



# **Chemistry of Matter**

## **Properties and Interactions of Elements**

**MS State Objectives 2.a. and 2.b.**



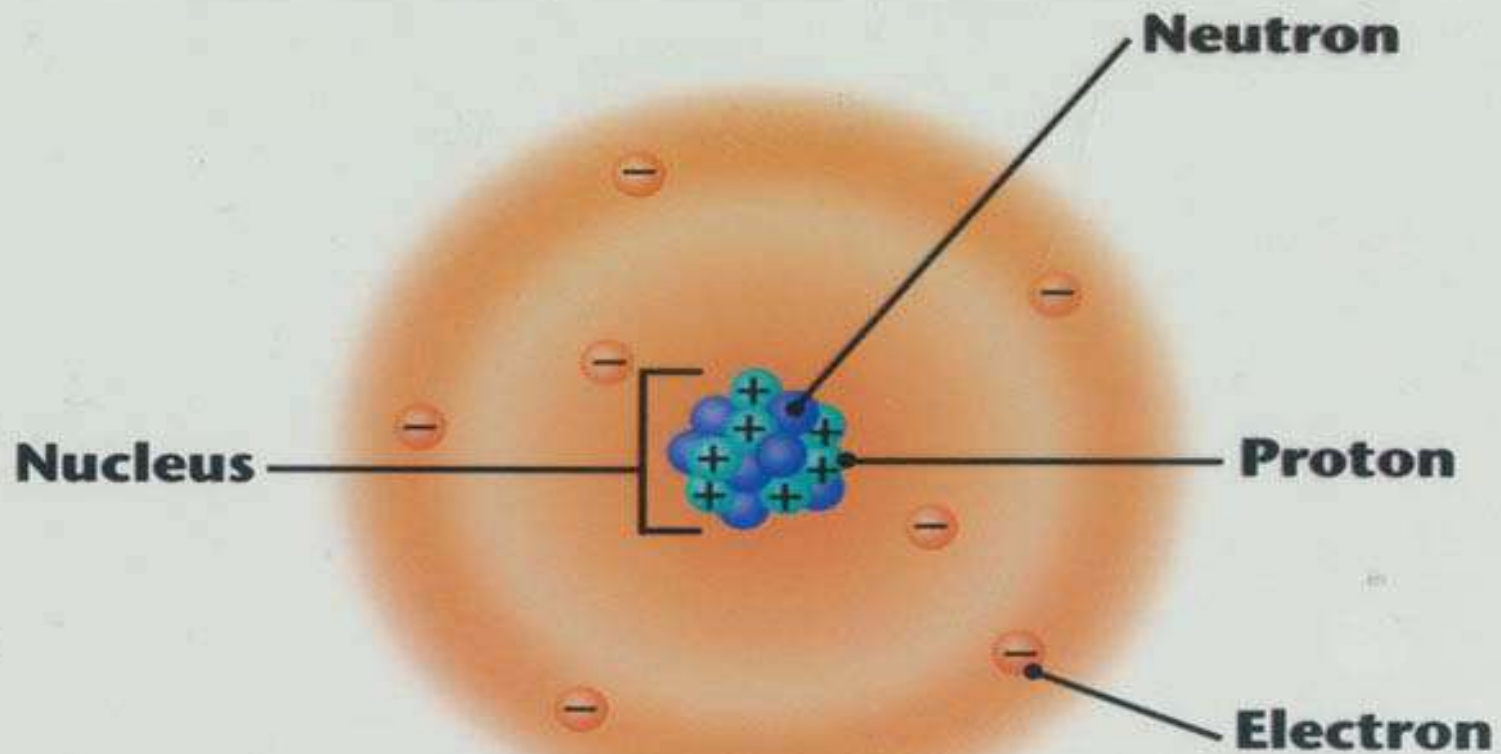
# Elements



- Elements are substances that cannot be broken down into simpler substances.
  - Made up of only one type of atom
  - Basic building blocks of matter
- The smallest particle of an element is an atom.

# Review

- How many protons does this element have?
- How many electrons does this element have?
- What is the atomic mass?



