



# Chapter 4

## The Periodic Table




# 4 – I Introduction to the Periodic Table


# Development of the Periodic Table

- Early man was familiar with a few elements.
  - Gold and Silver were used for coins.
  - Copper, Tin and Iron were used for weapons.

# Dmitri Mendeleev


- Russian Chemist.
- Published the first version of the Periodic Table in 1896.

- 
- Arranged the elements in order of increasing atomic mass.
  - He noticed that the properties of the elements seemed to repeat in a pattern.

- 
- He placed the elements onto a table.
  - He kept the same properties in vertical columns called “Groups”.

# Mendeleev's Periodic Table of 1871<sup>1</sup>

	I --- R <sub>2</sub> O	II --- RO	III --- R <sub>2</sub> O <sub>3</sub>	IV RH <sub>4</sub> RO <sub>2</sub>	V RH <sub>3</sub> R <sub>2</sub> O <sub>3</sub>	VI RH <sub>2</sub> RO <sub>3</sub>	VII RH R <sub>2</sub> O <sub>7</sub>	VIII --- RO <sub>4</sub>
1	H 1							
2	Li 7	Be 9.4	B 11	C 12	N 14	O 16	F 19	
3	Na 23	Mg 24	Al 27.3	Si 28	P 31	S 32	Cl 35.5	
4	K 39	Ca 40	? 44	Ti 48	V 51	Cr 52	Mn 55	Fe, Co, Ni, Cu 56, 59, 59, 63
5	Cu 63	Zn 65	? 68	? 72	As 75	Se 78	Br 80	
6	Rb 85	Sr 87	? Yt 88	Zr 90	Nb 94	Mo 96	? 100	Ru, Rh, Pd, Ag 104, 104, 106, 108
7	Ag 108	Cd 112	In 113	Sn 118	Sb 122	Te 125	I 127	
8	Cs 133	Ba 137	? Di 138	? Ce 140	? ?	? ?	? ?	?, ?, ?, ?
9	? ?	? ?	? ?	? ?	? ?	? ?	? ?	
10	? ?	? ?	? Er 178	?? La 180	Ta 182	W 184	? ?	Os, Ir, Pt, Au 195, 197, 198, 199
11	Au 199	Hg 200	Tl 204	Pb 207	Bi 208	? ?	? ?	
12	? ?	? ?	? ?	Th 231	? ?	U 240	? ?	

- 
- He left blanks for elements that had yet to be discovered.
  - He predicted the properties of those elements.
  - This led to their discovery.



# Henry Moseley

- English Physicist
- Improved upon Mendeleev's work in 1913.
- Ordered the Periodic Table by Atomic Number.

# Periodic Table of Elements

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Representative elements

Alkali metals    Alkaline earth metals

1    2

Group 1A    Group 2A

Period number

1	1 H 1.008	2 He 4.003	Transition elements										13 Group 3A	14 Group 4A	15 Group 5A	16 Group 6A	17 Group 7A	18 Group 8A
2	3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 98	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	57* La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po 209	85 At 210	86 Rn 222
7	87 Fr 223	88 Ra 226	89* Ac 227	104 Rf 261	105 Db 262	106 Sg 263	107 Bh 262	108 Hs 265	109 Mt 266	110 — 269	111 — 272	112 — 277		114 — 289				

Halogens    Noble gases

↓    ↓

\*Lanthanides

†Actinides

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm 145	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231	92 U 238.0	93 Np 237	94 Pu 244	95 Am 243	96 Cm 247	97 Bk 247	98 Cf 251	99 Es 252	100 Fm 257	101 Md 258	102 No 259	103 Lr 260

Metals

Metalloids

Nonmetals

# Today's Periodic Table

- Periodic – Repeating in a pattern.

# Groups

- Groups – the vertical columns in the table.
  - Numbered 1 – 18.

# Alkali Metals

H
Li
Na
K
Rb
Cs
Fr

# Alkaline Earth

Be
Mg
Ca
Sr
Ba
Ra

# Transition

Sc	Ti
Y	Zr
*	Hf
+	

# Periods

- Periods – The horizontal rows in the table.
  - Numbered 1 – 7.

