Warm-Up:

Two naturally occurring isotopes of uranium are uranium-234 (natural abundance 97.50%) and uranium-237(natural abundance 2.50%). What is the average atomic mass of this element?

Objectives:

TSWBAT:

- Describe historical atomic models as well as the current Schrodinger electron cloud model.
- Describe electronic energy levels in terms of quantum numbers and be able to assign orbital notation to electrons in a given atom.

P. 119 #30, #32

30. The number 194 stands for the mass number in platinum-194. The symbol is:

$^{194}_{78}Pt$

32. List the # of protons, neutrons, & electrons:

a. lithium-6: $3p^+$, $3e^-$, $3n^o$

lithium-7: $3p^+$, $3e^-$, $4n^o$

b. Ca-42, Ca-44 c. Se-78, Se-80

p. 123 #65 and #72

65. First, add the weights of the protons and neutrons in each isotope together.

Isotope:	Natural Abundance:
204	1.4%
206	24.1%
207	22.1%
208	52.4%

(204)(0.014) + (206)(0.241) + (207)(0.221) + (208)(0.524) =

2.856 + 49.646 + 45.747 + 108.992=

207.241 amu rounds to 207 amu

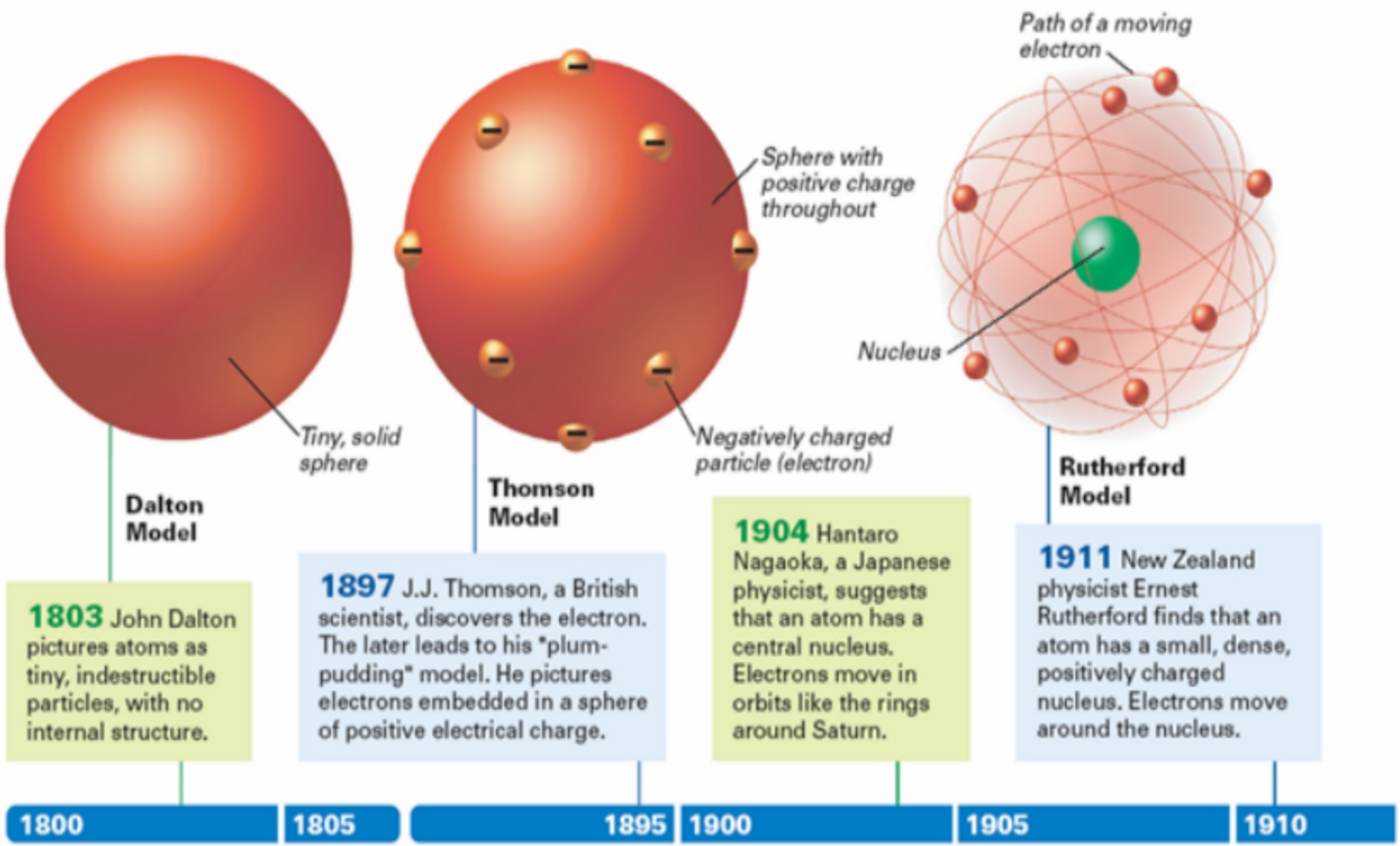
#72

What makes isotopes of the same element chemically alike?

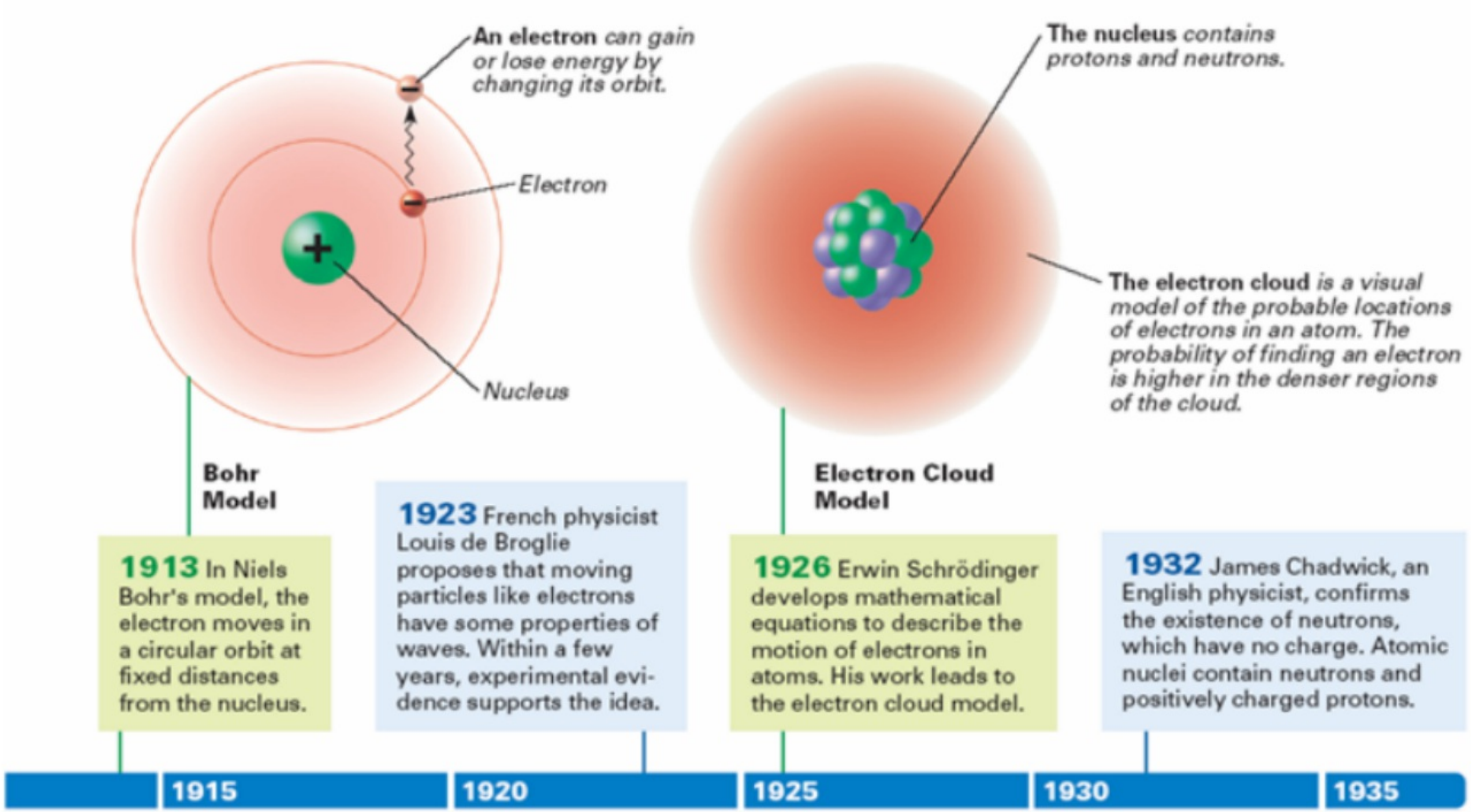
Atomic Models we've looked at so far:

