Hund's Rule, Orbital Diagrams, and Valence Electrons

The Big Questions

- Now that we know how electrons are arranged into atoms, how are they arranged into sublevels and orbitals?
- How can we communicate the arrangement of atoms in orbitals?
- What are valence electrons and why are they more important than other electrons?

Review

- Electrons arranged into energy levels.
  - n = 1, n = 2, n = 3, etc...
- Energy levels broken into sublevels.
  - n = 1 made of 1s.
  - n = 2 made of 2s and 2p.
  - n = 3 made of 3s, 3p, and 3d.
  - n = 4 made of 4s, 4p, 4d, and 4f.

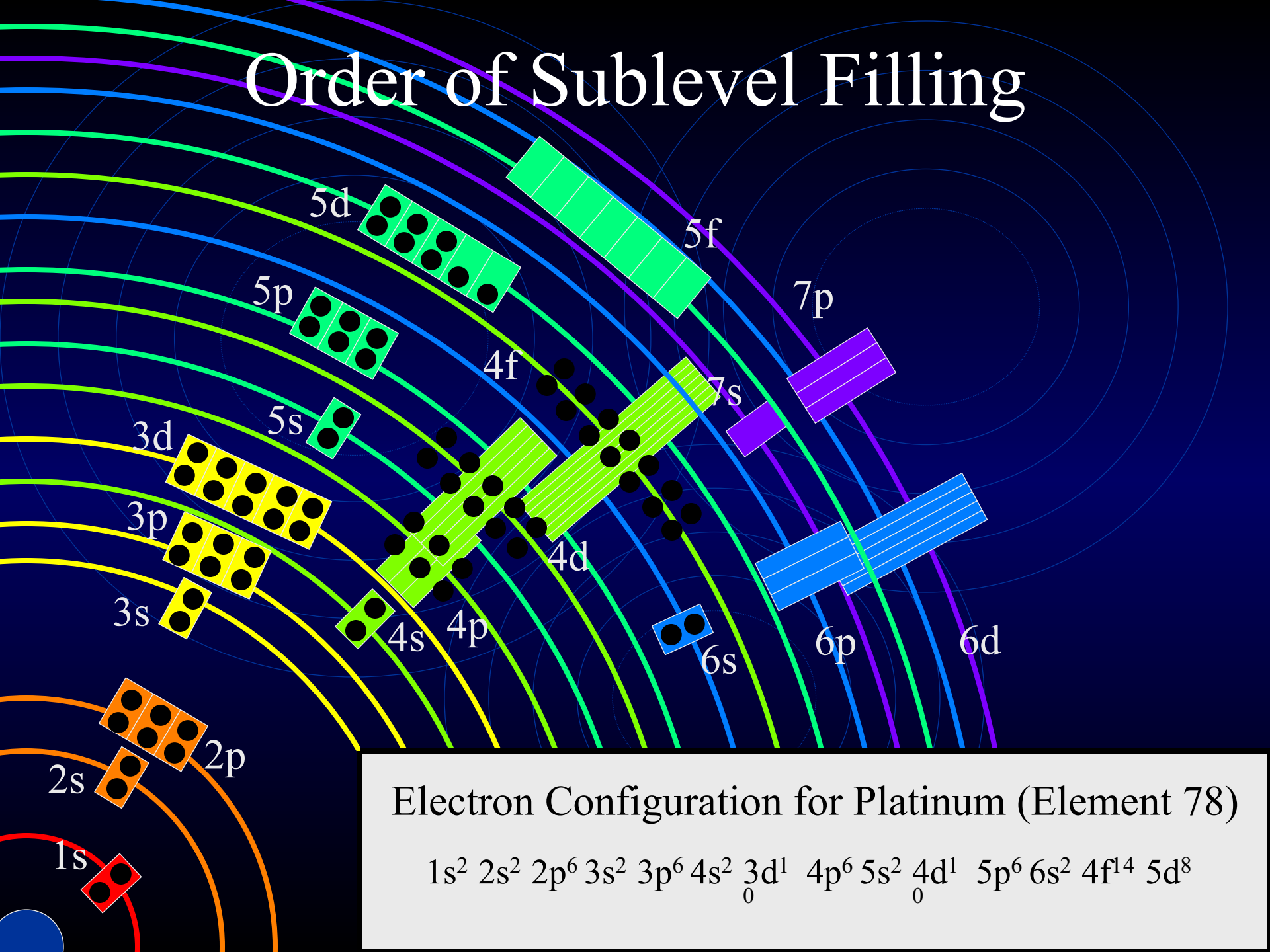
Review

- Sublevels are made of orbitals.
