

# Electron Configuration

The electron configuration of an atom tells us how the electrons are distributed among the various atomic orbitals.

# The Pauli Exclusion Principle

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two electrons can occupy the same orbital  
only when they have opposite spins

maximum of **two** electrons per orbital

## Spin quantum number $m_s$

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this is the fourth quantum number; it has no effect on the energy, size, shape or spatial orientation of an orbital but is very important in determining electron configuration

$m_s$  may have either of two values

$+1/2$

$-1/2$

# Orbital Filling Rules

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(1) electrons are added to orbitals beginning with the orbital of the lowest energy

(aufbau principle)

(2) maximum of two electrons per orbital

(Pauli exclusion principle)

# First Period

principal quantum number ( $n$ ) = 1

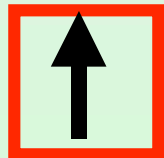
Hydrogen

$Z = 1$

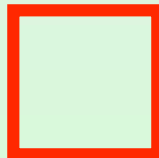
$1s^1$

$1s$

H

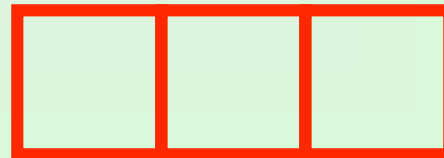


$2s$



$1s^2$

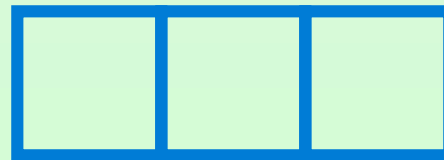
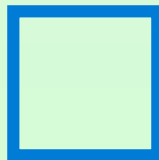
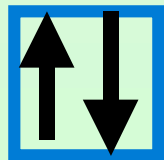
$2p$



Helium

$Z = 2$

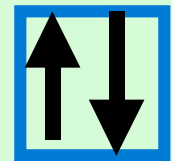
He



# Diamagnetism and Paramagnetism

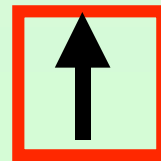
**Diamagnetic** substances are basically unaffected by a magnetic field.

all electron spins are paired He



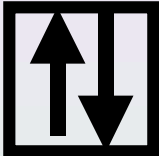

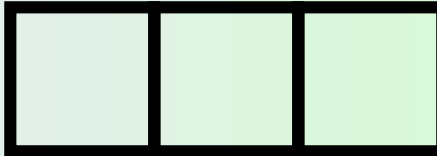

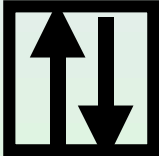
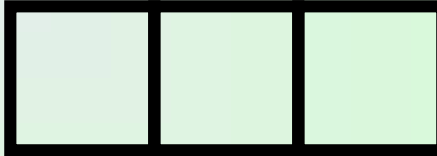
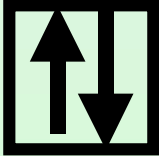
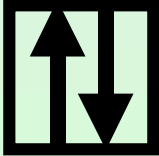
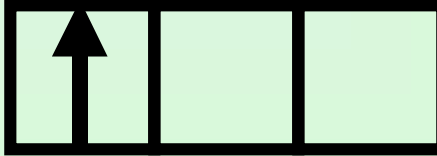


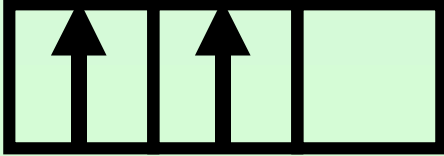
**Paramagnetic** substances are attracted by a magnet.

contain at least one electron with an unpaired spin H



# Second Period

principal quantum number ( $n$ ) = 2

	$Z$	$1s$	$2s$	$2p$
Li	3			
Be	4			
B	5			
C	6			



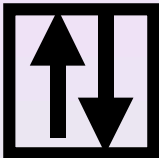
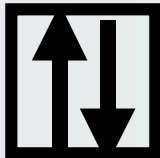
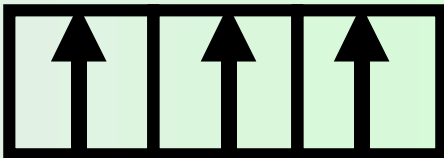
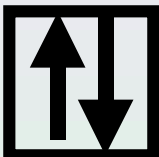
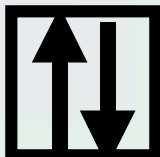
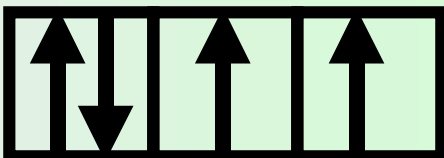
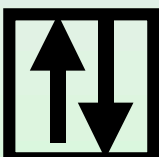
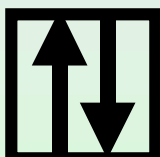
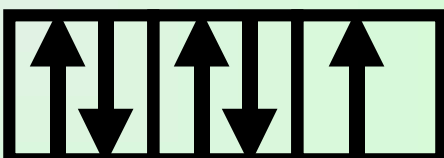
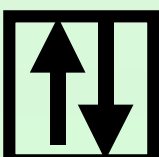
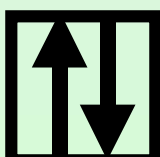
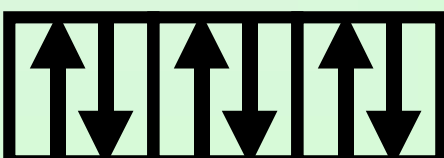
# Hund's Rule

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(3) when two or more orbitals are of equal energy, each one is singly occupied before any are doubly occupied

the most stable arrangement of the electrons in the sub-shells is the one with the greatest number of parallel spins

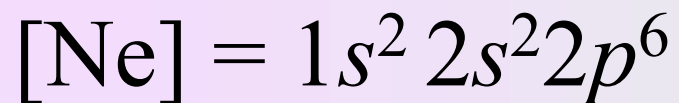
## Second Period cont...

