Electron Configuration

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

The Pauli Exclusion Principle

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

maximum of **two** electrons per orbital

Spin quantum number m_s

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

(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

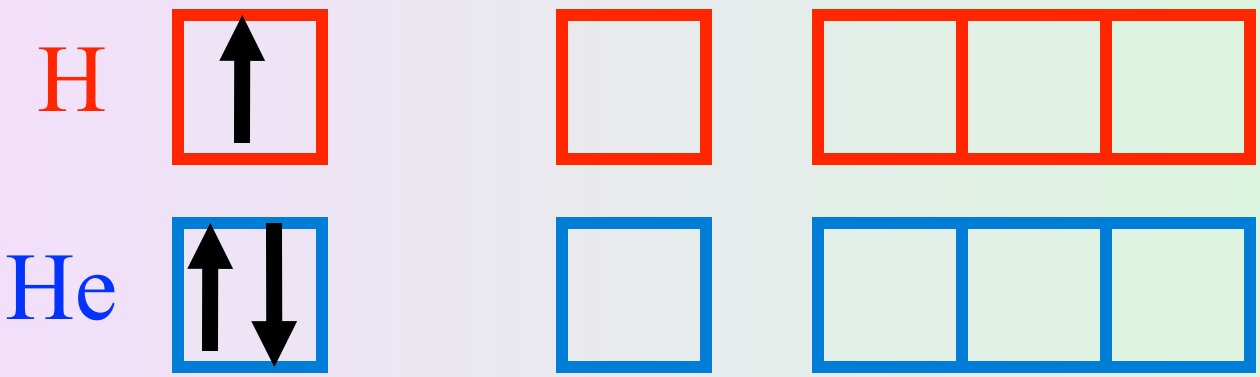
principal quantum number ***(n)*** = **1**

Hydrogen
Z = **1**

Helium
Z = **2**

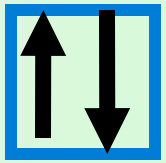
$1s^1$

$1s^2$



Diamagnetism and Paramagnetism

Diamagnetic substances are basically unaffected by a magnetic field.

all electron spins are paired He 

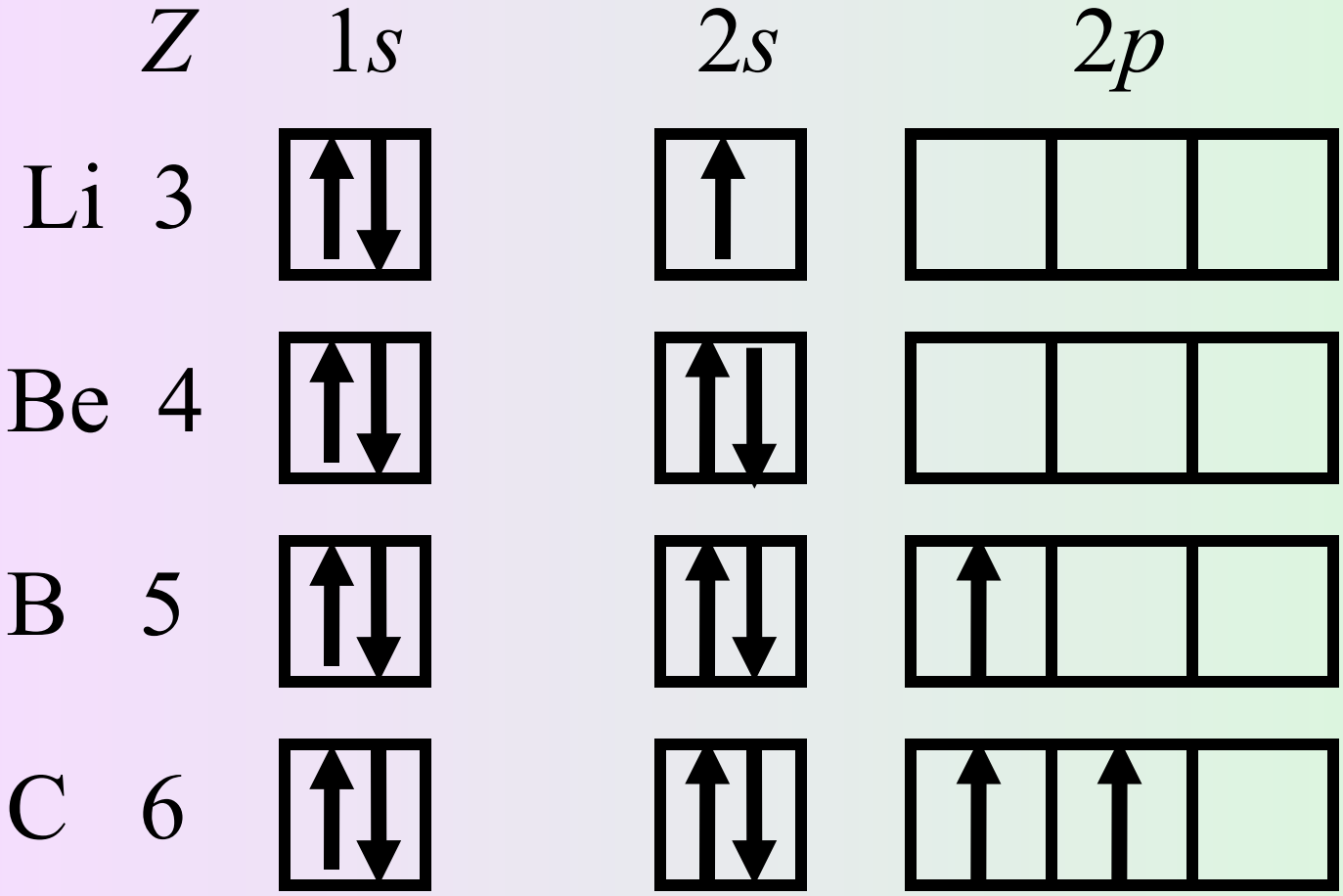
Paramagnetic substances are attracted by a magnet.

