

# Periodic Table



# I Can Statements

At the end of this lesson, you should be able to say, with confidence:

- I can use the periodic table to determine whether an element is a metal, nonmetal, or metalloid, as well as its state of matter at room temperature.
- I can use the periodic table to determine the number of protons, neutrons, and electrons of the most abundant isotope of any element.

# Alchemy

In ancient times, people called alchemists experimented with various materials trying to turn common metals into gold.

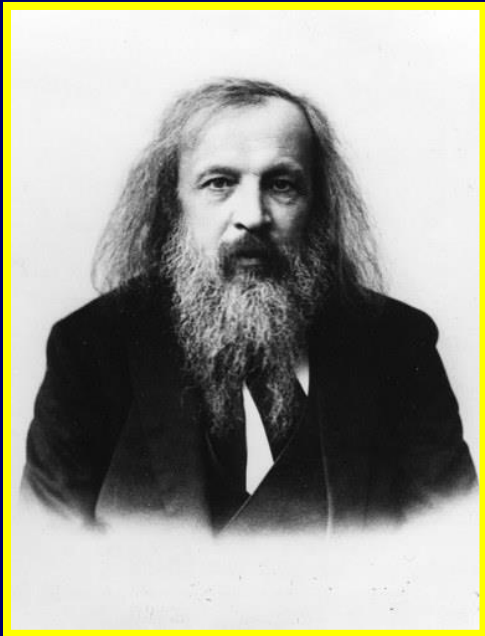


They also tried to find a potion or a mineral that would cure all illnesses and provide immortality.

Philosopher Stone

# Modern Chemistry

By the 1800's, several elements had been discovered but their connections to each other were not well understood.



In 1869, a Russian chemist, named Dimitri Mendeleev, discovered a periodic pattern in atomic behavior.

# Dimitri Mendeleev

Mendeleev began grouping the elements based on the patterns he discovered, to create the first Periodic Table.

Reihen	Gruppe I. — R'O	Gruppe II. — RO	Gruppe III. — R'O <sup>3</sup>	Gruppe IV. RH <sup>4</sup> RO <sup>2</sup>	Gruppe V. RH <sup>3</sup> R'O <sup>3</sup>	Gruppe VI. RH <sup>2</sup> RO <sup>3</sup>	Gruppe VII. RH R'O <sup>2</sup>	Gruppe VIII. — RO <sup>4</sup>
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=56, Co=59, Ni=59, Cu=63.
5	(Cu=63)	Zn=65	—=68	—=72	As=75	So=78	Br=80	
6	Rb=86	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	—=100	Ru=104, Rh=104, Pd=106, Ag=108.
7	(Ag=108)	Cd=112	In=113	Sn=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140	—	—	—	— — — —
9	(—)	—	—	—	—	—	—	
10	—	—	?Er=178	?La=180	Ta=182	W=184	—	Os=195, Ir=197, Pt=198, Au=199.
11	(Au=199)	Hg=200	Tl=204	Pb=207	Bi=208	—	—	
12	—	—	—	Th=231	—	U=240	—	— — — —



