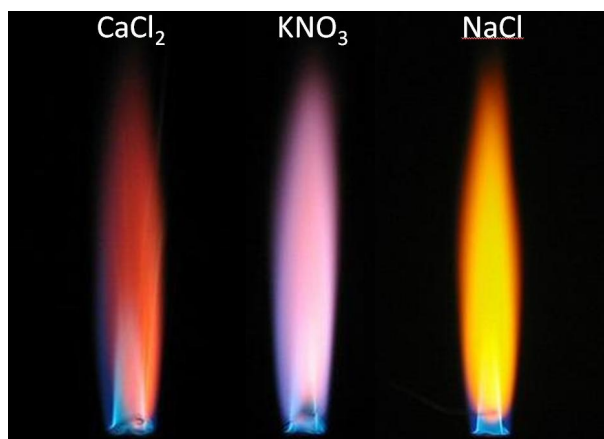


## Models of the Atom

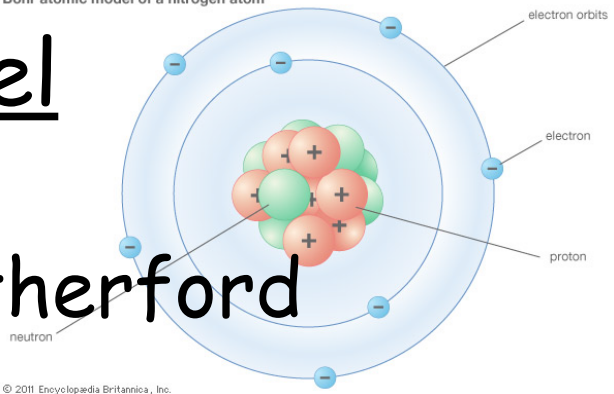
*Rutherford* - After discovering the nucleus, he proposed a model that had electrons moving around the nucleus.

His model, however, could not explain the chemical properties of elements. (like how colors are given off when elements are heated)



# The Bohr Model

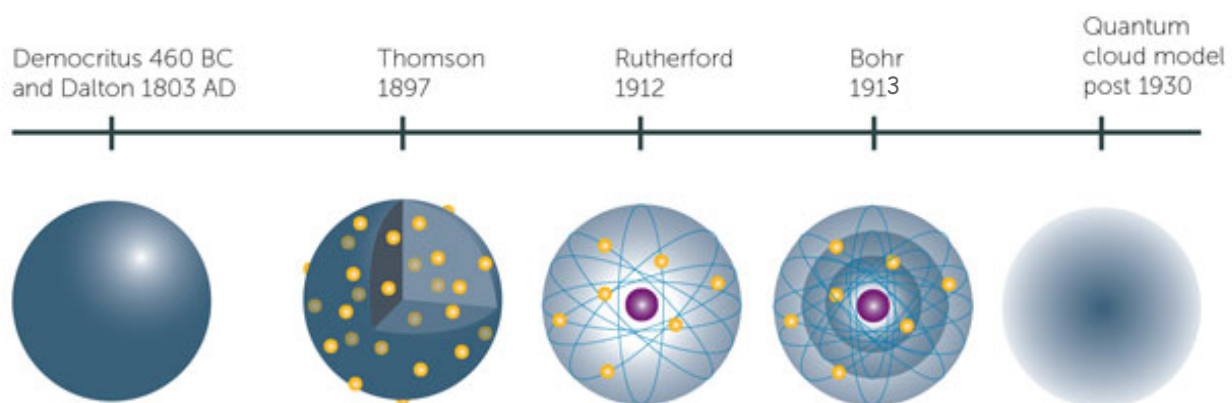
Bohr atomic model of a nitrogen atom



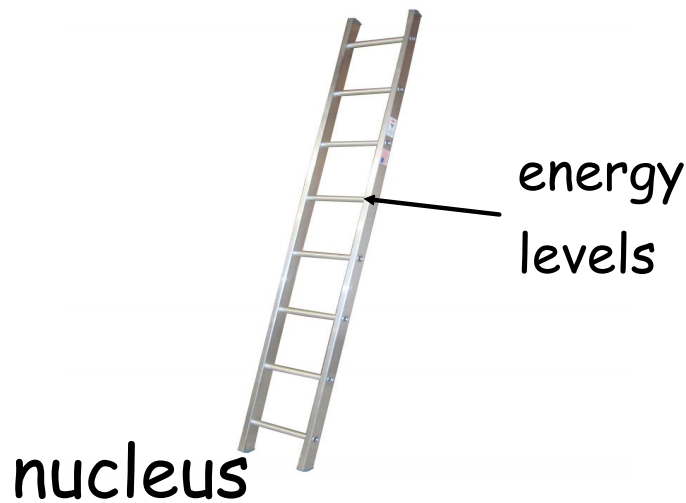
- Student of Rutherford

- Bohr proposed that an electron is found only in specific circular paths, or orbits, around the nucleus.

