

oxidation rules

free element = 0

group I = +1

group II = +2

group III = +3 (Al)

group VII = -1 (F)

H +1 except with metal (-2)

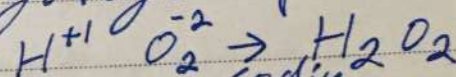
* O -2 except peroxide (-1)

OF₂ (+2)

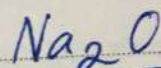
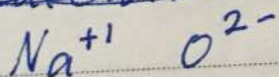
oxide O²⁻
peroxide O₂²⁻

so...

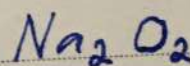
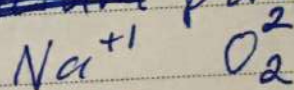
hydrogen peroxide



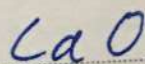
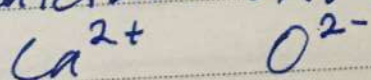
~~calcium~~ sodium oxide



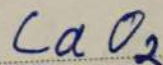
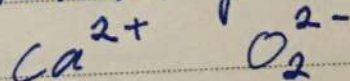
~~calcium~~ sodium peroxide



Calcium oxide



Calcium peroxide



* the sum of all oxidation state of all atoms

in compounds = zero

in Ions = charge of atom

ex: N₂O₅ 2N + 5(-2) = 0 N = +5

Cr₂O₇²⁻ 2Cr + 7(-2) = -2

Cr = +6

in terms of	oxidation	reduction
O	gain O	lose O
H	lose H	gain H
oxidation state	increase	decrease
e^- transfer	lose e^- s	gain e^- s

oxidising agent "oxidant":

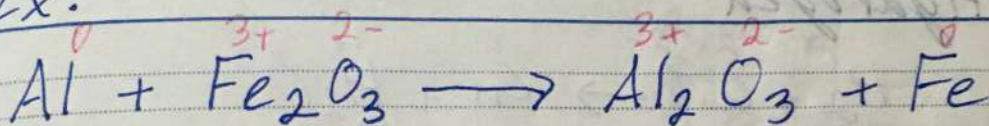
the substance itself reduces and causes the other substance to oxidise.

Reducing agent "reductant":

the substance that becomes oxidised and causes the other substance to reduce.

* If the substance is an ion in the compound you must ~~write~~ write the whole compound as the agent

ex:



oxidation: Al

oxidant: Fe_2O_3

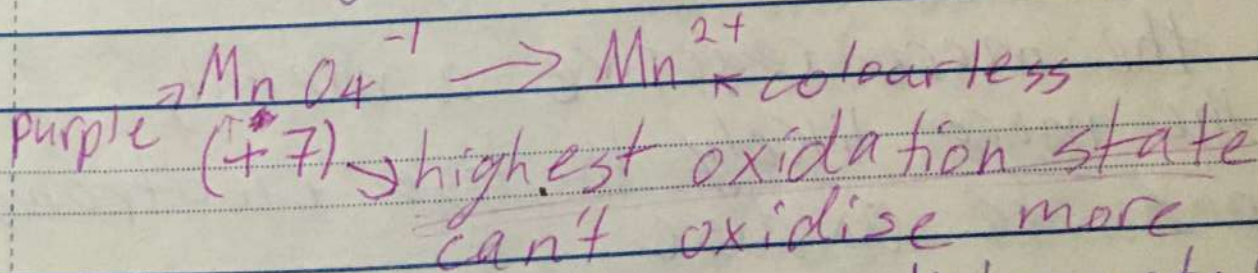
reduction: Fe^{3+}

reductant: Al

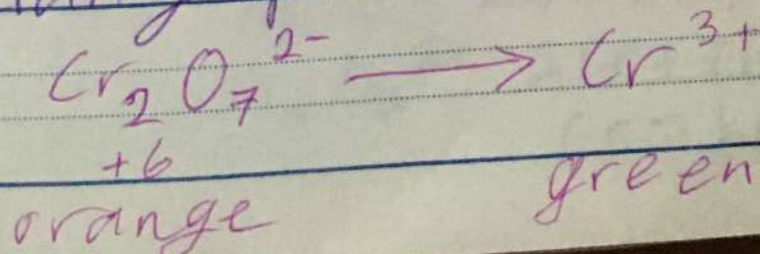
Most common oxidising agents:

1- Oxygen

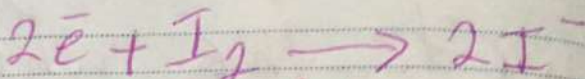
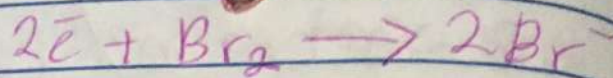
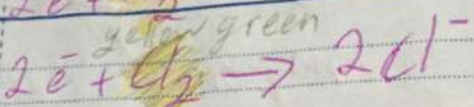
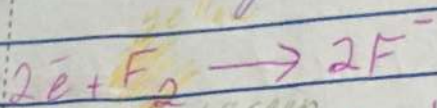
2- Acidify potassium manganate: KMnO_4



3- Acidify potassium dichromate $\text{K}_2\text{Cr}_2\text{O}_7$



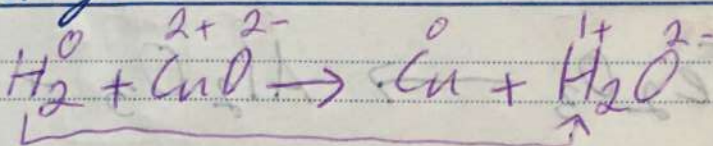
4- Halogens



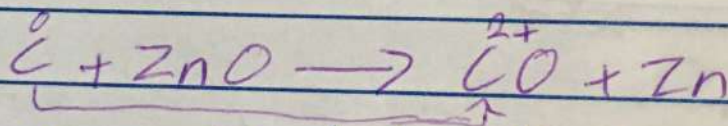
red brown
(aq) red brown
gas \rightarrow purple
solid \rightarrow black

Most common reducing agents:

1- Hydrogen

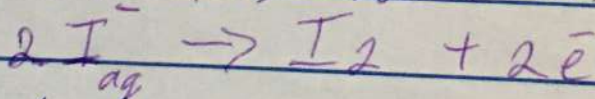


2- Carbon & carbon monoxide



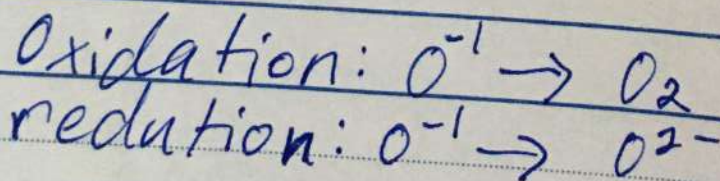
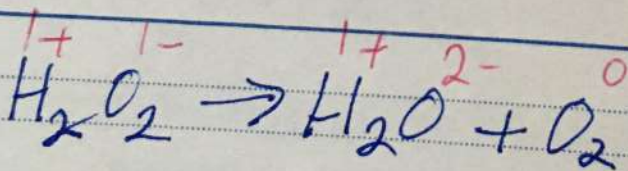
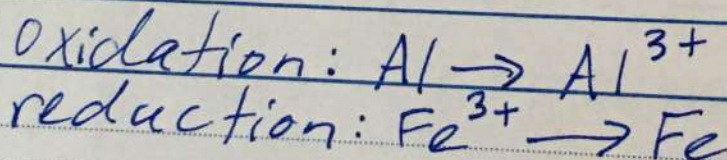
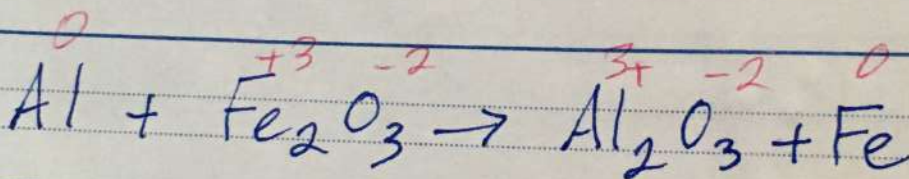
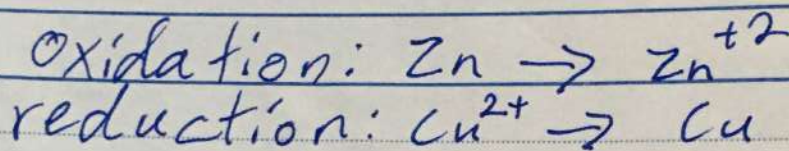
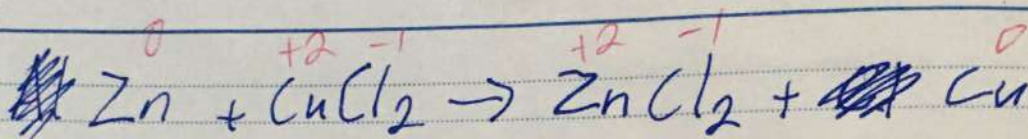
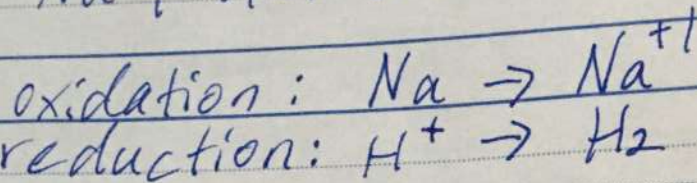
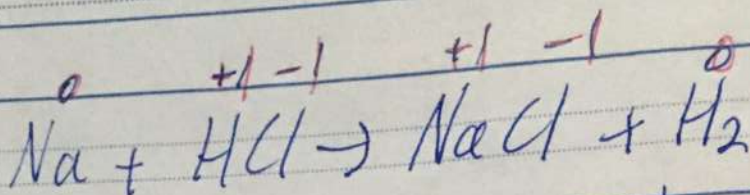
3- Potassium Iodide (KI)

colourless red-brown



4- Metals

the more reactive a metal,
the more likely to lose electrons
and to oxidise



Day: _____

Redox

Date: _____

Half of oxidation

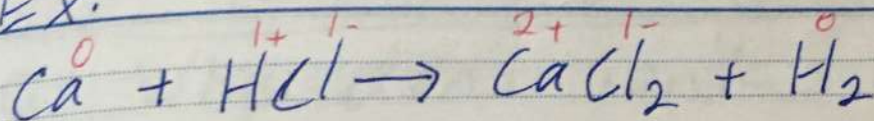
Half of reduction

- To balance the ionic equation:

① balance atoms

② balance charge by adding electrons to side with greater charge

Ex:



Half of oxidation: $\text{Ca} \rightarrow \text{Ca}^{2+} + 2e^-$

Half of reduction: $2\text{H}^+ + 2e^- \rightarrow \text{H}_2$

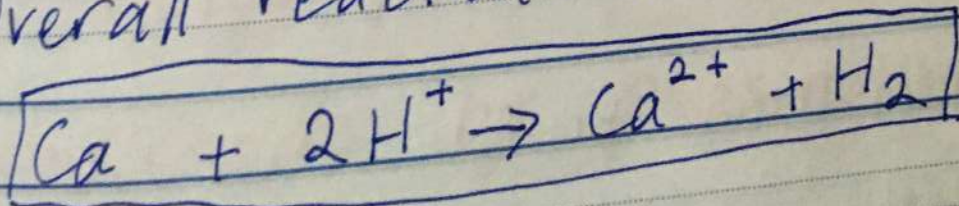
Half of oxidation: $\rightarrow e^-$ losing e^-

Half of reduction: $e^- \rightarrow$ gaining e^-

Oil Rig

oxidation is losing reduction is ~~losing~~ gaining

Overall reaction: ~~the~~ (ionic equation)



Day: Monday

Date: 5/9/2022

Electrolysis

Electricity

Analysis:
breaking down

Electrolyte: a chemical compound that conducts electricity

Q: Why don't ionic compounds conduct electricity when solid but do when molten or dissolved?

Ions are not free to move in solid state.

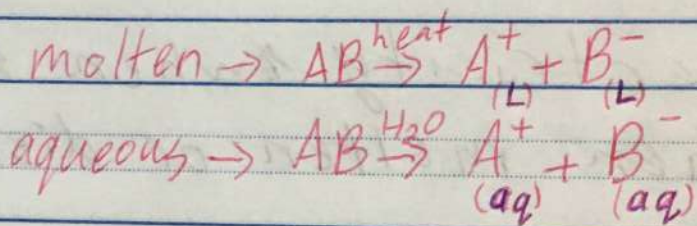
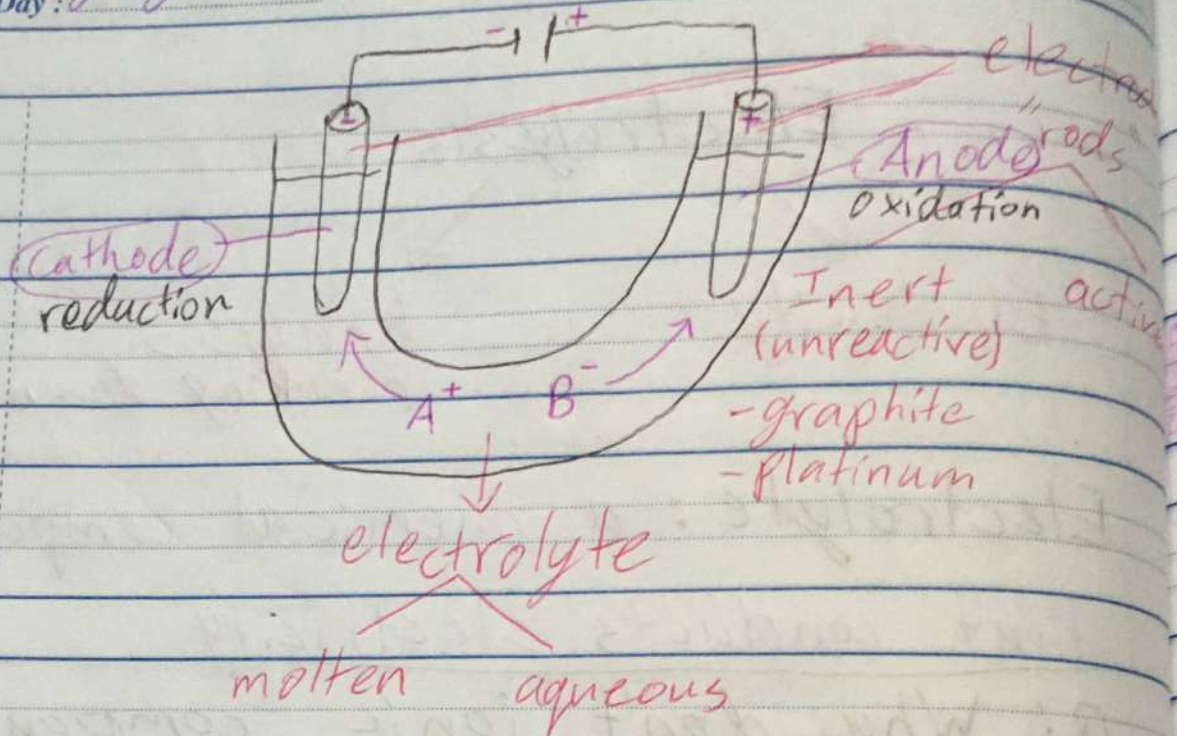
What is Electrolysis?

Breaking down of chemical compounds by passing electricity.

