Thermal Reactions

Exothermic reaction: releases energy or heat

↓

Expressed in a chemical equation:

reactants → products + energy

ΔH is negative

↑ Change in enthalpy

↳ ex: $C + O_2 \rightarrow CO_2 + 393.5\ kJ$

or

$C + O_2 \rightarrow CO_2 \quad \Delta H = -393.5\ kJ$

Endothermic reaction: absorbs energy or heat

↓

Expressed in a chemical equation:

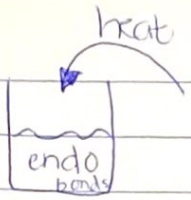
reactants + energy → product

ΔH is positive

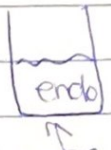
↳ $CO_2 + 393.5\ kJ \rightarrow C + O_2$

or

$CO_2 \rightarrow C + O_2 \quad \Delta H = +393.5\ kJ$



endothermic reaction



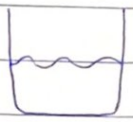
cold

$20^\circ C \rightarrow 5^\circ C$

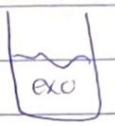
consumes heat to turn it into Chem. energy

endo

needs heat → ? → to form chemical bonds → heat will change to chemical energy



$20^\circ C \rightarrow 40^\circ C$

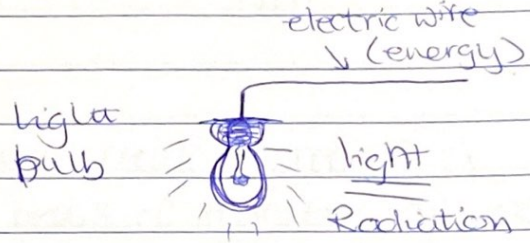


hot ← Chem bonds turn to heat

exothermic reaction

exo

bonds → thermal energy



endo:

(needs) to make bonds → consumes/changes

change of energy form electric → radiation

Chemical energy —exo (Produce heat (hot))→ Thermal energy

Chemical energy ←endo (losing heat (cold))— Thermal energy

Redox Reaction

Oxidation : losing electrons] usually metals
↳ increase of oxidation number

Reduction : gaining electrons] usually nonmetals
↳ decrease of oxidation number

Note : the term "Oxidation Number" or "Oxidation state" refers to the charge of a single atom "the charge of one atom only".

ex : Oxidation → $Na^{\circ} \rightarrow Na^{+} + e^{-}$

Reduction → $F^{\circ} + e^{-} \rightarrow F^{-}$

$Na + F \rightarrow Na^{+} + F^{-} \rightarrow NaF$

(e^{-})

Redox Reaction : oxidation-reduction reaction
↳ occurs as a result of transfer of one or more electron.

Rules for Calculation of Oxidation Number

(1) Free element = zero
ex: Na, Be, K, Pb, H_2, O_2, P_4.

(2) Ions composed of only one atom (monatomic) = the charge of the ion.
ex: Li^+, Fe^{3+}, O^{2+}

(3) Oxygen in most compounds = -2 but in hydrogen peroxide (H_2O_2) peroxide ion (O^{2-}_2) = -1.

(4) Hydrogen in most compounds = +1, if bonded to metals in binary compounds = -1.

(5) Fluorine always = -1 (bcuz its the most electroneg) (Cl, Br, and I) are always negative but when combined with oxygen they are positive.

(6) Elements of the 1st group = +1
Elements of the 2nd group = +2
Elements of the 3rd group = +3 (only Aluminium)

(7) In nuetral molecule, the sum of the oxidation numbers = zero. In polyatomic ion, the sum of oxidation numbers = net charge of the ion.

Naming Chemical compounds

When there is $\cdot H_2O$ after a compound, it means that it is Hydrated.

T-Metals have different charges for the same element
↳ ex: Fe^{2+}, Fe^{3+} *check what it's bound to.

When O_2 binds to metals don't give it the name mono- or di- ...

Chemical & Physical Properties

* $Fe + O_2 \rightarrow Fe_2O_3$ ← chem. prop. O_2 causes Fe to rust.

Allotropes: some chemical elements to exist in two or more different forms
↑
Physical Property

Sublimation: going from a solid to a gas (skip l)

CO_2 (dry ice) and naphthaline are known for Sublimation

* Sulfer burns in the air → $S + O_2 \rightarrow SO_2$
↳ chem

* $Na + Cl_2 \rightarrow NaCl$

* $AgNO_3 + NaCl \rightleftharpoons AgCl\downarrow + NaNO_3$ memorize

percipitate

The specific heat : the amount of heat per unit mass required to raise the temperature by One degrees celsius.

Surface Tension : the elastic tendency of a fluid surface which makes it acquire the least surface area possible.

