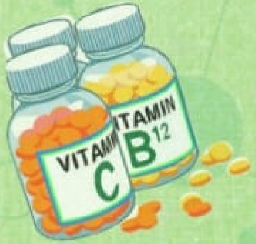
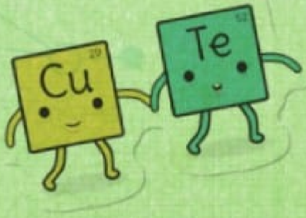
اسألني عن الهندسة 2020

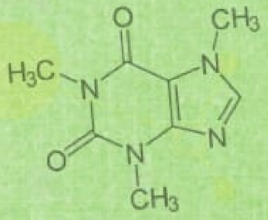
أهل الهمة

Chemistry 101

Dr. Wisam Helal







mass → الكتلة → كمية المادة → مقدار ما تحتوي الجسم من مادة
weight → efforce → قوة جذب الارض

matter (المادة)

Solid
↓
Fixed volume and shape
incomressible , rigid

Liquid
↓
Fixed volume put no Fixed shape , incomAressible.

gas
↓ change volume
put it comressible

Chapter one :- chemistry and measurement :- الكيمياء والقياس

⇒ How to deal with numbers
⇒ How to deal with units

* water boils at 100°C نستطيع التحكم بدرجة غليان الماء بالتحكم بالضغط الجوي
(فرضية)

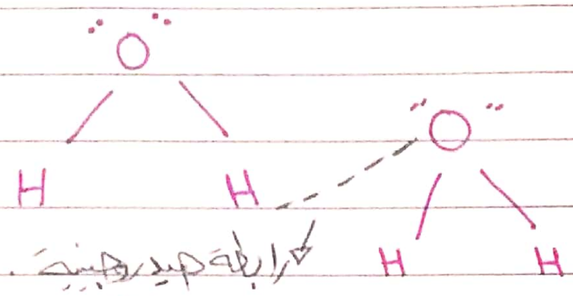
1) experiment تجربة
2) explanation (most important)
3) prediction تنبؤ
4) control تحكم

تفسير
*explanation → Hypothesis
→ Theory (نظرية)
→ Law (قانون)

example :- Hypothesis 1 : color X ((it's wrong put still a hypothesis))
(التوتر بين الجزيئات) [Inter moleculer forces]

Compound	color	IMF	B.p. (Boiling point)
H2O	colorLess	strong	100°C
Acetone	colorLess	weak	56°C
Nitro benzen	yellow	medium	88°C

كلما زادت قوة الرابطة تحتاج طاقة أكبر لكسرها

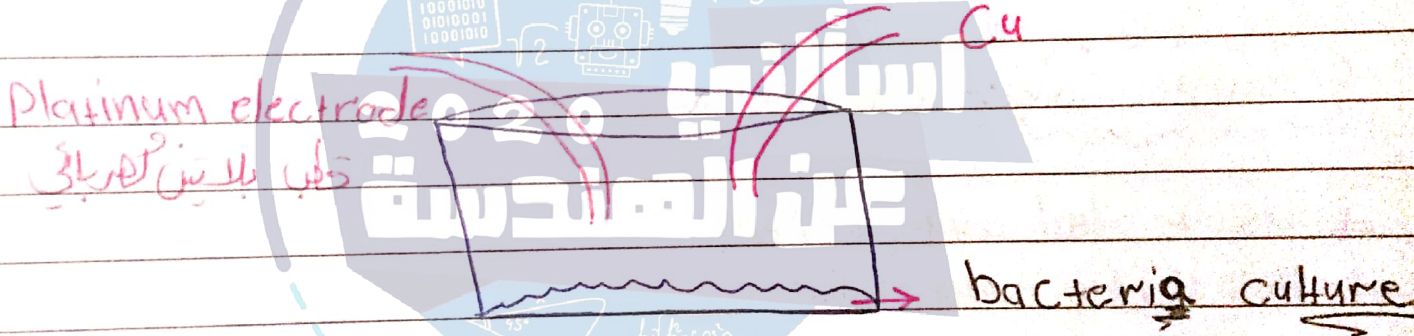


H → NOF

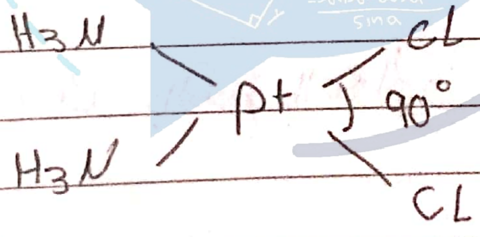
Hypothesis 1 → wrong

Hypothesis 2 → True

⇒ Bosenberg



≫ Cisplatin



ذرات عنصر مادة

atom → element → Matter

جدول التحويلات

#

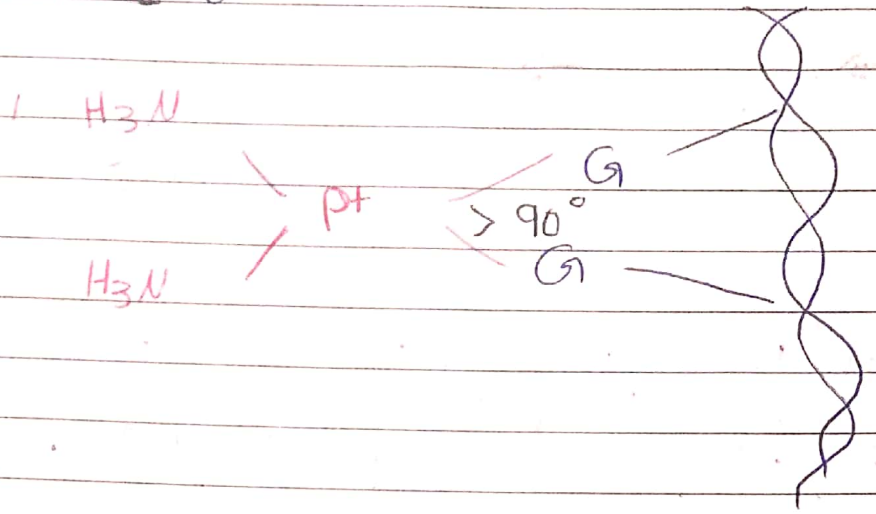
tera	giga	mega	Kilo	grame meter	deci	centi	milli	micro
T	G	M	K	g , m	d	c	m	μ
10^{12}	10^{9}	10^{6}	10^{3}	10^{0}	10^{-1}	10^{-2}	10^{-3}	10^{-6}

nano	pico
n	p
10^{-9}	10^{-12}

#

mL	L	10^{-3} L
μs	s	10^{-6} s
TJ	J	10^{12} J
K pa	pa	10^{3} pa
GW	W	10^{9} W

Introduction :-



※ مبدأين مهمين في الكيمياء :- ① مبدأ حفظ الكتلة
② مبدأ حفظ الطاقة

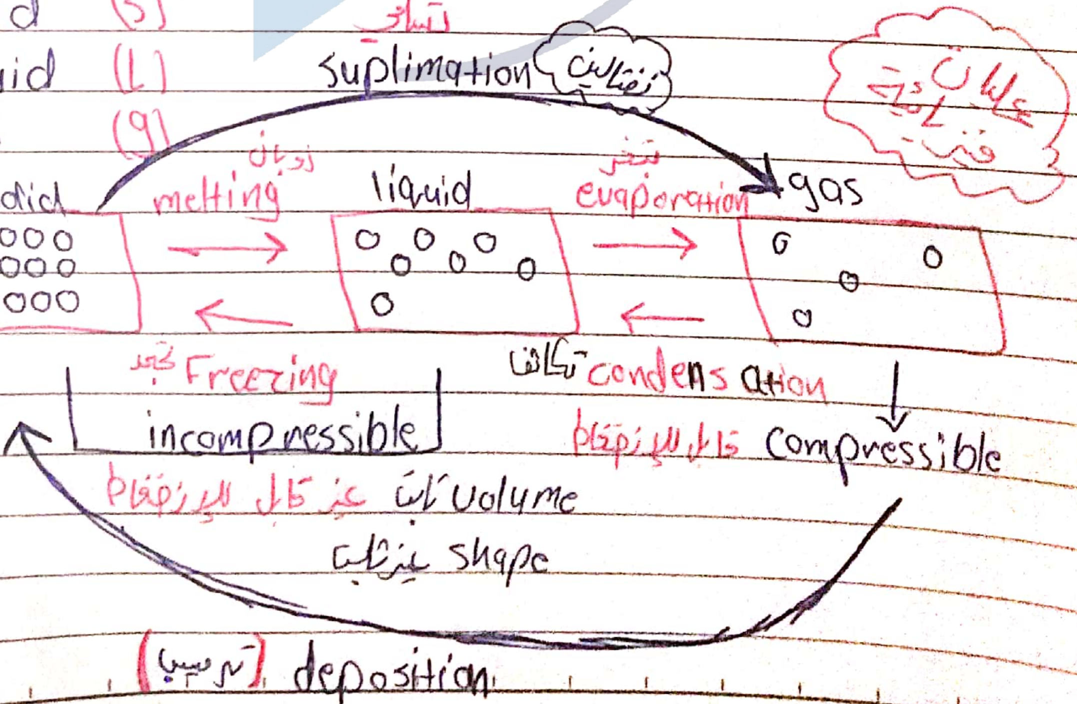
1.3 :- The Low of conservation of mass :-

$A + B \rightarrow C + D$

Beactors Products

1.4 :- Matter (اي شيء يشغل حيز وله كتلة)

① Solid (S)
② liquid (L)
③ gas (g)



ثوابت [Volume
shape

* Cannot move

كثافة density = $\frac{\text{mass}}{\text{volume}}$ كتلة / حجم

قياس

1.5 Measurement and significant figures.

ارقام معنوية

ز.ل

① 4.3 g ⇒ 2 significant figures

② 4.27 g ⇒ 3 significant figures

③ 4.268 g → الدقة ⇒ 4 significant figures

قياس الجهاز

الدقة ↑

0,000920100 → 6 significant figures.

* rules of counting significant fig

① any non-zero digit count as significant.

1.234 g → 4 sig. fig

② Zeros between non-zeros are significant.

3.07 → 3 sig. fig

③ Zeros on the left are not significant

0,08 L → 1 sig. fig

④ Zeros on the right with decimal point ⇒ significant

0,090 kg → 2 sig. fig

⑤ Zeros on the right without decimal point ⇒

400 cm

ثلاث [illegible] ; 8ح

① $4\,m \times \frac{100\,m}{1m} = 400cm = 4 \times 10^2 cm$

② $4,0 \times \frac{100m}{1m} = 400\ Cm = 4,0 \times 10^2\ cm$

③ $4,00 \times \frac{100m}{1m} = 400\ Cm = 4,00 \times 10^2\ cm$

* Significant figures as calculators:-

The result contains the some number of sig.fig as the measurement whith the Jeuest sig.fig

2,8 x 4,5039 = 12.61092 = 13 الاعتبار في الأصغر

هون one significant figures

$\boxed{1 \times 10^1}$ بل 10 خاطئ

* 2) Addition and Subtraction:-

The result has the same number of decimel places as the measurement with the fewest decimel places.

23.152 - 10.1 = 13.052 = 13.1

باخذ واحد بعد اقل عدد موجود بالأعداد

\# دائماً الخمسة تُقرّب للعدد الأعلى.

13,25 → 13,3

Example:- 1.2.d ⇒

= 4.18 - 58.16 x (3.38 - 3.01)

= 4.18 - 58.16 x 0.37

= 4.18 - 21.5192 → بالضرب تكون 2sig.fig

= -17.3392 لا تقرب

= -17 إلا في الأخير

فقط 2 sig.fig

حسب الأرقام يلي هي بالضرب

2 types of numbers :-

- Numpers of measured quantities.

- exact Numbers. يكون حتميا لا يخضع لدقة معينة

82 ⇛ 82,0 ≫ 82,000000

نفس الشيء

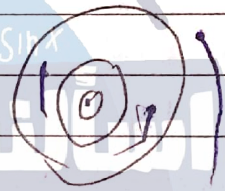
1m = 100 cm = 100,00cm ← مثال

Accurate

دقيق

Precise
but not accurate

متقاربة وغير دقيقة



not precise
nor accurate.

غير دقيقة وغير متقارب

1.6 SI units
↓
"International system of unit"

bese Units

length	M
mass	Kg
Temprature	K
time	S
elecric corrent	A
Amount of of substane mol	mol

10^{-1}	deci	10^{3}	Kilo	K
10^{-2}	centc	10^{6}		M
10^{-3}	melli	10^{9}		G
10^{-6}	micro (M)	10^{12}		T
10^{-9}	nano			
10^{-12}	pico			
10^{-15}	femto			

10^{-10} $\mathring{A}$

temperature →> Kelvin(K) is the SI unit of temperature.