# Periodic Table of Elements

Representative elements

Period number	Alkali metals ↓ Group 1A		Alkaline earth metals ↓ Group 2A										Halogens ↓ Group 7A					Noble gases ↓ Group 8A
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	H 1.008																He 4.002	
2	Li 6.941	Be 9.012	Transition elements										B 10.81	C 12.01	N 14.01	O 16.00	F 19.00	Ne 20.18
3	Na 22.99	Mg 24.31	3B	4B	5B	6B	7B	8B		11B	12B	Al 26.98	Si 28.09	P 30.97	S 32.06	Cl 35.45	Ar 39.95	
4	K 39.10	Ca 40.08	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga 69.72	Ge 72.59	As 74.92	Se 78.96	Br 79.90	Kr 83.80
5	Rb 85.47	Sr 87.62	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In 114.8	Sn 118.7	Sb 121.8	Te 127.6	I 126.9	Xe 131.3
6	Cs 132.9	Ba 137.3	57* La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl 204.4	Pb 207.2	Bi 209.0	Po 209	At 210	Rn 222
7	Fr 223	Ra 226	89* Ac	Rf	Db	Sg	Bh	Hs	Mt	—	—	—	—	114 —	—	—	—	—

\*Lanthanides

†Actinides

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce 140.1	Pr 140.9	Nd 144.2	Pm 145	Sm 150.4	Eu 152.0	Gd 157.3	Tb 158.9	Dy 162.5	Ho 164.9	Er 167.3	Tm 168.9	Yb 173.0	Lu 175.0
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th 232.0	Pa 231	U 238.0	Np 237	Pu 244	Am 243	Cm 247	Bk 247	Cf 251	Es 252	Fm 257	Md 258	No 259	Lr 260

Metals
  Metalloids
  Nonmetals

# Atomic Number

- Atomic Number – the number of protons in the nucleus.
- The largest (font size) whole number in the square on the Periodic Table of Elements.



H



HYDROGEN

1.01 .089<sup>G</sup>/<sub>L</sub>

-259 -253

Be

4

BERYLLIUM

9.01


1.85


1278

2970

# Chemical Symbol

- Chemical Symbol – The shorthand way to write the name of an element.
- The first letter is always capitalized, the following letter(s) is lower case.

- 
- Used the first letter if it was available.
  - Used the second letter if the first was already taken.
  - If the first two letters were taken, then a different second letter is taken out of the name.

- 
- Some elements were discovered when Latin or Greek was the official language of science.
    - They use the letters from the Latin version.
    - Sodium – Na

- 
- Some were named after famous people, or places.

