

Unit 3

Modeling Atomic Structure

Mr. Maxwell

PACS

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- 1 Atomic Structure
 - Atomic Number
 - Mass Number
 - Bohr Model
 - Energy Levels
 - The Periodic Table
 - groups and periods
 - Valence Electrons

Atomic Number

The _____ is the number of _____ in the nucleus of an atom.

Atomic Number

The **atomic number** is the number of in the nucleus of an atom.

Atomic Number

The **atomic number** is the number of **protons** in the nucleus of an atom.

Atomic Mass

The _____ the total number of _____ and _____ in the nucleus of an atom.

Atomic Mass

The **mass number** is the total number of **protons** and **neutrons** in the nucleus of an atom.

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Hydrogen



Hydrogen



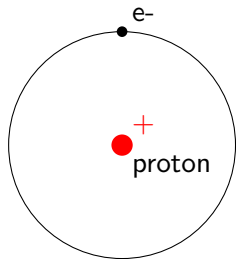
What does the 1 mean?

Hydrogen



What does the 1 mean?

1 is the total number of neutrons and protons.



Helium



Helium



What does the 4 mean?

Helium



What does the 4 mean?

4 is the total number of neutrons and protons.

Helium



What does the 4 mean?

4 is the total number of neutrons and protons.

What does the 2 mean?

Helium

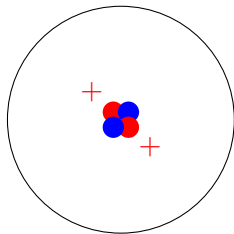


What does the 4 mean?

4 is the total number of neutrons and protons.

What does the 2 mean?

2 is the number of protons.



Helium

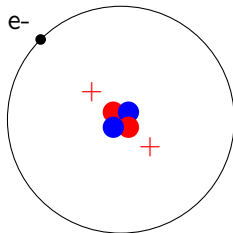


What does the 4 mean?

4 is the total number of neutrons and protons.

What does the 2 mean?

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Helium

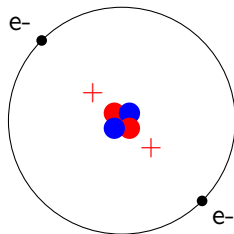


What does the 4 mean?

4 is the total number of neutrons and protons.

What does the 2 mean?

2 is the number of protons.



Lithium



How many protons does Lithium have?

Lithium



How many protons does Lithium have? 3



Lithium



How many protons does Lithium have? 3

How many neutrons?



Lithium



How many protons does Lithium have? 3

How many neutrons?

$$7 - 3 =$$



Lithium



How many protons does Lithium have? 3

How many neutrons?

$$7 - 3 = 4$$



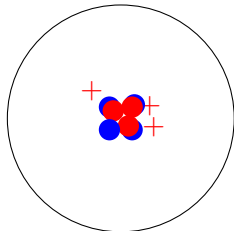
Lithium



How many protons does Lithium have? 3

How many neutrons?

$$7 - 3 = 4$$



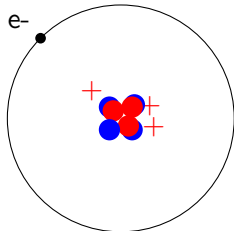
Lithium



How many protons does Lithium have? 3

How many neutrons?

$$7 - 3 = 4$$



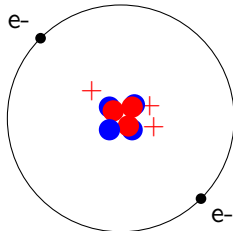
Lithium



How many protons does Lithium have? 3

How many neutrons?

$$7 - 3 = 4$$



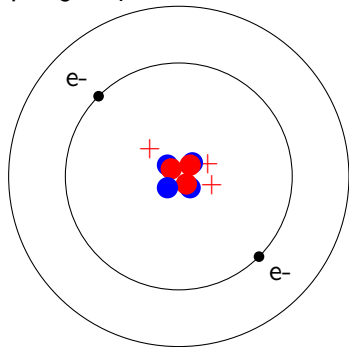
Lithium



How many protons does Lithium have? 3

How many neutrons?

$$7 - 3 = 4$$



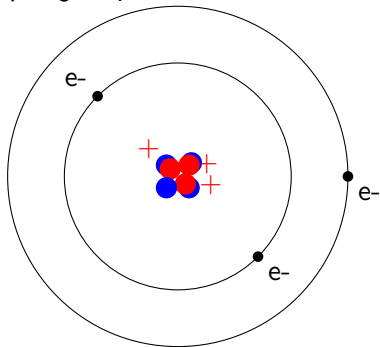
Lithium



How many protons does Lithium have? 3

How many neutrons?

$$7 - 3 = 4$$





The Bohr Model - Bohr proposed that an atom was a nucleus with electrons "orbiting" in different



The Bohr Model - Bohr proposed that an atom was a nucleus with electrons "orbiting" in different energy levels.

