Redox

- reduction
- oxidation

in terms of	reduction	oxidation
① oxygen	lose O	gain O
② in terms of hydrogen	gain H	lose H
③ oxidation state	decrease	increase

reduction: Fe in Fe_2O_3

$$Al + Fe_2O_3 \longrightarrow Al_2O_3 + Fe$$

oxidation: AL

reduction: Zn in ZnO

$$CO + ZnO \longrightarrow Zn + CO_2$$

oxidation: C in CO

reduction: Cu in CuO

$H_2 + CuO \rightarrow Cu + H_2O$

oxidation: H_2

reduction: Cl_2

$H_2S + Cl_2 \rightarrow HCl + S$

oxidation S in H_2S

reduction $Cu^{2+} \rightarrow Cu$

$Zn + Cu^{2+}Cl_2 \rightarrow Zn^{2+}Cl_2 + Cu$

oxidation $Zn^{0} \rightarrow Zn^{+2}$

$MnO_4^{-} + Fe^{2+} + H^{+} \rightarrow Mn^{2+} + Fe^{3+} + H_2O$

rules for oxidation state

1) oxidation state for any free element = 0

monoatomic, dio atomic, poly atomic

2) the oxidation no. of any compound from

group 1 = +1
group 2 = +2
group 3 = +3 always +3 only for Al

Five Apple

group 7 = -1 alway -1 only for F

(3) the oxidation no. of Hydrogen in a compound [(+1) 99%] except with metal in metal hydride (-1)

$\overset{+1}{CH_4}$, $\overset{+1}{NH_3}$, $\overset{+1}{Na}\overset{-1}{H}$, $\overset{+2}{Ca}\overset{-1}{H_2}$

(4) oxidation state of oxygen (-2)
except in peroxide (-1)
except in OF_2 (+2)

sodium oxide Na^{+1} O^{-2} -> Na_2O

sodium peroxide Na^{+1} O_2^{-2} -> Na_2O_2

H_2O^{-2} water

$H_2O_2^{-1}$

calcium oxide

Ca^{+2} O^{-2}

CaO

calcium peroxide

Ca^{+2} O_2^{-2}

↓

CaO_2

5) the sum of all oxidation state in a compound = 0
in an ion = charge of this ion

Five Apple

Fe_2O_3

$2Fe + -6 = 0$

$2Fe = 6$

$Fe = 3$

SO_4^{-2}

$S - 8 = -2$

$S = +6$

PO_4^{-3}

$P - 8 = -3$

$P = +5$

CO_2

$C - 4 = 0$

$C = +4$

OFe

$Fe = +2$

$r_2 O_5$

$2r - 10 = 0$

$2r = 10$

$r = 5$

CrO_4^{-2}

$Cr - 8 = -2$

$Cr = +6$

CO

$C - 2 = 0$

$C = +2$

CO_3^{-2}

$C - 6 = -2$

$C = +4$

writing balanced Half ionic equation
1) a com
2) the charge by adding e's to the side with greater charge by the difference

$\overset{0}{Ca} + 2\overset{+1}{n}Cl_2 \rightarrow \overset{+2}{Ca}\overset{-1}{Cl_2} + 2\overset{0}{n}$

H.O.O $Ca \rightarrow Ca^{2+} + 2e^-$

H.O.R $Zn^{+2} + 2e^- \rightarrow Zn^0$

$\overset{0}{Na} + \overset{+1}{H}\overset{-1}{Cl} \rightarrow \overset{+1}{Na}\overset{-1}{Cl} + \overset{0}{H_2}$

H.O.O $Na \rightarrow Na^{+1} + 1e^-$

H.O.R $2H^+ + 2e^- \rightarrow H_2$

$\overset{0}{Ca} + \overset{3+}{Al}\overset{-1}{Cl_3} \rightarrow \overset{2}{Ca}\overset{-1}{Cl_2} + \overset{0}{Al}$

H.O.O $Ca \rightarrow Ca^{2+}$

H.O.R $AL^{+3} + 3e^- \rightarrow AL$

$H_2\overset{-2}{S} + Cl_2 \rightarrow HCl + S$

H.O.O $S^{-2} \rightarrow S + 2e^-$
H.O.R $Cl_2 + 2e^- \rightarrow 2Cl$

oxidising agent reducing agent
~~oxidising agent "oxidant"~~

reducing agent oxidising agent

O gain O lose O

H lose H gain H

oxidesace ↑ ↓

e⁻ - transfer lose e gain e

Oxidising agent "oxidant"

the substance that itself reduced and cause the other substance to be oxidised

reducing agent "reductant"
the substance that itself oxidised and causes the other substance to be reduced.

If the substance is an ion in a compound, the agent is the compound itself

$\overset{0}{Al} + \overset{3+}{Fe_2}\overset{2-}{O_3} \rightarrow \overset{+3}{Al_2}\overset{-2}{O_3} + \overset{0}{Fe}$

oxidation: Al reducing agent: Al

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

$\overset{+2}{C}\overset{-2}{O} + \overset{+2}{Zn}\overset{-2}{O} \rightarrow Zn + CO_2$

oxidation: C^{+2} oxi

reduction: Zn^{+2}

~~oxidising~~

reducing agent: CO

oxidising agent: ZnO

$H_2\overset{-2}{S} + \overset{0}{Cl_2} \rightarrow \overset{+1}{H}\overset{-1}{Cl} + S^0$

