Final Review

MEMORIZATION:

- Polyatomic Ions:

NO_3^- Nitrate	NO_2^- Nitrite
SO_4^{2-} Sulfate	SO_3^{2-} Sulfite
PO_4^{3-} Phosphate	PO_3^{3-} Phosphite
CO_3^{2-} Carbonate	HCO_3^- Hydrogen Carbonate
CN^- Cyanide	NH_4^+ Ammonium
OH^- Hydroxide	ClO^- Hypochlorite
$CH_3CO_2^-$ Acetate	

- Solubility Rules:
  1. Salts containing 1A elements (Li^+, Na^+, K^+, Cs^+, Rb^+) are soluble.
  2. Ammonium ion is soluble (NH_4^+)
  3. Nitrate ion is soluble (NO_3^+)
  4. Chlorine, Bromine, Iodine (Cl^-, Br^-, I^-) are soluble. EXCEPTIONS - (Ag^+, Pb^{2+}, and Hg_2^{2+})
  5. Silver salts are insoluble. EXCEPTIONS - ($AgNO_3$, and $Ag(C_2H_3O_2)$)
  6. Sulfate salts are soluble (SO_4^{2-}) EXCEPTIONS - ($BaSO_4$, $PbSO_4$, and $SrSO_4$)
- Prefixes:

Number	Prefix
1	Mono
2	Di
3	Tri
4	Tetra
5	Penta
6	Hexa
7	Hepta
8	Octa
9	Nona
10	Deca

- Conversions:

Celsius to Kelvin: ℃ + 273	Celsius to Fahrenheit: ℃ (9/5) + 32
1 mol = 6.022 X 10^{23} atoms	1000(mg) = 1(g), 1000(g) = 1(kg), 1000(kg) = 1 metric ton
10(mm) = 1(cm), 100(cm) = 1(m), 1000(mm) = 1 (m), 1000(m) = 1(km)	12(in) = 1(ft), 36(in) = 1(yd), 3(ft) = 1(yd), 5280(ft) = 1(mile)
16(oz) = 1(lb), 2000(lb) = 1(t)	

- Gas Laws:

Gas Law Formula		
Gas Law	**Formula**	**Description**
Boyle's Law	$P_1V_1 = P_2V_2$	At constant *T*, as pressure increases, volume decreases.
Charles' Law	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$	At constant P, as volume increases, temperature increases.
Gay-Lussac's Law	$\frac{P_1}{T_1} = \frac{P_2}{T_2}$	At constant V, as pressure increases, temperature increases.
Combined Law	$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$	Obtained by combining Boyle's Law, Charles' Law and Gay-Lussac's Law.
Ideal Gas Law	$PV = nRT$	

V = volume in dm^3 T = temperature in K	P = pressure in kPa n = number of moles	R = ideal gas constant

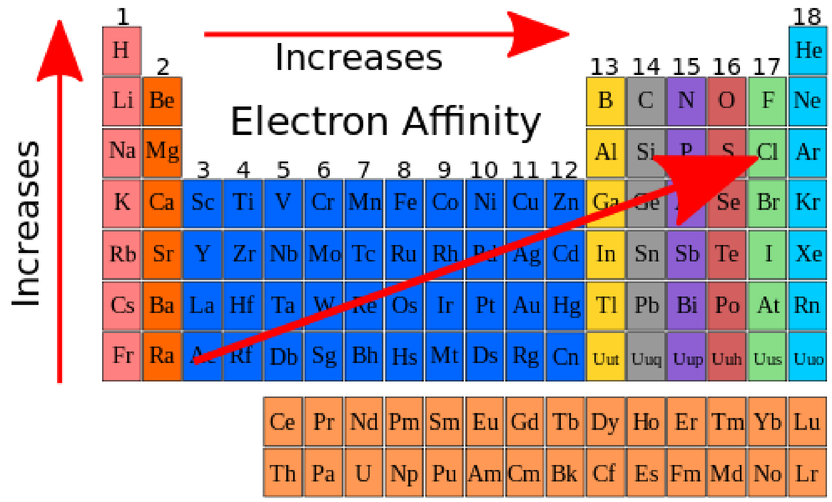
- Conversions:

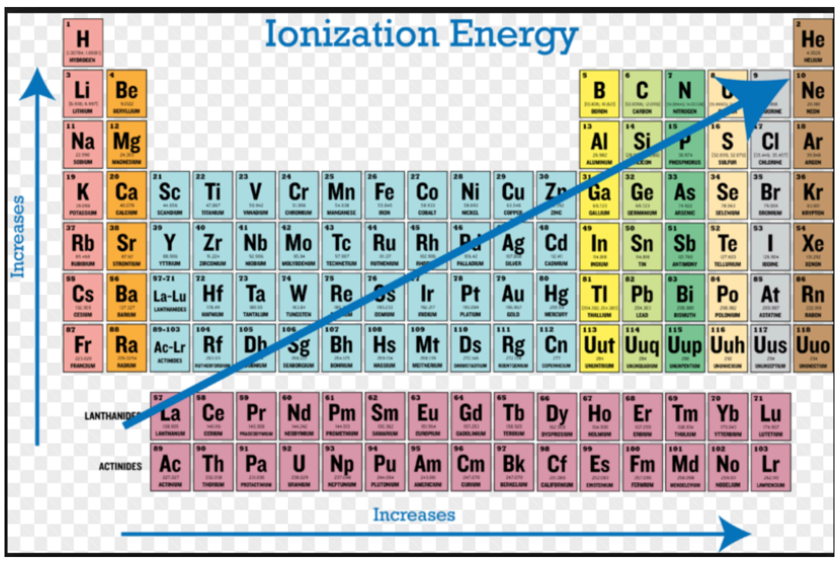
1 atm = 760 torr = 760 mmHg	1 atm = 1.01325 X 10^5 Pa = 101.325 kPa
Avogadro's Constant: 22.4 L per 1 mol of gas	R = .08205

- Wavelength:
  - Formulas and Conversions

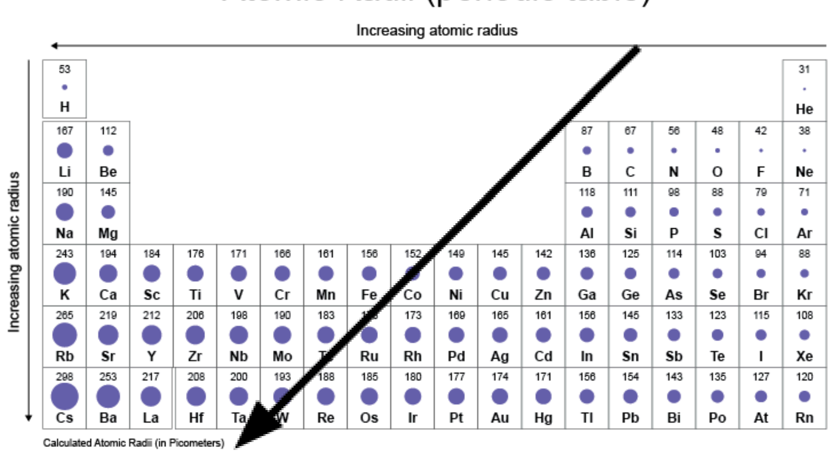
Speed of light: c = 2.998 X 10^8 m/s	Planck's Constant: h = 6.626 X 10^{-34} J * s
(Speed) c = v*λ	v = c/λ (v=wavelength(in meters))(c=speed)(v=frequency)
ΔE = hv (Frequency * Planck's constant)	1m = 10^{-9}nm (subtract exponents)

- <u>Periodic Trends:</u>

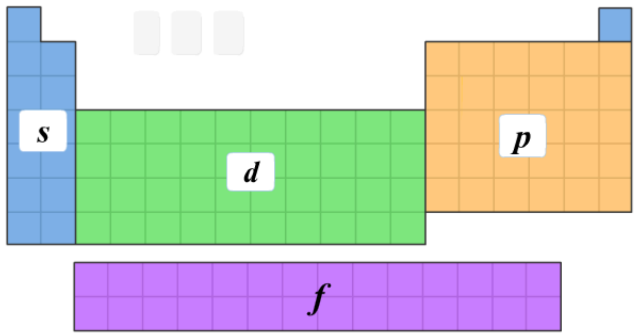




Atomic Radii (periodic table)



- Electron Configuration:
  - n - size and energy of the orbital (shell)
  - l - shape of the orbital (subshell) (s = 0, p = 1, d = 2, f = 3)
  - m_l - orientation of the orbital (orbitals)
  - m_s - spin states (2 electrons +½ -½)
  -



- Hybridization:
  - Overlap of valence electrons between two atoms
  - .
  - .
  - .