Energy Levels

Electrons can only have certain energy values known as

Energy Levels

Electrons can only have certain energy values known as **energy levels**

Energy Levels

The electrons closest to the nucleus have the lowest energy, while those further from away have higher energy.

Energy Levels

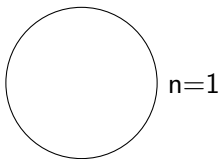
The electrons closest to the nucleus have the **lowest** energy, while those further from away have energy.

Energy Levels

The electrons closest to the nucleus have the **lowest** energy, while those further from away have **higher** energy.

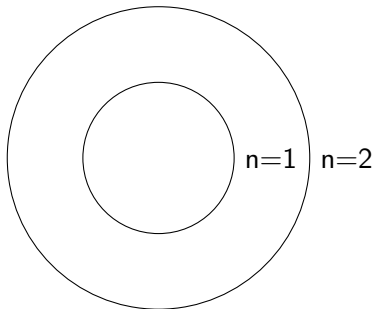
Energy Levels

The electrons closest to the nucleus have the **lowest** energy, while those further from away have **higher** energy.



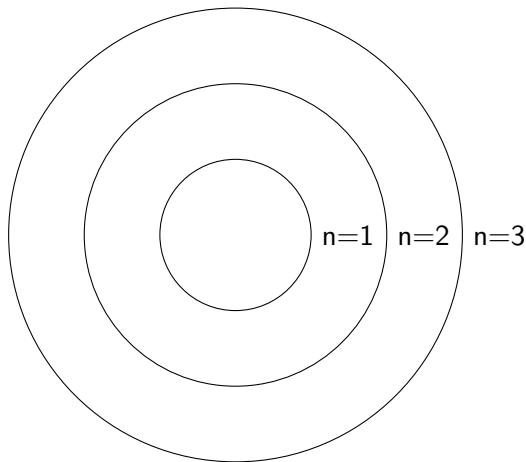
Energy Levels

The electrons closest to the nucleus have the **lowest** energy, while those further from away have **higher** energy.



Energy Levels

The electrons closest to the nucleus have the **lowest** energy, while those further from away have **higher** energy.



Energy Levels and the Periodic Table

	Group ▶	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Period ▼																			
Nonmetals	1	1 H																		
Metals	2	3 Li	4 Be																	2 He
	3	11 Na	12 Mg																	
	4	19 K	20 Ca																	
	5	37 Rb	38 Sr																	
	6	55 Cs	56 Ba	La to Yb																
	7	87 Fr	88 Ra	Ac to No																
		s-block (plus He)	f-block		d-block										p-block (excluding He)					
Lanthanides		57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb					
Actinides		89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No					

Energy Level of Hydrogen

Group 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

Period

Nonmetals

Metals

Transition metals (sometimes excluding group 12)

Lanthanides

Actinides

s-block (plus He)

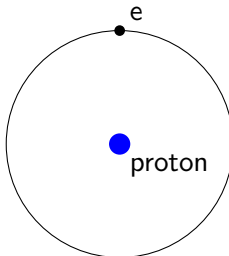
f-block

d-block

p-block (excluding He)

Some elements near the dashed staircase are sometimes called metalloids

Noble gases



Energy Level of Lithium

Group ▶	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18										
Period ▼																												
Nonmetals	1 H																	2 He										
Metals	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne										
	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar										
	19 K	20 Ca											21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
	37 Rb	38 Sr											49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe										
	55 Cs	56 Ba	La to Yb	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn									
	87 Fr	88 Ra	Ac to No	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og									
	s-block (plus He)		f-block	d-block										p-block (excluding He)														
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Energy Level of Lithium

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Nonmetals	1 H																		Noble gases
Metals	2 Li Be	4 He																	
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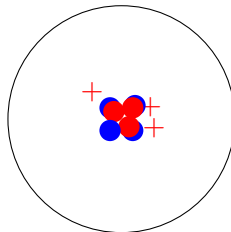
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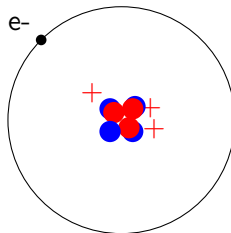
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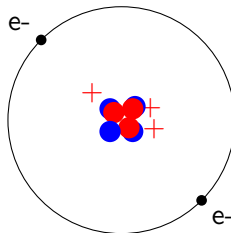
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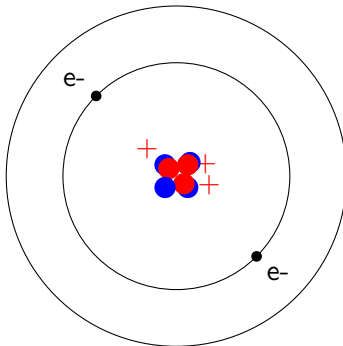
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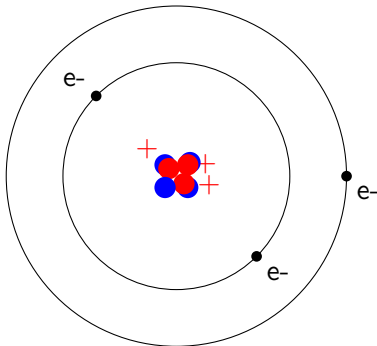
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Energy Level of Lithium