contain at least one electron with an unpaired spin

H 

Second Period

principal quantum number ***(n)*** = **2**

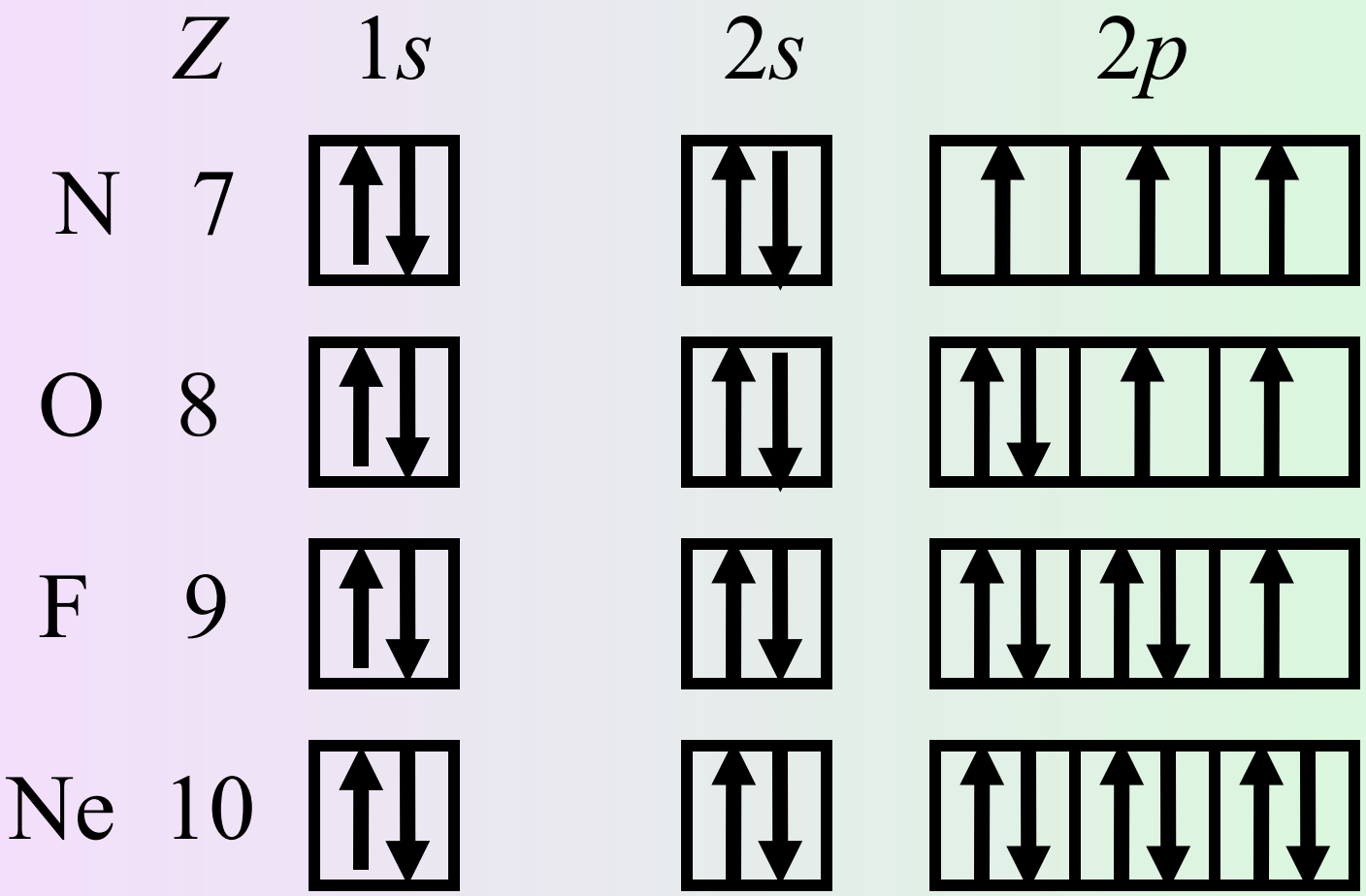


Hund's Rule

(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...



