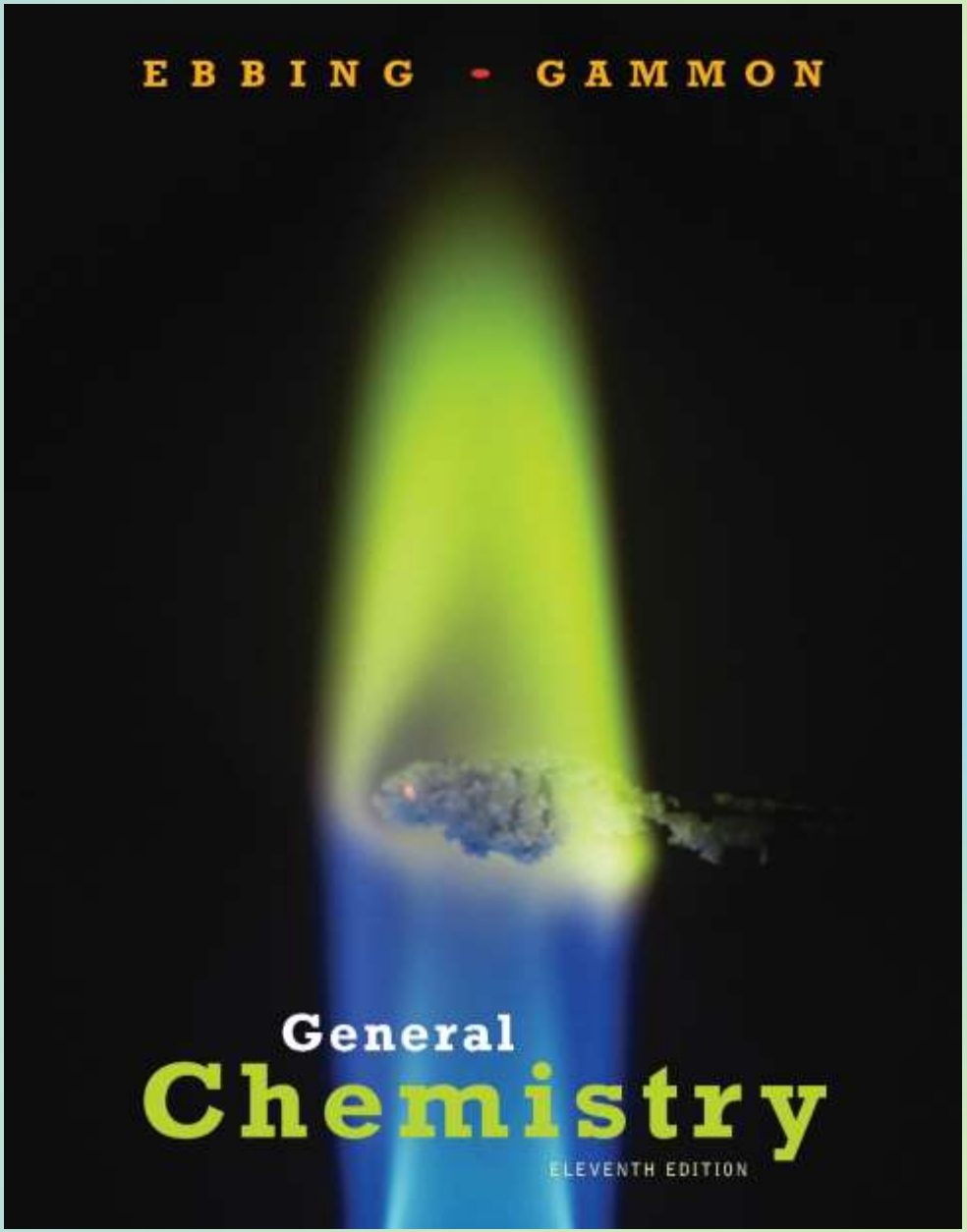


اللهم صلّ وسلّم على نبينا محمد وعلى آله وصحبه أجمعين

Chapter 2 Atoms, Molecules, and Ions

- Required sections:

2.3 Nuclear Structure and Isotopes
2.4 Atomic Weights
2.8 Naming Simple Compounds
2.9 Writing Chemical Equations
2.10 Balancing Chemical Equations

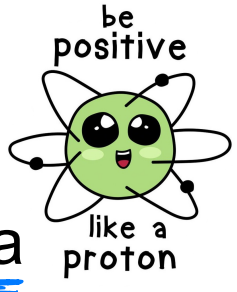
- *Excluded sections: 2.1, 2.2, 2.5, 2.6, 2.7*

2.3 Nuclear Structure; Isotopes

Atomic Number < Mass Number

العدد الكبير
Mass number → $^{A}_{Z}E$ ← Element symbol
Atomic number → Z
للعدد الصغير

e.g. $^{20}_{10}Ne$ ← Symbol



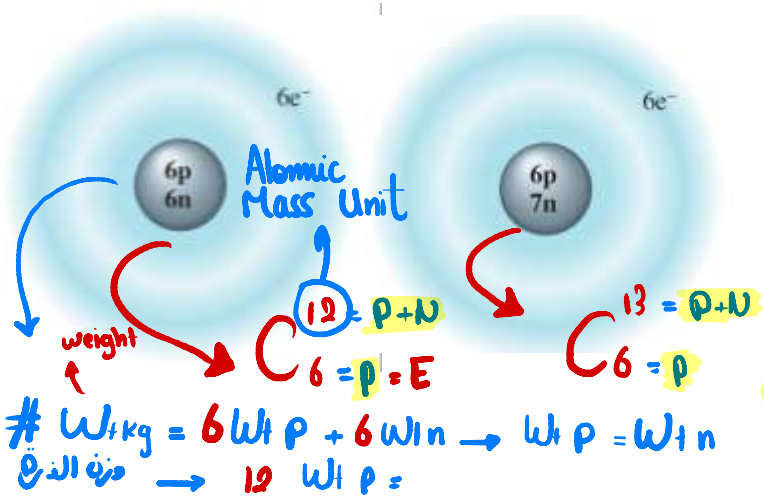
Neutral = ذرة متعادلة ← Ca

Atomic number = Z = number of protons in the nucleus = number of electrons
only when: → Neutral Atom

Mass number = A = number of protons + number of neutrons

Number of neutrons = $A - Z$

ذرة غير متعادلة ←
- Cation: Ca^{2+}
- Anaion: Cl^-



كسر صغير ← يمكن إهماله

TABLE 2.1 Properties of the Electron, Proton, and Neutron

Particle	Mass (kg)	Charge (C)	Mass (amu)*	Charge (e)
Electron	9.10939×10^{-31}	-1.60218×10^{-19}	0.00055	−1
Proton	1.67262×10^{-27}	$+1.60218 \times 10^{-19}$	1.00728	+1
Neutron	1.67493×10^{-27}	0	1.00866	0

*The atomic mass unit (amu) equals 1.66054×10^{-27} kg; it is defined in Section 2.4.

#

Example 2.1: What is the nuclide symbol for a nucleus that contains 38 protons and 50 neutrons?

$^{88}_{38}Sr$

→ Example :-

1) $Ni^{58}_{\square}$ ← Mass Number ← Atomic Mass → periodic table = 28

p = 28 N = 30 e = 28 [e = p] : Neutral Atom

2) $Ni^{58}_{\square}{}^{+2}$ loss = (p > e) ← Atomic Mass

p = 28 N = 30 e = 26

ثابت دائماً ←

Exercise 2.1 A nucleus consists of 17 protons and 18 neutrons. What is its nuclide symbol?

