

SCIENCE AND ENGINEERING MATERIALS

Atomic Structure

by

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Chapter Description

- Learning Objectives
 - Describe the nature and structure of an atom
 - Define atomic mass and atomic number of elements
 - Describe orbital and electron valence theory
 - Describe the trends of elements' physical and chemical properties in periodic table



Why we need to study atomic structure

- Atom is the fundamental building block of matter
- Help us to visualize the anatomy of atom, its interaction and behaviour (can predict the properties of matter/materials)



Atomic Structure: The Bohr Model

Atomic number:

The number of electrons or protons

Orbital electrons:

n = principal quantum number

Example: Iron

26 electron=26 protons

Nucleus:

$Z + N = \# \text{ protons} + \# \text{ neutrons}$

Atomic mass: $A \approx Z + N$

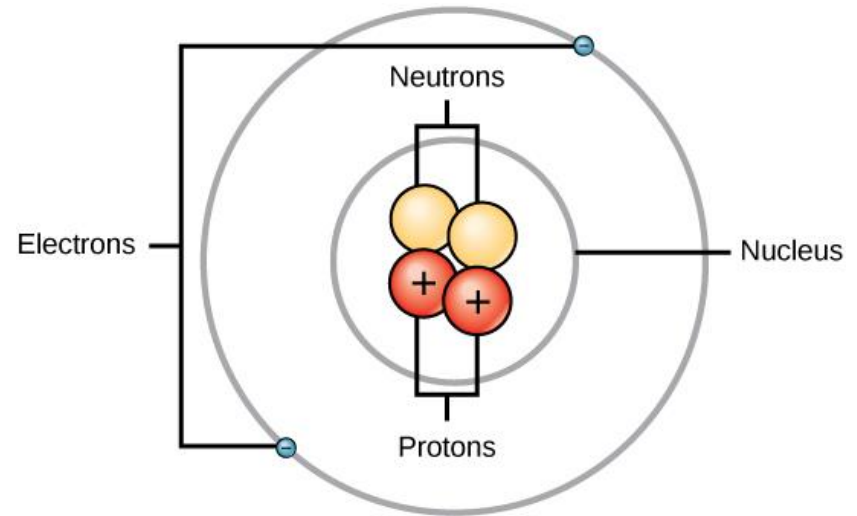
Atomic weight:

Dimensionless physical quantity. Corresponds to the ratio of the average mass of atoms of an element to 1/12 of the mass of an atom of carbon from a given source.

Example: Iron 55.85 g/mol

Electron?

Avogadro's Number = 6.023×10^{23} atoms/mol



Source: [CNX OpenStax](#); [Wikimedia](#)

