

Atoms, Elements, and the Building Blocks of Matter

6
C
12.0

- 1: atomic number (number of protons, electrons in neutral element)
- 2: symbol for element
- 3: molar mass (number of protons + neutrons)

isotopes: atoms of an element with different numbers of neutrons

Periodic Table Groups:

- group 1 alkali metals
- group 2 alkaline earth metals
- group 3-12 transition metals
- group 17 halogens
- group 18 noble gases

Moles & Molecules

$$1 \text{ mol} = 6.022 \times 10^{23} \text{ molecules}$$

$$\text{molarity (M)} = \frac{\text{moles of solute}}{\text{liters of solution}}$$

Some Types of Problems

percent composition multiply number of atoms in compound by their atomic mass, divide by total atomic mass

empirical & molecular formulas assume 100g sample, use atomic mass to convert to moles, compare mole ratio

↳ empirical = "reduced" form

Coulomb's Law

$$E = \frac{kq_1q_2}{r^2}$$

E = energy
k = Coulomb's constant
q₁ = magnitude of nucleus charge
q₂ = magnitude of electron charge
r = distance between charges

Energy & Electromagnetic Radiation

When atoms absorb electromagnetic radiation, they jump to higher energy levels.



$$E = h\nu$$

E = energy change (J)

h = Planck's constant ($6.626 \times 10^{-34} \text{ J}\cdot\text{s}$)

ν = frequency (s^{-1})

Frequency & Wavelength

$$c = \lambda\nu$$

c = speed of light

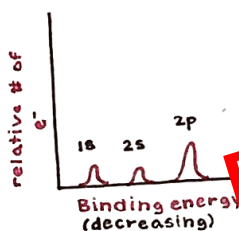
λ = wavelength (m)

ν = frequency (s^{-1})

speed of light:
 $2.998 \times 10^8 \text{ m}\cdot\text{s}^{-1}$

Photoelectron Spectroscopy

incoming radiation energy = binding energy + kinetic energy (of ejected electron)



Configuration rules:

Aufbau principle electrons are filled in orbitals/shells in order of increasing energy

Pauli exclusion principle: paired electrons in the same orbital cannot have the same spin

Hund's rule: when electrons are added to a subshell, they occupy an empty orbital if possible

paramagnetic - at least 1 unpaired electron - attracted to magnets

diamagnetic - no unpaired electrons

Periodic Trends

atomic radius

increases (downward arrow)

decreases (upward arrow)

cations < atoms < anions

ionization energy

decreases (downward arrow)

increases (upward arrow)

2nd IE > 1st IE

ionization energy makes a big jump after a shell is empty

electronegativity

decreases (shielding increases) (downward arrow)

increases (number of protons increases) (upward arrow)

Explanations for Periodic Trends

Coulomb's law: electrons are attracted to the protons in the nucleus

- the closer an electron is to the nucleus, the more strongly it is attracted
- the more protons in the nucleus, the more strongly electrons are attracted

electrons are repelled by other electrons

"shielding" - valence electrons repelled by inner e⁻

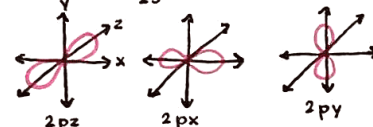
atoms will add or subtract valence electrons to complete shells, if possible

orbital shapes

s-orbital: spherical



p-orbital: dumbbell



d-orbital: 4 daisy-shape
1 axial-shape



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Page 1 of 1