

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.

Atomic Mass

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Atomic Mass

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Hydrogen



Hydrogen



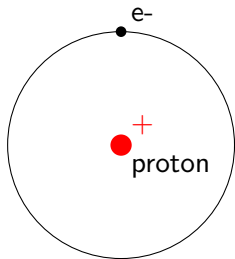
What does the 1 mean?

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?

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What does the 2 mean?

Helium

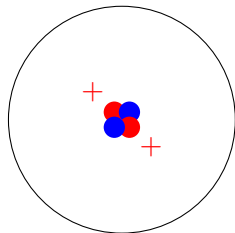


What does the 4 mean?

4 is the total number of neutrons and protons.

What does the 2 mean?

2 is the number of protons.



Helium

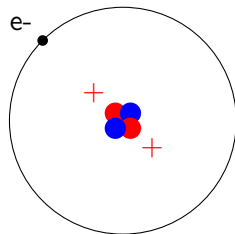


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Helium

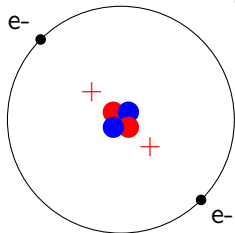


What does the 4 mean?

4 is the total number of neutrons and protons.

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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

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$$7 - 3 =$$



Lithium



How many protons does Lithium have? 3

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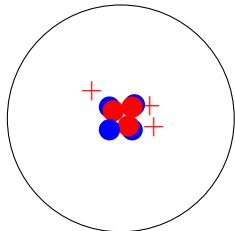
Lithium



How many protons does Lithium have? 3

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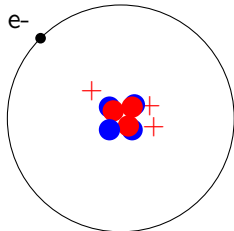
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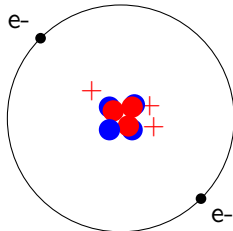
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How many protons does Lithium have? 3

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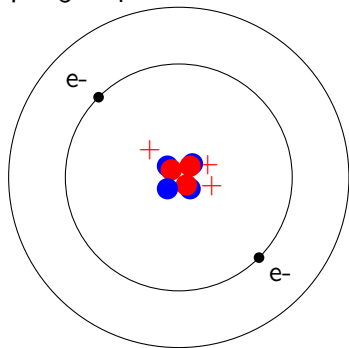
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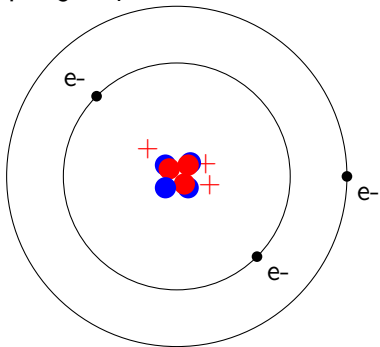
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How many protons does Lithium have? 3

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Niels Bohr



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

Niels Bohr



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

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Energy Levels

The electrons closest to the nucleus have the
further from away have energy.

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Energy Levels

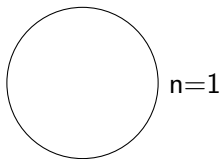
The electrons closest to the nucleus have the **lowest** energy, while those further from away have _____ energy.

Energy Levels

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

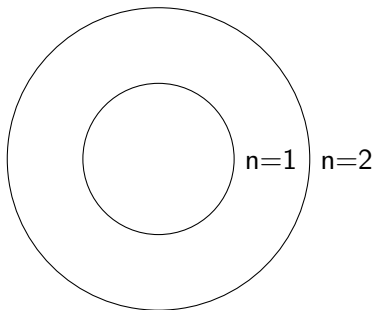
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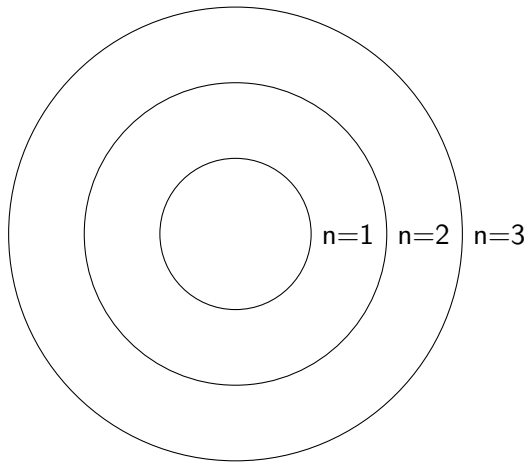
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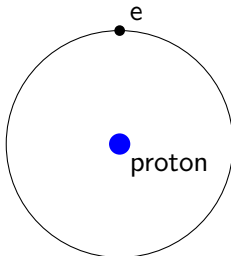
Energy Levels and the Periodic Table

