Isotopes

Aug. 25. 2023

Isotopes = the same element with different # of n^0 (or e^- (ions))

Weighted Average = isotope that is most abundant has a mass equal (closest) to what is on the periodic table. Ex:

$$\boxed{^{12}C} \qquad \left.\begin{aligned} p^+ &= 6 \\ n^0 &= 6 \\ e^- &= 6 \end{aligned}\right\} = 12 \text{ at. mass}$$

$\uparrow$ more of these

$$^{13}C \qquad \left.\begin{aligned} p^+ &= 6 \\ n^0 &= 7 \\ e^- &= 6 \end{aligned}\right\} 13 \text{ at. mass}$$

Atomic mass of: 12.011 for carbon

$$\overset{I_1}{(\text{mass} \times \%)} + \overset{I_2}{(\text{mass} \times \%)} = \text{Av. Atomic mass} = \text{amu} = \text{atomic mass units}$$

IB

Ions

Aug. 29

↳ = charged atom (+ or −)

Cat ion = positively charged, formed through removal of electrons

↳ metals form cat ions

An ion = negatively charged atom

↳ formed by adding electrons

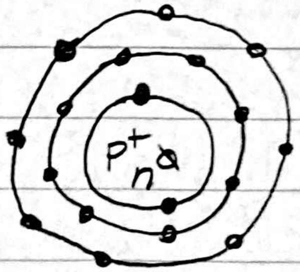
↳ formed by non-metals

Ions = responsable for bonding

Bohr Model

→ describes where electrons are found

aka Planetary Model



protons, nutrons found in nucleus

Electrons in at least 3 orbits:

2, 4, 4 per "shell"

Outer shell = valence shell

Ions formed by electron movement in the valence shell (V_e)

ex: Calcium has $2e^-$ in valence shell

-metal → to become a cation, Ca loses $2e^-$

Ca^{2+} $\underline{Ca^{+2}}$ $20p^+$ $20n^0$ e-18

Metric Conversions

Sept. 5. 2023

Base units

most used
(m) = meters → length
(g) = grams → mass
(L) = liters → volume

(s) = seconds → time

Converting = not changing value, just representation (change units)

Equivalence Statement / Conversion Statement

$$\frac{1\,m}{100\,cm}$$ same

- start with unit + # you want to convert
- what unit do you want to end in?

Conversion Statement

$$\left.\frac{16m}{1}\right|\frac{100\,cm}{1\,m} = \frac{1600\,\cancel{m}\,cm}{1\,\cancel{m}} = 1600cm$$

Converting 16m to cm.

87cm to m

$$\left.\frac{87cm}{}\right|\frac{1m}{100cm} = \frac{87\,\cancel{cm}\,m}{100\,\cancel{cm}} = .87\,m$$

2023
Sep. 19

Physical vs. Chemical Changes

- Physical Change
  - ↳ Does not form new substance
    - Ex: Tear paper, boil water

} Can get original substance back from change

- Chemical Change
  - ↳ Creates new substance
- Ex: Sodium+ Chlorine → $Na+Cl=NaCl$ = table salt

  Individually have dramatic reations to human ingestion
  - ↳ Reaction = Chemical Change

$$^{42}_{20}Ca^{2+}$$

- Atomic num. = 20
- $p^{+}=20$ • $n^{0}=22$ • $e^{-}=18$
- 2 more p^{+} than e^{-}
- Ion = charged
- Isotope = change in n^{0} count or ion

Density

Sep. 21. '23

$\text{Density} = \frac{\text{mass}}{\text{volume}}$ ← (any units) ←

$\frac{m}{v}$

- Used to identify substances
- Conversion factor:

1. Au (gold) → place on balance → weighs 42g
→ find volume through displacement

$\frac{19g}{mL}$ = gold's density

↳ (read at miniscus: bottom of liquid lip)