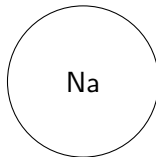
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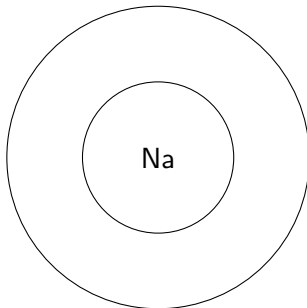
Energy Level of Sodium

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Nonmetals	1 H																	
Metals	3 Li	4 Be																
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	19 K	20 Ca																
	37 Rb	38 Sr																
	55 Cs	56 Ba																
	87 Fr	88 Ra																
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Lanthanides																		
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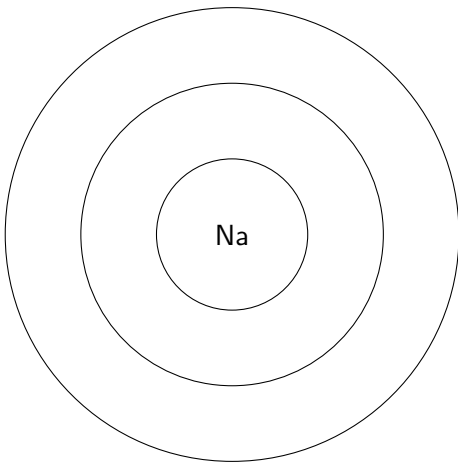
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Period																			
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Metals	2 Li Be		3 B	4 C										5 B	6 C	7 N	8 O	9 F	10 Ne
	3 Na Mg													13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
	4 K Ca													30 Ga	31 Ge	32 As	33 Se	34 Br	35 Kr
	5 Rb Sr													48 In	49 Sn	50 Sb	51 Te	52 I	53 Xe
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	3 Na Mg																		
	4 K Ca																		
	5 Sc Ti V Cr Mn Fe Co Ni Cu Zn																		
	6 Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd																		
	7 Rb Sr Br Kr																		
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The Periodic Table

The Periodic Table has periods and groups.

Group ▶	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period ▼																		
Nonmetals	1 H																	2 He
Metals	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
	19 K	20 Ca											31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
	37 Rb	38 Sr											49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
	55 Cs	56 Ba	La to Yb										81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
	87 Fr	88 Ra	Ac to No										113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
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Some elements near the dashed staircase are sometimes called *metalloids*

Noble gases

The Periodic Table

The Periodic Table has 7 periods and 18 groups.

Group ▶	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period ▼																		
Nonmetals	1																	2
	H																	He
Metals	3	4											5	6	7	8	9	10
	Li	Be											B	C	N	O	F	Ne
	11	12											13	14	15	16	17	18
	Na	Mg											Al	Si	P	S	Cl	Ar
	19	20											31	32	33	34	35	36
	K	Ca											Ga	Ge	As	Se	Br	Kr
	37	38											49	50	51	52	53	54
	Rb	Sr											In	Sn	Sb	Te	I	Xe
	55	56											81	82	83	84	85	86
	Cs	Ba	La to Yb										Tl	Pb	Bi	Po	At	Rn
	87	88											113	114	115	116	117	118
	Fr	Ra	Ac to No										Nh	Fl	Mc	Lv	Ts	Og
	s-block (plus He)		f-block		d-block								p-block (excluding He)					
Lanthanides	57	58	59	60	61	62	63	64	65	66	67	68	69	70				
	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb				
Actinides	89	90	91	92	93	94	95	96	97	98	99	100	101	102				
	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No				

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Noble gases

The Periodic Table

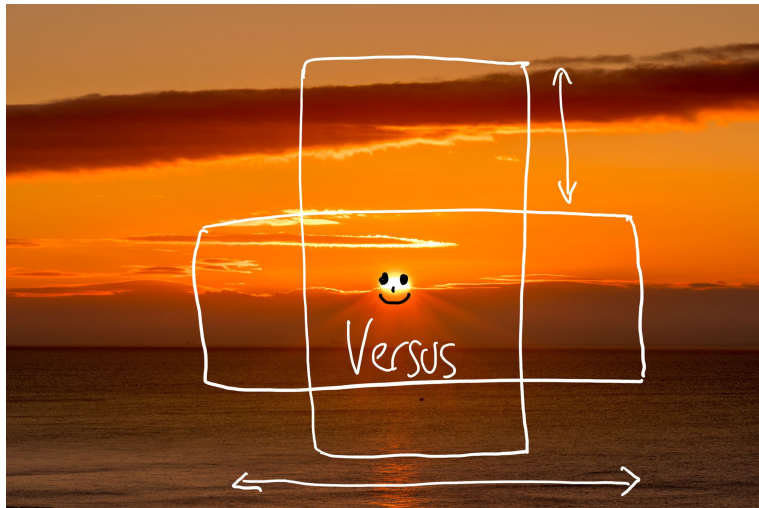
The Periodic Table has 7 periods and 18 groups.

