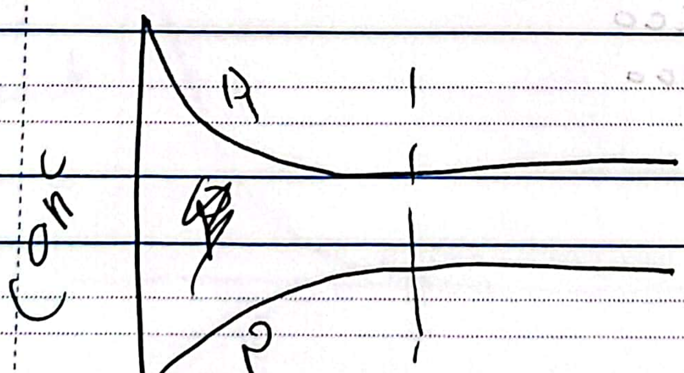








interms of conc.
equil when the ~~rate~~ conc of reactant and product are constant

Day : .... Date : ....

Ug (1) temp

↑temp ↑↑ rahe o Rendo) - Shiftto endo
↑ rahe o rexo)

↓temp ↓ rahe o lendo) - ~~Sheif~~ shift to exo
↓↓ rahe o fexo)

Day : .... Date : ....

② pressure

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

↓pressure ⇒ " " " " " more " " more " " "

↑pressure rate of less gas mole ↑↑, rate of more gas mole ↑ → shift to less gas mole

↓pressure rate of less gas mole ↓↓, rate of more gas mole ↓ → shift to more gas mole

$3H_{2(g)} + N_{2(g)} \rightleftharpoons 2NH_{3(g)}$ (4 mol → 2 mol)

↑pressure shift forward to the side which has less mole

↓pressure shift backward to the side which has more mole

$CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$ (0 mol → 1 mol)

↑pressure shift backward to the side with less gas mole

↓pressure shift forward to the side with more gas mole

Day : .... Date : ....

2nd　　　　2nd

$H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$

pressure has no effect on the position of equilibrium because they have the same amount of gas moles

complete the table

effect	rate of forward	rate of backward	yield of NH_3
↑ temp	↑	↑	↓
↑ pressure	↑	↑	↑
↓ pressure	↓	↓	↓

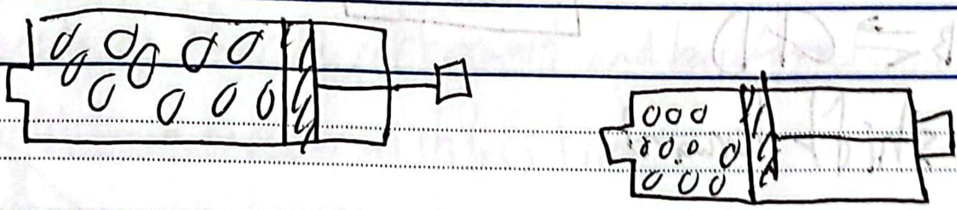
Q:- The reaction $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$ at equilibrium
(purple) (colorless)

1) 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

Day : .... Date : ....

(2) why by increasing the pressure the mixture becomes more purple



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

$$2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$$

dark brown — pale brown

by increasing the pressure the mixture :

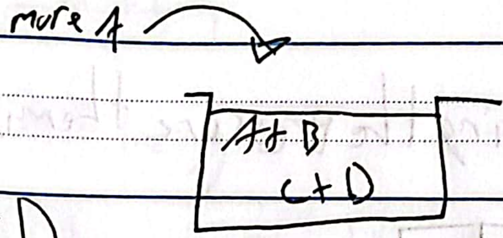
a) becomes darker and stays darker

(b) " darker " goes paler

c) " paler " stays paler

d) " paler " goes ~~paler~~ darker

Day : .... Date : ....



③ concentration

$A + B \rightleftharpoons C + D$

↑[A] shift forward

↓B ↑C ↑D

↓[C] shift backward

↑A ↑B ↓D

$3H_{2(g)} + N_{2(g)} \underset{endo}{\overset{exo}{\rightleftharpoons}} 2NH_{3(g)}$ (2 mol) $\Delta H = -ve$ ~~endo~~ exo

temp ~~...~~ 450°C

pressure 200 ATm

conc. add excess H_2 and N_2

remove NH_3 immedietly (condensation)

Indicator

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

color (1) color (2)

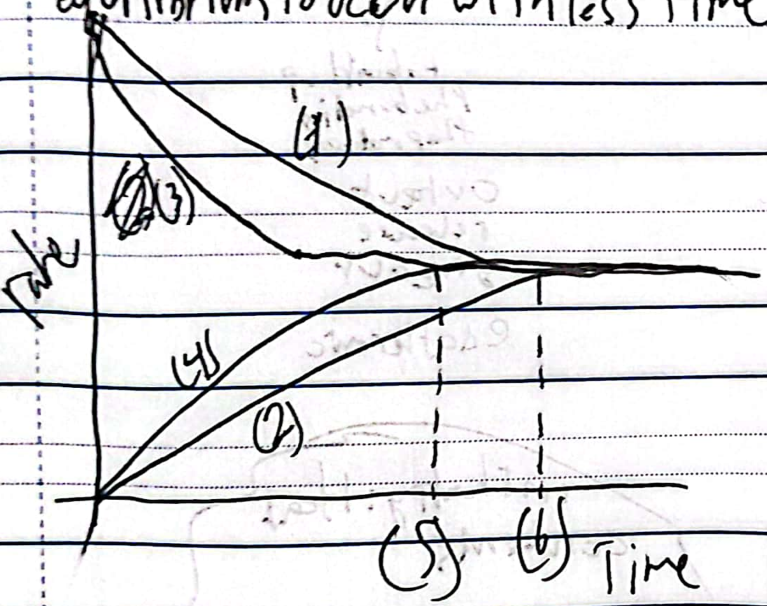
add HCl ~~acid~~ acid proton doner → ↑H^+ shift backward, more HIn more for color (1), less In^- less for color (2)

add NaOH proton aceptor $OH^- + H^+$ → ↓H^+ more In^- more color (2), less HIn less color (1)

Day :

Date :

catalyst: has no effect on the position of equilibrium because it speeds up the rate of forward and backward, 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

Day : .... Date : ....