↳ 6mL worth of gold

$\frac{42g}{6mL} = 7g/mL$ → not gold, different density than gold

2. 15g of Pb $\quad d_{Pb} = \frac{31g}{mL}$

$\frac{15g}{mL}\Big|\frac{mL}{31g} = 0.48mL$ of Pb for 15g

Sep. 28
2023

Light & Quantized Energy

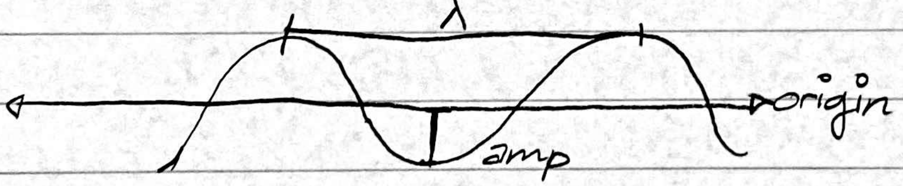
- In 1900's scientists found elements emit different color when heated

↳ Analysis found that light color was related to electron arrangement

- Visible light is a type of electromagnetic radiation

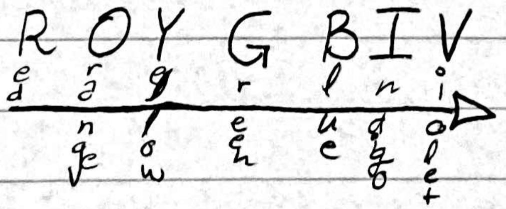
- Wavelength (λ) shortest distance between equivalent points on contin. wave
- Frequency (ν) # of waves that pass a point per seconds
- Amplitude: height of wave from origin to crest

↳ Wavelength (λ) distance between two crests on same side of origin



Speed of light, "c", $= \lambda\nu$ → as $\lambda\uparrow$, $\nu\downarrow$ & vice versa

Lower Energy
Lower Freq.
Longest λ



Higher Energy
Higher Freq.
Shortest λ

- Matter gains / loses energy: quanta

↳ 1 quantum is minimum amount of energy gainable / looseable

J = joules = measure of energy

photon → has no mass but carries energy

Orbitals

↳ Each energy sublevel relates to obritals of different shape

↳ Aufbau principle: each electron occupies the lowest power level availible

↳ A single orbital can contain 2 electrons, if they have opposite spin directions

d-orbitals → starts one level up

Ti: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^2$

Only Noble gases

Noble Gas Config. = [ ] = to include all e^-

He, Ne, Ar, Kr, Xe, Rn

Find the noble gas that comes before desired element

Ex: Sr[Kr]$5s^2$ Ex: Ba[Xe]$6s^2$

Ex: Fe[Ar]$3d^6 4s^2$

Isoelectric: Same electron config:

O^{-2}	Na^{+1}	Mg^{+2}
$1s^2 2s^2 2p^6$	$1s^2 2s^2 2p^6$	$1s^2 2s^2 2p^6$

Valence orbital → highest energy level → if 4 s, p; do not include 3d!

Spin Diagram electron configuration

↳ **Ions** are formed by the transfer of valence e^-

Cation → Remove from valence (highest energy level) + **Metals are Cations**

d-orbitals

↳ Silver, Cadmium, & Zinc make multiple ion formations

$Mn \rightarrow 1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^2$ ← Take from highest: "4s"

$Mn^{2+} \rightarrow 1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 \cancel{4}$ ↲ Looses 2 e^- from "4s"

$Mn^{5+} \rightarrow 1s^2 2s^2 2p^6 3s^2 3p^6 3d^2$ ↲ Moves to next highest energy level

↑↓	↑↓	↑↓	↑↓	↑↓	↑	Na
$1s^2$	$2s^2$	$2p_x$	$2p_y$	$2p_z$	$3s^1$	

- Up arrow 1st
- ★ Must fill single before double

N ↑↓ ↑↓ ↑ ↑ ↑ | ~~↑↓ ↑↓ ↑↓ ↑ _~~

O ↑↓ ↑↓ ↑↓ ↑ ↑

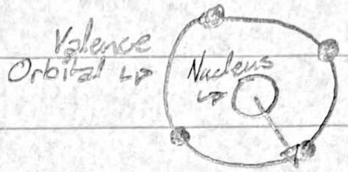
Spin Diagram

Periodic Trends part 1

Oct. 17
2023

(Atomic
·Diameter)