H

HYDROGEN

1.01 .089<sup>G</sup>/<sub>L</sub>

-259 -253

Be

4

BERYLLIUM

9.01      1.85

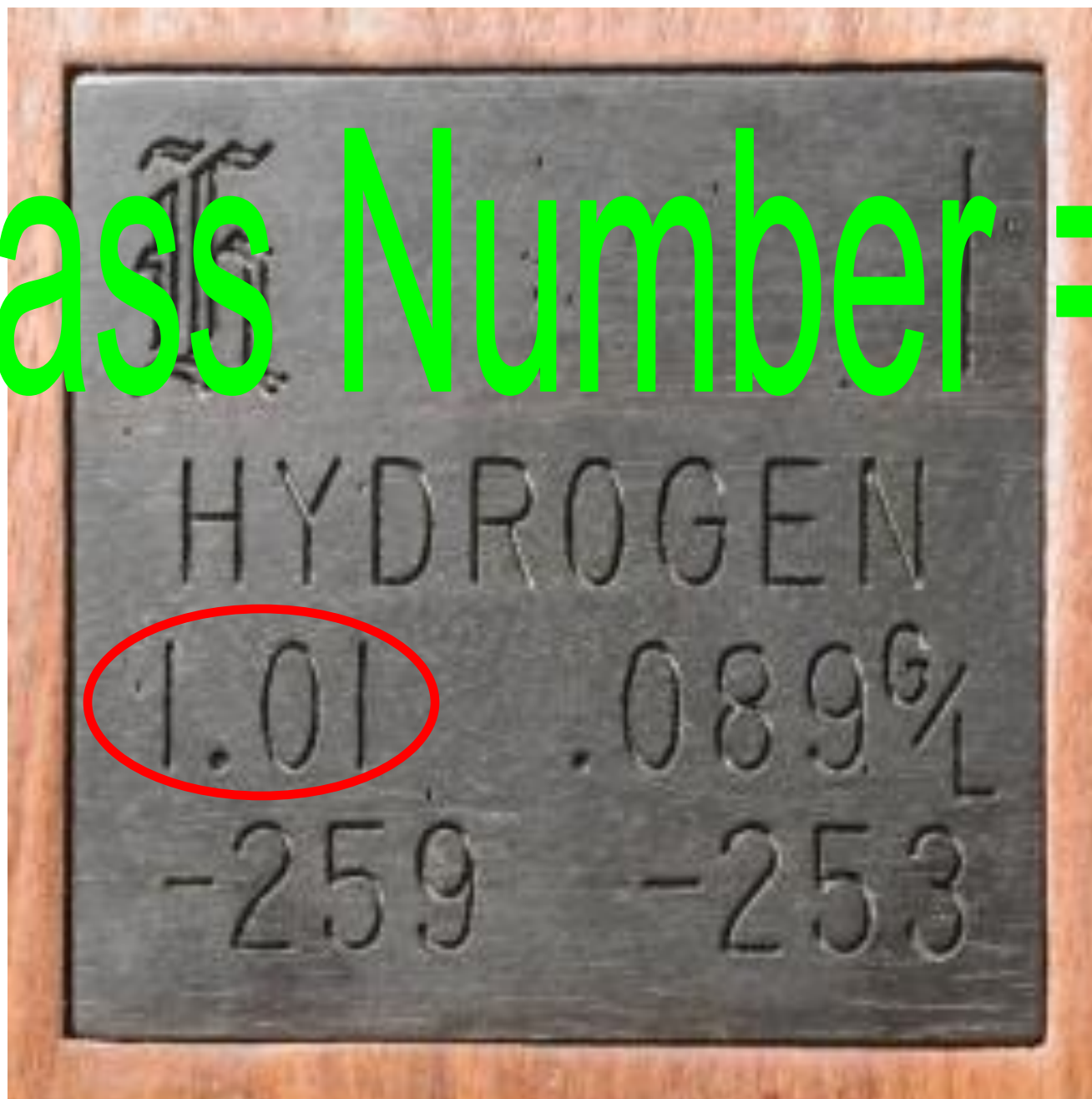
1278      2970



# Mass Number

- Mass Number – the sum of the number of Protons and Neutrons in the nucleus of an atom.
- It is found by rounding the Average Atomic Mass to a whole number.

Mass Number = 1



Mass Number = 9



# Zones on the Periodic Table

- Representative Elements –  
Groups 1, 2, 13 – 18.
- Transition Elements –  
Groups 3 – 12.
- Inner Transition Elements –  
Lanthanide and Actinide  
Series.

# Periodic Table of Elements

Representative elements

Period number	Alkali metals ↓ Group 1A		Transition elements										Halogens ↓ Group 17A					Noble gases ↓ Group 18A
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	H 1.008																	He 4.003
2	Li 6.941	Be 9.012											B 10.81	C 12.01	N 14.01	O 16.00	F 19.00	Ne 20.18
3	Na 22.99	Mg 24.31	3B	4B	5B	6B	7B	8B		11B	12B	Al 26.98	Si 28.09	P 30.97	S 32.06	Cl 35.45	Ar 39.95	
4	K 39.10	Ca 40.08	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga 69.72	Ge 72.59	As 74.92	Se 78.96	Br 79.90	Kr 83.80
5	Rb 85.47	Sr 87.62	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In 114.8	Sn 118.7	Sb 121.8	Te 127.6	I 126.9	Xe 131.3
6	Cs 132.9	Ba 137.3	57* La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl 204.4	Pb 207.2	Bi 209.0	Po 209	At 210	Rn 222
7	Fr 223	Ra 226	89* Ac	Rf	Db	Sg	Bh	Hs	Mt	—	—	—	—	114 — 289				

\*Lanthanides

†Actinides

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm 145	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231	92 U 238.0	93 Np 237	94 Pu 244	95 Am 243	96 Cm 247	97 Bk 247	98 Cf 251	99 Es 252	100 Fm 257	101 Md 258	102 No 259	103 Lr 260

Metals
  Metalloids
  Nonmetals

# Metals

- Most are solids at room temperature.
- Only one is a liquid at room temperature - Mercury

- Most are shiny ( **Luster** ), good conductors, can be pounded ( **Malleable** ), and can be drawn into wires ( **Ductile** ).
- Found to the left of the “**Stair-Step Line**”.