Group ▶	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18																																																																																								
Period ▼																																																																																																										
Nonmetals	1	H																	2	He																																																																																						
Metals	3	Li	4	Be									5	B	6	C	7	N	8	O	9	F	10	Ne																																																																																		
	11	Na	12	Mg	<i>Transition metals</i> (sometimes excluding group 12)								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	39	Y	40	Zr	41	Nb	42	Mo	43	Tc	44	Ru	45	Rh	46	Pd	47	Ag	48	Cd	49	In	50	Sn	51	Sb	52	Te	53	I	54	Xe																																																																						
	55	Cs	56	Ba	La to Yb		71	Hf	72	Ta	73	W	74	Re	75	Os	76	Ir	77	Pt	78	Au	79	Hg	80	81	Tl	82	Pb	83	Bi	84	Po	85	At	86	Rn																																																																					
	87	Fr	88	Ra	Ac to No		103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202
	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																																																																																								

Energy Level of Hydrogen

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18											
Period 1	1 H																	2 He											
Period 2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne											
Period 3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar											
Period 4	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	
Period 5	37 Rb	38 Sr											39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe	
Period 6	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	
Period 7	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)																
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															

Some elements near the dashed staircase are sometimes called metalloids



Energy Level of Lithium

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																	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	Transition metals (sometimes excluding group 12)										31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
	37 Rb	38 Sr	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	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	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	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
	s-block (plus He)		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				

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Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period																		
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Energy Level of Lithium

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Nonmetals	1 H																	2 He										
Metals	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne										
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	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											39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	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									
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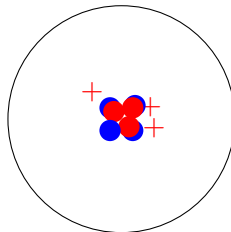
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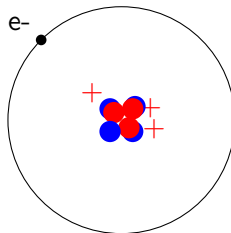
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	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar										
	19 K	20 Ca											21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
	37 Rb	38 Sr											39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	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)															
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 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											39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	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)															
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														

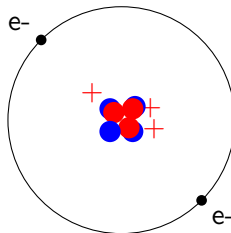
Some elements near the dashed staircase are sometimes called metalloids



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	2																	18
Metals	3	4																	10
	11	12											13	14	15	16	17	18	
	19	20											31	32	33	34	35	36	
	37	38											49	50	51	52	53	54	
	55	56											81	82	83	84	85	86	
	87	88											113	114	115	116	117	118	
	Fr	Ra											Nh	Fl	Mc	Lv	Ts	Og	
	La to Yb																		
	Ac to No																		
	Lr																		
	s-block (plus He)		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					

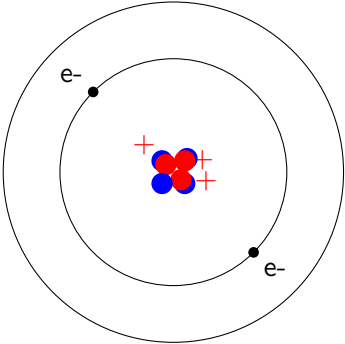
Some elements near the dashed staircase are sometimes called metalloids



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	2																	18
Metals	3	4																	10
	11	12											13	14	15	16	17	18	
	19	20											31	32	33	34	35	36	
	37	38											49	50	51	52	53	54	
	55	56											81	82	83	84	85	86	
	87	88											113	114	115	116	117	118	
	Fr	Ra											Nh	Fl	Mc	Lv	Ts	Og	
	s-block (plus He)		d-block										p-block (excluding He)						
	f-block																		
Lanthanides	57	58	59	60	61	62	63	64	65	66	67	68	69	70					
Actinides	89	90	91	92	93	94	95	96	97	98	99	100	101	102					