Group ▶	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period ▼																		
Nonmetals	1																	2
	H																	He
Metals	3	4											5	6	7	8	9	10
	Li	Be											B	C	N	O	F	Ne
	11	12											13	14	15	16	17	18
	Na	Mg											Al	Si	P	S	Cl	Ar
	19	20											31	32	33	34	35	36
	K	Ca											Ga	Ge	As	Se	Br	Kr
	37	38											49	50	51	52	53	54
	Rb	Sr											In	Sn	Sb	Te	I	Xe
	55	56											81	82	83	84	85	86
	Cs	Ba	La to Yb										Tl	Pb	Bi	Po	At	Rn
	87	88											113	114	115	116	117	118
	Fr	Ra	Ac to No										Nh	Fl	Mc	Lv	Ts	Og
	s-block (plus He)		f-block		d-block								p-block (excluding He)					
Lanthanides	57	58	59	60	61	62	63	64	65	66	67	68	69	70				
	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb				
Actinides	89	90	91	92	93	94	95	96	97	98	99	100	101	102				
	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No				

Some elements near the dashed staircase are sometimes called *metalloids*

Noble gases

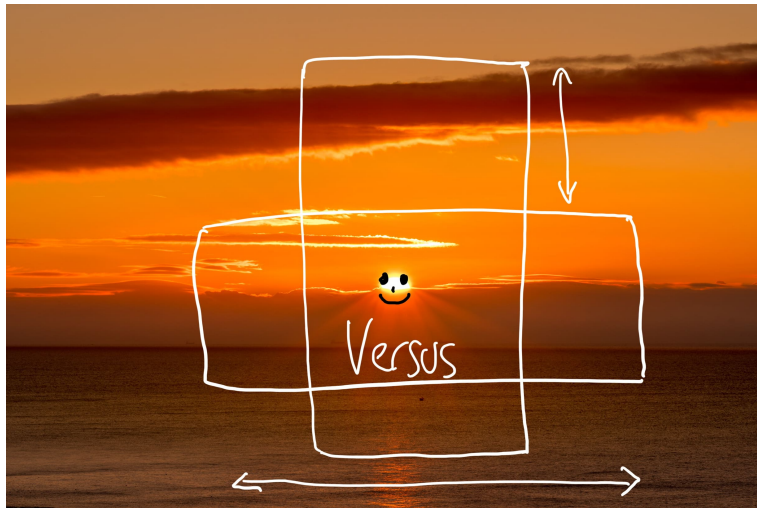
Horizontal and Vertical



The periods are

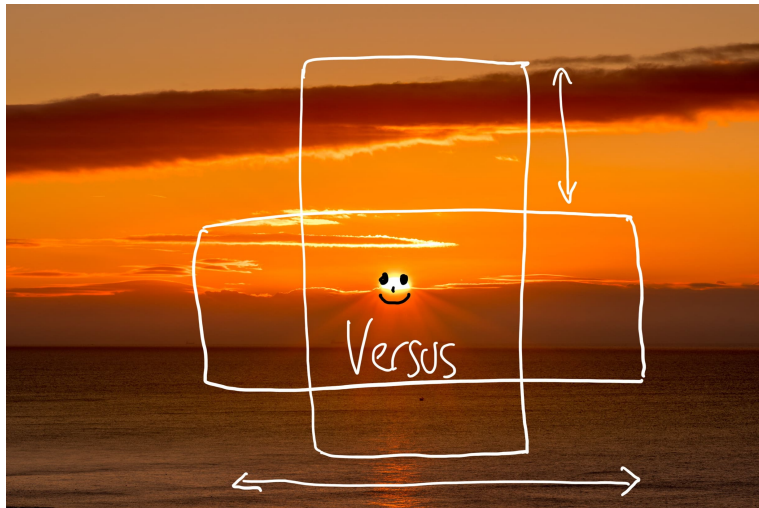
and the groups are

Horizontal and Vertical



The periods are **horizontal** and the groups are

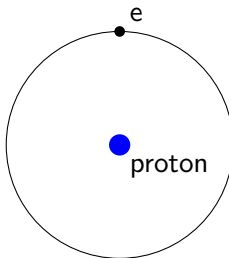
Horizontal and Vertical



The periods are **horizontal** and the groups are **vertical**.