# Periodic Table

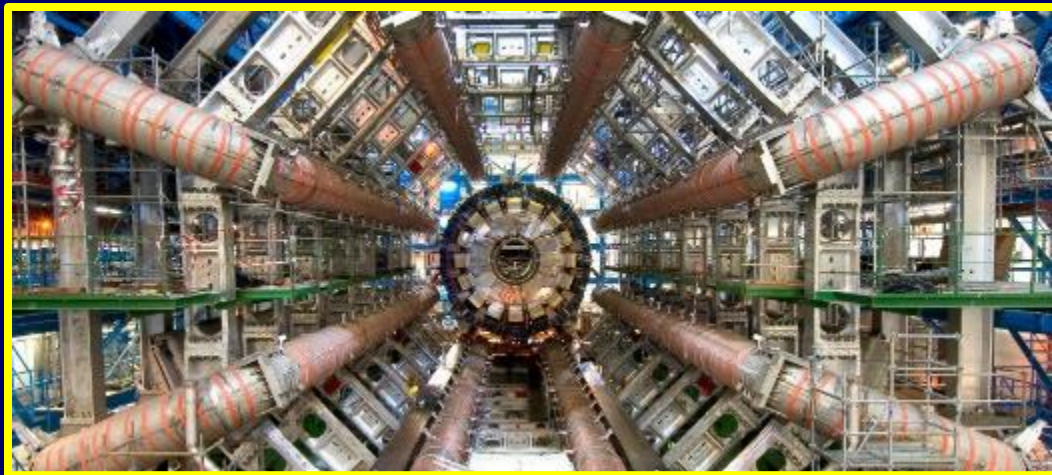
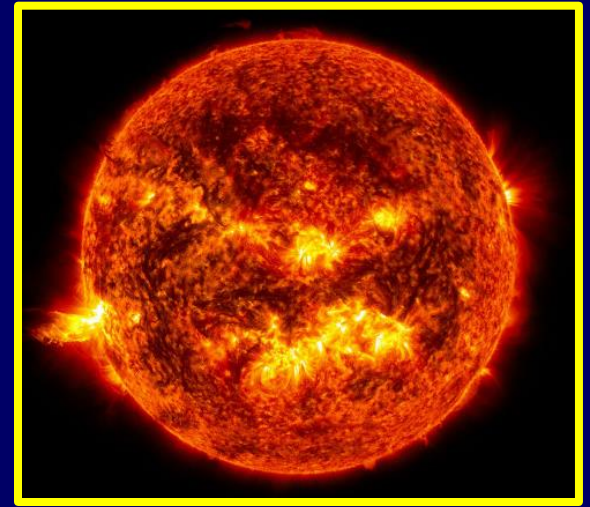
Over time, as more elements were discovered and scientist's understanding of atoms increased, the modern day Periodic table was created.

Periodic Table of the Elements

1 H 1.008																	2 He 4.003														
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														
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95														
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.71	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														
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														
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)														
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Ha (262)	106 Unh (263)	107 Uns (262)	109 Uue (267)																								
																		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 231.0	92 U 238.0	93 Np (244)	94 Pu (244)	95 Am (247)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

# 118 Elements

Currently there are 118 elements, 92 of which are formed through natural means within stars.



The other 26 elements are man-made within particle accelerators.

# Number of Protons

Because the number of protons is unique to each element, on the periodic table, elements are arranged according to their number of protons.

1																	18
1 H Hydrogen	2											13 5 B Boron	14 6 C Carbon	15 7 N Nitrogen	16 8 O Oxygen	17 9 F Fluorine	18 10 Ne Neon
3 Li Lithium	4 Be Beryllium	3	4	5	6	7	8	9	10	11	12	13 13 Al Aluminum	14 14 Si Silicon	15 15 P Phosphorus	16 16 S Sulfur	17 17 Cl Chlorine	18 18 Ar Argon
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton



# Groups of Elements

Based on their common characteristics that repeat periodically, elements are placed into columns or groups.

1																	18
1 H Hydrogen	2											13	14	15	16	17	2 He Helium
3 Li Lithium	4 Be Beryllium											5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon
11 Na Sodium	12 Mg Magnesium	3	4	5	6	7	8	9	10	11	12	13 Al Aluminum	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton

There are 18 groups of elements.

# Metals

Elements are also grouped, on the periodic table, according to if they are metals, nonmetals, or metalloids.

**Periodic Table of the Elements**

Metals  
 Nonmetals  
 Metalloids

1 H 1.008																	2 He 4.003
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
11 Na 23.00	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.70	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
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
55 Cs 132.9	56 Ba 137.3	57 La 138.9	58 Ce 178.5	59 Pr 180.9	60 Nd 183.9	61 Pm 186.2	62 Sm 190.2	63 Eu 192.2	64 Gd 195.1	65 Tb 197.0	66 Dy 200.6	67 Ho 204.4	68 Er 207.2	69 Tm 209.0	70 Yb (209)	71 Lu (210)	
87 Fr (223)	88 Ra (226)	89 Ac (227)	90 Th (261)	91 Pa (262)	92 U (263)	93 Np (263)	94 Pu (262)	95 Am (262)	96 Cm (262)	97 Bk (262)	98 Cf (262)	99 Es (262)	100 Fm (262)	101 Md (262)	102 No (262)	103 Lr (262)	
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 231.0	92 U 238.0	93 Np 237.0	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)				

The majority of elements are metals and are located on the left-hand side of the table.

# Nonmetals and Metalloids

The nonmetals are located on the right-hand side of the table, except for hydrogen.