- H
- W
- C
- tr

of



# Developing the Periodic table



I	II	III	IV	V	VI	VII	VIII		
H 1.01									
Li 6.94	Be 9.01	B 10.8	C 12.0	N 14.0	O 16.0	F 19.0			
Na 23.0	Mg 24.3	Al 27.0	Si 28.1	P 31.0	S 32.1	Cl 35.5			
K 39.1	Ca 40.1		Ti 47.9	V 50.9	Cr 52.0	Mn 54.9	Fe 55.9	Co 58.9	Ni 58.7
Cu 63.5	Zn 65.4			As 74.9	Se 79.0	Br 79.9			
Rb 85.5	Sr 87.6	Y 88.9	Zr 91.2	Nb 92.9	Mo 95.9		Ru 101	Rh 103	Pd 106
Ag 108	Cd 112	In 115	Sn 119	Sb 122	Te 128	I 127			
Ce 133	Ba 137	La 139		Ta 181	W 184		Os 194	Ir 192	Pt 195
Au 197	Hg 201	Tl 204	Pb 207	Bi 209					
			Th 232			U 238			

- Dmitri Mendeleev, a Russian scientist discovered a set of patterns that seemed to apply to all elements
  - arranged the elements in order of increasing atomic mass (protons + neutrons in the nucleus)



# Modern Periodic Table

- In 1913, Henry Moseley discovered a way to measure the positive charge in the nucleus to determine the atomic number
- arranged the elements by increasing atomic number instead of atomic mass

Periodic Table of the Elements

1 H 1.01																	18 He 4.00
3 Li 6.94	4 Be 9.01											13 B 10.81	14 C 12.01	15 N 14.01	16 O 16.00	17 F 19.00	18 Ne 20.18
11 Na 22.99	12 Mg 24.30											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
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 65.39	31 Ga 69.72	32 Ge 72.61	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 (97.91)	44 Ru 101.07	45 Rh 106.42	46 Pd 107.87	47 Ag 112.41	48 Cd 114.82	49 In 118.71	50 Sn 121.75	51 Sb 127.60	52 Te 126.90	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 La 138.91	58 Ce 140.91	59 Pr 140.91	60 Nd 144.24	61 Pm (144.91)	62 Sm 150.36	63 Eu 151.97	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97	
87 Fr (223.02)	88 Ra (226.03)	89 Ac (227.03)	90 Rf (261.11)	91 Ha (262.11)	92 Rf (263.12)	93 Db (263.10)	94 Sg (263.10)	95 Bh (264.10)	96 Hs (265.10)	97 Mt (266.10)	98 Ds (267.10)	99 Rg (268.10)	100 Og (269.10)	101 Lr (270.10)	102 Uu (271.10)	103 Uub (272.10)	
58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (144.91)	62 Sm 150.36	63 Eu 151.97	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97				
90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237.05)	94 Pu (244.06)	95 Am (243.06)	96 Cm (247.07)	97 Bk (247.07)	98 Cf (251.08)	99 Es (252.08)	100 Fm (257.10)	101 Md (258.10)	102 No (259.10)	103 Lr (262.11)				





# Periodic Table

- Arranged by increasing atomic number (proton #)
- Rows are called periods & are labeled 1-7
- There are 18 columns
  - Each column contains a group or family of elements.
  - Groups are elements that have similar physical or chemical properties.
    - Ex. All elements in group 1 are metals & react violently with water.



# Groups and Periods

hydrogen 1 1.0079 H																	helium 2 4.0026 He												
lithium 3 6.941 Li	beryllium 4 9.0122 Be															neon 10 20.180 Ne													
sodium 11 22.990 Na	magnesium 12 24.305 Mg															argon 18 39.948 Ar													
potassium 19 39.098 K	calcium 20 40.078 Ca	scandium 21 44.956 Sc	titanium 22 47.867 Ti	vanadium 23 50.942 V	chromium 24 51.996 Cr	manganese 25 54.938 Mn	iron 26 55.845 Fe	cobalt 27 58.933 Co	nickel 28 58.693 Ni	copper 29 63.546 Cu	zinc 30 65.39 Zn	boron 5 10.811 B	carbon 6 12.011 C	nitrogen 7 14.007 N	oxygen 8 15.999 O	fluorine 9 18.998 F	neon 10 20.180 Ne												
rubidium 37 85.468 Rb	strontium 38 87.62 Sr	yttrium 39 88.906 Y	zirconium 40 91.224 Zr	niobium 41 92.906 Nb	molybdenum 42 95.94 Mo	technetium 43 [98] Tc	ruthenium 44 101.07 Ru	rhodium 45 101.07 Rh	paladium 46 106.42 Pd	silver 47 107.87 Ag	cadmium 48 112.41 Cd	aluminum 13 26.982 Al	silicon 14 28.086 Si	phosphorus 15 30.974 P	sulfur 16 32.065 S	chlorine 17 35.453 Cl	argon 18 39.948 Ar												
cesium 55 132.91 Cs	barium 56 137.33 Ba	lanthanum 57 138.91 La	cerium 58 140.12 Ce	praseodymium 59 140.91 Pr	neodymium 60 144.24 Nd	europium 61 151.96 Eu	gadolinium 62 157.25 Gd	terbium 63 158.93 Tb	dysprosium 64 162.50 Dy	holmium 65 164.93 Ho	erbium 66 167.26 Er	thulium 67 168.93 Tm	ytterbium 68 173.04 Yb	lutetium 69 174.97 Lu	hafnium 72 178.49 Hf	tantalum 73 180.95 Ta	wolfram 74 183.84 W	reynoldsium 75 186.21 Re	osmium 76 190.23 Os	iridium 77 192.22 Ir	platinum 78 195.08 Pt	gold 79 196.97 Au	mercury 80 200.59 Hg	thallium 81 204.38 Tl	lead 82 207.2 Pb	bismuth 83 208.98 Bi	polonium 84 [209] Po	astatine 85 [210] At	radon 86 [222] Rn
francium 87 [223] Fr	radium 88 [226] Ra	actinium 89 [227] Ac	thorium 90 232.04 Th	protactinium 91 231.04 Pa	uranium 92 238.03 U	neptunium 93 [237] Np	plutonium 94 [244] Pu	americium 95 [243] Am	curium 96 [247] Cm	berkelium 97 [247] Bk	californium 98 [251] Cf	einsteinium 99 [252] Es	fermium 100 [257] Fm	mendelevium 101 [258] Md	nobelium 102 [259] No														