$T(K) = T(C^\circ) + 273.15$

volume →> m^3 SI unit

>> $1L = 1 dm^3 = (1 \times 10^{-1} m)^3 = 10^{-3} m^3$

التحويل

$1m^3 = 10^3 dm^3$

>> $1 cm^3 = (10^{-2} m)^3 = 10^{-6} m^3$

>> $1 m^3 = 10^6 cm^3$

>> $1 cm^3 = mL$

density : - الكثافة

$density = \frac{mass}{volume} = \frac{Kg}{m^3} = \frac{g}{mL}$

Dimensional Analysis : (Factor Loled Method

$57.8 \cancel{m} \times \frac{100\ cm}{1 \cancel{m}} = 5780\ cm \rightarrow 5.78 \times 10^3\ cm$ تحول

exact number مضبوط مقاس

مالهاش علاقة sig fig

لازم يبقى 3 sig.fig

$1\ m = 10^2\ cm$

^1_1H Hydrojen

^2_1H Deeterium

^3_1H tritium

[illegible] [^{235}U Radioactive

3neutrun ^{238}U

^{60}Co

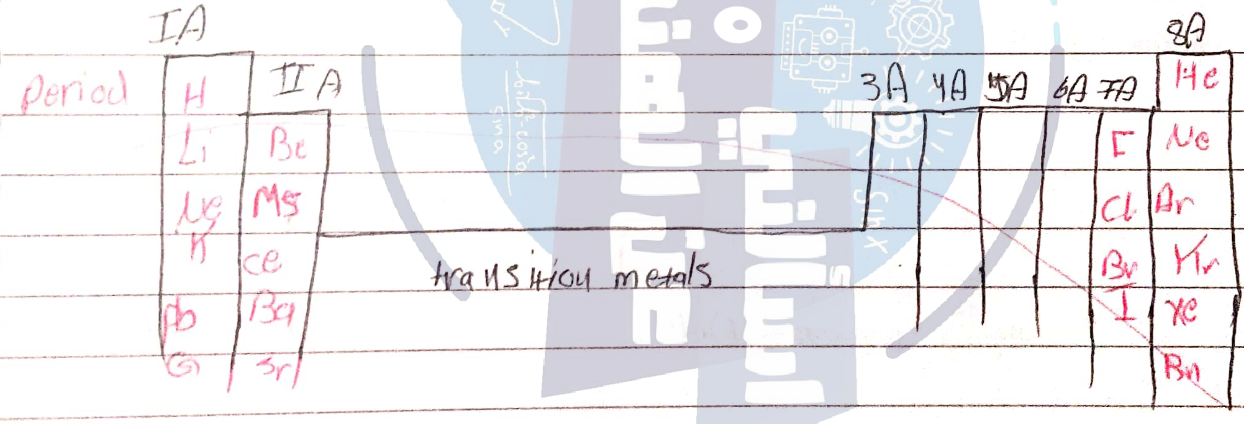
^{131}I → تشخيص

Nuclear medicine

Treatment Diagnosis

علاج وتشخيص

group



Alkali metals : Group 1A: Li, Na, K, Rb, Cs

Alkali earth metal (2A): Be, Mg, Ca, Ba, Sr

Halogens : (group 7A) F, cl, Br, I

Inert gases : (group 8A) : He, Ne, Ar, Kr Noble gases

[illegible]

Chemical Formulas :-

[1] Empenicel Formule : CH   الصيغة الأولية البسيطة

[2] Molecula Formule : C_6H_6

[3] Structuel Formule :

U.1

2.8 Naming Simple Compounds :-

Common name :- water , panacetamol

Scientific name :- Dihydrogen Oxide, N-acetol-pane-aminophenol

[1] Naming Ionic Compounds :-

-ve (anions) nonmetals

+ve (cations) metals

NH_4^+ → ammoniuem ion

H_3O → hydronium ion

Na^+ Sodium (Natrium)

K^+ Potassium (Halium)

Mg^{+2} magnesium

Al^{+3} Aluminum

N^{3-} → nitbide

P^{-3} → phosphide

C^{-4} → carbide

Si → silicide

F^- → Floride

Cl^- → Cloride

Br^- → Bromide

I^- → Iodide

O^{2-} → Oxide

S^{2-} → sulfide

$NaCL$: Sodium chloride
KBr : Potassium Bromide
PbI_2 : Led iodide
AL_2O_3 : Alominum oxide.
$NaOH$: Sodium hydroxide
KCN : potassium cyanide

P. 55 on the book
\# save the table

$FeCl_3$ Fe^{3+} : Iron(III) chloride

$FeCl_2$ Fe^{2+} : Iron(II) chloride

MnO manganese II oxide

Mn_2O_3 manganese III oxide

MnO_2 manganese IV oxide.

نأخذ الاسم الأول كما هو
والثاني كما اتعلمنا .

\## Molecular compounds :-

HCL : hydrogen chloride.
SiC : silicum carbide.

CO : Carbon monoxide
CO_2 : carbon dioxide

mono	1
di	2
tri	3
tetra	4
Penta	5
hexa	6
hepta	7
octa	8
nona	9

NO

NO_2

NO_3

N_2O

N_2O_4 di Nitrogen tetroxide

N_2O_5 di Nitrogen pentoxide.

Naming acids :-

an acid: gives H^{+1} when dissolved in water.

HCl → $HCl_{(aq)} \longrightarrow H^+_{(aq)} + Cl^-_{(aq)}$

↓ Hydrochloric acid

$HF_{(aq)}$	hydrofluoric acid
$HBr_{(aq)}$	hydroBromic acid
$HI_{(aq)}$	hydroiodic acid
$HCN_{(aq)}$	hydrocyanic acid

Oxo acids: ⇥ احماض الاكسجينية

HXO_n

$HClO$	hypochloreus acid
$HClO_2$	Chloreus acid
$HClO_3$	chloric acid
$HClO_4$	perchloric

HFO_3	Flouric acid	HNO_3	nitric acid
$HClO_3$	Chloric acid	H_2SO_4	sulfuric acid
$HBrO_3$	Bromic acid	H_3PO_4	phosphoric acid
HIO_3	iodic acid		
H_2CO_3	Carbonic acid		

1) The addition of 1 O atom to the ref "per ___ ic"

$HClO_4$ → per chloric acid

2) The removel of 1 O atom from the reference. "___ ous"

HNO_2 → nitrouse acid

3) Removel of 2 O atoms from the ref "hypo ___ ous"

$HBrO$ Hypobromous acid

$HCl_{(aq)} \rightarrow H^+ + Cl^-$

$HClO_3 \rightarrow H^+ + ClO_3^-$

Oxoanions :-

Rules of naming oxoanions :-

1) when all H^+ ions are removued from " per ___ ic" ↓ " per ___ ate"

$HClO_4$: perchloric acid

ClO_4^- : Per chlorate

2) when all H^+ are removued from " ___ ice" ⇒ " ___ ate"

H_2CO_3 : Carbonic acid

CO_3^{-2} : Carbonate

3) when all H^+ ions are removued from " ___ ous" ⇒ " ___ ite"

$HClO_2$: chlorous acid

ClO_2^- : chlorite

④ when all H^+ ions are removed from " hypo ~~~ ous"

⇒ " hypo ___ ite "

$HClO$: hypochlorous

ClO^- : hypochlorite

5) when some H^+ are removed .

\# H_3PO_4 : phosphoric acid

\# $H_2PO_4^-$: dihydrogen phosphate.

\# HPO_4^{2-} : hydrogen phosphate

\# PO_4^{3-} : phosphate

HCO_3^- : Hydrogen Carbonate ≫ bicarbonate

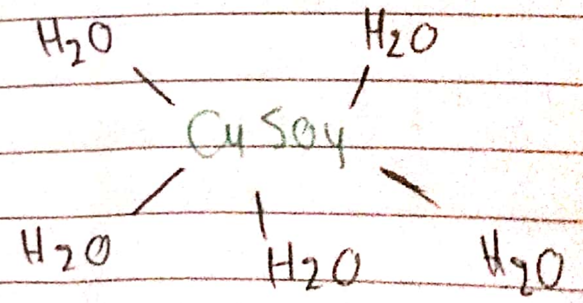
HSO_4^- : Hydrogen Sulfate ≫ bisulfate

$KHCO_3$: potassium bicarbonate.

مراجعة الجدول
p. 55

~~(4) Hydrates~~

$CuSO_4$: Copper(II) sulfate



$CuSO_4 \cdot 5H_2O$

Copper (II) sulfate pentahydrate.

$$CuSO_4 \cdot 5H_2O \xrightarrow{heat} CuSO_4 + 5H_2O$$

$\underbrace{\text{blue crystals}}_{\text{hydrated form}}$ $\underbrace{\text{white powder}}_{\text{anhydrous}}$

$BaCl_2 \cdot 2H_2O \rightarrow$

$LiCl \cdot H_2O \rightarrow$

$MgSO_4 \cdot 7H_2O \rightarrow$

2.9 writing chemical Equations.

Reactents → products

2.10 Balancing chemical Equations

$$\underbrace{\underset{\text{Reactants}}{2H_2(g) + O_2(g)} \rightarrow \underset{\text{Products}}{2H_2O(g)}}_{\text{Reagents}}$$

تفاعل احتراق (Combustion:)

#$C_2H_6 + O_2 \rightarrow CO_2 + H_2O$

ودائما عندما تحترق المادة العضوية ينتج $H_2O + CO_2$

① $C_2H_6 + O_2 \rightarrow 2CO_2 + H_2O$

② $C_2H_6 + \frac{7}{2}O_2 \rightarrow 2CO_2 + 3H_2O$

موزونة.

مجموعات نحفظها
أيونية - لازم
ونخشها

NH_4^+	Ammonium		
NO_2^-	Nitrite	NO_3^-	Nitrate
SO_3^{-2}	Sulfite	SO_4^{-2}	Sulfate
PO_3^{-3}	phosphite	PO_4^{-3}	phosphate
CrO_4^{-2}	chromate	$Cr_2O_7^{-2}$	Dichromate
MnO_4^-	permanganate	MnO_4^{-2}	Manganate
CN^-	Cyanide	SCN^-	Thiocyanate
H_3O^+	Hydronium	OH^-	Hydroxide
$S_2O_3^{-2}$	Thiosulfate	CO_3^{-2}	Carbonate
H^-	Hydride	O_2^{-2}	peroxide
HPO_4^{-2}	hydrogen phosphate	$H_2PO_4^-$	dihydrogen phosphate
$CH_3CO_2^-$	Acetate	$C_2O_4^{-2}$	Oxalate
HCO_3^-	Hydrogen Carbonate bicarbonate	HSO_4^-	Hydrogen sulfate bisulfate

---

FO^-	hypofluorite	ClO^-	hypochlorite	BrO^-	hypobomite
FO_2^-	fluorite	ClO_2^-	chlorite	BrO_2^-	bromite
FO_3^-	fluorate	ClO_3^-	chlorate	BrO_3^-	bromate
FO_4^-	perfluorate	ClO_4^-	perchlorate	BrO_4^-	prebromate

IO^-	hypoiodite
IO_2^-	iodite
IO_3^-	iodate
IO_4^-	Preiodate

إغريقية

\# mono → 1 di → 2 tri → 3 tetra → 4 pent → 5 hexa → 6

hept → 7 octa → 8 nona → 9 dica → 10

في حالة لافلز + لافلز

أسماء شائعة
لمركبات تساهمية

H_2O water CH_4 Methane NH_3 Ammonia

PH_3 Phosphine H_2S Hydrogen sulfide SiH_4 Silane B_2H_6 Diborane

كعنصر انتقالي
إذا كان يحيد
شحنته
II

2.4 Atomic weights:-

Mass → kg   weight → N

Atomis mass → the total messes of the particle composing an atom. [units : amu : atomic mass unit]

~~1 amu~~ $1\ amu = \frac{1}{12}$ of ^{12}C

↑ exact

$1\ ^{12}C = 12\ amu$

Example Experiment have shown that a H atom is 8.400 % of the mass of ^{12}C. Calculate atomic mass of H in amu

$12\ amu \times \frac{8.400}{100} = 1.008\ amu$

Examples:-

^{12}C : 12 amu . 98.90%

^{13}C : 13.003358 amu . 1.10 %

$$\text{average atomic mass} = \left[12 \times \frac{98.90}{100}\right] + \left[13.0033.5 \times \frac{1.10}{100}\right]$$

$= 12.07$ → موجود في بالجدول الدوري

Mass spectrometer :- الجهاز مطياف الكتلة

Chapter : 3 :- ~~[illegible]~~ Calculations with chemical Formulas and Equations :-

$H_2O = 2 \times 1.008$ amu $+ 1 \times 15.999$ amu

$= 18.016$ amu

molecular weight = total weight of the atoms composing molecule.

Stoichiometry :-

3.2 The mole concept :-

The mole (SI mole) is the amount of substanse that Contains as many elementary entities (atoms, moleculely ions, electrons, Protons, ...) as there are atoms in exactly 12 g of ^{12}C isotopes (0.012 Kg)

عدد أفوجادرو

$N_A = 6.02 \times 10^{23}$ mol^{-1} $= \dfrac{1}{mol}$] ن.أ

عدد أفوجادرو

The mass of 1 mol of C = 12.01 $\dfrac{g}{mol}$

\# 1 mol of ^{12}C = $12 \frac{g}{mol}$ \# 1 mol of C = $12.01\ g \cdot mol^{-1}$

\# 1 atom of ^{12}C = 12 amu \# 1 atom of C = 12.01 amu

$\boxed{12\ g \cdot mol^{-1}}$

H_2O molecule 18.0159 amu

the moler mass of H_2O = $18.0159 \frac{g}{mol}$

mole ← الرابط بين الرقم والكتلة »

no mass

$\text{عدد المولات} = \frac{\text{الكتلة}}{\text{الكتلة المولية}}$

$\boxed{n = \frac{m}{M}}$

n: amount of substance (no. of moles) mol

m: mass g

M: moler mass $\frac{g}{mol}$

\# mol = $\frac{\cancel{g}}{\frac{\cancel{g}}{mol}}$ = mol

\# $\boxed{N = n N_A}$

عدد افوجادرو

$= \cancel{mol} \times \frac{1}{\cancel{mol}}$

Example 8- How many atoms are there in 25.1 g of S ?