The Building-Up Principle

The Aufbau principle

$[Ne] = 1s^2\,2s^2 2p^6$

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]	$3s^2\,3p^6$

$[Ar] = 1s^2\,2s^2 2p^6 3s^2 3p^6$

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

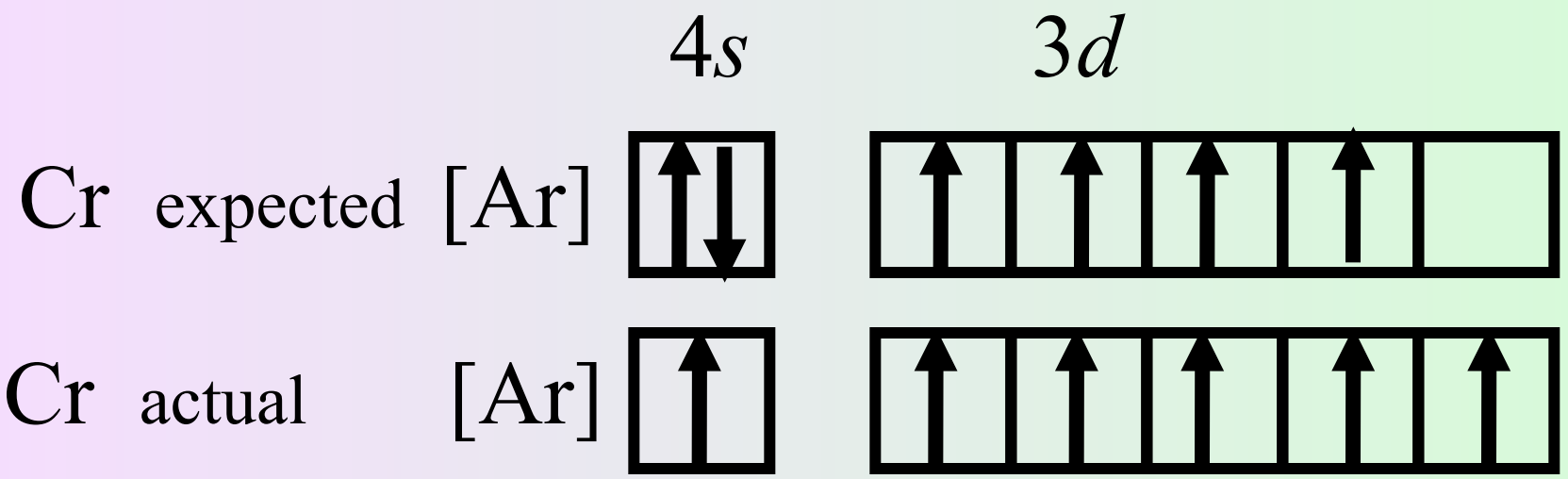
Transition Metals

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

First Transition Series

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

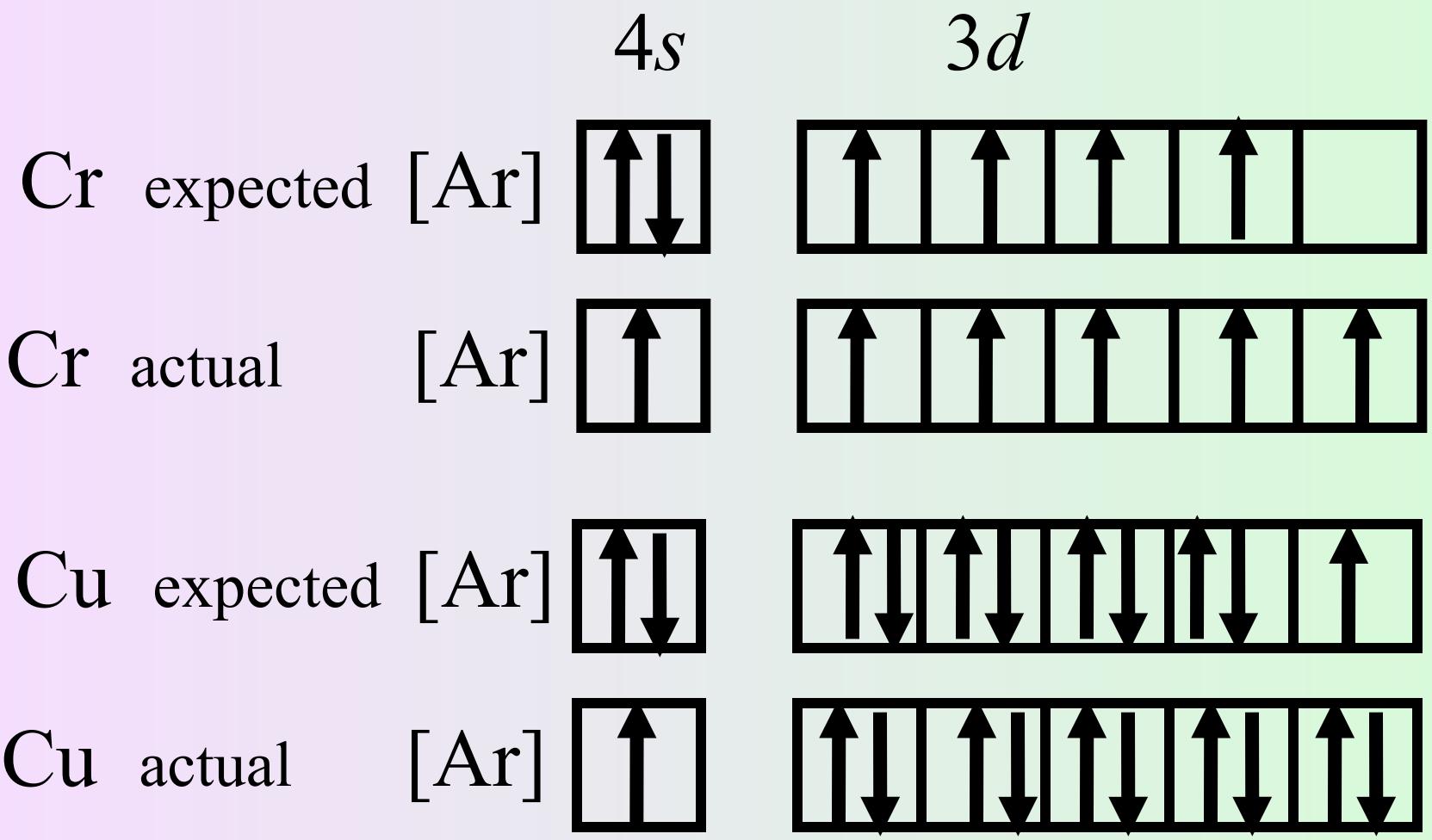
Periodic Anomalies



First Transition Series

Sc	21	[Ar]	$4s^2 3d^1$
Ti	22	[Ar]	$4s^2 3d^2$
V	23	[Ar]	$4s^2 3d^3$
Cr	24	[Ar]	$4s^1 3d^5$
Mn	25	[Ar]	$4s^2 3d^5$
Fe	26	[Ar]	$4s^2 3d^6$
Co	27	[Ar]	$4s^2 3d^7$
Ni	28	[Ar]	$4s^2 3d^8$
Cu	29	[Ar]	$4s^1 3d^{10}$
Zn	30	[Ar]	$4s^2 3d^{10}$