\* Lanthanide series

\*\* Actinide series

hydrogen 1 1.0079 H	beryllium 4 9.0122 Be																	helium 2 4.0026 He											
lithium 3 6.941 Li	magnesium 12 24.305 Mg															neon 10 20.180 Ne													
sodium 11 22.990 Na	calcium 20 40.078 Ca	scandium 21 44.956 Sc	titanium 22 47.867 Ti	vanadium 23 50.942 V	chromium 24 51.996 Cr	manganese 25 54.938 Mn	iron 26 55.845 Fe	cobalt 27 58.933 Co	nickel 28 58.693 Ni	copper 29 63.546 Cu	zinc 30 65.39 Zn	boron 5 10.811 B	carbon 6 12.011 C	nitrogen 7 14.007 N	oxygen 8 15.999 O	fluorine 9 18.998 F	neon 10 20.180 Ne												
rubidium 37 85.468 Rb	strontium 38 87.62 Sr	yttrium 39 88.906 Y	zirconium 40 91.224 Zr	niobium 41 92.906 Nb	molybdenum 42 95.94 Mo	technetium 43 [98] Tc	ruthenium 44 101.07 Ru	rhodium 45 101.07 Rh	paladium 46 106.42 Pd	silver 47 107.87 Ag	cadmium 48 112.41 Cd	aluminum 13 26.982 Al	silicon 14 28.086 Si	phosphorus 15 30.974 P	sulfur 16 32.065 S	chlorine 17 35.453 Cl	argon 18 39.948 Ar												
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francium 87 [223] Fr	radium 88 [226] Ra	actinium 89 [227] Ac	thorium 90 232.04 Th	protactinium 91 231.04 Pa	uranium 92 238.03 U	neptunium 93 [237] Np	plutonium 94 [244] Pu	americium 95 [243] Am	curium 96 [247] Cm	berkelium 97 [247] Bk	californium 98 [251] Cf	einsteinium 99 [252] Es	fermium 100 [257] Fm	mendelevium 101 [258] Md	nobelium 102 [259] No														

\* Lanthanide series

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lanthanum 57 138.91 La	cerium 58 140.12 Ce	praseodymium 59 140.91 Pr	neodymium 60 144.24 Nd	promethium 61 [145] Pm	samarium 62 150.36 Sm	europium 63 151.96 Eu	gadolinium 64 157.25 Gd	terbium 65 158.93 Tb	dysprosium 66 162.50 Dy	holmium 67 164.93 Ho	erbium 68 167.26 Er	thulium 69 168.93 Tm	ytterbium 70 173.04 Yb
actinium 89 [227] Ac	thorium 90 232.04 Th	protactinium 91 231.04 Pa	uranium 92 238.03 U	neptunium 93 [237] Np	plutonium 94 [244] Pu	americium 95 [243] Am	curium 96 [247] Cm	berkelium 97 [247] Bk	californium 98 [251] Cf	einsteinium 99 [252] Es	fermium 100 [257] Fm	mendelevium 101 [258] Md	nobelium 102 [259] No



# Groups/Families

- Groups 1 and 2 along with Groups 13 and 18 are called the representative elements -elements having similar properties.

hydrogen 1 H 1.0079																	helium 2 He 4.0026						
lithium 3 Li 6.941	beryllium 4 Be 9.0122																	boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305																	aluminum 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selecnium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80						
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29						
cesium 55 Cs 132.91	barium 56 Ba 137.33	* 57-70 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]						
francium 87 Fr [223]	radium 88 Ra [226]	* * 89-102 Lr [262]	rutherfordium 104 Rf [261]	bohrium 105 Db [262]	seaborgium 106 Sg [263]	bohrium 107 Bh [264]	hassium 108 Hs [265]	meitnerium 109 Mt [266]	unnilium 110 Uun [267]	ununium 111 Uuu [268]	unbibium 112 Uub [269]												