See Problems 2.47 and 2.48.

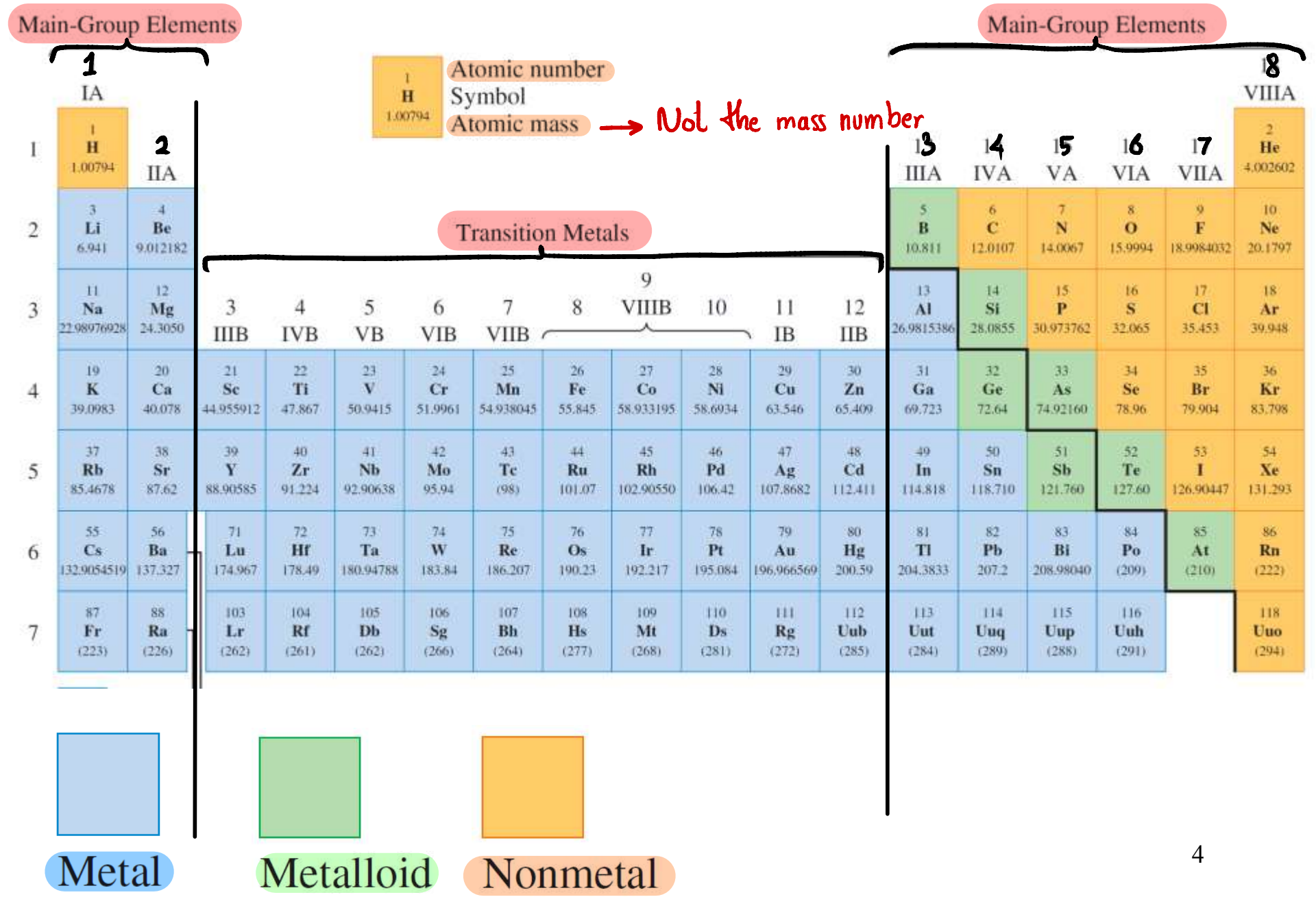
Cl^{35}_{17}

Atomic Mass ≠ Mass Number

في الـ Isotope : # عدد (E - P) ثابت

الذرة عدد الـ N هو الذي يختلف
Cl-35 / Cl-37
p = 17 - E = 17 → N = 18 - 20

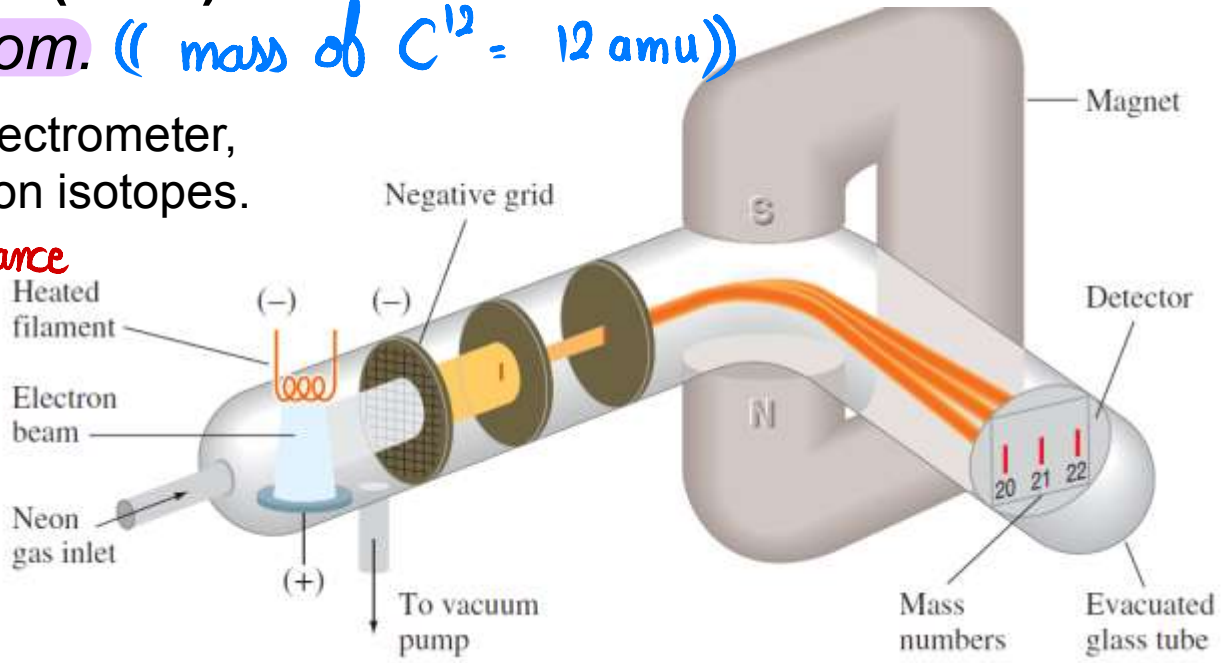
Periodic Table of The Elements



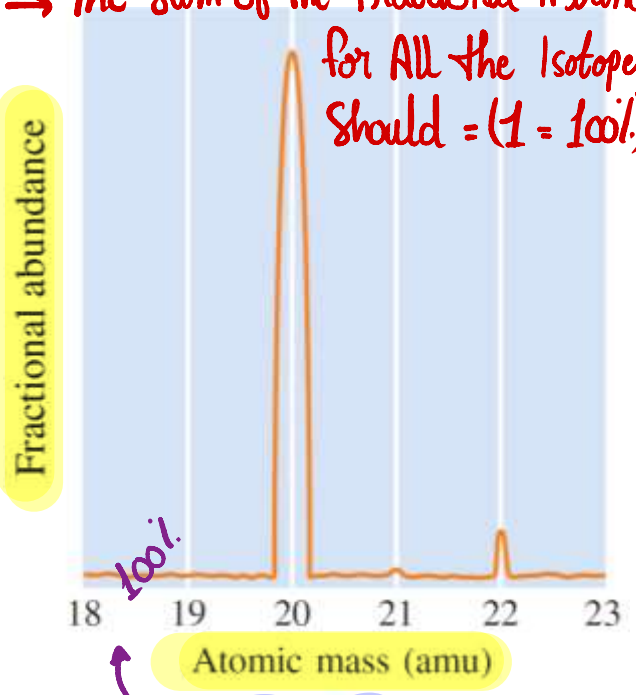
2.4 Atomic Masses and atomic mass Units (amu)

One **atomic mass unit (amu)** is *a mass unit = 1/12 of the mass of a carbon-12 (^{12}C) atom.* ((mass of C^{12} = 12 amu))

Diagram of a simple mass spectrometer, showing the separation of neon isotopes.