	$Z$	$1s$	$2s$	$2p$
N	7			
O	8			
F	9			
Ne	10			



# **The Building-Up Principle**

The Aufbau principle

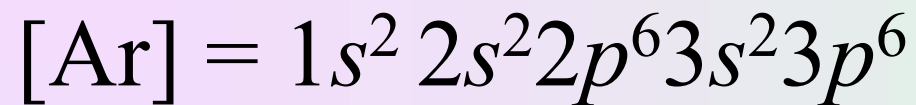


## Third Period

[Ne] core

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





## Fourth Period

[Ar] core

K	19	[Ar]	$4s^1$
Ca	20	[Ar]	$4s^2$
Sc	21	[Ar]	$4s^2 3d^1$

Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn  
first series of transition elements



# Transition Metals

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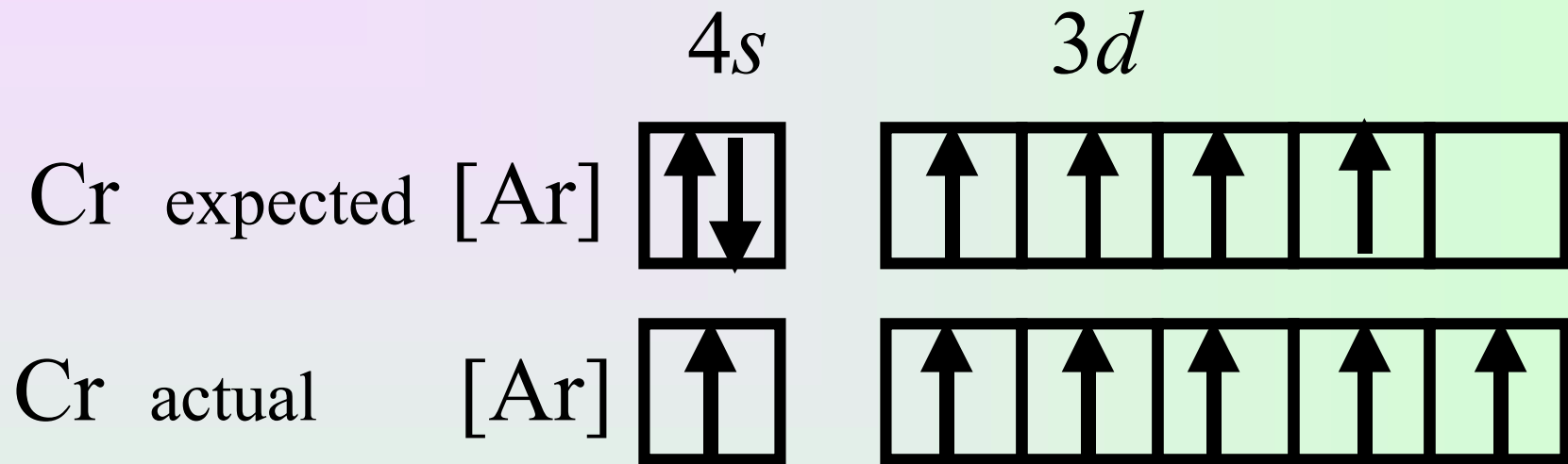
have incompletely filled  $d$  subshells or readily give rise to cations that have incompletely filled  $d$  subshells

# First Transition Series

Sc	21	[Ar]	$4s^23d^1$
Ti	22	[Ar]	$4s^23d^2$
V	23	[Ar]	$4s^23d^3$
Cr	24	[Ar]	$4s^13d^5$
Mn	25	[Ar]	
Fe	26	[Ar]	
Co	27	[Ar]	
Ni	28	[Ar]	
Cu	29	[Ar]	
Zn	30	[Ar]	