\* Lanthanide series

lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
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\*\* Actinide series

actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]
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# Groups/Families

- Groups 3 to 12 are called the transition metals.

hydrogen 1 <b>H</b> 1.0079																	helium 2 <b>He</b> 4.0026						
lithium 3 <b>Li</b> 6.941	beryllium 4 <b>Be</b> 9.0122																	boron 5 <b>B</b> 10.811	carbon 6 <b>C</b> 12.011	nitrogen 7 <b>N</b> 14.007	oxygen 8 <b>O</b> 15.999	fluorine 9 <b>F</b> 18.998	neon 10 <b>Ne</b> 20.180
sodium 11 <b>Na</b> 22.990	magnesium 12 <b>Mg</b> 24.305																	aluminum 13 <b>Al</b> 26.982	silicon 14 <b>Si</b> 28.086	phosphorus 15 <b>P</b> 30.974	sulfur 16 <b>S</b> 32.065	chlorine 17 <b>Cl</b> 35.453	argon 18 <b>Ar</b> 39.948
potassium 19 <b>K</b> 39.098	calcium 20 <b>Ca</b> 40.078		scandium 21 <b>Sc</b> 44.956	titanium 22 <b>Ti</b> 47.867	vanadium 23 <b>V</b> 50.942	chromium 24 <b>Cr</b> 51.996	manganese 25 <b>Mn</b> 54.938	iron 26 <b>Fe</b> 55.845	cobalt 27 <b>Co</b> 58.933	nickel 28 <b>Ni</b> 58.693	copper 29 <b>Cu</b> 63.546	zinc 30 <b>Zn</b> 65.39	gallium 31 <b>Ga</b> 69.723	germanium 32 <b>Ge</b> 72.61	arsenic 33 <b>As</b> 74.922	seelenium 34 <b>Se</b> 78.96	bromine 35 <b>Br</b> 79.904	krypton 36 <b>Kr</b> 83.80					
rubidium 37 <b>Rb</b> 85.468	strontium 38 <b>Sr</b> 87.62		yttrium 39 <b>Y</b> 88.906	zirconium 40 <b>Zr</b> 91.224	niobium 41 <b>Nb</b> 92.906	molybdenum 42 <b>Mo</b> 95.94	technetium 43 <b>Tc</b> [98]	ruthenium 44 <b>Ru</b> 101.07	rhodium 45 <b>Rh</b> 102.91	palladium 46 <b>Pd</b> 106.42	silver 47 <b>Ag</b> 107.87	cadmium 48 <b>Cd</b> 112.41	indium 49 <b>In</b> 114.82	tin 50 <b>Sn</b> 118.71	antimony 51 <b>Sb</b> 121.76	tellurium 52 <b>Te</b> 127.60	iodine 53 <b>I</b> 126.90	xenon 54 <b>Xe</b> 131.29					
cesium 55 <b>Cs</b> 132.91	barium 56 <b>Ba</b> 137.33	57-70 *	lutetium 71 <b>Lu</b> 174.97	hafnium 72 <b>Hf</b> 178.49	tantalum 73 <b>Ta</b> 180.95	tungsten 74 <b>W</b> 183.84	rhenium 75 <b>Re</b> 186.21	osmium 76 <b>Os</b> 190.23	iridium 77 <b>Ir</b> 192.22	platinum 78 <b>Pt</b> 195.08	gold 79 <b>Au</b> 196.97	mercury 80 <b>Hg</b> 200.59	thallium 81 <b>Tl</b> 204.38	lead 82 <b>Pb</b> 207.2	bismuth 83 <b>Bi</b> 208.98	polonium 84 <b>Po</b> [209]	astatine 85 <b>At</b> [210]	radon 86 <b>Rn</b> [222]					
francium 87 <b>Fr</b> [223]	radium 88 <b>Ra</b> [226]	89-102 **	lawrencium 103 <b>Lr</b> [260]	rutherfordium 104 <b>Rf</b> [261]	dubnium 105 <b>Db</b> [262]	seaborgium 106 <b>Sg</b> [263]	bohrium 107 <b>Bh</b> [264]	hassium 108 <b>Hs</b> [265]	meitnerium 109 <b>Mt</b> [266]	unnilium 110 <b>Uun</b> [267]	ununium 111 <b>Uuu</b> [268]	unbibium 112 <b>Uub</b> [269]	unquadrium 114 <b>Uuq</b> [269]										

