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University of Texas at Austin

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Atomic Theory Unit – Quantum Numbers, Orbital Diagrams and Electron Configurations

Quantum numbers (Q#s) tell about the energy and location of an electron in an atom. To review the four Q#s fill in the table below.

Q# name	Principle Q#	Angular Momentum Q#	Magnetic Q#	Spin Q#
Q# symbol	n	ℓ	m(ℓ)	m(s)
What does this Q# tell you about the electron?	The energy of the electron	The shape of the orbital the electron is in	The orientation of the orbital the electron is in	The spin of the electron
What are the possible values for this Q#?	1,2,3,… (positive integers)	0,1,2,3,… (n-1) OR s,p,d,f	-ℓ…0…ℓ	±½
Applying these rules, if n=3, what are the possible values for the 3 other Q#s?	3	0 1 2	0 -1, 0, 1 -2, -1, 0, 1, 2	±½
Is this combination of Q#s possible? ___**NO**___	4	3	-4 (problem!!)	-1/2
Is this combination of Q#s possible? ___**NO**___	7	2	-5 (problem!!)	+1/2

If you can change only one quantum number, how could you change the above sets of Q#s to make them possible sets?

4,3,**-4**,-1/2 could be 4,3,**-3**,-1/2 or 4,3,**2**,-1/2 or …
7,2,**-5**,+1/2 could be 7,**6**,-5,+1/2 or 7,2,**0**,+1/2 or …
These are just two examples of possible ways to change these Q# sets. However, there are many other ways to change only one number to make these sets possible.

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There are two main ways we depict the electrons in an atom: Orbital Diagrams and Electron Configurations. To help you link Orbital Diagrams, Electron Configuration, Quantum Numbers and the Periodic Table fill in the table below.

Q# name	Principle Q#	Angular Momentum Q#	Magnetic Q#	Spin Q#
Q# symbol	n	ℓ	m(ℓ)	m(s)
In orbital diagrams, does this Q# tell you about the shell, sub-shell, or orbital the electron is in?	shell	sub-shell	orbital	
In electron configuration notation, circle the element that is designated by each Q#.	$1s^2$ $6d^7$	$1s^2$ $6d^7$	$1s^2$ $6d^7$	
What does this Q# tell you about the position in the periodic table?	row	block		

