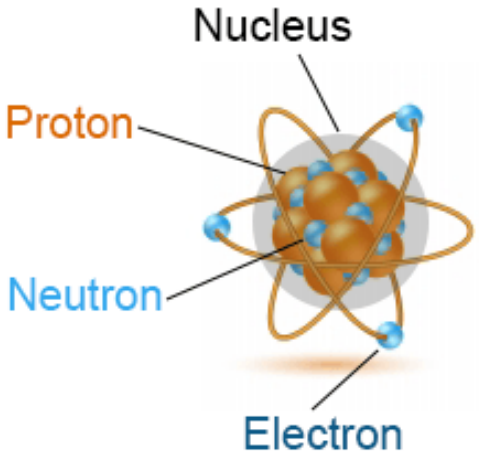
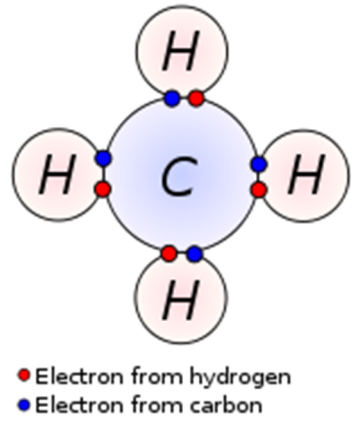