The melting Point : the temperature at which it changes state from solid to liquid.

The Viscosity of a fluid : a measure of its resistance to gradual deformation.

Seperation Method

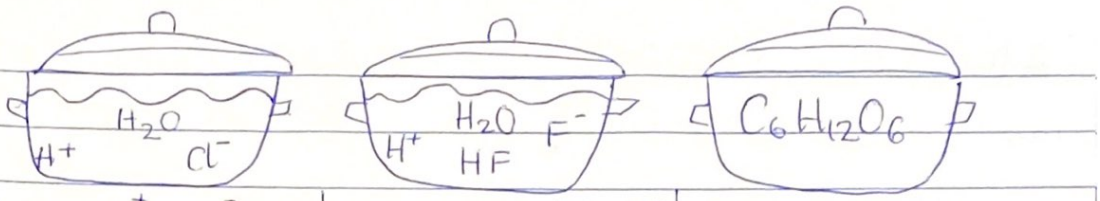
* centrifuge is used only for milk

Distinguishing between Substances

1. Silver nitrate $AgNO_3$ percipitates Cl^-, Br^-, I^-
2. ALWAYS Carbonate + acid = water + salt + CO_2
3. If 1 and 2 didn't apply, go for the sulfate $(SO_4)^{2-}$

* HCl is an acid.

→ SO_4^{2-} precipitates Ag^+, Sr^{2+}, Ba^{2+}, Pb^{2+}, and Ca^{2+}



• $HCl \rightarrow H^+ + Cl^-$	• $HF \rightleftharpoons H^+ + F^-$	• $C_6H_{12}O_6(s) \rightarrow C_6H_{12}O_{6(aq)}$
• Complete ionization	• partial ionization	• no ionization
• Alot of ions!!	• small amount of ions	• no ions
• Strong electrolyte	• weak electrolyte	• non-electrolyte

Electrolyte : when melted or dissolved in water, free ions are formed.

Free ions conduct electric current.

Weak Electrolyte : has a few free ions (weak conductor)

Strong Electrolyte : has a lot of free ions (strong / good conductor)

Non-Electrolyte : no free ions, doesn't conduct electricity.

↳ hydrocarbons : C_6H_{12}
Carbohydrates : $C_6H_{12}O_6$

Electrolytes : ionic compounds and polar covalent compounds.

During electrolysis, electric charges are carried within the solution by ions.

Electrolytic cell can be used to distinguish between metals and nonmetals.

Molarity & Dilution

molarity → $M = \frac{n}{V_L}$ ← number of moles; ← volume in litres

Dilution: adding water to a concentrated solution to make a diluted solution.

high concentration $\xrightarrow{H_2O}$ low concentration

$$M_1V_1 = M_2V_2$$

Equilibrium Constant

$K, K_c, K_a, K_b, K_p, K_{eq}$

K: products concentrations divided by reactants concentration (all raised to the power of their coefficients from the balanced equation).

Note: solids (s) and liquids (l) are not included

$$aA + bB \rightleftharpoons cC + dD$$

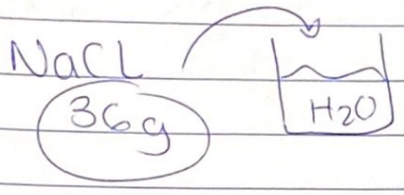
$$K = \frac{[C]^c \times [D]^d}{[A]^a \times [B]^b}$$

When the reactants and products are all gases then it can be expressed as pressure.

$$A_{(aq)} + B_{(g)} \rightleftharpoons C_{(s)}$$

$$k = \frac{1}{[A][B]}$$

Types of Saturation



100 mL H_2O max saturated

solubility: $\frac{36\text{ g NaCl}}{100\text{ mL } H_2O}$

* ↑ temp ↑ solubility
or colder

if you agitate a supersaturated solution, then it will crystalize.

- unsaturated solution: can dissolve more solute
- saturated solution: can't dissolve anymore solute
- supersaturated solution: dissolving more solute than it should.
- Solubility: the maximum amount of a solute dissolved in a solvent (making a saturated solution)
  ↳ the concentration of the saturated solution.

Solubility Product Constant (Ksp)

In case of Ksp, the reactants are ALWAYS solid.

ex: $Ag_2CrO_{4(s)} \rightleftharpoons 2Ag^+ + CrO_4^{2-}$

$$Ksp = \frac{[Ag^+]^2 + [CrO_4^{2-}]}{1}$$

ex: $Ag_2CrO_{4(s)} \rightleftharpoons 2Ag^+ + CrO_4^{2-}$

M — S — 2M — 2S — M — S

Acids and Bases

Acids
- ↳ have a sour taste
- ↳ causes color changes in plant dyes (litmus paper, blue → red)
- ↳ react with metals to produs H_2 gas:
  $2HCl + Mg \rightarrow MgCl_2 + H_2$
- ↳ react with carbonates and bicarbonates to give CO_2.

