Paramagnetism and Diamagnetism

- Atoms with unpaired $\underline{\uparrow}$ electrons are called ***paramagnetic***.
  - Paramagnetic atoms are attracted to a magnet.
- Atoms with paired $\underline{\uparrow\downarrow}$ electrons are called ***diamagnetic***.
  - Diamagnetic atoms are repelled by a magnet.

- The number of orbitals per n level is given by n^2.
- The maximum number of electrons per n level is $2n^2$.

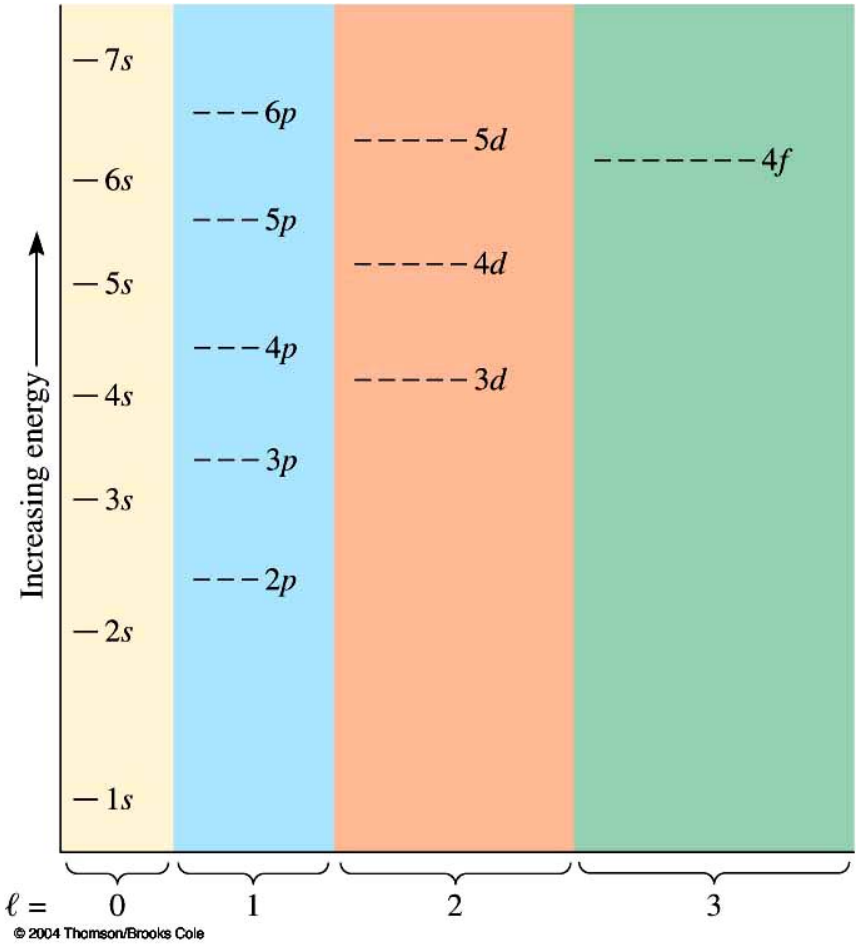
Energy Level	# of Orbitals	Max. # of e^-
n	**n^2**	$2n^2$
1	**1**	**2**
2	**4**	**8**
3	**9**	**18**
4	**16**	**32**