Periodic Anomalies



Fifth Period

[Kr] core

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

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

Sixth Period

[Xe] core

6*s* fills before 4*f*

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

4*f* fills before 5*d*

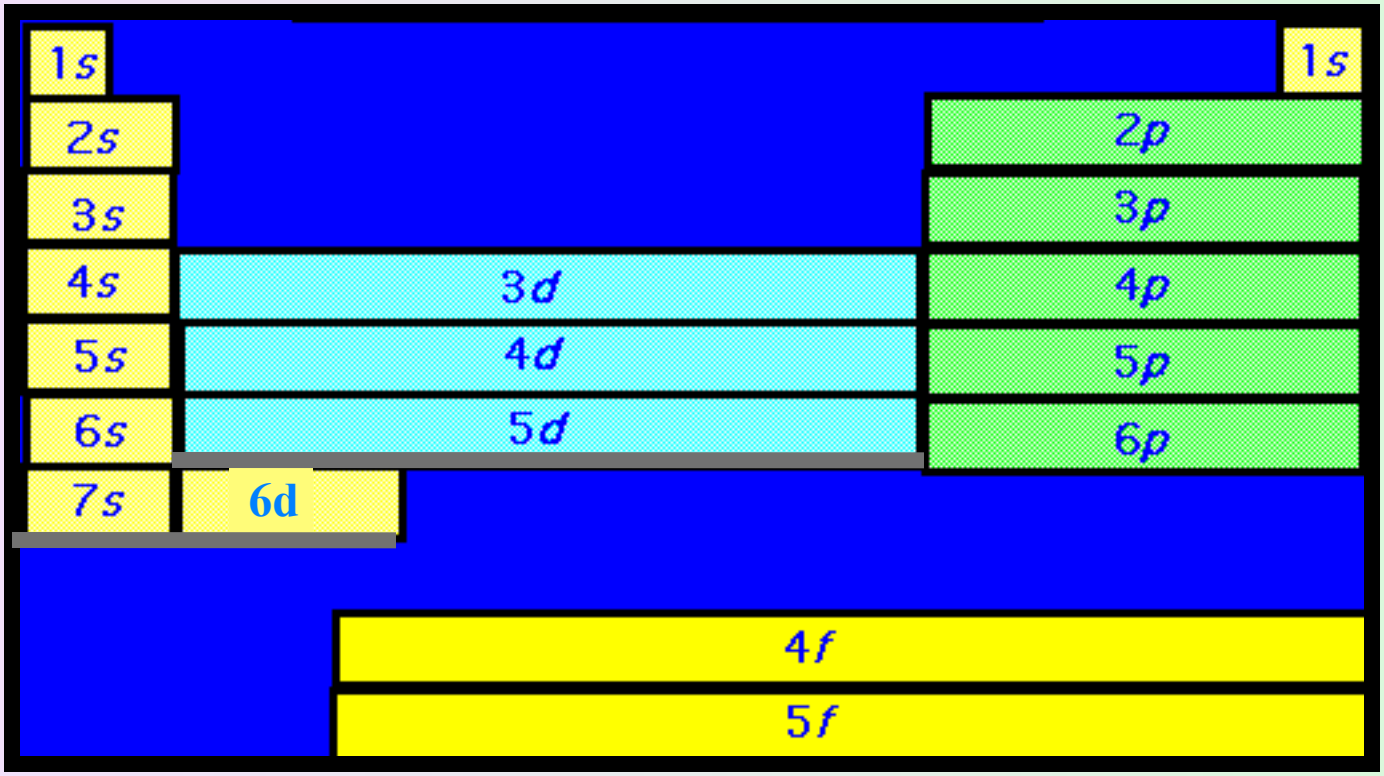
Seventh Period

[Rn] core

7*s* fills before 5*f*

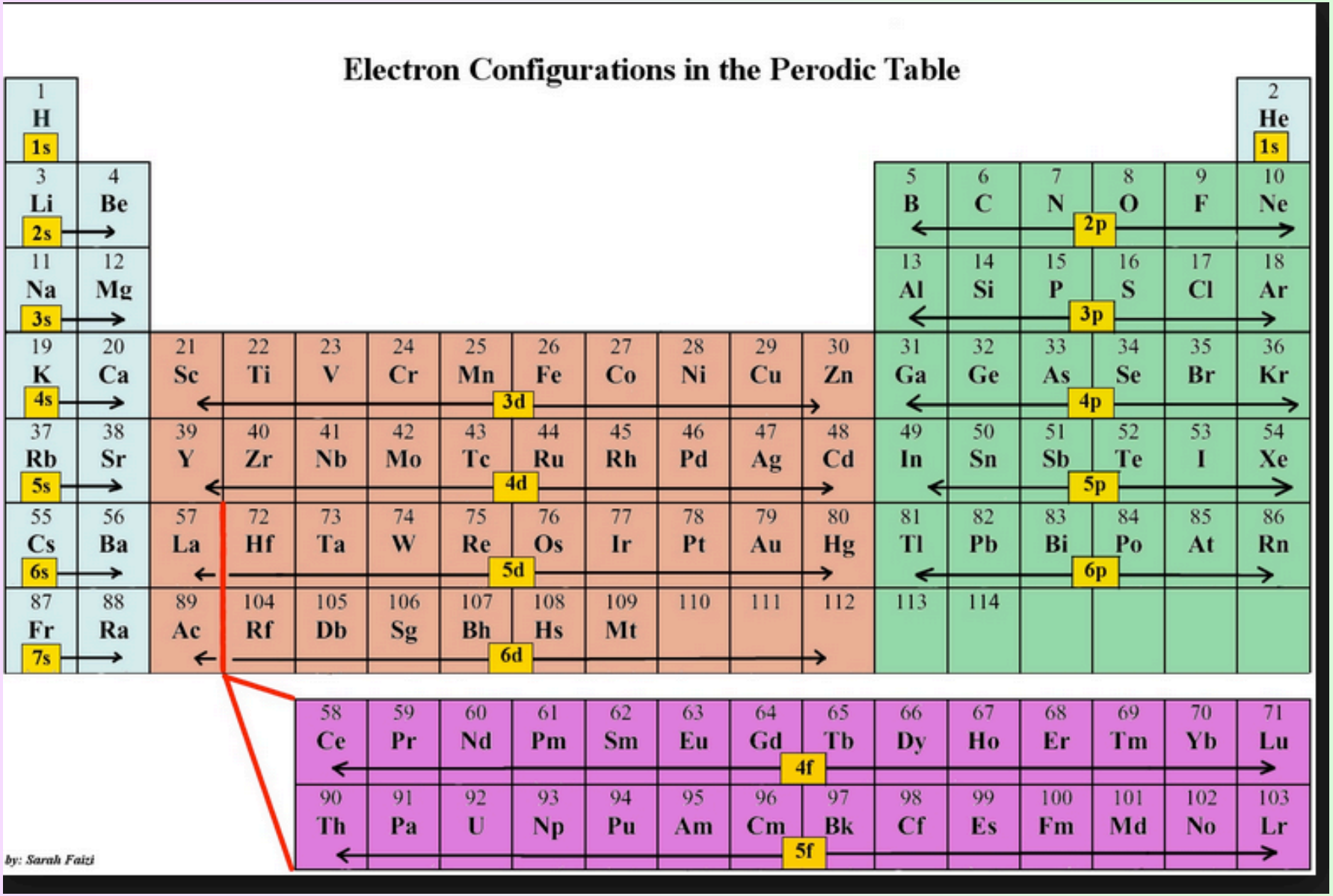
<u>actinide series</u>: 14 elements corresponding to filling 5*f* orbitals

