Chem1311Ch7Ep2 Transcript

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Hello, and welcome to the second episode of Theory and electronic structure of atoms.

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Previously, in theory and the electronic structure of atoms.

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We learned that electrons have a wave and particle nature.

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We learned that electrons don't follow predictable paths when they move.

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And we learned that the wavefunction describing an electron's orbital is a function of four quantum numbers.

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In today's episode.

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We will learn that allowed values for the quantum numbers describing a given electron.

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Can be more easily remembered using a hotel analogy.

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This table is a great place to start describing the relationship between the quantum numbers and the orbitals the electrons occupy.

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An orbital is the space that an electron or an electron pair occupy around the nucleus.

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It is where it lives.

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All orbitals have a maximum occupancy of two electrons.

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Some only have one and some can be thought of as being empty, but none have 3 electrons.

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Two maximum.

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Let's start with the principal quantum number.

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This number has values of positive integers.

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And it determines how far the electron is from the nucleus.

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It also tells you the energy level of the electron.

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The larger the value of n.

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The further the electron is from the nucleus and the higher its energy.

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And of course, the larger the orbital is.

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All electrons having the same principal quantum number are referred to as a shell or energy level.

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When you hear either of these two terms, shell or energy level, think of it as a single floor in a high-rise electron hotel where the atom is that hotel.

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Next is the angular momentum quantum number.

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This number has integer values from zero, to 1 less than what the principal quantum number n is.

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The value of l determines the shape the orbital has, and it has a minor effect on the electron's energy.

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Each different value of l represents a different orbital shape.

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All electrons having the same value of n and l.

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are refer to as a subshell.

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A shell or floor will have one or more subshells.

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Subshells are also sometimes referred to as energy sublevels.

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Subshells are designated by a letter to avoid confusion.

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When l is equal to 0, it is referred to as an “s”.

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L is equal to 1 is “p”.

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L is equal to two is “d”.

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L is equal to three is “f”.

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L is equal to four is “g” and so on, alphabetical.

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Think of the subshell as a room in the electron hotel.

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The room number.

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Would be listed with the values of “n” and “l”.

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For that particular room or subshell.

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For example, 3p means room one in the third floor.

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4s would need room 0 in the 4th floor.

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Next is the magnetic quantum number.

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This number has integer values ranging from –l to +l.

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Those values represent the orientation of the orbital in three-dimensional space.

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That is, the different directions the orbital can face correspond to the different values of m_l.

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All electrons having the same value of n, l and m_l are in the same orbital.

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A subshell will have one or more orbitals depending on the value of l.

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Think of the orbital as a bed.

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The bed or beds are in a room which is the subshell.

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And the room or rooms are in a floor or shell.

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Because the values of m_l depend on l, different rooms will have different number of beds.

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For example.

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“s” rooms or subshells have one bed or orbital.

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“p” rooms or subshells have three beds or orbitals.

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“d” rooms or subshells have five beds or orbitals.

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And “f” rooms or subshells have seven beds or orbitals.

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The 4th Quantum number is the spin quantum number.

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This number has two possible values, +½ or –½.

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These values represent a clockwise and a counterclockwise direction of spin, respectively.

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This quantum number applies directly to the electron and tells you nothing about the orbital.

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Think of each electron as a guest in the Electron hotel.

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OK.

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Now it's time for a virtual visit to that electron hotel.

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You don't see any electrons?

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Well, that's because we are at the nucleus.

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The one place where electrons have 0 probability of being.

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This is the hotel lobby, so let's close the elevator and see what we find.

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The elevator door opens to the first floor and you see that n is equal to 1.

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That's our floor.

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This is the first shell.

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We only see one room or subshell in the entire floor.

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The plaque by.

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The door reads “l” is equal to 0.

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That's our room number.

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We open the door to see what's in these and we find that there is a single bed or orbital and it is labeled with the “m_l” value of 0.

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Two electrons reside there with opposite spins.

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OK, back to the electron elevator and we arrive at the 2nd floor or shell, n is equal to 2.

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We can see two rooms or subshells having l values of zero and one.

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“s” and “p”

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We have already seen an “s” subshell, so let's have a look at the P room or subshell.

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Inside we see three orbitals having m_l values of –1, 0, and 1.

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And each holding 2 electrons which are spinning in opposite directions.

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So back to the elevator and we go up one floor to the third shell or energy level.

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We see that there are three subshells with l values of 0, 1, and 2.

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We've already seen, “s” and a “p” subshells, so let's look at the “d” subshell.

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Inside we see 5 orbitals labeled with their m_l values from –2 all the way to +2.

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Each one of these orbitals contains 2 electrons spinning in opposite directions.

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Back to the elevator and we go up one floor to the 4th shell.

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We see 4 subshells labeled with their l values.

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We have already seen all except for the “f” subshell.

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And so we open the door.

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We look inside and see that the “f” subshell has seven orbitals.

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Labeled with their m_l values, which span from –3 to +3.

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Each orbital contains 2 electrons.

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So that is a total of 14 electrons.

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In this “f” subshell.

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We head back to the elevator and up one floor to the fifth shell.

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We see that the 5th Shell has five subshells “s”, “p”, “d”, “f”, and “g”.

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Each labeled with its l value.

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We go straight for the “g” subshell and have a peek inside.

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Inside there are nine orbitals, each with two Oh my God.

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I guess we should have knocked.

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My apologies, we are going to have to cut short the tour.

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And that's all there is, there isn't anymore.