Oxidant: Cl_2 reductant: H_2S

$MnO_4^{-1} + Fe^{+2} + H^+ \rightarrow Mn^{+2} + Fe^{+3} + H_2O$

oxidising agent: MnO_4^{-1} reductant: Fe^{+2}

oxidation: Fe^{+2} reduction: Mn^{+7}

most common oxidising agents

① Oxygen

② acidify potassium permanganate $KMnO_4$/ H^+

③ acidify potassium dichromate $K_2Cr_2O_7$/ H^+

④ Halogens

most common reducing agent

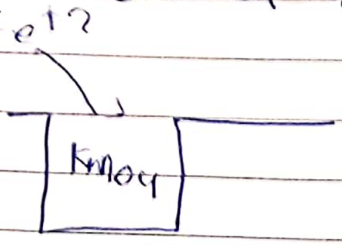
① Hydrogen

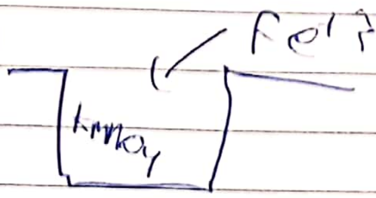
② carbon and carbon monoxide

③ Iodide $I^- \rightarrow I_2$ + 2e

④ metals

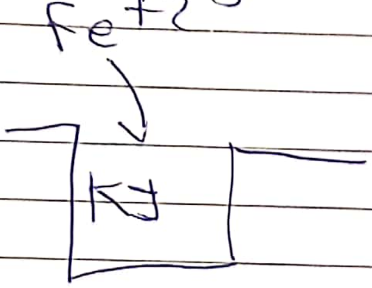
Q Fe^{+2} is a reducing agent
Fe^{+3} is an oxidising agen
record the observation in
each of the following reaction

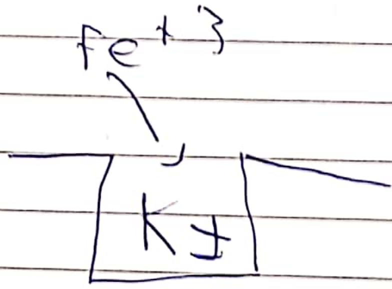
a)


b)


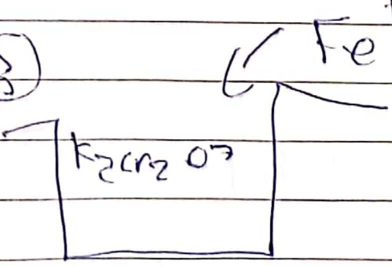
a) change color from purple to colourless

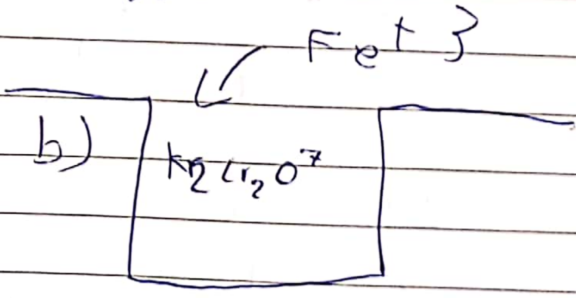
b) no change

② a)


b)


a) no change
b) colourles to red brown

③ a)


b)


a) change from orange to green
b) no change

electrolysis

Electrolysis: breaking down chemical compounds (ionic) when molten or aqueous by passing electricity

$CuCl_2$ (g) ramble

$CuCl_2$

Cu^{+2} cathode

Cl^- Anode

$2e + Cu^{+2} = Cu$
red brown solid

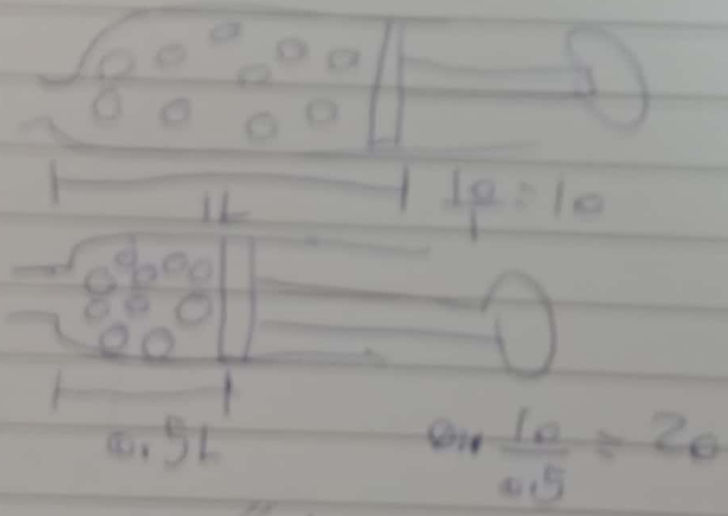
$2Cl^- \rightarrow Cl_2 + 2e$
bubbles of green yellow gas

electrolytes used up

4] pressure "only affects the gas" =

explain how the pressure affects the rate of reaction?

As the pressure increases (by reducing the volume) so more particles per unit volume so more effective collisions per unit time so faster rate of reaction.



5] ligh "only for photochemical reactions" =

reaction that need light to occur ex photosynthesis

phot synthesis

$6CO_2 + 6H_2O \xrightarrow{\text{light energy}} C_6H_{12}O_6 + 6O_2$

photographic films.

films coated with silve chloride / silver bromide

Subject Date No.

AgCl $\xrightarrow{light}$ $Ag_{(s)}$ + Br_2

AgBr $\xrightarrow{light}$ $Ag_{(s)}$ + Br_2

c) Catalyst
chemical substance that speeds up the reaction without being used up
How?→ it provides an alternative way with lower EA
so more particles will have energy equal to more tha EA
So more effective collisions per unit time so faster rate of rxns.

the reaction

$$2H_2O_{2(aq)} \xrightarrow[MnO_2]{CuO} H_2O_{(l)} + O_{2(g)}$$

① plan an experiment to show that CuO is a catalyst for this reaction.
take a known volume with a known (and same temp) conc of H_2O_2, measure the volume of O_2 produced per unit t
the exp. using CuO

N O T E B O O K

Subject Date No.