# Periodic Anomalies

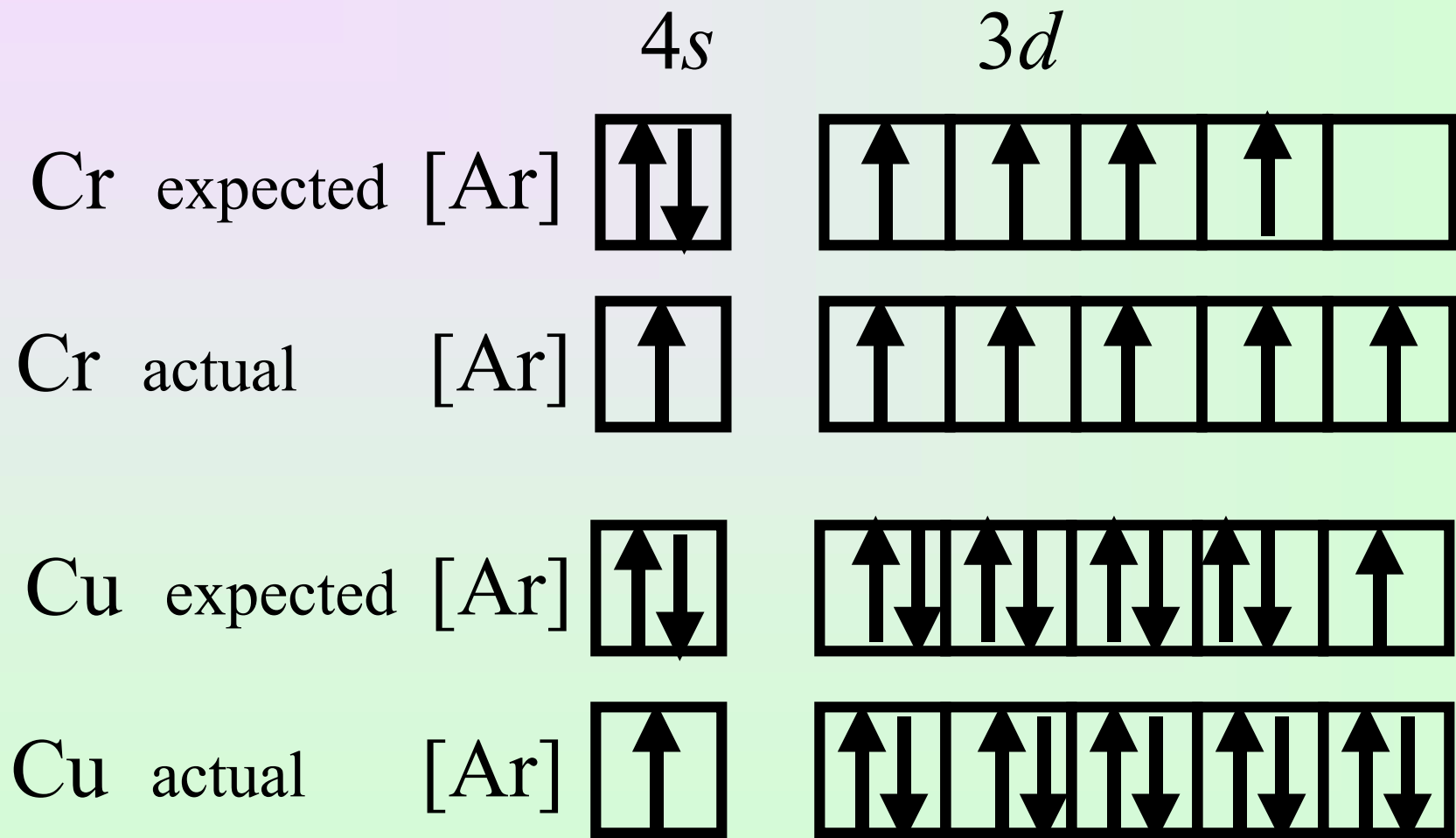


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Mn	25	[Ar]	$4s^23d^5$
Fe	26	[Ar]	$4s^23d^6$
Co	27	[Ar]	$4s^23d^7$
Ni	28	[Ar]	$4s^23d^8$
Cu	29	[Ar]	$4s^13d^{10}$
Zn	30	[Ar]	$4s^23d^{10}$



# Periodic Anomalies



## Fifth Period

[Kr] core

contains second series of transition elements in which the  $4d$  orbitals are filled

$4d$  orbitals are filled in a manner similar, but not identical, to that of  $3d$  orbitals in first transition series