~~Energy~~ Energetices
(energy in chemical reactions)

Energy: the ability to do work

the chemical rxn

- to break down bonds in reactants
  - input
  - absorb
  - take in
  - endothermic
- to build up the bonds in the products
  - output
  - release
  - give out
  - exothermic

input > output
endothermic

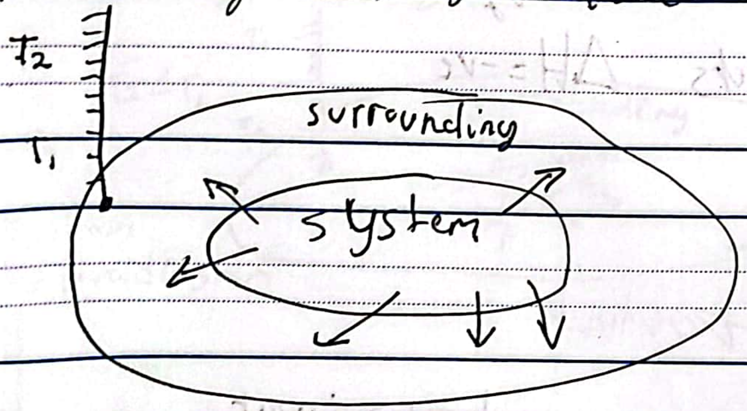
output ≥ input
exothermic

enthalpy: Heat contents.
Stored energy in bonds

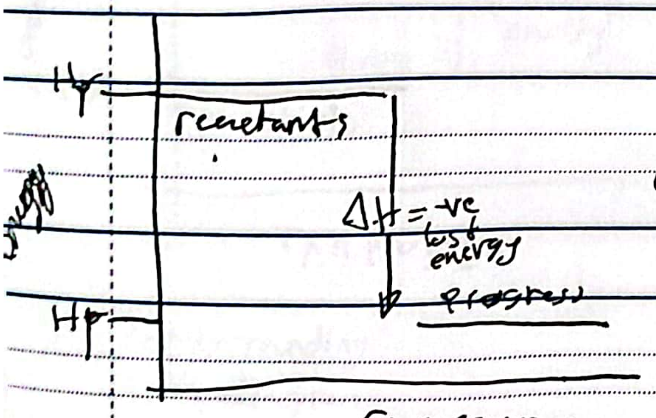
Day : ....

Date : ....

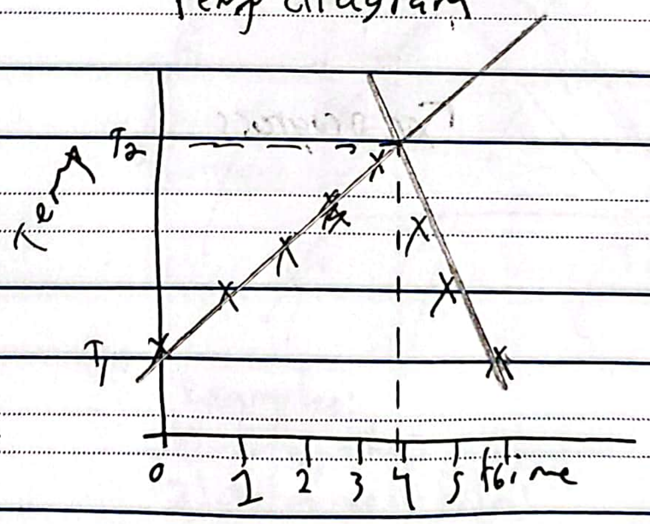
exothermic reactions: reactions that release (give out) energy to the surrounding when they take place



for system
energy level diagram



for surrounding
Temp diagram



$$Q = m\,c\,\Delta T$$

energy (J)
mass (g)
specific heat capacity
change in Temp

↑Q ↑ΔH more exothermic

examples:

1) combustion
2) ~~displacement~~
3) neutralization
4) respiration
5) Freezing, condensation
6) voltaic cell
7) building up bonds

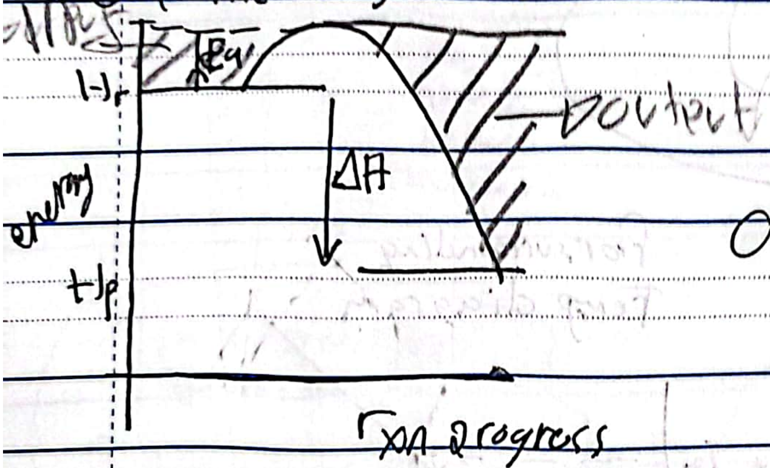
Day : .... Date : ....