- the experiment using CuO will produce more O_2 per the same unit time

2) plan an experiment to show which of the two catalyst is better CuO or MnO_2

same as Q1 + same mass of catalyst + the ~~exp~~ which will produce more O_2 per unit time used better catalyst

③ plan an exp. to show that CuO is not used ~~up~~ during the reaction

Measure the mass of CuO add H_2O_2 until no more fizzes filter the mixture dry the solid in oven ~~then~~ measure the mass

Films ~~c~~ ~~ca~~ ~~tch~~ ~~id~~ ~~an~~ find mass bromide

NOTEBOOK

Alternative resource of energy

- Volatic cell
- Hydrogen fuel cell
- Uranium
  - [illegible]

Hydrogen fuel cell

$H_2 + O_2 \rightarrow H_2O$

$Mg + HCl \rightarrow MgCl_2 + H_2$

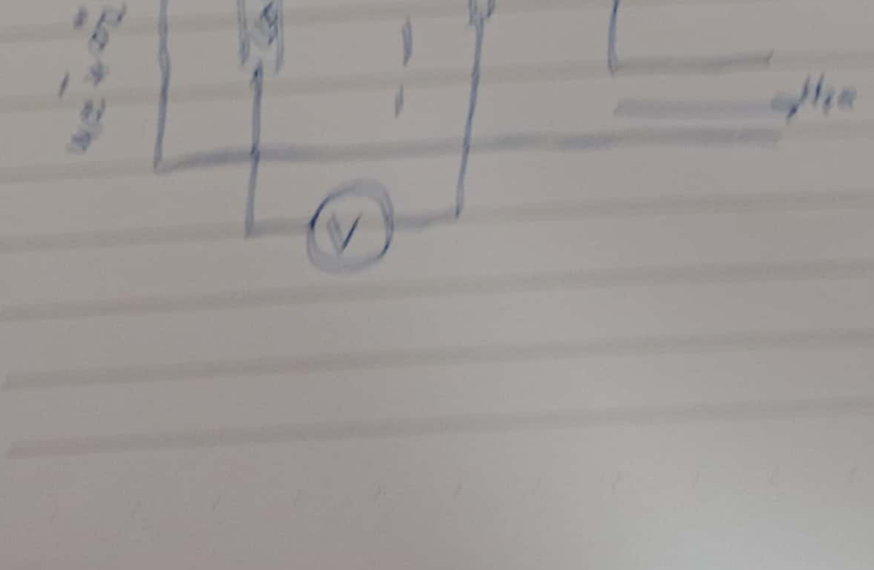
test water

physical test : Bp = 100°C

chemical test

① $CuSO_4$ [illegible] white → blue

② $CoCl_2$ + [illegible] blue → pink



Subject Date No.

advantages

- only one wase produces (no CO_2)
- produce high amount of energy
- generate electricity

disadvantages

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

Subject Date No.

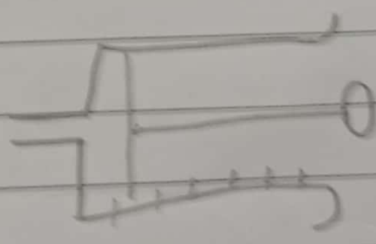
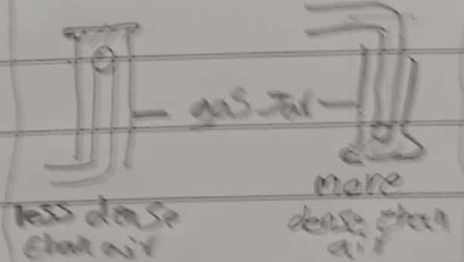
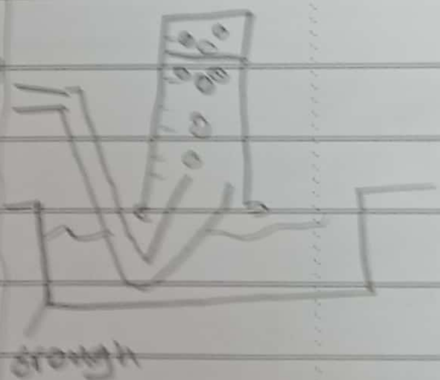
Industrial Chemistery

- Dealing with gasses
  - Dry
  - Collect
- Industry of
  - CO_3^{-2} Carbinate cycle
  - NH_3 Haber process
  - H_2SO_4 contact process
- Extraction of metals
  - Al
  - Fe
  - Zn
  - Cu

Dealing with gas

Rxn → gas (wet) → dry → collect

① Collect gas

gas syringe	Dilevery	over water
	upward dilevery / downward dilevery 	
used to collect and measure the volume of any gas no mixing with other gasses	* mix with air * can escape	Only for insoluble gasses

O_2 $H_2O_{(aq)} \xrightarrow{CuO} H_2O_{(l)} + O_{2(g)}$

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

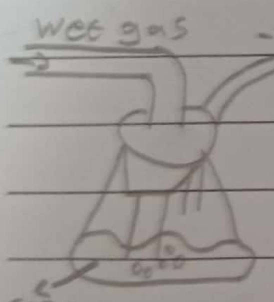
NH_3 $NH_4Cl_{(aq)} + NaOH_{(aq)} \xrightarrow{\Delta} NaCl_{(aq)} + H_2O_{(l)} + NH_{3(g)}$

