

Quantum Numbers

THIS IS JUST BOOKKEEPING

It's a way of giving each electron in an atom a unique tag

- Principle quantum number, n** , gives the primary energy level $n = 1, 2, 3, 4, 5, 6, 7$.
- Subsidiary quantum number, l** , gives the sublevel (s, p, d, f stuff) $l = 0, 1, 2, 3$

0 refers to an s-sublevel 1 refers to an p-sublevel 2 refers to an d-sublevel 3 refers to an f-sublevel	}	The letter designations come from history. They describe the spectral line relating to transitions involving these levels; eg, "s" denotes a "sharp" line.
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- Magnetic quantum number, m_l** , gives the orientation of the subshell $m_l = -l, \dots, 0, \dots, +l$
 (This gives each orbital in a sublevel a unique name). So like, there's only one orbital in an s-sublevel ($l=0$) so m_l can only have one value, 0. In a p-sublevel ($l=1$) you have 3 orbitals that can be uniquely named by m_l as +1, 0, and -1, and so on.
- Magnetic spin quantum number, m_s** , This differentiates the two electrons that can exist in an orbital $m_s = +1/2$ or $-1/2$. In combination with the other quantum numbers, it uniquely identifies an electron.

Quantum numbers give unique names to each electron. The orbital--energy level description (you know the spdf stuff), is a way of looking at all the electrons as belonging to groups. Be comfortable with the fact that the two ideas overlap.

Quantum #'s				Orbitals and Shells	
<u>n</u>	<u>l</u>	<u>m_l</u>	<u>m_s</u>	<u>Sublevel</u>	<u>Specific Orbital</u>
1	0	0	$+1/2, -1/2$	1s	s
2	0	0	$+1/2, -1/2$	2s	s
3	0	0	$+1/2, -1/2$	3s	s
3	1	-1	$+1/2, -1/2$	3p	p
3	1	0	$+1/2, -1/2$	3p	p
3	1	+1	$+1/2, -1/2$	3p	p

etc, GET A GRIP ON THIS

Student Packet: 1.4: Quantum Numbers: AssessMe questions

- 1) For a neutral As atom in the ground state, how many electrons have quantum numbers $n = 4$, $l = 1$?
- A) 2 B) 3 C) 4 D) 5 E) I'm clueless
- 2) What is the maximum number of electrons that can have a principal quantum number of 3 within one atom?
- A) 3 B) 8 C) 18 D) 32 E) I'm clueless
- 3) The maximum number of electrons in an atom that can have quantum numbers $n = 2$, $l = 1$ is:
- A) 2 B) 6 C) 8 D) 4 E) I'm clueless
- 4) The quantum numbers 3, 1, -1, +1/2 refer to an electron in
- A) the p orbital of the 3rd shell.
B) the p orbital of the 2nd shell.
C) carbon.
D) the s orbital of the 3rd shell.
E) I'm clueless
- 5) The energy levels of the hydrogen atom are related to the principal quantum number by:
- A) $E = k/n$ B) $E = k/n^2$ C) $E = kn$ D) $E = kn^2$ E) I'm clueless
- 6) How many atomic orbital configurations that satisfy Hunds' Rule can be written for the $1s^2 2s^2 2p^2$ structure of the carbon atom such that all the p electrons have a spin quantum number of +1/2?
- A) 1 B) 2 C) 3 D) 4 E) I'm clueless

Student Packet: 1.4: Quantum Numbers: ShowMe questions

- 1) If the principle quantum number of an electron in an atom is 2, list the possible values for the quantum numbers l , m_l , and m_s .

- 2) Give the notation (using letter designations) for the subshells designated by the following values of the subsidiary quantum number (the second quantum number).
 - a) $n = 3, l = 2$
 - b) $n = 2, l = 0$
 - c) $n = 4, l = 3$

- 3) List the number of electrons that can fit in each of the following subshells.
 - a) $l = 0$
 - b) $l = 1$
 - c) $l = 2$
 - d) $l = 3$

- 4) How many subshells are there for the principle quantum number 2? How many orbitals are there in the p subshell?

Student Packet: 1.4: Quantum Numbers: TestMe questions

1) Match the quantum number with its definition:

- a. Principle Quantum number (n)
- b. Angular Quantum number (l)
- c. Magnetic Quantum number (m_l)
- d. Spin Quantum number (m_s)

- 1. This number distinguishes orbitals of given energy and shape but having a different orientation in space.
- 2. This number distinguishes orbitals by their shape.
- 3. This number is the one on which the energy of an electron in an atom depends.
- 4. This number refers to the two possible orientations of the spin axis.

- A) a-2, b-3, c-4, d-1
- B) a-3, b-2, c-1, d-4
- C) a-2, b-4, c-3, d-1
- D) a-3, b-4, c-2, d-1
- E) None of the above

2) Which of the following sets of quantum numbers is permissible for an electron in an atom?

- A) $n = 3, l = 1, m_l = +2, m_s = +1/2$
- B) $n = 2, l = 2, m_l = 0, m_s = +1/2$
- C) $n = 1, l = 1, m_l = 0, m_s = 1$
- D) $n = 2, l = 1, m_l = -1, m_s = -1/2$
- E) $n = 4, l = 0, m_l = +1, m_s = +1/2$

3) Which of the following are incorrect designations for an atomic orbital?

- I. 2p II. 4s III. 1p IV. 2d

- A) I, III, IV B) II, III C) I, II, III D) III, IV E) None of the above

4) Calculate how many electrons can simultaneously possess the quantum numbers $n = 3$ and $m_s = +1/2$.

- A) 4 B) 9 C) 14 D) 28 E) None of the above

5) Which of the following is an allowable set of quantum numbers?

- A) 4, -2, -1, $1/2$ B) 3, 2, 3, $-1/2$ C) 4, 2, 0, 1 D) 3, 0, 0, $-1/2$ E) None of the above