☆ how to express exothermic reactions

1) reactants ⟶ products + energy

2) reactants ⟶ products $\Delta H = -ve$

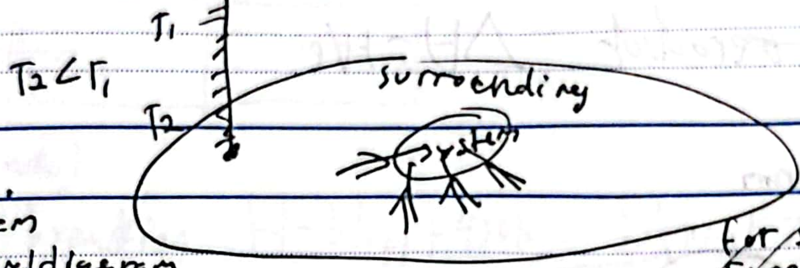
3) profile diagram

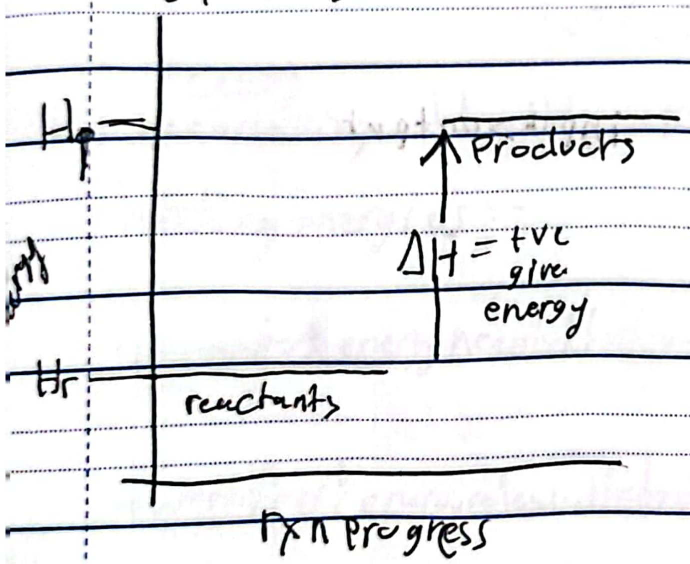


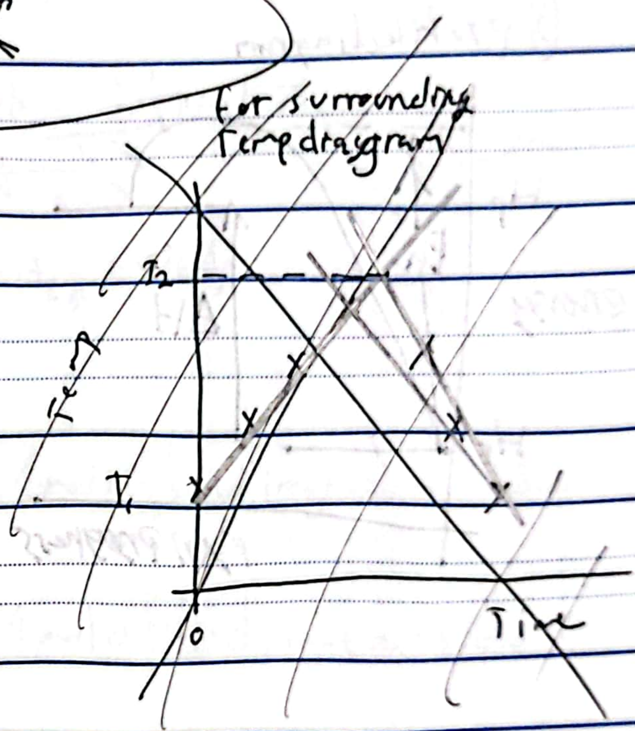
output > input

Day : .... Date : ....

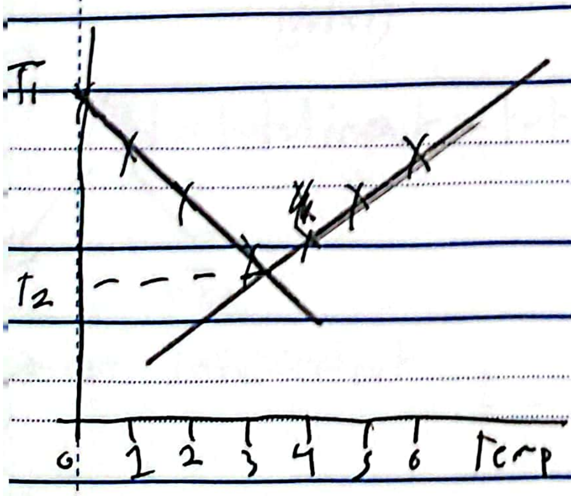
endothermic reactions: reactions that absorb (take in) energy from the surrounding when they take place







For surrounding
Temp diagram



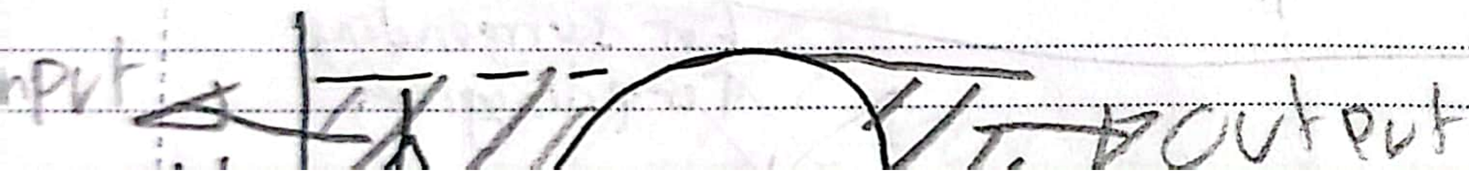
examples:
1) photosynthesis
2) photographic films
3) thermal decomposition
4) electrolysis
5) boiling and melting
6) breaking down bonds

$Q = mc\Delta T$ ↑ more endothermic

Day : .... Date : ....

☆ how to express endothermic reactions

1. ~~reactant gives out product~~ reactant + energy → product
2. reactants → product $\Delta H = +ve$
3. profile diagram



Day : .... Date : ....

measuring ΔH reaction using bond energies

bond	bond energy kJ/mol
H–H	436

(endo)
bond breaking $H-H_{(g)} + 436 kj \rightarrow H_{(g)} + H_{(g)}$

(exo)
bond breaking: $H_{(g)} + H_{(g)} \rightarrow H-H_{(g)} + 436 kj$

bonding energies :-

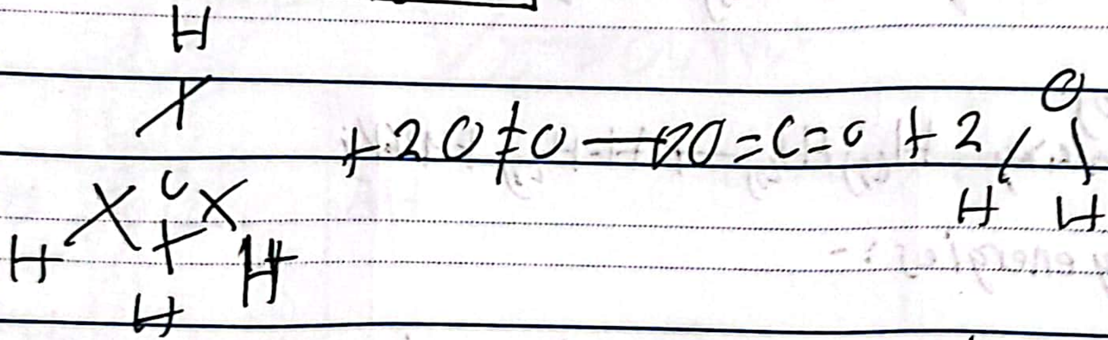
The amount of energy needed to break 1 mol of bond in a gaseous state
or
The amount of energy released to build 1 mol of bond in a gaseous state