Periodic Table of the Elements

Legend:  
■ Metals (Blue)  
■ Nonmetals (Yellow)  
■ Metalloids (Pink)

1 H 1.008																	2 He 4.003
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
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
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87 Fr (223)	88 Ra (226)	89 Ac (227)	90 Th (232)	91 Pa (231)	92 U (238)	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)	
			109 Unk (223)	110 Unk (226)	111 Unk (227)	112 Unk (228)	113 Unk (229)	114 Unk (232)	115 Unk (233)	116 Unk (236)	117 Unk (238)	118 Unk (243)	119 Unk (244)	120 Unk (247)	121 Unk (250)	122 Unk (253)	

Metalloids are elements that share characteristics with both metals and nonmetals.

Metalloids are located along what is called the Stair-Step Line.

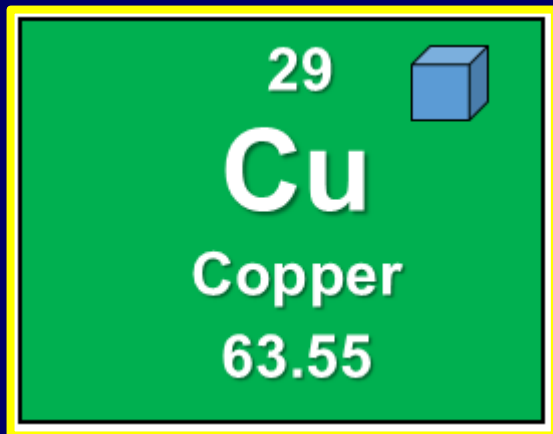
# Informational Box

Each element is given its own informational box on the periodic table.

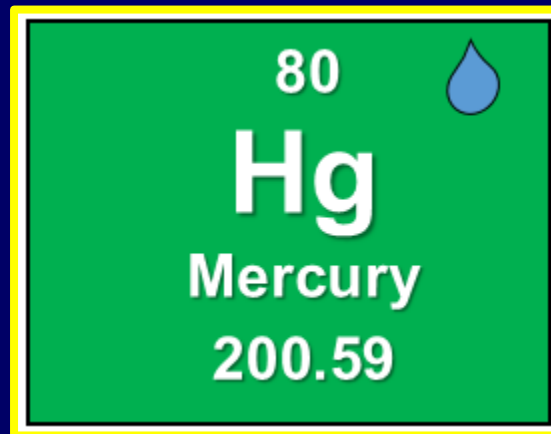
<b>Atomic Number</b>	→	8
<b>Chemical Symbol</b>	→	O
<b>Element Name</b>	→	Oxygen
<b>Average Atomic Mass</b>	→	16.00

# Solid, Liquid, or Gas

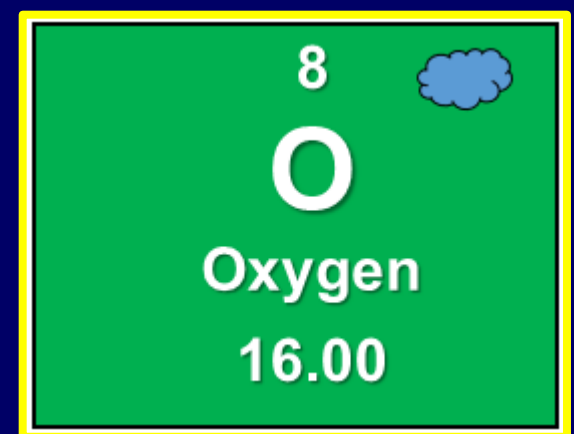
Some periodic tables may include a symbol to indicate whether the element is a solid, liquid, or gas at room temperature.