تجريبي

S → $n = \frac{m}{M}$ = [illegible]

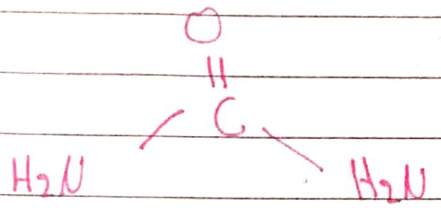
$\frac{25.1\ g}{32.07\ g}$ = 0.78266 mol = 0.783 mol

من الجدول الدوري

بال s.f

$N = n N_A = (0.783\ \cancel{mol}) \times (6.02 \times 10^{23}\ \cancel{mol^{-1}}) = 4.72 \times 10^{23}$ atoms \#

Example:- How many H atoms are present in 43.8 g of urea $(NH_2)_2CO$



1 molecule of urea $\longrightarrow$ 4 atoms of H

1 mole of urea $\longrightarrow$ 4 moles of H

$$n_{urea} = \frac{m}{M} = \frac{43.8\ \cancel{g}}{60.06\ \frac{\cancel{g}}{mol}} = 0.729\ mol$$

$$n_H = 4 \times 0.729\ mol = 2.92\ mol\ of\ H$$

$$N_H = n N_A = (2.92\ mol)(6.02 \times 10^{23}) = 1.76 \times 10^{24}\ atome$$

what is the mass of cl atom in g

$$M = 35.5\ \frac{g}{mol} \qquad \frac{M}{N_A} = \frac{35.5\ g\cdot \cancel{mol^{-1}}}{6.02 \times 10^{23}\ \cancel{mol^{-1}}} = 5.90 \times 10^{-23}\ g$$

3.3 Mass percentages from Formulas:-

$$\%\ Element = \frac{m\ of\ the\ element}{m\ of\ the\ compound} \times 100\%$$

$$\boxed{m = nM}$$

$$= \frac{n M\ of\ the\ element}{1 M\ of\ the\ compound} \times 100\%$$

n of compound is assumed to be 1

H_2O_2

$$\%H = \frac{2 \times 1.008 \cancel{\frac{g}{mol}}}{1 \times 34.02 \cancel{\frac{g}{mol}}} \times 100\% = 5.926\% \ \#$$

$$\%O = \frac{2 \times 16.00 \cancel{\frac{g}{mol}}}{34.02 \cancel{\frac{g}{mol}}} = 94.06\%$$

3.4 Eelemented Analysis :-

Percentages of C, H, O

مادة عضوية

$$\underset{C, H, O}{\text{Organic matter}} + O_2 \longrightarrow \underset{mass}{CO_{2(g)}} + \underset{mass}{H_2O_{(g)}}$$

نواتج احتراق #

Example :- 3.9 a compound Contain C, H, O.
4.24 mg of this compound is completely burned
It gives 6.21 mg of CO_2 and 2.54 mg H_2O.
what is the mass percentage of each element ?

التحويل لـ g — الكتلة المولية

[1] $\underline{C}$:

$$6.21 \times 10^{-3} \text{ g } CO_2 \times \frac{mol\ CO_2}{44.0 \text{ g}} \times \frac{1 \text{ mol } C}{1 \text{ mol } CO_2} \times \frac{12.01 \text{ g } C}{mol}$$

$$= 1.69 \times 10^{-3} \text{ g} = C \ \#$$

[2] $\underline{H}$:

$$2.54 \times 10^{-3} \text{ g } H_2O \times \frac{1 \text{ mol}}{18.0 \text{ g}} \times \frac{2 \text{ mol } H}{1 \text{ mol } H_2O} \times \frac{1.008 \text{ g}}{mol}$$

$$= 2.85 \times 10^{-4} \text{ g}$$

mass % C = $\frac{1.69 \times 10^{-3}\ g}{4.24 \times 10^{-3}\ g} \times 100\% = 39.9\%$

mass % H = $\frac{2.85 \times 10^{-4}\ g}{4.24 \times 10^{-3} g} \times 100\% = 6.72\%$

mass O% = $100\% - (39.9 + 6.72) = 53.4\%$

<< مابيجي مثلة >>

3.5 : Determing Formulas

Example :- Compound composed of 40.92 % C 4.58% H , and 54.50 % O . Calculate empenical formula .

assume : نفرض 100 g of sample

$n_C = \frac{40.92\ g}{12.01\ g.mol^{-1}} = 3.407$ mol C

$n_H = \frac{4.58\ g}{1.008\ g.mol^{-1}} = 4.54$ mol H

$n_O = \frac{54.50\ g}{16.00\ g.mol^{-1}} = 3.406$ mol O

اقسم عاقل عدد مولي

$C_{3.407}\ H_{4.54}\ O_{3.406}$

$C = \frac{3.407}{3.406} = 1$

$H = \frac{4.54}{3.406} = 1.33$

$O \quad \frac{3.406}{3.406} = 1$

$C_1 H_{1.33} O_1$

×2 $\rightarrow C_2 H_{2.66} O_2$

×3 $\rightarrow C_3 H_{3.99} O_3$

×100 $\rightarrow C_{100} H_{133} O_{100}$

قوة واحدة

$\boxed{C_3 H_4 O_3}$

↓

emperical

Emperical Formula → Molecular Formula

Molar mass : Mass spectrometer

\# N O Emperical Formula : NO_2

\# Molar mass = 92 [Molar mass Emp. Furmula $(1 \times 14 + 2 \times 16) = 46 \ g.mol^{-1}$

$n = \frac{92}{46} = 2 \Rightarrow N_2O_4$

3.6: Molecular Interprectation of chem. Eq.

$$N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$$

3.7 Amount of substances of chem. Reactions.

Example

$$2Li_{(s)} + 2H_2O_{(l)} \longrightarrow 2LiOH_{(aq)} + H_{2(g)}$$

? How many grams of Li are needed to produce. 7.79 g of H_2 ?

S8- $n_{H_2} = \frac{m_{H_2}}{M_{H_2}} = \frac{7.79 g}{2.02 \frac{g}{mol}} = 3.86$ mol

2 mol Li ⟶ 1 mol H_2 = 7.72 mol of Li

?? ⟶ 3.86 حولها لg

mass of Li = nM = $1.72 \cancel{mol} \times 6.941 \frac{g}{\cancel{mol}}$ = 53.6 g of Li

الطريقة الأخرى $3.86 \text{ mol } H_2 \times \frac{2 \text{ mol } Li}{1 \text{ mol } H_2} = 7.79 \text{ mol of } Li$

3.8 : Limiting Reagent :-

المادة التي تنفذ أسرع والتي تعطي نتائج أقل

$2H_2(g) + O_2(g) \longrightarrow 2H_2O(l)$

2 molecules H_2 1 mole O_2 $2H_2O$ molecule

$\underbrace{\text{10 molecules } H_2}_{L.R}$ $\underbrace{\text{10 molecules } O_2}$ 10 H_2O molecule

كل ال H_2 بتتفاعل ←   L.R

5 تتفاعل فقط

5 ويتبقى

Exeess . R

$2H_2(g) + O_2(g) \longrightarrow 2H_2O(l)$

$\underbrace{\text{6 moles } H_2}_{L.R}$ $\underbrace{\text{4 moles } O_2}_{Excess}$ $\longrightarrow$ 6 moles H_2O

Example

يوريا

$$2\,NH_3\,(g) + CO_2\,(g) \longrightarrow (NH_2)_2CO(aq) + H_2O\,(l)$$

849.2 (g) of NH_3 reacted with 1223 (g) of CO_2.

- [a] Find the L.R
- [b] Calculate the mass of the urea formed.
- [c] How much excess reagent (in grams) is left of the end of the reaction.

a) $n_{NH_3} = \dfrac{849.2\,(g)}{17.03\ g \cdot mol^{-1}} = 49.87$ mol NH_3

b) $n_{CO_2} = \dfrac{1223\ g}{44.01\ g \cdot mol^{-1}} = 27.79$ mol CO_2

$n_{CO_2} = 27.79$ mol CO_2 ~~urea~~

$n_{urea} = \dfrac{49.87}{2} = 24.93$ mol urea

L.R

$mass_{urea} = nM = (24.93\ mol)\left(60.06\ \dfrac{g}{mol}\right)$

$= 1497$ g of urea

c) 126 g of excess CO_2

$$\boxed{\text{Percentage Yield} = \dfrac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100\ \%}$$

Chapter 4

« Chemical Reactions »

4.1

Reaction in Aqueous Solutions:-

4.1 : Ionic Theory of solutions and solubility Rules:

A solution = homogeneous mixture.

Solution → solvent : large quantities الأكبر

Solution → solute : smaller qantities الأقل

Aq. Soln = solvent : H_2O

① # Electrolytes

$NaCl_{(s)} \xrightarrow{H_2O} Na^+_{(aq)} + Cl^-_{(aq)}$

يتأين ويوصل الكهرباء

HCl

② # weak Electrolyte

↓

قاعدة ضعيفة $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

$CH_3COOH \overset{+H_2O}{\rightleftharpoons} CH_3COO^- + H_3O^+$

حمض ضعيف

③ # Non electrolytes

$C_6H_{12}O_6$

Solution → محلول

solute → مذاب

solvent → مذيب

Solubility :- ذائبية

weak Electrolyte ء الكا جزئياً
Non electrolyte ء عدمياً

$K_w = 1 \times 10^{-14}$

Rule :	Apples	Solubility	Exceptions
①	Li^+, ~~Ne~~$^+$, K^+, NH_4^+	soluble	—
②	CH_3COO^-, NO_3^-	soluble	—
③	Cl^-, Br^-, I^-	soluble	Ag^+, Pb^{+2}, Hg_2^{+2}
④	SO_4^{-2}	soluble	Ag^+, Pb^{+2}, Hg_2^{+2}, Ca^{+2}, Ba^{+2} Sr^{+2}
⑤	CO_3^{2-}	Insoluble	Li^+, Na^+; K^+, NH_4^+
⑥	PO_4^{3-}	Insoluble	Li^+, Na^+, K^+, NH_4^+
⑦	S^{-2}	Insoluble	Li^+, Na^+, K^+, NH_4^+
⑧	OH^-	Insoluble	Li^+, Na^+, K^+, NH_4^+, Ca^{+2}, Ba^{+2} Sr^{+2}

دائماً ذائباً $C_2H_3O_2^-$

4.2 Molecular and Ionic Equations:-

Molecular equation → $Ca(OH)_{2(aq)} + Na_2CO_3\,(aq) \rightarrow CaCO_3\,(s) + 2\,NaOH(aq)$

Ionic Equation → $Ca^{+2}(aq) + \boxed{2(OH^-)(aq)} + \boxed{2\,Na^+(aq)} + CO_3^{-2}(aq) \rightarrow CaCO_3(s) + \boxed{2\,Na^+(aq)} + \boxed{2OH^-(aq)}$

دخل وطلع زي ما هو ما تفاعل ولا داخل بالمعمعة

Spectator ions
ايونات متفرجة

Net Ionic Equation → $Ca^{+2}(aq) + CO_3^{2-}(aq) \rightarrow CaCO_3\,(s)$

4.3 : Precipitation Reactions:- تفاعلات الترسيب

بنوول ↖ $Pb(NO_3)_2\,(aq) + 2\,KI\,(aq) \rightarrow PbI_{2(s)} + 2\,KNO_3(aq)$

Double exchange ↗

$\downarrow$ precipitate

Metathesis reactions

Net ionic $Pb^{+2}(aq) + 2\,I^-(aq) \rightarrow PbI_{2(s)}$

4.4

Acid - Base Reactions :-

most drugs very weak bases

Acid : H^+ donor in H_2O
Base : OH^- donor in H_2O] # Arhenious Definition.