  - *s*-type sublevels are made of 1 orbital.
  - *p*-type sublevels are made of 3 orbitals.
  - *d*-type sublevels are made of 5 orbitals.
  - *f*-type sublevels are made of 7 orbitals.
- Every orbital can hold up to 2 electrons.

Review

- In an atom, electrons fill the lowest sublevels first (aufbau principle).
  - Fill higher energy sublevels only when lower ones are already filled.
- Order of filling is not as expected.

Order of Sublevel Filling

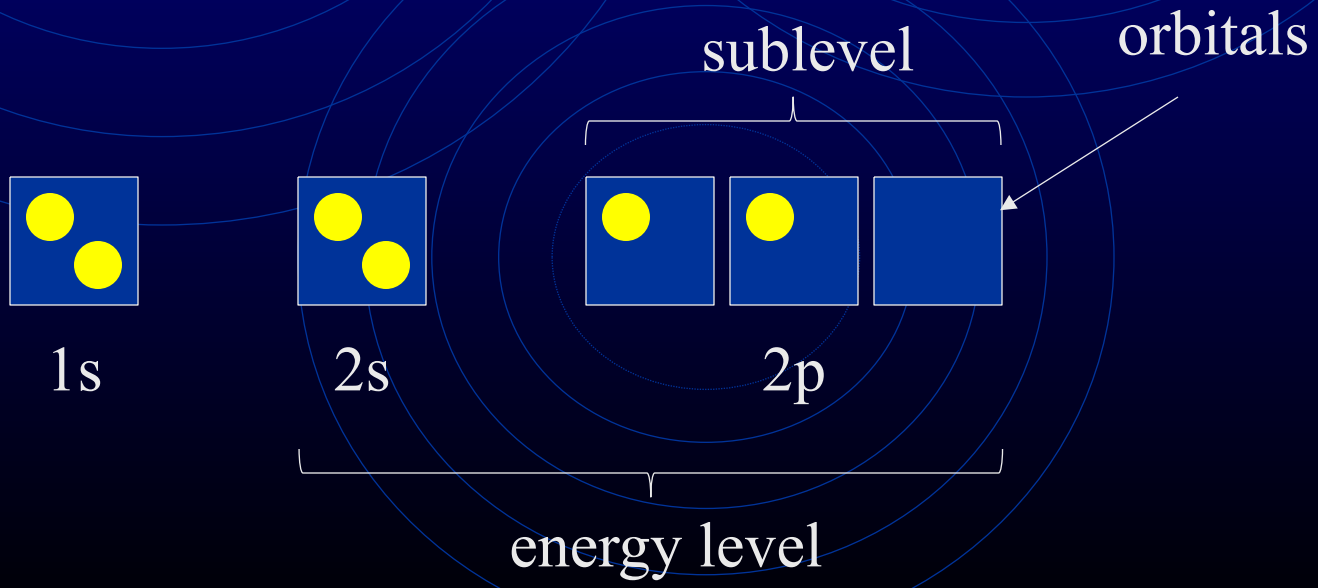


Electron Configuration for Platinum (Element 78)

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^1_0\ 4p^6\ 5s^2\ 4d^1_0\ 5p^6\ 6s^2\ 4f^{14}\ 5d^8$