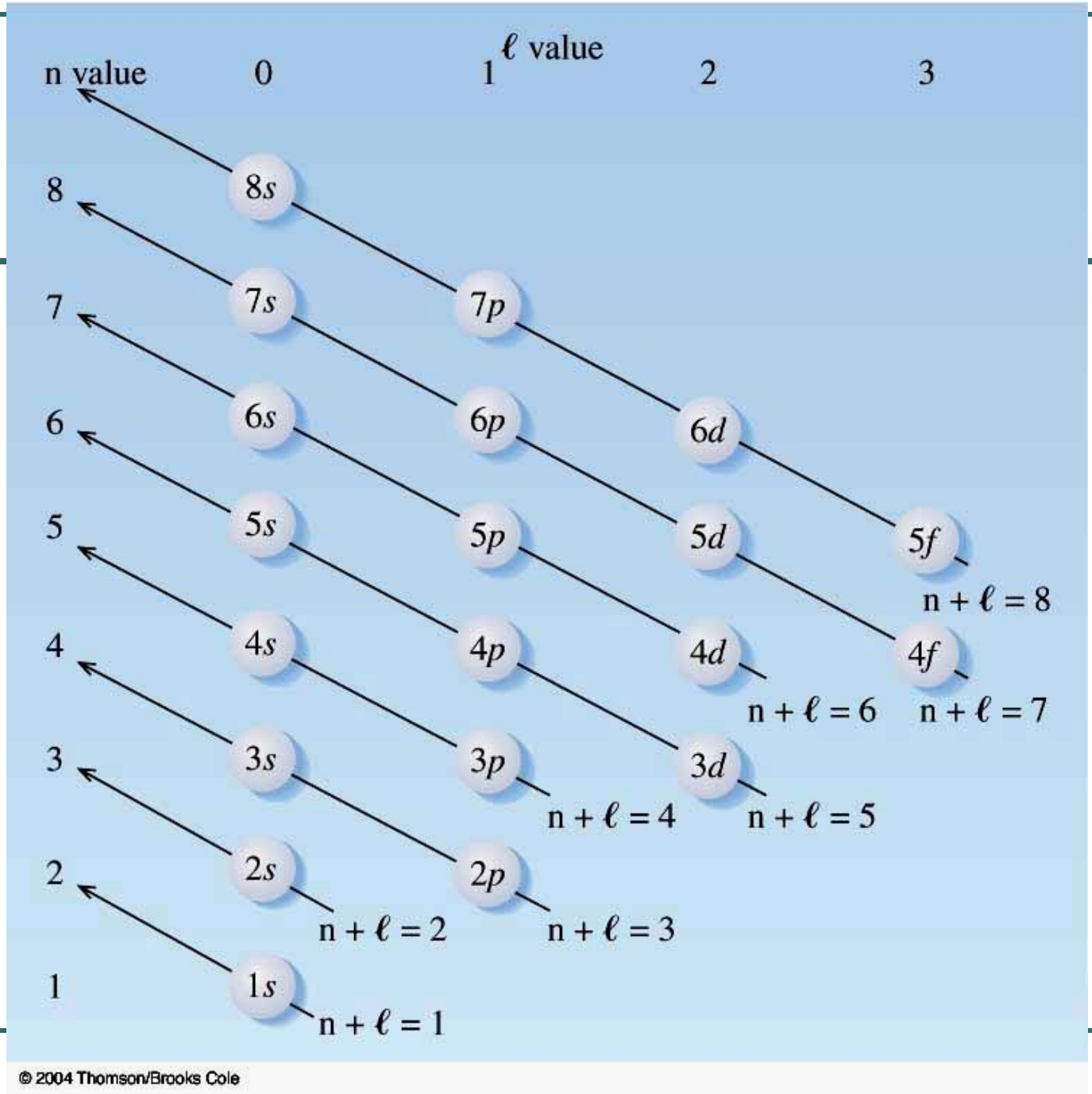
The Periodic Table and Electron Configurations

- The principle that describes how the periodic chart is a function of electronic configurations is the **Aufbau Principle**.
- The electron that distinguishes an element from the previous element enters the lowest energy atomic orbital available.

The Periodic Table and Electron Configurations

- The Aufbau Principle describes the electron filling order in atoms.





Hund's rule

- Hund's rule tells us that the electrons will fill the p orbitals by placing electrons in each orbital singly and with same spin until half-filled. Then the electrons will pair to finish the p orbitals.