1. Dalton
2. J.J. Thomson
3. Rutherford

Rutherford's Model of the atom also turned out to be missing something. It could not explain certain observations. For instance, why do some elements change color when they are heated? (Think about an iron horse shoe.)


Path of a moving electron
Sphere with positive charge throughout
Nucleus
Tiny, solid sphere
Negatively charged particle (electron)
Dalton Model
Thomson Model
Rutherford Model
1803 John Dalton pictures atoms as tiny, indestructible particles, with no internal structure.
1897 J.J. Thomson, a British scientist, discovers the electron. The later leads to his "plum-pudding" model. He pictures electrons embedded in a sphere of positive electrical charge.
1904 Hantaro Nagaoka, a Japanese physicist, suggests that an atom has a central nucleus. Electrons move in orbits like the rings around Saturn.
1911 New Zealand physicist Ernest Rutherford finds that an atom has a small, dense, positively charged nucleus. Electrons move around the nucleus.
1800
1805
1895
1900
1905
1910

Between 1913, when Rutherford did his experiments, and 1932 scientists began to revisit the atomic model. They needed a model that explained their observations.



The "Bohr Model" looks like a target with the nucleus at the center and the electrons orbiting in fixed paths around the nucleus. See p. 129 for a picture of this model.

Each possible electron orbit in Bohr's model has a fixed energy.

- The fixed energies an electron can have are called energy levels.
- A quantum of energy is the amount of energy required to move an electron from one energy level to another energy level.

The Bohr model works only for the hydrogen atom. It was a good place to start, though, and led to a highly mathematical model by Erwin Schrodinger based on where an electron probably could be found.

The modern description of electrons in atoms:

The quantum mechanical model of the atom comes from the mathematical solutions to the Schrödinger equation.

We think of electrons as little math equations in this model.

Probability and the Electron

- electrons are not baseballs
- electrons have properties of both particles and waves. This was NEW in the world of science.
- It turns out the most practical way to answer "where is the electron?" is "probably here."
- The truth is, with electrons, you never know for sure where they are or how fast they are moving.

Objectives
TSWBAT

- Describe the quantum mechanical model of the atom
- Define Heisenberg's Uncertainty Principle
- Describe some atomic orbital characteristics

Weird electrons:

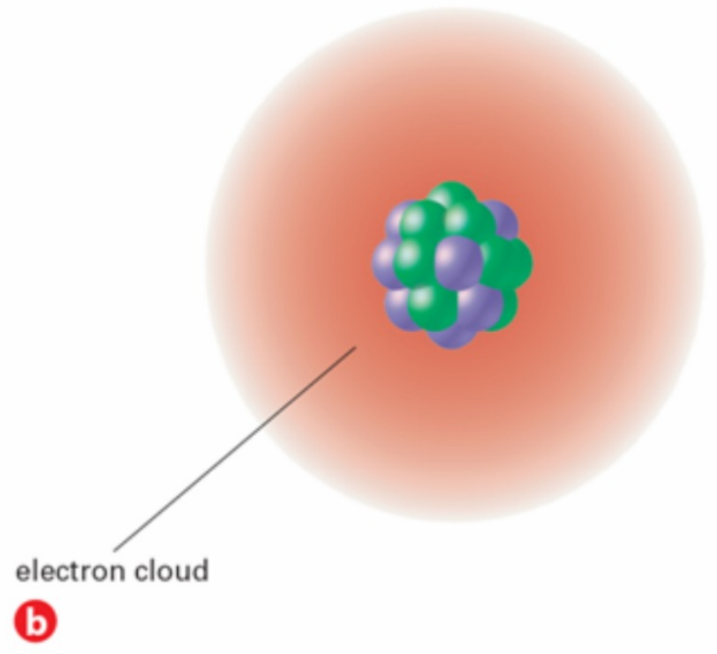
A physicist named Heisenberg went even further than Schrodinger. He also looked at the mathematics that described an electron.He said not only could you never know for certain where the electron is, if you try to measure the location or velocity of the electron, you CHANGE THE ANSWER!!!

Heisenberg's uncertainty principle:

It is not possible to know both the location and velocity of a given electron. Attempts to measure these quantities change the answer. Rather than try to pin it down, scientists talk about the probability of finding an electron in a certain region.

Schrodinger did not like his model being framed this way. Hence his "thought experiment" with the cat.

In the quantum mechanical model, the probability of finding an electron within a certain volume of space surrounding the nucleus can be represented as a fuzzy cloud.



Another way to think about "electron clouds" and probabliity is by thinking about an airplane propeller. When it is rotating you see a circular blur- you know the propeller is in there but it is hard to say EXACTLY where at any given moment.

Energy Levels

1. Electrons occupy energy levels around a nucleus. You can think of these as rungs on a ladder, except they are not evenly spaced.

The primary energy levels get numbers:

1, 2, 3, 4

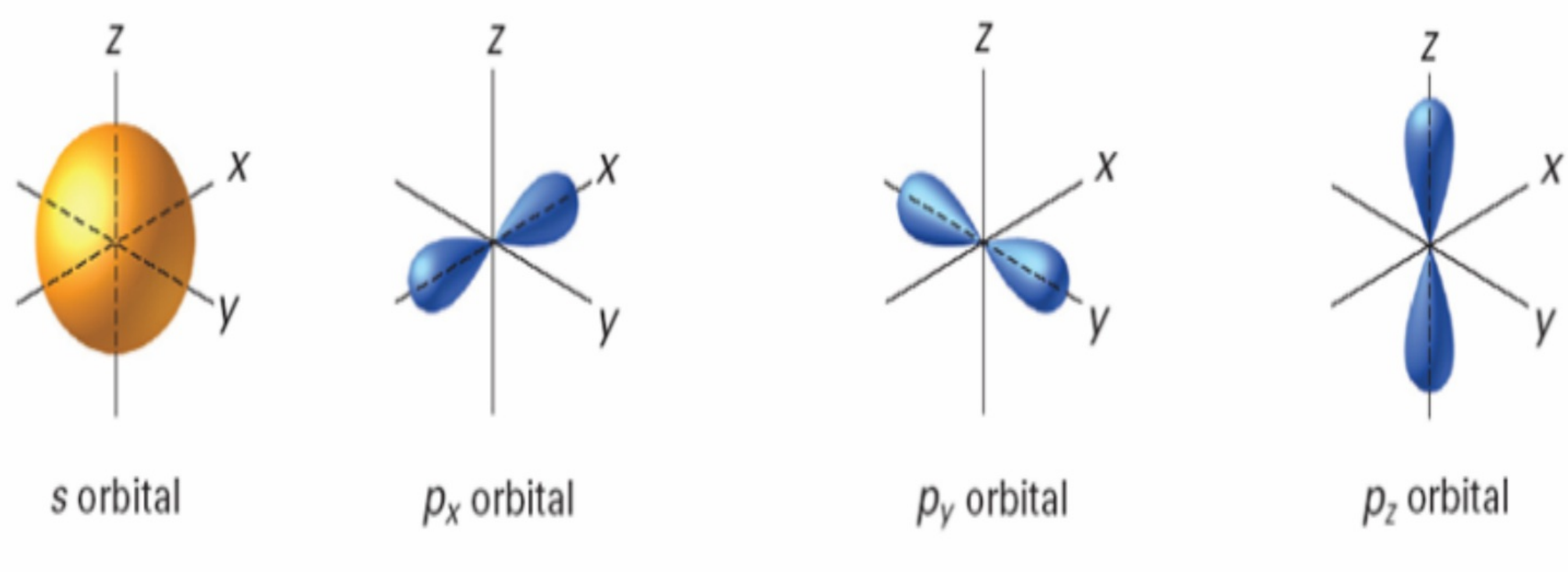
We designate these levels "n"