## Electrons in Atoms



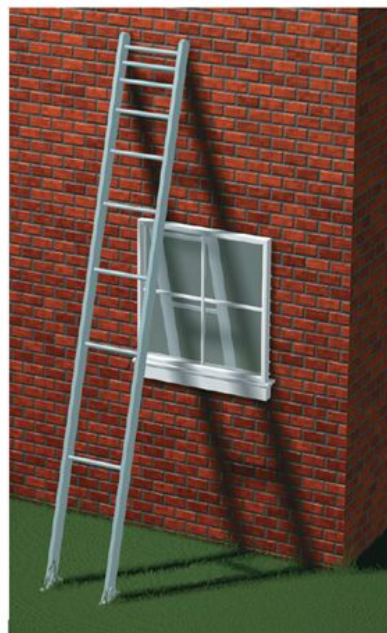
Each possible orbit in Bohr's model has a fixed energy. The fixed energies an electron can have are called *energy levels*.



A **quantum** of energy is the amount of energy required to move an electron from one energy level to another energy level.

## Electrons in Atoms

- Like the rungs of the strange ladder, the energy levels in an atom are not equally spaced.
- The higher the energy level occupied by an electron, the less energy it takes to move from that energy level to the next higher energy level.



## The Quantum Mechanical Model

The Rutherford and Bohr models were inconsistent with describing electron motion.

A physicist, Edwin Schrodinger, devised an equation to describe the electrons in atoms.

$$\frac{\partial^2 \psi}{\partial x^2} + \frac{8\pi^2 m}{h^2} (E - V) \psi = 0$$

Second derivative with respect to X

Shrodinger Wave Function

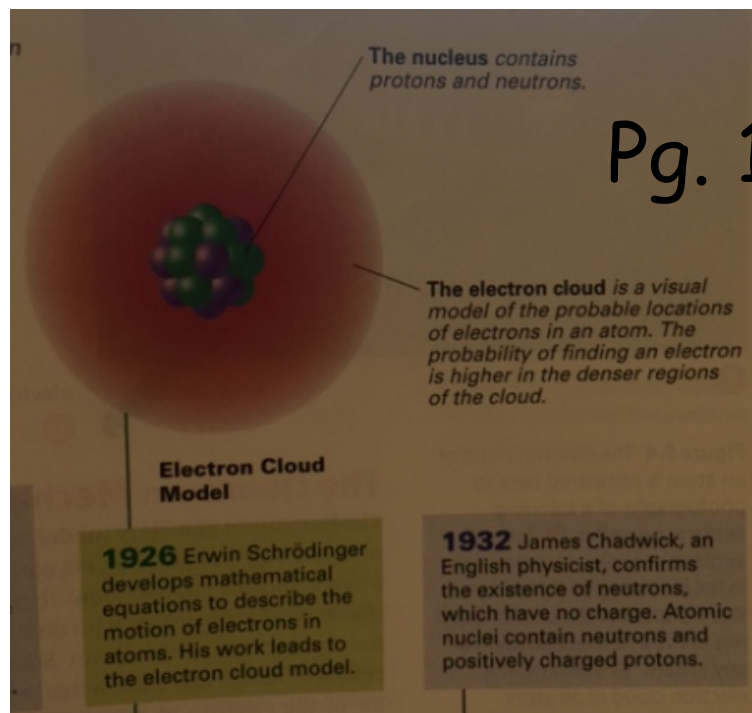
Position

Energy

Potential Energy

The quantum mechanical model comes from the solution to the Schrodinger equation.

The **quantum mechanical model** determines the allowed energies an electron can have and how likely it is to find the electron in various locations around the nucleus.



Pg. 129

## Atomic Orbitals

Solving the Schrodinger equation gives the energies an electron can have. These are its energy levels.