\* Lanthanide series

\*\* Actinide series

lanthanum 57 <b>La</b> 138.91	cerium 58 <b>Ce</b> 140.12	praseodymium 59 <b>Pr</b> 140.91	neodymium 60 <b>Nd</b> 144.24	promethium 61 <b>Pm</b> [145]	samarium 62 <b>Sm</b> 150.36	europium 63 <b>Eu</b> 151.96	gadolinium 64 <b>Gd</b> 157.25	terbium 65 <b>Tb</b> 158.93	dysprosium 66 <b>Dy</b> 162.50	holmium 67 <b>Ho</b> 164.93	erbium 68 <b>Er</b> 167.26	thulium 69 <b>Tm</b> 168.93	ytterbium 70 <b>Yb</b> 173.04
actinium 89 <b>Ac</b> [227]	thorium 90 <b>Th</b> 232.04	protactinium 91 <b>Pa</b> 231.04	uranium 92 <b>U</b> 238.03	neptunium 93 <b>Np</b> [237]	plutonium 94 <b>Pu</b> [244]	americium 95 <b>Am</b> [243]	curium 96 <b>Cm</b> [247]	berkelium 97 <b>Bk</b> [247]	californium 98 <b>Cf</b> [251]	einsteinium 99 <b>Es</b> [252]	fermium 100 <b>Fm</b> [257]	mendeleevium 101 <b>Md</b> [258]	nobelium 102 <b>No</b> [259]



# How Elements Interact

State Objective 2.a.



# Physical vs. Chemical Change

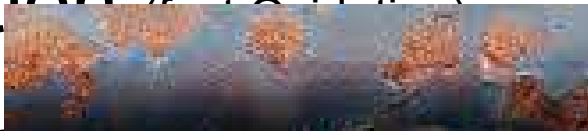


- Physical change occurs when the physical properties are changed, such as size or shape.
  - Ex. Folding a piece of paper or a change in the state of matter: solid, liquid, gas
- Chemical change occurs when the chemical properties of the substance cause a change producing a new substance (the atoms have rearranged)

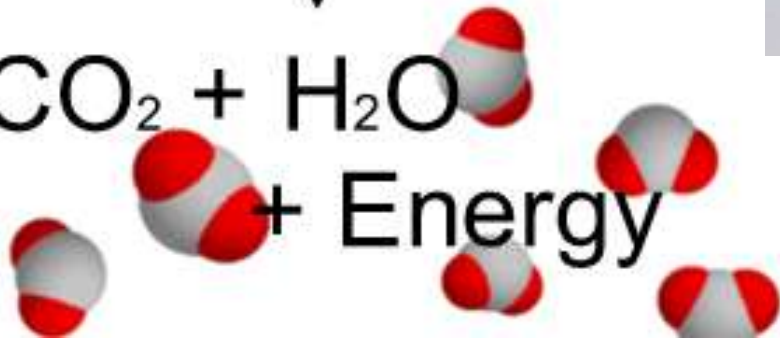
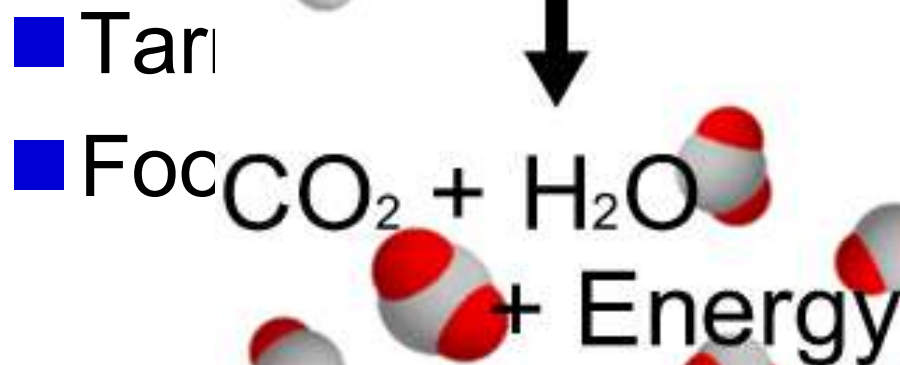
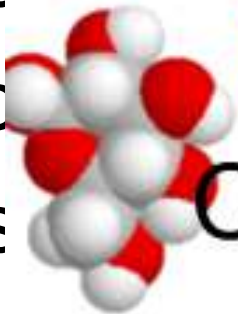


# Examples of Chemical Reactions

- Food spoiling
- Combustion
- Rusting
- Photosynthesis



Respiration





# Interaction Between Elements:

If there are 110+ elements, how is it possible to have millions of different substances?