Some elements near the dashed staircase are sometimes called metalloids



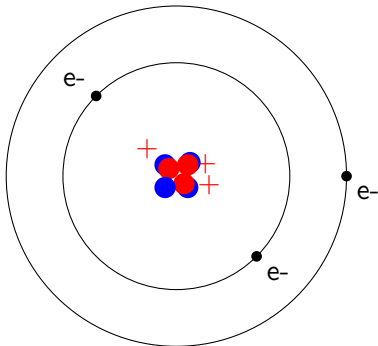
Energy Level of Lithium

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Period	↓																		
Nonmetals	1	2																	18
Metals	3	4																	10
	11	12											13	14	15	16	17	18	
	19	20											31	32	33	34	35	36	
	37	38											49	50	51	52	53	54	
	55	56											81	82	83	84	85	86	
	87	88											113	114	115	116	117	118	
	Fr	Ra											Nh	Fl	Mc	Lv	Ts	Og	
	La to Yb																		
	Ac to No																		
	Lanthanides																		
	Actinides																		

Some elements near the dashed staircase are sometimes called metalloids

Noble gases

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

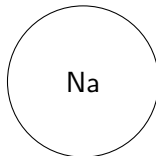


Energy Level of Sodium

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																	2 He	
Metals	3 Li	4 Be												5 B	6 C	7 N	8 O	9 F	10 Ne
	11 Na	12 Mg	Transition metals (sometimes excluding group 12)										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	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	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)						
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 Sodium

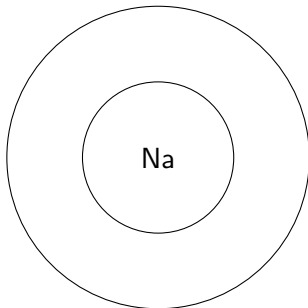
Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Period	1	2																	
Nonmetals	1 H																		
Metals	3 Li	4 Be																	2 He
	11 Na	12 Mg	Transition metals (sometimes excluding group 12)										Some elements near the dashed staircase are sometimes called metalloids						
	19 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	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	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)						
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 Sodium

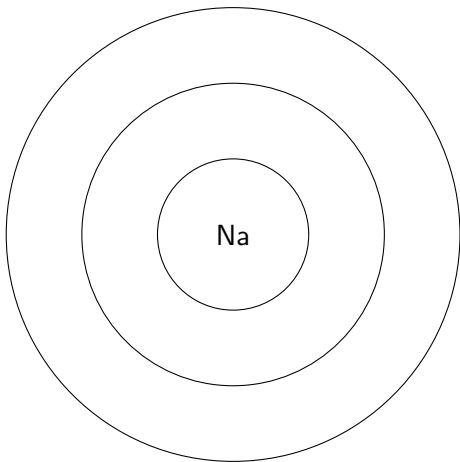
Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Period																		Noble gases	
Nonmetals	1 H																	2 He	
Metals	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne	
	11 Na	12 Mg	Transition metals (sometimes excluding group 12)										13 Al	14 Si	15 P	16 S	17 Cl	18 Ar	
	19 K	20 Ca	21 Sc	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	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	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)						
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					

Some elements near the dashed staircase are sometimes called metalloids



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																																
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											39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	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)																					
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																				



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

Metals

Noble gases

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

Transition metals
(sometimes excluding group 12)

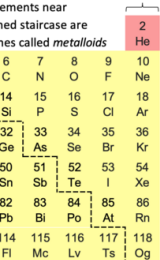
1	2											10	11	12	13	14	15	16	17	18	
H	He											B	C	N	O	F	Ne				
Li	Be											Al	Si	P	S	Cl	Ar				
Na	Mg											Ga	Ge	As	Se	Br	Kr				
K	Ca	21	22	23	24	25	26	27	28	29	30	In	Sn	Sb	Te	I	Xe				
Rb	Sr	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn				
Cs	Ba	La to Yb											113	114	115	116	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				
		Actinides		89	90	91	92	93	94	95	96	97	98	99	100	101	102				
				La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb				
				Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No				