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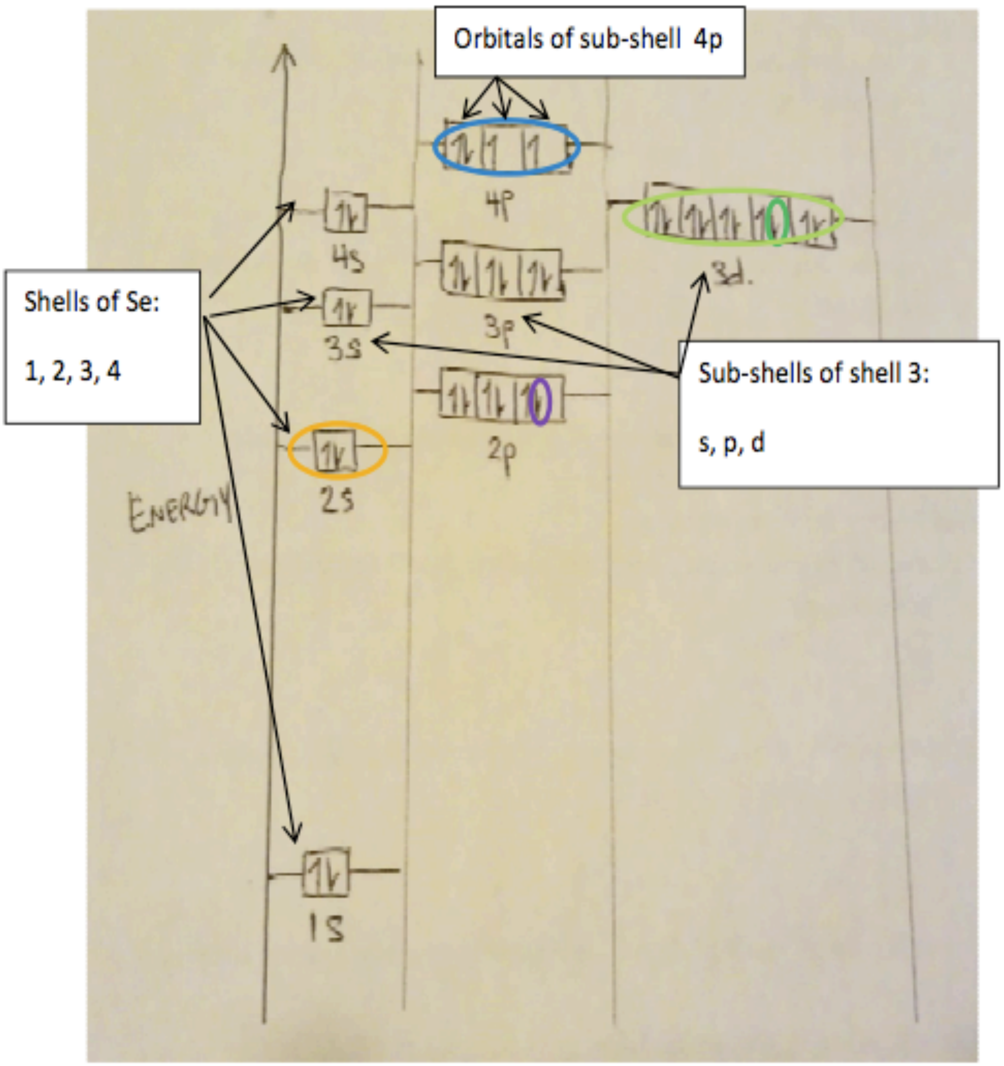
Let's apply all of this in an example: Given the electron configuration and the orbital diagram for Se, answer the following questions.

<u>Electron configuration for Se</u>

$1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^6$, $4s^2$, $3d^{10}$, $4p^4$

<u>Orbital Diagram for Se</u>



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Questions

1. Orbital Diagrams: Where are the shells, sub-shells and orbitals on the orbital diagram? Circle and label each one on the diagram above.
2. Electron Configuration and Orbital Diagrams
   a. Where are the electrons in blue in the electron configuration on the orbital diagram? Circle them in blue on the orbital diagram.

   b. Where is the electron circled in green in the orbital diagram in the electron configuration? Underline its location in green on the electron configuration.

      What shell is this electron in? n = 3
      What sub-shell is this electron in? The d sub-shell

3. Electron Configuration and Quantum Numbers
   a. What are the possible quantum number sets for the electrons in pink on the electron configuration?

      4, 0, 0, -½ OR 4, 0, 0, +½

   b. What are 3 possible quantum number sets for the electrons in red on the electron configuration? How many total possible quantum number sets are there for these electrons?

      3, 1, -1, -½ OR 3, 1, -1, +½ OR 3, 1, 0, +½ OR 3, 1, 1, -½ OR 3, 1, 1, +½ → There are 6 total possible sets

   c. In orange on the electron configuration, circle the electrons with the quantum numbers: 2, 0, 0, -1/2 and 2, 0, 0, +1/2.
4. Orbital Diagrams and Quantum Numbers
   a. What are the possible quantum number sets for the electron circled in purple on the orbital diagram?

      2, 1, -1, -½ OR 2, 1, -1, +½ OR 2, 1, 0, -½ OR 2, 1, 0, +½ OR 2, 1, +1, -½ OR 2, 1, +1, +½

   b. In light green on the orbital diagram, circle an electron with the quantum numbers: 3, 2, -2, -1/2.
5. Electron Configuration and the Periodic Table
   a. Without looking at the periodic table, what row in the periodic table would you find Se? 4^{th}

      How do you know this? Because n of the last electron is n = 4

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b. Without looking at the periodic table, what block in the periodic table would you find Se? p

   How do you know this? Because ℓ of the last electron is ℓ = 1 = p