Electrolysis \rightarrow discharging
 changing ions \rightarrow elements

Date:

Day:

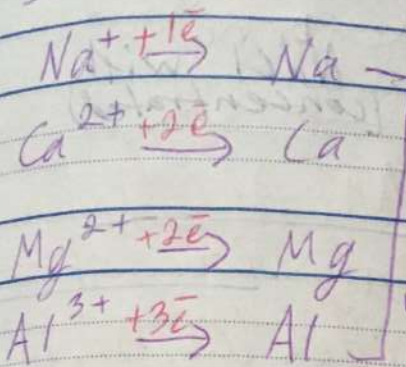


Cathode: the negative electrode that attracts cations where reduction takes place.

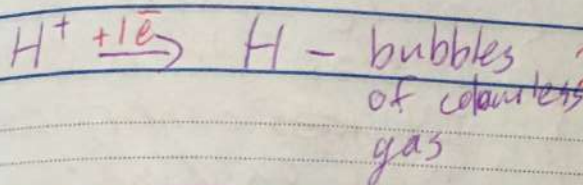
Anode: the positive electrode that attracts anions where oxidation takes place.

electrode rods
active

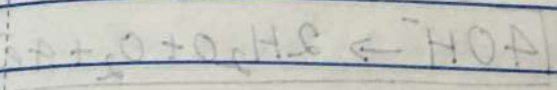
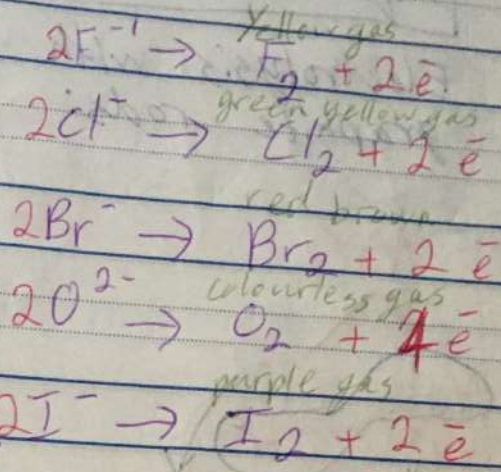
Cations



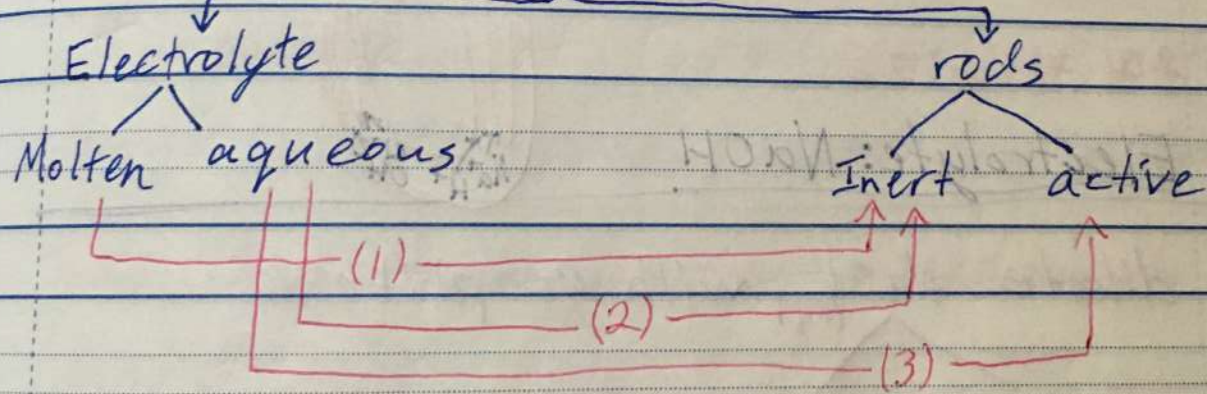
deposit of metal



Anions



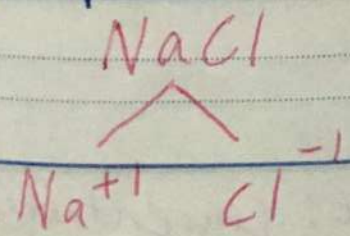
Electrolysis



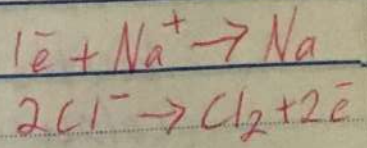
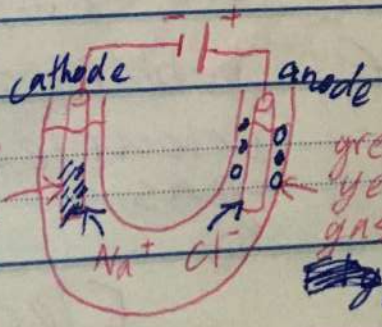
Molten + Inert:

Electrolysis for molten NaCl using

graphite rods



metal deposit Na



Electrolyte: used up

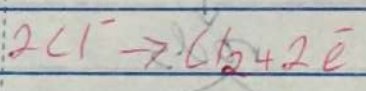
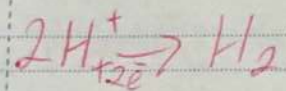
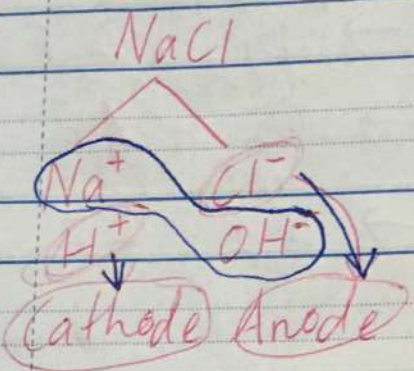
total ions

- K
- Na
- Li
- Ca
- Mg
- Al
- Zn
- Fe
- Pb
- H
- Cu
- Ag
- Au

Aqueous + Inert

Electrolysis with graphite rods:

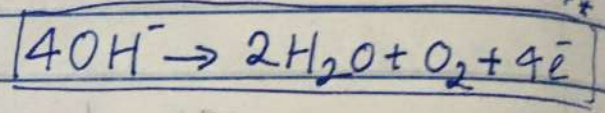
aqueous NaCl with concentrated



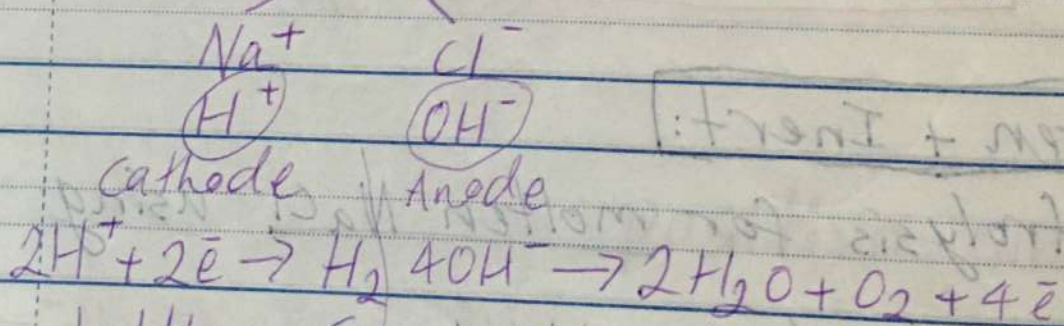
Electrolyte: NaOH

At cathode
the less reactive is more likely to reduce

At Anode
Only concentrated Halides (Cl⁻, Br⁻, I⁻) are more likely to oxidise than OH⁻
If ~~other~~ other, OH⁻ will oxidise:



dilute NaCl(aq) with graphite



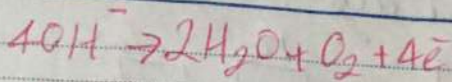
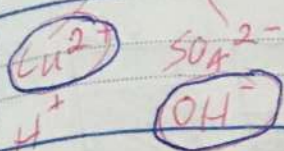
bubbles of colourless gas bubbles of colourless gas

Electrolyte: Concentrated NaCl

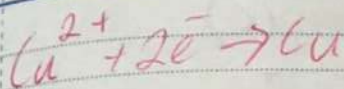
Day :

Date :

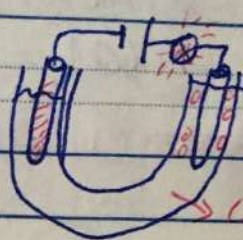
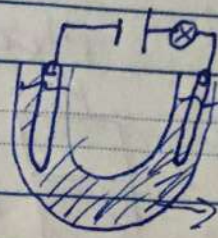
CuSO_4 (aq) and graphite



bubbles of colourless gas



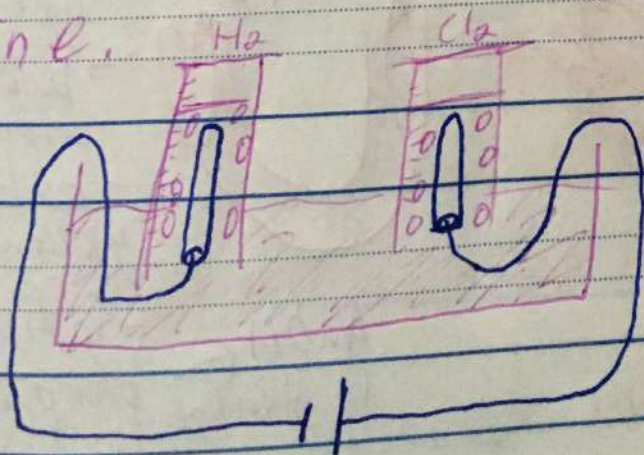
deposited of red-brown solid



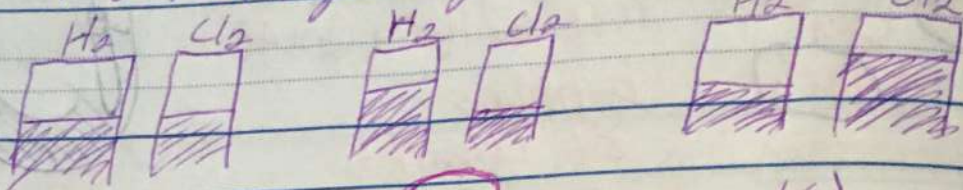
Electrolysis and brine solution

Q.1: Plan an experiment to collect the ~~gases~~ gases produced at cathode and anode and measure volume.

Use inverted cylinder filled with brine.



Q2. the final appearance of measuring cylinders:

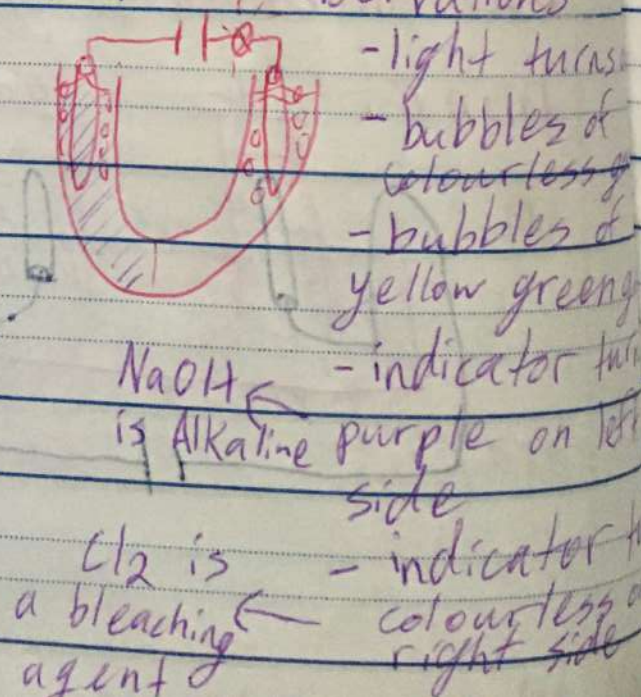
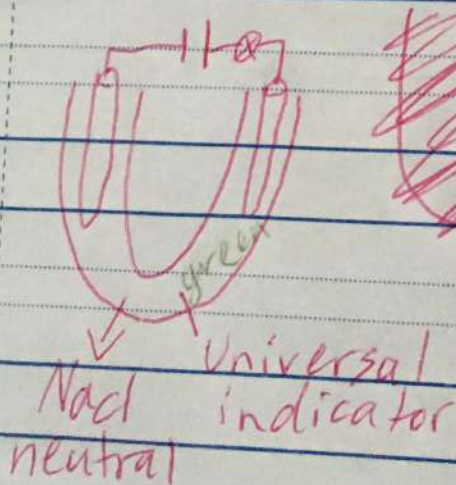


overall reaction: $2Cl^- + 2H^+ \rightarrow Cl_2 + H_2$

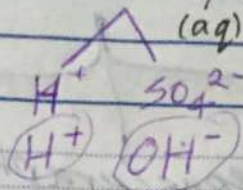
Q3. Why does the Cl_2 gas not immediately appear like H_2 ?

Some Cl_2 gas dissolves in the electrolyte.

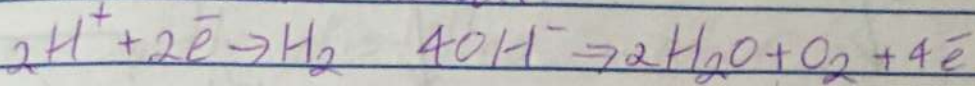
~~The~~ Electrolysis for brine solution with universal indicator observations



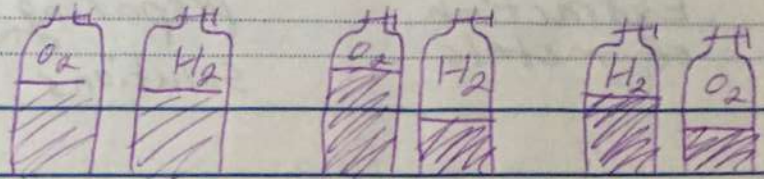
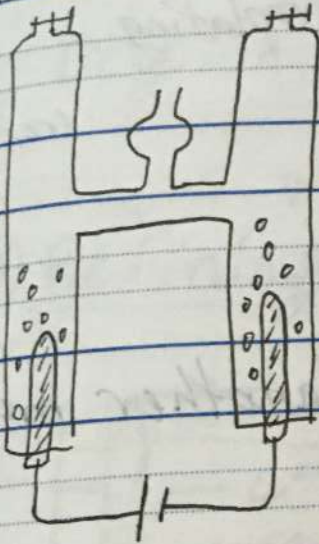
Electrolysis for H_2SO_4 / graphite rods



cathode anode



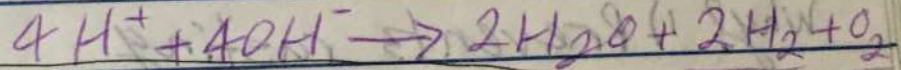
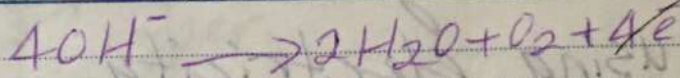
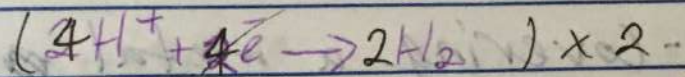
Hoff-man



(a)

(b)

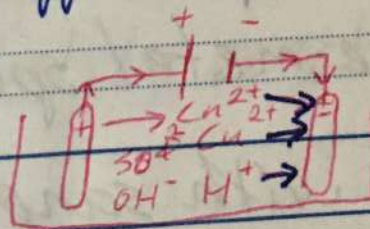
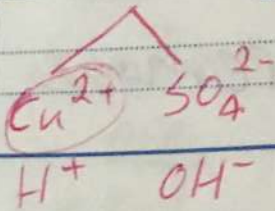
(c)