## Sixth Period

[Xe] core

$6s$  fills before  $4f$

lanthanaide series: 14 elements  
corresponding to filling  $4f$  orbitals

$4f$  fills before  $5d$

# Seventh Period

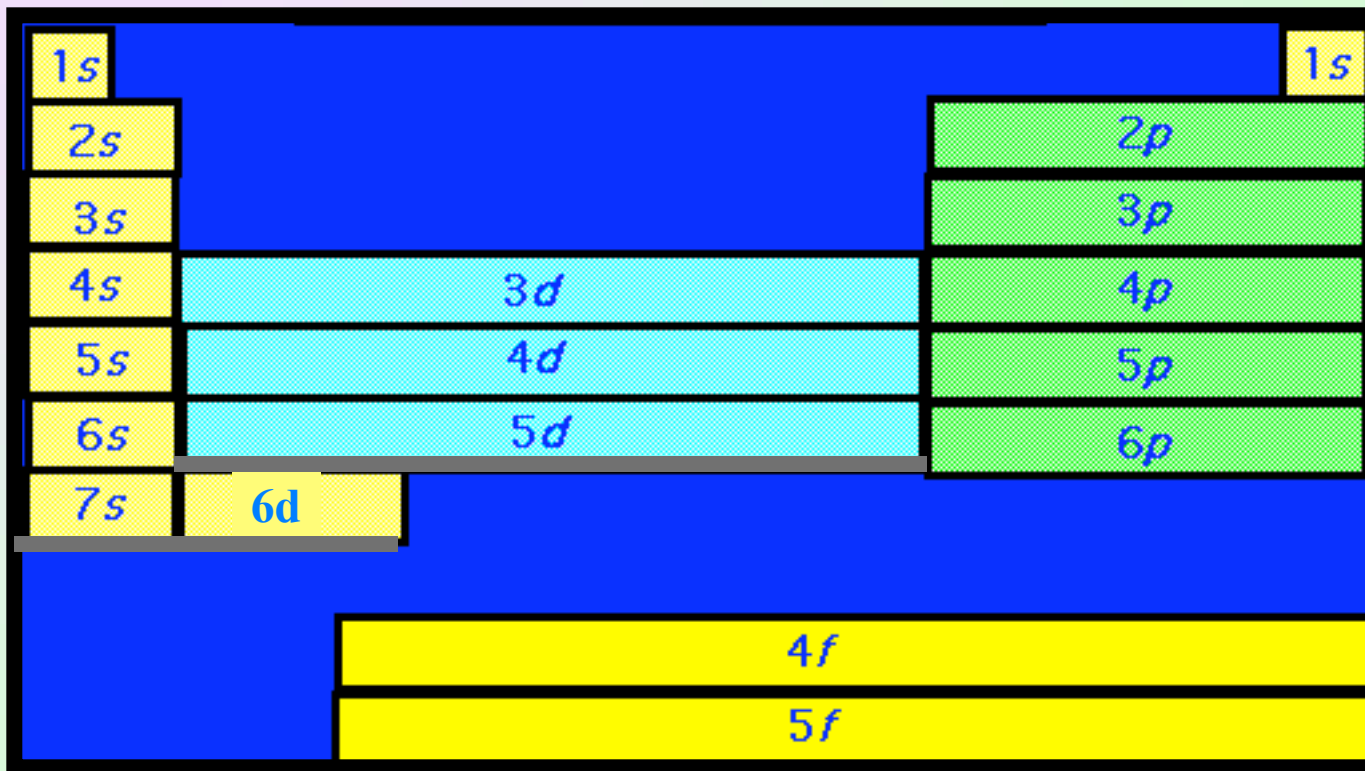
[Rn] core

$7s$  fills before  $5f$

actinide series: 14 elements

corresponding to filling  $5f$  orbitals

$5f$  fills before  $6d$



Subshell filling of elements in regions of the periodic table