- Compounds are substances that form when two or more elements combine from a chemical change.
  - Ex. NaCl (Sodium Chloride)
  - The properties of compounds are different from the properties of the elements that make up the compound
- A molecule is the smallest particle of a substance with the same properties of that substance. Ex. H<sub>2</sub>O (water)
  - Each molecule behaves like water, if the molecule is divided, Hydrogen and oxygen no longer behave like water





# How do Elements Interact in Chemical Changes?

- Chemical properties of elements are determined by the number of electrons in the outer most energy level called valence electrons
- Valence electron number is determined by the group number for representative elements

## Valence Electrons

IA	IIA	IIIA	IVA	VA	VIA	VIIA	VIIIA
Li·	·Be·	·B·	·C·	·N·	·O·	·F·	·Ne·

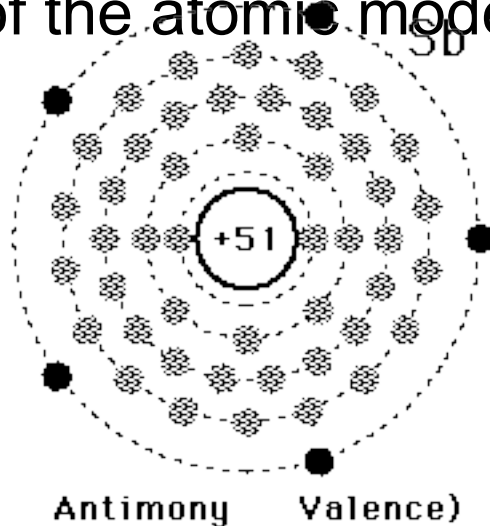
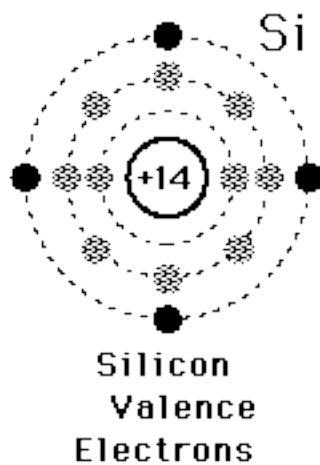
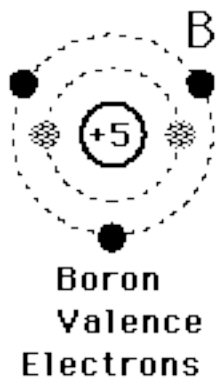




# Practice

Use the periodic table to answer the questions.

1. How many valence electrons does sodium have?
2. How many electrons are found in the electron cloud of an atom of chlorine?
3. What is the group number for each of the atomic models below?







# Chemical Bonds

- Elements bond to other elements to become stable by having a full valence shell.
  - Most elements need 8 valence electrons to become stable
- Elements will become stable by losing, gaining, or sharing valence electrons
  - Elements that lose electrons become positively charged ions.
  - Elements that gain electrons become negatively charged ions.
- Types of bonding:
  - Ionic
  - Covalent