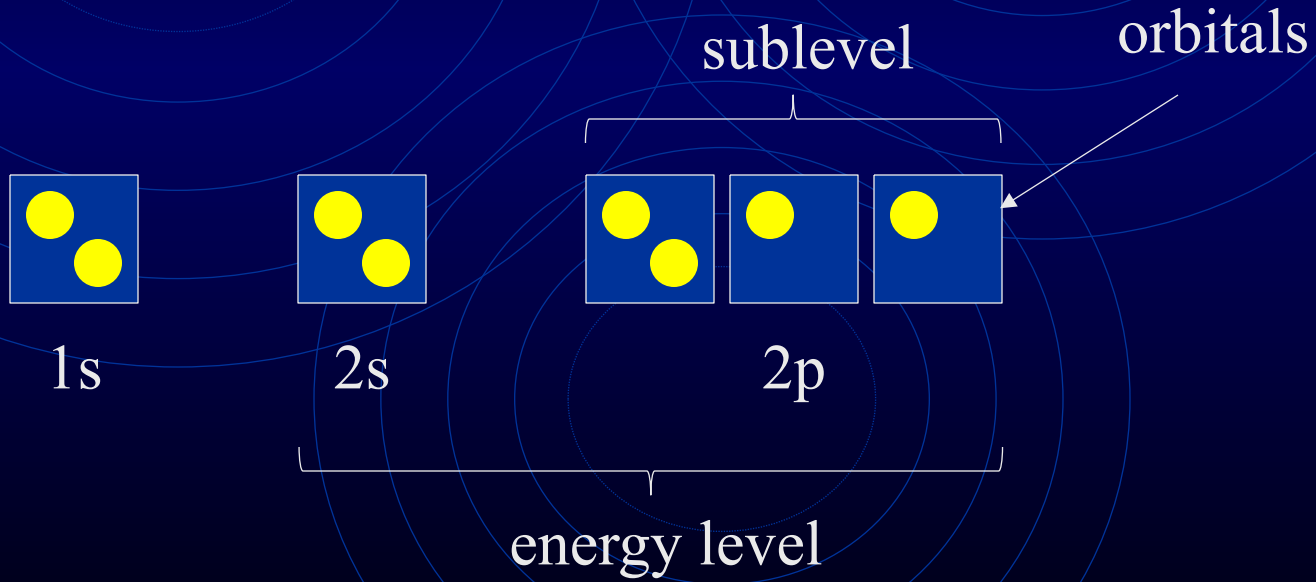
Hund's Rule

- In a sublevel, every orbital gets one electron before any orbital gets a pair.
  - Example:
    - e^- config. for carbon: $1s^2\ 2s^2\ 2p^2$



Hund's Rule

- e^- config. for oxygen: $1s^2 2s^2 2p^4$



Orbital Diagrams

- Show the arrangement of electrons in orbitals within an atom.
  - Use boxes to represent orbitals.
  - One arrow (↑) represents 1 e^-.
  - 2 arrows (↑↓) rep. 2 e^-.