Aqueous + active

* Rod must be the same metal as in electrolyte 2:1

$CuSO_4(aq)$ using copper rods



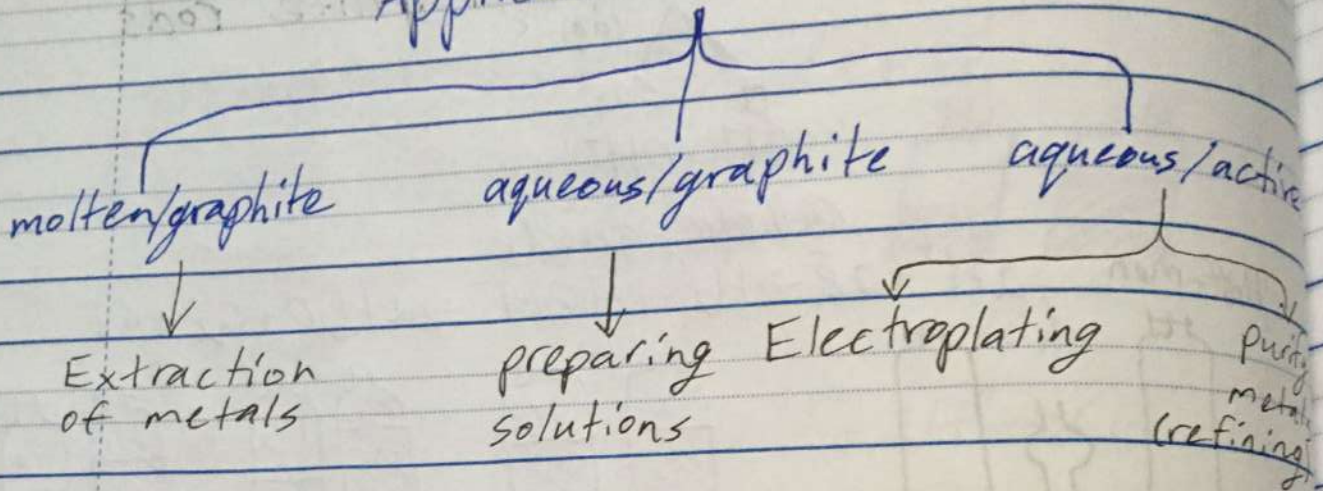
Cathode → increases in mass, gains e^- and deposit of Cu

Anode → decreases in mass, loses e^-

Electrolyte → stays the same, oxidises

and gains Cu^{2+} at the same rate

Applications of electrolysis



① Electroplating

- covering a metal with another metal using electricity

Why? 1) Prevents rusting

2) Decoration

How to electroplate a metal spoon with Ag?

1- Clean the metal spoon to remove oxide layer with sandpaper

2- Make the spoon the cathode

3- Anode must be Ag

4- the electrolyte must contain Ag^+

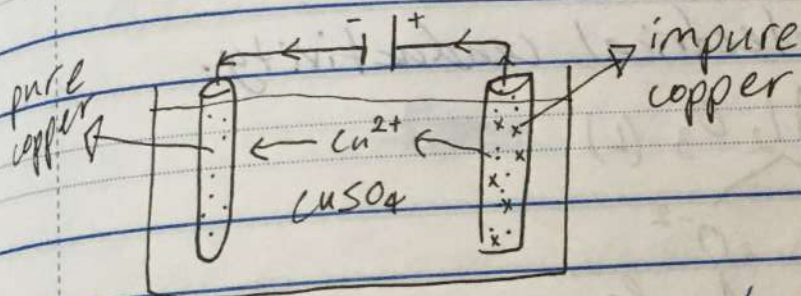
5- Turn on the circuit

6- Rotate metal spoon to ensure equal distribution

7- Rinse with distilled water

8- Dry in oven

② Refining / ~~purifying~~ purifying metals



③ Extraction of metals

* Method of extraction depends on the position of metal in reactivity series

ore

K → KCl

Na → NaCl

Li → LiCl

Ca → CaCl

Mg → MgCl₂

Al → Al₂O₃

Zn → ZnS

Fe → Fe₂O₃

Pb

Cu

Ag

Electrolysis - molten/graphite

bauxite → reduction by C/CO

zinc blende

hematite

Copper sulfide → reduction by H₂

** Extraction of Aluminium

ore: ~~Bauxite~~ Bauxite Al_2O_3

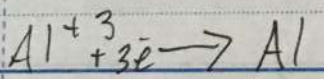
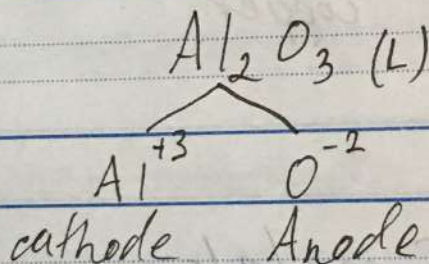
Method: Electrolysis for molten ore using graphite rods

- The m.p of Al_2O_3 is $2000^\circ C$
 \swarrow 50

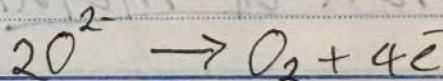
dissolve Bauxite in molten cryolite. Na₃

1- lowers m.p to $900^\circ C \rightarrow$ less cost

2- Increases electrical conductivity.



deposit of metal



bubbles of colourless gas

gases produced:

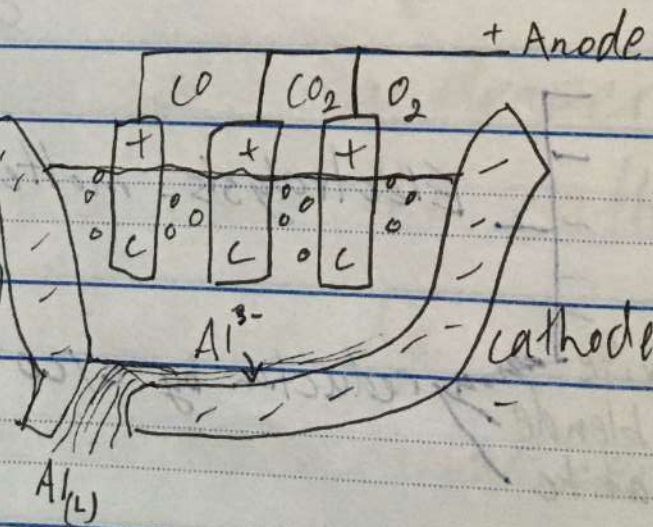
1- O_2

2- CO

3- CO_2

reaction of O_2 with rods (graphite) (consists of C)

rods need to be replaced periodically



Day :

Date :

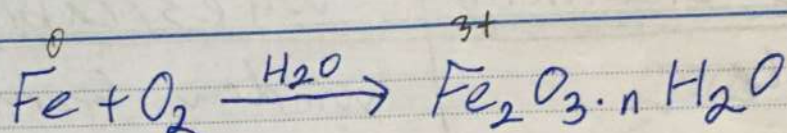
Aluminium

<u>Property</u>	<u>use</u>
<u>low density</u>	<u>Aircraft bodies</u>
<u>conducts electricity</u>	<u>wires/cables</u>
<u>malleable</u>	<u>window frame</u>
<u>form non-toxic oxide layer</u>	<u>food tins</u>
<u>ductile</u>	<u>electric wires</u>

~~Rules~~

Rusting

- ~~oxy~~ oxidation reaction
- The reaction of Iron with water and oxygen.

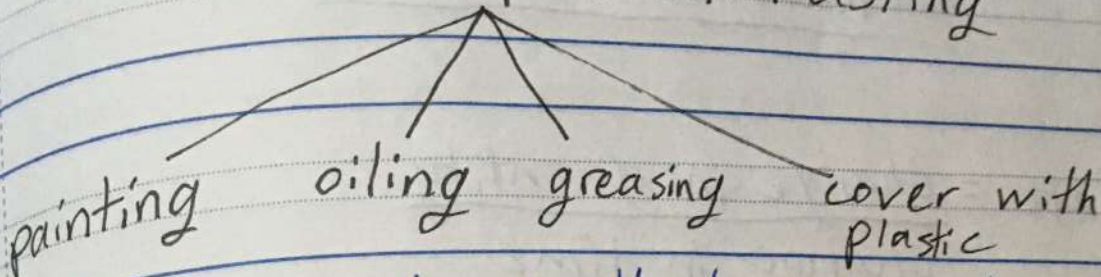


Q. A and B are two solutions used to prevent rusting. ~~Plan~~ Plan an experiment to show which solution is better.

- Take a known mass of Iron nail
- Apply a known quantity of solution A
- Put the nail in known volume of water
- After one week measure mass
- Repeat using solution B
- The experiment which causes less increase in mass is the better solution

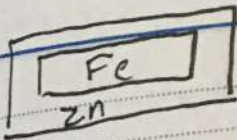
Day : _____ Date : _____

How to prevent rusting

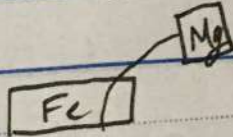


form a layer that prevents O_2 and H_2O from reaching iron

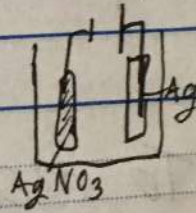
Galvanising



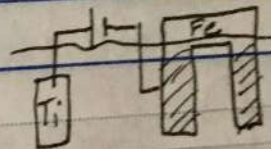
Sacrificial protection



Electroplating



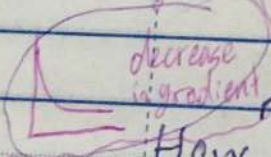
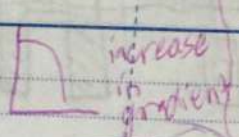
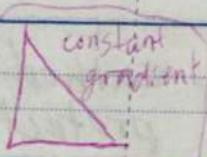
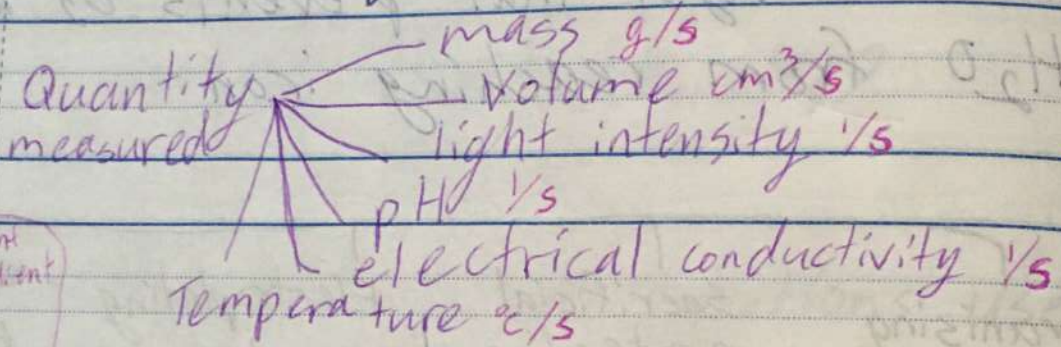
Cathodic protection



Mg and Zn are more reactive than Fe so more likely to oxidise and lose electrons

Rate of Reaction

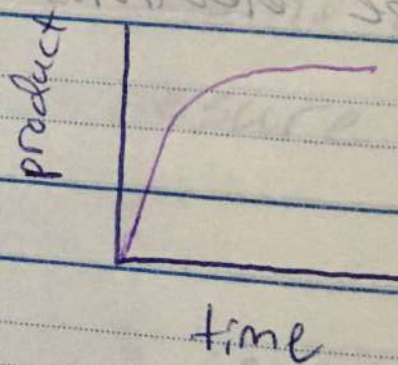
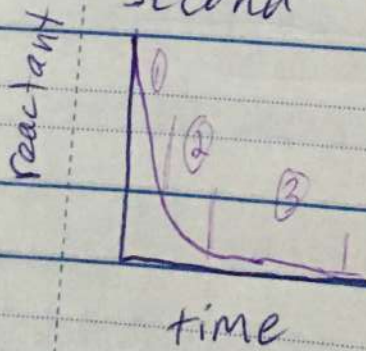
$$\text{Rate} = \frac{\text{change in quantity}}{\text{change in time}}$$



To measure the rate of reaction

How fast the reactants are consumed per second

How fast the products are produced per second

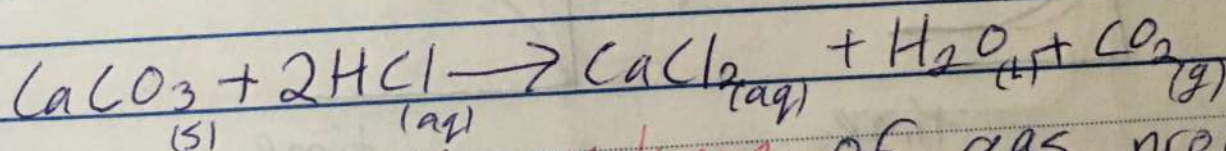


Why is the rate of reaction fastest at the start of the reaction?

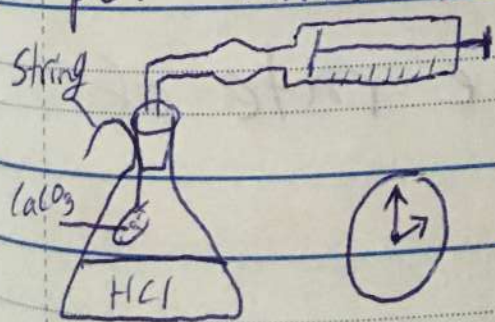
- More reactants \rightarrow more particles \rightarrow more effective collisions per second \rightarrow faster rate of reaction.

* Reaction is over in region 3 because the gradient = 0 / horizontal ~~line~~ line \rightarrow no more limiting reagent so reaction stops

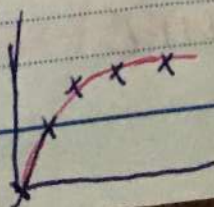
To measure rate of reaction



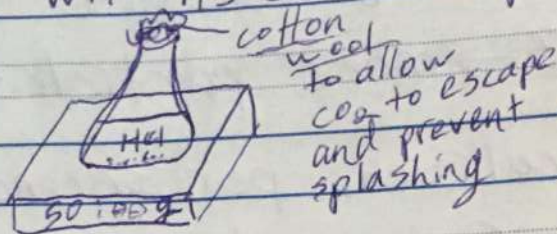
① Measure the volume of gas produced per unit time.



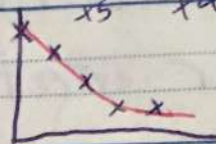
time (s)	0	30	60	90	120	150
Volume cm ³	0	20	30	33	34	34
		+20	+10	+3	+1	



② Measure the **mass** of conical flask with its contents per unit **time**.

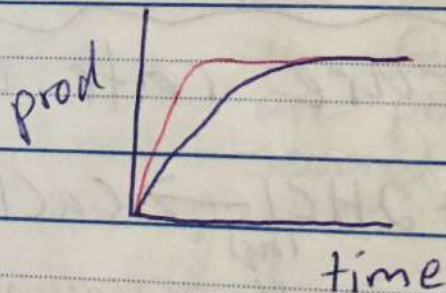
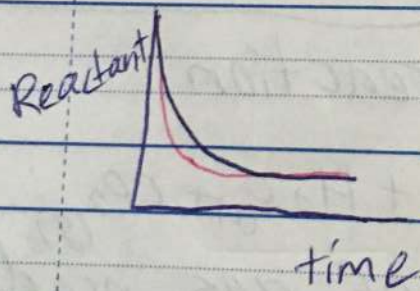


time (s)	0	30	60	90	120	150
mass (g)	50	45	41	40	39.5	39.5



Faster rate of reaction:

- **more** product per the **same** unit time
- the **same** product with **less** time



Factors affecting the rate of reaction:

① **Temperature**

② surface area

③ concentration

④ pressure

⑤ light intensity

⑥ catalysts

Temperature

Q.1- state how temperature affects the ~~the~~ rate of reaction and

explain why.