5*f* fills before 6*d*



Subshell filling of elements in regions of the periodic table

Electron Configurations in the Perodic Table



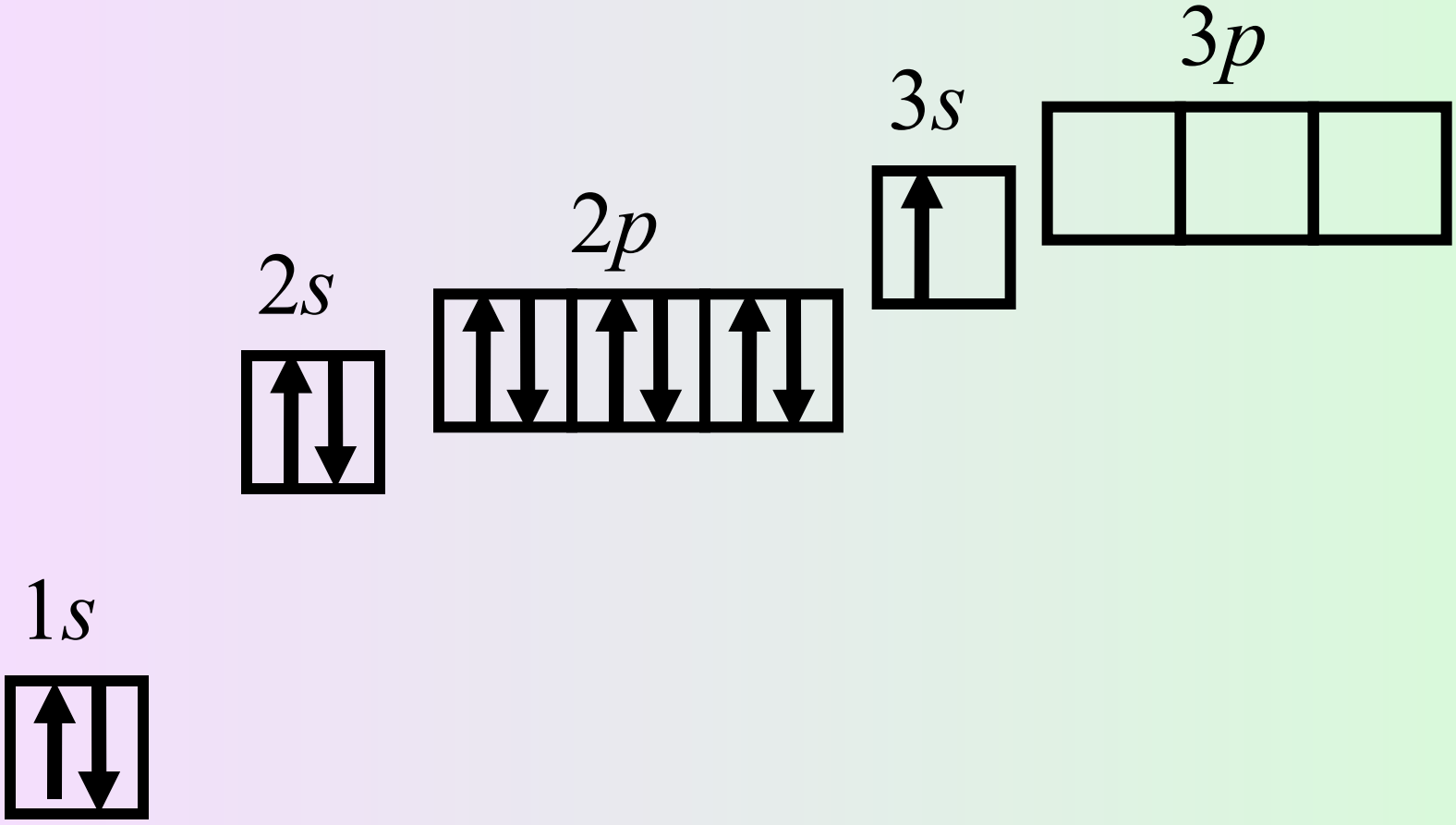
by: Sarah Faizi

Orbital Diagrams

use boxes with arrows to represent an electron configuration

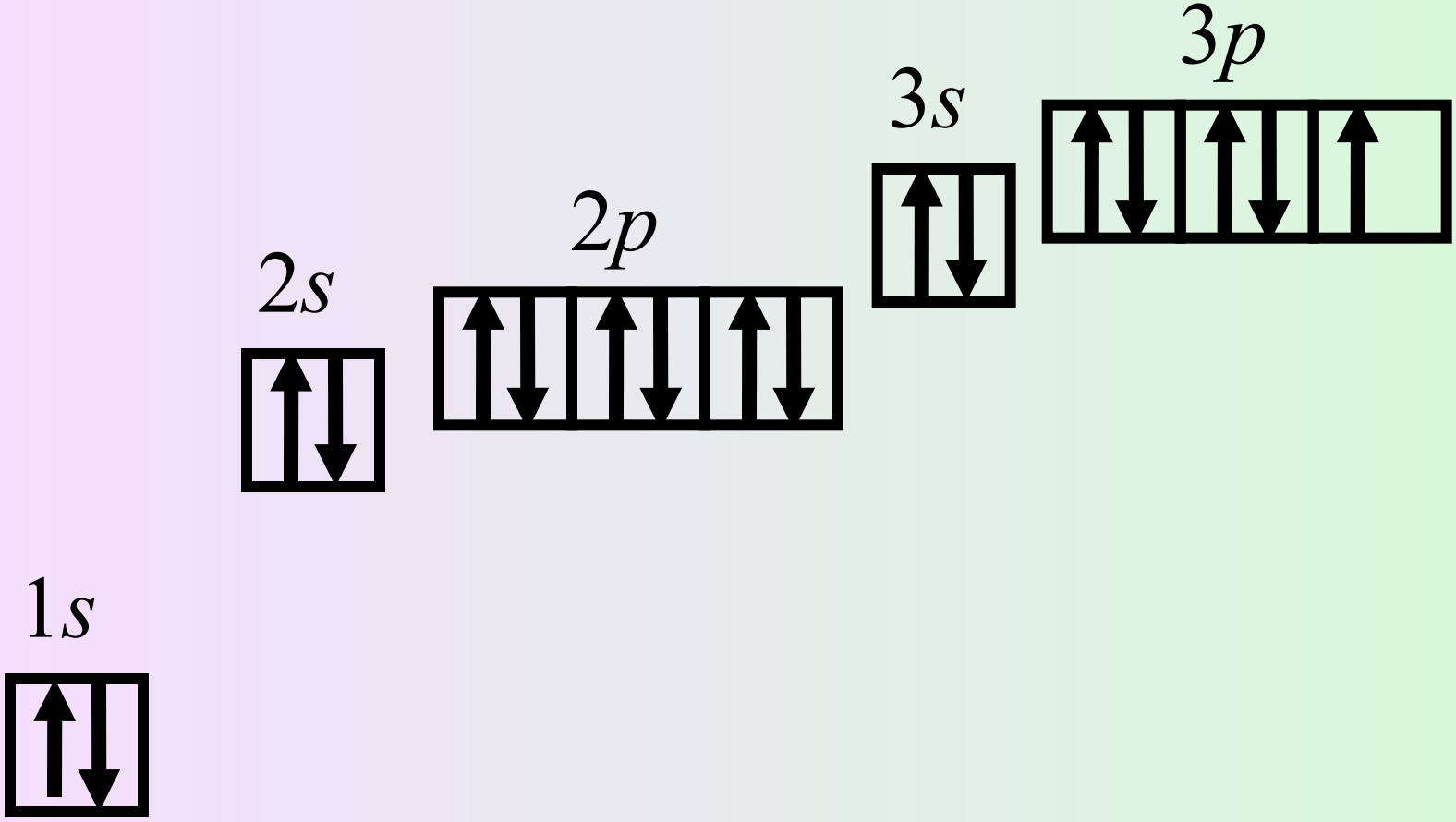
Na 11 $1s^2\ 2s^2 2p^6\ 3s^1$

[Ne] $3s^1$



Cl 17 $1s^2\ 2s^2 2p^6\ 3s^2 3p^5$

[Ne] $3s^2 3p^5$



Development of the Periodic Table

John Newlands - Law of Octaves

1864

When arranged in order of atomic mass, every eighth element had similar properties.

Dimitri Mendeleev / Lothar Meyer

1869

organized elements arranged according to atomic mass.

Mendeleev showed how useful the table could be in predicting the existence and properties of yet unknown elements

Modern Periodic Table - Henry Mosley

20th Century

Organized according to atomic number.

Periodic Classification of the Elements

Valence Electrons

The outer electrons of an atom, which are those involved in chemical bonding, are often called the **valence electrons**.

Elements in the same group of the periodic table have analogous valence-electron figurations.

Group 8A

noble gases

1	He	$1s^2$
2	Ne	$[He]2s^22p^6$
3	Ar	$[Ne]3s^23p^6$
4	Kr	$[Ar]3d^{10}4s^24p^6$
5	Xe	$[Kr]4d^{10}5s^25p^6$
6	Rn	$[Xe]5d^{10}4f^{14}6s^26p^6$

Group 1A

alkali metals

1	H	$1s^1$
2	Li	$[He]2s^1$
3	Na	$[Ne]3s^1$
4	K	$[Ar]4s^1$
5	Rb	$[Kr]5s^1$
6	Cs	$[Xe]6s^1$
7	Fr	$[Rn]7s^1$

Group 2A

Alkaline earth metals

2	Be	$[He]2s^2$
3	Mg	$[Ne]3s^2$
4	Ca	$[Ar]4s^2$
5	Sr	$[Kr]5s^2$
6	Ba	$[Xe]6s^2$
7	Ra	$[Rn]7s^2$

Group 7A

halogens

2	F	$2s^2\ 2p^5$
3	Cl	$3s^2\ 3p^5$
4	Br	$4s^2\ 4p^5$
5	I	$5s^2\ 5p^5$
6	At	$6s^2\ 6p^5$

Lewis Dot Symbols

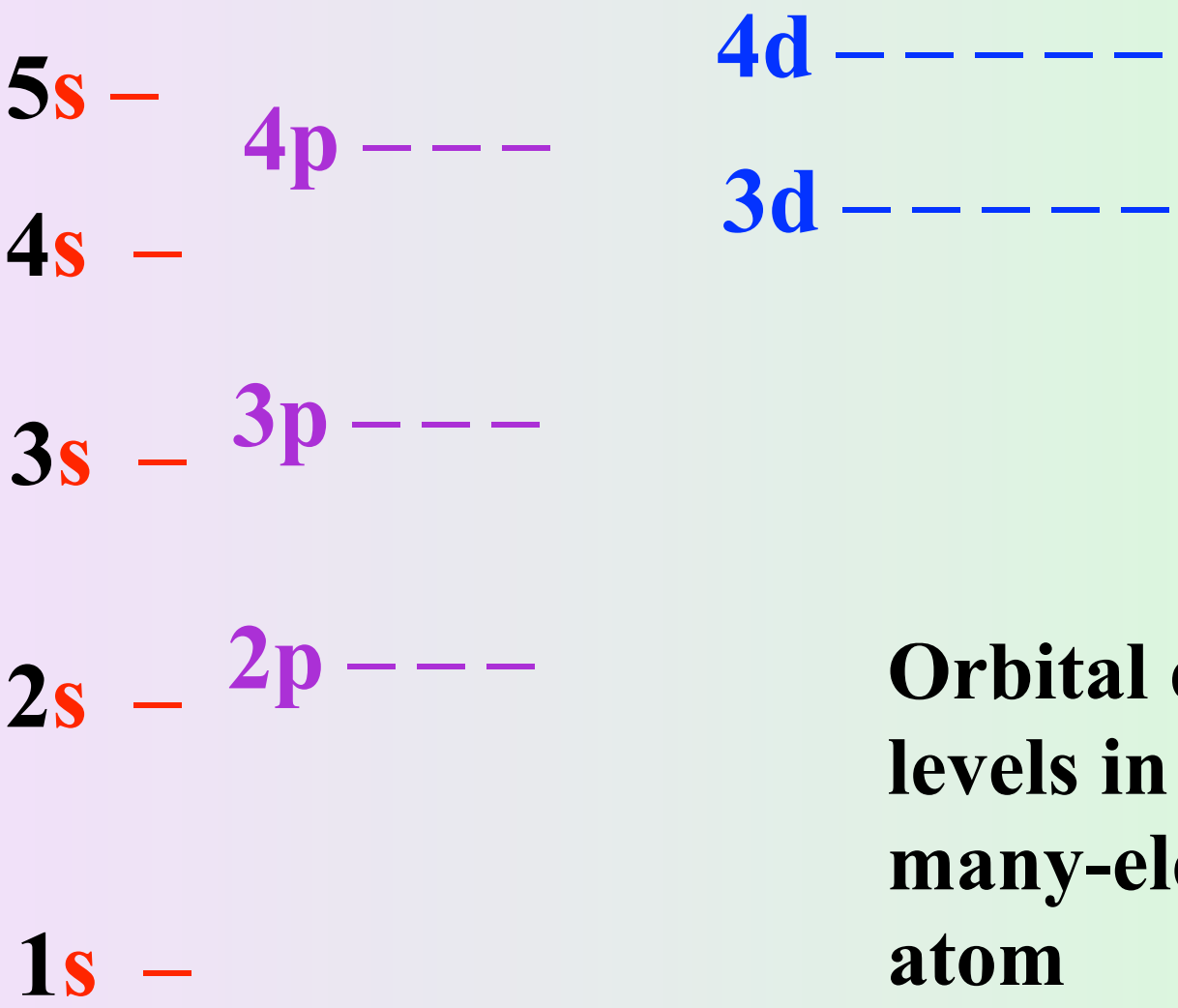
A Lewis dot symbol consists of the symbol of an element and one dot for each valence electron in an atom of the element.