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

ΔH = total input − total output

endo: input > output
exo: input < output

bond	bond energy Kj/mol
C-H	413
O-H	463
O=O	496
C=O	799
C-O	358



bond broken

4×C-H 4×413

2×O=O 2×496

total input 2644 Kj

bond built

2×C=O 2×799

4×O-H 4×463

total output 3450 Kj

ΔH = input − output

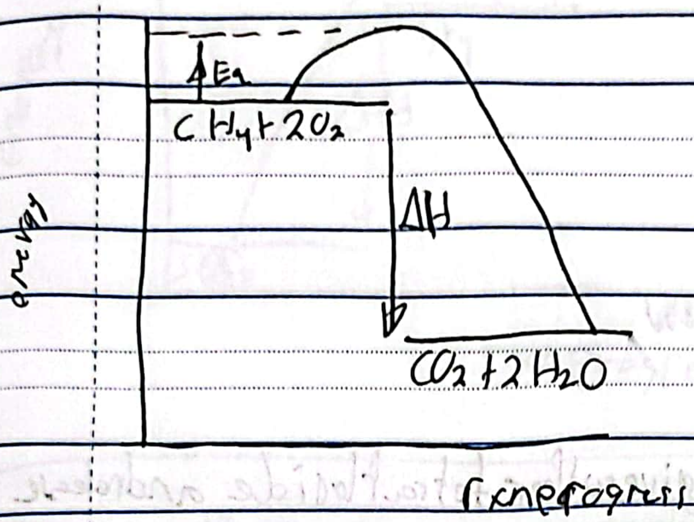
2644 − 3450

= −806 Kj/mol

exo

① $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + 806$ Kj/mol

(3) profile diagram



$2\,H-\underset{H}{\overset{H}{C}}-O-H + 3\,O=O \rightarrow 2\,O=C=O + 4\,H-O-H$

bond broken	
6x C-H	6x413 +
2x C-O	2x358 +
2x O-H	2x463 +
3x O=O	3x496

total input 5608 Kj

bond built	
4x C=O	4x799 +
8x O-H	8x463

total output 6900 Kj

ΔH = input - output

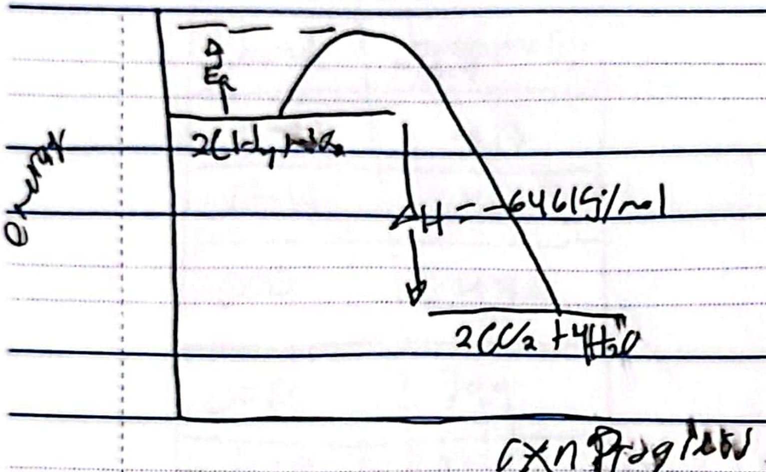
exo

ΔH = input - output
5608 - 6900
= (-)1292 Kj

$\Delta H = \frac{-1292}{2}$
= -646 Kj/mol
exo

ΔH is for one mole only

Day : .... Date : ....



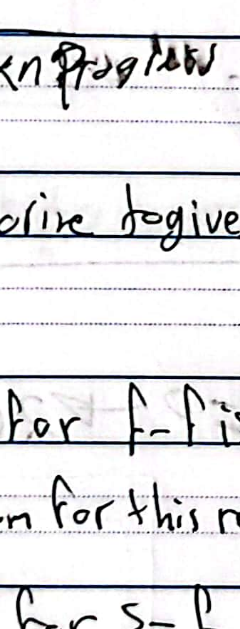
sulfer react with florine to give sulfer tetrafloride and release 780 kJ/mol

if the bond energy for F–F is 160 kJ/mol

draw a profile diagram for this reaction

and find the bond for S–F

$S + 2F{-}F \longrightarrow$



bond broken

$2 \times F{-}F \quad 2 \times 160$

total input 320 kJ

$320 + 780 = 1100$

bond built

$4 \times S{-}F \quad 4 \times x$

total output 1100

ΔH = input − output

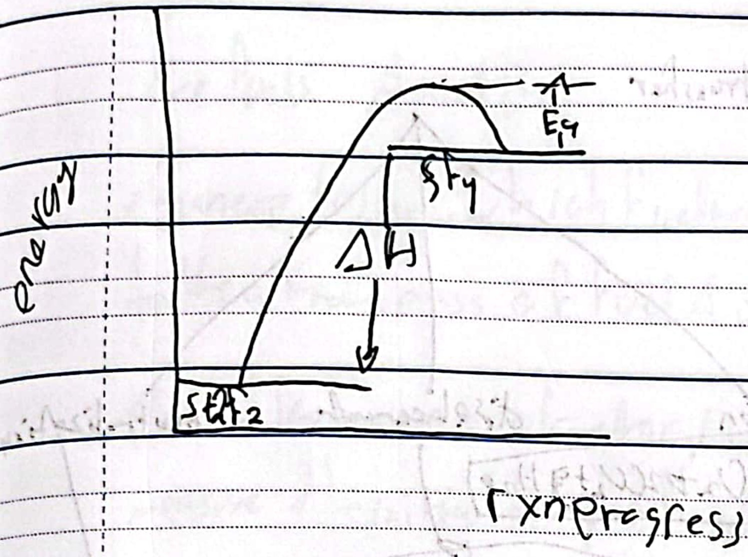
$320 - 1100$

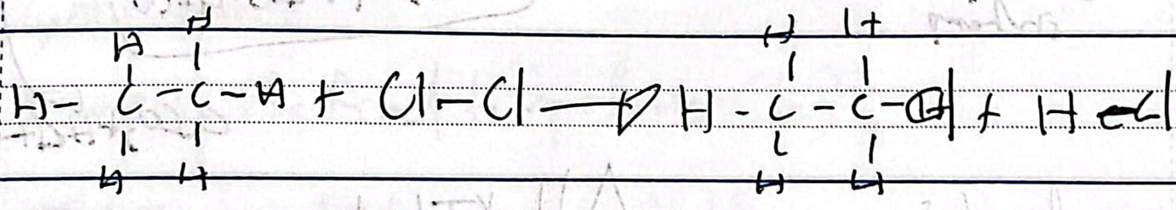
$= 780$ kJ/mol

$\frac{1100}{4} = 275$

$S{-}F = 275$

Day : .... Date : ....