The Periodic Table and Electron Configurations

- 1st row elements

	1s	Configuration
$_1H$	↑	$1s^1$

	1s	Configuration
$_1H$	↑	$1s^1$
$_2He$	↑↓	$1s^2$

- 2nd row elements

	1s	2s	2p	Configuration
$_{3}$Li	↑↓	↑	_ _ _	$1s^2\ 2s^1$
$_{4}$Be	↑↓	↑↓	_ _ _	$1s^2\ 2s^2$
$_{5}$B	↑↓	↑↓	↑ _ _	$1s^2\ 2s^2\ 2p^1$
$_{6}$C	↑↓	↑↓	↑ ↑ _	$1s^2\ 2s^2\ 2p^2$
$_{7}$N	↑↓	↑↓	↑ ↑ ↑	$1s^2\ 2s^2\ 2p^3$
$_{8}$O	↑↓	↑↓	↑↓ ↑ ↑	$1s^2\ 2s^2\ 2p^4$
$_{9}$F	↑↓	↑↓	↑↓ ↑↓ ↑	$1s^2\ 2s^2\ 2p^5$
$_{10}$Ne	↑↓	↑↓	↑↓ ↑↓ ↑↓	$1s^2\ 2s^2\ 2p^6$

- 3rd row elements

		3s	3p	Configuration
$_{11}$Na	[Ne]	↑	_ _ _	[Ne]3s^1
$_{12}$Mg	[Ne]	_	_ _ _	[Ne]3s^2
$_{13}$Al	[Ne]	↑↓	↑ _ _	[Ne]3s^2 3p^1
$_{14}$Si	[Ne]	↑↓	↑ ↑ _	[Ne]3s^2 3p^2
$_{15}$P	[Ne]	↑↓	↑ ↑ ↑	[Ne]3s^2 3p^3
$_{16}$S	[Ne]	↑↓	_ _ _	[Ne]3s^2 3p^4
$_{17}$Cl	[Ne]	↑↓	↑↓ ↑↓ ↑	[Ne]3s^2 3p^5
$_{18}$Ar	[Ne]	↑↓	↑↓ ↑↓ ↑↓	[Ne]3s^2 3p^6

There is an extra measure of stability associated with half-filled or completely filled orbitals.

	3d	4s	4p	Configuration
$_{19}$K [Ar]	_ _ _ _ _	↑	_ _ _	[Ar]$4s^1$
$_{20}$Ca [Ar]	_ _ _ _ _	↑↓	_ _ _	[Ar]$4s^2$
$_{21}$Sc [Ar]	↑ _ _ _ _	↑↓	_ _ _	[Ar]$4s^2$ $3d^1$
$_{22}$Ti [Ar]	↑ ↑ _ _ _	↑↓	_ _ _	[Ar]$4s^2$ $3d^2$
$_{23}$V [Ar]	↑ ↑ ↑ _ _	↑↓	_ _ _	[Ar]$4s^2$ $3d^3$
$_{24}$Cr [Ar]	↑ ↑ ↑ ↑ ↑	↑	_ _ _	[Ar]$4s^1$ $3d^5$

The Periodic Table and Electron Configurations

	3d	4s	4p	Configuration
$_{25}$Mn	[Ar] ↑ ↑ ↑ ↑ ↑	↑↓	_ _ _	[Ar]$4s^2\ 3d^5$
$_{26}$Fe	[Ar] ↑↓ ↑ ↑ ↑ ↑	↑↓	_ _ _	[Ar]$4s^2\ 3d^6$
$_{27}$Co	[Ar] ↑↓ ↑↓ ↑ ↑ ↑	↑↓	_ _ _	[Ar]$4s^2\ 3d^7$
$_{28}$Ni	[Ar] ↑↓ ↑↓ ↑↓ ↑ ↑	↑↓	_ _ _	[Ar]$4s^2\ 3d^8$
$_{29}$Cu	[Ar] ↑↓ ↑↓ ↑↓ ↑↓ ↑↓	↑	_ _ _	[Ar]$4s^1\ 3d^{10}$
$_{30}$Zn	[Ar] ↑↓ ↑↓ ↑↓ ↑↓ ↑↓	↑↓	_ _ _	[Ar]$4s^2\ 3d^{10}$