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 H																		2 He	Noble gases																										
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																								
	37 Rb	38 Sr											39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd																								
	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																							
	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																							
	s-block (plus He)		f-block	d-block										p-block (excluding He)																																
Lanthanides	<table border="1"> <tr> <td>57</td><td>58</td><td>59</td><td>60</td><td>61</td><td>62</td><td>63</td><td>64</td><td>65</td><td>66</td><td>67</td><td>68</td><td>69</td><td>70</td> </tr> <tr> <td>La</td><td>Ce</td><td>Pr</td><td>Nd</td><td>Pm</td><td>Sm</td><td>Eu</td><td>Gd</td><td>Tb</td><td>Dy</td><td>Ho</td><td>Er</td><td>Tm</td><td>Yb</td> </tr> </table>																		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
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	<table border="1"> <tr> <td>89</td><td>90</td><td>91</td><td>92</td><td>93</td><td>94</td><td>95</td><td>96</td><td>97</td><td>98</td><td>99</td><td>100</td><td>101</td><td>102</td> </tr> <tr> <td>Ac</td><td>Th</td><td>Pa</td><td>U</td><td>Np</td><td>Pu</td><td>Am</td><td>Cm</td><td>Bk</td><td>Cf</td><td>Es</td><td>Fm</td><td>Md</td><td>No</td> </tr> </table>																		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
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*

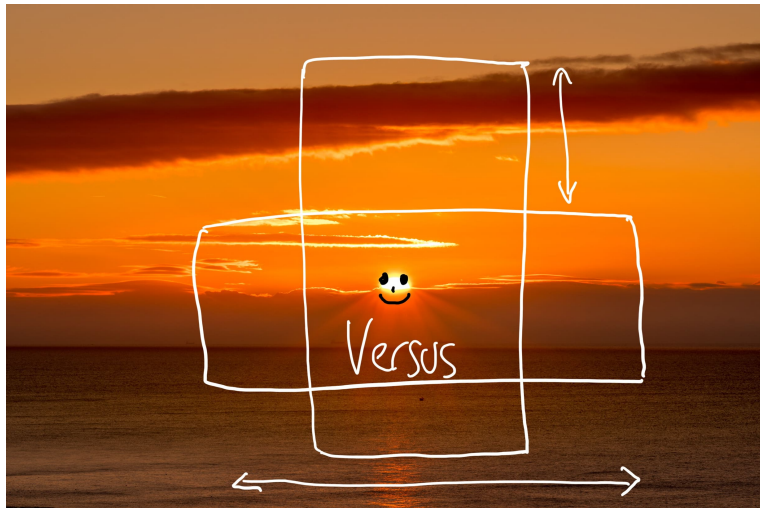


The Periodic Table

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 H																	2 He	Noble gases	
Metals	3 Li	4 Be	Transition metals (sometimes excluding group 12)										5 B	6 C	7 N	8 O	9 F	10 Ne		
	11 Na	12 Mg	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar		
	19 K	20 Ca	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr		
	37 Rb	38 Sr	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	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)							
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				