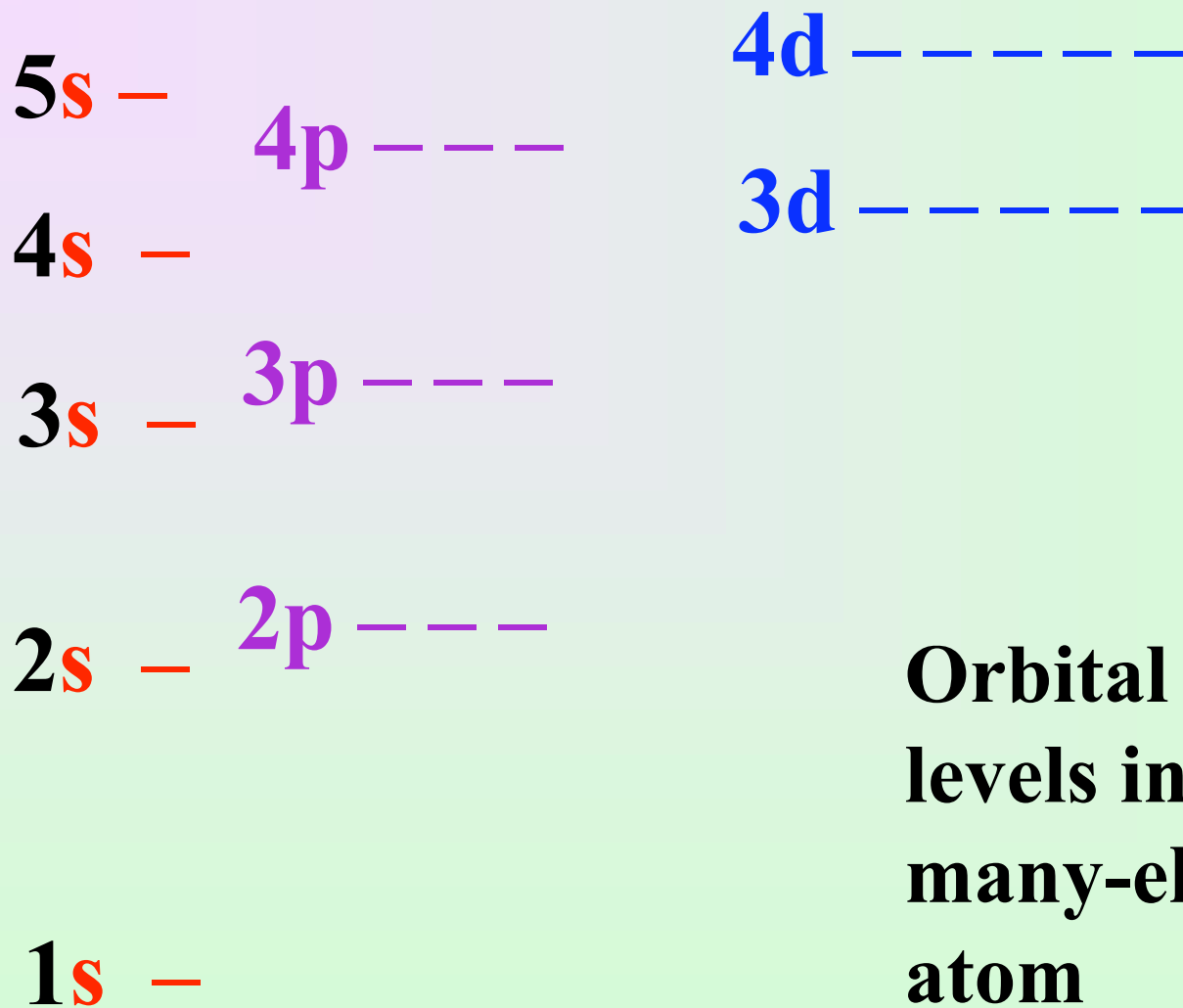


K	19	[Ar] $4s^1$
Ca	20	[Ar] $4s^2$
Sc	21	[Ar] $4s^23d^1$

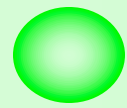
Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn

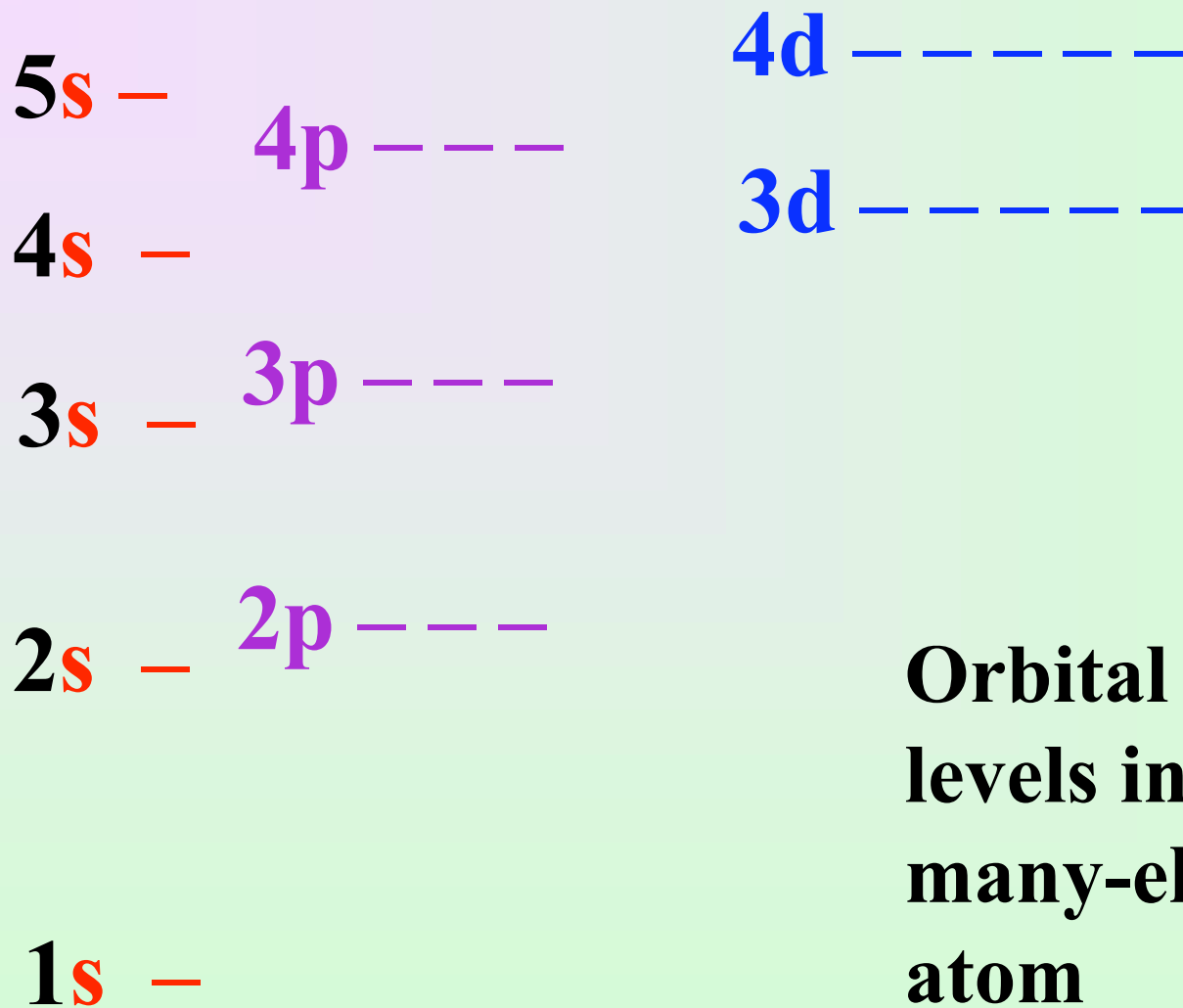
Zn	30	[Ar] $4s^23d^{10}$
Ga	31	[Ar] $4s^23d^{10}4p^1$
Ge	32	[Ar] $4s^23d^{10}4p^2$
As	33	[Ar] $4s^23d^{10}4p^3$
Se	34	[Ar] $4s^23d^{10}4p^4$
Br	35	[Ar] $4s^23d^{10}4p^5$
Kr	36	[Ar] $4s^23d^{10}4p^6$