→ The Sum of the fractional Abundance for All the Isotopes Should = (1 = 100%)



^{20}**Ne** (90.48%) x 20 +
^{21}**Ne** (0.27%) x 21 +
^{22}**Ne** (9.25%) x 22

(a.m.u) A.M → [20.180] ← P.T

-Ne gas atoms form +ve ions when they collide with electrons.
-Ne^+ atoms are accelerated from this region by the negative grid and pass between the poles of a magnet.
-The beam of positively charged atoms is split into three beams by the magnetic field according to the **mass/charge ratios**.
-The three beams then travel to a detector at the end of the tube

Relative Atomic Masses (A_r)

⇒ Weighted Average = بأخذ بعين الاعتبار الـ Isotopes

Calculate the value of A_r for naturally occurring chlorine if the distribution of isotopes is 75.77% $^{35}_{17}Cl$ and 24.23% $^{37}_{17}Cl$. Accurate masses for ^{35}Cl and ^{37}Cl are 34.97 and 36.97.

$$\left(35 \times \frac{75.77}{100}\right) + \left(37 \times \frac{24.23}{100}\right) =$$

isotope 1 — percentage — isotope 2

34.97 — 36.97

.7577 → Fractional Abundance

35.4546 ← الرقم يلي بالجدول الدوري

Exercise 2.2 Chlorine consists of the following isotopes:

Isotope	Isotopic Mass (amu)	Fractional Abundance
Chlorine-35	34.96885	0.75771 = 75.77%
Chlorine-37	36.96590	0.24229 = 24.229%

What is the atomic mass of chlorine? 35.45

نسبة مئوية

Example 2.2 Determining Atomic Mass from Isotopic Masses and Fractional Abundances

Chromium, Cr, has the following isotopic masses and fractional abundances:

Mass Number	Isotopic Mass (amu)	Fractional Abundance
50	49.9461	0.0435
52	51.9405	0.8379
53	52.9407	0.0950
54	53.9389	0.0236

الأولى

Fractional Abundance > نسبة وجوده بالطبيعة

إذا ما أعطاني الـ (Isotopic Mass) بستخدم الـ (Mass Number)

What is the atomic mass of chromium?

Solution Multiply each isotopic mass by its fractional abundance, then sum:

$$\begin{aligned} 49.9461 \text{ amu} \times 0.0435 &= 2.17 \text{ amu} \\ 51.9405 \text{ amu} \times 0.8379 &= 43.52 \text{ amu} \\ 52.9407 \text{ amu} \times 0.0950 &= 5.03 \text{ amu} \\ 53.9389 \text{ amu} \times 0.0236 &= 1.27 \text{ amu} \\ &\overline{51.99 \text{ amu}} \end{aligned}$$

The atomic mass of chromium is **51.99 amu.**

Answer Check The average mass (atomic mass)

Example 2:2

إذا أعطاني إياها بالسؤال
أنا ملزم استخدمها بالحل

* Atomic Mass (amu) ??
  Accurate Mass

* Mass Number = Isotopic Mass × (Fractional Abundance) =

1.) 49.9461 × 0.0435 = 2.17 (amu)
+
2.) 51.9405 × 0.8379 = 43.52 (amu)
+
3.) 52.9407 × 0.0950 = 5.03 (amu)
+
4.) 53.9389 × 0.0236 = 1.27 (amu)

Atomic Mass Number

[51.99 amu] = Atomic Mass

← percentage محوّل من
Fractional Abundance

[ ] % / 100 وذلك بالقسمة على

The Sum of these numbers give = 100% - 1

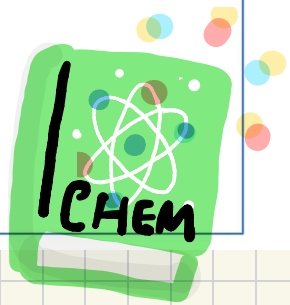
Example 2.2 *(continued)*

Exercise 2.2 Chlorine consists of the following isotopes:

Isotope	*Isotopic Mass (amu)*	*Fractional Abundance*
Chlorine-35	34.96885	0.75771
Chlorine-37	36.96590	0.24229

What is the atomic weight of chlorine?

See Problems 2.51, 2.52, 2.53, and 2.54.



⇒ Atomic weight mass ?

Accurate Mass ←

Mass Number = Isotopic Mass × (Fractional Abundance)

1.) 34.96885 × 0.75771 = 26.496 (amu)

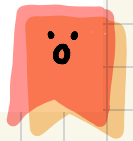
+

2.) 36.96590 × 0.24229 = 8.9565 (amu)

% 100

35.452 (amu) = Atomic Mass

If the relative atomic mass for Cl is 35.45, and the accurate masses of ^{35}Cl and ^{37}Cl are 34.97 and 36.97; What is the fractional abundance of ^{37}Cl ?



- Atomic mass Cl ⇒ 35.45
- Accurate Masses (Cl^{35} - Cl^{37}) ⇒ 34.97 - 36.97

* Fractional Abundance = Cl^{37} = ??

Accurate Mass (Cl^{35}) × Fractional Abundance (Cl^{37}) = Atomic Mass

(1) $(34.97 \otimes X) + (36.97 \otimes Y) = 35.45$ ----- (1)

(2) $X + Y = 100\%$ or 1 F.A → $\boxed{X = 1 - Y}$ ----- (2)

P.

$\rightarrow (34.97 \otimes (1 - y)) + (36.97 \otimes y) = 35.45$

$+ 34.97 - 34.97y + 36.97y = 35.45$

$2y = .48 \rightarrow y = .24229$

$y = .24$

All the Idea is here.

2.8 Naming Simple Compounds (Chemical nomenclature)

-nomenclature of some simple inorganic compounds

Naming ionic Compounds: (Cation - Anion) Formula

(Most ionic compounds contain **metal** + **nonmetal** atoms)

كيف أميّز؟؟ From the Periodic table

Cations

– Positively charged ions

– Formed from metals

– Atoms **lose** electrons

e.g., Na has 11 e^- and 11 p

Na^+ has 10 e^- and 11 p

Anions

– Negatively charged ions

– Formed from non-metals

– Atoms **gain** electrons

e.g., Cl has 17 e^- and 17 p

Cl^- has 18 e^- and 17 p

Examples:

NaCl

K_2SO_4 → polyatomic Anion

K^{+1} $(SO_4)^{-2}$

NH_4^{+1} + Cl^{-1}

Exception: $(NH_4)Cl$ → Polyatomic Cation

NH_4Cl → is an ionic Compound but doesn't Consist of metal + Non metal

TABLE 2.3 Common Monatomic Ions of the Main-Group Elements*

	IA	IIA	IIIA	IVA	VA	VIA	VIIA
Period 1							H^-
Period 2	Li^+	Be^{2+}	B	C	N^{3-}	O^{2-}	F^-
Period 3	Na^+	Mg^{2+}	Al^{3+}	Si	P	S^{2-}	Cl^-
Period 4	K^+	Ca^{2+}	Ga^{3+}	Ge	As	Se^{2-}	Br^-
Period 5	Rb^+	Sr^{2+}	In^{3+}	Sn^{2+}	Sb	Te^{2-}	I^-
Period 6	Cs^+	Ba^{2+}	Tl^+, Tl^{3+}	Pb^{2+}	Bi^{3+}		

metalloid — covalent — Transition metal

*Elements shown in color do not normally form compounds having monatomic ions.