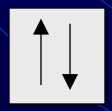
Orbital Diagrams

- Orbital diagram for hydrogen.
  - e^- config: $1s^1$

1s

Orbital Diagrams

- Orbital diagram for helium.
  - e^- config: $1s^2$



1s

Orbital Diagrams

- Orbital diagram for lithium.
  - e^- config: $1s^2\ 2s^1$

1s 2s

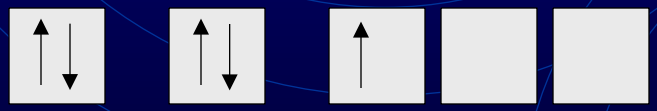
Orbital Diagrams

- Orbital diagram for beryllium.
  - e^- config: $1s^2\ 2s^2$

1s 2s

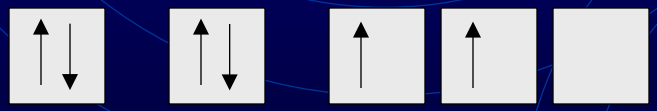
Orbital Diagrams

- Orbital diagram for boron.
  - e^- config: $1s^2\ 2s^2\ 2p^1$



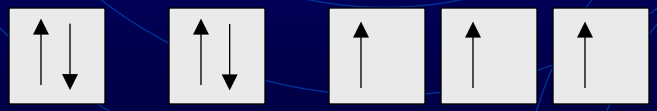
Orbital Diagrams

- Orbital diagram for carbon.
  - e^- config: $1s^2\ 2s^2\ 2p^2$



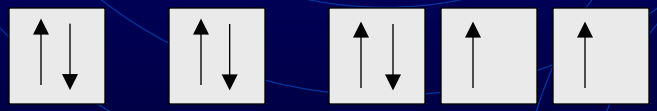
Orbital Diagrams

- Orbital diagram for nitrogen.
  - e^- config: $1s^2\ 2s^2\ 2p^3$



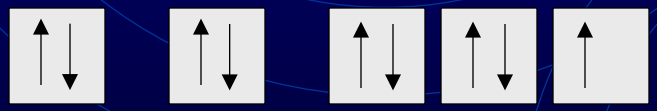
Orbital Diagrams

- Orbital diagram for oxygen.
  - e^- config: $1s^2\ 2s^2\ 2p^4$



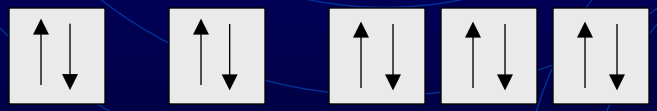
Orbital Diagrams

- Orbital diagram for fluorine.
  - e^- config: $1s^2\ 2s^2\ 2p^5$



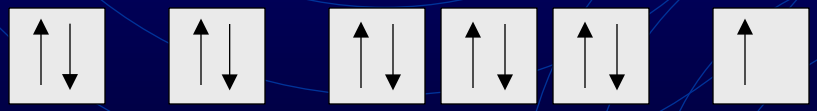
Orbital Diagrams

- Orbital diagram for neon.
  - e^- config: $1s^2\ 2s^2\ 2p^6$



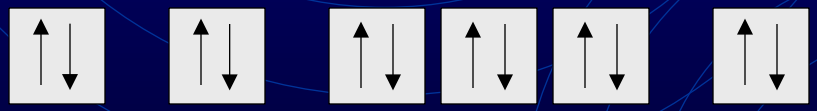
Orbital Diagrams

- Orbital diagram for sodium.
  - e^- config: $1s^2\ 2s^2\ 2p^6\ 3s^1$



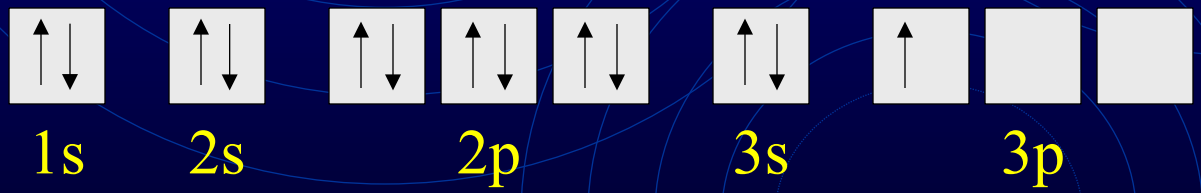
Orbital Diagrams

- Orbital diagram for magnesium.
  - e^- config: $1s^2\ 2s^2\ 2p^6\ 3s^2$



Orbital Diagrams

- Orbital diagram for aluminum.
  - e^- config: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$



