Electron Configuration: Practice

Electron Configuration Rules

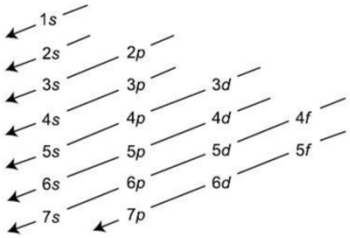
The orbital filling rules govern how electrons are distributed within the electron shells and subshells of an atom. These rules include the Aufbau principle, Pauli exclusion principle, and Hund's rule. Make sure to watch the 'Electron Configuration' videos on the meriSTEM Matter and Elements module or the corresponding videos in the 'Elements' Playlist on the meriSTEM Education YouTube Channel. Access the videos through the provided QR code or link below. Try the problems on your own or with a friend. Good luck!

https://bit.ly/44UTrU6

SUMMARY

Aufbau Principle

- Electrons occupy orbitals in increasing order of their energy levels, starting with the lowest energy level in the 1s orbital and then progressing through 2s, 2p, 3s, 3p, and so on.
- The diagram below offers the correct order of filling orbital shells. Note, 4s is filled before 3d as the energy level of '4s' is lower than '3d'.



Example: Scandium
Scandium has 21 electrons.

$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^1$ is CORRECT configuration as Aufbau principle is followed.

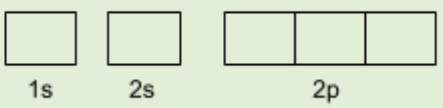
Pauli Exclusion Principle

- An orbital can accommodate a maximum of two electrons with opposite spins.
- In the boxes, electrons must be drawn ↑↓ (NOT ↑↑ OR ↓↓).

Hund's Rule

- When electrons are added to equal-energy orbitals, they will occupy separate orbitals with parallel spins before pairing up. This maximizes the total electron spin and thus increases stability.
- In the example, each orbital of 2p was filled first with parallel spins (upward arrow). For oxygen, we would add one electron of opposite spin (downward arrow) in the first box of 2p.

Example: Nitrogen; 7 electrons $1s^2 2s^2 2p^3$



Exception

- Elements can deviate from the standard filling pattern for d orbitals for increased stability.
- Instead of filling their 3d subshell after the 4s subshell, they prefer to have either a half-filled or filled 3d subshell by moving one electron from the 4s subshell to the 3d subshell.

Resource created by Sharon Ponnampalam

MeriSTEM CHEMISTRY – Matter & Elements

QUESTIONS

Electron Configurations + Diagrams

In the space provided, write, and draw the electron configurations (box diagram) of the following elements:

Sodium:

Oxygen:

Argon:

Phosphorus:

Chromium:

Manganese:

Elements

In the space provided, determine the element based off their electron configuration provided:

$1s^2 2s^2 2p^6 3s^2 3p^5$

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

Resource created by Sharon Ponnampalam

[Ar] $4s^2 3d^7$

[Kr] $5s^2 4d^9$

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

Worded Questions

1. According to the Aufbau principle, do electrons fill higher or lower energy orbitals first?

2. State the Pauli exclusion principle.

3. How does Hund's rule affect the electron configuration of degenerate orbitals?

4. Which elements deviate from the standard filling pattern and achieve extra stability by forming a half-filled or completely filled d subshell?

5. Why do chromium and copper exhibit exceptions to the usual filling order for d orbitals based on their electron configurations

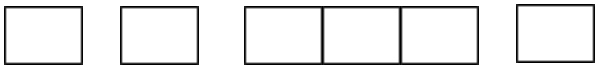
Resource created by Sharon Ponnampalam

ANSWERS

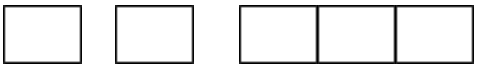
Electron Configurations + Diagrams

In the space provided, write, and draw the electron configurations (box diagram) of the following elements:

Sodium: 11 electrons ⇒ $1s^2 2s^2 2p^6 3s^1$



Oxygen: 8 electrons ⇒ $1s^2 2s^2 2p^4$



Argon: 18 electrons ⇒ $1s^2 2s^2 2p^6 3s^2 3p^6$

Phosphorus: 15 electrons ⇒ $1s^2 2s^2 2p^6 3s^2 3p^3$

Chromium: 24 electrons ⇒ $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$

Note: 1 electron from 4s moves to 3d so that both orbital levels are 'half-filled' (exception rule)

Manganese: 25 electrons ⇒ $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$

Elements

In the space provided, determine the element based off their electron configuration provided:

$1s^2 2s^2 2p^6 3s^2 3p^5$: Total 17 electrons ⇒ Chlorine

$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$: Total 35 electrons ⇒ Bromine

[Ar] $4s^2 3d^7$: Total 27 electrons ⇒ Cobalt

[Kr] $5s^2 4d^9$: Total 47 electrons ⇒ Silver

$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2$: Total 56 electrons ⇒ Barium

Resource created by Sharon Ponnampalam

Worded Questions

6. According to the Aufbau principle, electrons fill lower energy orbitals first before filling higher energy orbitals.

7. The Pauli exclusion principle states that in a single orbital, there can be a maximum of two electrons with opposite spins.

8. Hund's rule dictates that electrons will first occupy orbitals with the same energy singly, with parallel spins, before pairing up.

9. Elements that achieve extra stability by forming a half-filled or completely filled d subshell are chromium (Cr), copper (Cu), and some of the transition metals in Groups 6 and 11.

10. Chromium and copper exhibit exceptions to the usual filling order for d orbitals based on their electron configurations to achieve extra stability. In the case of chromium, one electron is removed from the 4s orbital and added to the 3d orbital, resulting in a half-filled $3d^5$ subshell. In copper, one more electron is removed from the 4s orbital, creating a fully filled $3d^{10}$ subshell. This configuration of half-filled or fully filled d orbitals is more stable, explaining the exceptions.

Resource created by Sharon Ponnampalam