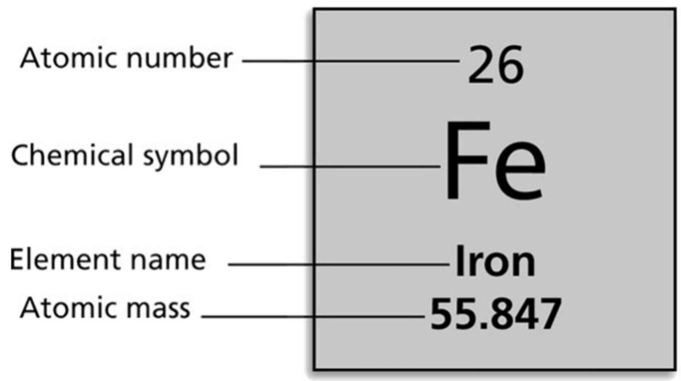
Elements

The *atomic number* (Z, # protons, p^+) can be used to identify the type of element being studied on the periodic table



Atomic Number

of p^+ and e^-

Determines name and symbol of element

Avg Atomic Mass

The *mass* of an atom in atomic mass units (*amu*)

1

Isotope Notation

Isotopes are commonly written in two notation forms, based on the Atomic Number, Mass Number, and/or number of neutrons (n^o)

$$^{23}_{11}\text{Na}$$

$^{23}_{11}Na$

Sodium-23

23 = Mass Number (*Top*)
11 = Atomic Number (*Bottom*)
Na = Element (*Sodium*)

23 = Mass Number (*Left*)
Sodium = Element (*Na*)
Also: Na-23

2

Isotope Recap

Isotopes are Based on the Following Recap Table

Isotope Notation

$$^{X}_{Y}A$$

Element A - X

Subatomic Particles

Y = Atomic Number

Element Name, Element Symbol (A)
Number protons (p^+)
Number electrons (e^-)

X = Mass Number

Protons (p^+) + Neutrons (n^o)

Neutrons (n^o) = Mass # - Atomic #
Neutrons (n^o) = X - Y

3

Subatomic Particles

Counting Valence Electrons (e^-) [*Representative Groups*]

Valence Electrons are based on group on the table

Group	Name	Val e^-	Group		Val e^-
1A (1)	Alkali Metals	1	5A (15)	Pnictogens	5
2A (2)	Alkali Earth Metals	2	6A (16)	Chalcogens	6
3A (13)	Earth Metals	3	7A (17)	Halogens	7
4A (14)	Carbon Group	4	8A (18)	Noble Gases	8

4

Subatomic Particles

Counting Valence Electrons (e^-) [*Transition Metals*]

Valence Electrons are based on group on the table
Transition Metals can have 1 – 7 valence electrons (*base 2*)

Group	3B (3)	4B (4)	5B (5)	6B (6)	7B (7)	8B (8)	8B (9)	8B (10)	1B (11)	2B (12)
Element	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Possible Valence electron	3	3 4	2 3 4 5	2 3 4 6	2 3 4 5 7	2 3 6	2 3	2 3	1 2 3	2

5

Subatomic Particles

Ion Charge

Charge of an ion is based on the group on the periodic table

Cation (+ ion): Ions formed due to gaining electrons (*metals*)
Anion (- ion): Ions formed due to losing electrons (*non-metals*)

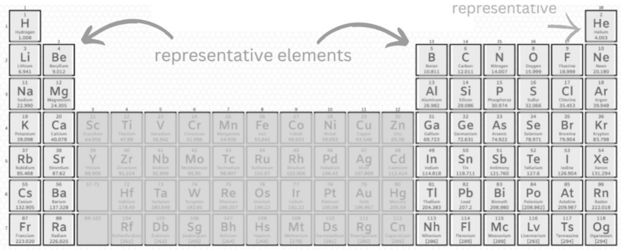
Group	Val e^-	Charge	Group	Val e^-	Charge	Group	Val e^-	Charge
1A (1)	1	1+	**3A (13)**	3	3+	**6A (16)**	6	2-
2A (2)	2	2+	**4A (14)**	4	4+ / 4-	**7A (17)**	7	1-
1B – 10B (3 – 12)	2 (Varies)	Varies	**5A (15)**	5	3-	**8A (18)**	8	No Charge

6

Periodic Blocks

Representative Elements

Elements that lose (*cation, +*) or gain (*anion, -*) a fixed number of valence electrons (val e^-)



Representative Metals

Groups 1A (1), 2A (2), and Al
Lose a fixed number of electrons

Representative Non-Metals

Groups 4A, 5A, 6A, 7A, and 8A
(*Above Zig-Zag Line*)
Gain a fixed number of electrons

Metalloids

B, Si, Ge, As, Sb, Te, Po, At (*Zig Zag Line*)
Can lose (*cation, +*) or gain (*anion, -*) electrons (e^-)