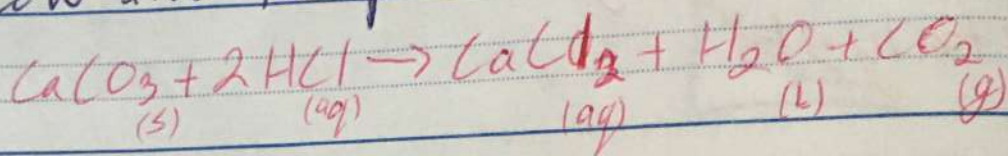
→ As the temperature increases, rate of reaction increases.

→ As temperature increases, particles gain kinetic energy so will move faster.

→ More particles will have energy that is equal to or greater than Activation

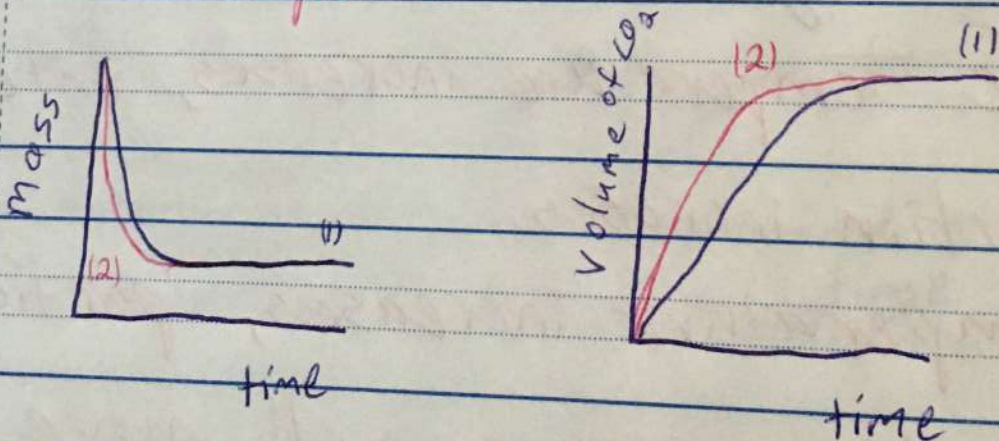
→ more effective collisions per unit time so faster rate of reaction.

Q. 2 - Plan an investigation to show how the temp affects rate of reaction.



exp 1: mass volume conc temp
 $\text{CaCO}_3 = 2\text{g}$ $\text{HCl} = 0.1\text{ dm}^3$ $\text{HCl} = 1\text{ mol}$ 25°C
 lumps

exp 2: mass volume conc temp
 $\text{CaCO}_3 = 2\text{g}$ $\text{HCl} = 0.1\text{ dm}^3$ $\text{HCl} = 1\text{ mol/dm}^3$ 50°C
 lumps



Surface Area

- state how the surface area affects the rate of reaction

As surface area increases by using pestal and mortar

~~crushing~~ crushing, rate of reaction increases

- Explain how surface area affects rate of reaction.

As surface area increases, more particles are exposed to reaction so more effective collisions per

unit time, so faster rate of reaction

- Plan an experiment to show how

the surface area affects rate of reaction

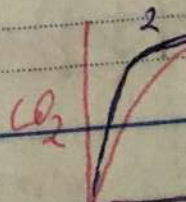
exp¹ $\text{CaCO}_3 = 2\text{g}$

lumps

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

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

Temp = 25°C



exp² $\text{CaCO}_3 = 2\text{g}$

powder

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

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

Temp = 25°C

** Concentration (Amount)

- State how the conc. affects the rate of reaction.

As concentration increases, the rate of reaction increases.

- Explain how the conc. affects the rate of reaction.

As the concentration increases, more particles are present so more effective collisions per unit time so faster rate of reaction

- Plan an experiment to show how conc. affects rate of reaction

exp 1 $\text{CaCO}_3 = 2\text{g}$

lumps

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

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

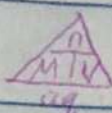
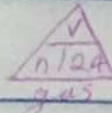
temp = 25°C

exp 2 CaCO_3
lumps

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

$M = 2 \text{ mol/dm}^3$

Day:

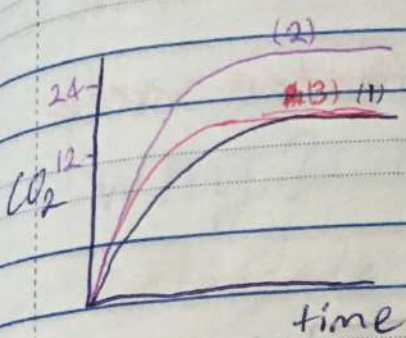


Date:

exp 3 $\text{CaCO}_3 = 4.0\text{g}$
lumps

$V \text{ HCl} = 0.1 \text{ dm}^3$
 $M \text{ HCl} = 1 \text{ mol/dm}^3$

* HCl is limiting



* If concentration of limiting reagent increases, both the ~~rate~~ rate and ^(mass) final result increase

* If concentration of excess reagent increases, only rate increases.

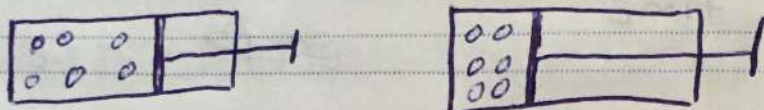
Pressure

• State how the ~~rate~~ pressure affects rate of reaction.

As pressure increases, rate of reaction increases

Why?

As pressure increases, more particles per unit volume, so more effective collisions occur so faster rate of reaction.

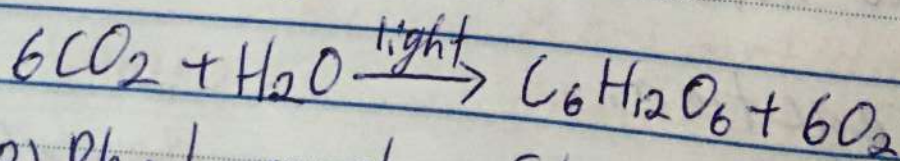


Light (for photochemical reactions which need light eg. photosynthesis)

- state the effect of light on rate of reaction.

As light intensity increases, rate of reaction increases.

1) Photosynthesis



2) Photographic films (not included)

Catalysts

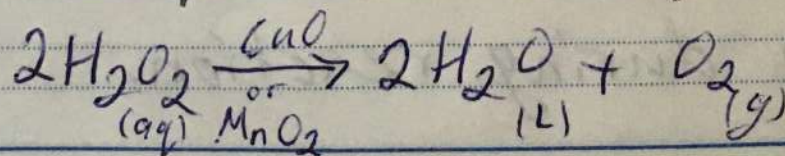
chemical substances that speed up the rate of reaction without being used up.

Why?

Catalysts provide an alternative pathway with lower Activation energy (E_a).

More particles will have energy equal to or greater than E_a .
So more effective collisions per unit time so faster rate of reaction.

Q. Decomposition of Hydrogen peroxide



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

→ Take ~~the~~ same volume and same

temperature of H_2O_2

→ Measure volume of O_2 produced.

per unit time

→ Repeat exp. with CuO

→ Conclusion: The exp with CuO produces more O_2 per ^{same} unit time.

② Plan an exp to show which catalyst (CuO or MnO_2) is better.

same as q.1 but add the same

~~volume~~ ^{mass} of catalyst to each exp

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

→ Take known mass of CuO

→ Do exp until no bubbles of O_2 remain

Day: _____

Date: _____

→ Filter mixture

→ dry in oven

→ remeasure the mass

→ Conclusion: the mass will not change

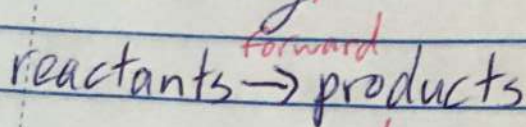
Day: Monday

Date: 11/10/2020

Reversible reactions

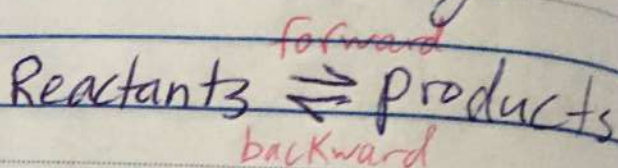
Types of reaction

One way / irreversible

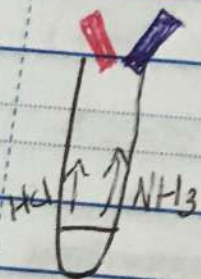
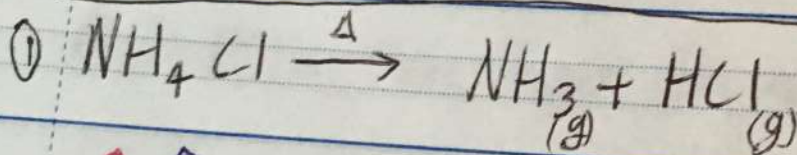


products are not suitable to react

both ways



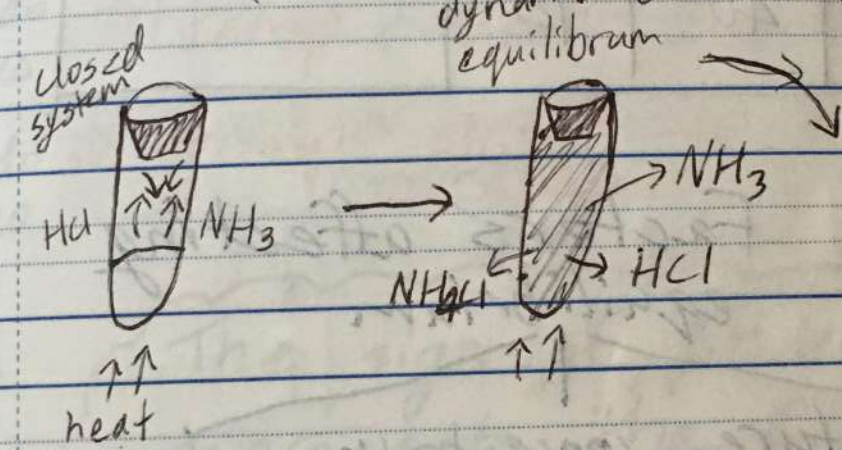
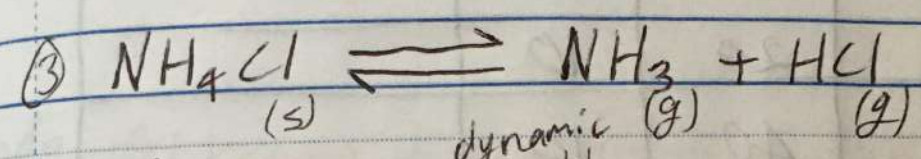
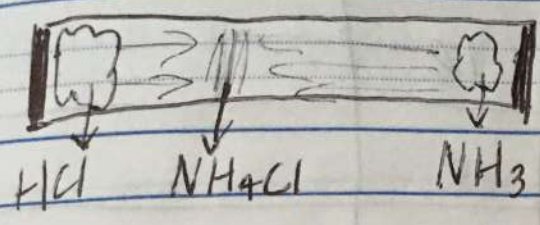
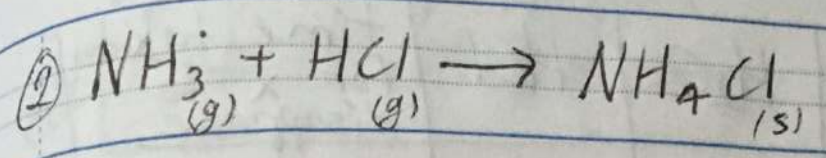
backward



Q. Which damp litmus paper will change colour first, why?

Damp red litmus paper will change colour first because

NH_3 is a basic gas and is lighter than HCl which is an acidic gas.



~~rate of evaporation~~
~~rate of condensation~~
 rate of 1st reaction = rate of 2nd

in terms of rate
 Dynamic equilibrium \rightarrow rate of forward reaction = rate of backward reaction

in terms of concentration
 Dynamic equilibrium \rightarrow when the concentration of reactants and product are constant

Day :

	$\text{Na}_2\text{S}_2\text{O}_3$	H_2O	HCl	time taken for x to disappear
1	50	0	10	
2	40	10	10	
3	35	15	10	
4	30	20	10	
5	10	40	10	

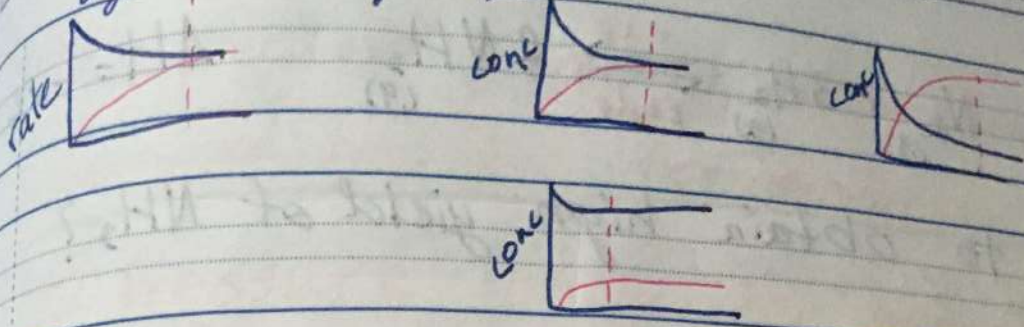
Factors affecting equilibrium

temperature concentration pressure

DATE:

dynamic equilibrium

Date:

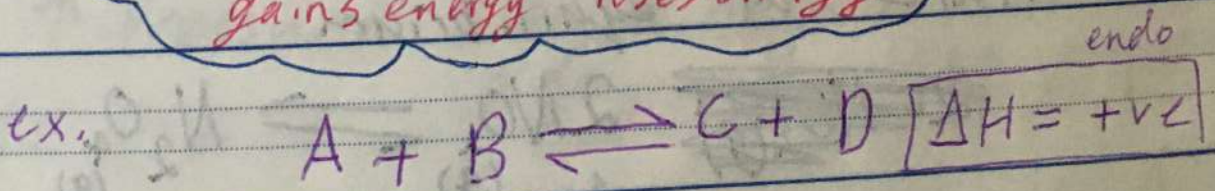
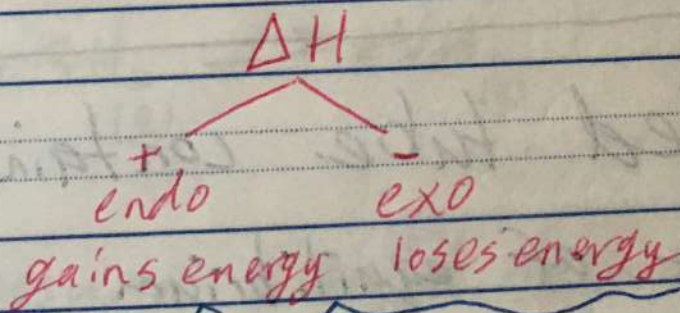


Temp

↑ temp shift to the **endo side**
 exo

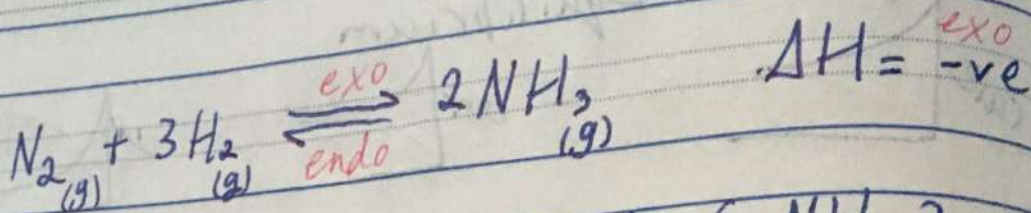
↓ temp shift to the **exothermic side**
 endo
 exo

The sign of ΔH (energy change) represents the forward reaction



↑ Temp shift forward reaction

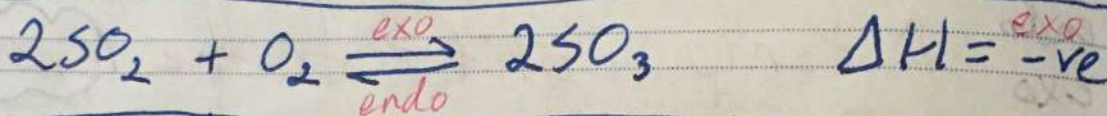
↓ Temp shift backward to exo, ↑A ↑B ↓C ↓D



to obtain high yield of NH_3 ?