Radius



Distance from nucleus to valence orbital

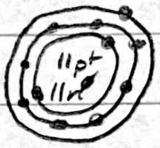
Atomic = neutral atom

- distance ½ atom's diameter → Think of circular model

Ionic

Larger, another energy level

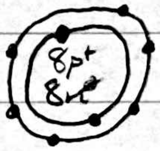
- Cation = (+); loses e^- → Na



Na^+

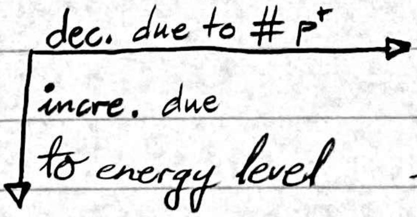
- Anion = (-); gains e^-

O



O^{2-}

gets larger due to addition of e^-



} How orbital size changes depending on whether one moves vertically or horizontally across the periodic table

Periodic Trends part 2

Oct.19.2023

Atomic Radius

- Distance & Force are inversely related in atoms

  Atomic radius decreases →
  p^+ increasing

- E^- repel each other, more e^- = more expansion of orbital

Electronegativity → Ability of an atom to attract an e^- to itself, "Tug of War between atoms of different elements"

P^+ attract e^-

p^+ increasing →
electoneg. increases

decrease in electro neg., due to increase in distance ↓

Florine is the most electroneg. atom

Both Atom. radius & electro neg. change due to change in p^+ count, and energy level

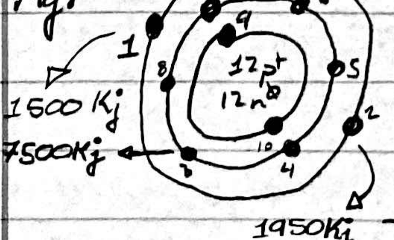
Ionization energy → energy it takes to remove an electron from an atom (use Bohr model to visualize)

More energy required →
More p^+ count

decrease due to increased distance with more energy levels ↓

Successive Ionization → (Bohr to visualize)

Mg:



Valence e^-

e^- #1,

e^- #2

Greatest difference in cost of energy is between energy levels

Core e^- = all others

e^- #3 and on

costs much more energy, per energy level, as electrons are much closer to nucleus

Backside →

Successively removing e^-:

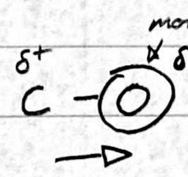
Ex: $\underbrace{\overset{I_1}{500}, \overset{I_2}{6000}}_{\text{Largest jump, 1 valence electron}}, \overset{I_3}{6600}, \overset{I_4}{6900}, \overset{I_5}{7800}, \overset{I_6}{8300}$ (in Kilo joules)

Polarity

Oct. 24, 2023

↳ seperation of elec. charge → leads to a bond or molecule having positive and negative ends

- ∴ unequal pull or <u>sharing of electrons</u> ← covalent bond
- based on electronegativity
  - ↳ Atom's tendency to attract e^-

Ex: 

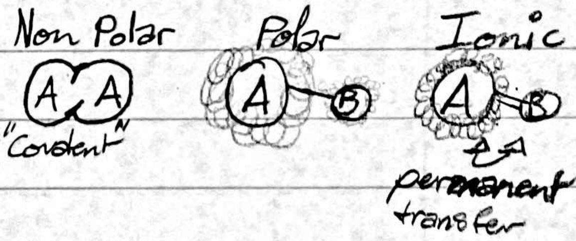
- polarity indicated by δ^+ and δ^-

★ Non polar bond → not charged → covalent bonds
both atoms are from non-metal section of peri. table

↳ "pure covalent bond"

↳ Usually same element

↳ Diatomic



★ Polar bond

↳ AKA Polar Covalent

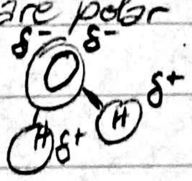
↳ Usually 2 different elements

↳ Non-metal side of peri. table

↳ diff. electronegativity, at least of 0.5

↳ Pull of e^- is unequal

↳ Most bonds are polar

↳ Ex: H_2O: 