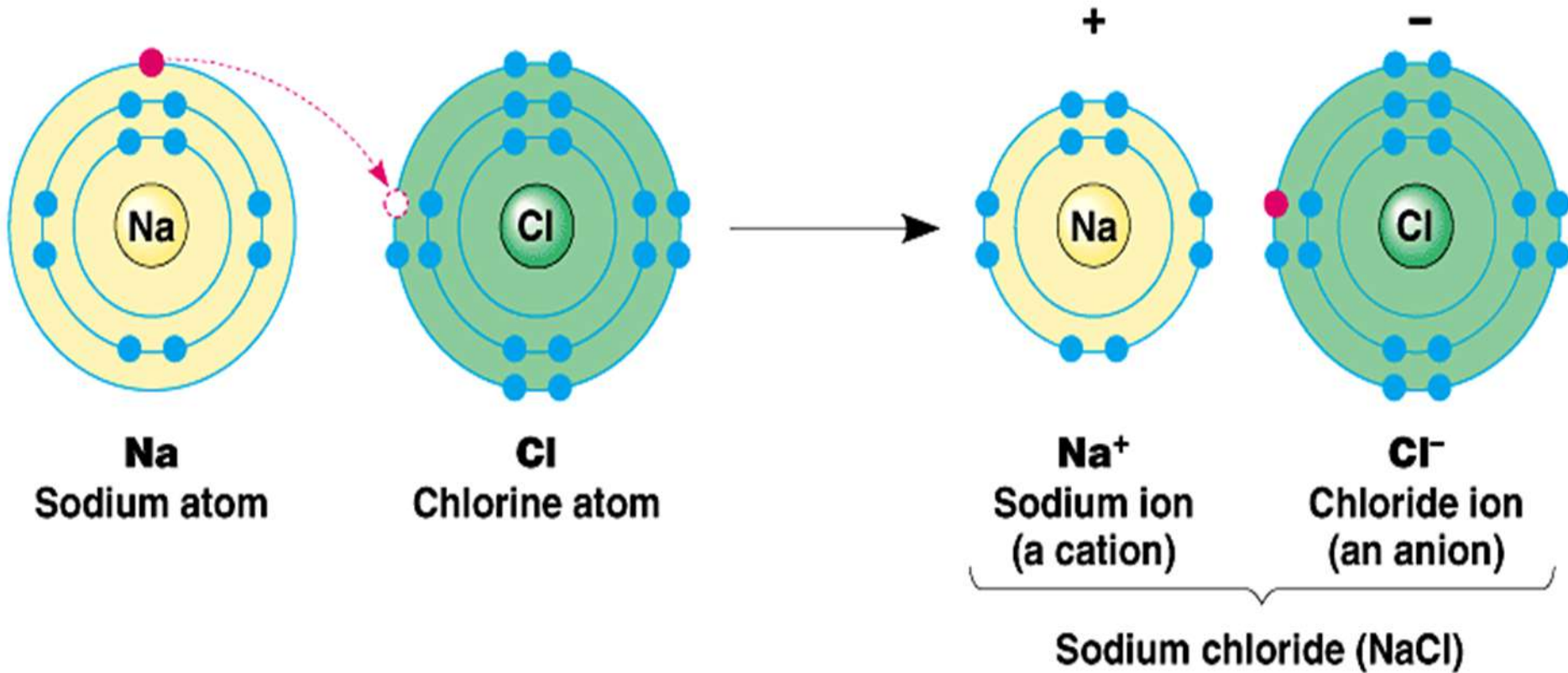


# Ionic Bonding

- Ionic bonding is when a strong attraction occurs between oppositely charged ions to hold them close together to become stable (like two magnets)
  - Ion: an atom that no longer has a neutral charge because it has lost or gained an electron
  - Typically between a metal & non-metal
  - Ex. Na<sup>+</sup>Cl<sup>-</sup>