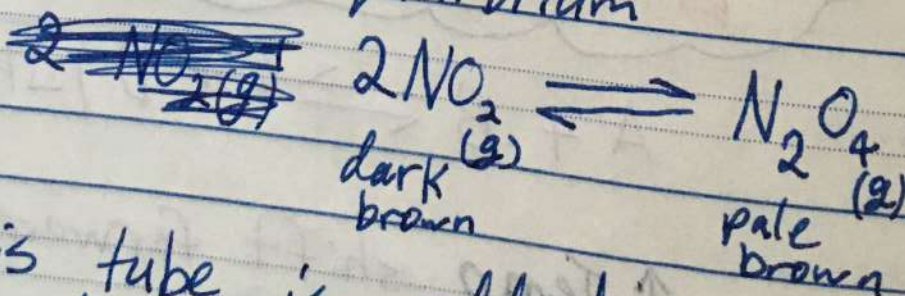
low temperature to shift to the exothermic side which is the

forward reaction.



	Rate of forward	rate of backward	yield of SO_3
Temp \uparrow	\downarrow less \uparrow	\uparrow more	\downarrow less
Temp \downarrow	\uparrow more \downarrow	\downarrow less	\uparrow more

A sealed tube contains a mixture of equilibrium



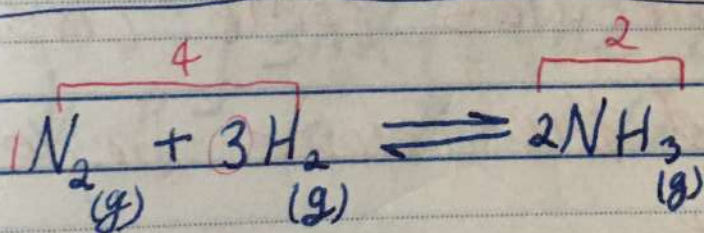
if this tube is added to a cold water bath the mixture becomes paler, explain why?

The forward reaction is exothermic
favoured by low temperatures.

(2) Pressure (only for gases)

↑ Pressure shift to the side
with less pressure
with less gas moles

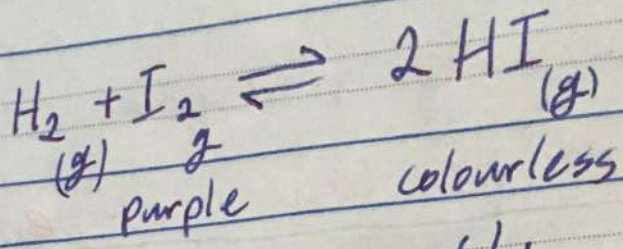
↓ Pressure shift to the
side with greater
pressure



↑ Pressure shift forward to the
side with less gas mole

↓ Pressure shift backward to the
side with more gas mole

Day : _____



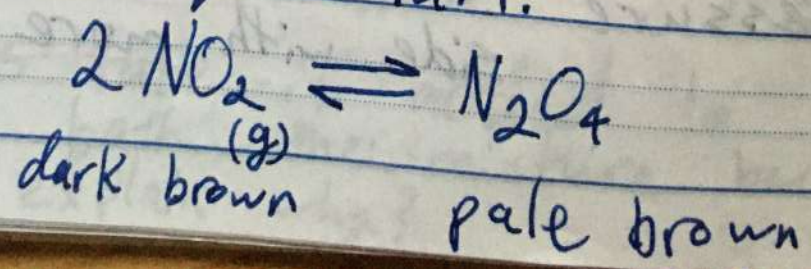
1. Why does the position of the equilibrium stay the same when pressure is increased?

Both sides have the same number of gas moles

2. Why does the mixture become more purple when pressure increases?

The I_2 molecules come closer together and the colour becomes more dense.

sealed tube contains NO_2 and N_2O_4 at equilibrium.



When the pressure of the system increases, the colour:

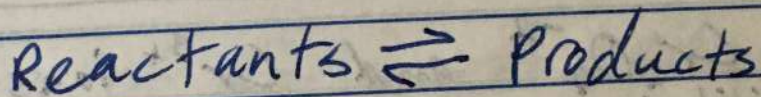
a) becomes darker then goes paler

b) becomes paler then goes darker

c) becomes paler and stays paler

d) becomes darker and stays darker

③ Concentration



$\begin{matrix} \uparrow R \\ \downarrow P \end{matrix} \left. \vphantom{\begin{matrix} \uparrow R \\ \downarrow P \end{matrix}} \right\}$ shift the equilibrium to the forward

$\begin{matrix} \downarrow R \\ \uparrow P \end{matrix} \left. \vphantom{\begin{matrix} \downarrow R \\ \uparrow P \end{matrix}} \right\}$ shift to the backward reaction



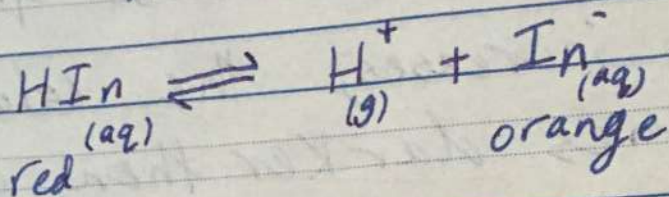
$\uparrow A$ shift forward $\downarrow A \downarrow B \uparrow C \uparrow D$

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

$\uparrow C$ shift backward

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

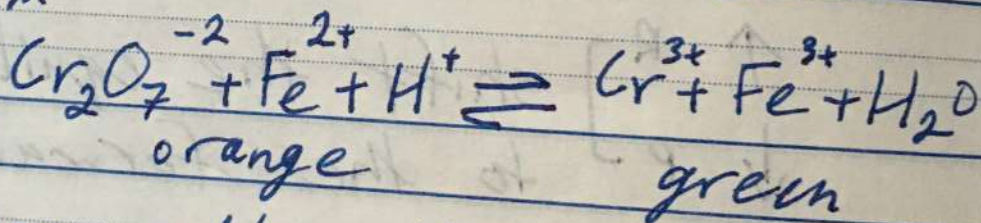
~~Methyl~~ Methyl orange indicator



add HCl $\uparrow \text{H}^+$ shift backward
more ~~HIn~~ HIn
less In^-

add NaOH $\downarrow \text{H}^+$ shift forward
more In^-
less HIn

~~B~~ $\text{Cr}_2\text{O}_7^{-2}$ and Cr^{3+} ions are in equilibrium



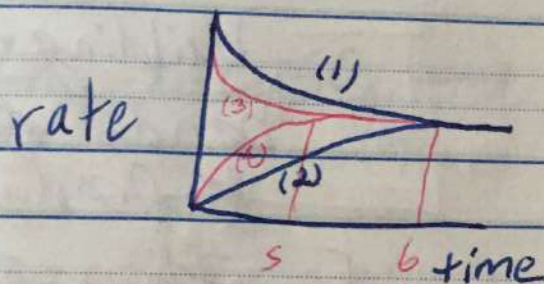
Why does adding HCl to the equilibrium make the colour more green?

Adding HCl will increase the amount of H^+ so equilibrium will shift forward so more Cr^{3+} so more green colour

Day :

Date :

* Catalysts have no effect on the position of equilibrium but it speeds up the rate of forward & backward reaction to reach equilibrium faster.



(1) Rate of forward without catalyst

(2) // // backward // //

(3) Rate of forward with catalyst

(4) // // backward // //

(5) Time taken to reach equilibrium with catalyst

(6) // // // // // without catalyst

Energetics

Energy: the ability to do work

Joules

work (in chemical reactions)

↓
Breaking down
bonds of
reactants

Endothermic

input

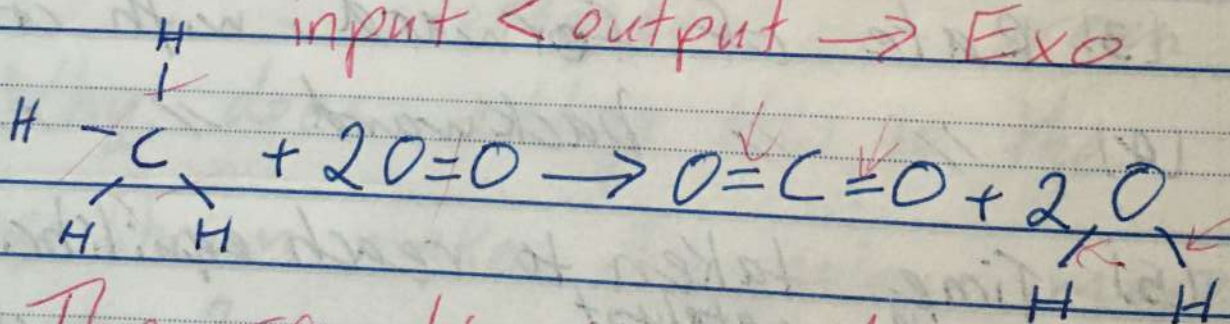
↓
building up
bonds in
products

Exothermic

output

input > output → Endo

input < output → Exo



The reaction is exothermic

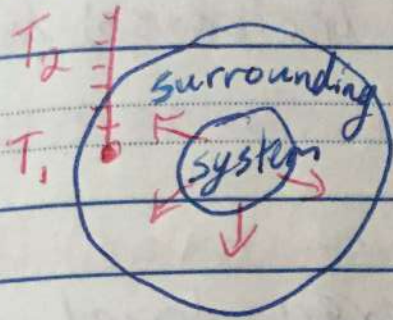
the amount of
energy released
by building up
bonds in product

amount of energy
absorbed by
breaking down bonds
in reactants

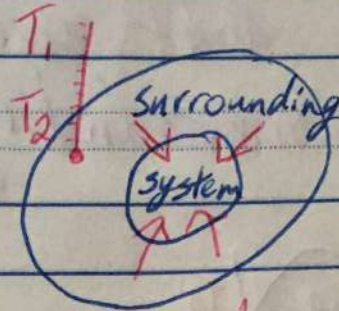
Day :

Date :

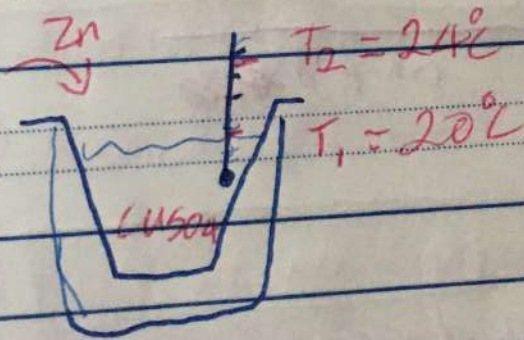
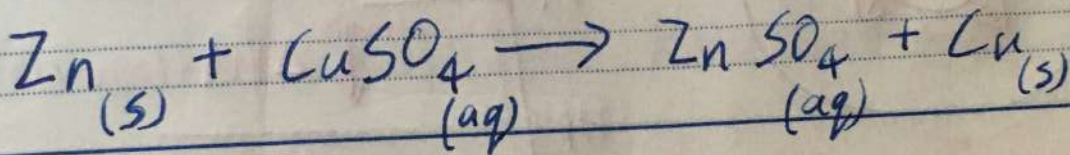
Chemical energy: Enthalpy: Heat energy (stored energy)



exo



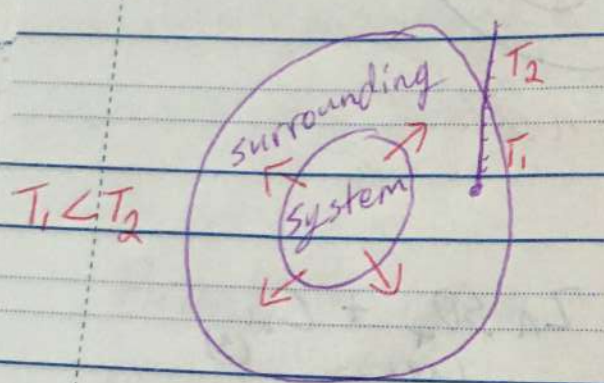
endo



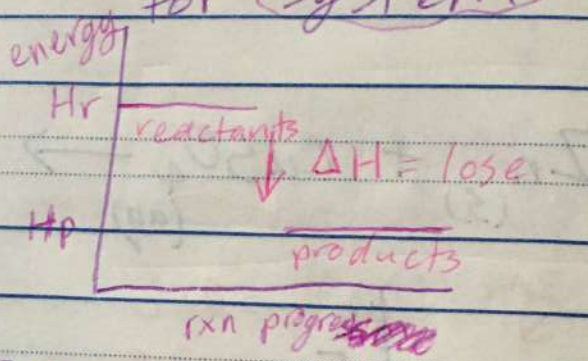
$Q = m c \Delta T \rightarrow$ change in temp
 Date:
 Q ↓ energy transfer
 m ↓ mass
 c ↓ specific heat capacity → 4.2 J/g.°C → water

Exothermic

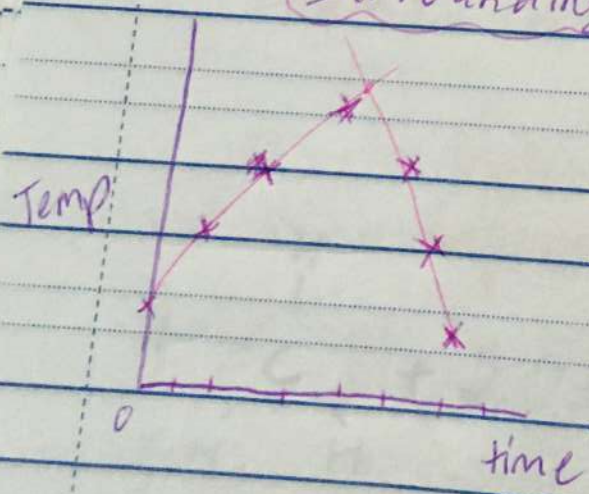
Reaction that gives out (releases) energy to the surrounding



energy level diagram for (system)



Temperature diagram for (surrounding)

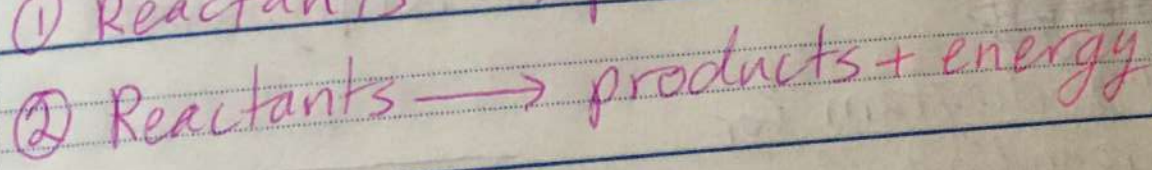
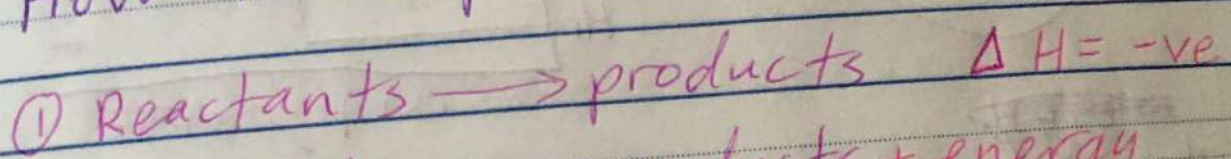


*temp decreases because reaction is over, temp returns back to room temp.