- Electron Jumping:
  - Absorbing energy - Jumps up levels
  - Emitting energy - Goes down levels

- Redox Reactions:
  - OIL RIG = Oxidation is loss   Reduction is gain
  - Oxidations = loss of electrons from a species
  - Reduction = Gain of electrons within a species
  - Oxidation Number Rules (O = -2, H = +1, I and II = +1 and +2)
  - $E_{cell} = E_{cathode} - E_{anode}$

- Naming Acids:
  - Rules for Naming Acids that Do Not Contain Oxygen in the Anion:
    Since all these acids have the same cation, H+, we don't need to name the cation.
  - The acid name comes from the root name of the anion name.
  - The prefix hydro- and the suffix -ic are then added to the root name of the anion. All acids beginning with the prefix, hydro" are otherwise known as binary acids.
  - EX: HCl, which contains the anion chloride, is called hydrochloric acid.
  - EX: HCN, which contains the anion cyanide, is called hydrocyanic acid.

- Rules for Naing Acids that DO CONTAIN Oxygen in the anion:
- Since all these acids have the same cation, H+, we don't need to name the cation.
- The acid name comes from the root name of the oxyanion name or the central element of the oxyanion.
- Suffixes are used based on the ending of the original name of the oxyanion. If the name of the polyatomic anion ended with -ate, change it to -ic for the acid and if it ended with -ite, change it to -ous in the acid.
- EX: HNO3, which contains the polyatomic ion nitrate, is called nitric acid.
- EX: HNO2, which contains the polyatomic ion nitrite, is called nitrous acid.

● Molecular Geometry:
    - AB_2 - Linear 180°
    - AB_3 - Trigonal Planar 120°
    - AB_4 - Tetrahedral 109.5°
    - AB_5 - Trigonal Bipyramidal 90°, 120°, 180°
    - AB_6 - Octahedral 90°
    - AB_2U - Bent 120°
    - AB_3U - Trigonal Pyramidal 90°, 120°
    - AB_4U - See Saw 180°, 120°, 90°
    - AB_4U - Square Planar 90°, 180°
    - AB_5U - Square Pyramidal 90°, 180°
    - AB_2U_2 - Bent 120°
    - AB_3U_2 - Tee Shape 90°, 180°
    - AB_2U_3 - Linear 180°

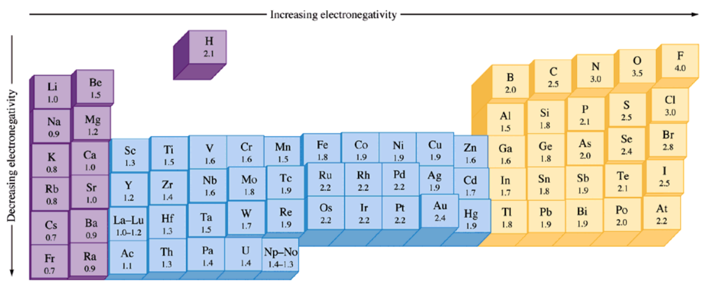
● Electron Geometry:
    - 2 - 180° Linear
    - 3 - 120° Trigonal Planar
    - 4 - 109.5° Tetrahedral
    - 5 - 120°, 90°, 180° Trigonal Bipyramidal
    - 6 - 180°, 90° Octahedral

● Bonding:
    - Single bond - 1 σ (Sigma) bond.
    - Double bond - 1 σ (Sigma) and 1 π (Pi) bond.
    - Triple bond - 1 σ (Sigma) and 2 π (Pi) bonds.