SO_2 $Na_2SO_3 + HCl \xrightarrow{\Delta} NaCl_{(aq)} + H_2O_{(l)} + SO_{2(g)}$

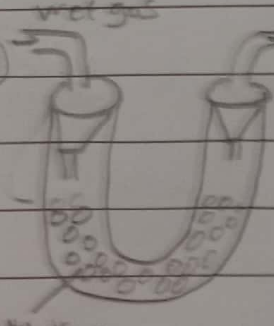
CO_2 $CaCO_{3(s)} + HCl_{(aq)} \rightarrow CaCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$

Drying gasses

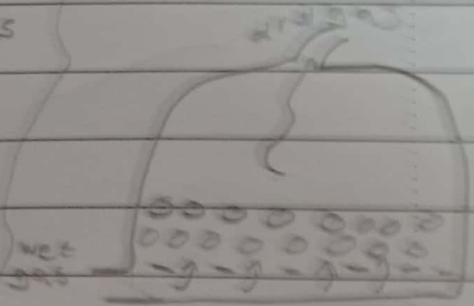
1. (concentrated H_2SO_4)
2. (Anhydrous $CaCl_2$)
3. Calcium oxide (CaO)



conc. H_2SO_4 → become dilute
used to dry
any gas except NH_3
because it neutralise the H_2SO_4
$NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$



Anhydrous $CaCl_2$
used to dry
any gas except
NH_3



Subject Date No.

Draw a suitable apparatus used to collect and measure volume of dry CO_2 gas from (insoluble)

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

N O T E B O O K

Subject Date No.

carbonate cycle

limestone
building
$CaCO_3$ (s) —— Thermal decompisition ——→ CaO (s) Quicklime

dry NH_3

extraction of iron

CO_2

bases
- neutralise acidic soil water
- desulfomation of flow gasses

+ limited H_2O

$Ca(OH)_2$ (aq) ←—— excess H_2O —— $Ca(OH)_2$ (s)

limewater — test for CO_2

slaked lime

steel making oxygen base proces

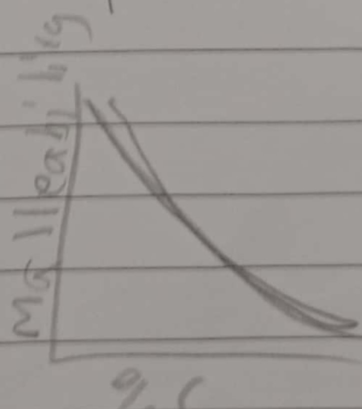
case iron:

Fe

impurities:
- CO_2 ↑ ← C — main impurity
- SO_2 ↑ ← S
- SiO_2 (s) ← Si ← CaO
- P_2O_5 (s) ← P

not O_2

steel:
- mild steel 0.3% — car bodies
- medium steel 0.31% < railway
- stainless steel 3–5% C — cutter machine



Subject Date No.

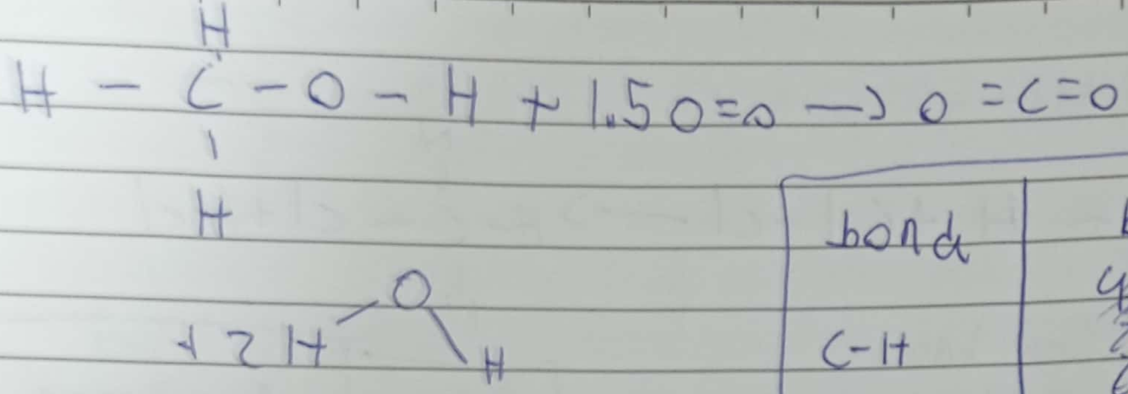
Alloy mixture of metal with other metal or semi-metal