1A	2A	3A	4A	5A	6A	7A	8A
H							He
Li	Be	B	C	N	O	F	Ne
Na	Mg	Al	Si	P	S	Cl	Ar
K	Ca	Ga	Ge	As	Se	Br	Kr
Rb	Sr	In	Sn	Sb	Te	I	Xe
Cs	Ba	Tl	Pb	Bi	Po	At	Rn
Fr	Ra						

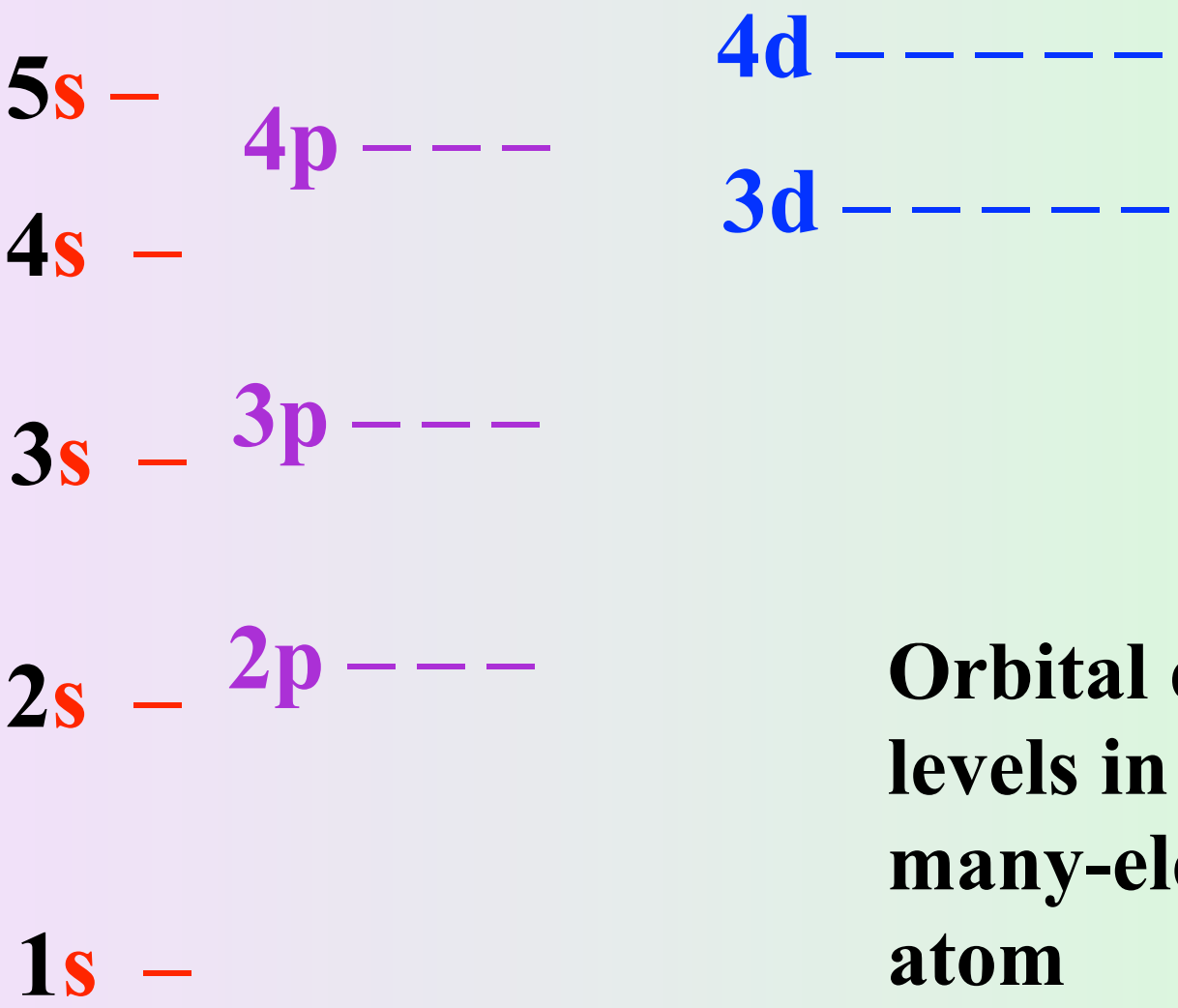
K	19	[Ar] $4s^1$
Ca	20	[Ar] $4s^2$
Sc	21	[Ar] $4s^2 3d^1$

