

*SECTION 3***THE ELECTRONIC STRUCTURE OF ATOMS OF THE ELEMENTS**

**Electronic structure of atoms:** The arrangement of electrons around the nucleus of the atom.

The properties of atoms can be understood in terms of **Quantum Theory**, which involves the **Heisenberg Uncertainty Principle** and the **Schrödinger Wave Equation**.

**Quantum Theory:** A theory that states that the energy of an object can only change by discrete steps. A change involves a packet of energy called a **quantum**.

**Heisenberg Uncertainty Principle:** The position and momentum of a particle cannot both be known simultaneously. This implies that in an atom the position and momentum of an electron cannot both be known simultaneously. (Thus a model of an atom containing electrons in fixed orbits around the nucleus is untenable.)

**Schrödinger Wave Equation**

**Spin of an electron:** The intrinsic angular momentum of an electron. Occurs in only two senses denoted  $\Rightarrow$  and  $\Leftarrow$ .

**Electron shells:** The electrons in an atom exist in shells, each shell being made up of atomic orbitals or subshells.

**Principal quantum number:** Symbol  $n$ , an integer, 1,2 3... which defines the shell. The smaller  $n$

**Valence electrons:** Those electrons in the outermost shell and in unfilled subshells [e.g. Cl has 7 valence electrons ( $3s^2p^5$ ) and Co has 9 valence electrons ( $3d^74s^2$ )]. Valence electrons are involved in chemical bonds - *section 4*.

**The Periodic Table:** A table showing the elements in rows and columns in a manner which shows up relationships between the properties of the elements.

**Periods:** Rows of the periodic table. Elements in the same row are in the same period [e.g. calcium, Ca, and copper, Cu, are both in the 4th period]. The number of the period (row) is equal to the principal quantum number of the outermost valence shell of the atoms.

**Groups:** Columns of the periodic table. Elements in the same column are in the same group and have the same number of valence electrons (which accounts for their similarities) [e.g. carbon, C, and tin, Sn, are both in group 14 and both have four valence electrons]. This numbering replaces a previous system, shown as Roman numbers on the table, still used by some older chemists.

**Blocks:** Groups having the same valence orbitals. Groups 1-2 are *s*-block because their elements have only *s* valence electrons; groups 3-12 are *d*-block because their elements have only *s* and *d* valence electrons; groups 13-18 are *p*-block because their elements have *s* and *p* valence electrons.

**Alkali metals:** The metals (elements) of group 1.

**Alkaline earth metals:** The metals (elements) of group 2.

**Halogens:** Elements of group 17 [e.g. chlorine].

**Halide:** A binary compound of a halogen and another element [e.g. HCl, CaCl<sub>2</sub>, PCl<sub>3</sub>], or with a group [e.g. CH<sub>3</sub>Cl, chloromethane but also called methyl chloride; see *section 6-2*].

**Halide ion:** Monoatomic anion of a halogen [e.g. chloride ion, Cl<sup>-</sup>].

**Transition metals:** The metals (elements) of the *d*-block.

**Ionisation energy:** The first ionisation energy is the minimum energy required to remove an electron from a neutral atom in the gas phase:

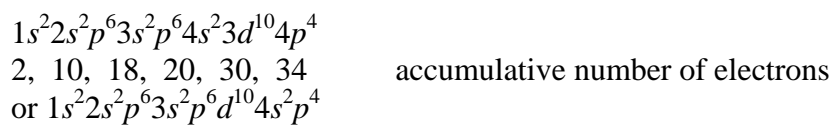
$$E(g) \quad E_{\text{electron}} \quad \text{Tw} < 006f \quad \text{Tw} / \text{A} . 26 \quad 333.8604 \quad \text{Tw} 010.0024 \text{has} 80.0009 \quad \text{Tw}$$

**Photon:** A particle-like package of electromagnetic radiation. The energy,  $E$ , of the photon is related to the frequency,  $\nu$ , of the radiation by the expression  $E = h\nu$  where  $h$  is the Planck constant.

### EXERCISES

Write the electron configuration of the ground states of the following elements:

1. *Example:* selenium, Se  
*Answer:* From the periodic table  $Z = 34$ ; there are 34 electrons to be placed in the orbital energy series.



2. carbon    3. fluorine    4. iron    5. arsenic    6. silver

7-12. Give a possible value for the principal quantum number and for the azimuthal quantum number for a valence electron of the elements in questions 1-6 above.

7. *Example:* selenium, Se  
*Answer:* For Se the valence electrons are  $4s$  and  $4p$