Atomic Orbitals:

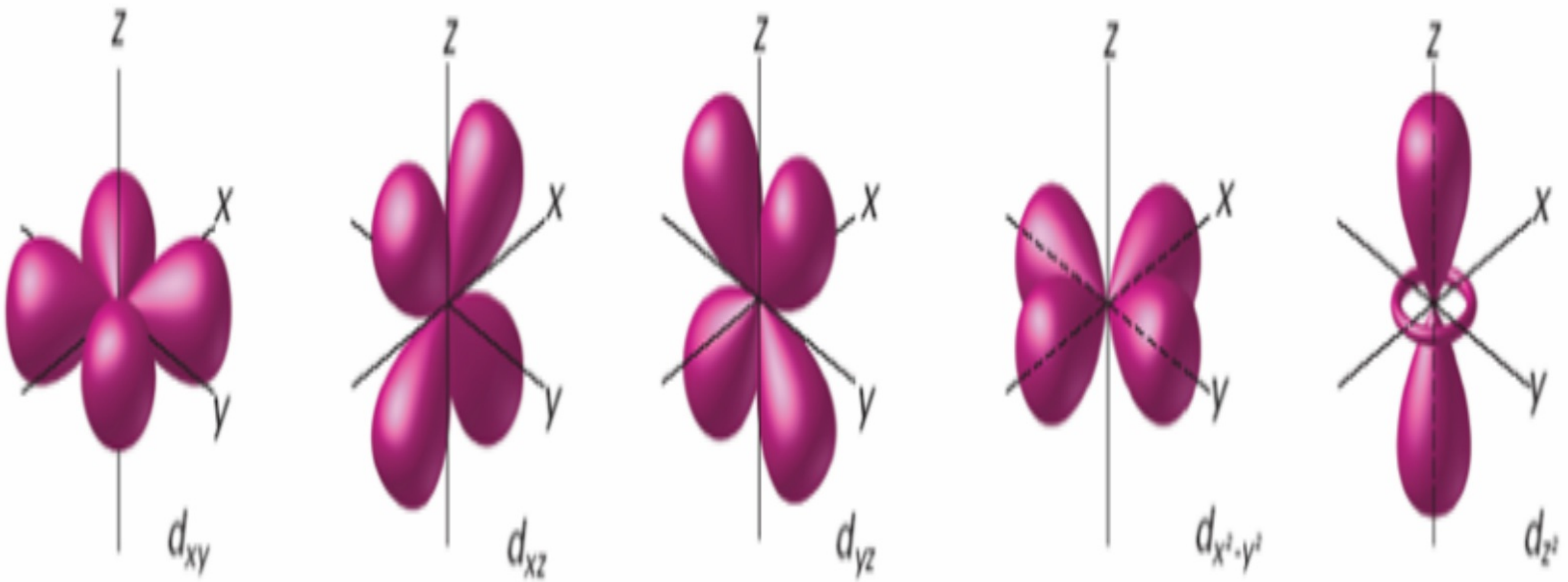
Within the primary energy levels (n) there are sublevels.

These are areas within the primary cloud where you are MORE likely to find an electron. These probability densities have SHAPES.