7

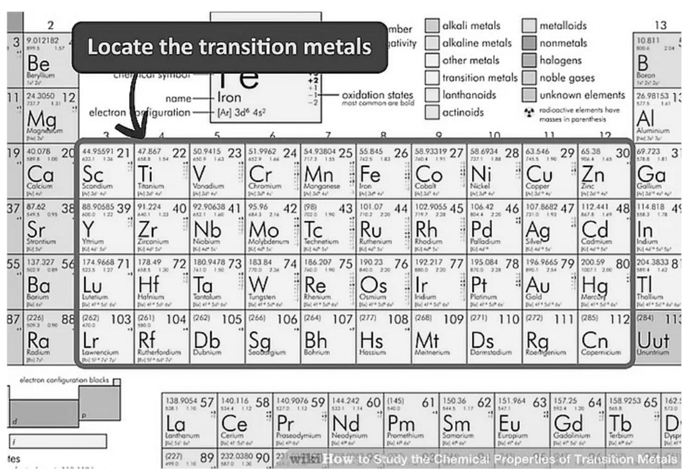
Periodic Blocks

Transition Elements

Elements in the *b groups* on the periodic table

The following elements below the zig-zag line are commonly also considered transition elements

3A (13): In, Tl
4A (14): Sn, Pb
5A (15): Bi



Transition Elements

Groups 1B (3) – 10B (12)

8

Periodic Blocks

Rare Earth Elements

Elements in the very bottom (*extended table, center*) of the table. Rare Earth elements are commonly unstable with no or few stable *isotopes*. These elements are common in nuclear radiation (*U, Pu, Ac, Ce, etc.*)

Lanthanide Series	57 **La** 138.905 Lanthanum	58 **Ce** 140.116 Cerium	59 **Pr** 140.908 Praseodymium	60 **Nd** 144.242 Neodymium	61 **Pm** (145) Promethium	62 **Sm** 150.36 Samarium	63 **Eu** 151.964 Europium	64 **Gd** 157.25 Gadolinium	65 **Tb** 158.925 Terbium	66 **Dy** 162.500 Dysprosium	67 **Ho** 164.930 Holmium	68 **Er** 167.259 Erbium	69 **Tm** 168.934 Thulium	70 **Yb** 173.045 Ytterbium	71 **Lu** 174.967 Lutetium
Actinide Series	89 **Ac** (227) Actinium	90 **Th** 232.038 Thorium	91 **Pa** 231.036 Protactinium	92 **U** 238.029 Uranium	93 **Np** (237) Neptunium	94 **Pu** (244) Plutonium	95 **Am** (243) Americium	96 **Cm** (247) Curium	97 **Bk** (247) Berkelium	98 **Cf** (251) Californium	99 **Es** (252) Einsteinium	100 **Fm** (257) Fermium	101 **Md** (258) Mendelevium	102 **No** (259) Nobelium	103 **Lr** (266) Lawrencium

Rare Earth Elements consist of two groups: *Lanthanides* and *Actinides*

Elements above Uranium (*U*) are called *trans-uranium elements* and (*with exception of Np and Pu*) do not occur in nature naturally.

9

Formation of Ions

Comparing Ionization Energy and Electron Affinity

Energy required to remove an electron from atom to form an ion

Element Type	Ionization Energy	Electron Affinity
Metals (0 – 4 Valence Electrons)	Low IE (*easy to lose* e^-) Atoms want to lose e^-	Low EA (*Low desire to gain* e^-) Atoms don't want e^-
Non-Metals (5 – 8 Valence Electrons)	High IE (*hard to lose* e^-) Atoms don't want to lose e^-	High EA (*High desire to gain* e^-) Atoms want to gain e^-

In general: Atoms always want to lose heat (*q*), - to become more stable

10

Atomic Stability – Z-Ratio (n^o:p^+ Ratio)

The Stability of an isotope of an atom is based on the relationship between protons (p^+) and neutrons (n^o) in an atom. Atoms with too many or too new n^o will become unstable.

Z-Ratio

Ratio between the protons (p^+) and neutrons (n^o) in the atom.

$$\text{Z-Ratio} = \frac{\#n^o\ (\textit{neutrons})}{\#p^+\ (\textit{protons})}$$

Most stable isotopes of elements have the following ratios:

Small (1 – 20): 1.0 – 1.2

Medium (1 – 54): 1.2 – 1.3

Large (55 – 82): 1.4 – 1.5

No Stable Isotopes Above 82

11

Solving for Half-Life

The following are equations to solve for particles at given half-life

$$\mathrm{N}(t) = \frac{\mathrm{N_0}}{0.5^{\mathrm{n}}} \qquad N(t) = N_0 \left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$$

n = number of HL

t = elapsed time

$t_{1/2}$ = half-life of the substance

$N(t)$ = quantity remaining

N_0 = initial quantity

12