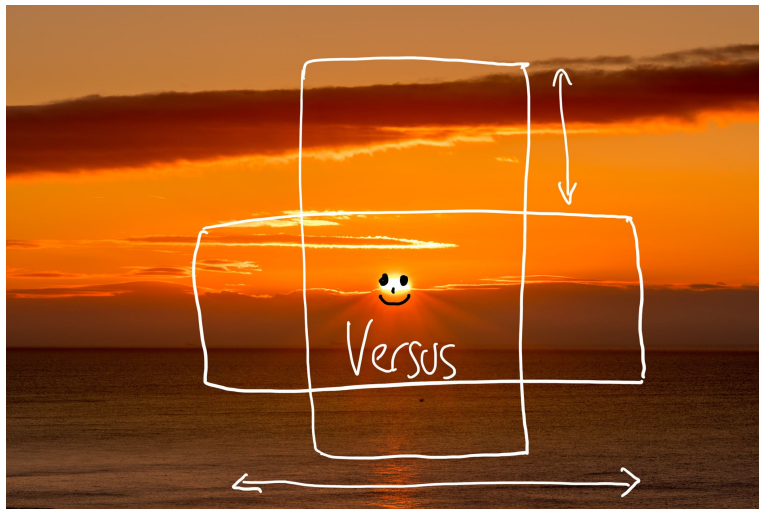
Horizontal and Vertical



The periods are

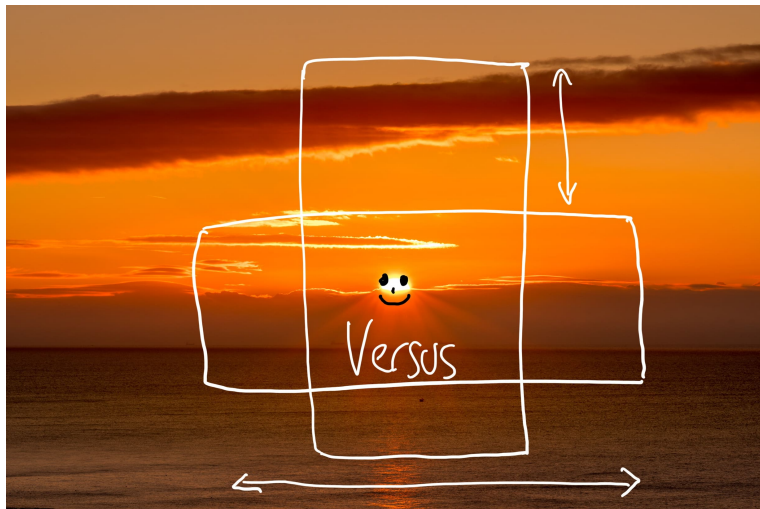
and the groups are

Horizontal and Vertical



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

Horizontal and Vertical

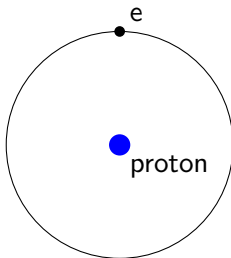


The periods are **horizontal** and the groups are **vertical**.

Energy Level of Hydrogen

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18										
Period 1	1 H																	2 He										
Period 2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne										
Period 3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar										
Period 4	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
Period 5	37 Rb	38 Sr											39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
Period 6	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									
Period 7	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)															
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														

Some elements near the dashed staircase are sometimes called metalloids



You can know the
the periodic table.

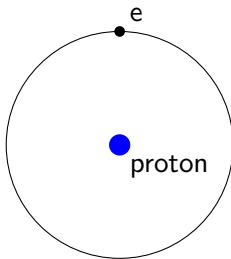
configuration of an element from its

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																																														
Nonmetals	1	2																18																												
Metals	H	He																Ne																												
	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											Nh	Fl	Mc	Lv	Ts	Og																												
	s-block (plus He)		d-block								p-block (excluding He)																																			
Lanthanides	<table border="1"> <tr> <td>57</td><td>58</td><td>59</td><td>60</td><td>61</td><td>62</td><td>63</td><td>64</td><td>65</td><td>66</td><td>67</td><td>68</td><td>69</td><td>70</td> </tr> <tr> <td>La</td><td>Ce</td><td>Pr</td><td>Nd</td><td>Pm</td><td>Sm</td><td>Eu</td><td>Gd</td><td>Tb</td><td>Dy</td><td>Ho</td><td>Er</td><td>Tm</td><td>Yb</td> </tr> </table>																		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
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	<table border="1"> <tr> <td>89</td><td>90</td><td>91</td><td>92</td><td>93</td><td>94</td><td>95</td><td>96</td><td>97</td><td>98</td><td>99</td><td>100</td><td>101</td><td>102</td> </tr> <tr> <td>Ac</td><td>Th</td><td>Pa</td><td>U</td><td>Np</td><td>Pu</td><td>Am</td><td>Cm</td><td>Bk</td><td>Cf</td><td>Es</td><td>Fm</td><td>Md</td><td>No</td> </tr> </table>																		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
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

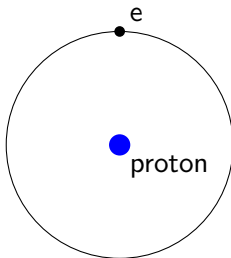


You can know the **electron** configuration of an element from its position in the periodic table.