Brass Cu, Zn

Bronze Cu, Sn

steel Fe, C, Ni, Cr

NOTEBOOK



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

bond broken

3 × C–H   3 × 413

1 × C–O   1 × 358 +

1 × O–H   1 × 463

1.5 × O=O   1.5 × 495

2802.5 kJ

bond build

2 × C=O   2 × 799

4 × O–H   4 × 463

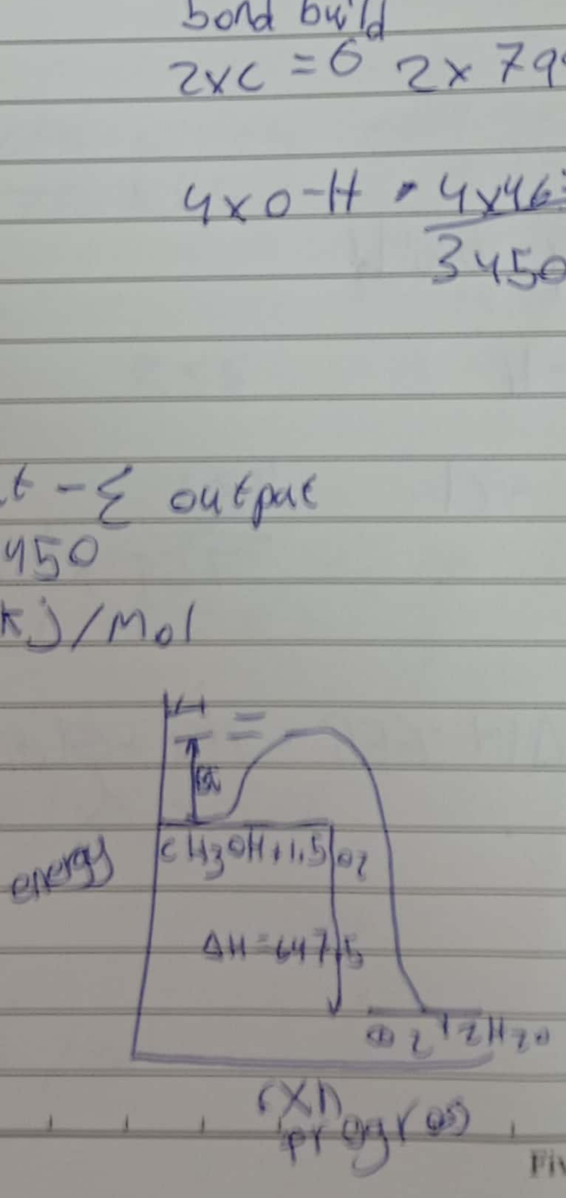
3450 kJ

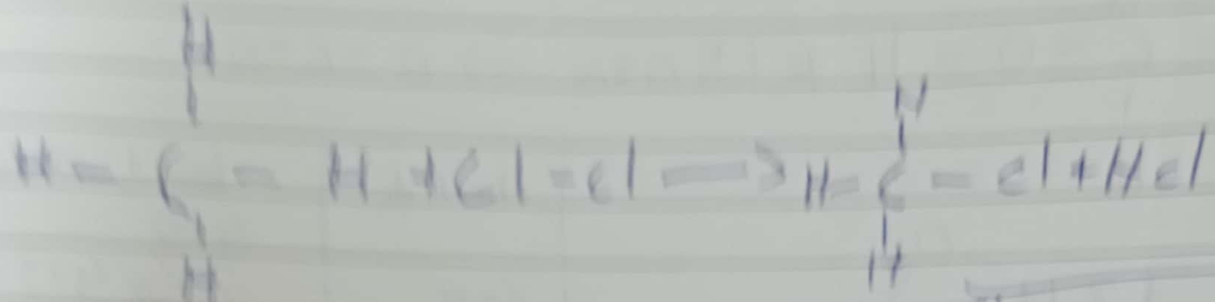
$\Delta H = \sum \text{input} - \sum \text{output}$

$= 2802.5 - 3450$

$= (-) 647.5 \text{ kJ/Mol}$

ex





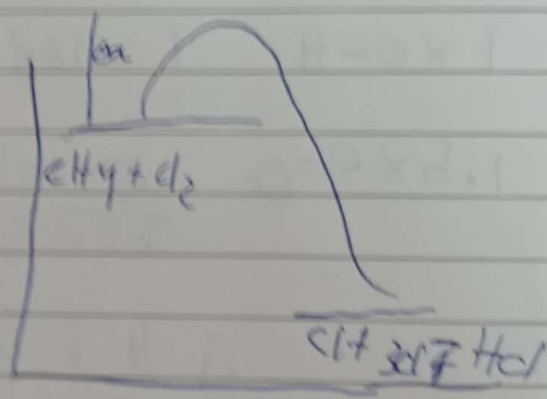
bond broken

1×C–H 413

1×Cl–Cl 242

655 kJ

bond	bond energy
C–H	413
Cl–Cl	242
H–Cl	431



bond build

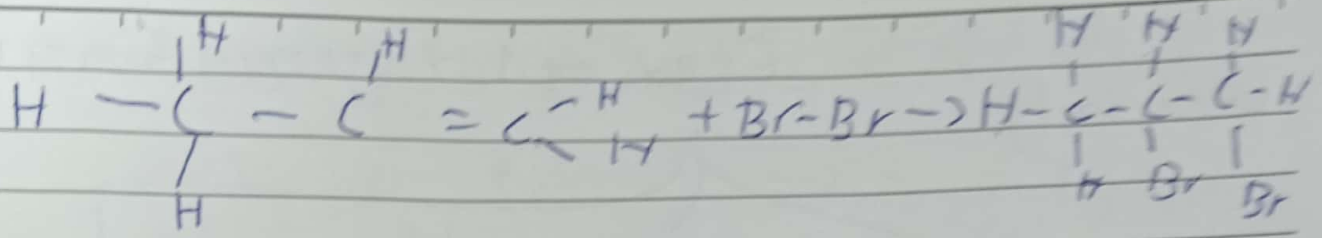
C–H 328

H–Cl 431

759 kJ

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

ex



bond broken

Br - Br 193 +

C = C 614

807 kJ

bond built

2x C - Br 2x276 +

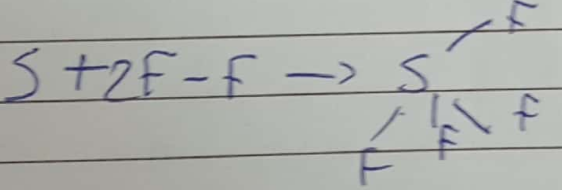
C - C 348

900 kJ

807 - 900 [illegible] kJ/mol

exo

when sulfur reacts with flourine the reaction gives 780 kJ/mol



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

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

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

$S\text{-}F = 273\ kJ/mol$

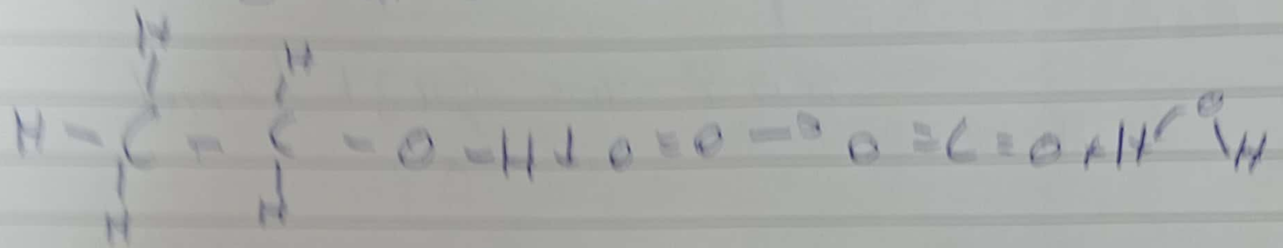
Five Apple

primarily

Finding ΔH (energy change)

