

Orbital Chart Overhead

Electron Configuration



Introduction

Introduce students to the basics of electron configuration using orbital chart diagrams and facilitate better understanding through a layered teaching technique.

Concepts

- Electron configuration
- Hund's rule
- Aufbau principle
- Quantum numbers

Discussion

Assigning quantum numbers can be intimidating for students because of the multitude of steps that are involved. A layered teaching technique separates those steps into individual lessons, where each subsequent lesson builds upon the previous. Students will first learn the aufbau principle, then move to Hund's rule, followed by electron configuration, and end on quantum numbers.

Electron configurations are shorthand ways of summarizing how electrons are situated around the nuclei of atoms. There are three basic rules to follow when determining the electron configurations of atoms—the aufbau principle, the Pauli exclusion principle, and Hund's rule.

The *aufbau principle* states that electrons enter orbitals of the lowest energy first. The *s*-orbital is always the lowest energy sublevel. Beyond the second energy level, the filling of atomic orbitals does not follow a simple pattern. For example, the *5s* orbital is of lower energy than the *4d* orbital (see Figure 3 for a complete pattern of orbital levels).

The *Pauli exclusion principle* states that an atomic orbital may contain a maximum of two electrons and that in order to occupy the same orbital, the two electrons must have opposite spins. A vertical arrow is often used in electron configuration diagrams to represent an electron and its direction of spin.

Hund's rule states that when electrons occupy orbitals of equal energy, an electron enters each orbital until all of the orbitals contain one electron with parallel spins. For example, five electrons of the same spin would occupy five orbitals of the same energy level as shown in Figure 1.



Figure 1.

As more electrons are added to the orbitals in this energy level, they enter with spins opposite to those of the first electrons in the orbitals. Two electrons occupying the same orbital are said to have paired spins (see Figure 2).



Figure 2.

A sample electron order filling diagram is shown in Figure 3 for calcium.

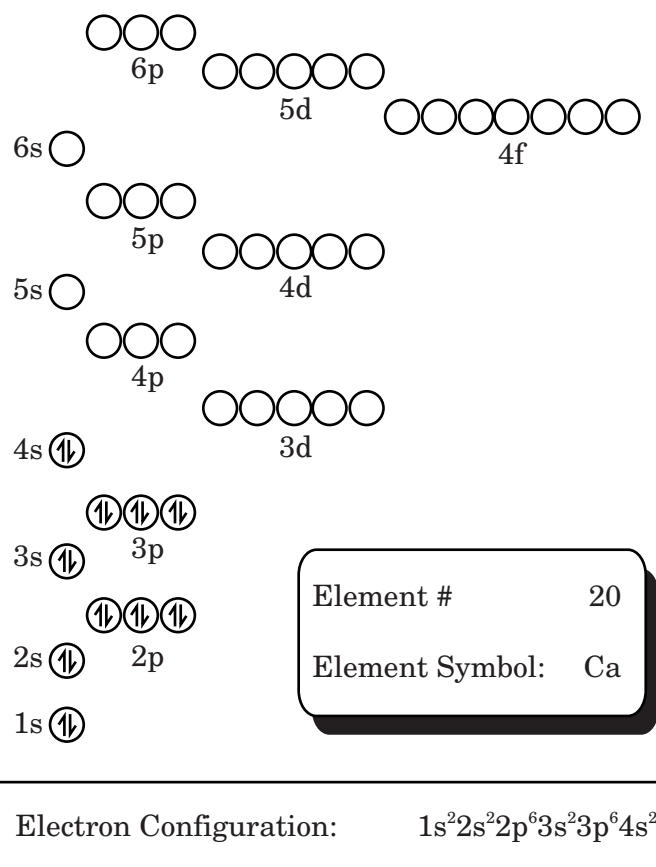


Figure 3. Sample electron order filling for calcium

Valence electron configurations can also be presented in this manner. Valence electrons are the electrons in the highest occupied energy level of an element. For example, sodium has one valence electron in the 3s orbital. The number of valence electrons largely determines the properties of an element. The valence number of an element is also related to its group number in the periodic table. For example, all elements in IUPAC Group 2 (formerly known as Group IIA)—beryllium, magnesium, calcium, etc.—contain two valence electrons.

Quantum numbers are used to describe the properties of atomic orbitals and the electrons occupying those orbitals of electron configuration. Every electron is assigned a unique set of four quantum numbers, designated by the letters n , l , m , and s . The principal quantum number n corresponds to the value of the principal energy level 1, 2, 3 . . . The angular quantum number l may have integer values from 0 to $n-1$ and corresponds to the sublevel orbitals s , p , d , f that have different shapes. For $n = 1$, there is only one allowed value of l , $l = 0$, representing an s orbital. For $n = 2$, there are two allowed values of l , $l = 0$ (s orbital) and $l = 1$ (p orbital). The magnetic quantum number m (or m_l) is used to differentiate different orientations of the same sublevel orbitals. The allowed values of m are integers from $-l$ to l . Example: There are three p ($l = 1$) orbitals having m values -1 , 0 , and 1 . Finally, the spin quantum number s (or m_s) may be $+\frac{1}{2}$ or $-\frac{1}{2}$.