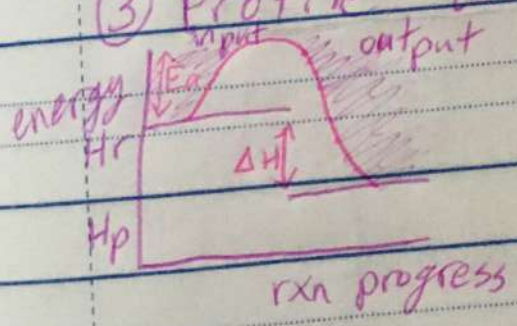
Examples:

- 1) Combustion
- 2) neutralization
- 3) displacement
- 4) voltaic cell
- 5) Freezing
- 6) condensing
- 7) building up bonds
- 8) respiration

How to express exothermic



③ Profile diagram



input $<$ output

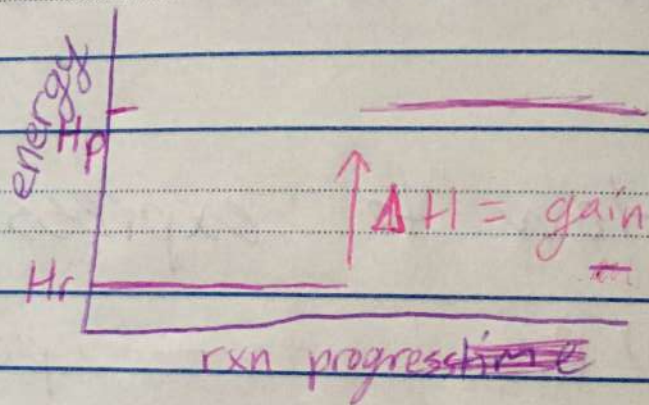
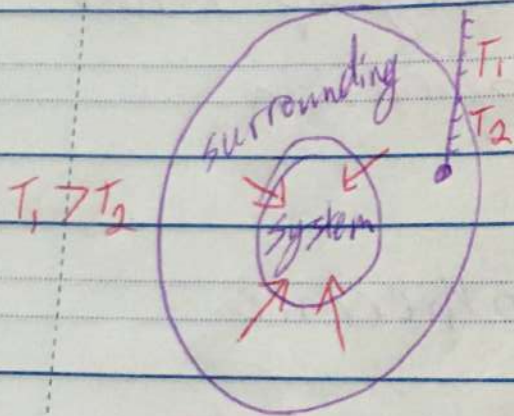
Date :

Day :

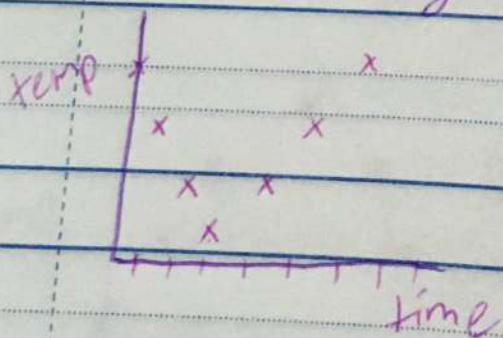
Endothermic

Reaction that absorbs energy from the surrounding

energy level diagram for system



~~energy~~
temp diagram for surrounding



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

Examples:

1) Combustion

5) Evaporation

Examples:

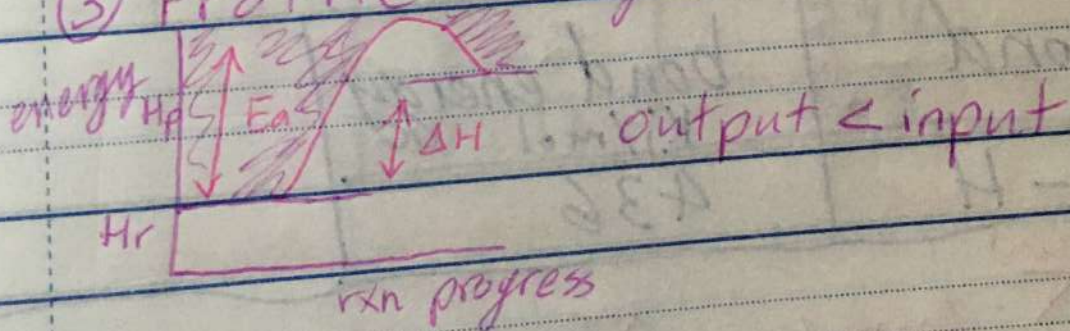
- 1) Photosynthesis
- 2) Photographic films
- 3) Electrolysis
- 4) boiling
- 5) melting
- 6) breaking down bonds
- 7) Thermal decomposition

How to express endothermic

① Reactants \rightarrow products $\Delta H = +ve$

② Reactants $\xrightarrow{\text{energy}}$ products

③ Profile diagram



Measuring ΔH

theoretical

using bond energy

practical

combustion displacement neutralization

Measuring ΔH using bond energy

Bond energy: amount of energy

needed to break or released to build 1 mol of a bond in gaseous state.

bond	bond energy KJ/mol
H-H	436

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

to break down bonds to build up bonds

input > output
+
endoinput < output
-
exo

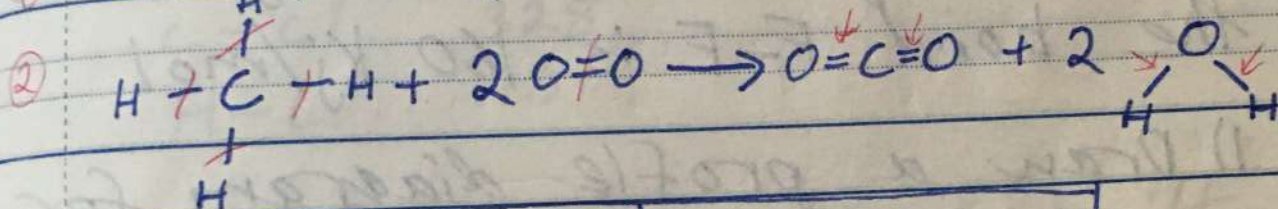
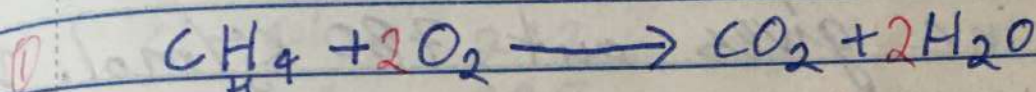
To use this equation:

1- balanced equation

2- Covalent structure

3- bond energy

example:



③

bond	bond energy
C-H	413
O=O	458
C=O	799
O-H	463

bonds broken

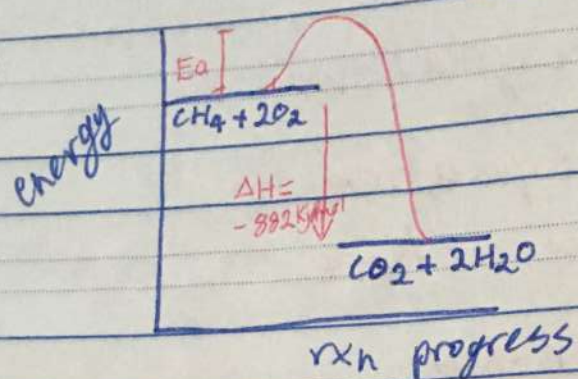
bonds built

$$\begin{array}{r}
 4 \times \text{C-H} \quad 4 \times 413 \\
 + \\
 2 \times \text{O=O} \quad 2 \times 458 \\
 \hline
 2568 \text{ KJ}
 \end{array}$$

$$\begin{array}{r}
 2 \times \text{C=O} \quad 2 \times 799 \\
 + \\
 4 \times \text{O-H} \quad 4 \times 463 \\
 \hline
 3450 \text{ KJ}
 \end{array}$$

(exo)

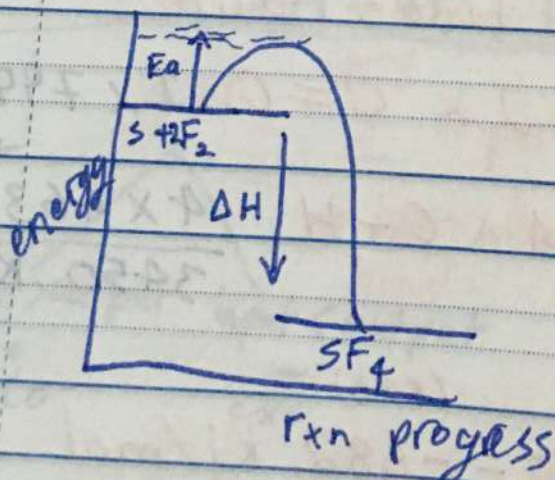
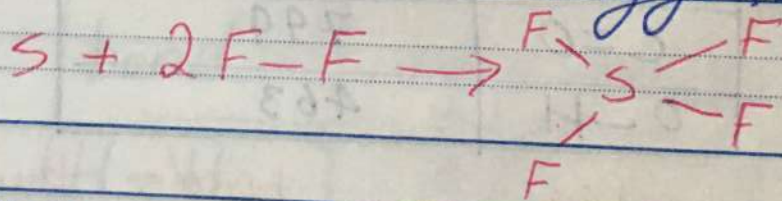
$$\Delta H = 2568 - 3450 = -882 \text{ KJ/mol}$$



- The reaction between sulfur and fluorine gives out 780 kJ/mol . If the bond $\text{F}-\text{F}$ is 160 kJ/mol

1) Draw a profile diagram for the reaction

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



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

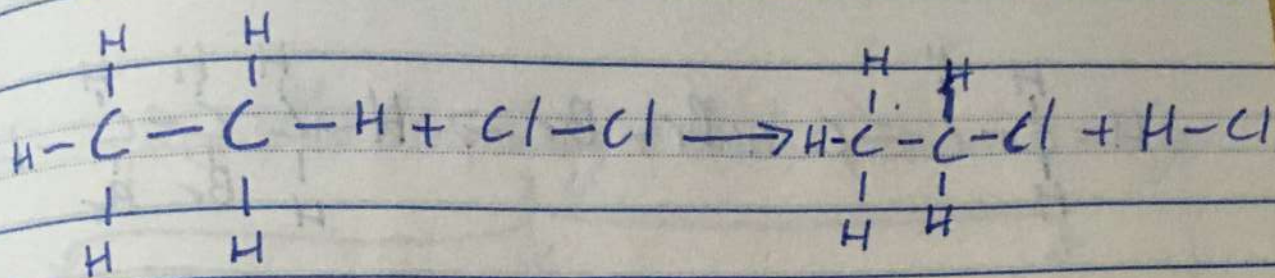
$$-780 = (2 \times 160) - (4 \times \text{S}-\text{F})$$

$$-780 = 320 - 4\text{S}-\text{F}$$

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

Day :

Date :



bond bond
 energy

C-H 413

C-C 348

Cl-Cl 242

C-Cl 328

H-Cl 431

bond broken

C-H 413 ~~x1~~

~~C-C 348~~

Cl-Cl 242

= ~~3068~~ ~~1003~~ **655**

~~$\Delta H = 3068 - 2824$~~

$\Delta H = 655 - 759$

= -104

bond built

~~C-H 413 x1~~

C-Cl 328

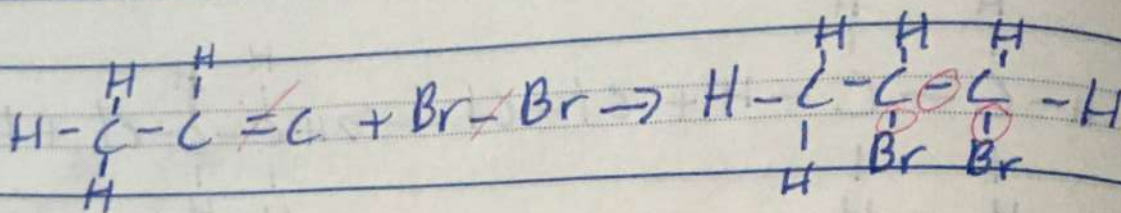
H-Cl 431

= ~~2824~~ 759

exothermic
reaction

Date :

Day :



bond broken	Bond built
C=C	C-C
Br-Br	2x C-Br
807	900

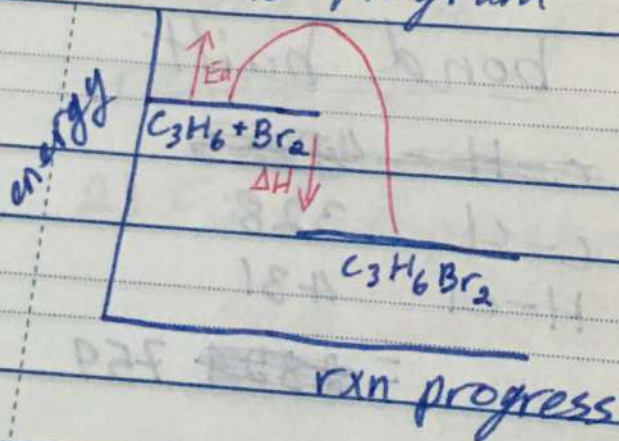
bond	bond energy
C-H	413
C-C	348
C=C	614
Br-Br	193
C-Br	276 276

$$\Delta H = 807 - 900$$

$$= -93 \text{ KJ/mol}$$

exothermic

profile diagram



Day :

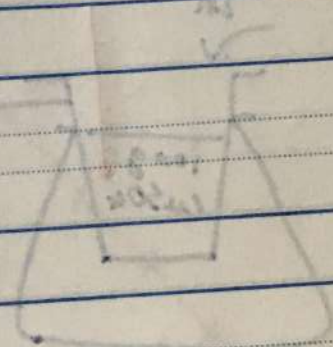
Date :