➢ Rules for Predicting the Charges on Monatomic Ions:

1. In most main-group **metallic** elements:
   # charge = group number in the periodic table (the Roman numeral).
   group Number: → (3+4+5+6)
2. Some (metallic) elements of high atomic number have more than one cation:

(i) Common cations, charge = (group number – 2) #

(ii) Charge = group number.

Example (Pb): common ion Pb^{2+} in addition to Pb^{4+}

$SnCl_2$ — Tin (II), Chloride — +4, +2

3. Most transition elements form more than one monatomic cation.

-Most of these elements have one ion with a charge of 2+. Ag^{+1}

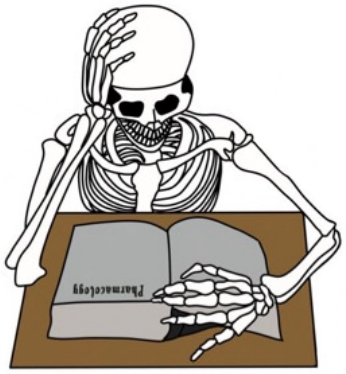
Examples: (Fe) has common cations Fe^{2+} and Fe^{3+}.

(Cu) has common cations Cu^{+} and Cu^{2+}.

4. Charge on a (monatomic) anion for a **nonmetallic main-group element** = (**group number – 8**). #

Example: (O) has the monatomic anion O^{2-}.

(The group number is 6; the charge is [(6-8)= -2]



➢ Rules for Naming Monatomic Ions

one Cation - one Anion.

الاسم الطبيعي للعنصر

1. Monatomic "cations" are named after the element if there is only one such ion. → (Transition metal) يعني هش / high atomic Number (main group metal)

Example: Al^{3+} is called aluminum ion; Na^{+} is called sodium ion.

TABLE 2.5 Monatomic Negative Ions "Anion" + ide

#	H^-	Hydride		C^{4-}	Carbide	N^{3-}	Nitride	O^{2-}	Oxide	F^-	Fluoride
			#	Si^{4-}	Silicide	P^{3-}	Phosphide	S^{2-}	Sulfide	Cl^-	Chloride
						# As^{3-}	Arsenide	# Se^{2-}	Selenide	Br^-	Bromide
						# Te^{2-}	Telluride	I^-	Iodide		

2. If there is more than one (monatomic) cation of an element → Rule 1 is not sufficient → Use "***Stock system***"

Transition element - main group metal (H.A.N) ⇒ have more than one Oxidation state

Example: Fe^{2+} is called iron(II) ion and Fe^{3+} is called iron(III) ion.

-Older system of nomenclature, such ions are named by adding the suffixes *-ous* and *-ic* to a stem name of the element to indicate the ions of lower and higher charge, respectively.

$Fe^{+2}Cl_2^{-1}$ Iron II Chloride $Fe^{+3}Cl_3^{-1}$ Iron III Chloride

Examples:

Fe^{2+} (ferrous ion) and Fe^{3+} (ferric ion)

Cu^{+} (cuprous ion) and Cu^{2+} (cupric ion)

Exeption (Ag^{+1})

- Few transition metal cations, such as Zn, have only a single ion → usually name them by just the metal name.
- Also, It's not wrong to name Zn^{2+} as zinc(II) ion. / Zinc - Ion ✓

3. The names of the monatomic **anions** are obtained from a stem name of the element followed by the suffix *-ide.*

Example: Br^- is called **bromide** ion, from the stem name *brom-* for bromine and the suffix *-ide.*

TABLE 2.4 Common Cations of the Transition Elements

Transition metal have one oxidation State

Ion	Ion Name
Cr^{+2}	Chromium II or Chromous
Cr^{3+}	Chromium(III) or chromic
Mn^{2+}	Manganese(II) or manganous
Fe^{2+}	Iron(II) or ferrous
Fe^{3+}	Iron(III) or ferric
Co^{2+}	Cobalt(II) or cobaltous
Ni^{2+}	Nickel(II) or nickel (more Common)
Cu^{+}	Copper(I) or cuprous
Cu^{2+}	Copper(II) or cupric
Zn^{2+}	Zinc
Ag^{+1}	Silver
Cd^{2+}	Cadmium
# Hg^{2+}	Mercury(II) or mercuric

Polyatomic Ions → Cation / Anion

(oxoanions) O^{+}

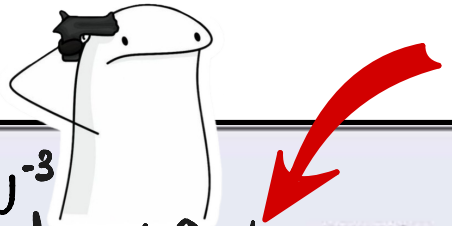


TABLE 2.5 Some Common Polyatomic Ions

(($Hg^{+1} + Hg^{+1} = Hg_2^{+2}$)) → $(Hg^{+1})^{X}$

Name	Formula
# Mercury(I) or mercurous	Hg_2^{2+}
Ammonium	NH_4^{+}
Cyanide	CN^{-}
Carbonate ← reference	CO_3^{2-}
Hydrogen carbonate (or bicarbonate)	HCO_3^{-}
Acetate → +H	$C_2H_3O_2^{-}$
Oxalate	$C_2O_4^{2-}$
Hypochlorite	ClO^{-}
Chlorite	ClO_2^{-}
Chlorate ← reference	ClO_3^{-}
Perchlorate	ClO_4^{-}
Chromate ← reference	CrO_4^{2-}
# Dichromate	$Cr_2O_7^{2-}$