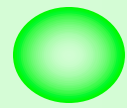


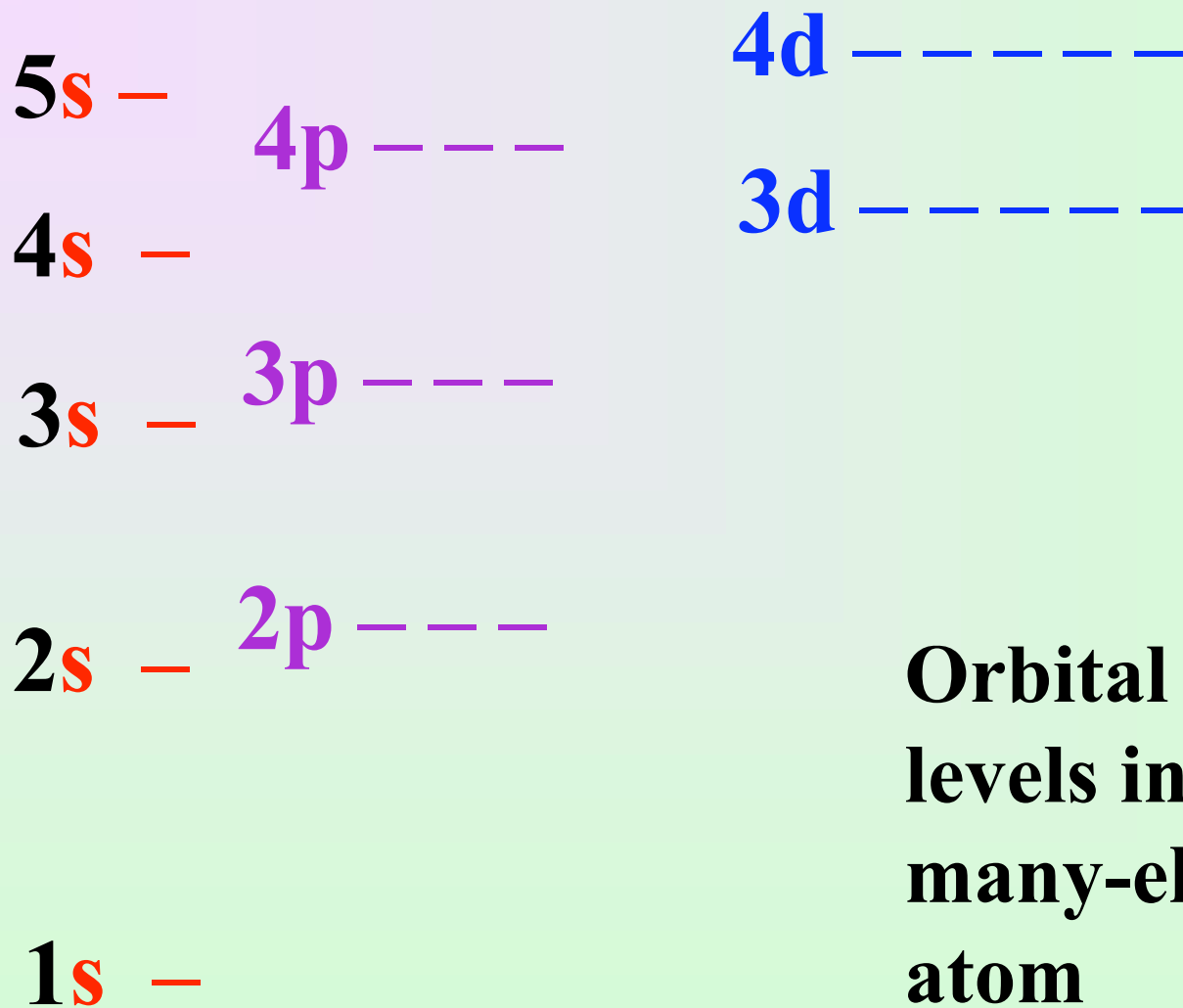
**Orbital energy  
levels in a  
many-electron  
atom**