- combustion
- displacement
- neutralisation

Finding ΔH combustion



measuring ΔH combustion for ethanol

$C_2H_5OH_{(l)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)}$

$Q = mc\Delta T$

energy transfer = 100 × 4.2 × 10
= 4200 J = 4.2 kJ

4.2 kJ produced by C_2H_5OH from

ΔH
96.6 kJ/mol ← mol made 46g

$\Delta H = -96.6 kJ/mol$

m₁ = 200g
m₂ = 198g

two fuels A and B
plan an exp to show which one produce more energy.

take a known mass of water with known initial temp in a copper can

take a known mass of fuel A)
ignite the fuel and record the final mass and final temp of water
repeat the exp using fuel (B)
the fuel which causes more temperature rise per gram of fuel produce more energy.

Industrial
Industry of ammonia "haber" process =

$$3H_{2(g)} \rightarrow N_{2(g)} \underset{}{\overset{Fe}{\rightleftharpoons}} 2N_{3(g)} \quad \Delta H = -ve$$

How to obtain

① Nitrogen :- fractional distillation of liquid air
↓ differen B.p
↓ cooling under High pressure

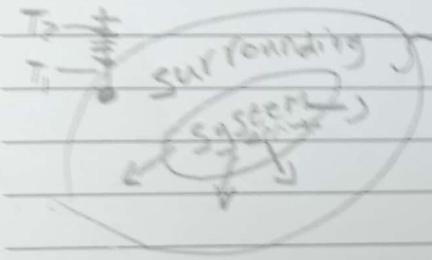
② Hydroggen

① cracking of Alkanes (organs)
② $CH_{4(g)} + H_2O_{(g)} \rightarrow CO_{(g)} + 3H_{2(g)}$

78%

Exothermic

Reaction that give out/release energy to the surrounding.



$Q = mc\Delta T$

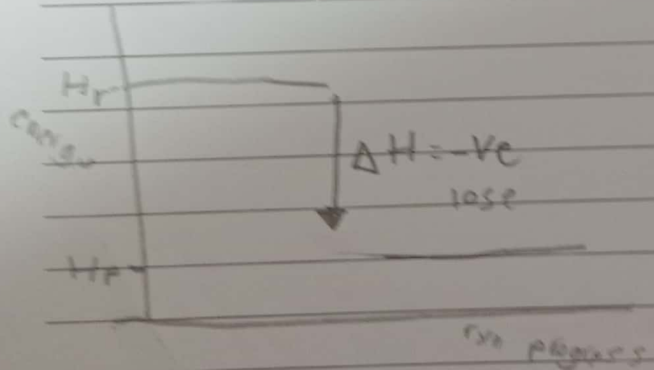
enthalpy: heat contents / stored energy

H_r: enthalpy of reactant

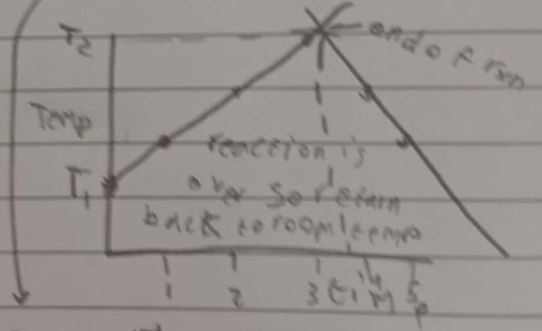
H_p: enthalpy of products

$T_2 > T_1$

for system (energy level diagram)



for surrounding (Temp diagram)



$Q = mc\Delta T$

- Q: energy transfer = J
- m: mass, g
- c: specific heat capacity, 4.18 J/g°C
- ΔT: change in temp.

↑Q ↑ΔT more exothermic.

examples on Exo :-

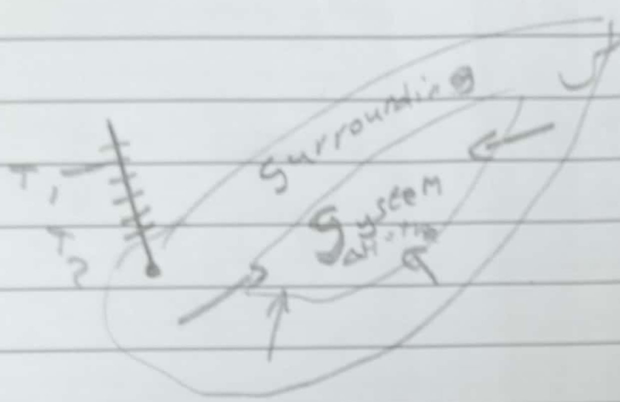
- freezing, condensation
- respiration
- Combustion
- neutralization
- displacement ($Zn + CuSO_{4(aq)}$)
- voltic cell
- building up bonds

Five Apple

Endo thermic

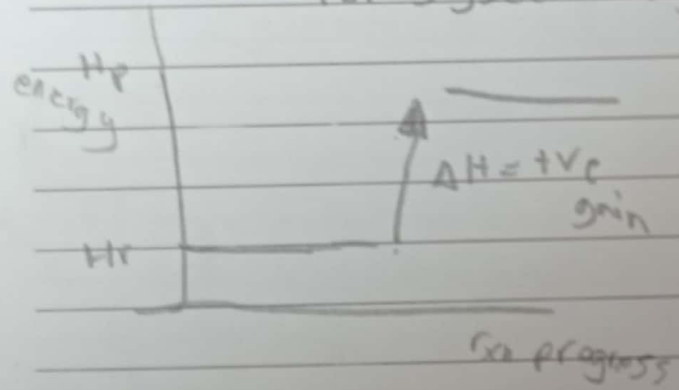
reaction the absorbs/ take in energy from the surrounding.