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

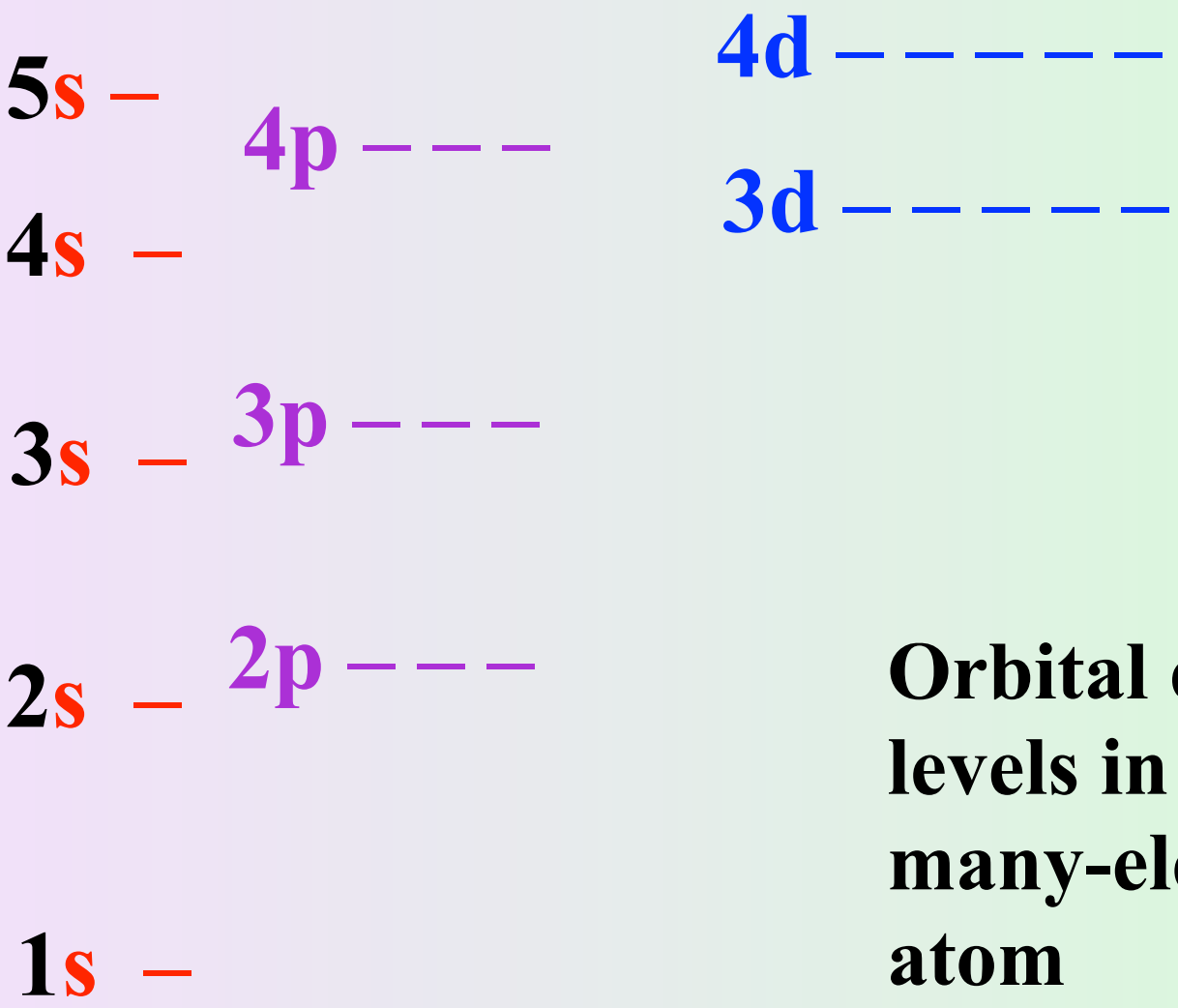
Zn	30	[Ar] $4s^2 3d^{10}$
Ga	31	[Ar] $4s^2 3d^{10} 4p^1$
Ge	32	[Ar] $4s^2 3d^{10} 4p^2$
As	33	[Ar] $4s^2 3d^{10} 4p^3$
Se	34	[Ar] $4s^2 3d^{10} 4p^4$
Br	35	[Ar] $4s^2 3d^{10} 4p^5$
Kr	36	[Ar] $4s^2 3d^{10} 4p^6$



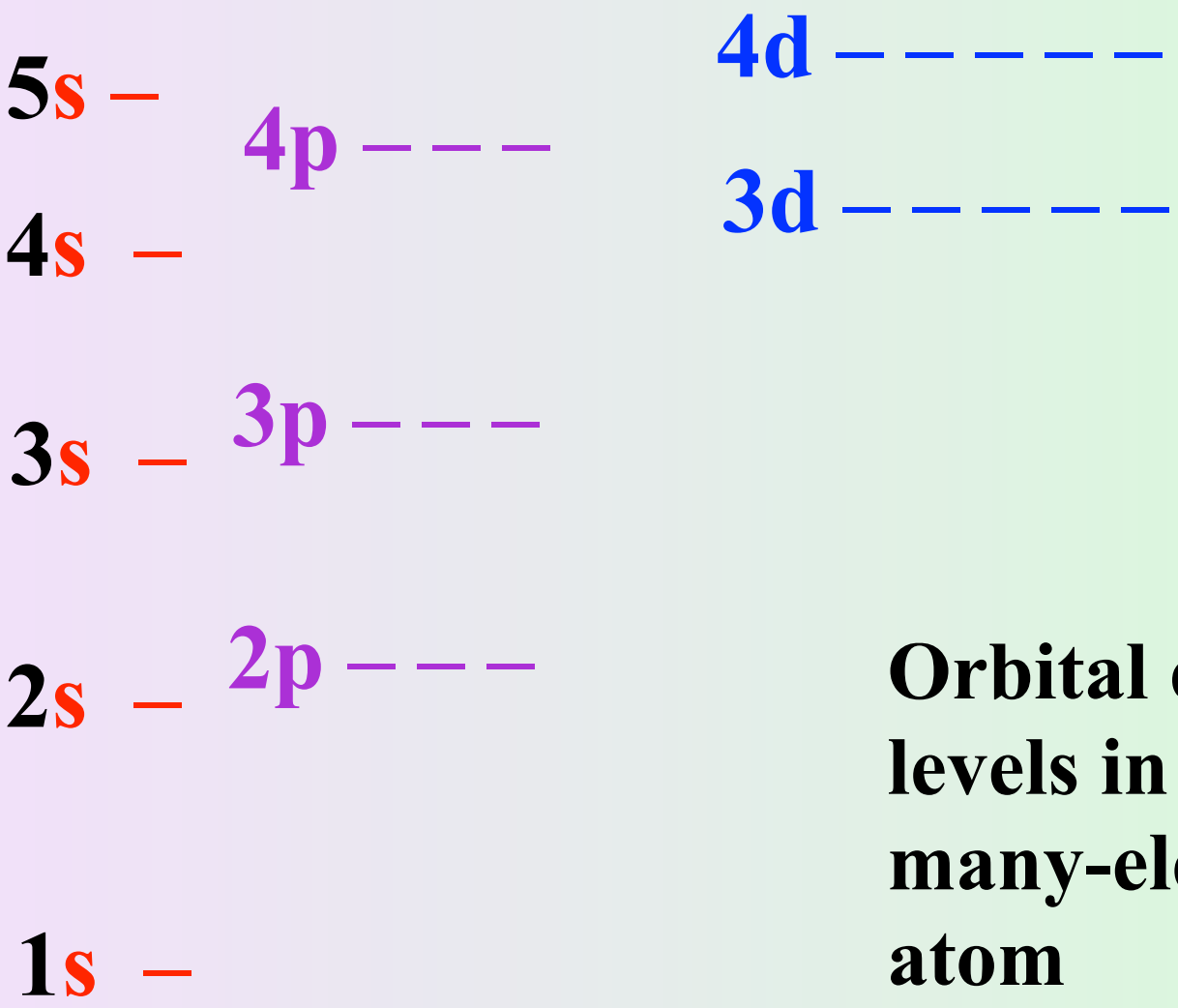
Orbital energy levels in a many-electron atom