Solid



Liquid

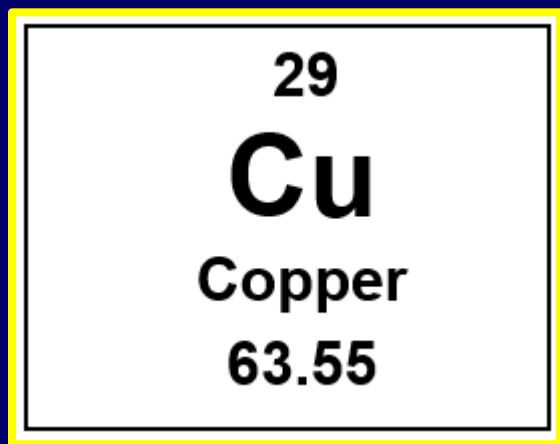


Gas

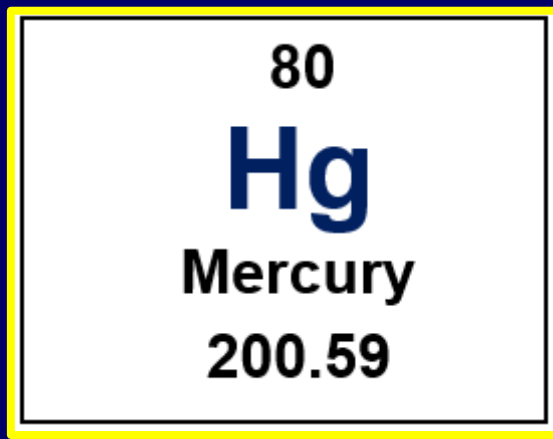


# Solid, Liquid, or Gas

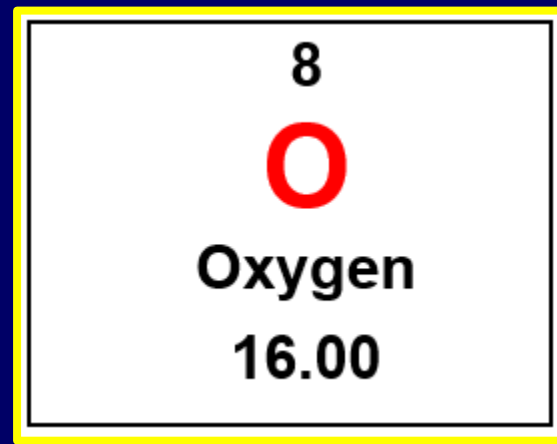
Other periodic tables may use colors to indicate whether the element is a solid, liquid, or gas at room temperature.



Solid



Liquid



Gas

# Atomic Number

The atomic number on the periodic table is equal to the number of protons in any element.

Atomic Number	8
	O
	Oxygen
	16.00

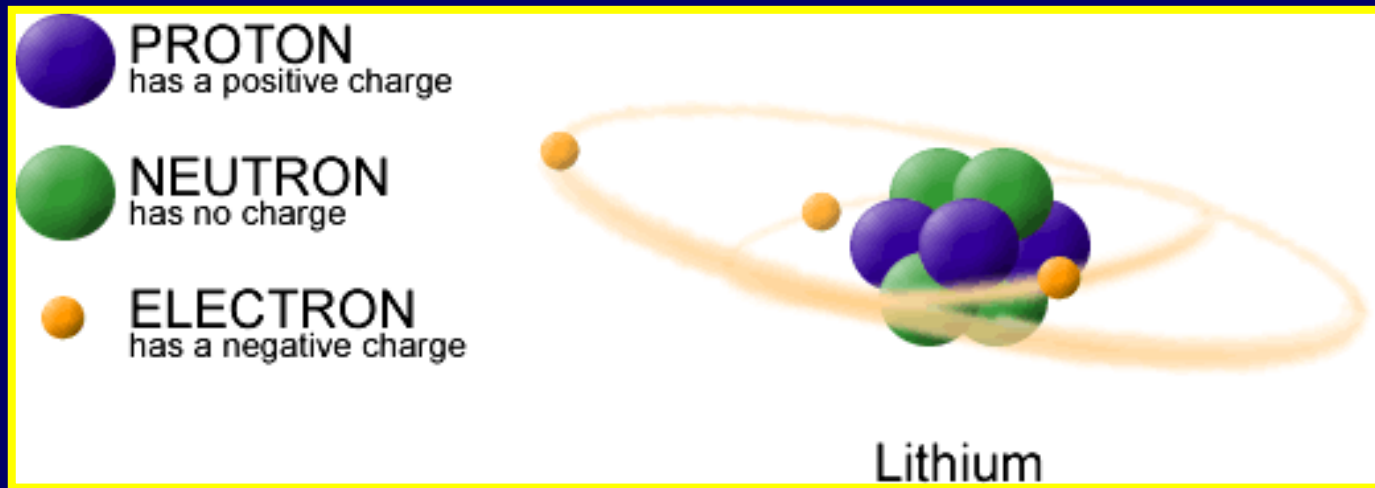
However, the atomic number is also equal to the number of electrons in an element.