Base
- ↳ have a bitter taste
- ↳ causes color changes in plant dyes (litmus paper from red to blue)
- ↳ feels slippery (soap)

Acids react with bases to produce salt and water:
neutralization reaction

$$HCl + NaOH \rightarrow NaCl + H_2O$$

	Arrhenius	Bronsted
Acid	① a substance that contains H	
	② dissolves in water	Proton Donor
	③ ionizes to produce $H^+ (H_3O^+)$	
Base	① substances containing Hydroxide	
	② dissolves in water	Proton Acceptor
	③ ionizes in water to produce OH^-	

Strong acid or base : complete ionization.

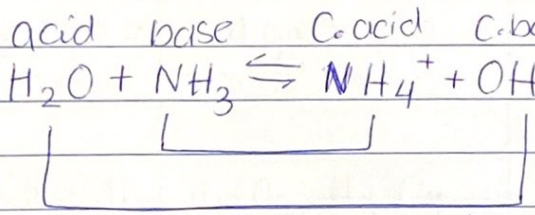
Weak acid or base : partial ionization.

Salt: ionic compound results from the reaction of an acid and a base.

types of salt	Acid	Base
Acidic	Strong	Weak
Basic	Weak	Strong
Neutral	Strong	Strong

Note:
- metal oxides aqueous solutions are basic eg: Na_2O, K_2O, CaO, MgO.
- nonmetal oxides aqueous solutions are acidic eg: CO, CO_2, NO_2, SO_2.

Complete neutralization of acid: loses all its hydrogens.
complete neutralization of base: loses all its hydroxides.



conjugate pair: $(H_2O, OH^-)(NH_3, NH_4^+)$

A conjugate acid: is a base with a hydrogen ion added to it.

A conjugate base: is what is left after an acid has donated a proton ← i think H^+

A conjugate pair: an acid and it conjugate base or a base with its conjugate acid

Strong acid or base : complete ionization
weak acid or base : partial ionization

Weak Bases	Weak acids	Strong bases	Strong acids
		$LiOH$	$HClO_4$
	CH_3COOH	$NaOH$	H_2SO_4
NH_3	$HCOOH$	KOH	HNO_3
	HF	$Ca(OH)_2$	HCl
		$Mg(OH)_2$	HBr
		$Ba(OH)_2$	HI

Brönsted-Lowry acid is defined as:
↳ proton donor.

Monoprotic Acids (Monobasic acids)	Diprotic Acids (Dibasic acids)	Triprotic Acids (Tribasic acids)
each unit of the acid yields one hydrogen ion upon ionization	each unit of the acid gives up to two H^+ ions.	yield three H^+ ions.
HCl, HNO_3, CH_3COOH, $HCOOH$, HBr, HF.	H_2CO_3, H_2SO_4.	H_3PO_4

after

COOH ← weak

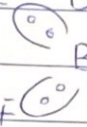
Monoacidic Base	Diacidic Base	Triacidic Base
each unit of the base yields one hydroxide ions upon ionization	each unit of the base yields two hydroxide ions upon ionization.	each unit of the base yields three hydroxide ions upon ionization.
$NaOH$, KOH, $LiOH$.	$Ca(OH)_2$, $Cu(OH)_2$	$Al(OH)_3$, $Fe(OH)_3$

Lewis acids and bases

Lewis acid : accepts electrons $\leftarrow e^-$

A) cations : Ag^{+}, Na^{+}, Mg^{2+}, NH_4^{+}

B) electron deficient compounds : BF_3, $BeMg_2$, $AlCl_3$



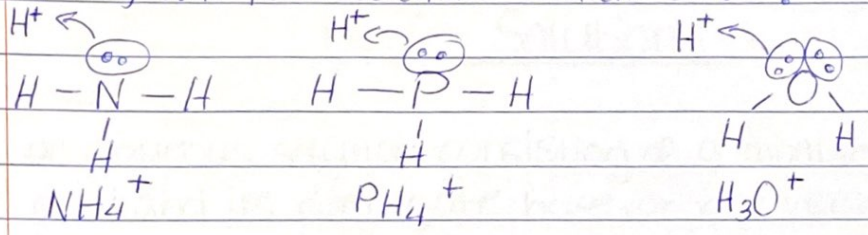
← if they are attatched to less than 4 atoms then it is electron deficient but it is still stable.

Lewis based : donates electrons $\rightarrow e^-$

A) anions : NO_3^{-}, SO_4^{2-}, Cl^{-}, O^{2-}

B) electron rich compounds : NH_3, H_2O, PH_3

! They will form coordinate covalent bonds !