Energy Level of Hydrogen

Group	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period																			
Nonmetals	1 H																		Noble gases
Metals	2 Li Be	3 Na Mg	4 Al Si P S Cl Ar																He
	3 K Ca																		
	4 Rb Sr																		
	5 Cs Ba	La to Yb																	
	6 Fr Ra	Ac to No																	
s-block (plus He)																			
f-block																			
d-block																			
p-block (excluding He)																			
Lanthanides	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb					
Actinides	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No					



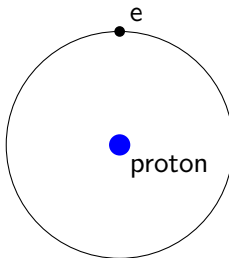
You can know the
the periodic table.

configuration of an element from its

in

Energy Level of Hydrogen

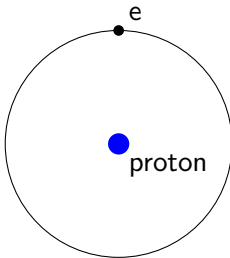
Group ▶	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Period ▼																			Noble gases		
Nonmetals	1	H																	He		
	2	Li	Be											B	C	N	O	F	Ne		
	3	Na	Mg											Al	Si	P	S	Cl	Ar		
	4	K	Ca											Ga	Ge	As	Se	Br	Kr		
	5	Rb	Sr											In	Sn	Sb	Te	I	Xe		
	6	Cs	Ba	La to Yb										Hg	Tl	Pb	Bi	Po	At	Rn	
	7	Fr	Ra	Ac to No										(H)	Fl	Mc	Lv	Ts	Og		
		s-block (plus He)	f-block	d-block										p-block (excluding He)							
Lanthanides				57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Dy	66 Ho	67 Er	68 Tm	69 Yb	70 Lu				
Actinides				89 Ac	Th	90 Pa	91 U	92 Np	93 Pu	Am	94 Cm	95 Bk	96 Cf	97 Es	98 Fm	99 Md	100 No	101 Lr	102 Nh	103 Ts	104 Og



You can know the **electron** configuration of an element from its **atomic number** in the periodic table.

Energy Level of Hydrogen

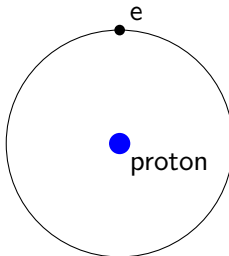
Group	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period																			
Nonmetals	1 H																		Noble gases
Metals	2 Li Be																		He
	3 Na Mg																		
	4 K Ca																		
	5 Rb Sr																		
	6 Cs Ba	La to Yb																	
	7 Fr Ra	Ac to No																	
s-block (plus He)																			
f-block																			
d-block																			
p-block (excluding He)																			
Lanthanides	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Er	68 Ho	69 Tm	70 Yb					
Actinides	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No					



You can know the **electron** configuration of an element from its **position** in the periodic table.

Energy Level of Hydrogen

Group	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period																			
Nonmetals	1 H																		Noble gases
Metals	2 Li Be	4 Be																	He
	3 Na Mg	4 Mg																	
	19 K Ca	20 Ca																	
	37 Rb Sr	38 Sr																	
	55 Cs Ba	La to Yb																	
	87 Fr Ra	Ac to No																	
s-block (plus He)																			
f-block																			
d-block																			
p-block (excluding He)																			
Lanthanides	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb					
Actinides	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	Es	99 Fm	100 Md	101 No	102 Lr				

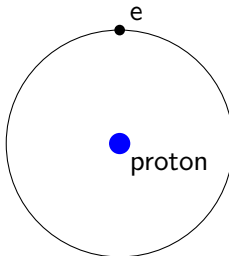


The number of electron number.

(or energy levels) is equal to the

Energy Level of Hydrogen

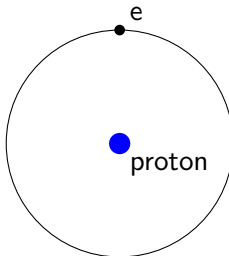
Group	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period																			
Nonmetals	1 H																		Noble gases
Metals	2 Li Be	4 Be																	He
	3 Na Mg	4 Mg																	
	19 K Ca	20 Ca																	
	37 Rb Sr	38 Sr																	
	55 Cs Ba	La to Yb																	
	87 Fr Ra	Ac to No																	
s-block (plus He)																			
f-block																			
d-block																			
p-block (excluding He)																			
Lanthanides	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb					
Actinides	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	Es	99 Fm	100 Md	101 No	102 Lr				



The number of electron **shells** (or energy levels) is equal to the number.