# Mass Number

The atomic mass for any atom is equal to the total number of protons and neutrons in an atom and is known as its mass number.



This lithium atom has 3 protons and 4 neutrons, so it has a mass number of 7.



# Average Atomic Mass

On the periodic table, an Average Atomic Mass is given that includes a number with a decimal point.

Atomic Number	→	3
Chemical Symbol	→	Li
Element Name	→	Lithium
Average Atomic Mass	→	6.941

To find the mass number for that element, just round off the Average Atomic Mass.

# Rounding Off Rules

- If the number after the decimal is below 5, just drop all of the numbers after the decimal.

$$3.46 = 3$$

- If the number after the decimal is above 5, raise the number before the decimal by 1 and drop all the numbers after the decimal.

$$4.76 = 5$$

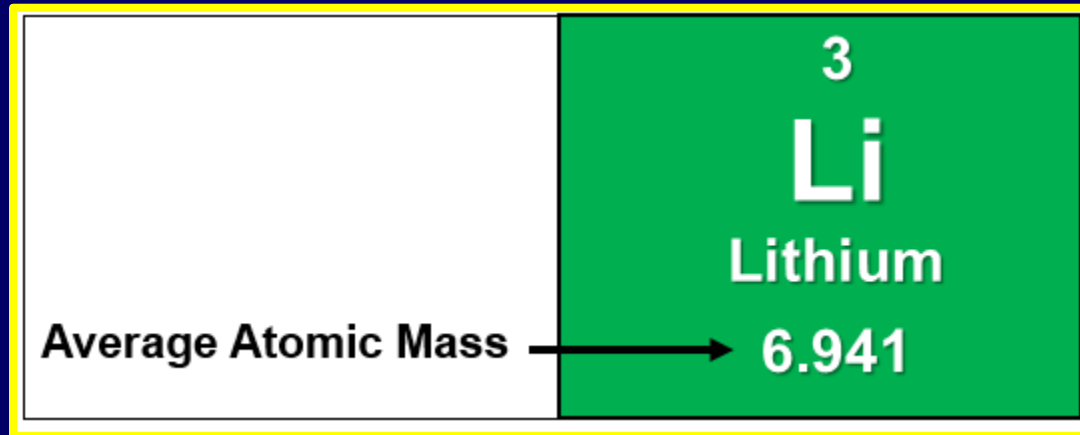
- If the number after the decimal is a 5, and the number before the decimal is even, just drop the numbers after the decimals.

$$8.53 = 8$$

# Rounding Off Rules

- If the number after the decimal is a 5, and the number before the decimal is even, raise the number before the decimal and drop all of the numbers after the decimal.