● Intermolecular Forces:
    - Hydrogen Bonds: H-F, H-O, H-N (Very Strong - Increased Boiling Point etc;)
    - Dipole-Dipole: When there are polar bonds but not hydrogen bonding (Not as strong)

- London Dispersions: Between Nonpolar molecules (Same elements bonded to each other) (Weak)
- Ionic Bonding: Stronger ^. Metal + Nonmetal
- Metallic Bonding: Strongest

- Electronegativity:



The ability of an atom in a molecule to attract shared electrons to itself. 100% non polar if bonded to itself.

- Polarity:
  - When there are no lone pairs on the center atom, then the molecule is nonpolar
  - If it is linear or square planar, then it is non-polar.
  - If it has different terminal atoms, then it is polar.
  - Most polar - Distance between them on periodic table with electronegativity in mind

- Cubic Unit Cells:
  - Primitive - 1 atom/cell
  - Body Centered - 2 atom/cell
  - Face Centered - 3 atom/cell

- Types of Solids:
  - Crystalline: Repetitive Patterns, Higher Density, Specific Meltings, More Strong points EX: Quartz, Sugar, Salt, Diamond,
  - Amorphous: Disordered Patterns, Lower Density, Varying Melting Points (Has glass transition point instead), More Flexible EX: Rubber, Glass, Polymers,

- Energy:
  - Conversions and Formulas

q = mcΔT (q = energy in J), (m = mass in g), (c=specific heat in J/gXC) (T = change in temp)	1000 calorie = 1 kilocalorie = 1kcal, 1kcal = 1 Calorie, 1 cal = 4.184J (Also specific heat of water)

1km = 1000m, 1kg = 1000g	1kJ = 1000J, 1kcal = 4.184kJ

Solve for the specific heat of the metal.

$$c_{metal} = \frac{q_{metal}}{m_{metal} \times \Delta T_{metal}} = \frac{-q_{water}}{m_{metal} \times \Delta T_{metal}} = \frac{-c_{water} \times m_{water} \times \Delta T_{water}}{m_{metal} \times \Delta T_{metal}}$$

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When 1.610×10^3 J of heat energy is added to 45.6 g of hexane, C_6H_{14}, the temperature increases by 15.6 °C.
Calculate the molar heat capacity of C_6H_{14}.

Number
195 $J/(mol \cdot °C)$

:planation Previous View Solution Check Answer Next E

Convert 45.6 g of hexane to moles. The molar mass of C_6H_{14} is 86.177 g/mol.

$$45.6 \text{ g} \times \frac{1 \text{ mol}}{86.177 \text{ g}} = 0.529 \text{ mol}$$

Now calculate the molar heat capacity C_P.

$$C_P = \frac{q_P}{n\Delta T} = \frac{1.610 \times 10^3 \text{ J}}{(0.529 \text{ mol})(15.6 \text{ °C})} = 195 \text{ J}/(\text{mol} \cdot \text{°C})$$

- Types of Energy:
  - Kinetic: Energy of Motion (EX: Thermal, Mechanical, Electrical)
  - Potential: Energy Stored (EX: Gravitational, Electrostatic, Chemical and Nuclear)

- Energy Transfer:
  - Exothermic: Gives off heat, Energy Released, (EX: Heat from condensation abosrbed by skin)
  - Endothermic: Takes in heat, (EX: when you sweat, water on your skin evaporates)

- Enthalpy:
  - Conversions and Formulas

H = q_p (H = enthalpy) (energy with constant pressure $_p$)	H = U + PV (PV = work done) (U =
$\Delta H = \Delta(U + PV)$	$\Delta H = (H_f - H_i)$

- Enthalpy is a function of Temperature and Pressure
- Taken at Standard Conditions: 1atm/760 torr, 298.15K/25C

Hess's Law Problem:

Example: **Hess's Law Problem:**

Example: Determine the $\Delta_r H$ for the reaction:

$$3H_2(g) + N_2(g) \longrightarrow 2NH_3(g) \quad \Delta_r H^o = ???$$

Given: (1) $2\,H_2(g) + N_2(g) \longrightarrow N_2H_4(g) \quad \Delta_r H°_1 = +95.4\text{ kJ}$