Measuring ΔH practically

ΔH Combustion

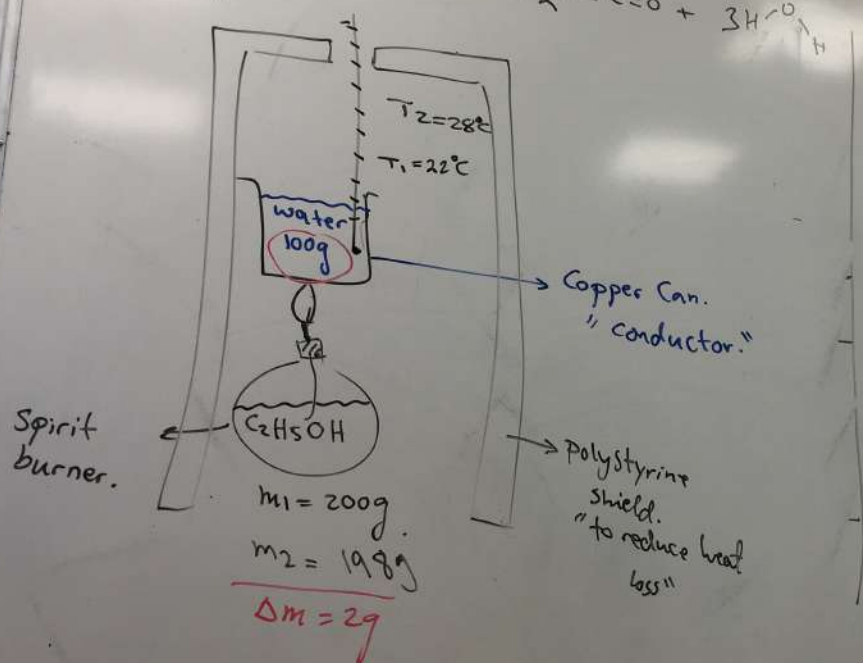
ΔH displacement

ΔH neutralization



$$Q = m C \Delta T$$
$$= 100 \times 4.2 \times 8$$
$$= 3360 \text{ J}$$

$$Q = m C \Delta T$$
$$= 100 \times 4.2 \times 8$$
$$= 3360 \text{ J}$$



$$Q = m c \Delta T$$

$$= 100 \times 4.2 \times 6 = 2520 \text{ J}$$

$$\times 2.52 \text{ KJ}$$

$$2.52 \text{ KJ} \xrightarrow{\text{released by burning}} 2\text{g } \text{C}_2\text{H}_5\text{OH}$$

$$\Delta H \longleftarrow \begin{array}{l} \text{Mr} = \\ \text{1 mol } \text{C}_2\text{H}_5\text{OH} \\ = 46 \text{ g} \end{array}$$

$$\Delta H = \frac{46 \times 2.52}{2} = -57.96 \text{ KJ/mol}$$

$$\text{Mr } \text{C}_2\text{H}_5\text{OH} = 2(12) + 5(1) + 1(16) + 1(1) = 46$$

$$Q = m c \Delta T$$

$$= 100 \times 4.2 \times 6 = 2520 \text{ J}$$

$$\times 2.52 \text{ KJ}$$

2.52 KJ $\xrightarrow{\text{released by burning}}$ 2g $\text{C}_2\text{H}_5\text{OH}$

ΔH

$$M_r = 1 \text{ mol } \text{C}_2\text{H}_5\text{OH} = 46 \text{ g}$$

$$\Delta H = \frac{46 \times 2.52}{2} = -57.96 \text{ KJ/mol}$$

$$M_r \text{ C}_2\text{H}_5\text{OH} = 2(12) + 5(1) + 1(16) + 1(1) = 46$$

two fuels A & B

Plan an exp to show which fuel produce more energy.

take a known mass of water with a known initial temp

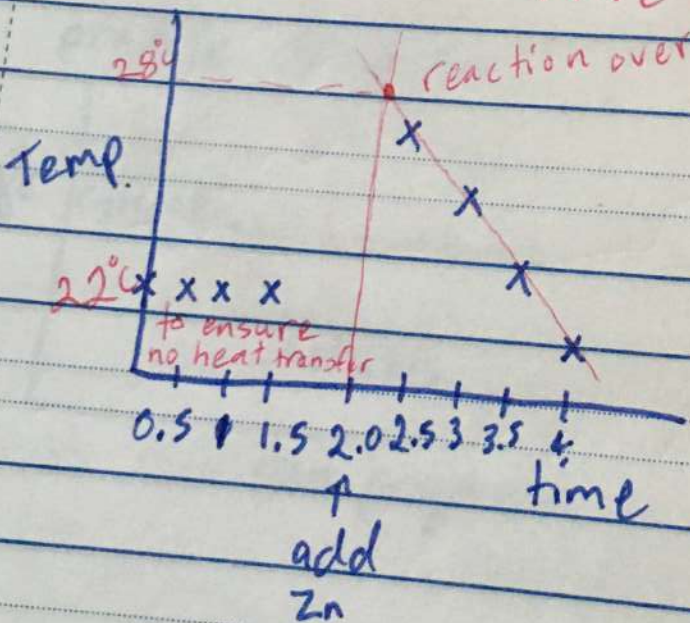
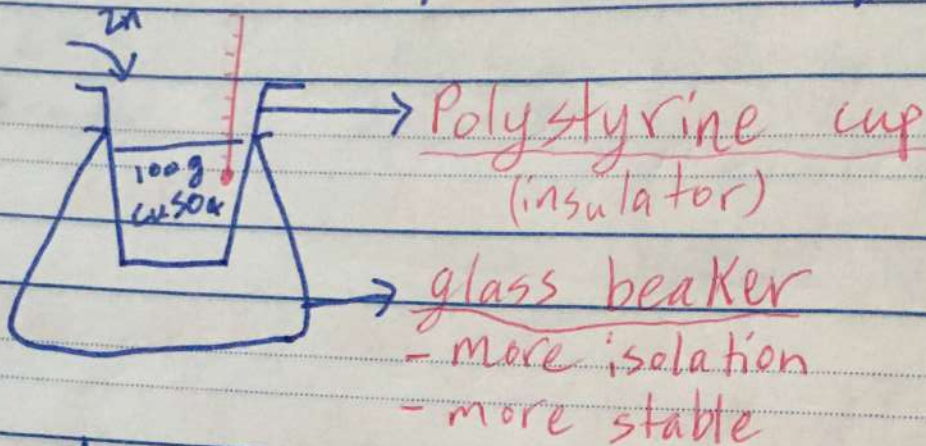
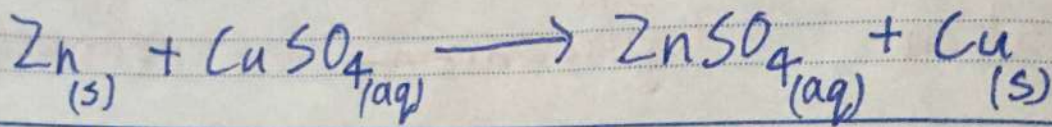
take a known mass of fuel A

Ignite the fuel, and measure the final mass and final temp of water.

Repeat with fuel B.

The fuel which cause more temp change is the one that produce more energy.

ΔH reaction for displacement



$$Q = m c \Delta T$$

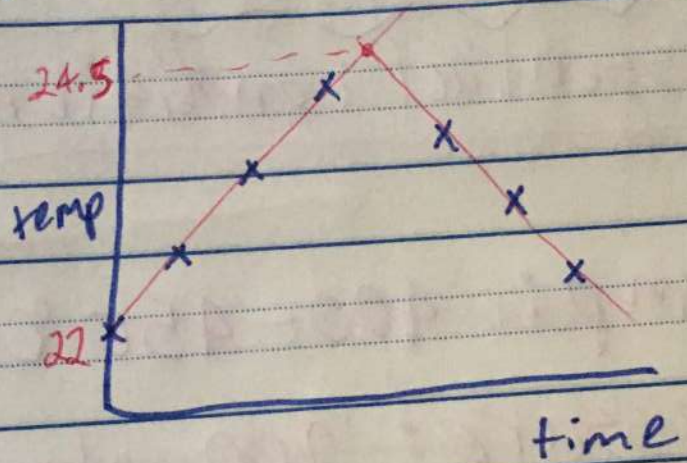
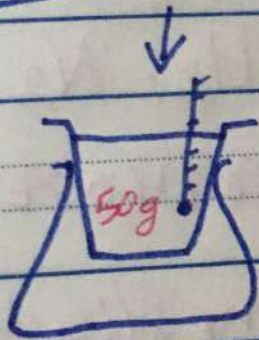
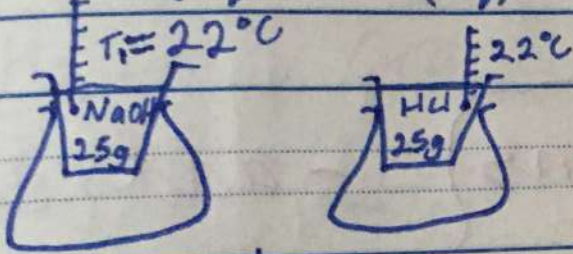
$$= 100 \times 4.2 \times 6$$

$$= 2520 \text{ J}$$

Day :

Date :

ΔH reaction for neutralization



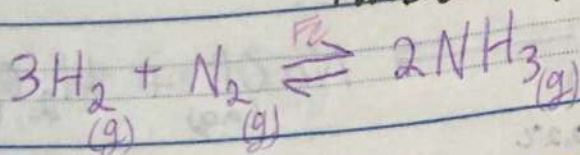
$$Q = m c \Delta T$$

$$Q = 50 \times 4.2 \times 2.5$$

$$= 525 \text{ J}$$

Industry of Ammonia (NH₃)

Haber process



$$\Delta H = \overset{\text{exo}}{-ve}$$

Essential conditions

- Temp: 400-450°C
- pressure: 200 atm
- catalyst: Iron

- add excess

H₂, N₂

- remove NH₃ immediately

Uses of ammonia:

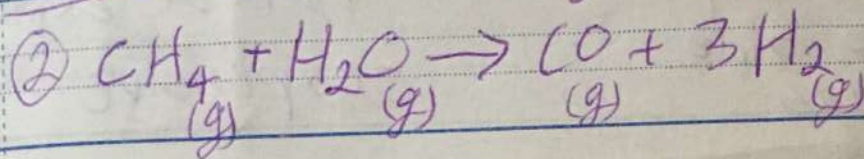
- 1) fertilizers
- 2) cleaning detergents
- 3) smelling salts

~~How to do~~

How to obtain:

• $N_2 \rightarrow$ fractional distillation of liquid air (cool air under high pressure)

• $H_2 \rightarrow$ (1) cracking of Alkanes (organic)



\rightarrow * H_2 and N_2 are returned back to converter

\rightarrow * NH_3 is extracted by cooling,

liquid NH_3 is collected

Temp. $400 - 450^\circ C$

less than
 $400^\circ C$

adv.

- more NH_3 shift forward to exo side

dis.

- slower rate of reaction

more than
 $450^\circ C$

adv.

faster rate of reaction

dis.

less yield of NH_3 shift backward to endo side

Pressure 200 atm

high pressure

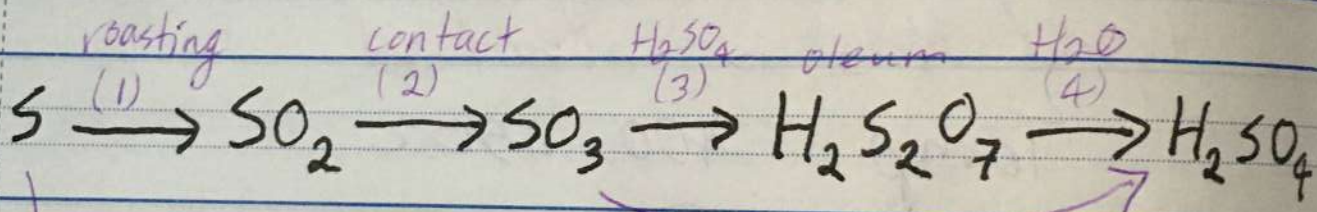
advantages

- more NH_3 shifts forward to side with less gas moles
- faster rate of reaction

disadvantages

- risk of explosion
- expensive

Industry of sulfuric acid



↓ source of S: fossil fuels

Ore: Zinc blend (ZnS)

- uses:
- fireworks
 - matches
 - medicine

~~uses of SO_2~~

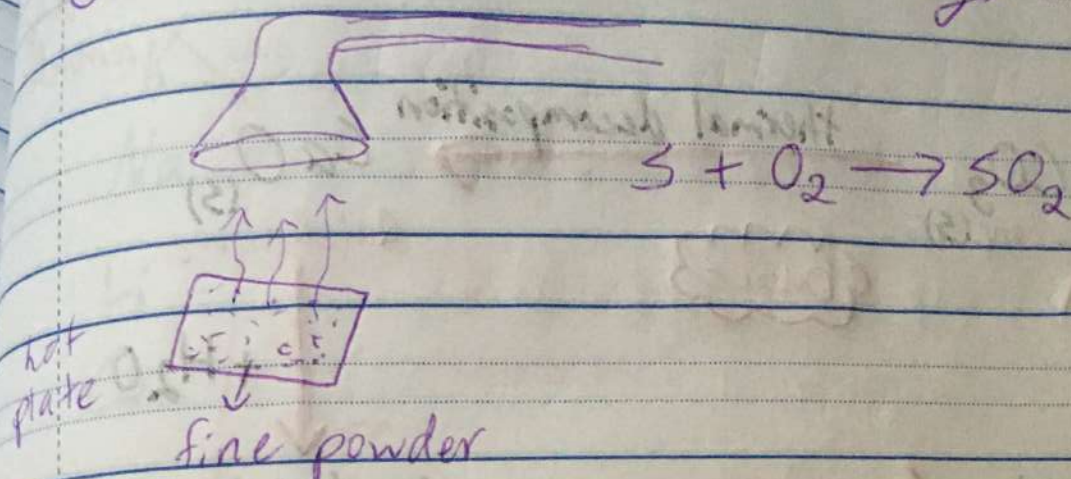
~~(ZnS)~~

uses of SO_3

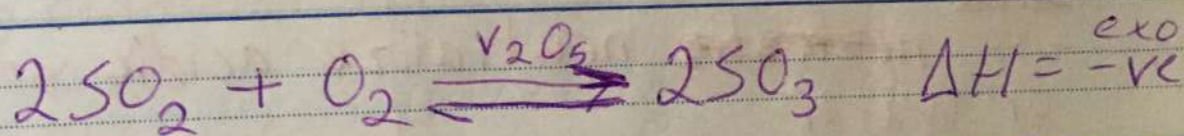
- food preserving (kills bacteria)
- paper industry (bleaching agent)

highly reactive / exothermic / low yield

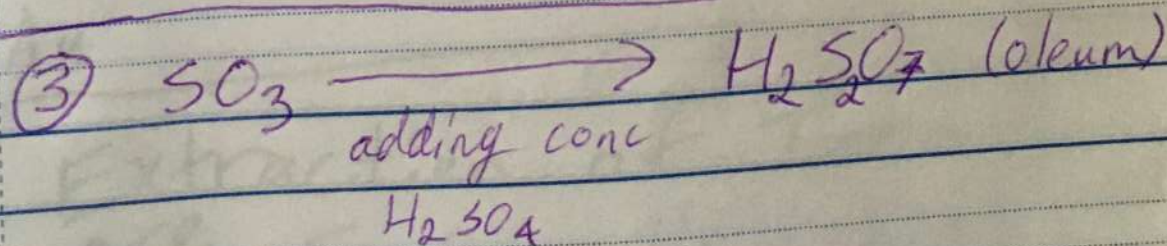
① from S to SO_2 (Roasting)



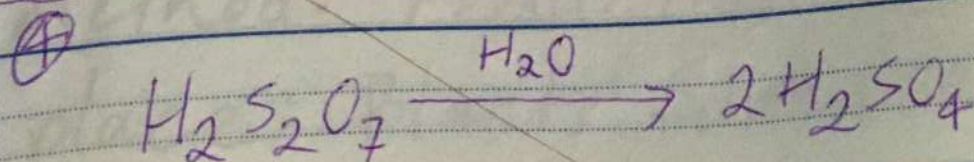
② from SO_2 to SO_3 (contact process)