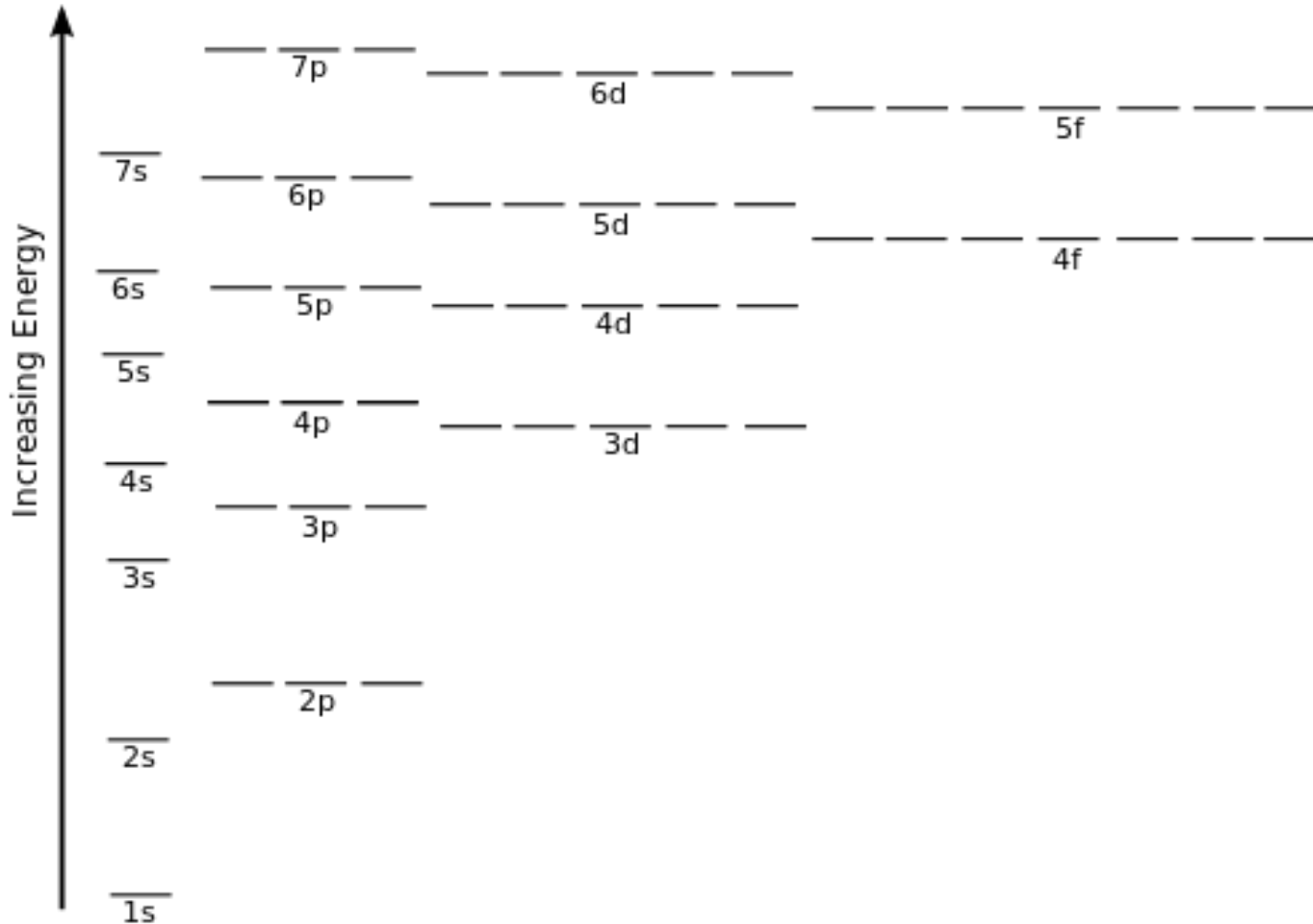


Atomic Structure: Valence Electrons

- Atoms with filled shells is more stable
- Valence electrons: Unfilled shells
- Valence electrons are readily available for atomic bonding –tend to control the chemical properties of elements.
 - example: Carbon (atomic number = 6) has 4 electron valence.
 - Electron configuration of Carbon:
 - $1s^2 2s^2 2p^2$



Atomic Structure: Orbital Energy Level



Source: [CK-12 Foundation, Adrignola](#); [Wikimedia](#)



Atomic Structure: Periodic Table

Group 1 18

Periodic Table of the Elements

1 H 1.01 Hydrogen																	2 He 4.00 Helium
3 Li 6.94 Lithium	4 Be 9.01 Beryllium											5 B 10.81 Boron	6 C 12.11 Carbon	7 N 14.01 Nitrogen	8 O 15.99 Oxygen	9 F 18.99 Fluorine	10 Ne 20.18 Neon
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminum	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.09 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 51.99 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.41 Zinc	31 Ga 69.72 Gallium	32 Ge 72.64 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.79 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc [98] Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Cesium	56 Ba 137.3 Barium	57-71 La-Lu * Lanthanides	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.8 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 196.9 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 208.9 Bismuth	84 Po [209] Polonium	85 At [210] Astatine	86 Rn [222] Radon
87 Fr [223] Francium	88 Ra [226] Radium	89-103 Ac-Lr ** Actinides	104 Rf [261] Rutherfordium	105 Db [262] Dubnium	106 Sg [266] Seaborgium	107 Bh [264] Bohrium	108 Hs [277] Hassium	109 Mt [268] Meitnerium	110 Ds [269] Darmstadtium	111 Rg [272] Roentgenium	112 Cn [285] Copernicium	113 Uut [284] Ununtrium	114 Fl [289] Flerovium	115 Uup [288] Ununpentium	116 Lv [293] Livermorium	117 Uus [294] Ununseptium	118 Uuo [294] Ununoctium
* 57 La 138.9 Lanthanum, 58 Ce 140.1 Cerium, 59 Pr 140.9 Praseodymium, 60 Nd 144.2 Neodymium, 61 Pm [145] Promethium, 62 Sm 150.4 Samarium, 63 Eu 151.9 Europium, 64 Gd 157.3 Gadolinium, 65 Tb 158.9 Terbium, 66 Dy 162.5 Dysprosium, 67 Ho 164.9 Holmium, 68 Er 167.3 Erbium, 69 Tm 168.9 Thulium, 70 Yb 173.1 Ytterbium, 71 Lu 174.9 Lutetium																	
** 89 Ac [227] Actinium, 90 Th 232.0 Thorium, 91 Pa 231.0 Protactinium, 92 U 238.0 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] Mendeleevium, 102 No [259] Nobelium, 103 Lr [262] Lawrencium																	

- All Elements are positioned according to its electron configuration
- Basic important information that can be obtained from periodic table:
 - Atomic Number
 - Atomic Mass