Hydrogen forms covelant bonds

★ Ionic Bond:

↳ Metal ↔ Non-metal bond

↳ All bonds between metal ↔ non-metal are ionic

↳ Not sharing e^-, permanently transferred

Covalent Bonds and Names

Subscript → # of that atom in a compound; if 1, it is unessisary

Ex: CO = 1 carbon, 1 oxygen

CO_2 = 1 carbon, 2 oxygen

$C_{25}H_{52}$ = 25 carbon, 52 hydrogen

Naming:

final element changes suffix

S_2O_3 → disulfertrioxide

2 sulfer, 3 oxygen

Type I = "s" & "p" orbitals

1. Use charges to form a neutral compound
2. Name it
   ↳ Write the cation first ↳ Write anion second ↳ Leave cation, anion's suffix is "-ide"
3. Subscripts for # of atoms of certain elements

Polyatomics & Acids

Polyatomics → "Multiple atoms", ↳ function as one unit
↳ Charged (Need to balance)
↳ they keep their name ↳ Leave the subscripts attached!

Ex: CO_3^{2-} Na^+ → Na_2CO_3 → Sodium carbonate

↳ Use parenthesis for multiple polies

Al^{3+} NO_2^{1-} → $Al(NO_2)_3$ → Aluminum nitrite

Al^{3+} NO_3^{1-} → $Al(NO_3)_3$ Aluminum nitrate

Ca^{2+} SO_4^{2-} → $CaSO_4$ → Calcium sulfate

Acids → Starts with a hydrogen ↳ CH_4 is not an acid
2 types: ↳ HCl is an acid

$\boxed{1}$ Acids with oxygen
↳ Use polyatomic to name
○ "ic" is suffix, comes from "ate"
Ex: HNO_3 NO_3^- → nitrate
nitric acid ↲
HNO_2 NO_2^- → nitrite
nitrous acid ↲ "ite"-"ous"

$\boxed{2}$ No Oxygen
prefix → "hydro", base of element, suffix "ic"
HCl → Hydrochloric Acid

D-orbitals → Must be charge balenced; need Roman Numeral in name, indicates charge on the Cation

Ex: Fe^{2+}, Fe^{3+}

↳ FeO

Fe_2O_3

need charge!

iron ↓ oxide

↳ O^{2-}

Don't put the Roman Numeral in the formula!

Ex: Ni_2S → S^{2-} → Ni^{1-} } nickel (I) sulfide

Balancing Equations

Nov 10.2023

- Same # & type of atom on each side of equation
  - ↳ Conservation of mass!

Ex: $\underbrace{CaCl_2 + Na_2O}_{\text{Reactants}} \xrightarrow[\text{produces}]{\text{yields}} \underbrace{CaO + NaCl}_{\text{products}}$

Subscripts = # of atom in compound

$Ca^{2+}\ Cl^{1-} + Na^{+}\ O^{-} \rightarrow Ca^{2+}O^{2-} \quad Na^{+}Cl^{-}$

Coefficients: atom balance shows conservation of mass

Method 1: "Guess & Check"

$CaCl_2 + Na_2O \rightarrow CaO + \underset{*}{2}NaCl$

Atom table

	R	P	
Ca	1	1	
Cl	2	1	$\}2$
Na	2	1	
O	1	1	

$\left.\begin{matrix} NaCl \\ NaCl \end{matrix}\right\} \underset{*}{2}$

Method 2: Alg.