Bronsted Lowry definition

Acid : proton donor.
Base : Proton acceptor.

$$\underbrace{HCl_{(aq)}}_{acid} + \underbrace{H_2O_{(l)}}_{base} \longrightarrow Cl^-_{(aq)} + H_3O^+_{(aq)}$$

$$HCl_{(aq)} \longrightarrow Cl^-_{(aq)} + H^+_{(aq)}$$

H_2O : $\boxed{\text{Amphiprotic}}$

Monoprotic acids :-

HCl
HNO_3
CH_3COOH

Diprotic acids

tri Protic acid

$$\underbrace{H_2SO_4 \qquad\qquad H_3PO_4}_{\text{Poly protic acids}}$$

$H_2SO_4(aq) \rightarrow HSO_4^-(aq) + H^+(aq)$
$HSO_4^-(aq) \rightleftarrows SO_4^{-2}(aq) + H^+(aq)$

$H_3PO_4(aq) \rightleftharpoons H^+(aq) + H_2PO_4^-(aq)$
$H_2PO_4^-(aq) \rightleftharpoons H^+ + HPO_4^{2-}(aq)$
$HPO_4^{-2} \rightleftharpoons PO_4^{3-}(aq)$

Acid - Base Neutralization:- تفاعلات التعادل

$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O$

Net equation. $H^+(aq) + OH^-(aq) \rightarrow H_2O$

$HCN(aq) + NaOH(aq \rightarrow H_2O + NaCN(aq)$

$HCN(aq) + OH^-(aq) \rightarrow CN^-(aq) + H_2O(l)$

4.5 Oxidation Reduction Reactions.

Redox اختصار

1. Acid-Base Reaction: proton transfer
2. Redox Reaction: electron transfer

reduction

$$2\overset{0}{Ca}_{(s)} + \overset{0}{O}_2{}_{(g)} \longrightarrow 2\,\overset{2+}{Ca}\overset{2-}{O}_{(s)}$$

Oxidation

Oxidation: loss of electrons or (increase in the Oxidation State)

reduction: gain of electrons or (decrease in the OX. St).

Oxidating agent : O_2

reducing agent : Ca

4.4

Alkoli metals 1+

Alkoline Earth metals 2+

Al 3+

O 2- (Except H_2O_2 : O → 1-)

H 1+ (Except with metals (-) LiH, NaH, CaH_2

Halogens

Ionic compounds : 1-

$H\overset{1+}{Cl}O$

$H\overset{3+}{Cl}O_2$

$H\overset{5+}{Cl}O_3$

$H\overset{7+}{Cl}O_4$

Some Common Redox Reactions:-

[1] Combination Reaction.

تركيب $\overset{0}{S}(s) + \overset{0}{O_2}(s) \rightarrow \overset{4+\;2-}{SO_2}(s)$

[2] decomposition Reaction.

$2\overset{2+\;2-}{HgO}(s) \rightarrow 2\overset{0}{Hg}(l) + \overset{0}{O_2}(g)$

oxidation

Reduction

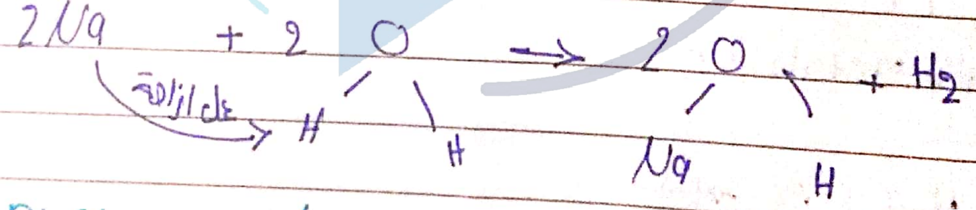
[3] Combusition Reaction.

$C_3H_8(s) + 5O_2(s) \rightarrow 3CO_2(s) + 4H_2O(g)$

[4] Displacement Reaction:

4.1 Hydrogen displacement:

$2\overset{0}{Na}(s) + 2\overset{1+\;2-}{H_2O}(l) \rightarrow 2\overset{1+\;2-\;1+}{NaOH}(aq) + \overset{0}{H_2}(g)$



4.2 Metal Displacement:-

$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$

↓ oxidation. ↓ reduction

$ZnSO_4 + Cu \rightarrow X$

لايحدث تفاعل

4.3 Halogen Displacement:-

$$\underbrace{Cl_{2(g)} + \overbrace{2KBr_{(aq)} \rightarrow 2KCl_{(aq)} + Br_{2}}^{}}_{} (l)$$

oxidation

Reduction.

$F_2 > Cl_2 > Br_2 > I_2$

F (g)
Cl (g)
Br (l)
I (s)

consentrations:-

4.7 4.i Molar. :-

$$Molarity\ (M) = \frac{n\ solute}{V\ solution\ (L)}$$

$$\boxed{\frac{n}{M \cdot V}}$$

n : amount of substance (mol) مولات المذاب

V : volume of Soln (L) حجم المحلول

$M : \frac{mol}{L} = Molar (M)$ التركيز

1 mole of NaCl in 1 L of soln.

$M = \frac{1}{1} = 1\ Molar.$

Molar consentration is an intensive property. (M, T, d)

لا تعتمد على الكمية

تركيز حرارة كثافة

تعتمد على الكمية Extensive Properites (m, V, E)

كتلة حجم مساحة

Example 8- A chemist needs to add 4.07 g of glucose. calculate the volume in mL of a 3.16 M glucose solution should be added.

$$n = \frac{m}{M} = \frac{4.07\ g}{180.2\ \frac{g}{mol}} = 2.26 \times 10^{-2}$$

$$M = \frac{n}{V} , \quad V = \frac{n}{M} = \frac{2.26 \times 10^{-2}\ mol}{3.16\ \frac{mol}{L}} = 0.00715\ L$$

$$0.00715\ L \times \frac{1000\ mL}{1\ L} = \underline{7.15\ mL}$$

4.8 Diluting solutions:

$n_1 = n_2$

$n_i = n_f$

$$\boxed{M_i V_i = M_f V_f}$$

Examples- Describe how would you prepare 2.50×10^2 mL of a 2.25 M H_2SO_4 solution, starting from a 7.41 M stock solution of H_2SO_4.

$M_i V_i = M_f V_f$

انتبهي للوحدات

$$\left(7.41\ \frac{mol}{L}\right) V_i = \left(2.25\ \frac{mol}{L}\right)\left(2.50 \times 10^2\ mL\right)$$

$$V_i = \frac{2.25\ mol/L}{7.41\ mol/L} \times 2.50 \times 10^2\ mL = \boxed{75.9\ mL}$$

4.9 /
4.10 /

تحليل نوعي

Gravimetric Analysis } Quamtitative Analysis.
Volumetric Analysis

$\boxed{4.9}$ Example :- A 0.7077 g sample of an ionic compound containing Cl^- and an unknown metal is dissolude in an excess $AgNO_{3(aq)}$ solution.
If 1.3602 g of AgCl precipitate forms, what is the mass persen of Cl in the sample.

$n_{AgCl} = \frac{m}{M} = \frac{1.3602\ g}{143.49\ \frac{g}{mol}} = 9.485\times10^{-3}$ mol of AgCl = 9.485×10^{-3} mol of Cl

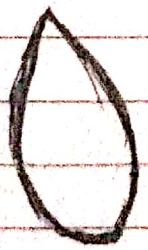
$m_{Cl} = nM = (9.485\times10^{-3}\ mol)(35.45\ \frac{g}{mol}) = 0.3362\ g$

mass % Cl = $\frac{0.3362\ g}{0.7077\ g} \times 100\% = 47.51\%$

4.10 Volumetric analysis :-
- Acid-Base Titration → [illegible]

Ж Eng. Mais Al-MKawi.

Ж Dr. Wessam Hlal.



Example :- An unknown quentity of HCl(aq) we titoured 0.207 M of NaOH(aq). If it takes 4.47 mL of NaOH to complete the rxn what is the mass of HCl.

← هذا صحيح في بعض الامثلة ليس تعميما. $n_b = n_a$

$$V_{base} \rightarrow n_{base} \rightarrow n_a \rightarrow m_{a\,HCl}$$

$$4.47 \times 10^{-3}\ \cancel{L\ NaOH} \times \frac{0.207\ \cancel{mol\ NaOH}}{1\ \cancel{L\ NaOH}} \times \frac{1\ \cancel{mol\ HCl}}{1\ \cancel{mol\ NaOH}} \times \frac{36.5\ g}{1\ \cancel{mol\ HCl}}$$

$= 0.0338\ g$

<< Chapter "5" >>

Gases :-

[Ar, He, Ne, Kr, H_2, O_2, O_3, N_2, F_2, Cl_2, NO, NO_2, N_2O, N_2O_4, N_2O_5, CO, CO_2, SO_2, SO_3.

gas at normal conditions → 25 C°
→ 1 atm

دستور المتغيرات بتاعهم.

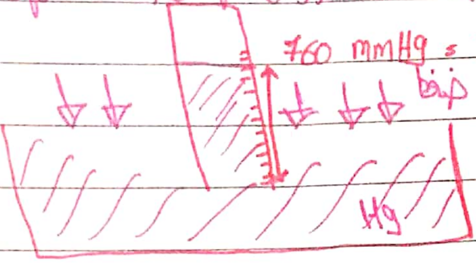
ضغط	P
حجم	V
الحرارة	T
عدد المولات	n

5.1 :- Gas Pressure and its measurment :

$$\boxed{P = \frac{F}{A}} = \frac{N}{m^2} = pascal = (Pa)$$

→ SI unit

1) Measuring Atmospheric Pressure : (Barometer)



at sec lead
at 0°C

* كلما زاد الضغط ارتفع المستوى بالأنبوب والعكس صحيح.

$\boxed{1 \text{ atm} = 101325 \text{ Pa}}$

1 torr = 1 mmHg
1 atm = 760 torr

Hg → Heavy metals
سام جداً لا يستطيعوا التخلص منه

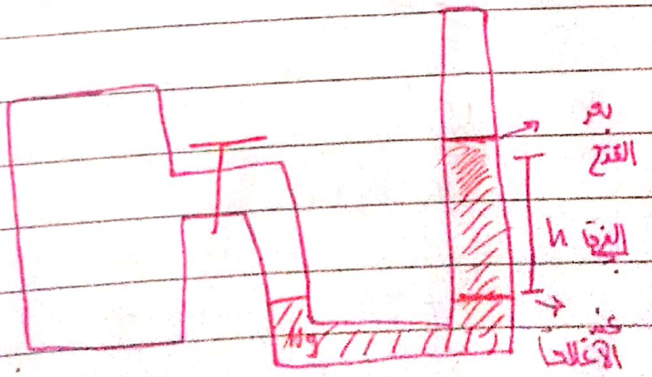
اخترنا Hg لأنا كثافته أعلى ولا يمكن ضغطها

* Hg * H₂O

$13 \frac{g}{mL}$ $1 \frac{g}{mL}$

$13 \frac{Kg}{L}$ $1 \frac{Kg}{L}$

2) Measuring presure of a gas in a containes:-



sphygmomanometer:

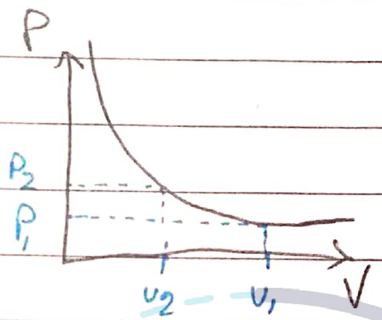
$\frac{120}{80}$ $\frac{mm\,Hg}{mm\,Hg}$

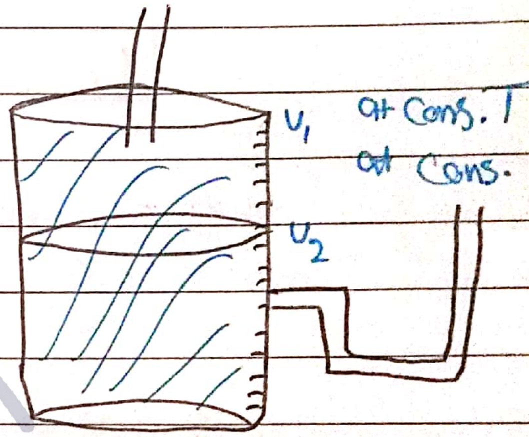
5.2 Emperical Gas laws :-

① pressure - volume Relationship [Boyl's Lawr]

$P \propto \frac{1}{V}$

$P = \frac{K}{V}$



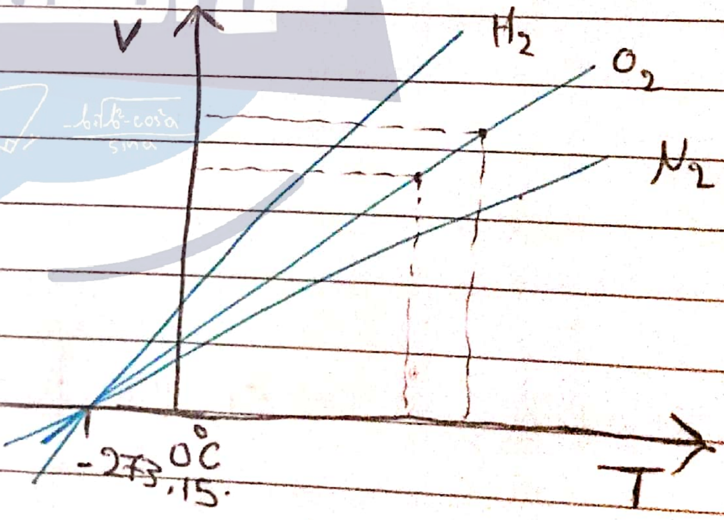


$P_1V_1 = K = P_2V_2$

$\boxed{P_1V_1 = P_2V_2}$ at Constant T and n

② charl's law.

