Totally Epic AP Chem Review: Atomic Structure & Periodicity in a Day!

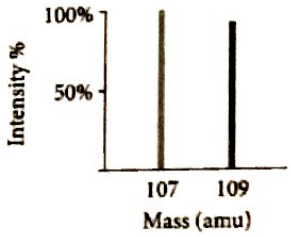
Average Atomic Mass: weighted average mass of an element's isotopes (same # p^+, diff. n^0) and is the mass found on the periodic table.

$$Average\ atomic\ mass = mass_1\left(\frac{\%\ Abundance}{100}\right) + mass_2\left(\frac{\%\ Abundance}{100}\right) + \cdots$$

- The average atomic mass will be between the masses of the largest and smallest isotopes.
- The average atomic mass will generally be closest to the most abundant isotope.

Mass Spectrometry: Measuring the Mass of Atoms and Molecules: The masses of elements and their percent abundances of isotopes of elements are measured using mass spectrophotometry, a technique that separates particles according to their mass.

Result: The ionized material is separated according to their mass, the result of which produces a mass spectrum.



a. The position (location) of each peak on the x-axis indicates the mass of the isotope.

b. The intensity (indicated by the height of the peak) indicates the relative abundance (how common that isotope is in nature).

Rules Governing How Electrons Fill Orbitals

A. The Aufbau principle states that an electron will occupy the lowest-energy orbital that can receive it. (in the ground state)

YES:  1s

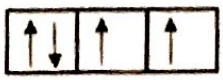
NO:  1s 2s

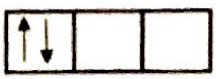
B. The Pauli Exclusion principle states that no two electrons can have the same set of four quantum numbers. For the new AP CHEM exam, you do NOT have to answer questions about quantum numbers. So, basically, recognize that no two electrons can exist in the exact same orbital having the exact same spin.

YES:  1s

NO:  2s

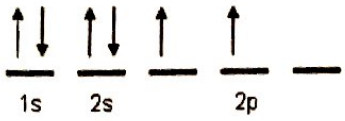
C. Hund's rule states that orbitals of equal energy are each occupied by one electron before any orbital is occupied by a second electron, and all electrons in singly occupied orbitals must have the same spin.

YES:  2p

NO:  2p

Electron Configurations

1. **Orbital Notation:** uses arrows (or diagram) to represent electrons.



2. **Standard Notation:** Standard electron configurations eliminate the lines and arrows of orbital notation.
   - ➔ The number of electrons in a sublevel is shown by adding a superscript.

$$1s^2 2s^2 2p^2$$

3. **Noble Gas Electron Configurations:** A noble gas configuration is an electron configuration that utilizes a noble gas which has its valence level fully occupied.

$$[Ne]2s^2 2p^2$$

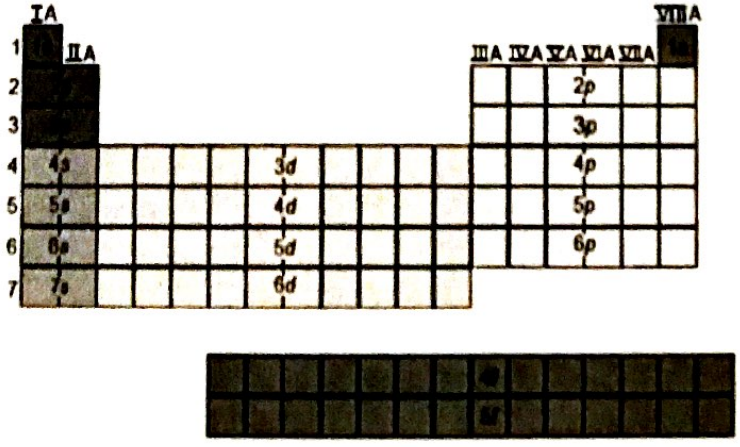
TIMESAVER:

Any question on the AP FR which asks for the electron configuration will accept EITHER standard or noble gas notation (unless it asks for "complete electron configuration") but NEVER orbital notation.

Noble gas notation takes less time to write!!!

Adding Electrons

The periodic table holds the answer for the order in which electrons FILL orbitals.



The Order in Which Electrons FILL Energy Levels

$$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10} 6p^6 7s^2 5f^{14} 6d^{10}$$

Removing electrons: Those pesky transition metals!

➔ When REMOVING electrons from transition metals, remove valence S electrons before removing electrons from a d sublevel!

Example

The iron atom, Fe, has two valence electrons:

Fe = $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$ [Ar] 4s ⇅ 3d ⇅ ↑ ↑ ↑ ↑

When iron forms a cation, it FIRST loses its valence electrons FROM THE 4s SUBLEVEL:

Fe^{2+} = $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$ [Ar] 4s ___ 3d ⇅ ↑ ↑ ↑ ↑

It can then lose 3*d* electrons:

Fe^{3+} = $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$ [Ar] 4s ___ 3d ↑ ↑ ↑ ↑ ↑

Isoelectronic atoms and ions: the "iso" in "isoelectronic" means "Same", so isoelectronic atoms and ions have the same number of electrons.

Quantitative Atomic Structure: Mmm, math!

- Electromagnetic radiation (including light) can behave like a wave, characterized by measurable properties of wavelength and frequency, or like a stream of particles (photons).

$$E = h\nu \quad \text{J/1 photon}$$
$$c = \lambda\nu$$

Where: E = energy, ν = frequency, λ = wavelength

and: Planck's constant, $h = 6.626 \times 10^{-34}$ J s; Speed of light, $c = 2.998 \times 10^{8}$ m s^{-1}

Note: This energy represents the energy of a **single photon.** Be prepared to convert to energies absorbed or emitted to kJ/mol instead of joules (J/photon).

Example: E = 2.40 E-19 J → kJ/mol?

$$\frac{2.40\text{ E-19 J}}{1\text{ photon}} \times \frac{1\text{ kJ}}{1000\text{ J}} \times \frac{6.022\text{E23 photons}}{1\text{ mol}} = 145\text{ kJ/mol}$$