A valence electron is an electron that is associated with an atom, and that can participate in the formation of a chemical bond; in a single covalent bond, both atoms in the bond contribute one valence electron in order to form a shared pair. The presence of valence electrons can determine the element's chemical properties and whether it may bond with other elements: For a main group element, a valence electron can only be in the outermost electron shell.

An atom with a closed shell of valence electrons (corresponding to an electron configuration \(s^2p^6\)) tends to be chemically inert. An atom with one or two valence electrons more than a closed shell is highly reactive, because the extra valence electrons are easily removed to form a positive ion. An atom with one or two valence electrons fewer than a closed shell is also highly reactive, because of a tendency either to gain the missing valence electrons (thereby forming a negative ion), or to share valence electrons (thereby forming a covalent bond).

Like an electron in an inner shell, a valence electron has the ability to absorb or release energy in the form of a photon. An energy gain can trigger an electron to move (jump) to an outer shell; this is known as atomic excitation. Or the electron can even break free from its associated atom's valence shell; this is ionization to form a positive ion. When an electron loses energy (thereby causing a photon to be emitted), then it can move to an inner shell which is not fully occupied.

### The number of valence electrons

The number of valence electrons of an element can be determined by the periodic table group (vertical column) in which the element is categorized. With the exception of groups 3–12 (the transition metals), the units digit of the group number identifies how many valence electrons are associated with a neutral atom of an element listed under that particular column.

<table>
<thead>
<tr>
<th>Periodic table group</th>
<th>Valence Electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 (I) (alkali metals)</td>
<td>1</td>
</tr>
<tr>
<td>Group 2 (II) (alkaline earth metals)</td>
<td>2</td>
</tr>
<tr>
<td>Groups 3-12 (transition metals)</td>
<td>2* (The 4s shell is complete and cannot hold any more electrons)</td>
</tr>
<tr>
<td>Group 13 (III) (boron group)</td>
<td>3</td>
</tr>
</tbody>
</table>
Periodic table group | Valence Electrons
---|---
Group 14 (IV) (carbon group) | 4
Group 15 (V) (pnictogens) | 5
Group 16 (VI) (chalcogens) | 6
Group 17 (VII) (halogens) | 7
Group 18 (VIII or 0) (noble gases) | 8**

* The general method for counting valence electrons is generally not useful for transition metals. Instead the modified d electron count method is used. ** Except for helium, which has only two valence electrons.

The Concept of Open Valence ("Valence")

The valence (or valency) of an element is a measure of its combining power with other atoms when it forms chemical compounds or molecules. The concept of valence was developed in the last half of the 19th century and was successful in explaining the molecular structure of many organic compounds. The quest for the underlying causes of valence lead to the modern theories of chemical bonding, including Lewis structures (1916), valence bond theory (1927), molecular orbitals (1928), valence shell electron pair repulsion theory (1958) and all the advanced methods of quantum chemistry.

The combining power or affinity of an atom of an element was determined by the number of hydrogen atoms that it combined with. In methane, carbon has a valence of 4; in ammonia, nitrogen has a valence of 3; in water, oxygen has a valence of two; and in hydrogen chloride, chlorine has a valence of 1. Chlorine, as it has a valence of one, can be substituted for hydrogen, so phosphorus has a valence of 5 in phosphorus pentachloride, PCl₅. Valence diagrams of a compound represent the connectivity of the elements, lines between two elements, sometimes called bonds, represented a saturated valency for each element.[¹] Examples are:-

<table>
<thead>
<tr>
<th>Compound</th>
<th>H₂</th>
<th>CH₄</th>
<th>C₂H₈</th>
<th>C₂H₂</th>
<th>NH₃</th>
<th>NaCN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagram</td>
<td><img src="Acetylene-2D.png" alt="Acetylene-2D.png" /></td>
<td><img src="Acetylene-2D.png" alt="Acetylene-2D.png" /></td>
<td><img src="Acetylene-2D.png" alt="Acetylene-2D.png" /></td>
<td><img src="Acetylene-2D.png" alt="Acetylene-2D.png" /></td>
<td><img src="Acetylene-2D.png" alt="Acetylene-2D.png" /></td>
<td><img src="Acetylene-2D.png" alt="Acetylene-2D.png" /></td>
</tr>
<tr>
<td>Valencies</td>
<td>Hydrogen 1</td>
<td>Carbon 4 Hydrogen 1</td>
<td>Carbon 4 Hydrogen 1</td>
<td>Carbon 4 Hydrogen 1</td>
<td>Nitrogen 3 Hydrogen 1</td>
<td>Sodium 1 Carbon 4 Nitrogen 3</td>
</tr>
</tbody>
</table>

Valence only describes connectivity, it does not describe the geometry of molecular compounds, or what are now known
to be ionic compounds or giant covalent structures. The line between atoms does not represent a pair of electrons as it does in Lewis diagrams.

Further Reading

*Khan Academy*

Valence Electrons

*Cliffs Notes*

Valence Electrons

Contributors

• Wikipedia