Valence Electrons

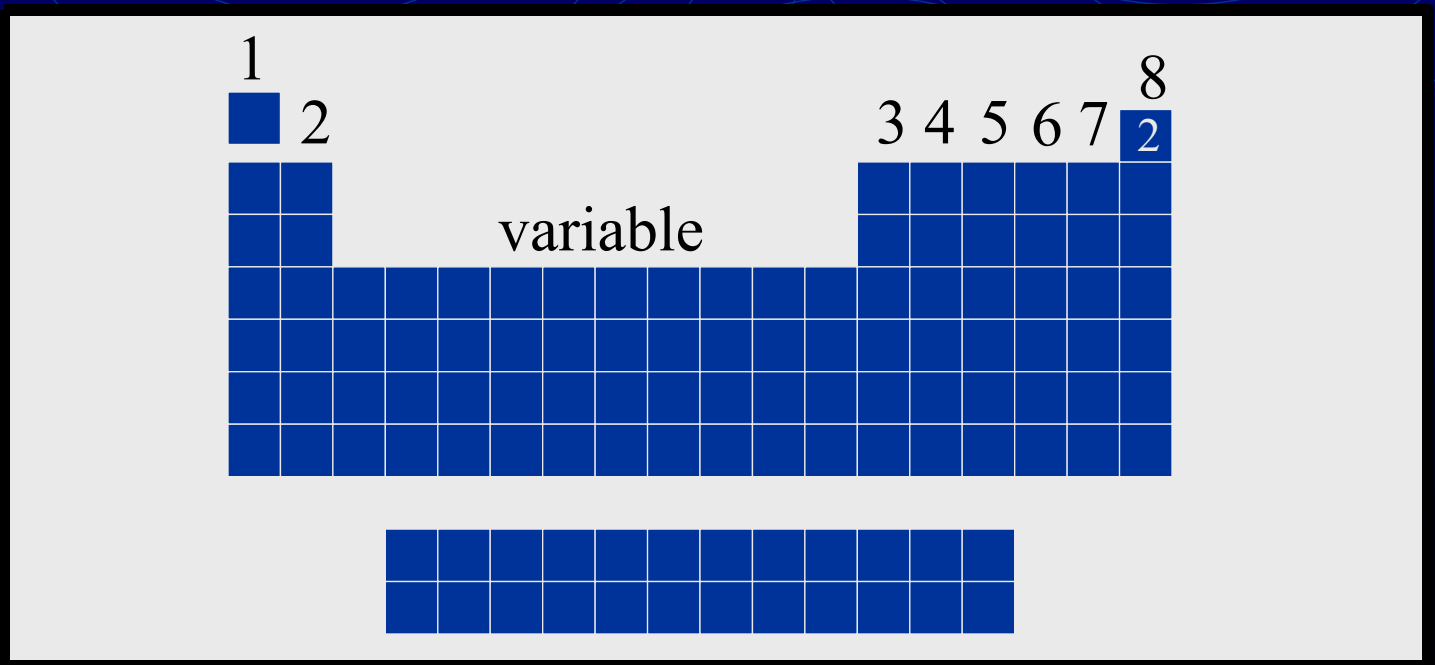
- **Valence electrons** – Electrons in an atom's highest-numbered energy level.
  - e^- config. for Si: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$
    - Si has four valence electrons.
    - $3s^2 + 3p^2 = 4\ e^-$
  - e^- config. for C: $1s^2\ 2s^2\ 2p^2$
    - C also has four valence electrons.

Valence Electrons

- How many valence electrons does selenium have (element 34)?
  - e^- config: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^4$
  - Se has 6 valence electrons.

Valence Electrons Shortcut

- You can tell how many valence electrons any atom should have by its position in the periodic table.



Electron Dot Diagrams

- **Electron Dot Diagram** – shows the valence electrons of an atom as dots.
  - Distribute dots around atomic symbol to represent valence electrons.
  - Should *never* have more than 8 dots.

Lewis Dot Diagrams

- Here are the Lewis diagrams for 8 elements, which have 1 – 8 valence electrons.