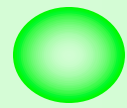


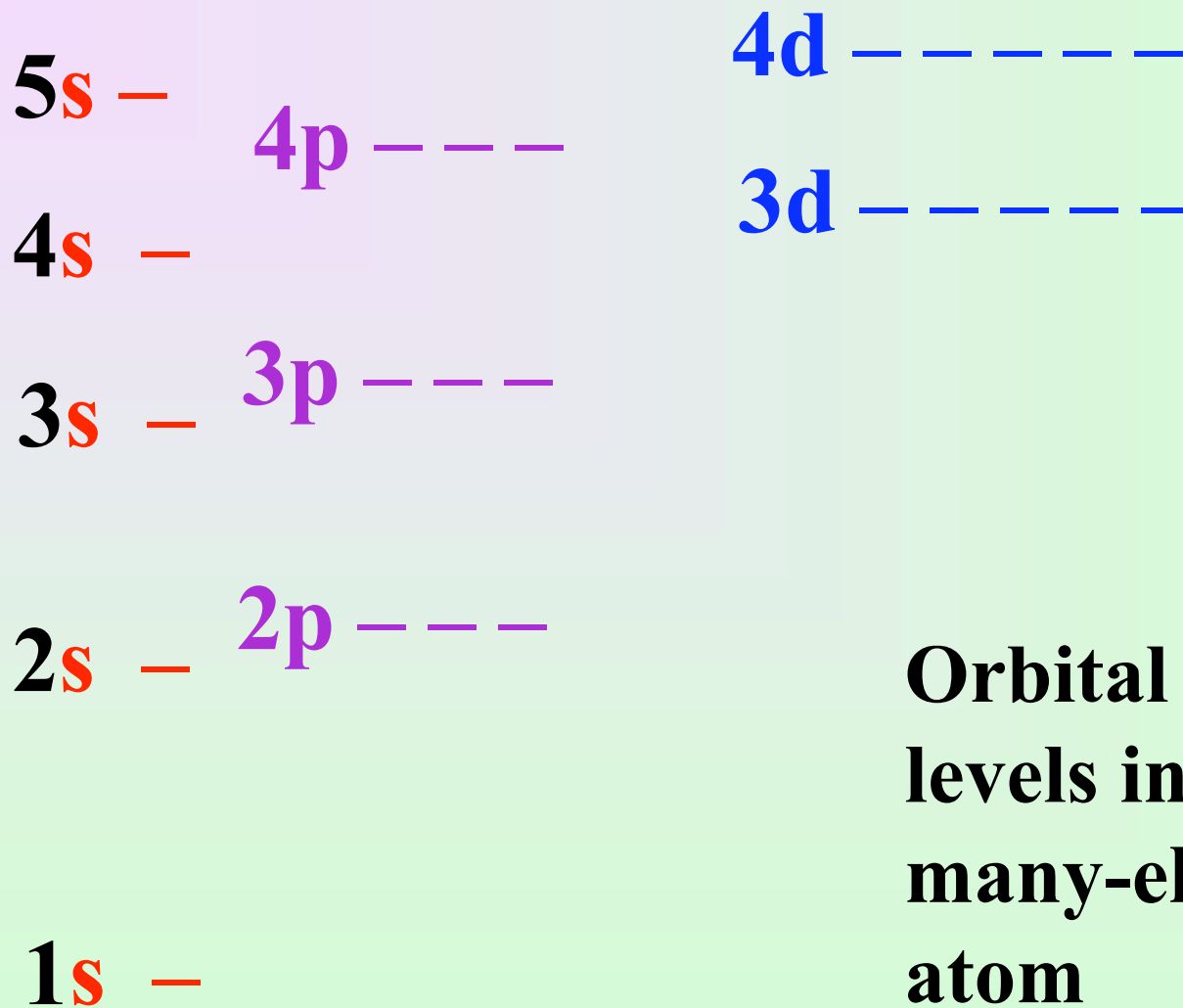
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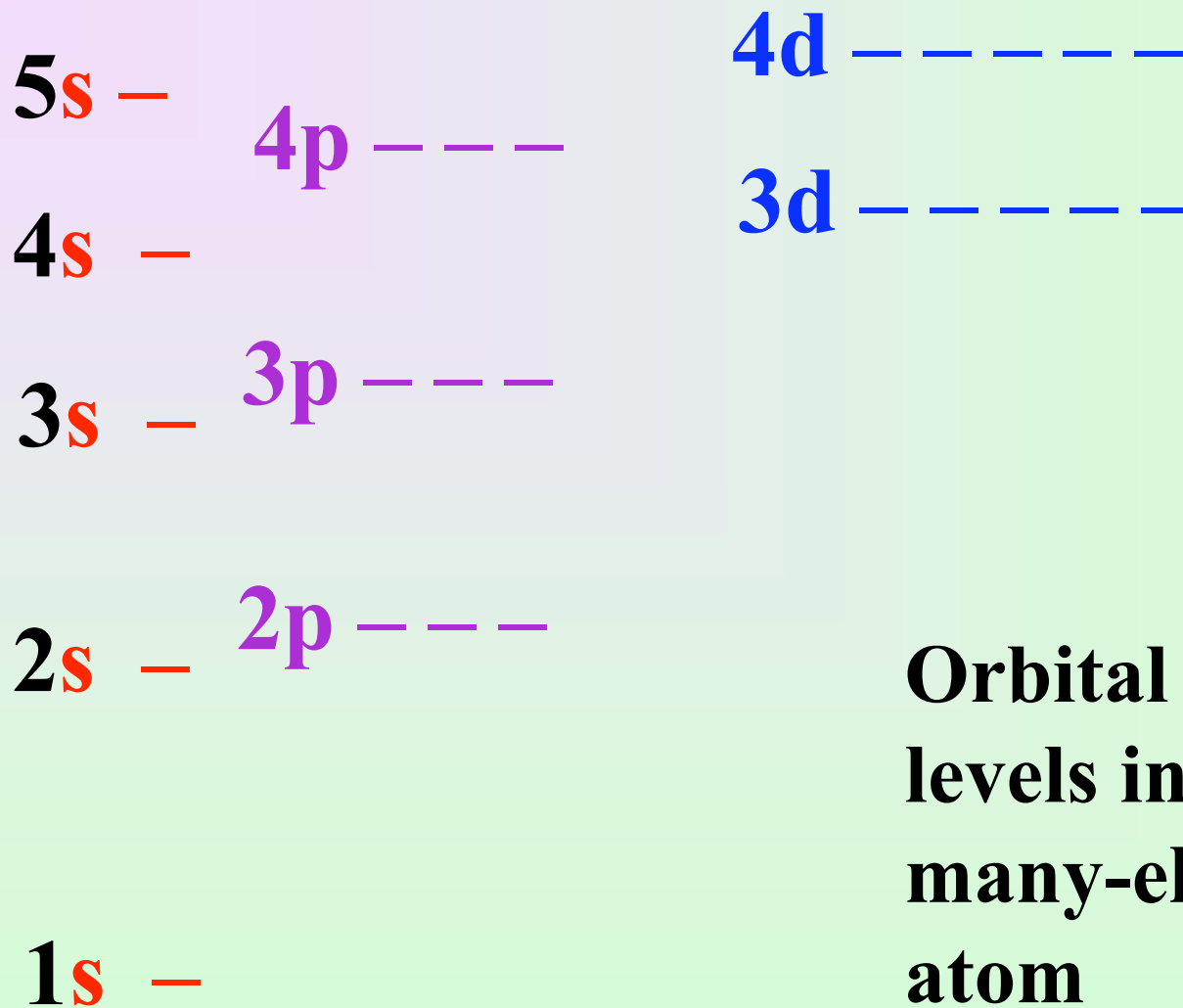
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