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

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

bond broken
6×C-H 6×413 +
Cl-Cl 242
total energy ~~2720~~ kJ
~~2720~~

~~104 = 2720 - x~~

bond built
5×C-H 5×413 +
Cl-C 328 +
H-Cl x
2393 x kJ

Day : .... Date : ....

measuring the amount of energy transfer

surrounding

$Q = mC\Delta T$

- Q → energy transfer (J)
- m → mass (g)
- C → Specific heat capacity
- ΔT → change in temp

combustion / displacement / neutralization

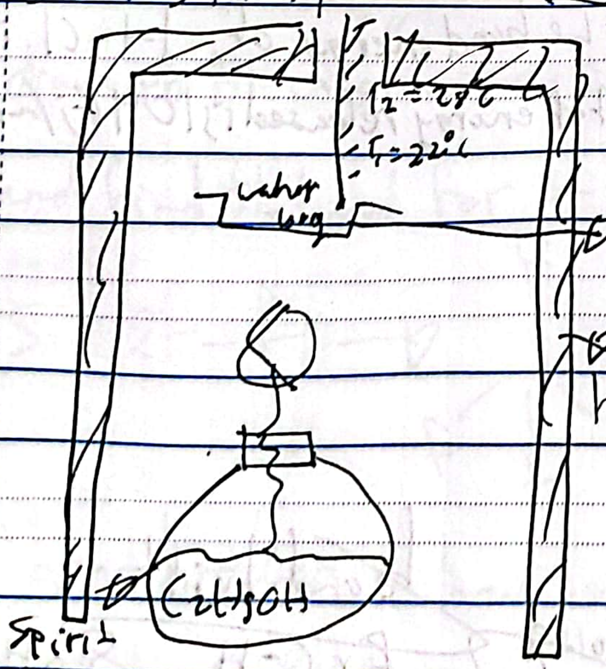
combustion: $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

displacement: $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

neutralization: $CaCO_3 + HCl \rightarrow CaCl_2 + CO_2$

combustion

$\Delta H = kJ/mol$



$m_1 = 200g$

$m_2 = 198g$

$C_{water} = 4.2 J/g.°C$

$Q = mC\Delta T$

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

$= 2520 J$

2520 —burn→ 2g C_2H_5OH

62790 ← 46g

$\Delta H = 62.79 kJ/mol$

Day : .... Date : ....

two fuels A and B

plan an exp 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 fuel A

measure the final temp of water (T_2)

~~repeat~~ repeat the exp using fuel B

the fuel which cause more temp change is the one that

produce more energy

displacement reaction

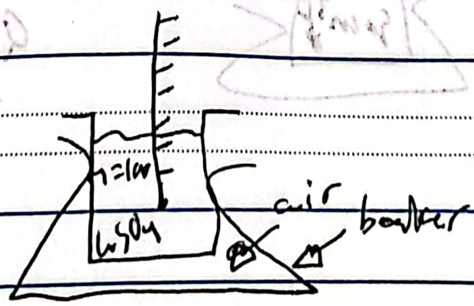
$Zn_{(s)} + CuSO_{4(aq)} \longrightarrow ZnSO_{4(aq)} + Cu_{(s)}$

m = 0.65g

v = 100 cm³

d = 1g/cm³

M = 100g



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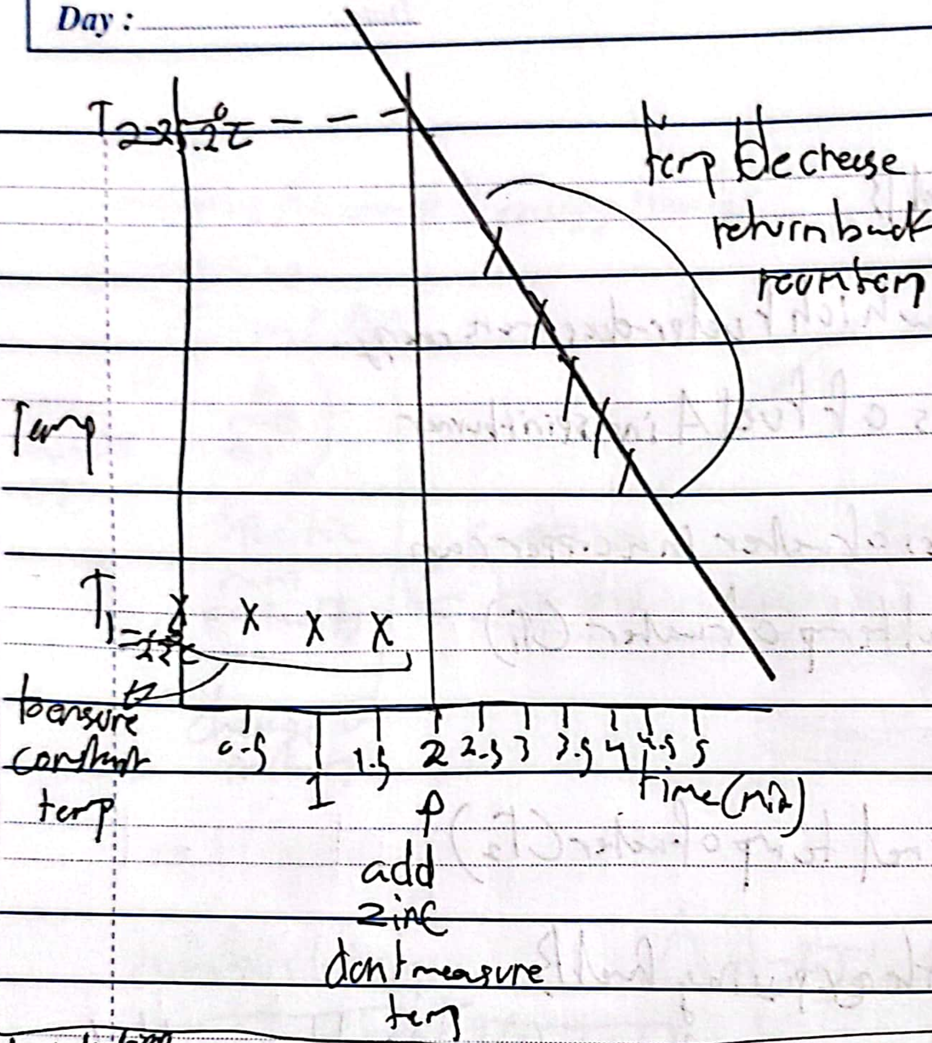