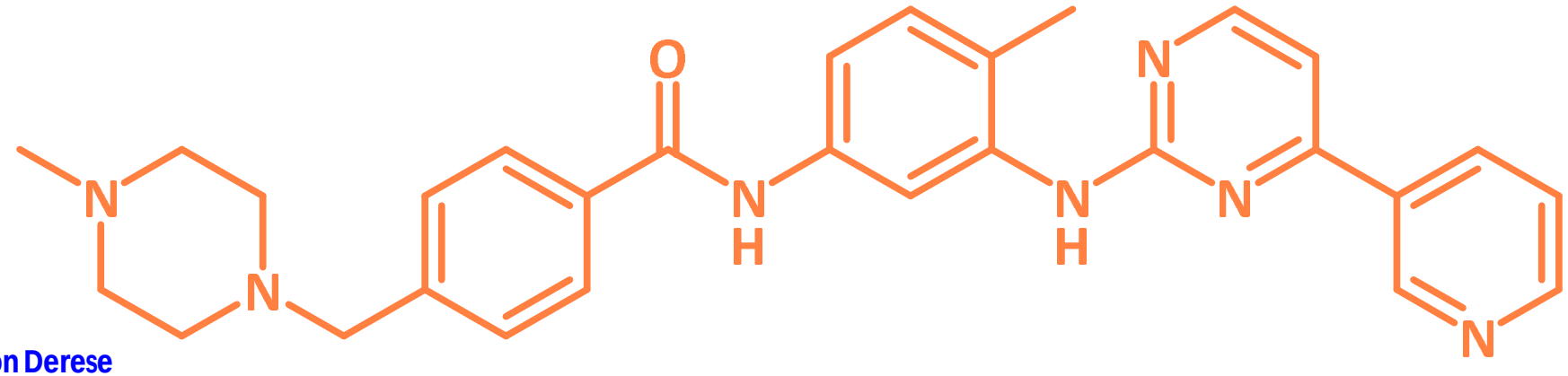
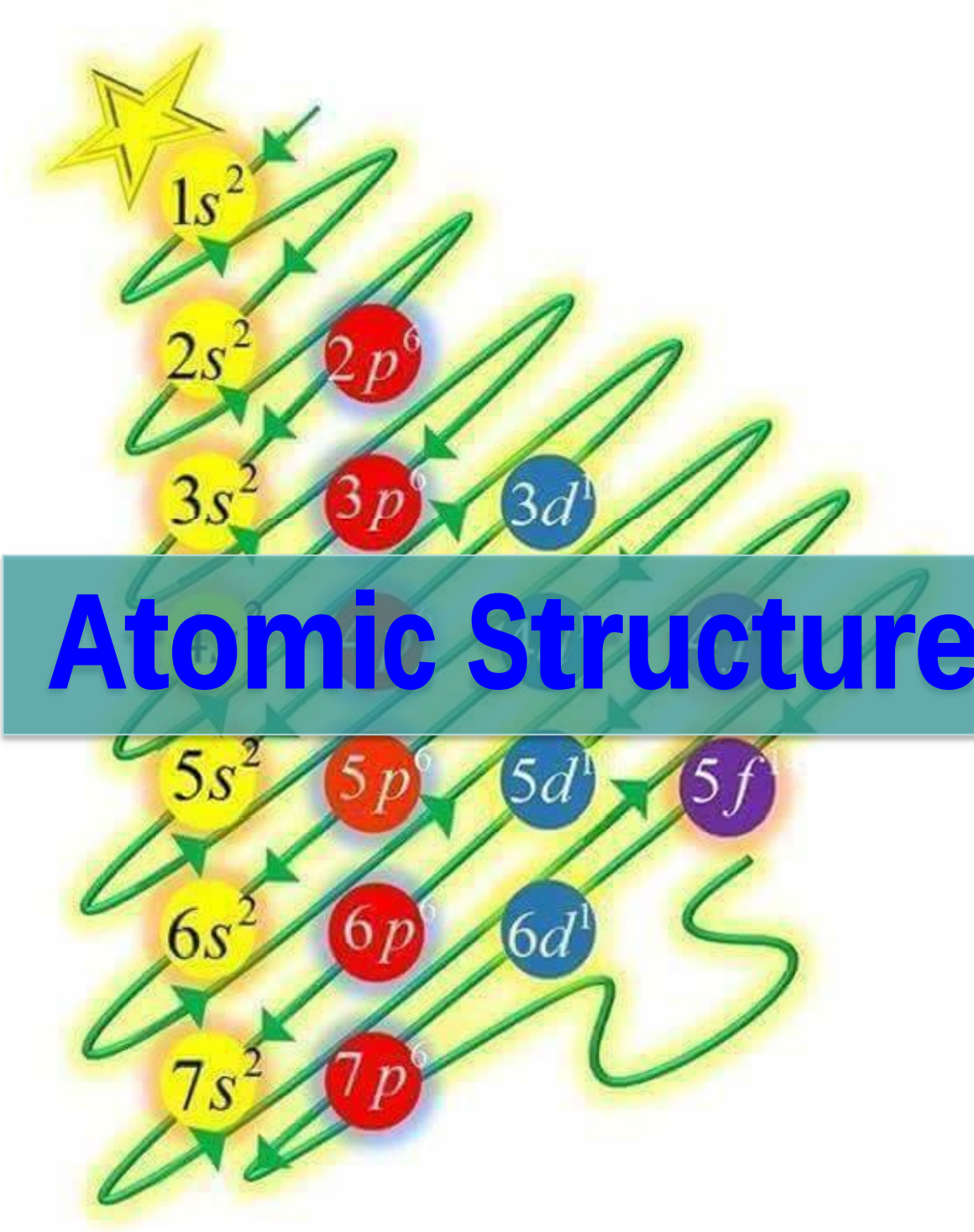




Atomic Structure Chemical Bonding and Chemical Structure





Atomic Structure

Atoms

The basic building block of all matter is called an atom.

Atoms are a collection of various subatomic particles containing negatively charged electrons, positively charged protons and neutral particles called neutrons.

Each element has its own unique number of protons, neutrons and electrons. Both protons and neutrons have mass, whereas the mass of electrons is negligible.

The three fundamental subatomic particles of an atom are electrons, protons and neutrons.

Particle	Actual mass (kg)	Relative mass (amu)	Charge (Coulomb)	charge
Proton, p	1.6726×10^{-27}	1.007	1.6022×10^{-19}	+1
Neutron, n	1.6749×10^{-27}	1.008	0	0
Electron, e^-	9.1094×10^{-31}	5.489×10^{-4}	-1.6022×10^{-19}	-1

mass p ≈ mass n ≈ 1840 × mass e^-

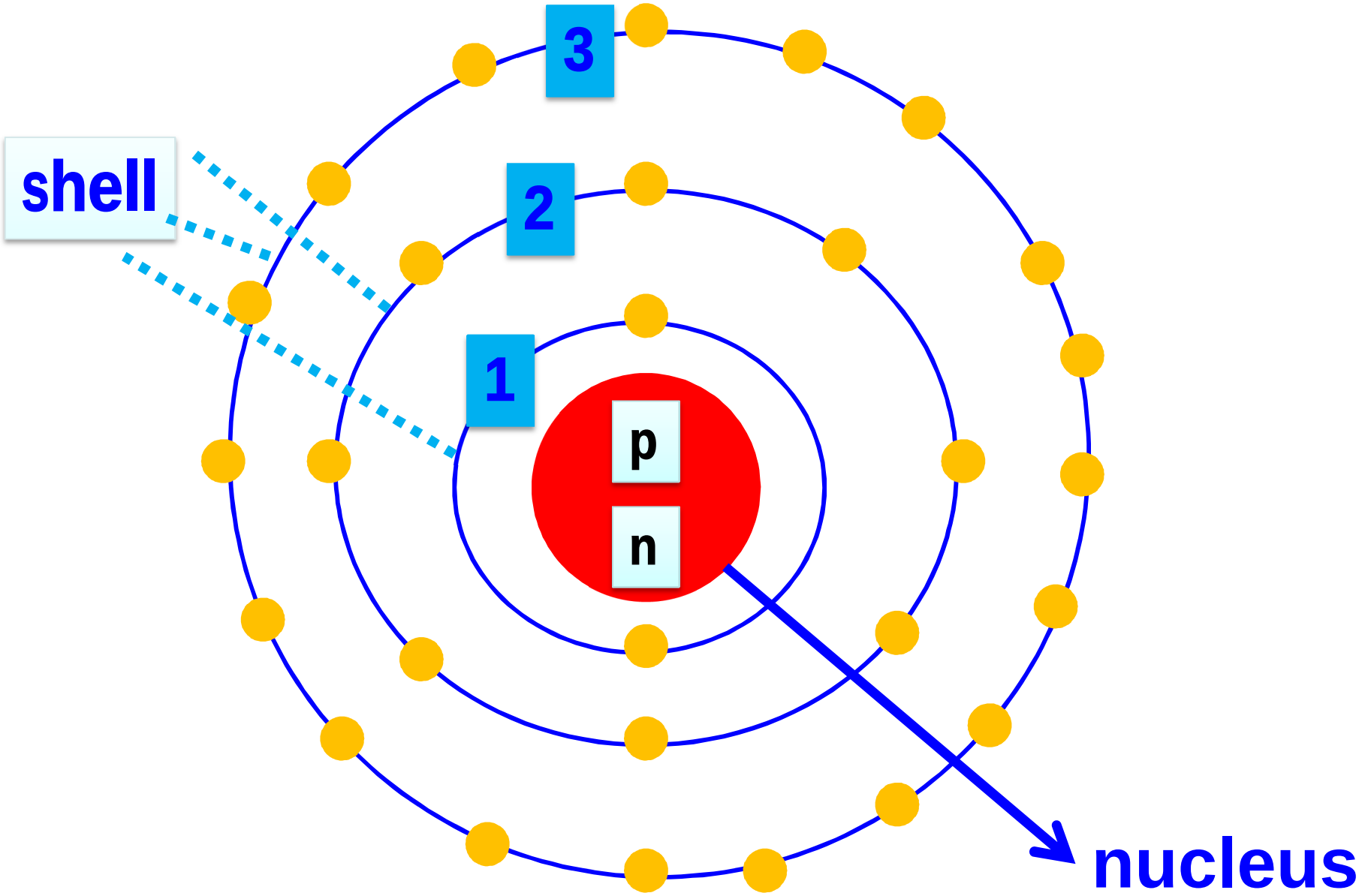
Protons and neutrons exist at the centre of the atom in the nucleus.

It is important to understand the location of electrons, as it is the arrangement of the electrons that creates the bonds between the atoms. Electrons are involved in the chemical bonding and reactions of an atom.

Electrons move around the nucleus, and are arranged in shells at increasing distances from the nucleus. These shells represent different energy levels, the outermost shell being the highest energy level.

Electrons do not move freely in the space around the nucleus but are confined to regions of space called shells.

Model of an atom



p = protons n = neutrons = electrons

Each shell can contain up to a maximum of $2n^2$ electrons, where n is the number of the shell. For the first shell n = 1, for the second shell n = 2, for the third shell n = 3 and so on.

Low energy

High energy

Shell	Maximum number of electrons
1	2
2	8
3	18
4	32

Each shell contains subshells known as atomic orbitals.

Electrons are said to occupy orbitals in an atom. An orbital can hold two electrons.

The different orbitals are *s, p, d and f.*

Subshell	# of orbitals of equal energy	Maximum # of electrons
s	**1**	**2**
p	**3**	**6**
d	**5**	**10**
f	**7**	**14**

Each shell contains subshells known as atomic orbitals.