$V = KT$



$K = T(°C) + 273.15$

$\boxed{PV = nRT}$

$$\frac{V_1}{T_1} = K = \frac{V_2}{T_2}$$

$\boxed{\frac{V_1}{T_1} = \frac{V_2}{T_2}}$ at cons P and n

$V \alpha n$

$V \alpha T$

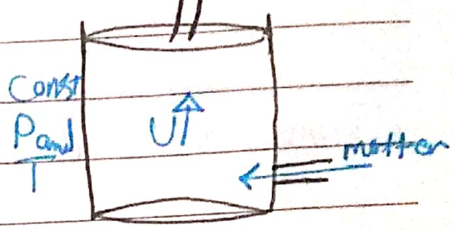
$V \alpha \frac{1}{P}$

$V \alpha \frac{Tn}{P}$

$V = \frac{RnT}{P}$

at Const. P and T

$\hookrightarrow V \alpha n$



$$\boxed{PV = nRT}$$

Ideal gas Law

at Law Pressure

R : Universal gas Constant

$R = \frac{PV}{nT} = \frac{Pa \cdot m^3}{mol \cdot K}$

Volume . Pascal = $\frac{N}{m^2} \cdot m^3$

$w = N \cdot m = Jol$

$= Jol \cdot mol^{-1} \cdot K^{-1}$ #

$$\boxed{R = 8.314\ J \cdot K^{-1} \cdot mol^{-1}}$$

Important conditions

STP

Standard Temperature and Pressure

$$STP \begin{cases} \nearrow 0\ °C = 273.15\ K \\ \searrow 1\ atm \end{cases}$$

$$\boxed{R = 0.0821\ L \cdot atm \cdot K^{-1} \cdot mol^{-1}}$$

at STP condition 1 mol of any ga

$V = \frac{\overset{1}{n}\overset{const}{R}\overset{const}{T}}{\underset{const}{P}} = 22.4\ L$

$$V = \frac{1(\text{mol})(0.0821\ \text{L}\cdot\text{atm}\cdot\text{mol}^{-1}\cdot\text{K}^{-1})(273.15\ \text{K})}{1\ \text{atm}}$$

Example 8- Calculate the volume in L of 5.58 g of NH_3 at STP

$$n = \frac{m}{M} = \frac{5.580\ \text{g}}{17.03\ \frac{\text{g}}{\text{mol}}} = 0.328\ \text{mol}\ NH_3$$

$$V = \frac{nRT}{P} = (0.328\ \text{mol})(0.0821\ \text{L}\cdot\text{atm}\cdot\text{mol}^{-1}\cdot\text{K}^{-1})(273.15\text{K}$$

$$\boxed{\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}} \qquad \boxed{\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}}$$

Density and Molar mass of a gas

$$PV = nRT$$

$$\frac{m}{M} \leftarrow \frac{n}{V} = \frac{P}{RT}$$

$$d\ \frac{\left(\frac{m}{V}\right)}{M} = \frac{P}{RT}$$

$$\boxed{d = \frac{PM}{RT}} \qquad \boxed{M = \frac{dRT}{P}}$$

Examples:- A gaseous compound Cl and O has $d = 8.14 \frac{g}{L}$ at 47 °C and 3.15 atm. Find Molar mass and determine its molecular formula.

$$M = \frac{\left(8.414 \frac{g}{L}\right)\left(0.0821 L \cdot atm \cdot mol^{-1} \cdot K^{-1}\right)(320K)}{3.15 atm}$$

$$= 67.9 \frac{g}{mol}$$

منحسب الرقم

ClO

Cl_2O

\# $\boxed{ClO_2} \rightarrow 67.5 \frac{g}{mol}$

5.4 Stoichiometry of Gases

Example: Sodium azide NaN_3 is used in automobile air bags. The impact of a collision triggers the following rxn.

$$2NaN_3\ (g) \rightarrow 2Na(s) + 3N_2\ (g)$$

Calculate the volume of N_2 gas generated at 85°C and 812 mm by the decomposition of 50 g of NaN_3.

S → $V = \frac{nRT}{P}$

$$n_{NaN_3} = \frac{50.0\ g}{65.02 \frac{g}{mol}} = \boxed{0.769\ mol\ of\ NaN_3}$$

$$n_{\cancel{NaN_3}} \times \frac{n_{N_2}}{n_{\cancel{NaN_3}}} = 0.769\ mol\ NaN_3 \times \frac{3\ mol\ N_2}{2\ mol\ NaN_3}$$

$$\boxed{n_{N_2} = 1.15\ mol\ of\ N_2}$$

$812 \text{ mm Hg} \times \frac{1 \text{ atm}}{760 \text{ mm Hg}} = \boxed{1.068 \text{ atm}}$

$$V = \frac{(1.15 \text{ mol})(0.0821 \text{ L.atm mol}^{-1} \text{ K}^{-1})(358 \text{ K})}{1.068 \text{ atm}}$$

$= 31.6 \text{ L}$ #

5.5 : Gas Mixtures : and Partial Pressures :

$\boxed{P_{Total} = P_1 + P_2 + P_3 + \dots}$ # Dalton's Law of Partial Pressures

$P_1 = P_T X_1$ X : mole fraction.

$P_2 = P_T X_2$

$P_3 = P_T X_3$

3 mol O_2
2 mol H_2

$X_{H_2} = \frac{2}{5} = 0.4$

$X_{O_2} = \frac{3}{5} = 0.6$

$$X_i = \frac{n_i}{n_T}$$

Example : 3.85 moles Ne
0.92 mole Ar
2.59 mol Kr

The Toral Pressure 2.50 atm

$X_{Ne} = \frac{3.85 \text{ mol}}{7.36 \text{ mol}} = 0.523$

$X_{Ar} = 0.125$

$X_{Kr} = 0.352$

P_{Ne} = 2.50 atm X 0.523 = 1.31 atm #

P_{Ar} = 0.125 X 2.50 = 0.313 atm #

P_{K} = 0.352 X 2.50 = 0.880 atm #

Collecting Gases . water :-

$$2HCl_{(aq)} + Zn \xrightarrow{H_2O} ZnCl_2 + H_{2(g)}$$

Examples:- If 156 ml of gas is collected at 19°C and 769 mm Hg of total pressure. what is the mass of H 2 collected.

Sol at 19°C vapor pressure of H_2O = 16.5 mm Hg

$$P_{Hg} = P_{Total} - P_{H_2O} = 769 \text{ mmHg} - 16.5 \text{ mm Hg} = \boxed{752 \text{ mm Hg}}$$

$$n = \frac{PV}{RT} = \frac{(0.989 \text{ atm})(0.156L)}{(0.082 \text{ L.atm}\cdot\text{mol}^{-1}.K^{-1})(293K)}$$

$$= \boxed{0,00641 \text{ mol}}$$

5.6 Kinetic Theory of Gases:- (KMT)

1850 - 1890

Maxwell
Boltzmann

Assumptions in KMT: ① Gases are composed of a separated particles from each others by distances for geater tha their own dimensions

[2] Particles are contant motion.

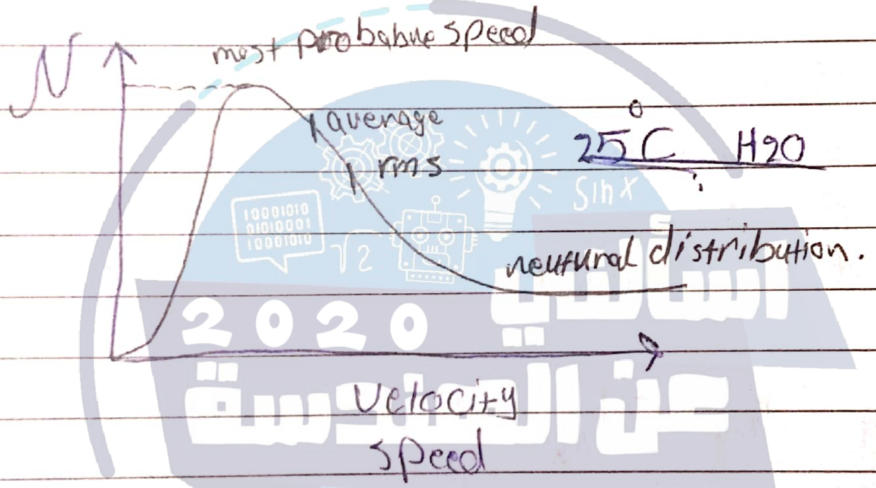
[3] Collision are elastic

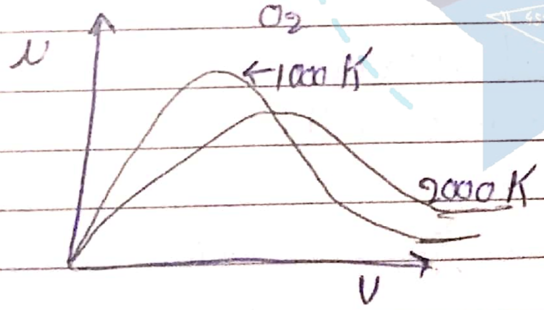
[4] Gas molecules exert neither attractive nor repulsive forces.

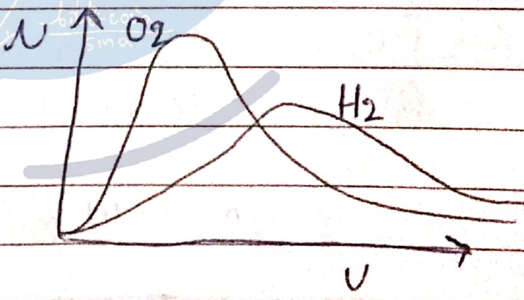
[5] The averege KE of particles is proportional to the tempreture.

$$KE \propto T$$

5.7 Molecular speeds Effusion and Differsion:-







اسرع ∴ اخف H_2 # اثقل O_2
ابطأ

---

u_{rms} ≡ root mean square speed.

$$u_{rms} = \sqrt{\frac{3RT}{M}}$$

Examples:- Calculate Urms of He atoms and nitrogen molecules in m/s at 25 °C.

He: $U_{rms} = \sqrt{\dfrac{3 * 8.314\ J.K^{-1}.mol^{-1} * 298\ K}{4.002 \times 10^{-3}\ \frac{Kg}{mol}}} = \sqrt{1.86 \times 10^{6}}$ = jol/Kg

$1\ jol = 1\ N \cdot 1\ m = 1\ Kg \cdot m^2 \cdot s^{-2}$ $= 1.36 \times 10^{3}\ \frac{m}{s}$

$= 1360 \frac{m}{s}$ #

زي الفوق

N₂: $U_{rms} = \sqrt{\dfrac{\quad}{28 \times 10^{-3}\ \frac{Kg}{mol}}}$ $= 515\ \frac{m}{s}$ #

* Diffusion and Effusion :- التدفق والانتشار

~~Mais Malkawi~~

الأقل كتلة مولية الأكثر سرعة #

$$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}} \qquad \frac{t_1}{t_2} = \sqrt{\frac{M_1}{M_2}}$$

r: rate

t: time

Examples:- It taken 192 s for an unknown gas to effuse throught a porous well and 84 s for the same volume of N₂ gas to effuse at the same T and P what is the molar mass of the unknown gas?

$$\frac{t_2}{t_1} = \sqrt{\frac{M_2}{M_1}} = \frac{192\ s}{84\ s} = \sqrt{\frac{M}{28\ g/mol}}$$

$M = 146\ \frac{g}{mol}$ *

5.8 Reel Gases

Equations of states:-

Van der Weal's Equation.

$$\boxed{\left(P + \frac{n^2 a}{V^2}\right)(V - nb) = nRT}$$ معطاة.

Chapter 6:- Thermo chemistry:-

6.1 Energy and its units:-

Energy: The capacity to do work

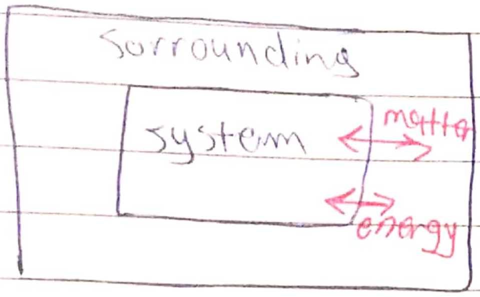
Kinetic Energy:-
Potential Energy:-
Neyclear Energy:-
Solar Energy:-
Thermal Energy
Chemical Energy

1st law of thermodynamics

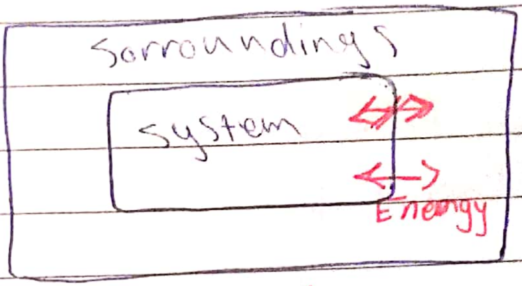
The Energy of the universe is constant.

The universe in Thermodynamiss:-

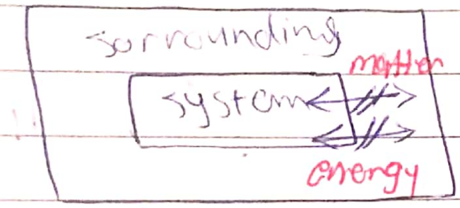
- system
- sorroundings



open system

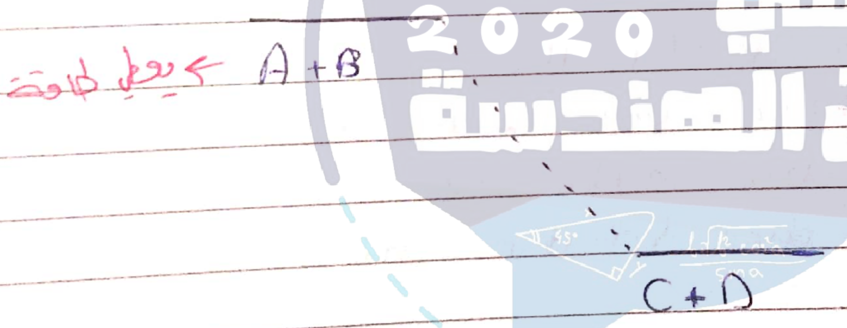


closed system.



isoleted system.

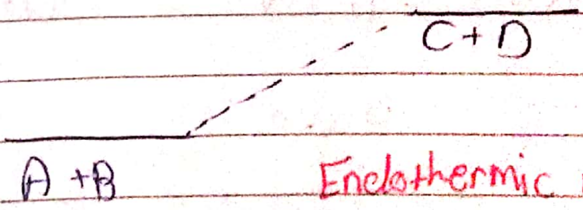
$A + B \rightarrow C + D$



Exo thermic reaction

طارد للطاقة

$\Delta E = -ve$



Endothermic reaction

$\Delta E = +ve$

30/11 second Ch → 4,5,6

Work = W
Heat = q

First law of tharmodynamics

U : Internal Energy. the total Kenitic Eenrgy (K.E) and P.E of all particles (electrons, Protone, neutrons, ...) composing an object.

Cannot be calculate

$\Delta E \begin{cases} \Delta U \\ \Delta H \end{cases}$

$\boxed{\Delta U = q + w}$ can be calculated

Internal energy is a state Function

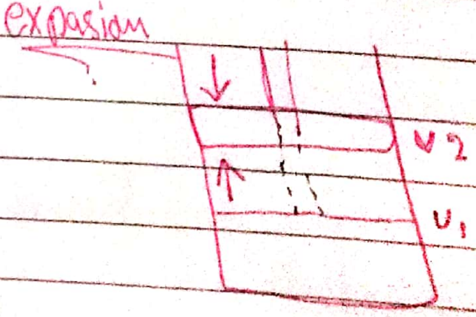
SI unit J

1) +q : heat is added to the system
2) -q : heat flows out of the system
3) +w : work done on the system.
4) -w : work done by the system.

work:-

$$W = -\overset{\text{const}}{P} \Delta V$$

$$J = Pa \cdot m^3$$



Heat :-

Two cases:

[1] Constant volume:-

$$\Delta U = q + w$$

$$\Delta U = q - \cancel{P \Delta V}^{\text{zero}}$$

$$\boxed{\Delta U = q_v}$$

2 ~~Proc~~ processes of Constant Pressure :-

$\Delta U = q + w$

$= q - P\Delta V$

$\boxed{q_p = \Delta U + P\Delta V}$

$\boxed{H = U + PV}$ Enthalpy

$\Delta H = \Delta U + \Delta(PV)$

$\boxed{\Delta H = \Delta U + P\Delta V}$

at Const. Volume $\Delta U = q_v$ ← internal energy change

at Const pressure $\Delta H = q_p$ ← enthalpy changes.

Enthalpy of ~~change~~ chemical reaction :-

$\Delta H = H(\text{products}) - H(\text{reactansts})$

$H_2O(g) \longrightarrow H_2O(l)$

يتحول من غاز إلى سائل
يحتاج حرارة

$\Delta H = +\ 6.01\ \frac{KJ}{mol}$

Energy is an Extensive property : do depends on the quantity of matter.

$CH_4(g) + O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$ تفاعل احتراق

$\Delta H = -890 \frac{KJ}{mol}$

$\Delta U = \Delta H - RT\Delta n$

Δn = n of products of gases only − n reaction of gases only.

Example Calculate ΔU for the following rxn at 25°C

$2CO(g) + O_2(g) \rightarrow 2CO_2(g)$

3 2

$\Delta n = 2 - 3 = -1$

$\Delta H = -566.0 \frac{KJ}{mol} \times 10^3 \frac{J}{KJ}$

$\Delta U = -566 \times 10^3 \frac{J}{mol} - (8.314 \frac{J}{K.mol} \times 298.15\, K \times -1)$

$\Delta U = -563500 \frac{J}{mol} = -563.5 \frac{KJ}{mol}$

الفرق بين قيمة ΔU و ΔH غير كبير.

6.6 Measuring Heats of Reaction

Calorimetry

Specific heat (s) the energy required to raise the T of 1g of any substance by 1°C.

$s = \frac{J}{g.°C}$

heat Capacity (C) the energy required to raise the T of any amount of any substance by 1°C

$= \frac{J}{°C}$

$$C = m\,s$$

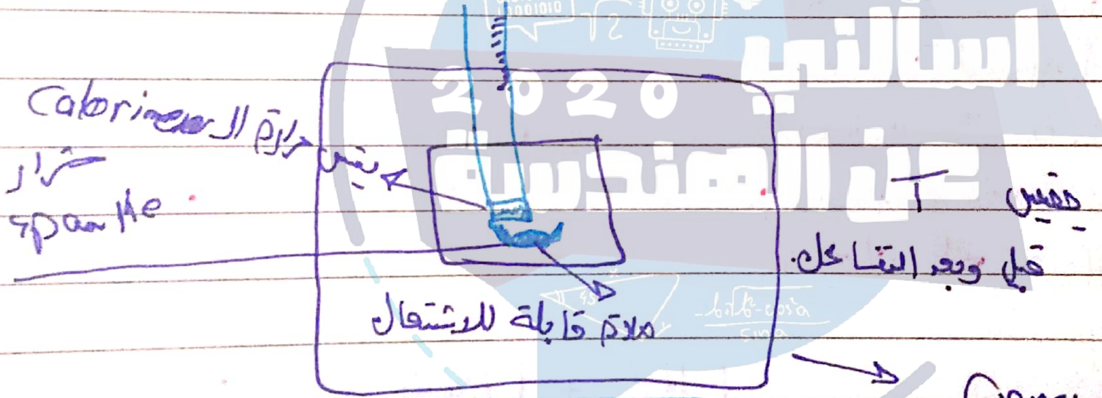
$$\frac{J}{°C} = g \cdot \frac{J}{g \cdot °C}$$

$$\boxed{q = m\,s\,\Delta T} \qquad \boxed{q = C\,\Delta T}$$

$$J = g \cdot \frac{J}{g \cdot °C} \cdot °C$$

$$J = J$$

① Constant Volume Calorimeter. (Bomb calorimeter)



→ Constant Volume

$$\boxed{q_{cal} = -q_{rxn}}$$

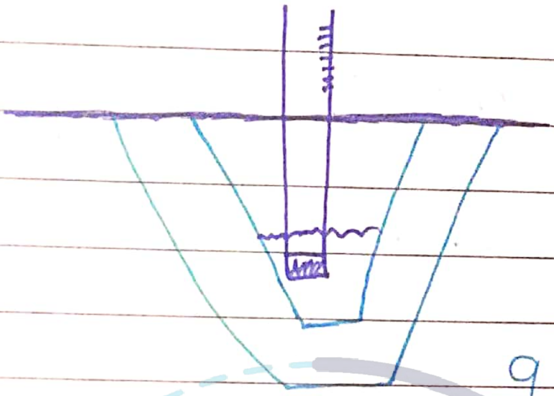
$$q_{cal} = \underline{C_{cal}}\,\Delta T$$

Const is given.

$$\Delta U = q_v$$

2 Constant - pressure Calorimeters : Coffe - Cup Calorime

غير محكم الاغلاق
فان الضغط بالداخل يساوي
ضغط الغرفة لذلك
الضغط ثابت



$q_p = \Delta H$

$q_{rxn} = -q_{soln}$

Example : A quantity of 150 ml of 0.350 M of HCl was mixed with 150 ml of 0.350 M NaOH in a constant pressure calorimeter. Initial T = 23.25 °C. Final T = 25.60 °C calculate the heat of reaction on a molar basis. Assume that d and s of solution is the same as that of H_2O ~~=~~ $d = 1 \frac{g}{ml}$

$S = 4.184 \frac{J}{g.°C}$

$1 HCl_{(aq)} + 1 NaOH_{(aq)} \rightarrow 1 NaCl_{(aq)} + H_2O_{(l)}$

$q_{soln} = m_{soln} \, S_{soln} \, \Delta T_{soln}$

$= (300g)\left(4.184 \frac{J}{g.°C}\right)(2.35°C)$; Exothermic

$= 2950 J$

$q_{rxn} = -2950 J = \Delta H$

$n_{HCl} = MV = \left(0.350 \frac{mol}{\cancel{L}}\right)(0.150 \cancel{L}) = 0.0525 \, mol$

$\Delta H = \frac{-2950 J}{0.0525 \, mol} = -56.2 \frac{kJ}{mol}$

6.7 Hess's Law:

Example: $2C_{(s)} + H_{2(g)} \rightarrow C_2H_{2(g)}$ $\Delta H = ?$

1 $\left(C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} \quad \Delta H = -393.5 \frac{KJ}{mol} \right) \times 2$

2 $\left(H_{2(g)} + \frac{1}{2} O_{2(g)} \rightarrow H_2O_{(l)} \quad \Delta H = -285.8 \frac{KJ}{mol} \right) \times 1$

$\times -\frac{1}{2}$

3 $\left(2C_2H_{2(g)} + 5O_{2(g)} \rightarrow 4CO_{2(g)} + 2H_2O_{(l)} \quad \Delta H = -2598.8 \frac{KJ}{mol} \right)$

$2C_{(s)} + \cancel{2O_{2(g)}} \rightarrow \cancel{2CO_2} \quad \Delta H = -787.0 \frac{KJ}{mol}$

$H_{2(g)} + \cancel{\frac{1}{2}O_{2(g)}} \rightarrow \cancel{H_2O_{(l)}} \quad \Delta H = -285.8 \frac{KJ}{mol}$

$\cancel{2CO_{2(g)}} + \cancel{H_2O_{(l)}} \rightarrow C_2H_{2(g)} + \cancel{\frac{5}{2}O_{2(g)}} \quad \Delta H = 1299.4 \frac{KJ}{mol}$

$2C_{(s)} + H_{2(g)} \rightarrow C_2H_{2(g)} \quad \Delta H = 226.6 \frac{KJ}{mol}$

6.8 Standard Enthalpies of Formation:

$aA + bB \rightarrow cC + dD$

25°C
1 atm } standard cond. → $\Delta H^{\circ}_{rxn} =$

Enthalpy of formation

ΔH°_{f}

ΔH°_{f} : The heat change that result when 1 mol of the compound is formed from its elements at 1 atm and 25°C.

ΔH_f° for pure element in their most stab state = 0

ΔH_f° ((graphite) = 0

ΔH_f° (diamond) $\neq 0$

O_2 $\Delta H_f^\circ = 0$

O_3 $\Delta H_f^\circ \neq 0$

$$\Delta H^\circ_{f\,rxn} = [c\Delta H C + d\Delta H D] - [a\Delta H A + b\Delta H B]$$

$$4\,NH_3\,(g) + 5O_2\,(g) \rightarrow 4\,NO(g) + 6\,H_2O\,(g)$$

$$\left[4\left(90.3\,\frac{KJ}{mol}\right) + 6\left(-241.8\,\frac{KJ}{mol}\right)\right] - \left[\left(4\left(-45.9\,\frac{KJ}{mol}\right)\right) + 5(0)\right]$$

$$= -906\,\frac{KJ}{mol}$$

Chapter "7": Quantum Theory of Atoms:

7.5: Quantum Numbers:

Schrodinger Equation.

Hydrogen Atom

A) n: Principal Quantum Numbers.

$n = 1, 2, 3, 4, \dots \infty$

1) Energy of the orbital

2) Average distance from the nucleons

B) Angular Momentum Quantum Number (L)

$L = 0, 1, 2, 3, \dots n-1$

$n = 1$ $L = 0$

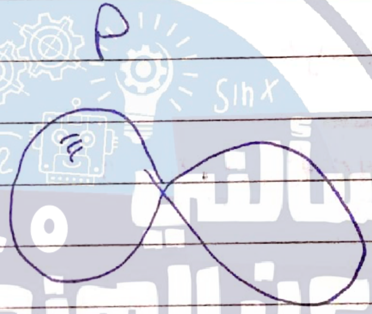
$n = 2$ $L = 0$ $L = 1$

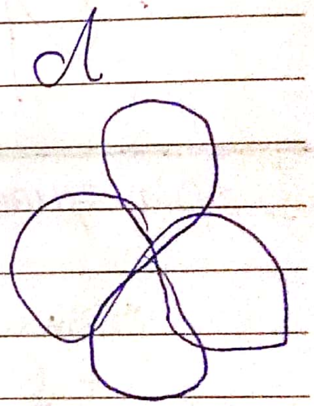
L value	0	1	2	3	4	5	6
L symbol	s	p	d	f	g	h	i

n=1 shell — L=0 — 1s subshell

n=2 shell — L=0 — 2s subshell — L=1 — 2p subshell

n=3 shell — L=0 — 3s supshell — L=1 — 3p supshell — L=2 — 3d subshell



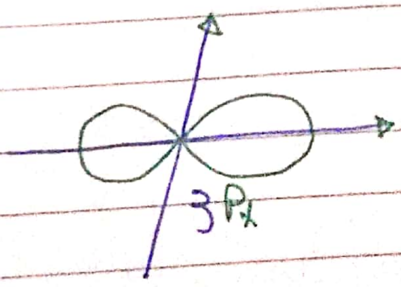


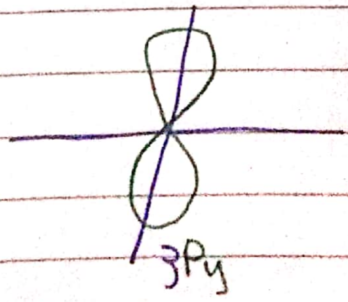
Ⓒ magnetic quantum number (m_L)

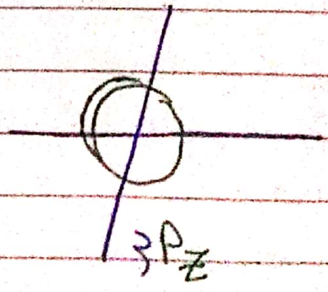
$m_L = -L, \ldots\ldots, 0, \ldots\ldots +L$

$L=0$ (s) $mL = 0$
$L=1$ (p) $m_L = -1, 0, +1$
$L=2$ (d) $m_L = -2, -1, 0, +1, +2$

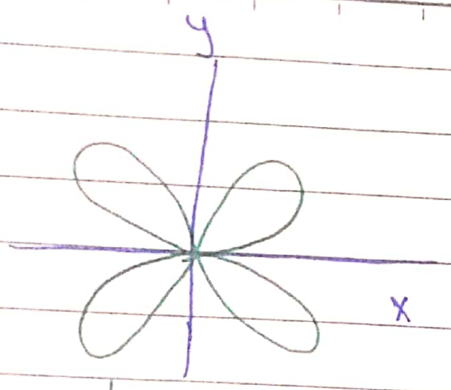
The no. of values of m_L = 2L+



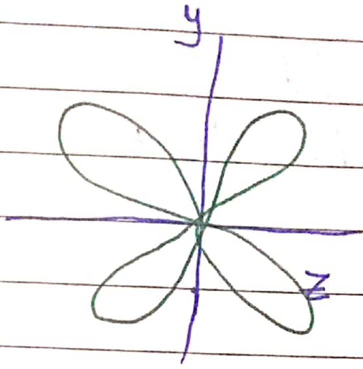




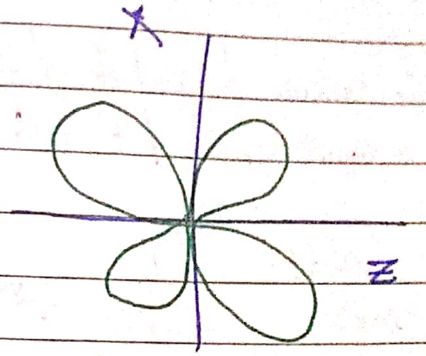
متساوين في الطاقة لأن اللي بحدد الطاقة هي n وهيا 3



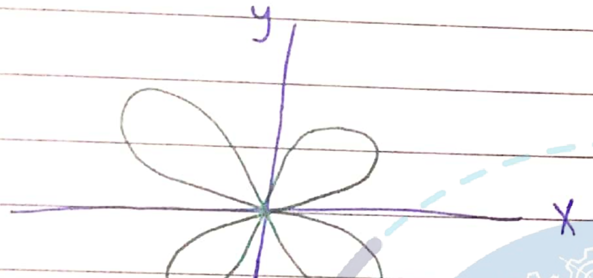
d_{xy}



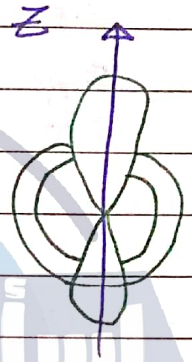
d_{yz}



d_{xz}

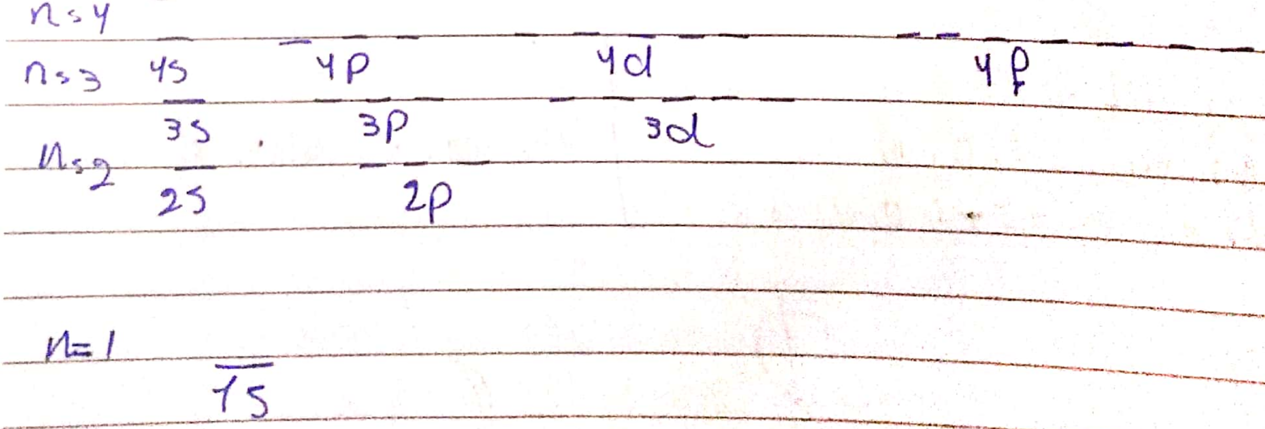


$d_{x^2 y^2}$



d) spin quantum number m_s :-

Energy Law's of H atom :-



Chapter 8: Electron Configuration on of periodicity:

1 # Pouli Exclusion principle : مبدأ استبعاد باولي .

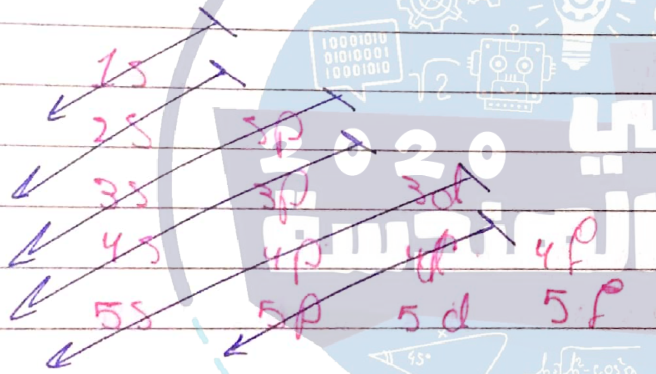
$(2, 1, 0, +\frac{1}{2})$

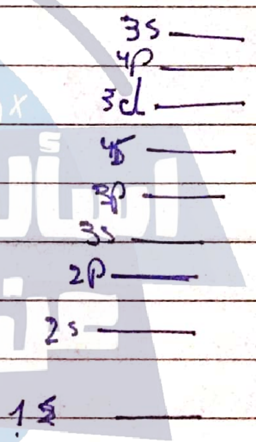
(n, L, m_L, m_s)

$2P_z$ spinup ※

no two electrons in an atom have the same 4 quantum numbers.

2

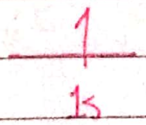




Elecronic configuration :

1. H (Z=1)

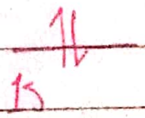
$1s^1$



s ✓ have the same Energy.

2. He (Z=2)

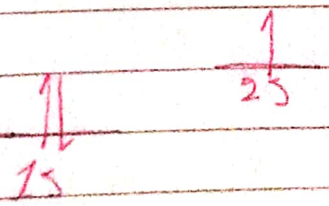
$1s^2$



diamagnetic: not effected by amagnetic field .

3. Li (Z=3)

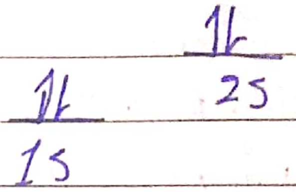
$1s^2 \; 2s^1$



para magnetic: affected by amagnetic field

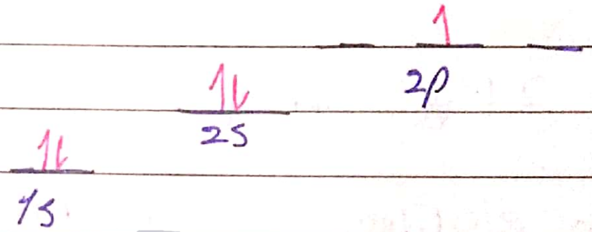
4 Be (Z = 4)

$1s^2 \; 2s^2$



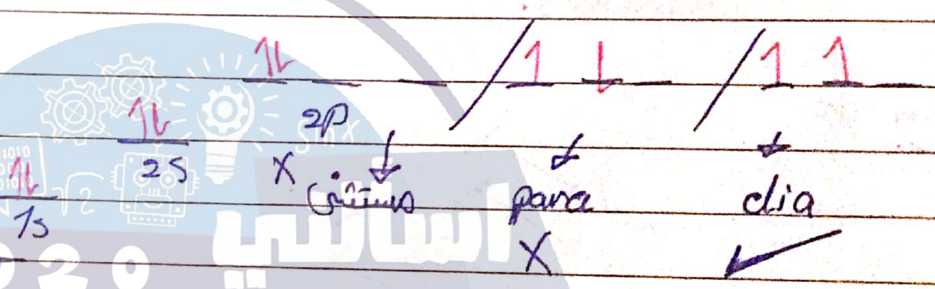
5 B (Z = 5)

$1s^2 \; 2s^2 \; 2p^1$



6 C (Z = 6)

$1s^2 \; 2s^2 \; 2p^2$

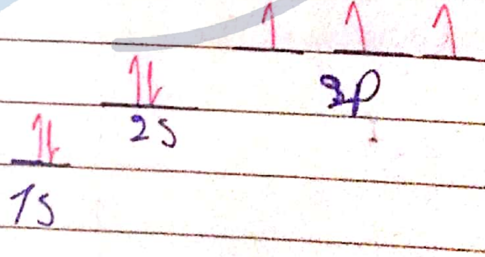


Hund's Rule :-

the most stable arrangenment of electrons in subshells is the one with the greatest number of Paralleel spins.

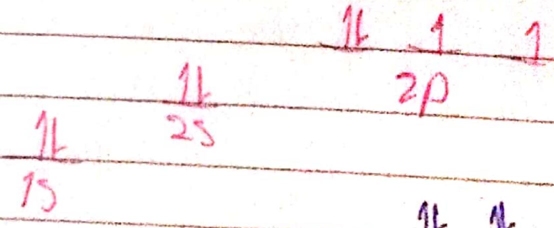
7 N (Z = 7)

$1s^2 \; 2s^2 \; 2p^3$



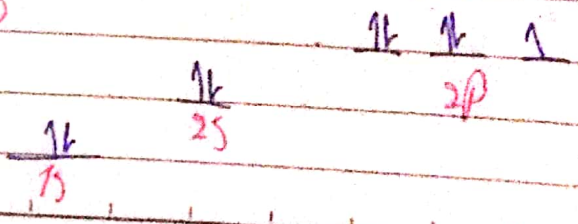
8 O (Z = 8)

$1s^2 \; 2s^2 \; 2p^4$



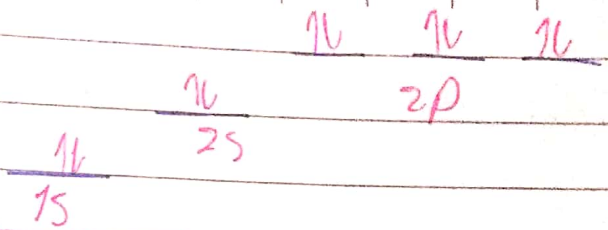
9 F (Z = 9)

$1s^2 \; 2s^2 \; 2p^5$



Ne (Z = 10)

$1s^2$ $2s^2$ $2p^6$



Aufbau Principle :

↳ to build : نبنيه

Na (Z = 11)