$\underset{a}{\underline{\ \ }}CaCl_2 + \underset{b}{\underline{\ \ }}Na_2O \longrightarrow \underset{c}{\underline{\ \ }}NaCl + \underset{d}{\underline{\ \ }}CaO$

Ca	1a = 1d	a = 1
Cl	2a = 1c	b = 1
Na	2b = 1c	c = 2
O	1b = 1d	d = 1

Nov. 14, 2023

Diatomic Elements

- When isolatated in reaction, they're not an ion, instead diatomic

Ex: $SrO + F_2 \rightarrow SrF_2 + O_2$

- Oxygen in compound → not diatomic → when isolated = diatomic (O)
- Double replacements & cations get new partners

Ex: $Ba(OH)_2 + Al_2(CO_3)_3 \rightarrow BaCO_3 + Al(OH)_3$

1. Predict products and charge balance

Ba^{2+} OH^- Al^{3+} CO_3^{2-}

$$\underset{a}{\underline{\ 6\ }}\, Ba(OH)_2 + \underset{b}{\underline{\ 2\ }}\, Al_2(CO_3)_3 \rightarrow \underset{c}{\underline{\ 6\ }}\, BaCO_3 + \underset{d}{\underline{\ 4\ }}\, Al(OH)_3$$

Ba: $1a = 1c$ — a: 6

$2a + 9b = 3c + 3d$ — b: 2

Al: $2b = 1d$ — c: 6

H: $2a = 3c$ — d: 4

C: $3b = 1c$

Combustion Rxn

Memorize products

burns in oxygen — hydrocarbon → hydrogen + carbon

produces $\boxed{H_2O + CO_2}$

Ex: $CH_4 + O_2 \rightarrow 2H_2O + CO_2$

4 oxygen — 4 oxygen

Types of reactions & Balancing

Nov. 16. 2023

Double Replacement

- Each cation gets new anion partners per compound

Ex: $AlBr_3 + K_2SO_4$

↳ Al^{3+} Br^{-1} K^+ SO_4^{2-}

$\rightarrow Al_2(SO_4)_3 + KBr$

★ $2AlBr_3 + 3K_2SO_4 \rightarrow Al_2(SO_4)_3 + 6KBr$

! Don't forget to atom balance !

Ex: $3Mg(OH)_2 + 2K_3PO_4 \rightarrow Mg_3(PO_4)_2 + 6K(OH)$

Single Replacement

Ex: $4AlF_3 + 3O_2 \rightarrow 2Al_2O_3 + 6F_2$

- Cation changes partners, diatomics switch

Combustion Reaction

Ex $C_{12}H_{26} + O_2 \rightarrow CO_2 + H_2O$

$2C_{12}H_{26} + 37O_2 \rightarrow 24CO_2 + 26H_2O$

} Double hydrocarbon compound
Balance atoms

Synthesis → Combination / coming together

Synthesis Reaction

- 2 or 3 compounds become 1

Ex: $H_2 + O_2 \rightarrow H_2O$ * $2H_2 + O_2 \rightarrow 2H_2O$

↓

Decomposition Reaction

atom balancing

↑

Ex: $H_2O_2 \rightarrow H_2O + O_2$ * $2H_2O_2 \rightarrow 2H_2O + O_2$

Phase States (4 to memorize)

Liquid (l) *must be pure*
Solid (s)
Gas (g)
Aqueous (aq) *in water*
→ Solute in solvant

state of compound derives from distance of atoms = energy of compound (temperature)

Activity Series - Single Replacements

- ordering system for elements based on their reactivity relative to other elements

Ex: $AB + C \rightarrow AC + B$

If "B" is more reactive than "C", then no reaction

Ex: $AB + C \rightarrow AB + C$

If "C" is more reactive than "B", there is a reaction

Mole & Molar Mass

Nov. 30. 2023

Mole describes specific amount

$1\text{ mol} = 6.022 \times 10^{23}$ ↔ Avagadro's number

↔ Only used for atoms, molecules or formula units in chemistry

• Conversion factor Ex's:

8 mol → atoms:

$$\begin{array}{c|c} 8\text{ mol} & 6.022E^{23} \\ \hline & 1\text{ mol} \end{array} = 4.82E^{24}\text{ atoms}$$

400 atom → mol:

$$\begin{array}{c|c} 400 & 1\text{ mol} \\ \hline & 6.022E^{23} \end{array} = 6.64E^{-22}\text{ mol}$$

Periodic Table = atomic mass → $\frac{\text{grams}}{\text{mol}}$ → $\left(\frac{g}{mol}\right)$

Ex:

C: $12.011\frac{g}{mol}$

N: $14.01\frac{g}{mol}$