Energy Level of Hydrogen

Group	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period																			
Nonmetals	1 H																		Noble gases
Metals	2 Li Be	4 Be																	He
	3 Na Mg	4 Mg																	
	19 K Ca	20 Ca																	
	37 Rb Sr	38 Sr																	
	55 Cs Ba	La to Yb																	
	87 Fr Ra	Ac to No																	
s-block (plus He)																			
f-block																			
d-block																			
p-block (excluding He)																			
Lanthanides	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb					
Actinides	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	Es	99 Fm	100 Md	101 No	102 Lr				



The number of electron **shells** (or energy levels) is equal to the **period** number.

Valence Electrons

Group ▾ 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Period ▼

1	2																	18
1	2																	2
3	4																	10
11	12																	18
19	20																	36
37	38																	54
55	56																	86
87	88																	118
Fr	Ra																	Og

Some elements near the dashed staircase are sometimes called **metalloids**

Transition metals (sometimes excluding group 12)

s-block (plus He)

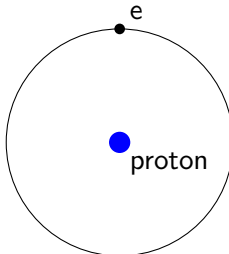
f-block

d-block

p-block (excluding He)

Lanthanides

Actinides



The number of valence electrons is related to the

Valence Electrons

Group ▾ 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Period ▼

1	2																	2
H	He																	He
Li	Be																	Ne
Na	Mg																	Ar
K	Ca																	Kr
Rb	Sr																	Xe
Cs	Ba																	Rn
Fr	Ra																	Og

Some elements near the dashed staircase are sometimes called metalloids

Transition metals (sometimes excluding group 12)

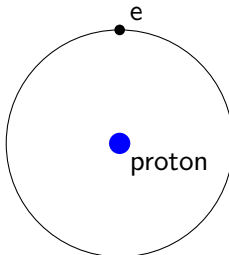
s-block (plus He) f-block d-block p-block (excluding He)

Lanthanides

57	58	59	60	61	62	63	64	65	66	67	68	69	70
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb

Actinides

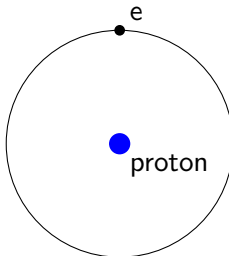
89	90	91	92	93	94	95	96	97	98	99	100	101	102
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No



The number of valence electrons is related to the **group** number.

Valence Electrons

Group	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period																			
Nonmetals	1 H																		Noble gases
Metals	2 Li	4 Be																	He
	3 Na	11 Mg																	
	4 K	20 Ca																	
	5 Rb	37 Sr																	
	6 Cs	55 Ba	La to Yb																
	7 Fr	87 Ra	Ac to No																
s-block (plus He)																			
f-block																			
d-block																			
p-block (excluding He)																			
Lanthanides	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb					
Actinides	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	Es	99 Fm	100 Md	101 No	102 Lr				

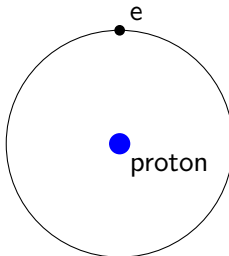


For atoms in groups _____ and _____ the number of _____ are equal to the group number.

For atoms in groups 1 to 10 the number of valence electrons are equal to the group number minus 10.

Valence Electrons

Group	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period																			
Nonmetals	1 H																		Noble gases
Metals	2 Li	4 Be																	He
	3 Na	11 Mg																	
	4 K	20 Ca																	
	5 Rb	37 Sr																	
	6 Cs	55 Ba	La to Yb																
	7 Fr	87 Ra	Ac to No																
s-block (plus He)																			
f-block																			
d-block																			
p-block (excluding He)																			
Lanthanides	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb					
Actinides	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	Es	99 Fm	100 Md	101 No	102 Lr				

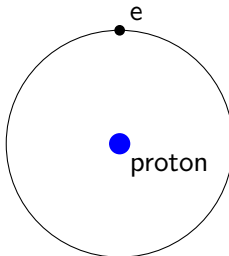


For atoms in groups **one** and **two** the number of valence electrons are equal to the group number.

For atoms in groups 1 to 10 the number of valence electrons are equal to the group number minus 10.

Valence Electrons

Group	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period																			
Nonmetals	1 H																		Noble gases
Metals	2 Li	4 Be																	He
	3 Na	11 Mg																	
	19 K	20 Ca																	
	37 Rb	38 Sr																	
	55 Cs	56 Ba	La to Yb																
	87 Fr	88 Ra	Ac to No																
s-block (plus He)																			
f-block																			
d-block																			
p-block (excluding He)																			
Lanthanides	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb					
Actinides	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	Es	99 Fm	100 Md	101 No	102 Lr				

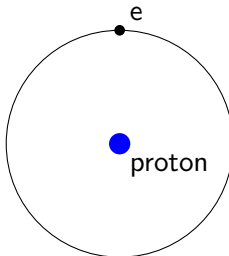


For atoms in groups **one** and **two**, the number of _____ are equal to the group number.