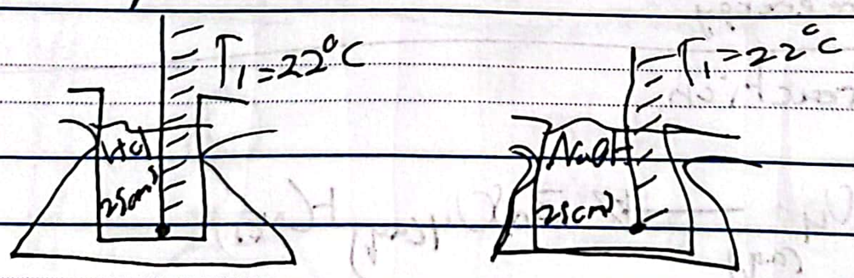
$Q = mc\Delta T$

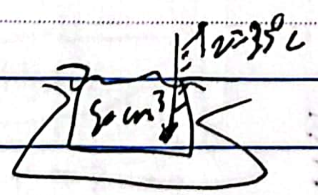
$= 100 \times 4.2 \times 5.2$

$=$ ___

Neutralization

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



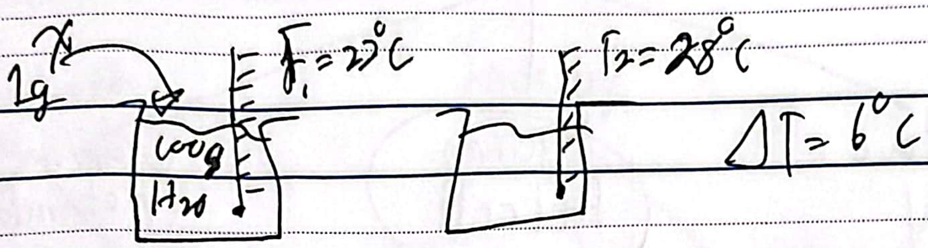


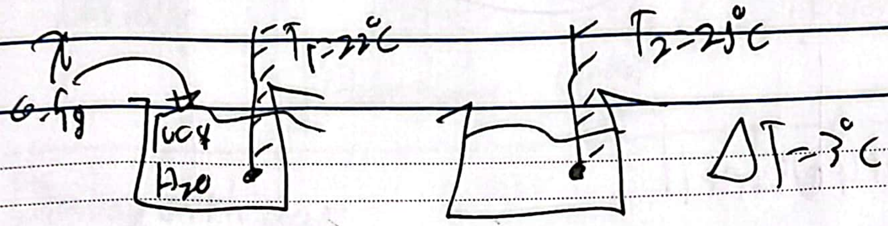
surrounding

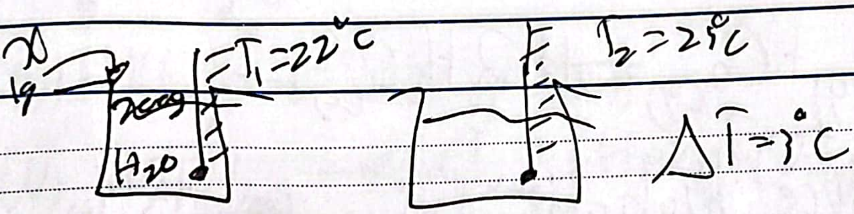
$Q = mc\Delta T$

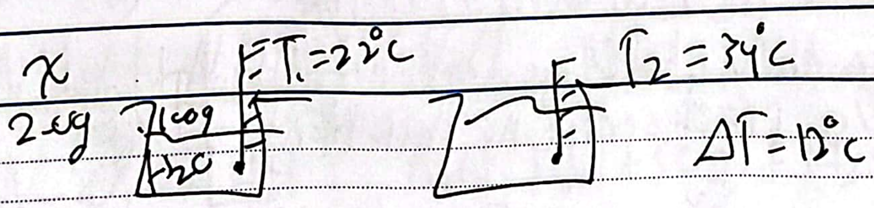
$= (25 + 25) \times 4.2 \times 13 =$ ___ J

Day : .... Date : ....


x
1g
100g
H2O
T1=22°C
T2=28°C
ΔT=6°C


x
0.5g
100g
H2O
T1=22°C
T2=25°C
ΔT=3°C


x
1g
200g
H2O
T1=22°C
T2=25°C
ΔT=3°C


x
2.0g
100g
H2O
T1=22°C
T2=34°C
ΔT=12°C

Day : .... Date : ....

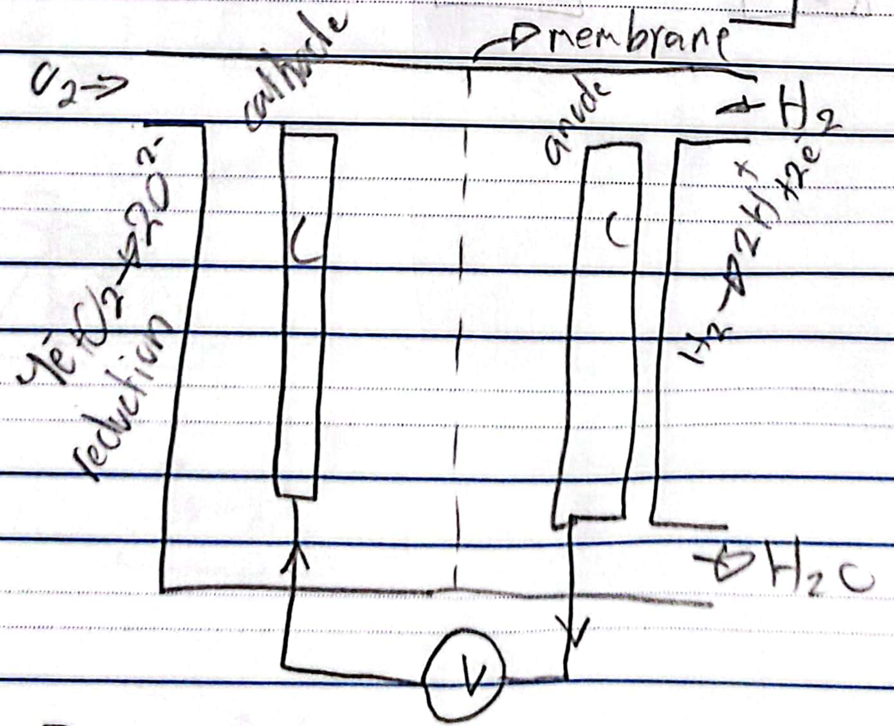
Alternative resources of energy

- Voltaic cell (not included)
- Hydrogen fuel cell
- Uranium (not included)

Hydrogen fuel cell

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$$

+ve:
- produce high amount of energy
- produce only H_2O as waste product
- no CO_2 produced (no pollution)



−ve:
- hard to store and transport
- risk of explosions

Day :   Date :

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 gas

H_2: $Mg_{(s)} + HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$

CO_2: $CaCO_{3(s)} + 2HCl_{(aq)} \rightarrow CaCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$

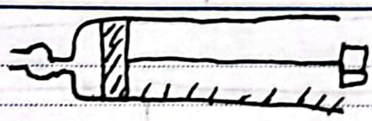
NH_3: $NH_4Cl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)} + NH_{3(aq)}$