- 2O
-O
+O

S^{-2} = Sulfide

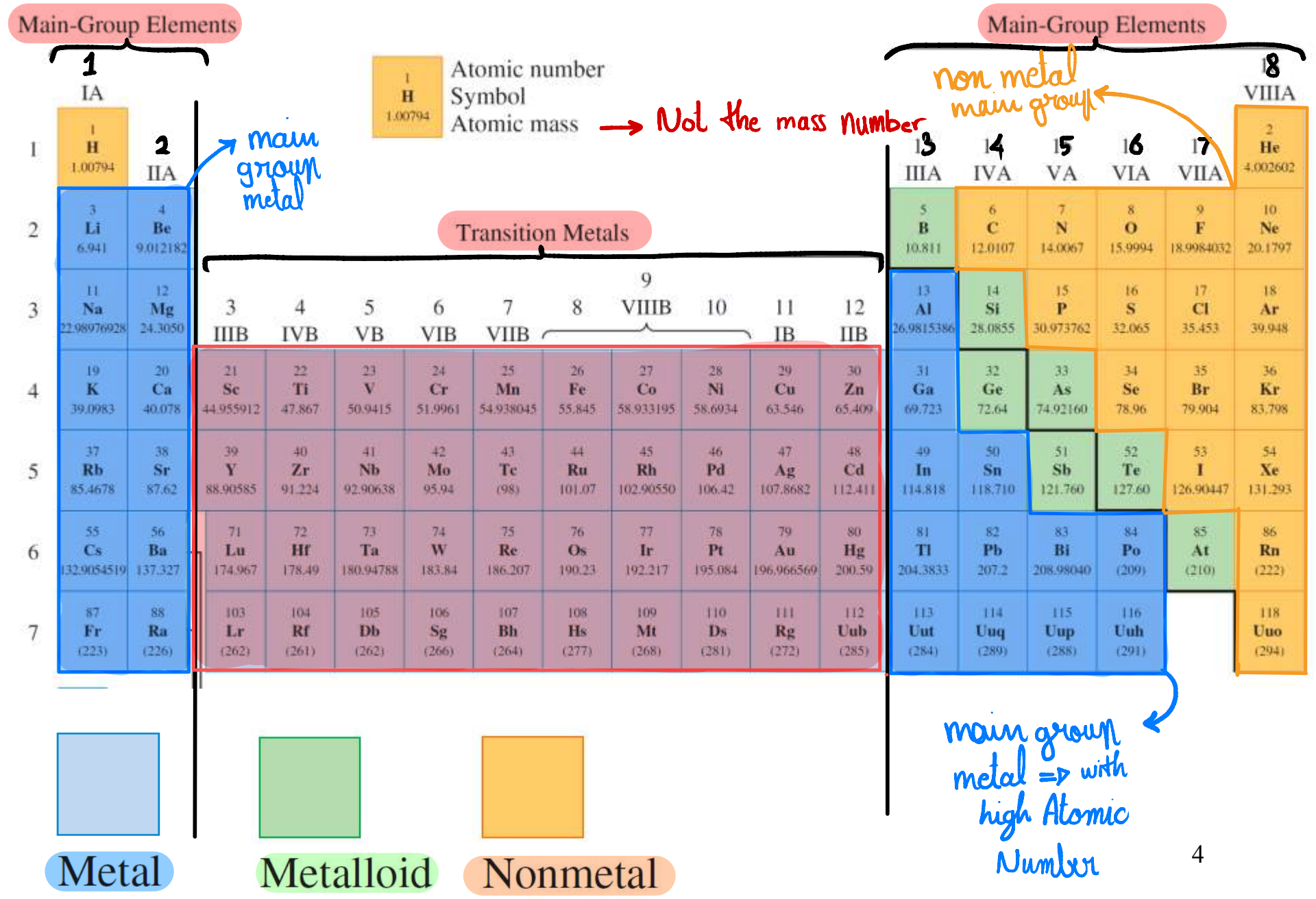
Nitride = N^{-3}

manganate = MnO_3^{-1}

Name	Formula
Permanganate	MnO_4^{-}
Nitrite	NO_2^{-}
Nitrate ← reference	NO_3^{-}
Hydroxide	OH^{-}
# Peroxide	O_2^{2-}
Phosphate ← reference	PO_4^{3-}
Monohydrogen phosphate	HPO_4^{2-}
Dihydrogen phosphate	$H_2PO_4^{-1}$
Sulfite	SO_3^{2-}
Sulfate ← reference	SO_4^{2-}
Hydrogen sulfite (or bisulfite)	HSO_3^{-1}
Hydrogen sulfate (or bisulfate)	HSO_4^{-1}
# Thiosulfate	$S_2O_3^{2-}$

* Iodate : IO_3^{-1}

Periodic Table of The Elements



➢ Polyatomic Ions

NO_2^- → nitrite ion

NO_3^- → nitrate ion

ClO^- → hypochlorite ion

ClO_2^- → chlorite ion

ClO_3^- → chlorate ion

ClO_4^- → perchlorate ion

Example:

1. K_2SO_4 : potassium Sulfate
2. K_2SO_3 : potassium Sulfite
3. K_2S : potassium Sulfide

Example:

1. KNO_3 : potassium Nitrate
2. KNO_2 : Potassium Nitrite
3. K_3N : potassium Nitride

Example 2.4

➢ Naming an Ionic Compound from Its Formula

(Q) Name the following compounds:

Metal → nonmetal

Mg_3N_2 : magnesium nitride (Mg = Main group metal)

$CrSO_4$: chromium(II) sulfate (Cr = Transition element)

$PbCrO_4$: Lead(II) chromate (Pb = high main group metal)

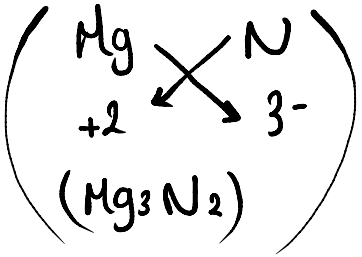
$FeCl_2$: Iron (II) chloride

$FeCl_3$: Iron (III) chloride

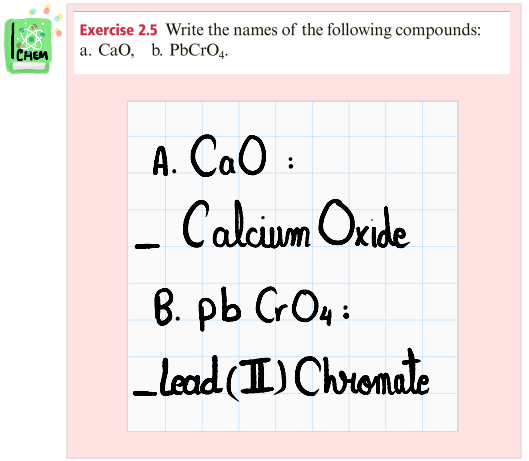
(Transition element)

Cr_2S_3: chromium(III) sulfide (Cr = Transition element)

"Criss-cross" rule



- K_2O — potassium oxide
- $(NH_4)ClO_3$ — ammonium chlorate (Polyatomic Cation)
- $Mg(C_2H_3O_2)_2$ — magnesium acetate ($(CH_3COO)^-$)
- Cr_2O_3 — chromium(III) oxide
- $ZnBr_2$ — zinc bromide (Transition metal with one Oxidation State)



(Q) Determine The Formula of the following compounds: Using the Criss Cross Rule

- Calcium hydroxide — $Ca(OH)_2$
- Manganese(II) bromide — $MnBr_2$
- Ammonium phosphate — $(NH_4)_3PO_4$
- # Mercury(I) Fluoride — Hg_2F_2 → $\times\frac{1}{2}$ = HgF ✗
- # Mercury(II) Fluoride — HgF_2
- Mercury(I) nitride — $(Hg_2)_3N_2$
- Iron(II) phosphate — $Fe_3(PO_4)_2$
- # Titanium(IV) oxide — TiO_2 → Ti_2O_4
- # Thallium(III) nitrate — $Tl(NO_3)_3$

Example 2.5

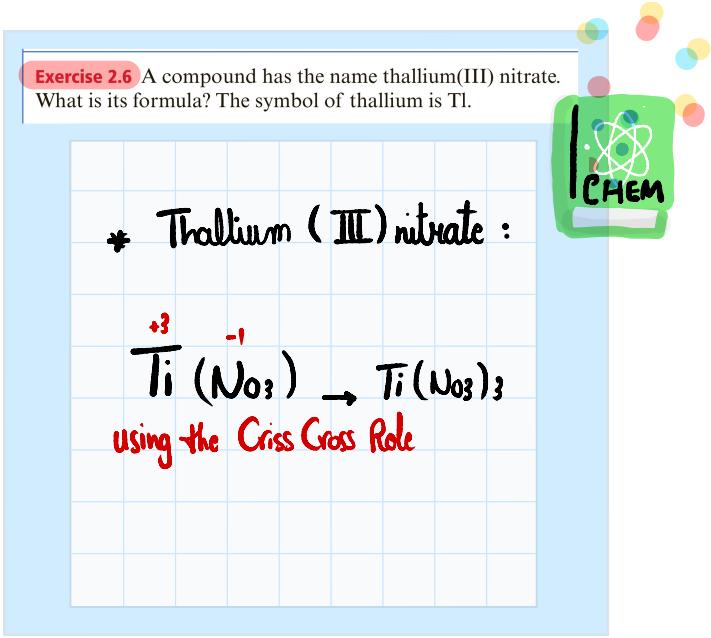
(Q) Which is the correct name for Cu_2S?