**Atomic orbitals** are a region in space where there is a high probability of finding an electron.



The energy levels of electrons are then labeled by principal quantum numbers ( $n$ ) where

$$n = 1, 2, 3, 4, \dots$$

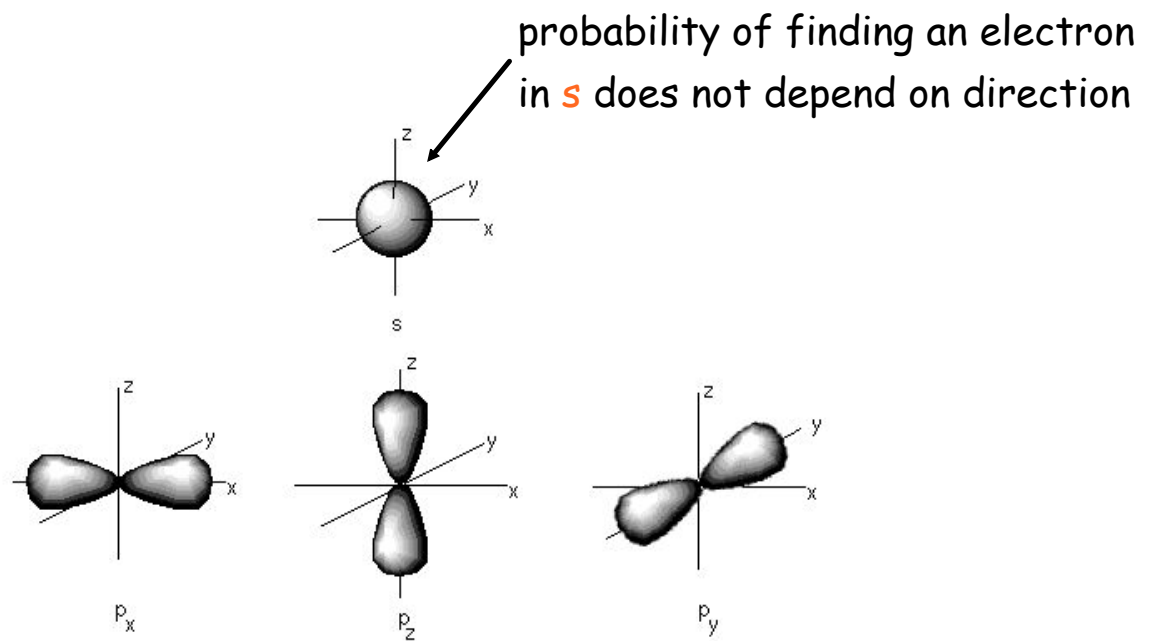
For each principal energy level, there may be several orbitals with different shapes and at different energy levels.

These are called **sublevels**

Each energy sublevel corresponds to an orbital of a different shape, which describes where the electron is likely to be found.

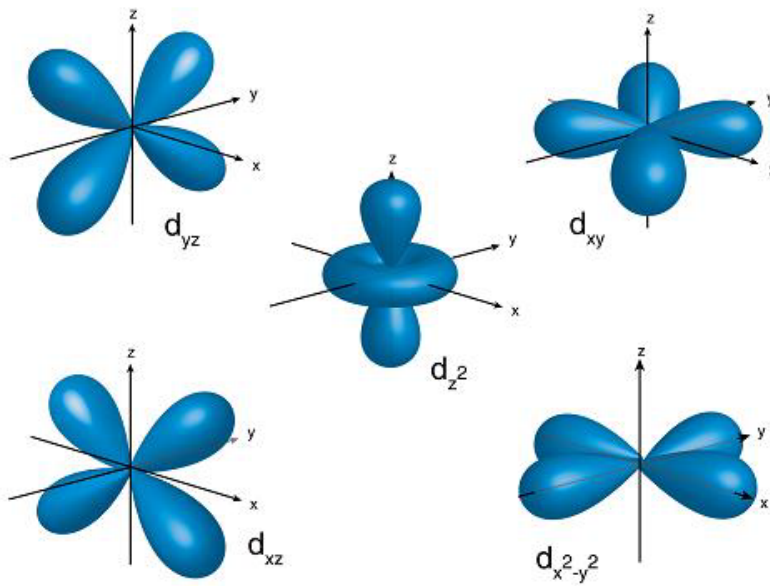
Different atomic orbitals are given different letters.