# Periodic Table of Elements

Representative elements

	Alkali metals ↓ Group 1A		Transition elements										Halogens ↓ Group 7A					Noble gases ↓ Group 8A
Period number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Group 1A	Group 2A	3B	4B	5B	6B	7B	8B			1B	2B	Group 3A	Group 4A	Group 5A	Group 6A	Group 7A	Group 8A
1	1 H 1.008	2											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
2	3 Li 6.941	4 Be 9.012											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
3	11 Na 22.99	12 Mg 24.31	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
4	19 K 39.10	20 Ca 40.08	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
5	37 Rb 85.47	38 Sr 87.62	57* La	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
6	55 Cs 132.9	56 Ba 137.3	89† Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110	111	112	114	114	114	114	114	114
7	87 Fr 223	88 Ra 226	103	104	105	106	107	108	109	110	111	112	114	114	114	114	114	114

\*Lanthanides

†Actinides

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm 145	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
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Metals



Metalloids



Nonmetals



# Nonmetals

- Most are gases or brittle solids at room temperature.
- Most do not conduct heat nor electricity well.
- Found to the right of the “Stair-Step Line”

# Periodic Table of Elements

Representative elements

	Alkali metals ↓ Group 1A		Transition elements										Halogens ↓ Group 7A					Noble gases ↓ Group 8A
Period number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Group 1A	Group 2A	3B	4B	5B	6B	7B	8B			1B	2B	Group 3A	Group 4A	Group 5A	Group 6A	Group 7A	Group 8A
1	1 H 1.008	2											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
2	3 Li 6.941	4 Be 9.012											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
3	11 Na 22.99	12 Mg 24.31	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
4	19 K 39.10	20 Ca 40.08	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
5	37 Rb 85.47	38 Sr 87.62	57* La	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
6	55 Cs 132.9	56 Ba 137.3	89† Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110	111	112	114	114	114	114	114	114
7	87 Fr 223	88 Ra 226	103	104	105	106	107	108	109	110	111	112	114	114	114	114	114	114

\*Lanthanides

†Actinides

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm 145	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231	92 U 238.0	93 Np 237	94 Pu 244	95 Am 243	96 Cm 247	97 Bk 247	98 Cf 251	99 Es 252	100 Fm 257	101 Md 258	102 No 259	103 Lr 260

Metals
  Metalloids
  Nonmetals

# Metalloids

- They have properties of both metals and nonmetals
- Found along the “Stair-Step Line”

# Periodic Table of Elements

Representative elements

	Alkali metals ↓ Group 1A		Transition elements										Halogens ↓ Group 7A					Noble gases ↓ Group 8A
Period number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H 1.008	2 He 4.003											3 B 10.81	4 C 12.01	5 N 14.01	6 O 16.00	7 F 19.00	8 Ne 20.18
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3	11 Na 22.99	12 Mg 24.31	3 B 10.81	4 C 12.01	5 N 14.01	6 O 16.00	7 F 19.00	8 Ne 20.18	9 Na 22.99	10 Mg 24.31	11 Al 26.98	12 Si 28.09	13 P 30.97	14 S 32.06	15 Cl 35.45	16 Ar 39.95	17 K 39.10	18 Ca 40.08
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 98	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	57* La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po 209	85 At 210	86 Rn 222
7	87 Fr 223	88 Ra 226	89† Ac 227	104 Rf 261	105 Db 262	106 Sg 263	107 Bh 262	108 Hs 265	109 Mt 266	110 —	111 —	112 —	113 —	114 —	115 —	116 —	117 —	118 —

\*Lanthanides

†Actinides

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90 Th 232.0	91 Pa 231	92 U 238.0	93 Np 237	94 Pu 244	95 Am 243	96 Cm 247	97 Bk 247	98 Cf 251	99 Es 252	100 Fm 257	101 Md 258	102 No 259	103 Lr 260



Metals



Metalloids



Nonmetals