SO_2: $Na_2S_2O_3 + HCl \rightarrow NaCl + S + SO_2 + H_2O_{(l)}$

Cl_2: $NaCl_{(aq)} \xrightarrow{electrolysis} H_2 + Cl_2 + NaOH$

collect gases

① gas syringe

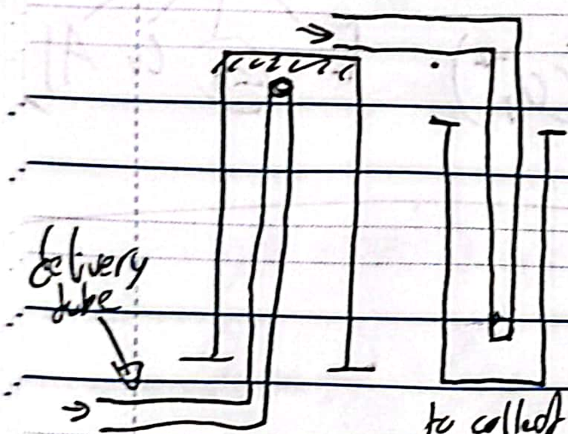


* collect and measure the volume of any gas

Day : ________ Date : ________

② Delivery

Upward downward



to collect less dense gas than air

NH_3

H_2

to collect more dense gas than air

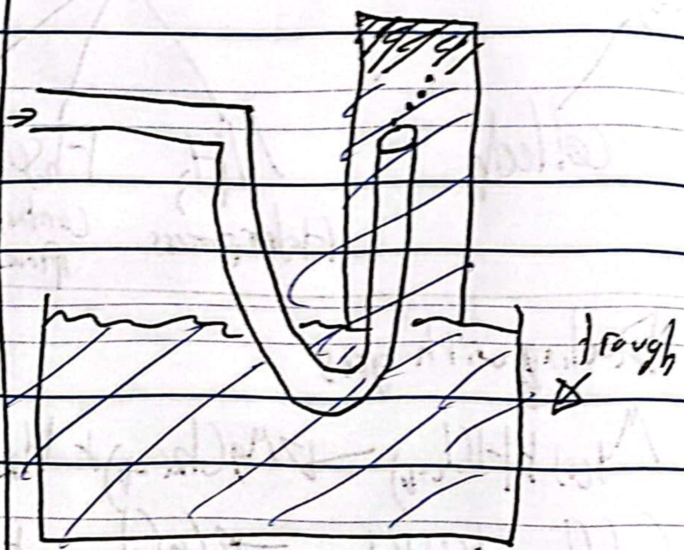
SO_2

CO_2

Cl_2

* some gas might escape
* mix with other gases

③ Over water



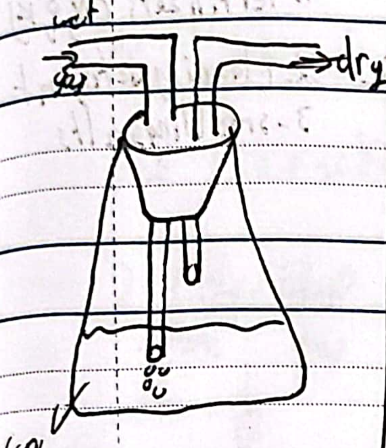
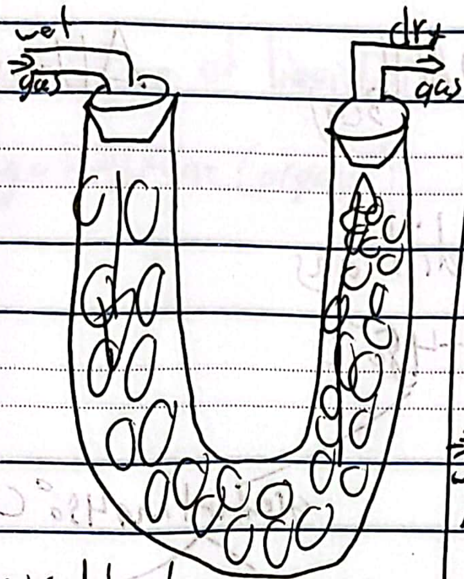
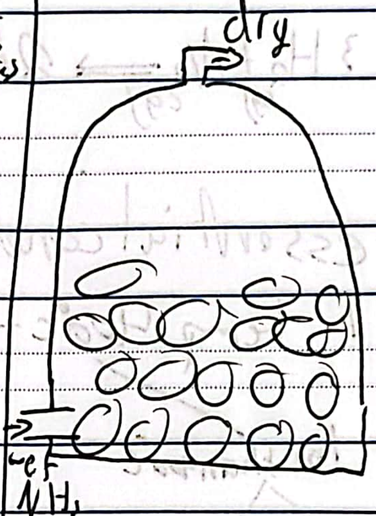
used only for insoluble gas in water

* CO_2 slightly soluble in water
* hard to use

drying gases

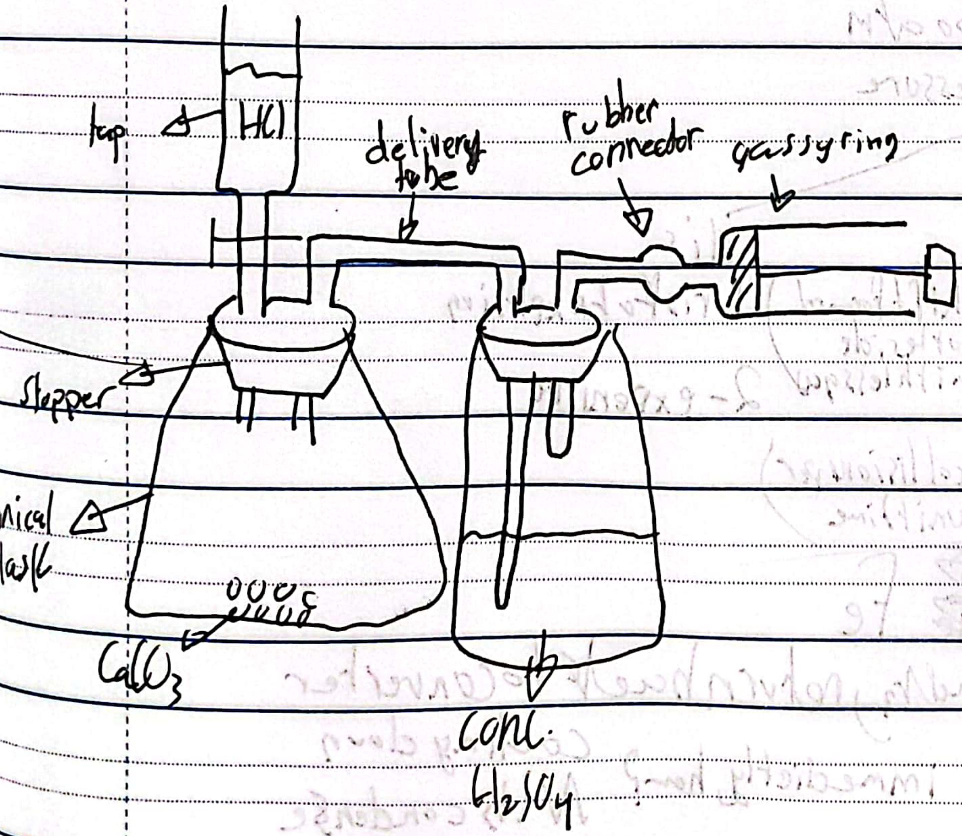
- conc. H_2SO_4
- Anhydrous $CaCl_2$
- CaO Quicklime

Day : .... Date : ....

