

### 1240: Atom electrons enter atomic orbitals

(Atoms and molecules are in a stationary state. In a stationary state, the Virial theorem is held. A reaction process system is in a non-stationary state, so the Virial theorem does not hold.)

**Key words:** standing waves; wave functions; atomic orbitals; stationary state; potential energy; kinetic energy; Virial theorem

Electrons have wave properties. There are traveling waves, which change position and shape over time, and standing waves (also called stationary waves), which do not change shape over time. Since atoms are systems that do not change over time, the waves of electrons within them must be standing waves. Such standing waves and the wave function that represents them are called atomic orbitals. An atomic orbital is formed only when an atomic nucleus and electrons are involved, but it is customary to say that there is an atomic orbital and that electrons enter it.

[Important theorem of stationary states]

The state of a system that does not change with time is called a stationary state. There is an important theorem regarding stationary state energy. If the potential energy of the system is  $V$  and the kinetic energy is  $T$ , the relationship  $V = -2T$  holds. This is called the virial theorem.

The virial theorem is a very important theorem that holds for atoms, molecules, and even for classical mechanical systems, such as the relationship between the kinetic energy and potential (positional) energy of the Earth orbiting the Sun.