$\boxed{1s^2\ 2s^2\ 2p^6}\ 3s^1$

Ne

Na = [Ne] $3s^1$

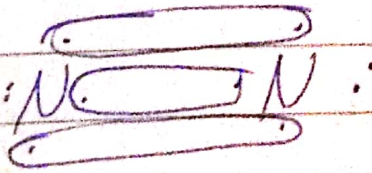
C_2H_2

$H-C\equiv C-H$

O_2

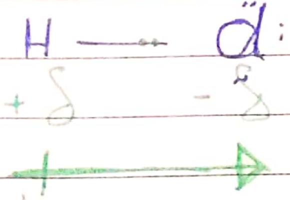
$..\ddot{O}=\ddot{O}..$

N_2



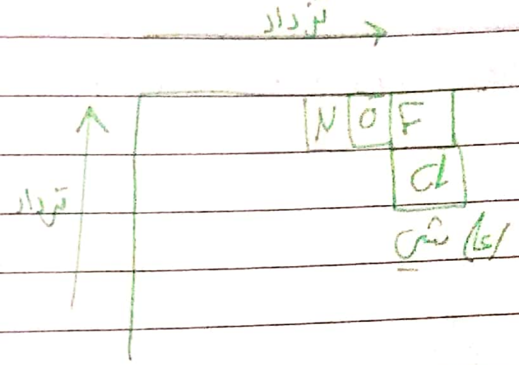
$\ddot{N}\equiv N$

9.5 Electronegativity 8 مقدار جذب الذرة الإلكترونات.



bipolar bond

polar bond



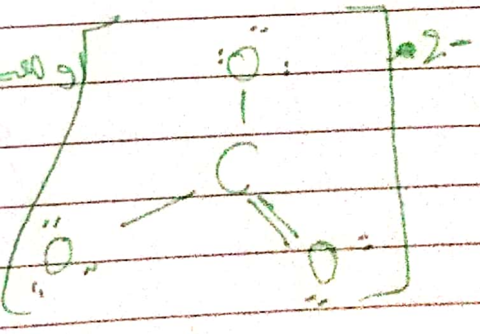
Covalent bonds → polar bonds
→ non-polar bonds O_2, N_2, H_2

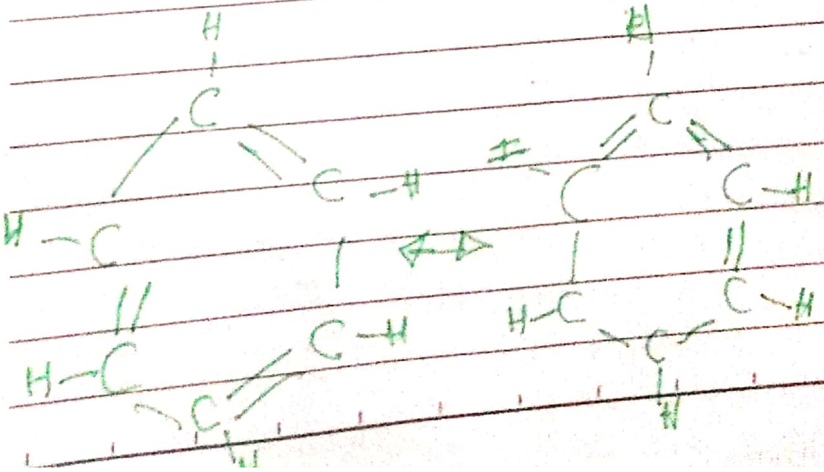
ionic compound : Large difference in electronegativity values.

Example : write down the lewis structure of CO_3^{2-}

1C : 4el = 4el
3O : 6el = 18el
2el of the anion : 2el
24el

9.7 Delocalized Bonding 8 (Resonance)





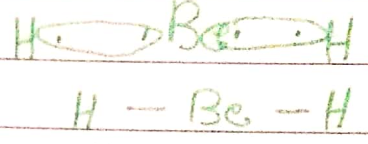
Chemistry 101

9.8 Exceptions to the Octet Rules

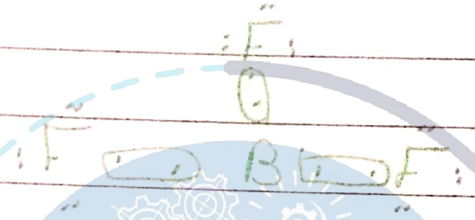
8

I) Incomplete Octet

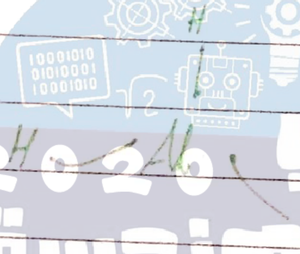
BeH_2



BF_3



AlH_3

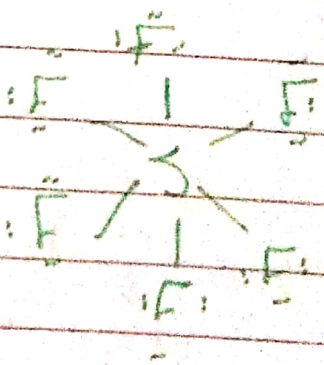


NO

Free radicals

II) Expanded octet

SCl_2 SF_6



	XV	VI	IX
البداية من هنا	P	S	Cl
ممكن يعلو			Br
Expanded octet			I

Chapter 10 :- Molecular Geometry :-

Valence Shell Electron pair Repulsion Theory

VSEPR Theory

1) X – X
X = X
X ≡ X

2) No difference for resonance structures

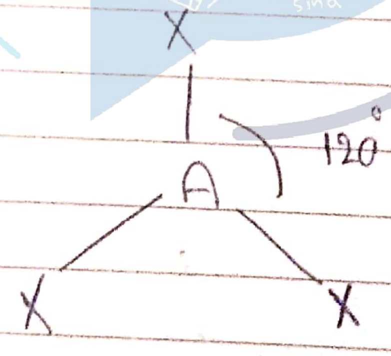
10.1 :- VSEPR

1 AX_2
ذرة جانبية

linear shape

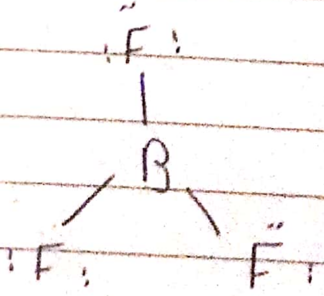
Ex BeH_2 H — Be — H

2 AX_3



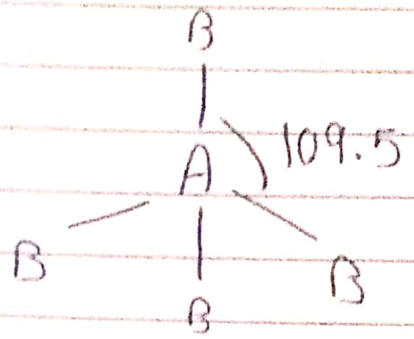
trigonal Planar

Ex BF_3



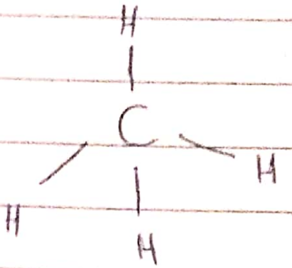
[3] AB_4

3-D

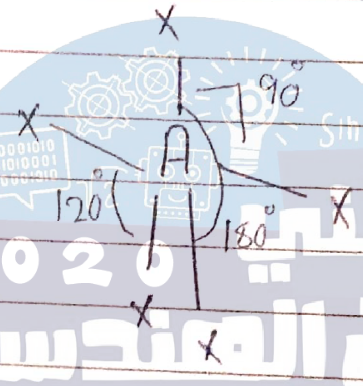


tetra hedral

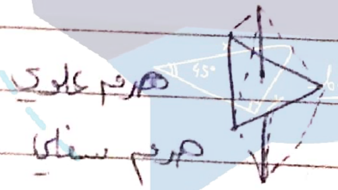
Ex : CH_4 ميثان



[4] AX_5



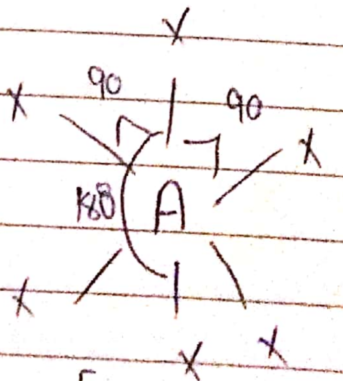
trigonal bipyramidal



Ex PCl_5

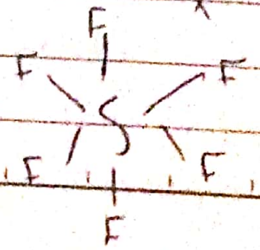
[5] AX_6

٨ أوجه
زي الهرمات الكبيرة



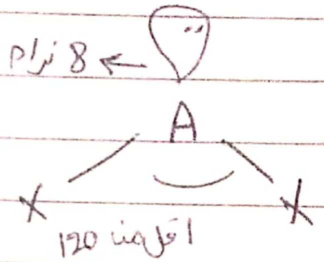
octahedral

Ex SF_6



II - Moleculas with Lone pairs on central Atom·

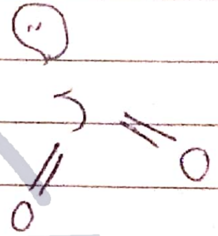
AX_2E



bent shape
V - shape

Ex SO_2:

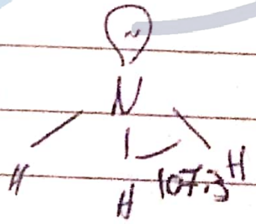
$O = \ddot{S} = O$ E



AX_3E

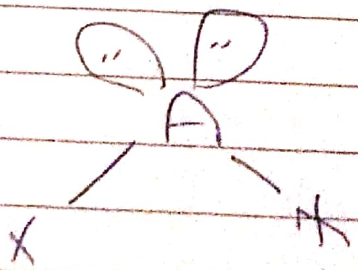
Trigonal Pyramidal

Ex NH_3

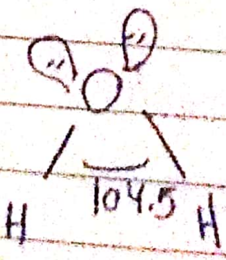


الزوايا لازم نعرفهم.

AX_2E_2

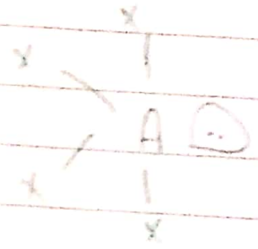


Ex H_2O



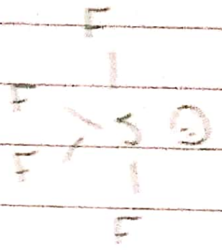
V- shap
bent.

AX$_4$E

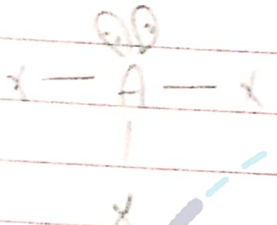


see-saw
distorted tetra hedral

Example : SF$_4$

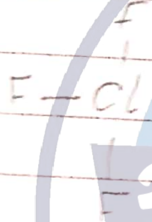


AX$_3$E$_2$

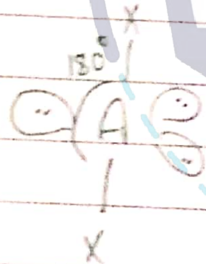


T-shape

Ex: ClF$_3$



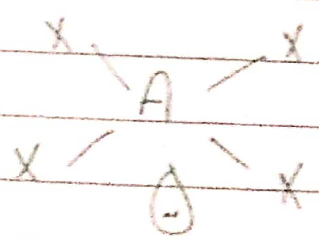
AX$_2$E$_3$



linear

Ex I$_3^-$

AX$_5$E

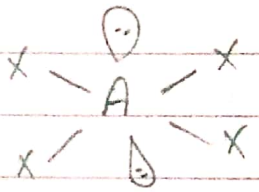


square pyramidal.

Ex: BrF$_5$

(329 ص

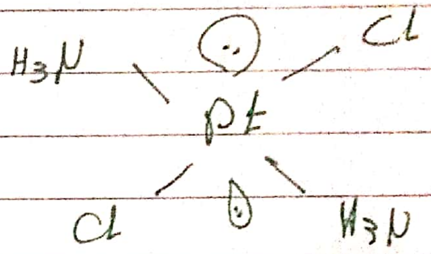
AX_4E_2 :



square planar

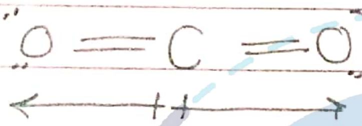
XeF_4

زينون

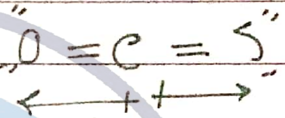


non polar

10.2 : Dipole Moment



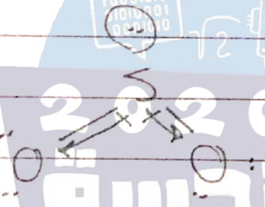
non polar compound المركب غير قطبي



غير متساويان

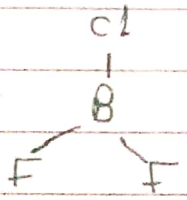
polar

SO_2

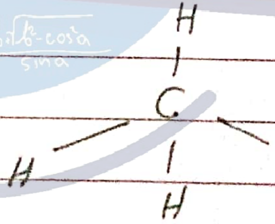


Polar

non polar



polar



كل الزوايا 109.5

non ∴
polar

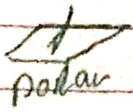
non polar
يلغو بعض

polar

polar

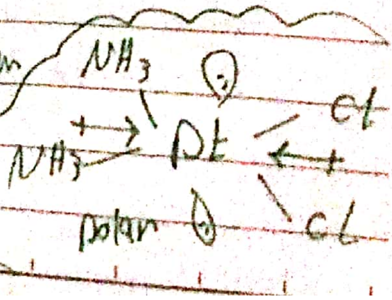
Linear
non - polar

non polar



polar

non polar



polar