Energy Level of Hydrogen

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18										
Period 1	1 H																	2 He										
Period 2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne										
Period 3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar										
Period 4	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
Period 5	37 Rb	38 Sr											39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
Period 6	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									
Period 7	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)															
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														

Some elements near the dashed staircase are sometimes called metalloids



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

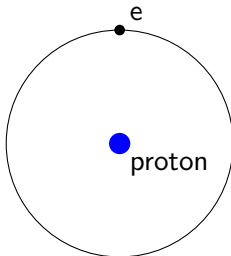
Some elements near the dashed staircase are sometimes called metalloids

Transition metals (sometimes excluding group 12)

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

Lanthanides: La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb

Actinides: Ac, Th, Pa, U, Np, Pu, Am, Cm, Bk, Cf, Es, Fm, Md, No



The number of electron

(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	1	2																	
Nonmetals	1	2																	
Metals	3	4																	
	11	12																	
	19	20																	
	37	38																	
	55	56																	
	87	88																	
	Fr	Ra																	

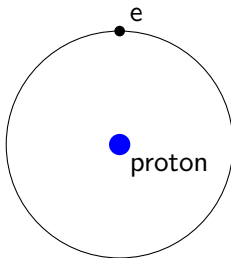
Some elements near the dashed staircase are sometimes called metalloids

Transition metals (sometimes excluding group 12)

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

Lanthanides: 57 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



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	1	2																	2
Nonmetals	1	H																	2
Metals	3	Li	4	Be															He
	11	12																	
	19	20																	
	37	38																	
	55	56																	
	87	88																	
	Fr	Ra																	

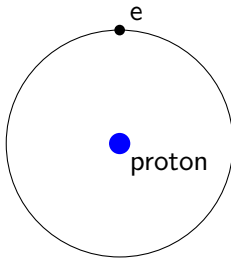
Some elements near the dashed staircase are sometimes called metalloids

Transition metals (sometimes excluding group 12)

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

Lanthanides: 57 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

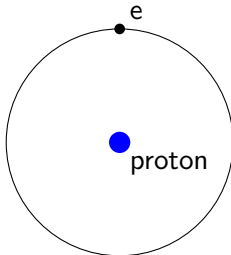


The number of electron shells (or energy levels) is equal to the period number.

Valence Electrons

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Nonmetals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Metals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	H	He																
2	Li	Be	B	C	N	O	F	Ne										
3	Na	Mg	Al	Si	P	S	Cl	Ar										
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
6	Cs	Ba	La to Yb	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
7	Fr	Ra	Ac to No	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	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				
Actinides	89	90	91	92	93	94	95	96	97	98	99	100	101	102				

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



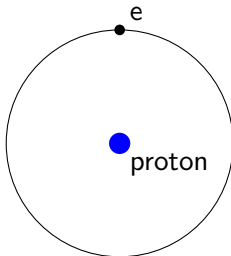
The number of valence electrons is related to the

Valence Electrons

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Nonmetals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Metals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Transition metals																		
Lanthanides																		
Actinides																		

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

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

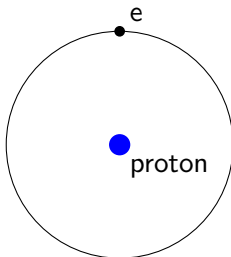


The number of valence electrons is related to the **group** number.

Valence Electrons

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18						
Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18						
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											Tl	Pb	Bi	Po	At	Rn						
7	Fr	Ra											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

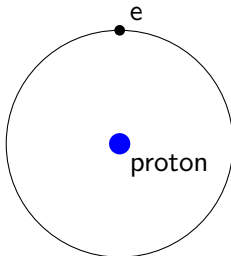


For atoms in groups 1 and 2 the number of valence electrons are equal to the group number.

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																		Noble gases		
1	1 H																	2 He		
2	3 Li	4 Be																		
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	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						



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

For atoms in groups **thirteen to sixteen** 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 1 2 3 4 5 6 7

Nonmetals

Metals

Transition metals (sometimes excluding group 12)

Some elements near the dashed staircase are sometimes called metalloids

Noble gases

s-block (plus He)

f-block

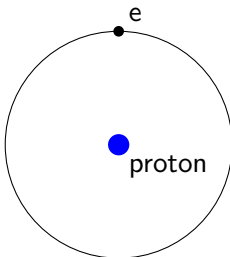
d-block

p-block (excluding He)