- Temp $400 - 450^\circ C$
- Pressure 2 atm (high pressure favours forward reaction. Maximum yield 98% at 2 atm)
- Catalyst: Vanadium (V) oxide

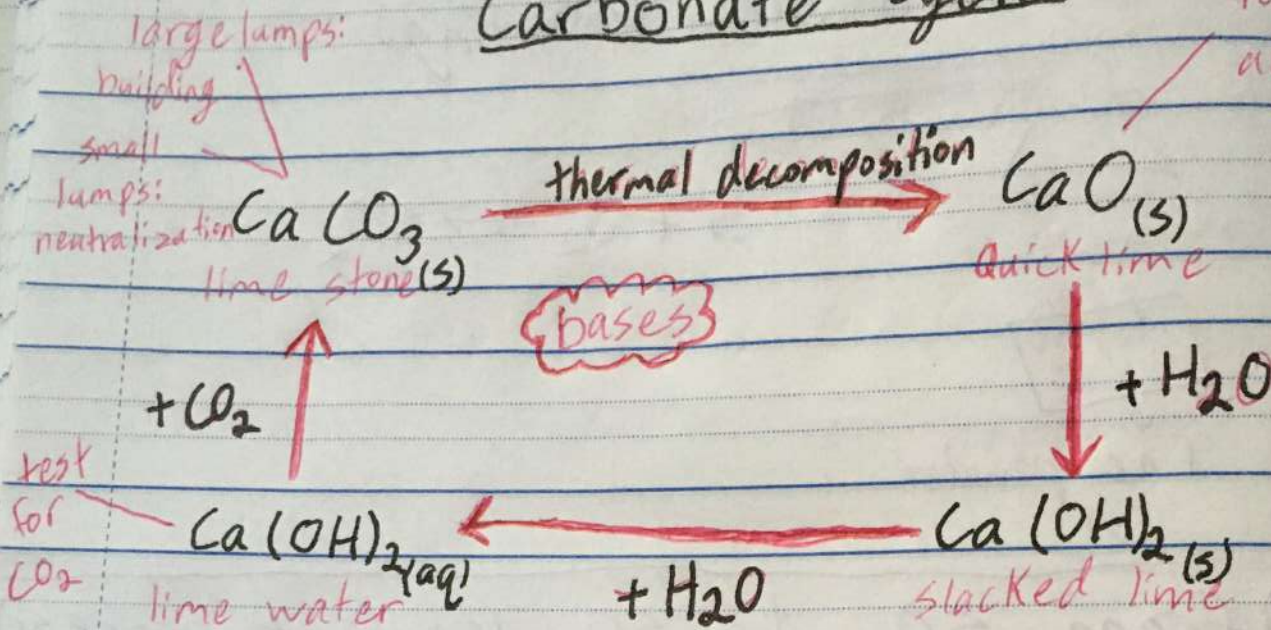


or by electrolysis



Carbonate cycle

to dry ammonia



uses: (for all)

- to ~~neutralize~~ neutralize acidic soil or water
- de sulfonation (remove SO_2 from pollutant)

Extraction of Metals

K

Na

Li

Ca

Mg

Al

C, CO

Zn

Fe

Pb

H

Cu

Ag

Au

Electrolysis
for molten
ore

reduction by
C/CO
"blast furnace"

reduction
by H₂

Extraction of Iron

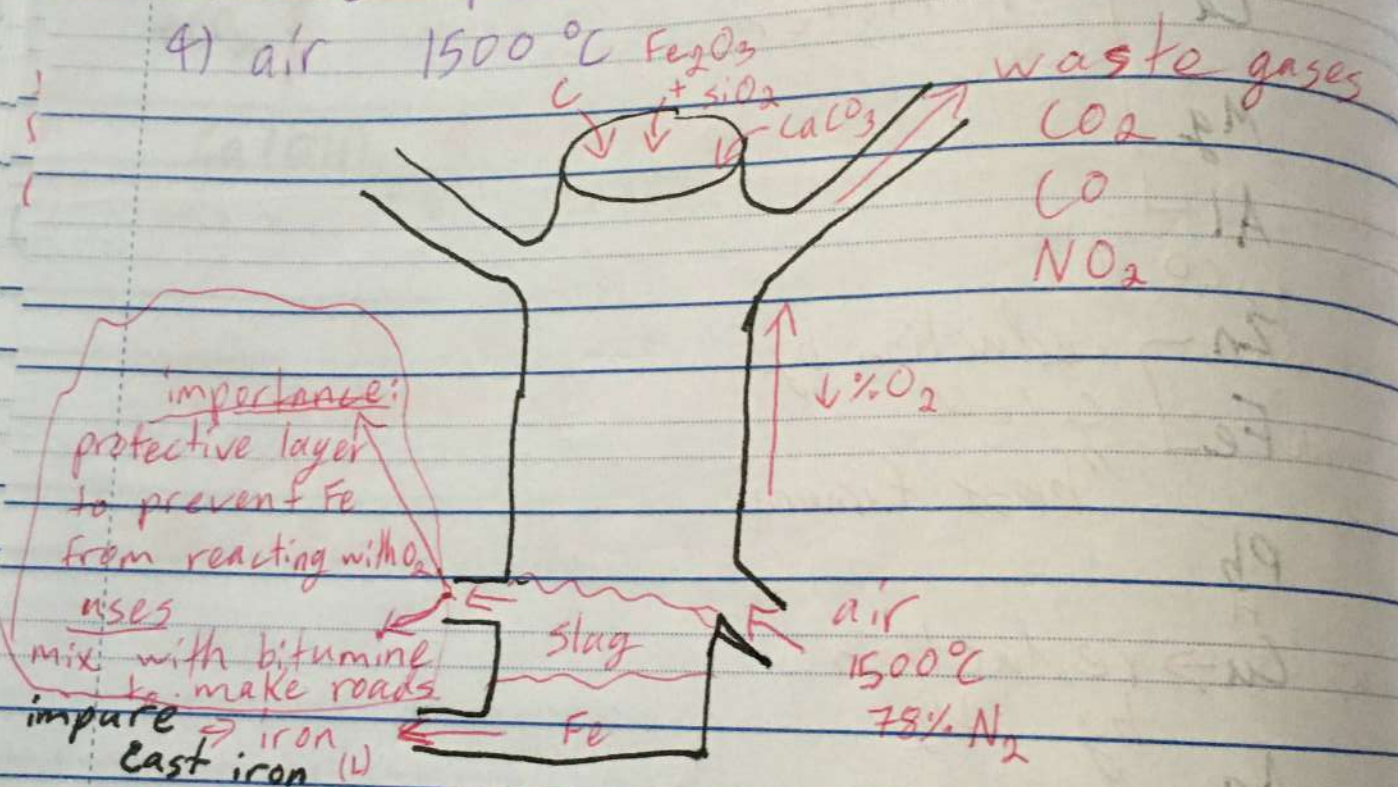
ore: ~~ore~~ Fe₂O₃ Hematite

method: reduction by C & CO

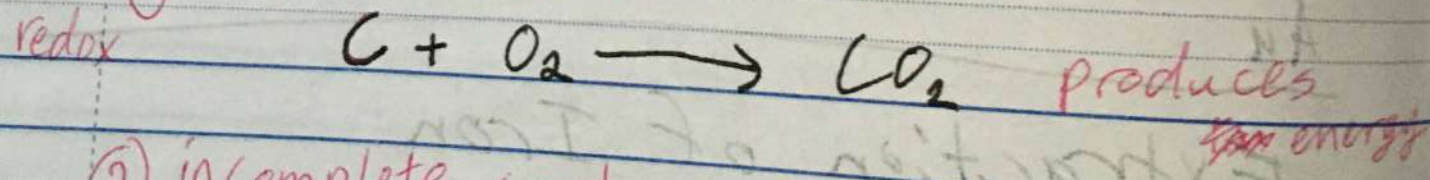
place: Blast furnace

Raw materials:

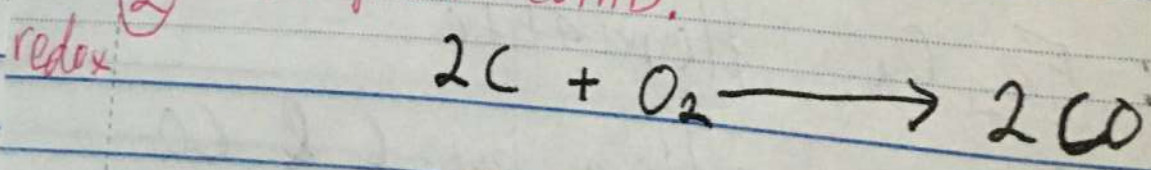
- 1) Fe_2O_3 with acidic impurities, SiO_2
- 2) Calcium carbonate $CaCO_3$ (lime stone)
- 3) Coke (pure carbon) C
- 4) air $1500^\circ C$



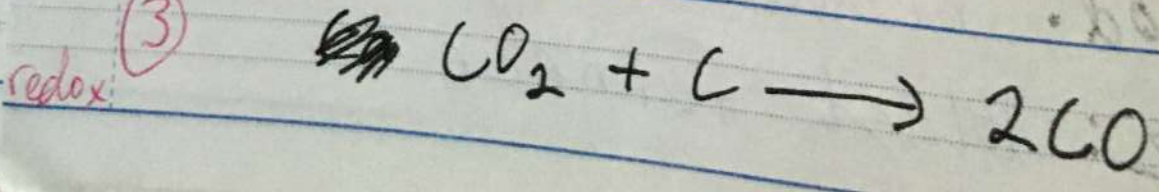
① complete combustion



② incomplete comb.

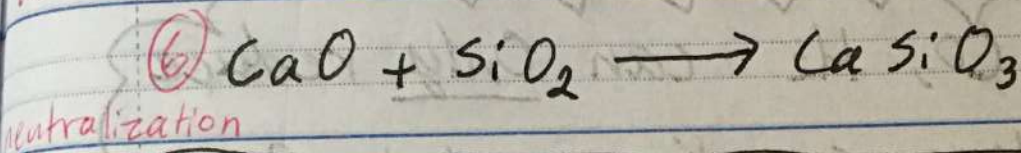
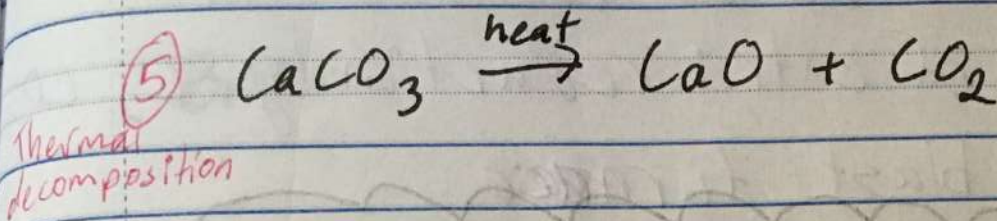
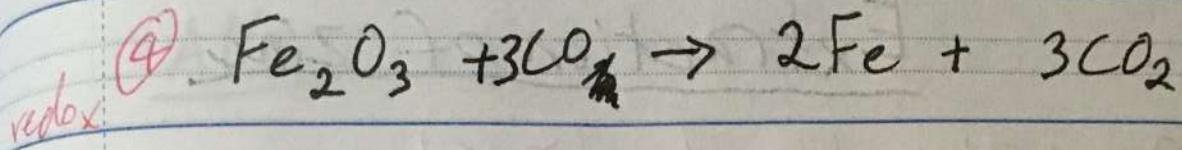


③



Day :

Date :



Steel-making "oxygen-base process"

Cast iron:

Fe

$CO_2 \leftarrow C$

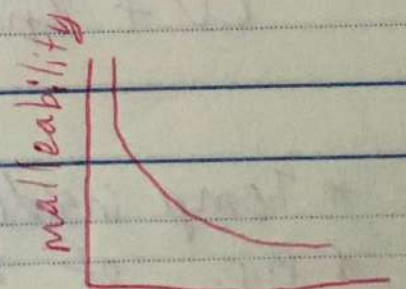
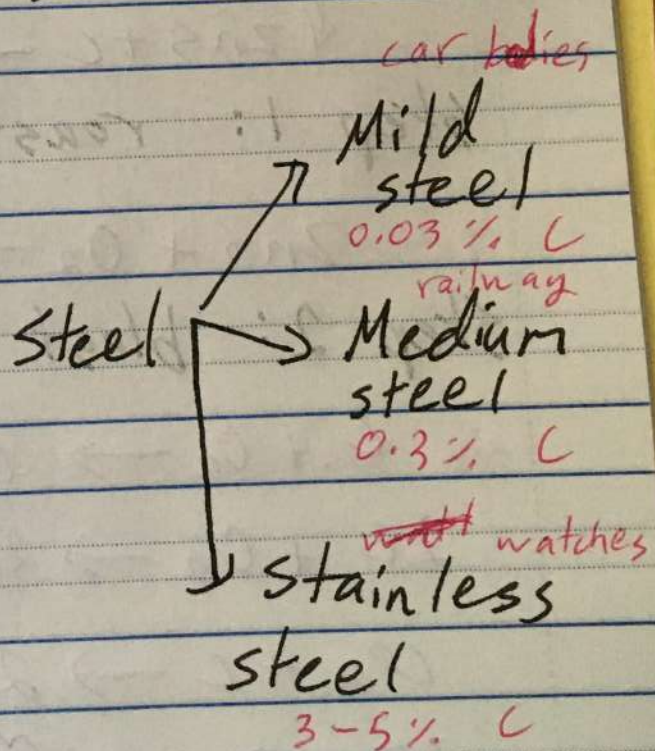
$SO_2 \leftarrow S$

$SiO_2 \leftarrow Si$

acid $P_2O_5 \leftarrow P$

blow with hot O_2

base CaO



Day :

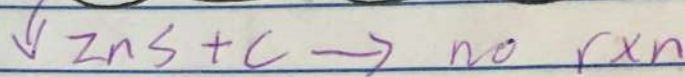
Extraction of zinc

Ore: zinc blende (ZnS)

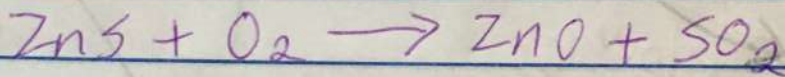
method of extr.: reduction by C, CO

place: blast furnace

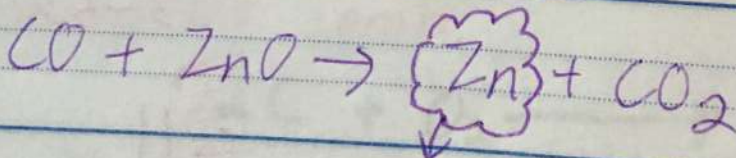
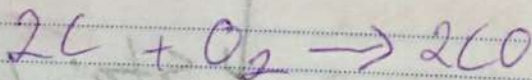
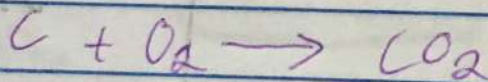
C, CO, H₂ can only reduce a less reactive metal from their oxide.



Step 1: roasting with O₂



Step 2: blast furnace



Zn is 100% pure

* Temp inside blast furnace is 1500 °C

* B.p. of Zn is 907 °C

So Zn is produced as gas leaving impurities behind