For atoms in groups 1 to 10 the number of valence electrons are equal to the group number minus 10.

Valence Electrons

Group	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period																			
Nonmetals	1 H																		Noble gases
Metals	2 Li	4 Be																	He
	3 Na	11 Mg																	
	4 K	20 Ca																	
	5 Rb	37 Sr																	
	6 Cs	55 Ba	La to Yb																
	7 Fr	87 Ra	Ac to No																
s-block (plus He)																			
f-block																			
d-block																			
p-block (excluding He)																			
Lanthanides	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb					
Actinides	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	Es	99 Fm	100 Md	101 No	102 Lr				

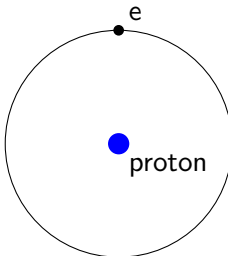


For atoms in groups **one** and **two**, the number of **valence** electrons are equal to the group number.

For atoms in groups 1 to 10 the number of valence electrons are equal to the group number minus 10.

Valence Electrons

Group	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period																			
Nonmetals	1 H																		Noble gases
Metals	2 Li	4 Be																	He
	3 Na	11 Mg																	
	4 K	20 Ca																	
	5 Rb	37 Sr																	
	6 Cs	55 Ba	La to Yb																
	7 Fr	87 Ra	Ac to No																
s-block (plus He)																			
f-block																			
d-block																			
p-block (excluding He)																			
Lanthanides	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb					
Actinides	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	Es	99 Fm	100 Md	101 No	102 Lr				

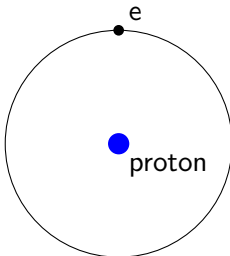


For atoms in groups **one** and **two**, the number of **valence** electrons are equal to the group number.

For atoms in groups 13 to 10, the number of valence electrons are equal to the group number minus 10.

Valence Electrons

Group	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period																			
Nonmetals	1 H																		Noble gases
Metals	2 Li	4 Be																	He
	11 Na	12 Mg																	
	19 K	20 Ca																	
	37 Rb	38 Sr																	
	55 Cs	56 Ba	La to Yb																
	87 Fr	88 Ra	Ac to No																
s-block (plus He)																			
f-block																			
d-block																			
p-block (excluding He)																			
Lanthanides	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb					
Actinides	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	Es	Fm	100 Md	101 No	102 Lr				

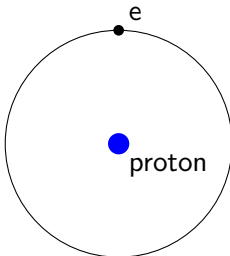


For atoms in groups **one** and **two**, the number of **valence** electrons are equal to the group number.

For atoms in groups 13 to 18, the number of valence electrons are equal to the group number minus 10.

Valence Electrons

Group	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period																			
Nonmetals	1 H																		Noble gases
Metals	2 Li	4 Be																	He
	3 Na	11 Mg																	
	4 K	20 Ca																	
	5 Rb	37 Sr																	
	6 Cs	55 Ba	La to Yb																
	7 Fr	87 Ra	Ac to No																
s-block (plus He)																			
f-block																			
d-block																			
p-block (excluding He)																			
Lanthanides	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb					
Actinides	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	Es	99 Fm	100 Md	101 No	102 Lr				

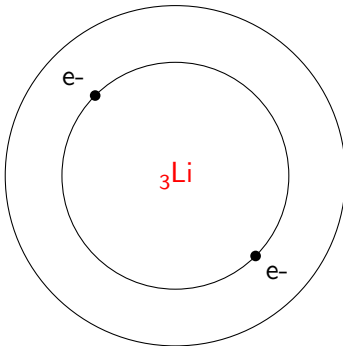


For atoms in groups **one** and **two**, the number of **valence** electrons are equal to the group number.

For atoms in groups 13 to 18, the number of valence electrons are equal to the group number minus 10.