↳ Transition metal with one Oxidation State

A. copper sulfide
B. copper(II) sulfide
C. copper(II) sulfate
D. copper(I) sulfide
E. copper(I) sulfite

(Q) Which is the correct formula for ammonium sulfite?

A. NH_4SO_3
B. $(NH_4)_2SO_3$
C. $(NH_4)_2SO_4$
D. NH_4S
E. $(NH_4)_2S$



(Q) Name the following compounds:

(a) $Fe(NO_3)_2$ → Iron (II) Nitrate

(b) Na_2HPO_4 → Sodium MonoHydrogen phosphate

(c) $(NH_4)_2(C_2O_4)$ → Ammmnium Oxalate

(Q)Write chemical formulas for the following compounds:

(a) cesium sulfide → Cs_2S

(b) calcium phosphate → $Ca_3(PO_4)_2$

JU. MEDICINE

$FeCl_2$ → Fe^{+2} iron, Cl^- chloride → iron (II) chloride — Ferrous chloride

$FeCl_3$ → Fe^{+3} iron, Cl^- chloride → iron (III) chloride — Ferric chloride

iron (II) chloride, iron (III) chloride ⟶ Stock system [iron (II), iron (III)]

Elements which have more than one oxidation state:

1- Transition metals except Zn / Ag / Cd

2- Ga, In, Sn, Tl, Pb, Bi, Po, ... (main group metal high A.M)

- $MgCl_2$

magnesium chloride ✓

magnesium (II) chloride ✗ ⟶ because Mg has only one oxidation state

- $SnCl_2$

Tin (II) Chloride

- CaH_2

Calcium hydride

- NaH

Sodium hydride

Naming Hydrates

1. Name ionic compound
2. Give number of water molecules in formula using Greek prefixes

$Ca(SO_4).2H_2O$: calcium sulfate dihydrate

$CoCl_2.6H_2O$: cobalt(II) chloride hexahydrate

$FeI_3 \cdot 3H_2O$: iron(III) iodide trihydrate

$Fe(NO_2)_3.9H_2O$: iron(III) nitrite nonahydrate

* If ($Fe(NO_2)_3.9H_2O$) was heated and all the water was heated name the Resulting Compound :

anhydrous Iron (III) nitrate

anhydrous $\xleftarrow{\Delta}$ Hydrate

TABLE 2.6

Greek Prefixes for Naming Compounds

Number	Prefix
1	mono-
2	di-
3	tri-
4	tetra-
5	penta-
6	hexa-
7	hepta-
8	octa-
9	nona-
10	deca-

Naming Molecular Compounds:

(Non-metal + Non-metal) **or** **(Non-metal + Metalliod)**

-binary compounds: *composed of only two elements*

e.g. NaCl, $MgCl_2$ (**ionic**). CO, H_2O, CCl_4, NH_3 (**molecular**)

-Order of Elements in the Formula:

In ionic compounds: metal → non-metal

NaCl not ClNa

In molecular compounds:

*

Element	B	Si	C	Sb	As	P	N	H	Te	Se	S	I	Br	Cl	O	F
Group	3A	4A		5A					6A			7A				

NF_3 not F_3N

H_2S not SH_2

SbH_3 not H_3Sb

➢ Rules for Naming Binary Molecular Compounds

1. The name of the compound has the elements in the order given in the previous formula.
2. Name the first element using the exact element name.
3. Name the second element by writing the stem name of the element with the suffix *-ide*
4. You add a prefix, derived from the Greek, to each element name to denote the subscript of the element in the formula.

Note: the **prefix *mono-*** is not used, unless it is needed to distinguish two compounds of the same two elements. ⇒ بنحط الـ (Mono) لما يكون في أكثر من صيغة للمركب ...

Element	B	Si	C	Sb	As	P	N	H	Te	Se	S	I	Br	Cl	O	F
Group	3A	4A		5A					6A			7A				

Examples:

N_2O_3	dinitrogentrioxide
HCl	hydrogen chloride
CO	carbon monoxide
CO_2	carbon dioxide
SF_4	sulfur tetrafluoride
SF_6	sulfur hexafluoride

NOT ~~monohydrogen~~ monochloride

There is no HCl_2 - HCl_3 Mono مابنحكي

"Mono" العنصر الأول مابنحطلو

ClO_2	chlorine dioxide
Cl_2O_7	dichlorine heptoxide

x ← Heptaoxide

H_2S dihydrogen sulfide — common name: hydrogen sulfide

NO nitrogen monoxide — common name: nitric oxide

H_2O water – *Dihydrogen monoxide*

NH_3 ammonia – *Nitrogen trihydride*

NO_2 nitrogen dioxide

N_2O dinitrogen monoxide

N_2O_4 dinitrogen **tetroxide** #

P_4O_6 tetraphosphorus **hexoxide** #

Cl_2O_6 dichlorine hexoxide

PCl_3 phosphorus trichloride

PCl_5 phosphorus pentachloride

Example - 2.6

Exercise - 2.7

* hecta + Oxide → Hect Oxide
* tera + Oxide → Tetr Oxide
* hexa + Oxide → hex oxide

disulfur dichloride S_2Cl_2 → SCl ✗

tetraphosphorus trisulfide P_4S_3

carbon disulfide CS_2

sulfur trioxide SO_3

Example - 2.7

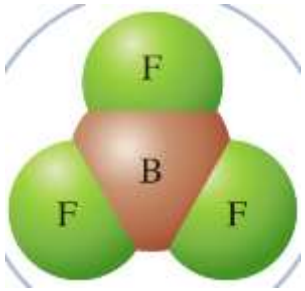
Exercise - 2.8

البسيط فقط لل "Ionic Compound"

إذا أعطاكِ الإسم وحكالك بدي الـ Formula فاخلك بـ .... charge الـ

nitrogen dioxide NO_2 / ClF Chlorine monofluoride

Example - 2.8



Exercise - 2.9

Boron trifluoride

BF_3

Common Name

Hydrogen selenide

Or dihydrogen selenide

H_2Se

عشان نقدر نميّز بين المركبات (Molecular - Ionic) ← بنرجع ← Periodic table ال

$GaBr_3$	Gallium (III) bromide	Ionic
$GeBr_4$	Germanium tetrabromide	Molecular
$CaBr_2$	Calcium bromide	Ionic
$Hg_2(NO_2)_2.H_2O$	Mercury(I) nitrite monohydrate	Ionic

Acids and Corresponding Anions

Corresponding anion

Anion Suffix	Acid Suffix
-ate	-ic
-ite	-ous

Acid	Contains	Name
HNO_3	→	nitrate anion therefore nitric acid (ate to ic)
HNO_2	→	nitrite anion therefore nitrous acid (ite to ous)

