

# Quantum Mechanics



## Quantum Mechanics overview

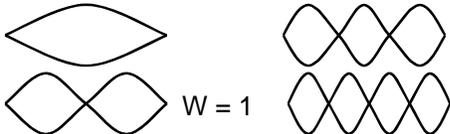
- We will see: electrons have discrete energies, not because they are in shells but because they can only have certain wavelengths
- Line spectra are not due to electrons jumping from shell to shell (as in Bohr's model)...
- Instead they're due to electrons transforming from one wavelength (waveform) to another
- Each electron is a wave that can be described by a series of "quantum numbers"
- There are four quantum numbers:  $n, l, m_l, m_s$
- Today we will be looking at the first three
- The combination of these 3 defines an "orbital"

## Waves: standing, travelling

Read pg. 199 - 200 (stop at "The theory of quantum mechanics..." -3<sup>rd</sup> paragraph)

Q1: What is the difference between standing and traveling waves?

Q2 – How many wavelengths (W) are represented in each figure below?

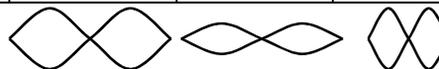


## Classifying waves: hypothetical ex.

- We have used the symbol "W" to represent wavelength. If there were other important variations in waveforms we would use other symbols to represent these characteristics.
- For example, we could add length and height to our list (symbolize with L and H)

Hypothetical "quantum" numbers and values

W	1		
L	10		
H	1		



## Classifying electron waves

- The waves of electrons are similarly classified according to certain variables ( $n, l, m_l$ )
- The rationale for the numbers is not always clear. These numbers come from some pretty advanced math. You don't have to know why we use certain formulas for determining quantum numbers.
- You do have to know what the formulas are, when to use them, and what the resulting quantum numbers represent.

## The Quantum Numbers

- Recall: we are looking at the first three of four quantum numbers:  $n, l, m_l, m_s$
- The principal quantum number is  $n$
- $n$  ranges from 1 to infinity
- Bohr thought  $n$  represented shells. He was close.  $n$  is related to the size of the electron wave.  $n=1$  is smallest (closest to nucleus)
- The secondary quantum number is  $l$
- $l$  ranges from 0 to  $n - 1$ , in increments of one
- Q - what are the possible values of  $l$  when  $n=3$
- A -
- Q - what are the possible values of  $l$  when  $n=6$
- A -

## $l$ : The secondary quantum number

- Each value of  $l$  is associated with a letter:
- $0 = s, 1 = p, 2 = d, 3 = f$
- after 3, the associated letters go alphabetically from f up, so  $4 = g, 5 = h$ , etc.
- Normally, we don't talk about electrons beyond  $l = 3$  (the f subshell)
- Whereas  $n$  represents size and energy,  $l$  tells us of the shape of an electron (we will look at this in more detail later).
- We often identify electrons by shell and subshell: e.g. 1s, 3d, 2s, and 5d subshell

## $l$ : The secondary quantum number

- If  $n$  can be thought of as shells,  $l$  can be thought of as "subshells" dividing each shell into subsections ... ( $l = 0 \rightarrow n - 1$ )