Valence Electrons of Li

Group	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period																			
Nonmetals	1 H																		Noble gases
Metals	2 Li Be																		He
	3 Na Mg																		
	4 K Ca																		
	5 Rb Sr																		
	6 Cs Ba	La to Yb																	
	7 Fr Ra	Ac to No																	
s-block (plus He)																			
f-block																			
d-block																			
p-block (excluding He)																			
Lanthanides	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Dy	66 Ho	67 Er	68 Tm	69 Yb	70 Lu					
Actinides	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No					



Valence Electrons of Li

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18																														
Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18																														
													Some elements near the dashed staircase are sometimes called <i>metalloids</i>						Noble gases																													
Nonmetals	1 H																		He																													
Metals	2 Li Be	3 B C N O F Ne	Transition metals (sometimes excluding group 12)										12 Zn Cd Hg	13 Al Ga In Sn Pb Bi Po At Rn	14 Si Ge As Se Br Kr	15 P As Sb Te I Xe	16 S Se Te Po	17 Cl Br I At	18 Ar Kr Xe Rn																													
	3 Na Mg	4 Al Si P S Cl Ar	5 K Ca	6 Sc Ti V Cr Mn Fe Co Ni Cu Zn	7 21 Y Zr Nb Mo Tc Ru Rh Pd Ag Cd	8 22 Zr Nb Mo Tc Ru Rh Pd Ag Cd	9 23 Y Zr Nb Mo Tc Ru Rh Pd Ag Cd	10 24 V Cr Mn Fe Co Ni Cu Zn	11 25 Cr Mn Fe Co Ni Cu Zn	12 26 Mn Fe Co Ni Cu Zn	13 27 Fe Co Ni Cu Zn	14 28 Co Ni Cu Zn	15 29 Ni Cu Zn	16 30 Cu Zn	17 31 Zn	18 32 Ga	19 33 Ge	20 34 As	21 35 Se	22 36 Br	23 37 Kr	24 38 Rb	25 39 Sr	26 40 Y Zr	27 41 Nb Mo	28 42 Tc Ru	29 43 Rh Pd	30 44 Ag Cd	31 45 In Sn	32 46 Sb Te	33 47 I Xe	34 54 Xe	35 55 Cs	36 56 Ba	37 57 La	38 58 Ce	39 59 Pr	40 60 Nd	41 61 Pm	42 62 Sm	43 63 Eu	44 64 Gd	45 65 Tb	46 66 Dy	47 67 Ho	48 68 Er	49 69 Tm	50 70 Yb
	4 K Ca	5 Sc Ti V Cr Mn Fe Co Ni Cu Zn	6 19 K Ca	7 21 Y Zr Nb Mo Tc Ru Rh Pd Ag Cd	8 22 Zr Nb Mo Tc Ru Rh Pd Ag Cd	9 23 Y Zr Nb Mo Tc Ru Rh Pd Ag Cd	10 24 V Cr Mn Fe Co Ni Cu Zn	11 25 Cr Mn Fe Co Ni Cu Zn	12 26 Mn Fe Co Ni Cu Zn	13 27 Fe Co Ni Cu Zn	14 28 Co Ni Cu Zn	15 29 Ni Cu Zn	16 30 Cu Zn	17 31 Zn	18 32 Ga	19 33 Ge	20 34 As	21 35 Se	22 36 Br	23 37 Kr	24 38 Rb	25 39 Sr	26 40 Y Zr	27 41 Nb Mo	28 42 Tc Ru	29 43 Rh Pd	30 44 Ag Cd	31 45 In Sn	32 46 Sb Te	33 47 I Xe	34 54 Xe	35 55 Cs	36 56 Ba	37 57 La	38 58 Ce	39 59 Pr	40 60 Nd	41 61 Pm	42 62 Sm	43 63 Eu	44 64 Gd	45 65 Tb	46 66 Dy	47 67 Ho	48 68 Er	49 69 Tm	50 70 Yb	
	5 K Ca	6 Sc Ti V Cr Mn Fe Co Ni Cu Zn	7 19 K Ca	8 21 Y Zr Nb Mo Tc Ru Rh Pd Ag Cd	9 22 Zr Nb Mo Tc Ru Rh Pd Ag Cd	10 23 Y Zr Nb Mo Tc Ru Rh Pd Ag Cd	11 24 V Cr Mn Fe Co Ni Cu Zn	12 25 Cr Mn Fe Co Ni Cu Zn	13 26 Mn Fe Co Ni Cu Zn	14 27 Fe Co Ni Cu Zn	15 28 Co Ni Cu Zn	16 29 Ni Cu Zn	17 30 Cu Zn	18 31 Zn	19 32 Ga	20 33 Ge	21 34 As	22 35 Se	23 36 Br	24 37 Kr	25 38 Rb	26 39 Sr	27 40 Y Zr	28 41 Nb Mo	29 42 Tc Ru	30 43 Rh Pd	31 44 Ag Cd	32 45 In Sn	33 46 Sb Te	34 47 I Xe	35 54 Xe	36 55 Cs	37 56 Ba	38 57 La	39 58 Ce	40 59 Pr	41 60 Nd	42 61 Pm	43 62 Sm	44 63 Eu	45 64 Gd	46 65 Tb	47 66 Dy	48 67 Ho	49 68 Er	50 69 Tm	51 70 Yb	
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