$Q = mc\Delta T$



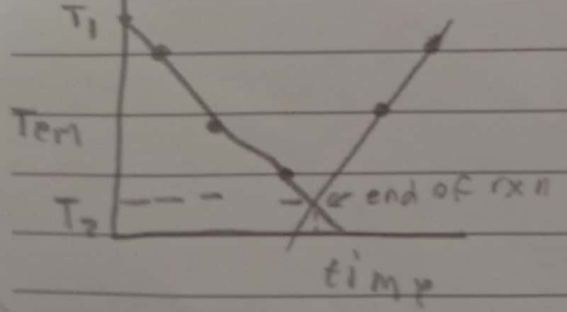
$T_1 > T_2$

for system(energ level diagram)



For surranding (Temp diagram)

$Q = mc\Delta T$



↑Q ↑ΔT
more endothermic

Examples on Endo

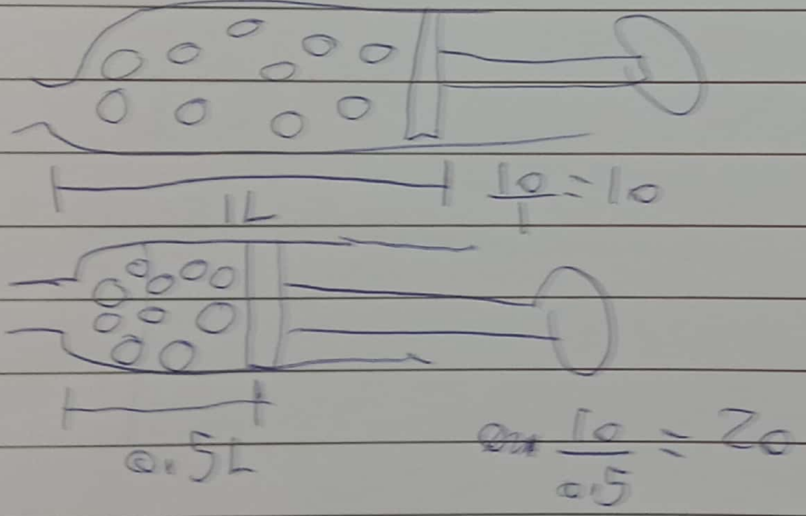
- Boiling, melting
- photosynthesis
- Thermal decomposition
- electrolysis
- photographic films
- dissolve ammonium salts
- breaking down bonds

Subject Date No.

4) pressure "only affects the gas"

explain how the pressure affects the rate of reaction?

As the pressure increases (by reducing the volume) so more particles per unit volume so more effective collisions per unit time so faster rate of reaction.



5] ligh "only for photochemical reactions"

reaction that need light to occur eg photosynthesis

photosynthesis
$6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{light}} C_6H_{12}O_6 + 6O_2$
photographic films.
Films coated with silve chloride / silver bromide

$AgCl \xrightarrow{light} Ag_{(s)} + Br_2$

$AgBr \xrightarrow{light} Ag_{(s)} + Br_2$

c) Catalyst
chemical substance that speeds up the reaction without being used up
How? → it provides an alternative way with lower EA
so more particles will have energy equal to more than EA
so more effective collisions per unit time so faster rate of rxns.

the reaction

$$2H_2O_{2(aq)} \xrightarrow[MnO_2]{CuO} H_2O_{(l)} + O_{2(g)}$$

① plan an experiment to show that CuO is a catalyst for this reaction.
take a known volume (and known temp) with a known conc of H_2O_2, measure the volume of O_2 produced per unit t
the exp. using CuO

Subject Date No.

- the experiment using CuO will produce more O_2 per the same unit time

2) plan an experiment to show which of the two catalyst is better CuO or MnO_2

same as Q1 + same mass of catalyst + the ~~ep~~ which will prod ~~uc~~ more O_2 per unit time used better catalyst

③ plan an expe. to show that CuO is not used up during the reaction

Measure the mass of CuO
~~add~~ H_2O_2 until no more fizzes
filter the mixture dry the solid in oven, measure the mass

photographic ~~al~~ ~~as~~ find ~~mass~~
films coated
bromide

Le Chatelier principle

If the system at equil ⇌
and any external factor disturbs the equil
the equil can shift itself either
to the forward ⇀
or the backward ↽
to return back to the equil

Factors affect the
position of equilibrium

① Temp
② pressure
③ conc.