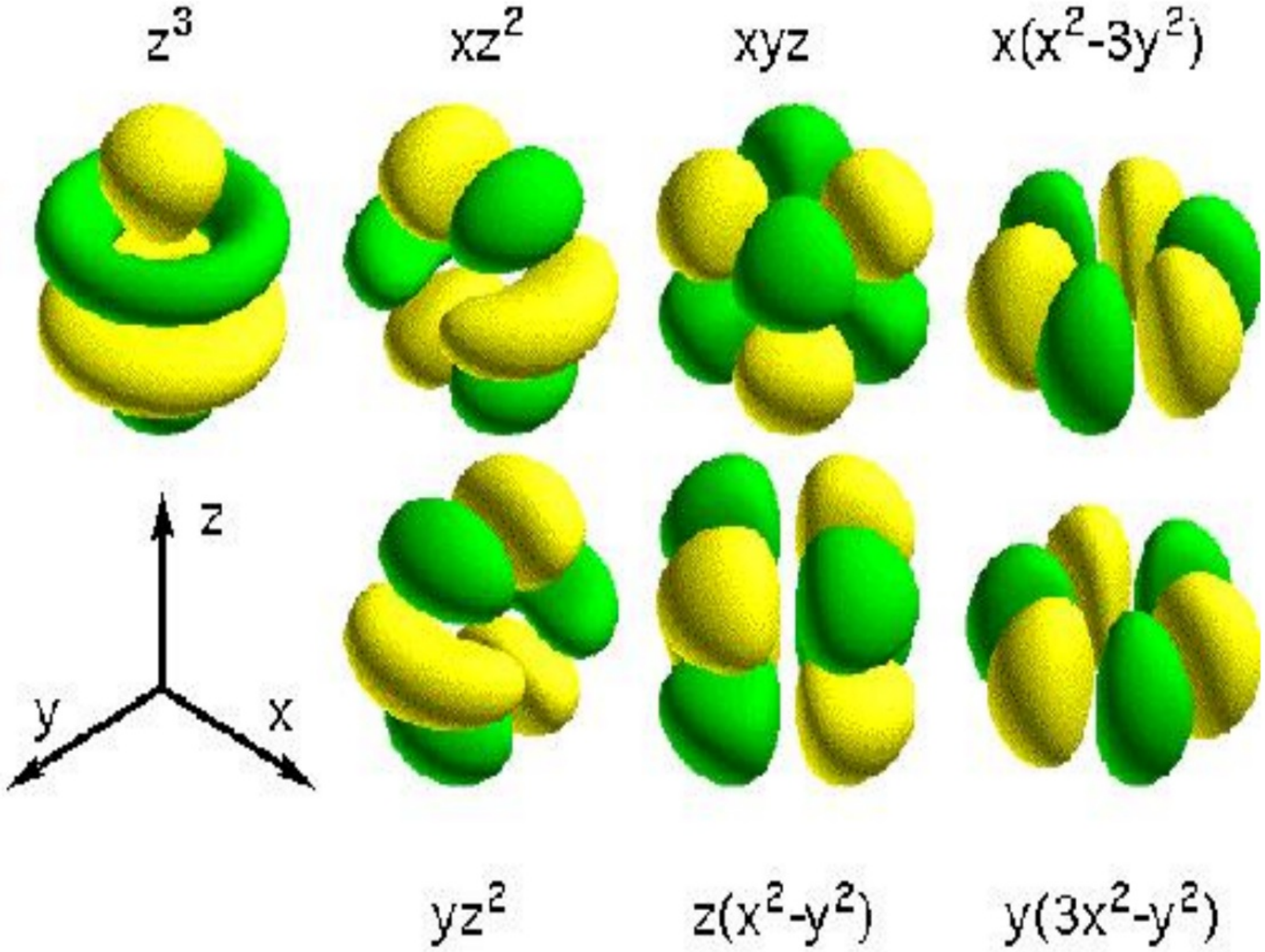
Different atomic orbitals are denoted by letters. The *s* orbitals are spherical, and *p* orbitals are dumbbell-shaped.