Lanthanides

Actinides

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18														
1	2													2																	
3	4											5	6	7	8	9	10														
11	12	Transition metals										13	14	15	16	17	18														
19	20											31	32	33	34	35	36														
37	38											49	50	51	52	53	54														
55	56	La to Yb									Ag		Se		Br		Kr														
57	58	Lanthanides										Au		Hg		Tl		Pb		Bi		Po		At		Rn					
87	88	Ac to No									Pt		Au		Hg		Tl		Pb		Bi		Po		At		Rn				
89	90	Actinides										Ir		Pt		Au		Hg		Tl		Pb		Bi		Po		At		Rn	



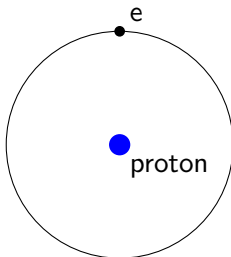
For atoms in groups **one** and **two**, the number of are equal to the group number.

For atoms in groups **three** to **ten** the number of 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																			
1	1 H																	2 He	
2	3 Li	4 Be																	
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					

Some elements near the dashed staircase are sometimes called metalloids



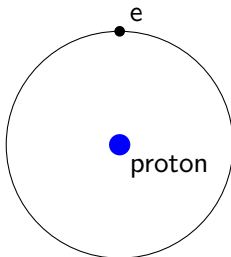
For atoms in groups **one** and **two**, the number of **valence** electrons are equal to the group number.

For atoms in groups **three** to **ten**, 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																		Noble gases	
1	1 H																	2 He	
2	3 Li	4 Be																	
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					

Some elements near the dashed staircase are sometimes called metalloids



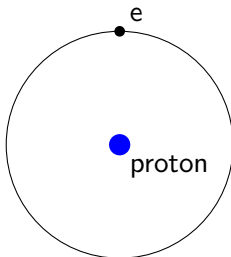
For atoms in groups **one** and **two**, the number of **valence** electrons are equal to the group number.

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																		Noble gases						
1	1 H																		2 He					
2	3 Li	4 Be																						
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

Some elements near the dashed staircase are sometimes called metalloids



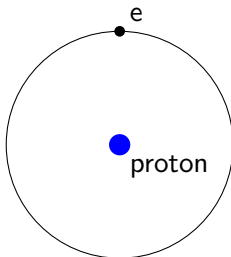
For atoms in groups **one** and **two**, the number of **valence** electrons are equal to the group number.

For atoms in groups **13** to **18**, the number of _____ 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																		Noble gases	
1	1 H																	2 He	
2	3 Li	4 Be																	
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					

Some elements near the dashed staircase are sometimes called metalloids



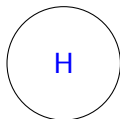
For atoms in groups **one** and **two**, the number of **valence** electrons are equal to the group number.

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

Valence Electrons of H

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Period																			
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										Tl	Pb	Bi	Po	At	Rn	
7	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					

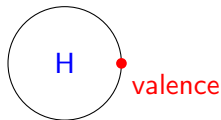
Some elements near the dashed staircase are sometimes called *metalloids*



Valence Electrons of H

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Period 1	1 H																	2 He	
Period 2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne	
Period 3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar	
Period 4	19 K	20 Ca	Transition metals (sometimes excluding group 12)										31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr	
Period 5	37 Rb	38 Sr	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe	
Period 6	55 Cs	56 Ba	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn	
Period 7	87 Fr	88 Ra	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 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 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			

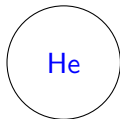
Some elements near the dashed staircase are sometimes called *metalloids*



Valence Electrons of He

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	<i>Transition metals</i> (sometimes excluding group 12)										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	
	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					

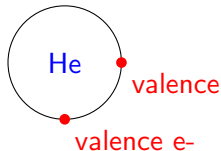
Some elements near the dashed staircase are sometimes called *metalloids*



Valence Electrons of He

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Period																			
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										Tl	Pb	Bi	Po	At	Rn	
7	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					

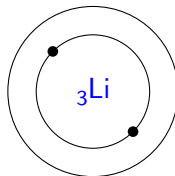
Some elements near the dashed staircase are sometimes called *metalloids*