Atomic Number → 1

Symbol → H

Relative Atomic Mass → 1.01

Name → Hydrogen

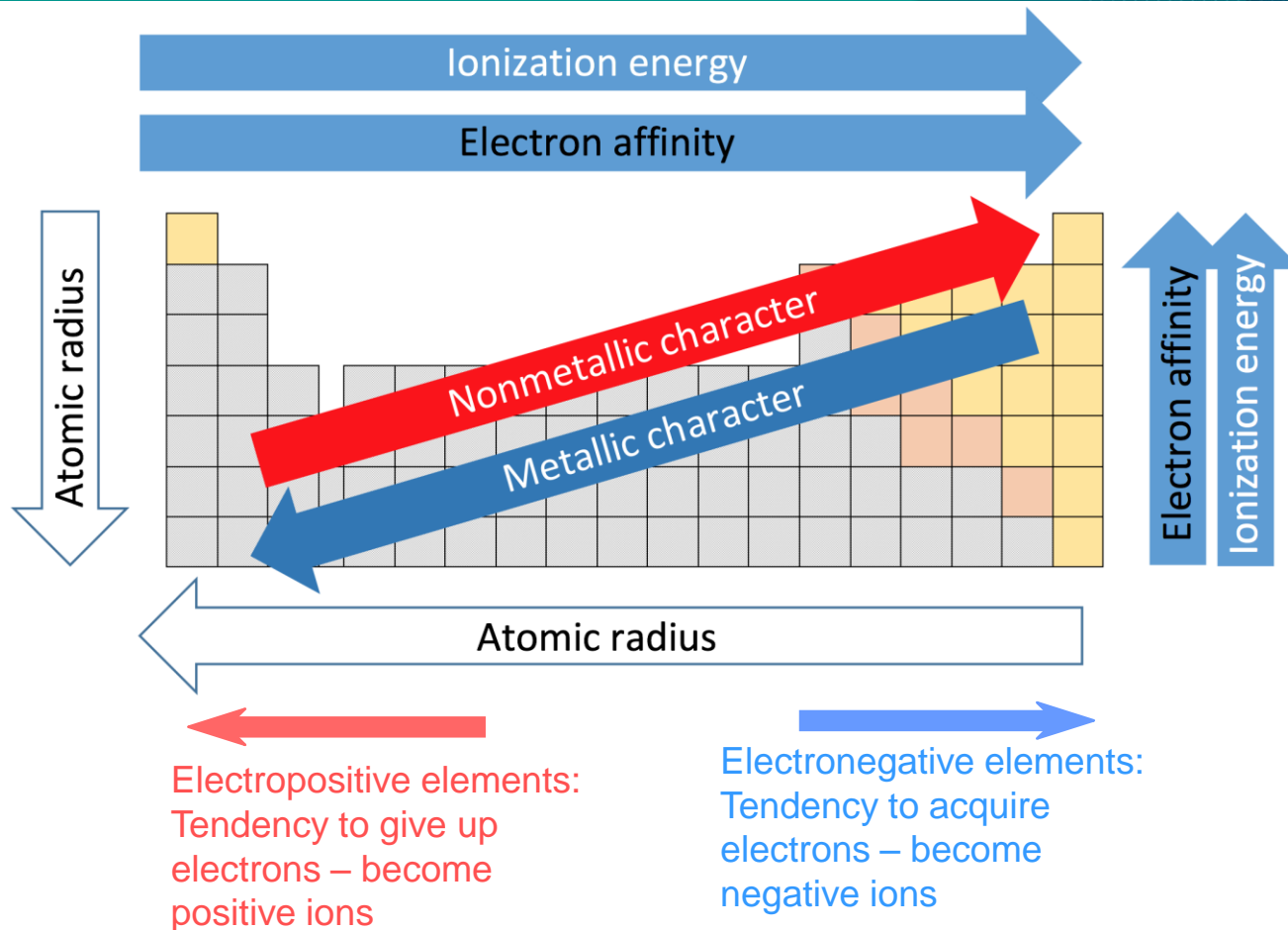
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 Other non-metals	 Noble gases
 Alkali metals	 Lanthanides
 Transition metals	 Actinides
 Other metals	 Unknown chemical properties
 Alkaline earth metals	
 Halogens	

Source: [CNX OpenStax](#); [Wikimedia](#)



Atomic Structure: Periodic Table



Source: [Sandbh](#); [Wikimedia](#)



Conclusion of The Chapter

- Atoms are comprised of three particles
 - Proton
 - Neutron
 - Electron
- Nucleus of atom contains proton and neutron
- Negatively charged electron orbits the nucleus of atom
- The atomic number: the number of protons
- The mass number: sum of protons and neutrons



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