Conc H_2SO_4	Anhydrous $CaCl_2$	Quicklime CaO
		
used to dry any gas except NH_3	used to dry any gas except NH_3	

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

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



Day : .... Date : ....

Industry of NH_3
(haber process)

Uses of NH_3
1. Fertilizers ...
2. cleaning detergents
3. smelling salts

$3H_{2(g)} + N_{2(g)} \longrightarrow 2NH_{3(g)}$ $\Delta H = -ve$

essential conditions

1- temp 400°C - 450°C

- less than 400°C
  - adv: more yield of NH_3 shift forward to the exo side
  - dis: slow rate of rxn - particles lose K.E so less effective collisions per unit time
- greater than 450°C
  - adv: faster rate
  - dis: less yield of NH_3 shift backward to endo side

2- pressure 200 atm

high pressure

- adv:
  1. more yield of NH_3 (shift forward to the side with less gas)
  2. Faster rate (more collisions per unit time)
- dis:
  1. risk of explosion
  2. expensive

3- catalyst Fe

* add excess H_2 and N_2, return back to converter
* remove NH_3 immediately, how? cooling down NH_3 condense

Day : .... Date : ....

habtrocblain

N_2 : fractional distilation of liquid air

H_2 :- 1 : cracking of Alkane (organic)

2 : $CH_4 + H_2O$

methane gas

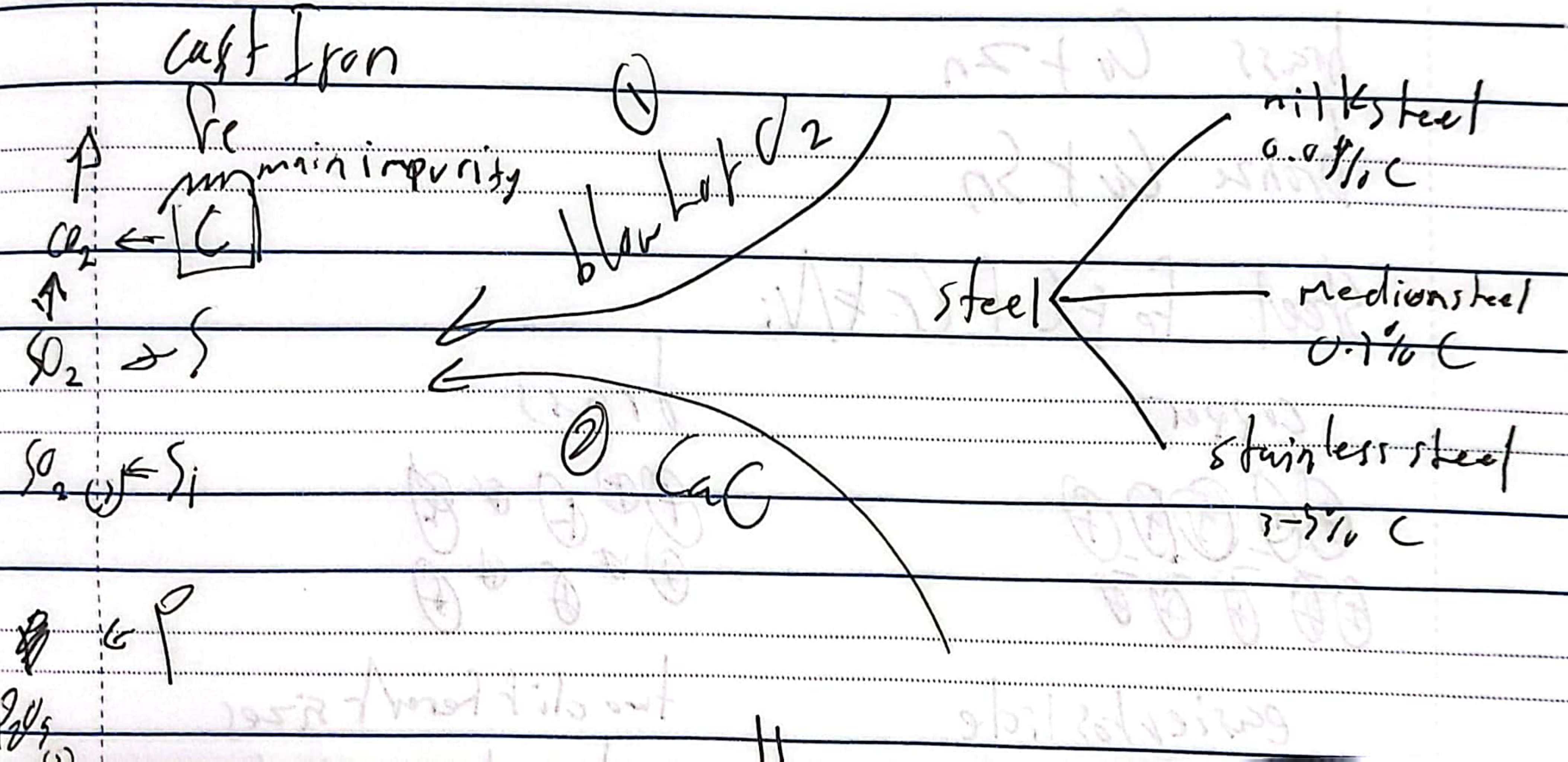
↓

$3H_2 + CO$

Day : ....

Date : ....

steel making "oxygen-base process"



Day : .... Date : ....

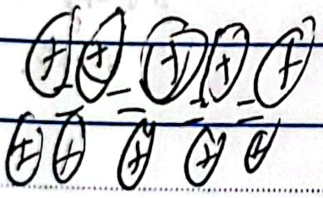
Alloy :- mixture of metal with another metal or semimetal

brass $Cu + Zn$

bronze $Cu + Sn$

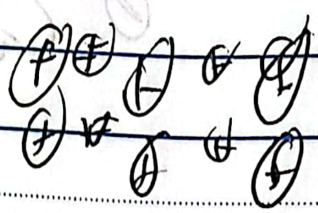
Steel $Fe + C + Cr + Ni$

copper



easier to slide

brass



two different sizes so harder to slide