① Temp

⇌ ... endo and exo

↑ Temp shift to endo

↓ Temp shift to exo

② pressure

↑ press
As the equil shifts
to the side
with less
pressure

① Tempeturo

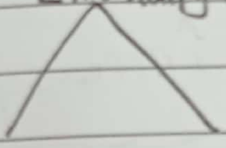
↑ ~~matter of~~

as the tempeture increasese the rate of ↑↑endo and ↑exo increases, (Shift to endo)

as the tempreture decresese the rate of ↓exo and ↓↓endo decrases (Shift to exo)

ΔH =

Enthaley change



+ve gain Endo

-ve lose exo

(the sign of ΔH is always represent the forward reaction)

$$A + B \underset{exo}{\overset{endo}{\rightleftharpoons}} C + D \quad \Delta H = +ve$$

↑temp ↑↑rate of forward
↑rate of backward

↓A ↓B ↑C ↑D
shift forward to the endo

↓Temp ↓ rate of forward
↓rate of backward

↑A ↑B ↓C ↓D

$$X + W \underset{endo}{\overset{exo}{\rightleftharpoons}} y + z \quad \Delta H = -ve$$

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

↑ x ↑ w ↓ y ↓ z

Q $3H_2 + N_2 \underset{endo}{\overset{exo}{\rightleftharpoons}} 2NH_3$ $\Delta H \overset{exo}{=} -ve$
(g) (g) (g)

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

Q: $2SO_{2(g)} + O_{2(g)} \underset{endo}{\overset{exo}{\rightleftharpoons}} 2SO_{3(g)}$ $\Delta H \overset{exo}{=} -ve$

	rate of forward	rate of backward	% SO_3
↑ temp	increase	increase	decrease
↓ temp	decrease	decrease	increase

mixture of NO_2 and N_2O_4 at equ'l in a sealed tube.

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

if we put this sealed tube in a cold water bath the mixture becomes paler why?

because the forward reaction is exothermic enhanced by cooling.

Q3 a) iii) adv: faster rate
reason: more particles per unit time / volume
so more effective collisions per unit time

adv: higher yield of CH_3OH

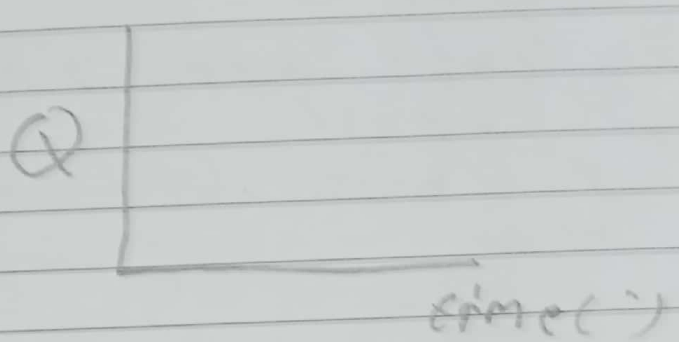
reason: shift forward to the side with less gas mole

Q4:
a) i)

rate of reaction

Rate = change in a quantity / change in time

$$Rate = \frac{\Delta Q}{\Delta t}$$



$\frac{\Delta mass}{\Delta time}$ $\frac{\Delta conc.}{\Delta time}$ $\frac{\Delta PH}{\Delta time}$

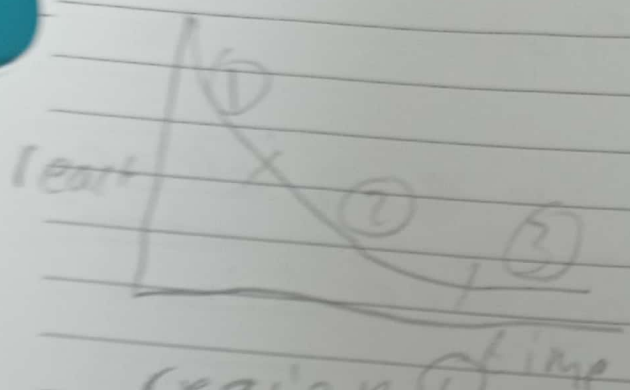
$\frac{\Delta volume}{\Delta time}$ $\frac{\Delta temp}{\Delta time}$

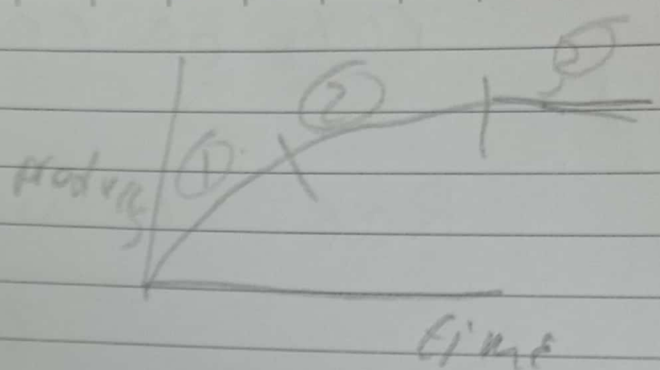
$\frac{\Delta \text{ heigh of ppt}}{\Delta time}$ $\frac{\Delta \text{ light intensity}}{\Delta time}$

measure the rate of reaction

How fast the reactents consumed per unit timy

How Fast the product produced per unit time





region ①
Fastest rate => from the graph steepest,
more amount of reactants,
more particles,
more effective collisions per unit time,

region ②

Slower rate => from the graph less steeper. less no. of particles.

so less no. of effective collisions per unit time

region ③

reaction is over => gradient = 0 (horizontal)

no more limiting factor so no more effective collisions

* Cathod: the negative rod that attracts the positive ions where reduction occurs

* Anode: the positive rod that attracts the negative ions where oxidation occurs

Electrolysis

electrolyte

molten aqueous

①

ions

inert

②

③

Molten lead (II) bromide

Pb

Br_2

total ions Pb^{+2}

cathod

$2e + Pb^{+2} \rightarrow Pb$

deposit of metal

$Br^- \rightarrow Br_2 + 2e$

Bubble of red brown gas

Al_2O_3

$Al^{+3} + 3e \rightarrow Al_2$ { Anode

$O_2 + 4e$

bubbles of colourless gas

~~Electrolyte used up~~

gas	test	result
H_2	lighted splint	Pop
O_2	glowing splint	relight
Cl_2 Br_2	damp litmus paper	turns red then bleach