\*Table 5.1, page 131\*



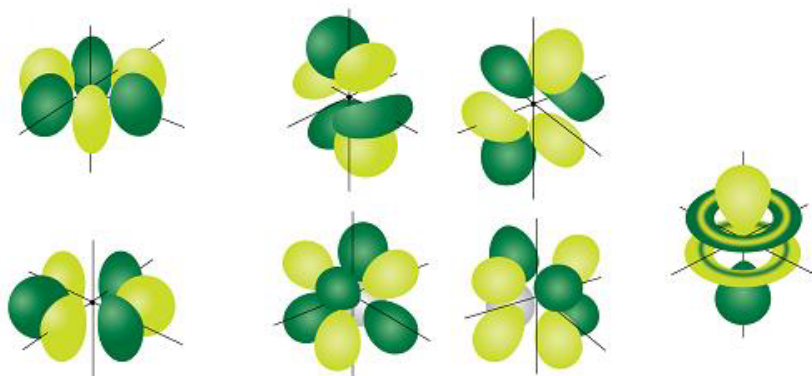
**s** orbitals are spherical while **p** orbitals are dumbbell-shaped.

There is one type of **s** orbital and 3 types of **p** orbitals.



There are 5 types of **d** orbitals that take on a clover leaf shape.

There are 7 different **f** orbitals that grow in complexity.



As the energy level increases, there is an increase in the number of orbitals

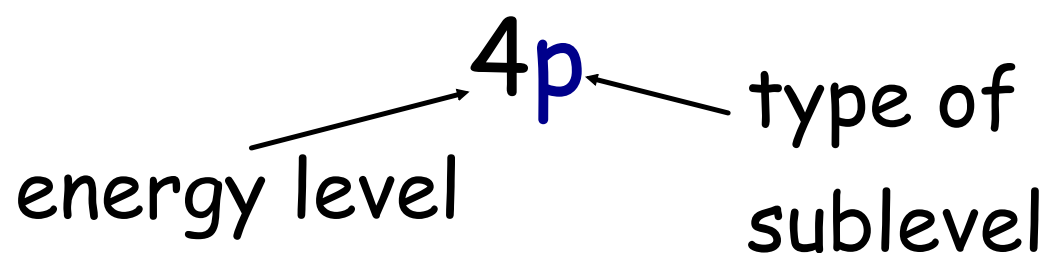
The number of orbitals follows the formula  $n^2$  where  $n$  is the energy level.

Each orbital can fit two electrons, so  $2n^2$  will give the maximum number of electrons

So, in summary we have

<b>Principal Energy Level</b>	<b>Number of Sublevels</b>	<b>Type of sublevel</b>	<b>Maximum number of electrons</b>
$n = 1$	1	1s (1 orbital)	2
$n = 2$	2	2s (1 orbital), 2p (3 orbitals)	8
$n = 3$	3	3s (1 orbital), 3p (3 orbitals), 3d (5 orbitals)	18
$n = 4$	4	4s (1 orbital), 4p (3 orbitals), 4d (5 orbitals), 4f (7 orbitals)	32

## Writing orbitals



## Colour in Periodic Table

### Periodic Table of Elements

	1 1A																		18 8A							
1	H 1.0079	2A																		2 He 4.0026						
2	3 Li 6.94	4 Be 9.0122																		5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180	
3	11 Na 22.990	12 Mg 24.305	3B	4B	5B	6B	7B	8B	9B	10B	11B	12B	13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.066	17 Cl 35.453	18 Ar 39.948								
4	19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.88	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80								
5	37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc 98.906	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29								
6	55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po 209.98	85 At 209.99	86 Rn 222.02								
7	87 Fr 223.02	88 Ra 226.03	89 Ac 227.03	104 Rf 257	105 Db 260	106 Sg 263	107 Bh 262	108 Hs 265	109 Mt 266	110 Ds 271	111 Rg 272	112 Cn 285	113 Uut 284	114 Uuq 289	115 Uup 288	116 Uuh 293	117 Uus 294	118 Uuo 294								

■ s      ■ p      ■ d      ■ f

Lanthanide series	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm 146.92	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
Actinide series	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu 239.05	95 Am 241.06	96 Cm 244.06	97 Bk 249.08	98 Cf 252.08	99 Es 252.08	100 Fm 257.10	101 Md 258.10	102 No 259.10	103 Lr 262.11



Try questions 1-7 on page 132