Valence Electrons of Li

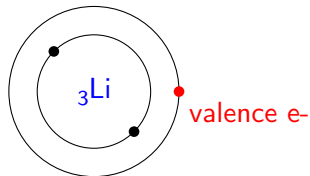
Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Nonmetals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Metals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
	H	He	Li	Be	B	C	N	O	F	Ne	Na	Mg	Al	Si	P	S	Cl	Ar	
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
	Cs	Ba	La to Yb	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
	Fr	Ra	Ac to No	Lr	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	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



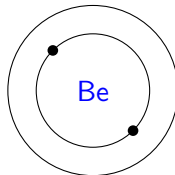
Valence Electrons of Li

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Period																				
1	H	He																		
2	Li	Be	B	C	N	O	F	Ne												
3	Na	Mg	Al	Si	P	S	Cl	Ar												
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr		
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe		
6	Cs	Ba	La to Yb	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn		
7	Fr	Ra	Ac to No	Lr	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	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						



Valence Electrons of Be

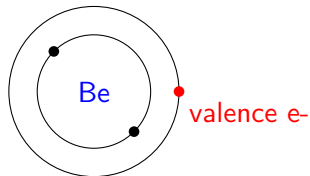
Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Period																				
1	H	He																		
2	Li	Be	B	C	N	O	F	Ne												
3	Na	Mg	Al	Si	P	S	Cl	Ar												
4	K	Ca	Transition metals (sometimes excluding group 12)							Ga	Ge	As	Se	Br	Kr					
5	Rb	Sr								In	Sn	Sb	Te	I	Xe					
6	Cs	Ba	Lanthanides (La to Yb)									Tl	Pb	Bi	Po	At	Rn			
7	Fr	Ra	Actinides (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				
Actinides			89	90	91	92	93	94	95	96	97	98	99	100	101	102				



Valence Electrons of Be

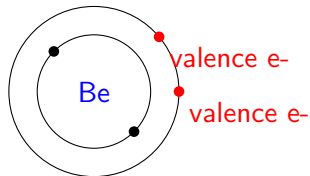
Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Period																			
1	H	He																	
2	Li	Be											B	C	N	O	F	Ne	
3	Na	Mg											Al	Si	P	S	Cl	Ar	
4	K	Ca											Ga	Ge	As	Se	Br	Kr	
5	Rb	Sr											In	Sn	Sb	Te	I	Xe	
6	Cs	Ba	La to Yb										Hg	Tl	Pb	Bi	Po	At	Rn
7	Fr	Ra	Ac to No										Cn	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



Valence Electrons of Be

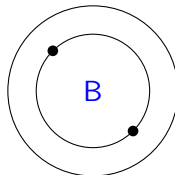
Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Period																			
1	H	He																	
2	Li	Be	B	C	N	O	F	Ne											
3	Na	Mg	Al	Si	P	S	Cl	Ar											
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
6	Cs	Ba	La to Yb	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
7	Fr	Ra	Ac to No	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	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					



Valence Electrons of B

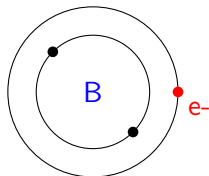
Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Period																			
1	H	He																	
2	Li	Be											B	C	N	O	F	Ne	
3	Na	Mg											Al	Si	P	S	Cl	Ar	
4	K	Ca											Ga	Ge	As	Se	Br	Kr	
5	Rb	Sr											In	Sn	Sb	Te	I	Xe	
6	Cs	Ba	La to Yb										Tl	Pb	Bi	Po	At	Rn	
7	Fr	Ra	Ac to No										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



Valence Electrons of B

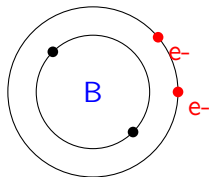
Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Nonmetals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Metals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
	H	He	Li	Be	B	C	N	O	F	Ne	Na	Mg	Al	Si	P	S	Cl	Ar	
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
	Cs	Ba	La to Yb	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
	Fr	Ra	Ac to No	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	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					



Valence Electrons of B

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	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Metals																					
	H	He	Li	Be	B	C	N	O	F	Ne	Na	Mg	Al	Si	P	S	Cl	Ar			
			K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
			Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
			Cs	Ba	La to Yb	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
			Fr	Ra	Ac to No	Lr	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	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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Valence Electrons of B

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Period																				
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										Tl	Pb	Bi	Po	At	Rn		
7	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						
Actinides	89	90	91	92	93	94	95	96	97	98	99	100	101	102						

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