Tip

- Up to eight orbital charts can fit on a page (four on each side) to create a student practice handout or worksheet. You may wish to instruct the students to fill out the worksheet over the period of a few lessons working through the layers as you teach them.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12

Evidence, models, and explanation

Content Standards: Grades 5–8

Content Standard B: Physical Science, properties and changes of properties in matter, transfer of energy

Content Standards: Grades 9–12

Content Standard B: Physical Science, structure and properties of matter

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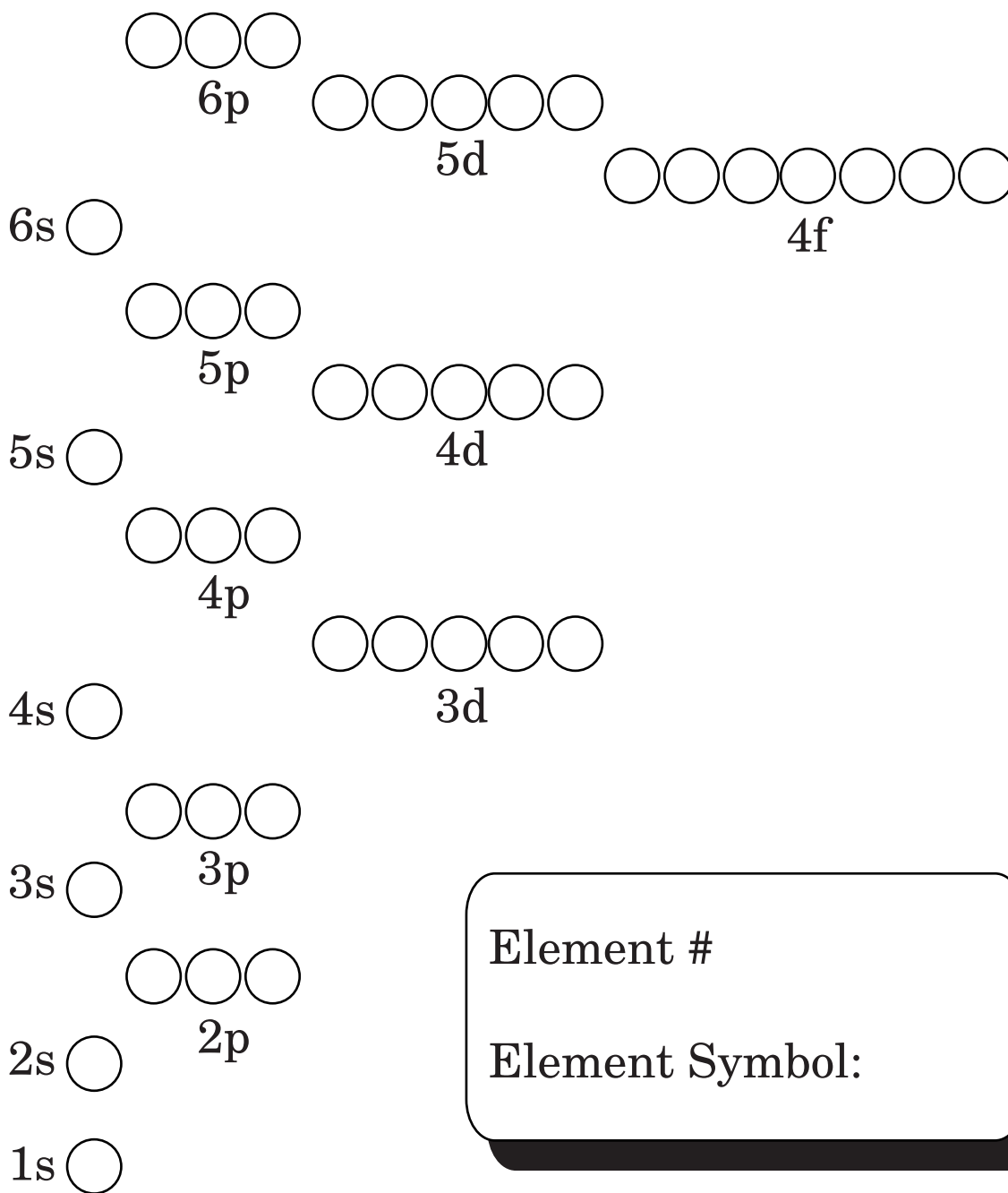
A video of the *Orbital Chart Overhead* activity, presented by Jeff Bracken, is available in *Electron Configuration*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Alternative electron configuration learning activities and games are available from Flinn Scientific.

Catalog No.	Description
AP6379	Electron Configuration Bingo
AP6130	Electron Configuration Concert
AP4580	Lewis Electron Dot Models Kit

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.

Electron Order Filling Diagram Master



Electron Configuration: