

- Giving the four parameters will uniquely identify an electron around an atom. No two electrons in the same atom can share all four. These parameters are called QUANTUM NUMBERS.

① PRINCIPAL QUANTUM NUMBER (n):

- "energy level", "shell"

- Represents two things:

* The distance of the electron from the nucleus.

* Energy. "n" is one factor that contributes to the energy of the electron.

$$n = 1, 2, 3, 4, \dots \text{ (integers)}$$

② ANGULAR MOMENTUM QUANTUM NUMBER: l

- "subshell"

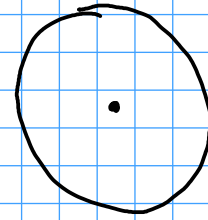
- Represents the SHAPE of the region of space where the electron is found.

- (Bohr assumed CIRCULAR orbits for electrons ... but there are more possibilities.)

- "l" also contributes ENERGY. Higher values for "l" mean the electron has higher energy.

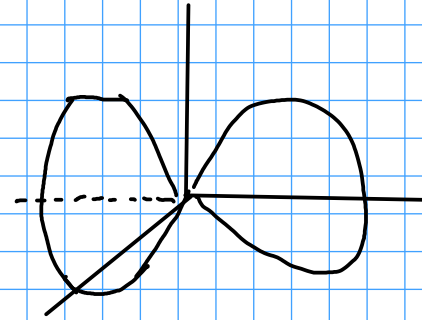
$l = 0$ to $n-1$, integers

$n=1$; $l=0$



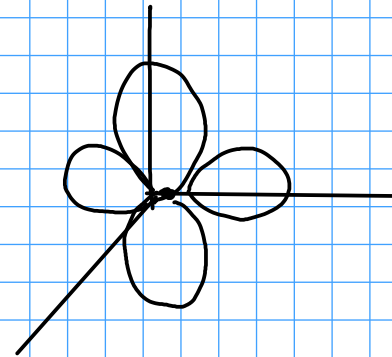
" l " = 0 ; speherical subshell
Also called an "s" subshell.

$n=2$; $l=0, 1$



" l " = 1 ; dumbbell shaped
Also called a "p" subshell

$n=3$, $l=0, 1, 2$



" l " = 2 ; flower-shaped
Also called a "d" subshell

Higher values for " l " translate to higher energies for the electron!

For convenience, and partially for historical reasons, we use letters to designate the different subshells.

$l=0$ "s"

$l=2$ "d"

$l=4$ "g"

$l=1$ "p"

$l=3$ "f"

↓ The rest follow the
alphabet

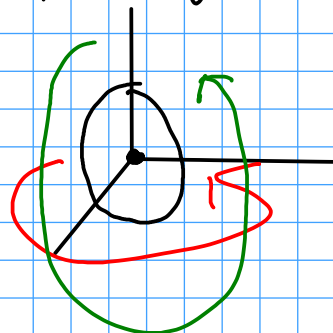
③ MAGNETIC QUANTUM NUMBER m_l

- Represents the ORIENTATION of a subshell in 3D space.

$$m_l = -l \text{ to } +l, \text{ integers}$$

$$l = 0, m_l = 0$$

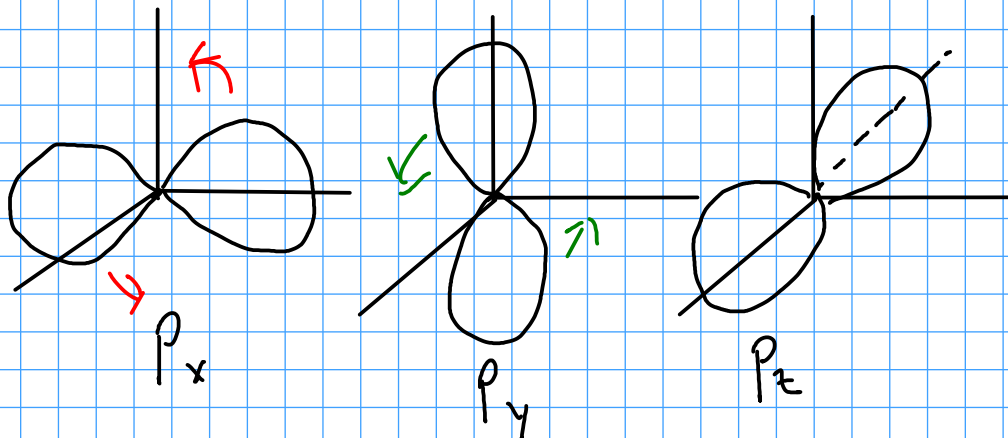
"s"



There is only one possible orientation for an "s" subshell!

$$l = 1, m_l = -1, 0, 1$$

"p"



There are THREE possible orientations for a "p" subshell!

$$l = 2, m_l = -2, -1, 0, 1, 2 \text{ (five orientations)}$$

"d"

picture p285

$$l = 3, m_l = -3, -2, -1, 0, 1, 2, 3 \text{ (seven orientations)}$$

"f"

... all the arrangements of a single subshell have the same energy. The magnetic quantum number DOESN'T contribute to the energy of an electron.

4

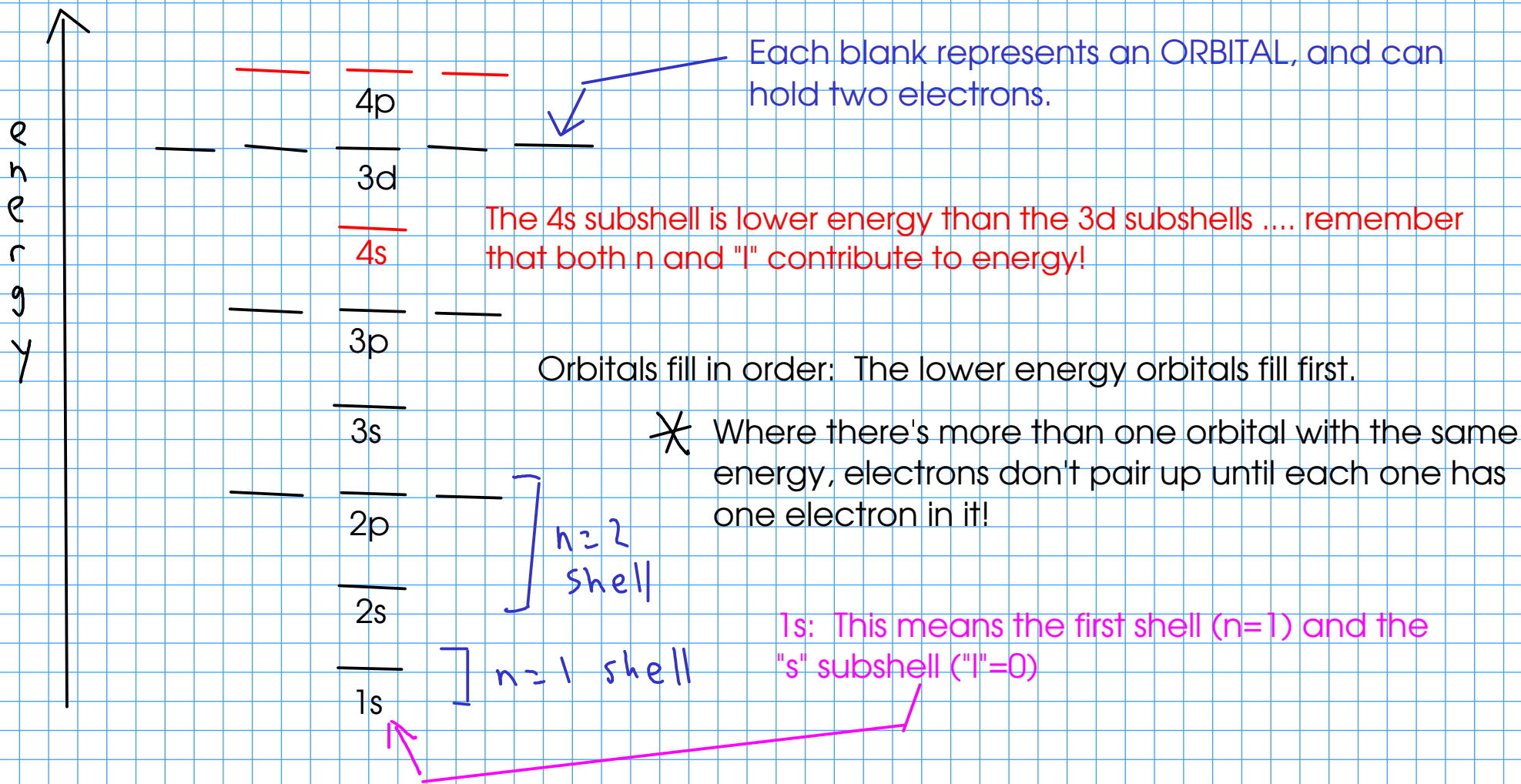
(MAGNETIC) SPIN QUANTUM NUMBER: m_s

$m_s = -\frac{1}{2}$ OR $+\frac{1}{2}$ "spin down" or "spin up"

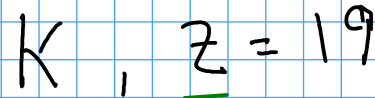
- An ORBITAL (region with fixed "n", "l" and "ml" values) can hold TWO electrons.

ORBITAL DIAGRAM

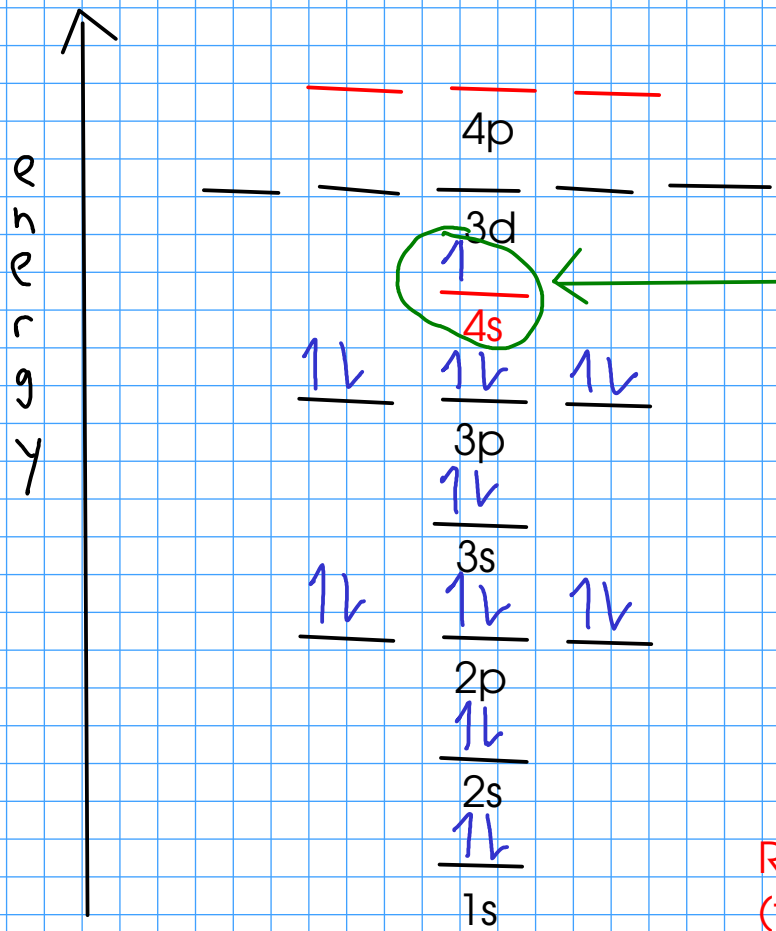
- A graphical representation of the quantum number "map" of electrons around an atom.



How would an orbital diagram for the element POTASSIUM look?



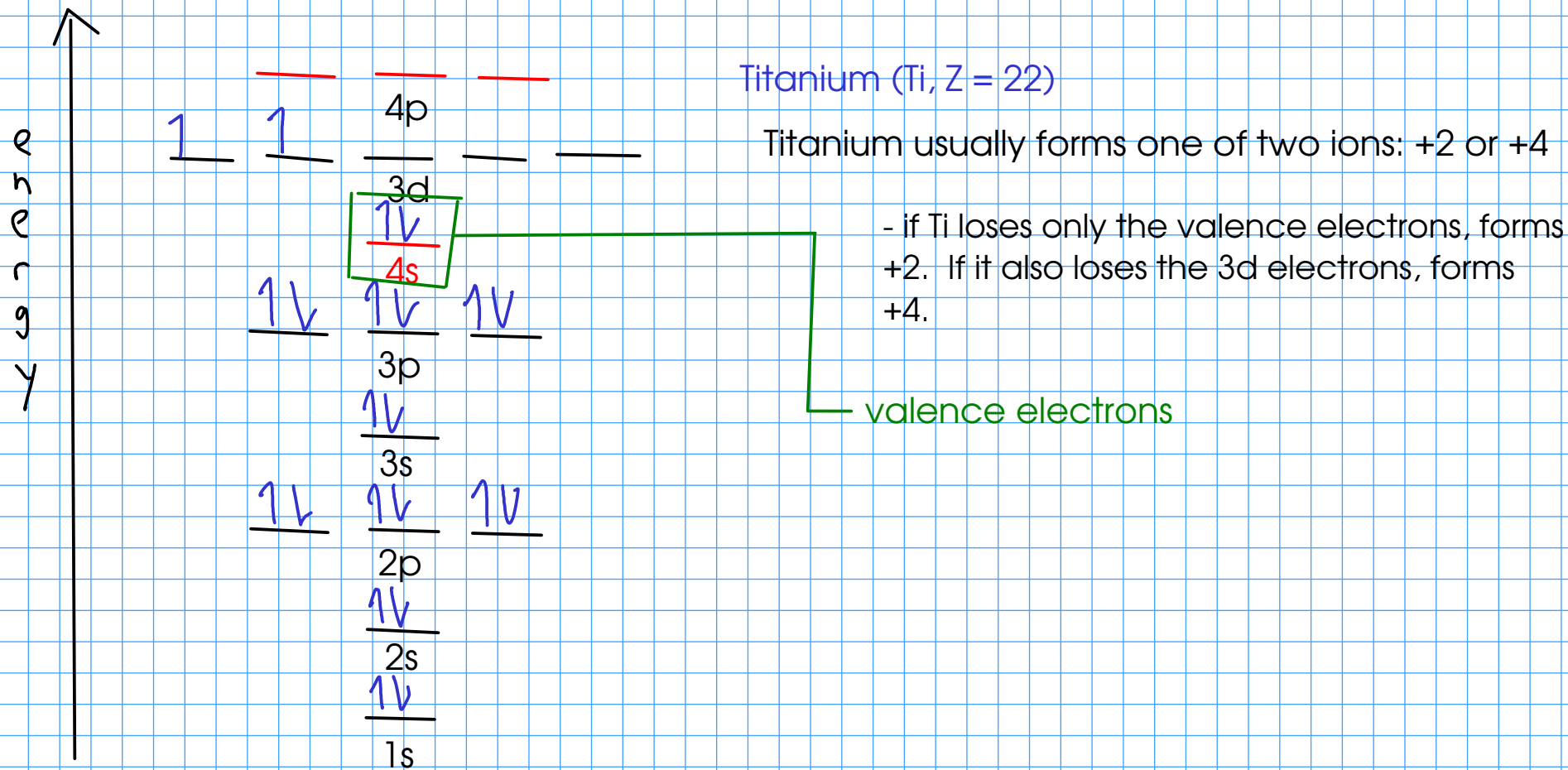
atomic number



Electrons in the outermost shell of an atom are called VALENCE electrons. THESE electrons are normally involved in chemical bonding.

Remember: Potassium tends to lose a single electron (forming a cation) in chemical reactions. K^+

A little bit about transition metals...



- Most transition metals have TWO valence electrons (in an "s" subshell), and the other ions they form come from electron loss in "d" subshells.