The Periodic Table and Electron Configurations

		3d	4s	4p	Configuration
$_{31}$Ga	[Ar]	↑↓ ↑↓ ↑↓ ↑↓ ↑↓	↑↓	↑ _ _	$[Ar]4s^2\ 3d^{10}\ 4p^1$
$_{32}$Ge	[Ar]	↑↓ ↑↓ ↑↓ ↑↓ ↑↓	↑↓	↑ ↑ _	$[Ar]4s^2\ 3d^{10}\ 4p^2$
$_{33}$As	[Ar]	↑↓ ↑↓ ↑↓ ↑↓ ↑↓	↑↓	↑ ↑ ↑	$[Ar]4s^2\ 3d^{10}\ 4p^3$
$_{34}$Se	[Ar]	↑↓ ↑↓ ↑↓ ↑↓ ↑↓	↑↓	↑↓ ↑ ↑	$[Ar]4s^2\ 3d^{10}\ 4p^4$
$_{35}$Br	[Ar]	↑↓ ↑↓ ↑↓ ↑↓ ↑↓	↑↓	↑↓ ↑↓ ↑	$[Ar]4s^2\ 3d^{10}\ 4p^5$
$_{36}$Kr	[Ar]	↑↓ ↑↓ ↑↓ ↑↓ ↑↓	↑↓	↑↓ ↑↓ ↑↓	$[Ar]4s^2\ 3d^{10}\ 4p^6$

The Periodic Table and Electron Configurations

- Now we can write a complete set of quantum numbers for all of the electrons in these three elements as examples.
  - Na
  - Ca
  - Fe

	3s	3p	Configuration
$_{11}$Na [Ne]	↑	_ _ _	[Ne]$3s^1$

	n	ℓ	m_ℓ	m_s	
1st e⁻	1	0	0	+ 1/2	1 s electrons
2nd e⁻	1	0	0	– 1/2	
3rd e⁻	2	0	0	+ 1/2	2 s electrons
4th e⁻	2	0	0	– 1/2	
5th e⁻	2	1	- 1	+ 1/2	2 p electrons
6th e⁻	2	1	0	+ 1/2	
7th e⁻	2	1	+ 1	+ 1/2	
8th e⁻	2	1	– 1	– 1/2	
9th e⁻	2	1	0	– 1/2	
10th e⁻	2	1	+ 1	– 1/2	
11th e⁻	3	0	0	+ 1/2	3 s electron

	3d	4s	4p	Configuration
$_{20}$Ca [Ar]	_ _ _ _ _	↑↓	_ _ _	[Ar] $4s^2$

	n	ℓ	m_ℓ	m_s	
[Ar] 19^{th} e^-	4	0	0	+1/2	4 s electrons
20^{th} e^-	4	0	0	−1/2	

	3d	4s	4p	Configuration
$_{26}$Fe	[Ar] ↑↓ ↑ ↑ ↑ ↑	↑↓	_ _ _	[Ar] $4s^2\ 3d^6$

		n	ℓ	m_ℓ	m_s	
[Ar]	19th e⁻	4	0	0	+1/2	4 s electrons
	20th e⁻	4	0	0	−1/2	
	21st e⁻	3	2	-2	+1/2	
	22nd e⁻	3	2	-1	+1/2	
	23rd e⁻	3	2	0	+1/2	
	24th e⁻	3	2	+1	+1/2	
	25th e⁻	3	2	+2	+1/2	
	26th e⁻	3	2	-2	−1/2