Table 2.8 Some Oxoanions and Their Corresponding Oxoacids

having no charge

Oxoanion (O + non metal)		Oxoacid (H + O + non metal)	
CO_3^{2-} + $2H^+$	Carbon**ate** *ion*	H_2CO_3	Carbon**ic** *acid*
NO_2^- + H^+	Nitr**ite** *ion*	HNO_2	Nitr**ous** *acid*
NO_3^- + H^+	Nitr**ate** *ion*	HNO_3	Nitr**ic** *acid*
PO_4^{3-} + $3H^+$	Phosph**ate** *ion*	H_3PO_4	Phosphor**ic** *acid*
SO_3^{2-} + $2H^+$	Sulf**ite** *ion*	H_2SO_3	Sulfur**ous** *acid*
SO_4^{2-} + $2H^+$	Sulf**ate** *ion*	H_2SO_4	Sulfur**ic** *acid*
ClO^- + H^+	**Hypo**chlor**ite** *ion*	HClO	**Hypo**chlor**ous** *acid*
ClO_2^- + H^+	Chlor**ite** *ion*	$HClO_2$	Chlor**ous** *acid*
ClO_3^- + H^+	Chlor**ate** *ion*	$HClO_3$	Chlor**ic** *acid*
ClO_4^- + H^+	**Per**chlor**ate** *ion*	$HClO_4$	**Per**chlor**ic** *acid*

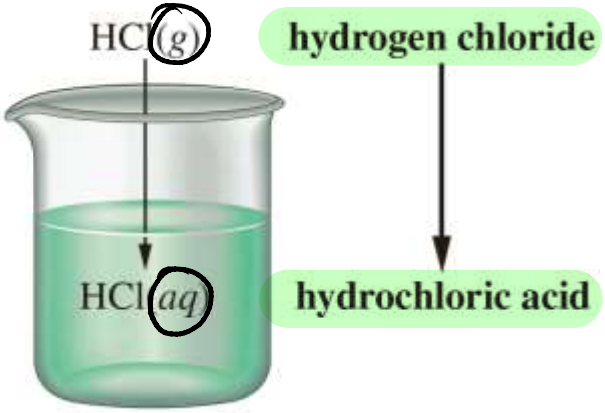
Binary Compound

HBr(g), hydrogen bromide
HF(g), hydrogen fluoride

Molecular compound

Acid Solution

*hydro*bromic acid, HBr(aq)
*hydro*fluoric acid, HF(aq)



إذا ما ذكر السؤال "
إنو Solution نعتبره
" Binary

Example 2.9

(Q)Selenium has an oxoacid, H_2SeO_4, called selenic acid. What is the formula and name of the corresponding anion?

Remove the (H)

Selenate SeO_4^{2-}

Exercise 2.10

What are the name and formula of the anion corresponding to perbromic acid, $HBrO_4$?

BrO_4^- perbromate

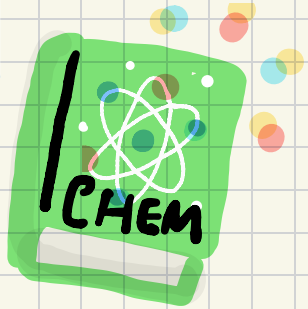
Example 2.10 Naming a Hydrate from Its Formula

Gaining Mastery Toolbox

Epsom salts has the formula $MgSO_4 \cdot 7H_2O$. What is the chemical name of the substance?

→ $MgSO_4 \cdot 7H_2O$ = Magnesium Sulfate – heptahydrate

Ionic Compound



Exercise 2.11 Washing soda has the formula $Na_2CO_3 \cdot 10H_2O$. What is the chemical name of this substance?

See Problems 2.91 and 2.92.

→ $Na_2CO_3 \cdot 10H_2O$ = Sodium Carbonate – decahydrate

Ionic Compound

Example 2.11 Writing the Formula from the Name of a Hydrate

Gaining Mastery Toolbox

Critical Concept 2.11

The mineral gypsum has the chemical name calcium sulfate dihydrate. What is the chemical formula of this substance?

$Ca(SO_4) \cdot 2H_2O$

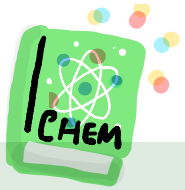
Exercise 2.12 Photographers' hypo, used to fix negatives during the development process, is sodium thiosulfate pentahydrate. What is the chemical formula of this compound?

See Problems 2.93 and 2.94

$Na_2(S_2O_3) \cdot 5H_2O$

➢ Chemical Reactions: Equations 2:9 + 2:10

Example 2.12 Balancing Simple Equations



Balance first the atoms for elements that occur in only one substance on each side of the equation.

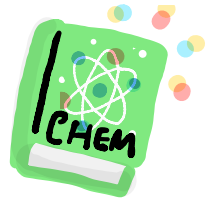
(a) $H_3PO_3 \rightarrow H_3PO_4 + PH_3$

(b) $Ca + H_2O \rightarrow Ca(OH)_2 + H_2$

(c) $Fe_2(SO_4)_3 + NH_3 + H_2O \rightarrow Fe(OH)_3 + (NH_4)_2SO_4$

Exercise 2.13

Find the coefficients that balance the following equations.



a. $O_2 + PCl_3 \rightarrow POCl_3$

b. $P_4 + N_2O \rightarrow P_4O_6 + N_2$

c. $As_2S_3 + O_2 \rightarrow As_2O_3 + SO_2$

d. $Ca_3(PO_4)_2 + H_3PO_4 \rightarrow Ca(H_2PO_4)_2$

Example 2.12 :

A) $4\,H_3PO_3 \rightarrow 3\,H_3PO_4 + PH_3$

B) $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$

C) $Fe_2(SO_4)_3 + 6NH_3 + 6H_2O \rightarrow 2Fe(OH)_3 + 3(NH_4)_2SO_4$

H

Exercise : 2.13 :

A) $\frac{1}{2}O_2 + 2PCl_3 \rightarrow 2POCl_3$ — حل سريع

B) $P_4 + 6N_2O \rightarrow P_4O_6 + 6N_2$

C) $2As_2S_3 + \frac{9}{2}O_2 \rightarrow 2As_2O_3 + 6SO_2$

D) $Ca_3(PO_4)_2 + 4H_3PO_4 \rightarrow 3Ca(H_2PO_4)_2$

Some Notes :

* يفضل أخلي الـ (H - O) آخر اشي بالموازنة ...
* يجب أن تكون المعادلة بأبسط صورة ...
* الـ Coefficients = عدد صحيح ...