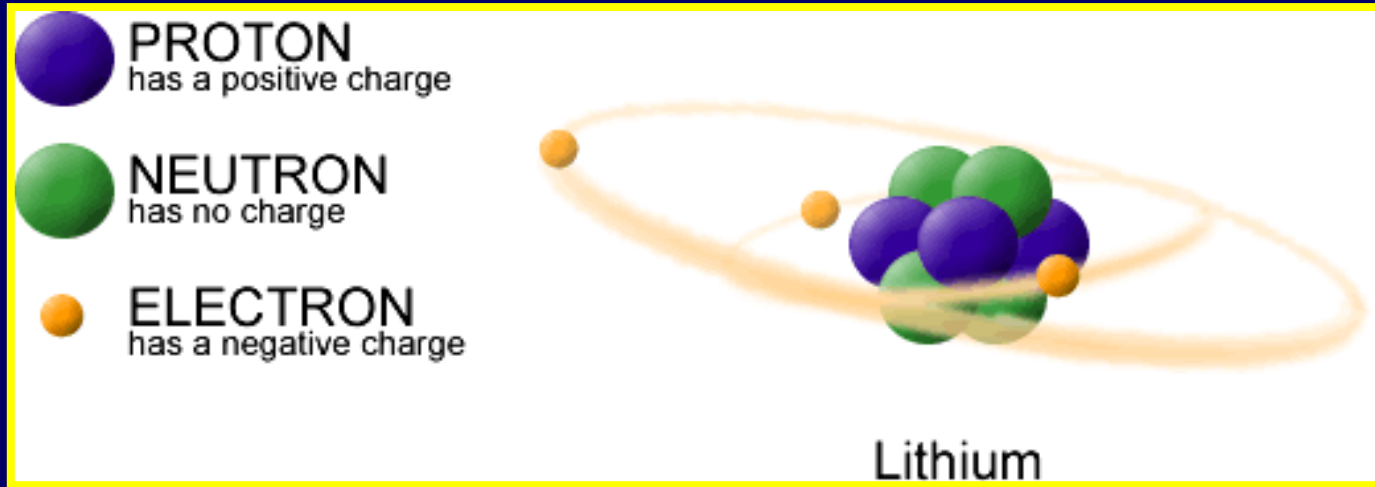
$$3.46 = 3$$



When the average atomic mass for lithium is rounded off, the mass number for the most abundant lithium isotope is 7.

# Mass Number

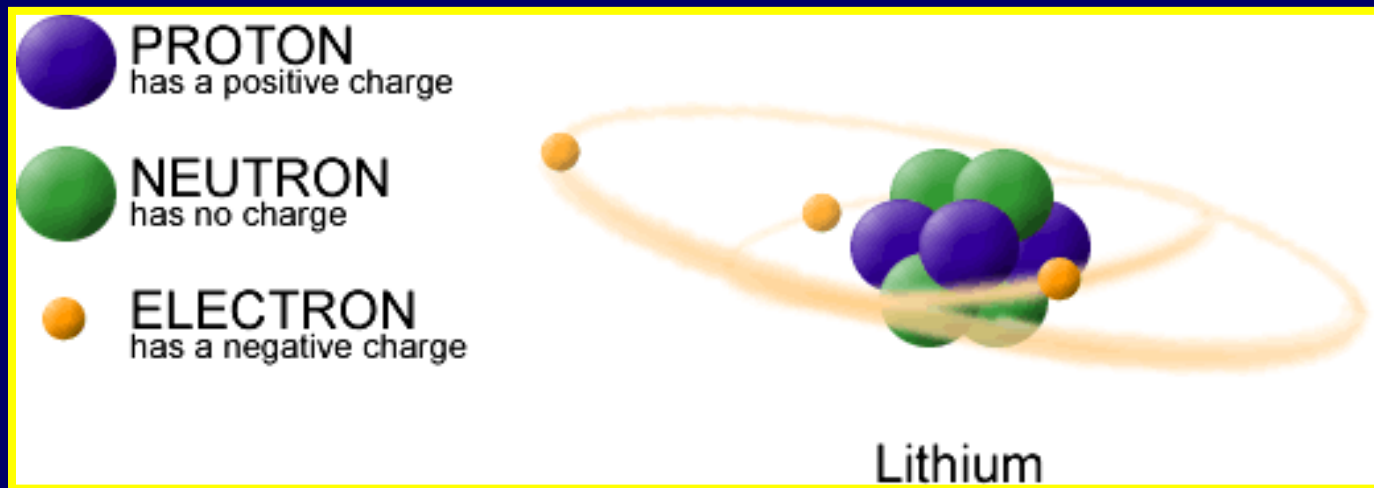
Recall that the mass number for any atom was equal to the total number of protons and neutrons in the atom.



$$3 \text{ protons} + 4 \text{ neutrons} = 7$$

# Number of Neutrons

If we subtract the number of protons from the mass number, we can find the number of neutrons for that atom.



$$7 - 3 \text{ protons} = 4 \text{ neutrons}$$



# Number of Neutrons

To find the number of neutrons for any element on the periodic table, round off the average atomic mass and subtract the atomic number.

Atomic Number	→	3
		Li
		Lithium
Average Atomic Mass	→	6.941

$$\text{Number of Neutrons} = 6.941 \approx 7 - 3 = 4$$

# Review

- To find the number of protons → Atomic Number  
Number of Protons = 5
- To find the number of electrons → Atomic Number  
Number of Electrons = 5
- To find the number of neutrons → Round off the atomic mass and subtract the atomic number.

$$\text{Number of Neutrons} = 10.81 = 11 - 5 = 6$$

Atomic Number	→	5
		<b>B</b>
		Boron
Average Atomic Mass	→	10.81

# The End