NH_4^+ $\quad$ PH_4^+ $\quad$ H_3O^+

Hydrogen ions Concentration

$[H^+] = [OH^-]$ → neutral

$[H^+] > [OH^-]$ → acidic

$[H^+] < [OH^-]$ → basic

$[H^+] \times [OH^-] = 1 \times 10^{-14}$

pH and pOH

$[H^+] = 10^{-pH}$

$pH = -\log[H^+]$

$[OH^-] = 10^{-pOH}$

$pOH = -\log[OH^-]$

$pH + pOH = 14$

$pH = 7 \rightarrow$ neutral

$pH < 7 \rightarrow$ acidic

$pH > 7 \rightarrow$ basic

Buffer Solutions

an aqueous solution consisting of a mixture of weak acid and its conjugate base, or vice versa. It resists the change in pH when a small amount of strong acid or base is added to it.

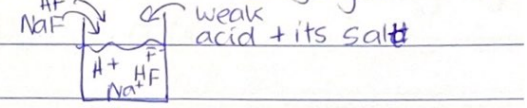
How to prepare it?

A) a mixture of a weak acid and its conjugate base

$HF + NaF$

$HCOOH + HCOONa$

$CH_3COOH + CH_3COOK$



B) a mixture of a weak base and its conjugate acid

$NH_3 + NH_4Cl$

$NH_3 + NH_4NO_3$

(ex) what is a buffer solution possibility?

aqueous solution of (weak acid + salt of this acid).

Titration

a common laboratory method that is used to determine the unknown concentration of an identified analyte by reacting with a standard solution.

moles of acid → $\frac{n_a}{a} = \frac{n_b}{b}$ ← moles of Base

a ← coefficient of acid

b → coefficient Base

Indicator: weak organic (acid or base) that changes color when the pH is changed.
↳ shows the end point.

Organic Chemistry

organic compound: contains carbon bonded to hydrogen.

organic compounds are:

1. Hydrocarbon: contains only carbon and hydrogen.
2. Hydrocarbon derivative: contains carbon bonded hydrogen and other atoms.

Types of Hydrocarbons only

General Formula	Type of C-C bond	compound	
C_nH_{2n+2}	Single	Alkane	C-C-C
C_nH_{2n}	all single with 1 double	Alkene	C-C=C
C_nH_{2n-2}	all single with 1 triple	Alkyne	C-C≡C

for Hydrocarbons ONLY

alkene: C_nH_{2n} hydrogen atoms double the carbon atoms

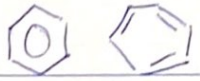
C_2H_4
C_3H_6
C_4H_8

alkane: C_nH_{2n+2} hydrogen atoms are double the carbon atoms plus two

C_2H_6
C_3H_8
C_4H_{10}

alkyne: C_nH_{2n-2} hydrogen atoms are double the carbon atoms minus three

C_2H_2
C_3H_4
C_4H_6

Aromatic Hydrocarbons  benzene ring

↳ contains benzene C_6H_6 or phenyle group C_6H_5

Aliphatic Hydrocarbons

↳ does not contain benzene

↳ could be saturated (all c-c bonds are single) alkane

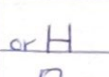
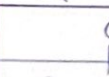
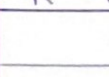
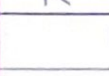
↳ could be unsaturated (contains C-C double or triple) alkene or alkyne

Alkyl group R : the remaining of an alkane after losing one H atom eg: CH_3- ← bond

Aryl group Ar : the remaining of a benzene ring after losing one H atom eg: C_6H_5-

Another Formula	alkyl	alkane	n. of carbon
–	CH_3-	CH_4	1
CH_3CH_2-	C_2H_5-	C_2H_6	2
$CH_3CH_2CH_2-$	C_3H_7-	C_3H_8	3
$CH_3CH_2CH_2CH_2-$	C_4H_9-	C_4H_{10}	4

Functional Groups

General Formula	Functional group Formula	Functional Group name	Group
R-X	-X (I, Br, Cl)	Halogen atom	halohydrocarbon
R-OH	-OH	Hydroxyl	alcohol
R-O-R	-O-	oxy	ether
or 		carbonyl	aldehyde
		carbonyl	ketone
		carboxyl -COOH	Carboxylic acid (weak organic acid)
		alkoxy carbonyl	ester -COOR
$R-NH_2$	$-NH_2$	amine	amine

★ What is the name of this ion ($-COO^-$):

$-COO^-$ carboxylate

$-COOH$ carboxyl

hydrocarbon — Derivative

$CH_4 \xrightarrow{-H} CH_3- \xrightarrow{+Cl} CH_3Cl$

CH_4 alkane — CH_3- alkyle group

the R's can be more than 1