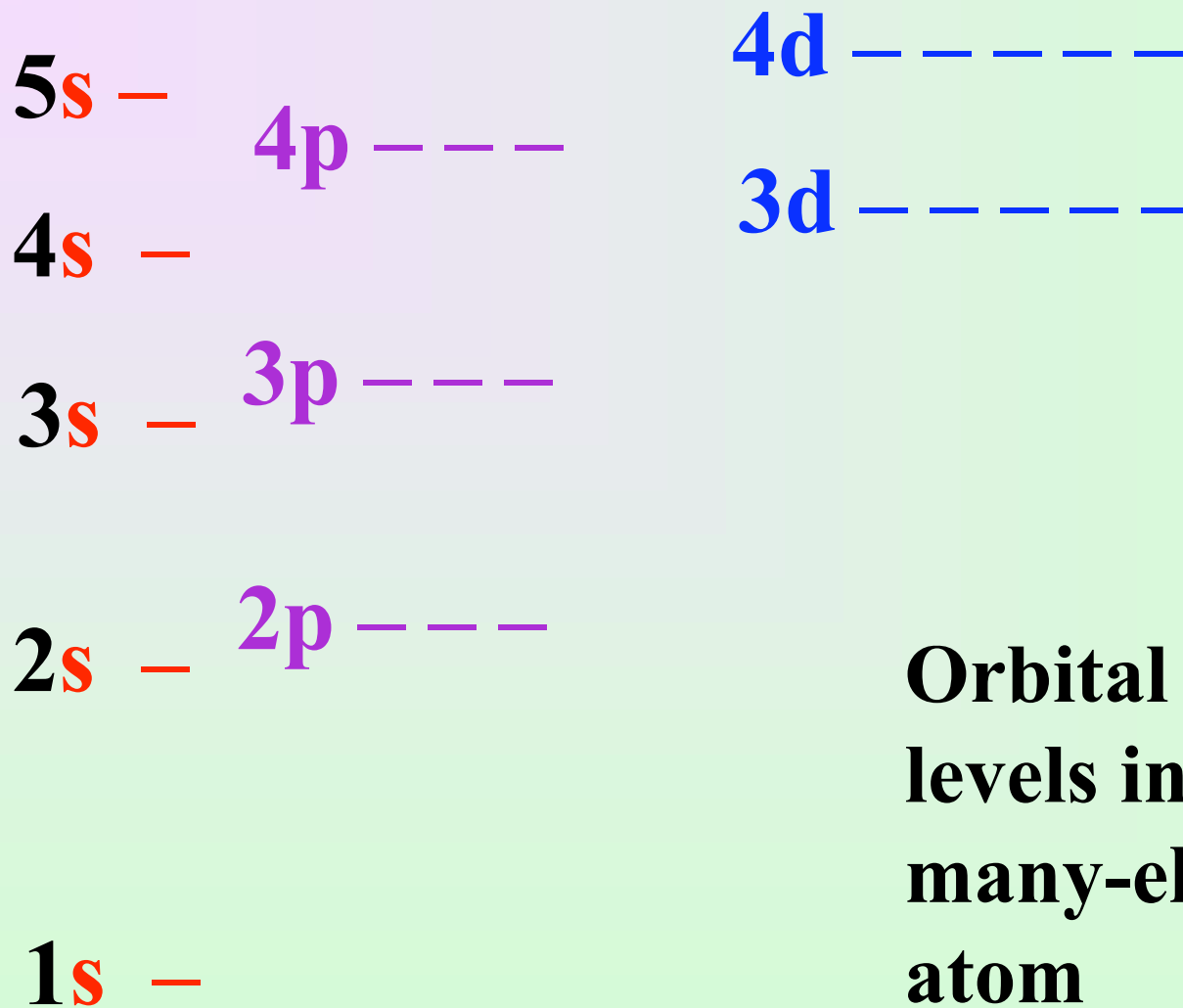
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**Orbital energy levels in a many-electron atom**





**Orbital energy levels in a many-electron atom**