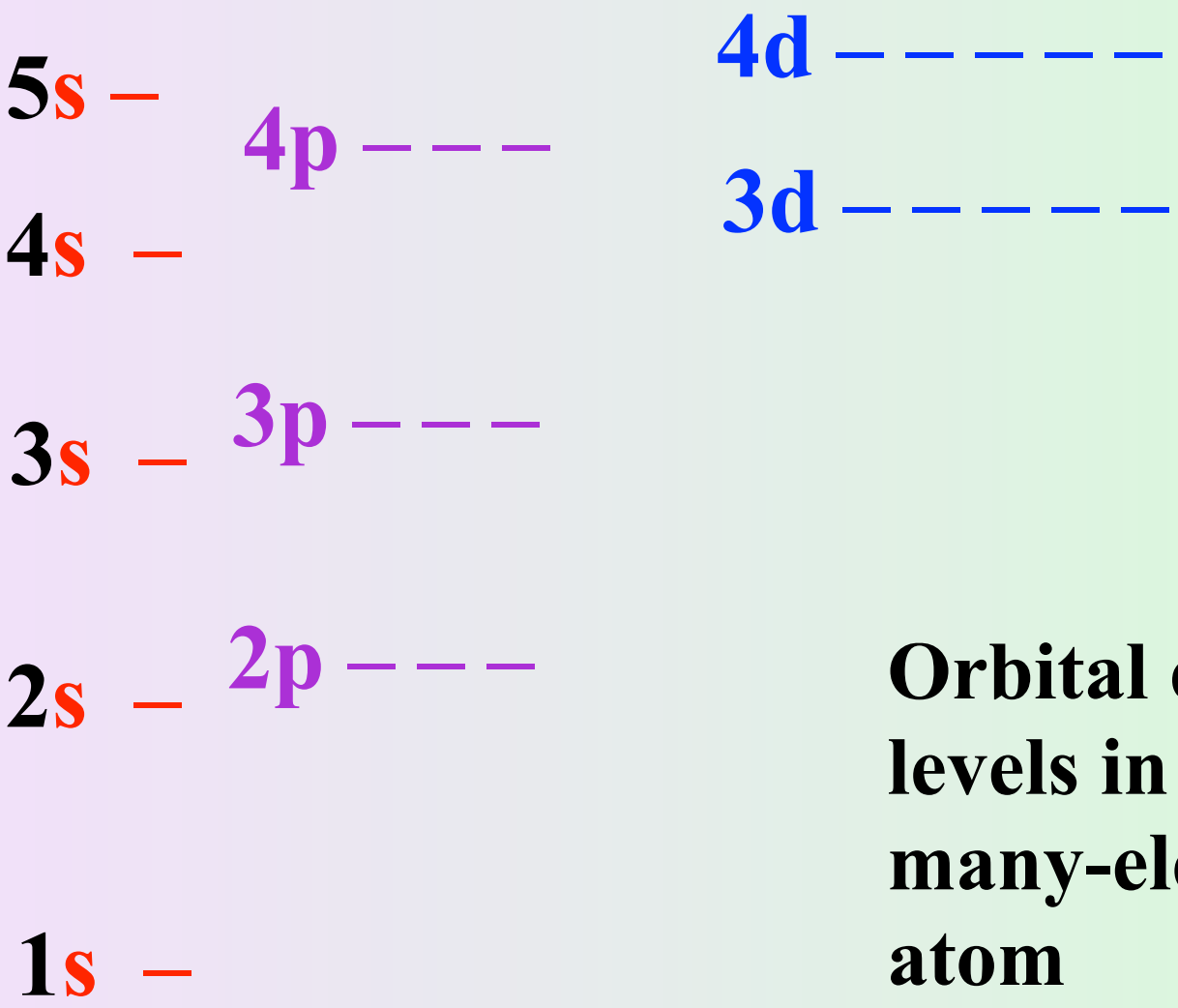
Orbital energy levels in a many-electron atom



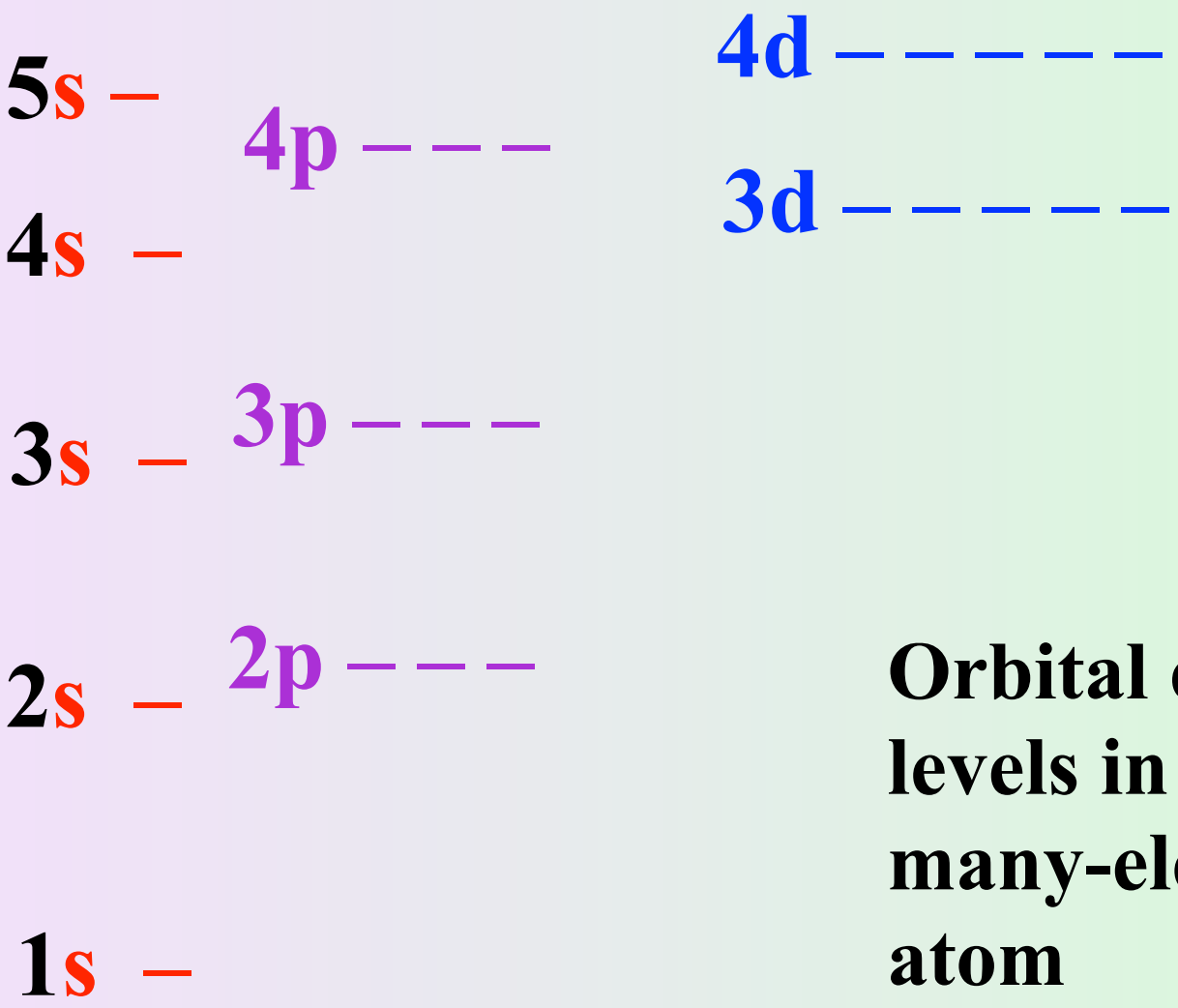
Orbital energy levels in a many-electron atom



Orbital energy levels in a many-electron atom



Orbital energy levels in a many-electron atom



Orbital energy levels in a many-electron atom