There are 5 d-orbitals:



There are 7 f-orbitals



Warm Up

What is a "quantum of energy?"

All atomic orbitals are not in every energy level. The higher the primary energy level, the more atomic orbitals that energy level can hold.

Table 5.1

Summary of Principal Energy Levels, Sublevels, and Orbitals

Principal energy level	Number of sublevels	Type of sublevel
$n = 1$	1	1*s* (1 orbital)
$n = 2$	2	2*s* (1 orbital), 2*p* (3 orbitals)
$n = 3$	3	3*s* (1 orbital), 3*p* (3 orbitals), 3*d* (5 orbitals)
$n = 4$	4	4*s* (1 orbital), 4*p* (3 orbitals), 4*d* (5 orbitals), 4*f* (7 orbitals)

A primary energy level (the ladder rungs) can hold up to $2n^2$ electrons, where n= the energy level.

So,

n = 1 can hold $2(1)^2$ =2 electrons

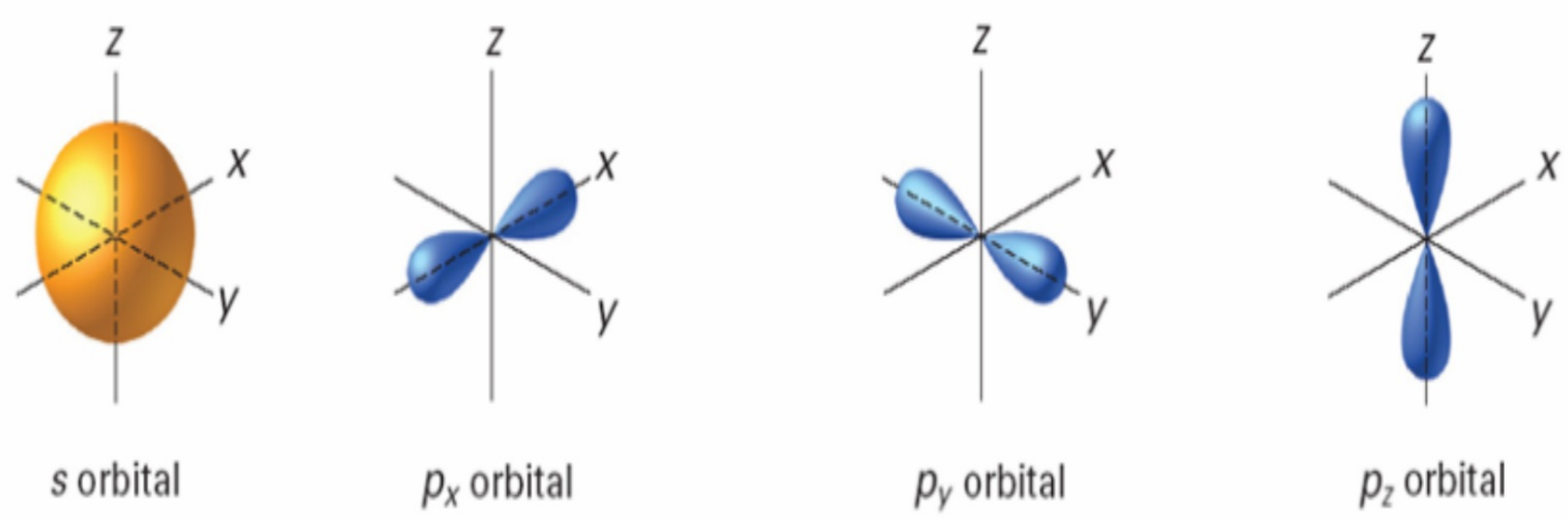
n = 2 can hold $2(2)^2$ = 8 electrons

find the maximum number of electrons for the 3rd and 4th energy levels.

Within each atomic orbital in a given energy level the maximum number of electrons in any one atomic orbital is 2.

2 electrons

2 electrons



2 electrons

2 electrons