Examples:

(Q)When the following equation is balanced and written with the smallest whole number coefficients, what is the coefficient of Al? 8

$$3Fe_3O_4 + 8Al \rightarrow 4Al_2O_3 + 9Fe$$

(Q) When the following equation is balanced and written with the smallest whole number coefficients, what is the sum of coefficients of Al and Fe? 17

$$Fe_3O_4 + Al \rightarrow Al_2O_3 + Fe$$

(Q) When the following equation is balanced and written with the smallest whole number coefficients, what is the sum of all coefficients?

$$Fe(OH)_3 + 3HNO_3 \longrightarrow Fe(NO_3)_3 + 3\,H_2O$$

The equation is Balanced => The Sum = 1 + 3 + 1 + 3 = 8

Q38. Name the following compounds: ($MnSO_3 . H_2O$ / $CuI(O3)$

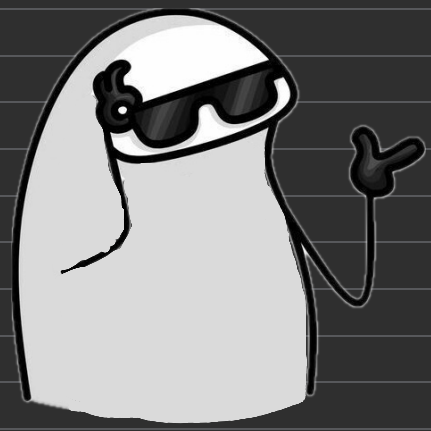
a) Magnesium Sulfate monohydrate / Copper(l) iodide

b) Manganese(ll) sulfide hydrate/ Copper (l) iodate

c) Manganese (II) sulfite monohydrate/Copper(l) iodate

d) Manganese (II) Sulfate monohydrate/Copper(l) iodate

e) Manganese(ll) thiosulfate monohydrate / Copper(I) iodide



Q39. Name the following compounds: $MgSO_4.7H_2O$ / **Ni**$(lO_4)_2 . H_2O$

a) Magnesium Sulfate heptahydrate / Nickel (II) periodate monohydrate

b) Manganese(ll) Sulfate heptahydrate / Nickel iodide monohydrate

c) Magnesium thiosulfate heptahydrate / Nickel (II) periodate hydrate

d) Magnesium (II) Sulfate heptahydrate / Nickel periodate monohydrate

e) Magnesium sulfite heptahydrate/ Nickel periodate monohydrate.

Q41. Name the following compounds: (MnS.3H_2O / $Cs_3P.H_2O$)

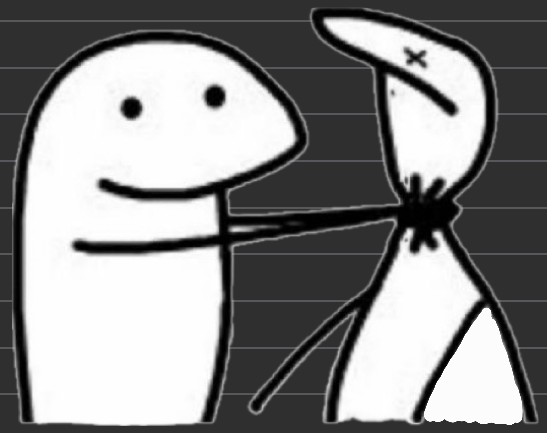
a) Manganese (II) Sulfate trihydrate / Cesium phosphide monohydrate

b) Magnesium (II) Sulfide trihydrate / Cesium phosphate monohydrate

c) Manganese (ll) Sulfite trihydrate / Cesium phosphide monohydrate

d) Manganese (II) Sulfide trihydrate/ Cesium phosphide monohydrate

e) Manganese (II) Sulfate trihydrate/Cesium phosphate monohydrate.



Q44. Which one of the following is correct?

a)The name of Fe_2O_3 is iron(ll) oxide

b)The name of MnO_2 is manganese(ll) oxide

c)The name of Cr_2O_3 is chromium (III) oxide

d)The name of CrO_3 is chromium trioxide

e)The name of Cu_3N_2 is copper(ll) nitrite

Learning Objectives	Important Terms
2.1 Atomic Theory of Matter	
▪ List the postulates of atomic theory. ▪ Define *element, compound,* and *chemical reaction* in the context of these postulates. ▪ Recognize the atomic symbols of the elements. ▪ Explain the significance of the law of multiple proportions.	**atomic theory** **atom** **element** **compound** **chemical reaction** **atomic symbol** **law of multiple proportions**
2.2 The Structure of the Atom	
▪ Describe Thomson's experiment in which he discovered the electron. ▪ Describe Rutherford's experiment that led to the nuclear model of the atom.	**nucleus** **electron**
2.3 Nuclear Structure; Isotopes	
▪ Name and describe the nuclear particles making up the nucleus of the atom. ▪ Define *atomic number, mass number,* and *nuclide.* ▪ Write the nuclide symbol for a given nuclide. ▪ Define and provide examples of *isotopes* of an element. ▪ Write the nuclide symbol of an element. **Example 2.1**	**proton** **atomic number (Z)** **neutron** **mass number (A)** **nuclide** **isotope**
2.4 Atomic Weights	
▪ Define *atomic mass unit* and *atomic weight.* ▪ Describe how a *mass spectrometer* can be used to determine the *fractional abundance* of the isotopes of an element. ▪ Determine the atomic weight of an element from the isotopic masses and fractional abundances. **Example 2.2**	**atomic mass unit (amu)** **atomic weight** **fractional abundance**
2.5 Periodic Table of the Elements	
▪ Identify periods and groups on the periodic table. ▪ Find the *main-group* and *transition* elements on the periodic table. ▪ Locate the *alkali metal* and *halogen* groups on the periodic table. ▪ Recognize the portions of the periodic table that contain the *metals, nonmetals,* and *metalloids* (*semimetals*).	**periodic table** **period (of periodic table)** **group (of periodic table)** **metal** **nonmetal** **metalloid (semimetal)**

2.[illegible] Chemical Formulas; Molecular and Ionic Substances

- [illegible]etermine when the *chemical formula* of a compound represents a *molecule.*
- Determine whether a chemical formula is also a *molecular formula.*
- Define *ion, cation,* and *anion.*
- Classify compounds as *ionic* or *molecular.*
- Define and provide examples for the term *formula unit.*
- Specify the charge on all substances, ionic and molecular.
- Write an ionic formula, given the ions. **Example 2.3**

chemical formula
molecule
molecular formula
polymer
monomer
ion
anion
cation
ionic compound
formula unit

[illegible] Organic Compounds

- L[illegible]t the attributes of molecular substances that make them *organic compounds.*
- Explain what makes a molecule a *hydrocarbon.*
- Recognize some *functional groups* of organic molecules.

organic compound
hydrocarbon
functional group

2.[illegible] Naming Simple Compounds

- Recognize *inorganic compounds.*
- Learn the rules for predicting the charges of *monatomic ions* in ionic compounds.
- Apply the rules for naming monatomic ions.
- Learn the names and charges of common *polyatomic ions.*
- Name an ionic compound from its formula. **Example 2.4**
- Write the formula of an ionic compound from its name. **Example 2.5**
- Determine the order of elements in a *binary (molecular) compound.*
- Learn the rules for naming binary molecular compounds, including the Greek prefixes.
- Name a binary compound from its formula. **Example 2.6**
- Write the formula of a binary compound from its name. **Example 2.7**
- Name a binary molecular compound from its molecular model. **Example 2.8**
- Recognize molecular compounds that are acids.
- Determine whether an acid is an *oxoacid.*
- Learn the approach for naming binary acids and oxoacids.
- Write the name and formula of an anion from the acid. **Example 2.9**
- Recognize compounds that are *hydrates.*
- Learn the rules for naming hydrates.
- Name a hydrate from its formula. **Example 2.10**
- Writ[illegible] the formula of a hydrate from its name. **Example 2.11**

chemical nomenclature
inorganic compound
monatomic ion
polyatomic ion
binary compound
oxoacid
hydrate

2.[illegible] Writing Chemical Equations

- Identify the *reactants* and *products* in a chemical equation.
- Write chemical equations using appropriate phase labels, symbols of reaction conditions, and the presence of a catalyst.

chemical equation
reactant
product

2.[illegible] Balancing Chemical Equations

- Determine if a chemical reaction is balanced.
- Master the techniques for balancing chemical equations. **Example 2.12**

Done by: Joud Jaber

Thank you