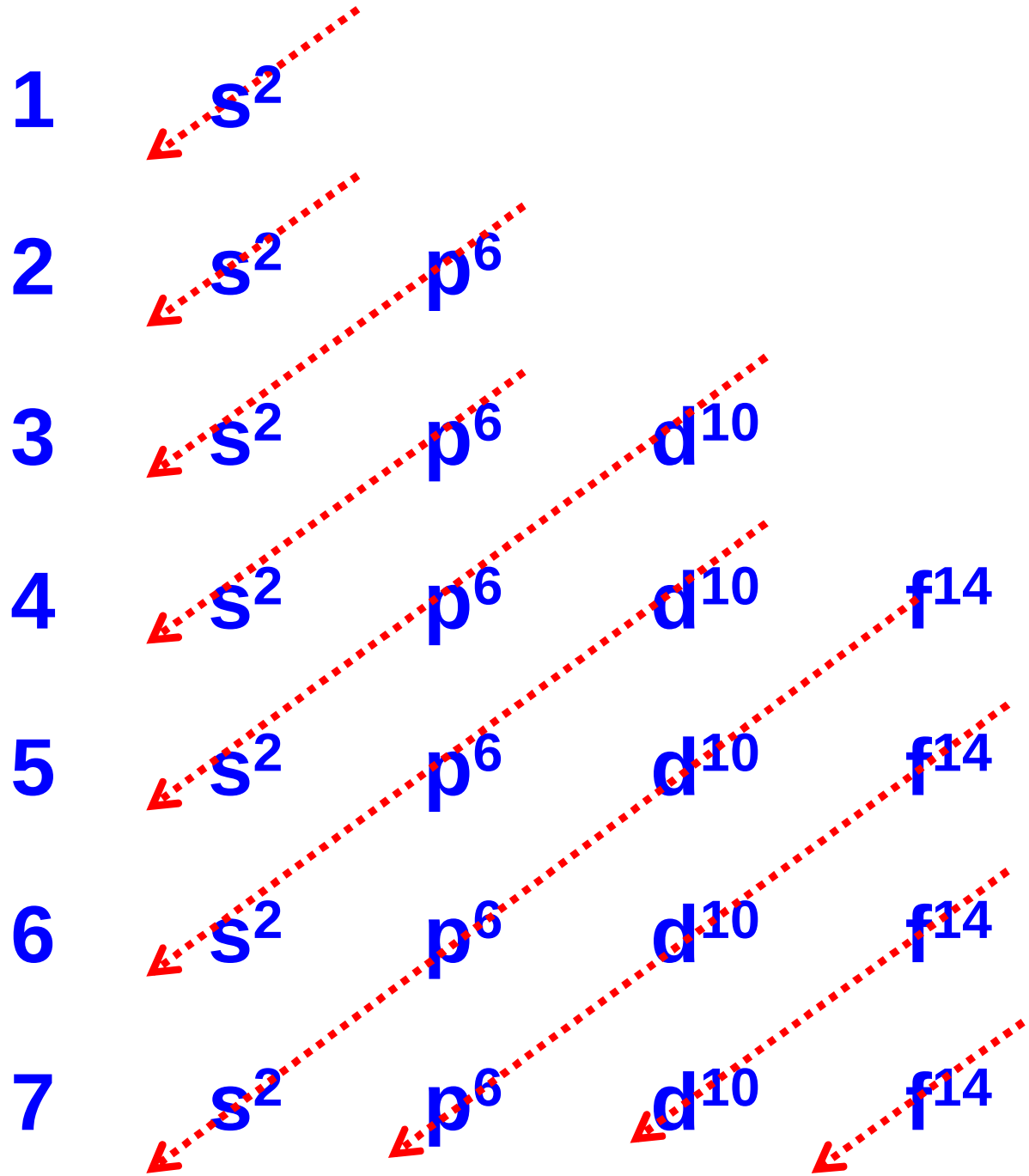
Shell	Subshells and Orbitals
1	1s
2	2s and 2P (p_x, p_y and p_z)
3	3s and 3P (p_x, p_y and p_z) and five 3 d

Electronic Configuration

The electronic configuration of an atom describes the number of electrons that an atom possesses, and the orbitals in which these electrons are placed.

The arrangements of electrons in orbitals, subshells and shells are called electronic configurations.

Building up of electronic configurations



Rules of Filling Electron Orbitals

Aufbau Principle:

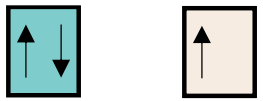
Electrons are added one at a time to the lowest energy orbitals available until all the electrons of the atom have been accounted for.

Pauli Exclusion Principle:

An orbital can hold a maximum of two electrons. To occupy the same orbital, two electrons must spin in opposite directions.

Hund's Rule:

Electrons occupy equal-energy orbitals so that a maximum number of unpaired electrons results.

Element	Electron Configuration	Orbital Filling
		1s 2s $2p_x$ $2p_y$ $2p_z$
$_{1}H$	$1s^1$	
$_{2}He$	$1s^2$	
$_{3}Li$	$1s^2 2s^1$	
$_{6}C$	$1s^2 2s^2 2p^2$	
$_{7}N$	$1s^2 2s^2 2p^3$	
$_{8}O$	$1s^2 2s^2 2p^4$	
$_{9}F$	$1s^2 2s^2 2p^5$	
$_{10}Ne$	$1s^2 2s^2 2p^6$	
$_{11}Na$	$1s^2 2s^2 2p^6 3s^1$