(2) $N_2H_4(g) + H_2(g) \rightarrow 2NH_3(g) \quad \Delta_r H°_2 = –187.6\text{ kJ}$

adding equations (1) & (2) yields:

$$2\,H_2(g) + N_2(g) + \cancel{N_2H_4(g)} + H_2(g) \,□\, \cancel{N_2H_4(g)} + 2NH_3(g)$$

$$3H_2(g) + N_2(g) \,□\, 2NH_3(g)$$

therefore…

$$□_r H = \Delta rH_1 + \Delta_r H_2 = +95.4\text{ kJ} + (–187.6\text{ kJ}) = \underline{–92.2\text{ kJ}}$$

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- <u>Phase Changes and Energy:</u>
    - Low to High = Exo
    - High to Low = Endo

<u>CONCEPTS:</u>

- <u>Nomenclature</u>
- <u>Ionic: Metal + Nonmetal</u>

1. Name the cation (Positively Charged Ion) (Cathode)
2. Then name the anion (Negatively Charged Ion) (Anode)
3. Add -ide to the end of the anion
4. Balance it when you have various charges on metals
5. EX: $CaCl_2$ - Calcium Chloride
6. EX: $Fe(OH)_2$ - Iron (II) Hydroxide. Because OH is 1- and you have 2. For an overall 2-. Iron has to be a positive charge of 2+ so that its balanced.

- <u>Covalent: Nonmetal + Nonmetal</u>

1. Use prefixes EXCEPTION: No "mono" on the first atom if there is only one of them
2. Add -ide to the end of the second atom
3. EX: CO_2 - Carbon Dioxide
4. EX: SF_6 - Sulfur Hexafluoride

- <u>Molarity:</u> $\frac{Mols}{Liters}$
- <u>Concentration:</u> Mole ratios in equations

- <u>Total Ionic Equations:</u> Write all the ions in solution (Solubility Rules)

- Net Ionic Equations: Write ONLY the ions that change (Solubility Rules)
- EX:

An Example

The reaction between aqueous sodium chloride & silver nitrate.

Chemical Equation:

$$NaCl_{(aq)} + AgNO_{3(aq)} \rightarrow NaNO_{3(aq)} + AgCl_{(s)}$$

Total Ionic Equation:

$$\cancel{Na^{+}_{(aq)}} + Cl^{-}_{(aq)} + Ag^{+}_{(aq)} + \cancel{NO_{3}^{-}{}_{(aq)}} \rightarrow \cancel{Na^{+}_{(aq)}} + \cancel{NO_{3}^{-}{}_{(aq)}} + AgCl_{(s)}$$

Net ionic Equation:

$$Ag^{+}_{(aq)} + Cl^{-}_{(aq)} \rightarrow AgCl_{(s)}$$

- Isotopes:
- Percent Abundance = $\frac{\# \text{ of atoms of the isotope}}{\# \text{ of atoms of total isotopes}}$ X 100 (Set 1 = x and Set 2 = x - 1, solve for x)
- Atomic Mass = (Mass of Isotope 1)*(Percent Abundance Isotope 1 /100) + (Mass of Isotope) * (Percnt Abundance Isotope 2 / 100) + ...
- Percent Yield = $\frac{Actual}{Theoretical}$ X 100

- Strongs Acids:
    - HCl - hydrochloric acid
    - HNO3 - nitric acid
    - H2SO4 - sulfuric acid (HSO4- is a weak acid)
    - HBr - hydrobromic acid
    - HI - hydroiodic acid
    - HClO4 - perchloric acid
    - HClO3 - chloric acid

- Voltaics Cells:
    - Primary Battery: Not reusable, Cannot be recharged, EX: Alkaline Battery
    - Secondary Battery: Reusable, Reaction can be reversed. EX: Lead-acid car battery
    - Salt Bridge (NaNO3)
      ions do not react (neutralize charge)
    - Anions migrate to anode

- Cations migrate to cathode
- Anode—oxidation—(negative)
  Both begin with vowel
- Cathode—reduction—(positive)
  Both begin with a consonant
- Electrons flow from the anode to the cathode

- <u>Photoelectric Effect:</u>
  - Ground State: The lowest energy level (n = 1)
  - Excited State: A subsequently higher energy level. n = 2 is the “first excited state” and so on.
  - Absorption: An electron moving from a lower energy level to a higher energy level
  - Emission: An electron moving from a higher to a lower energy level accompanied by the release of a photon.