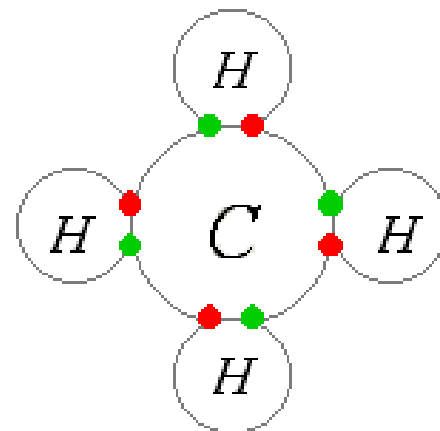
# Ionic Bonding





# Covalent Bonding

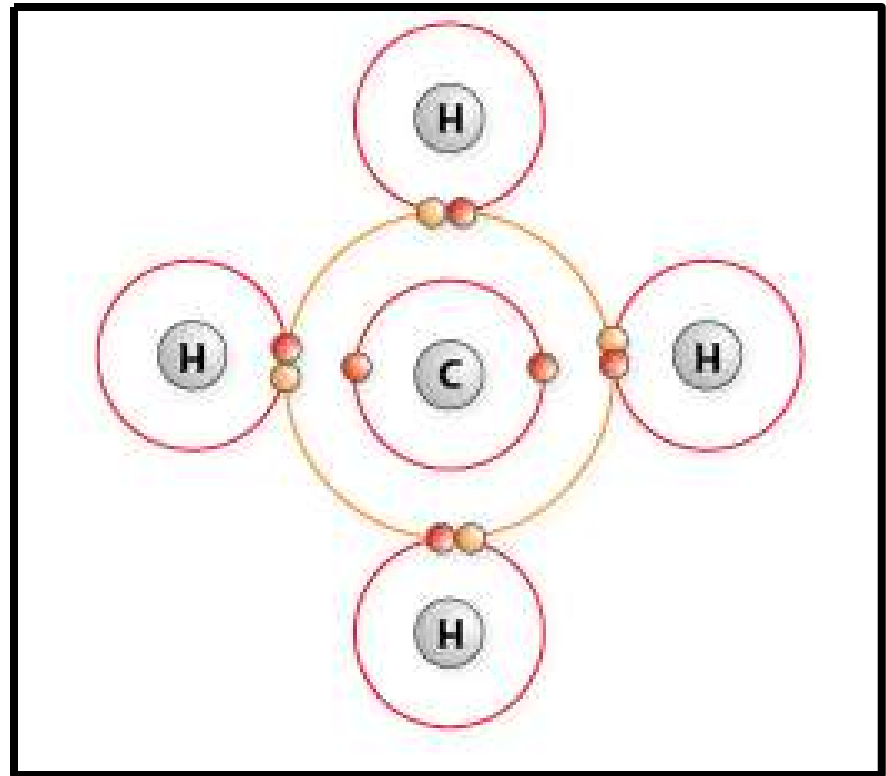
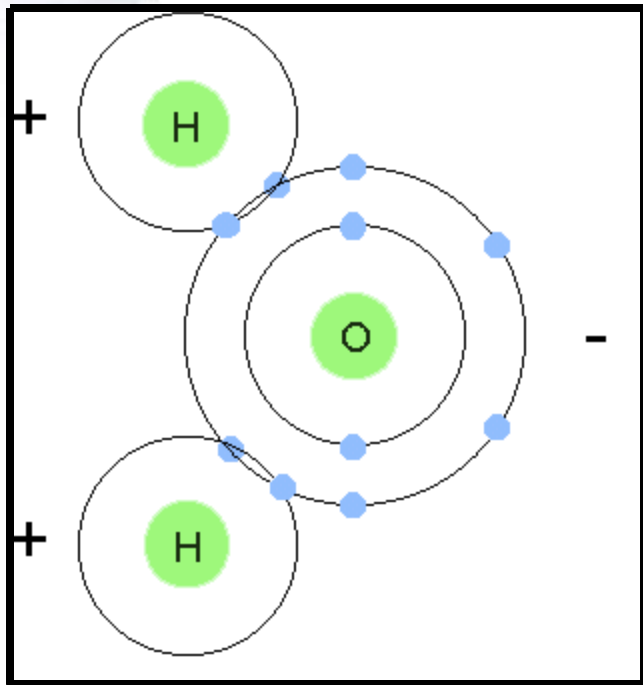
- Covalent bonds are chemical bonds that form from atoms that share valence electrons to become stable
- Occurs between two or more nonmetals
- Ex.  $H_2$  ,  $Cl_2$  ,  $H_2O$  ,  $C_6H_{12}O_6$



- *Electron from carbon*
- *Electron from hydrogen*



# Covalent Bonding

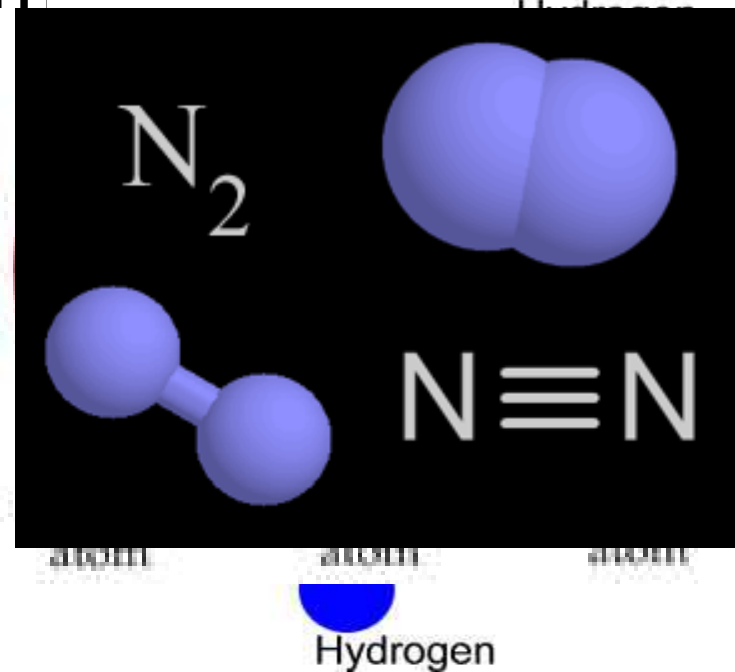




# Chemical Formulas

- Chemical formulas show a combination of chemical symbols & numbers that indicate which elements & how many atoms of each element are present in a compound

- H<sub>2</sub>O (Water)
- C<sub>6</sub>H<sub>12</sub>O<sub>6</sub> (Sugar/glucose)
- O<sub>2</sub> (Oxygen Molecule)
- CO<sub>2</sub> (Carbon Dioxide)
- N<sub>2</sub> (Nitrogen Molecule)



Subscript: # of atoms



# Chemical Equations

- A process that produces a chemical change is called a chemical reaction.
  - Reactants are substances that exist before the reaction begins
  - Products are substances that form as a result of the reaction
- Chemical equations tell chemists the reactants, products, and proportions of each substance present in a reaction ( like a recipe)
  - Ex.  $2\text{H}_2 + \text{O}_2 \longrightarrow 2\text{H}_2\text{O}$   
*Reactant* *Product*



# Law of Conservation of Mass

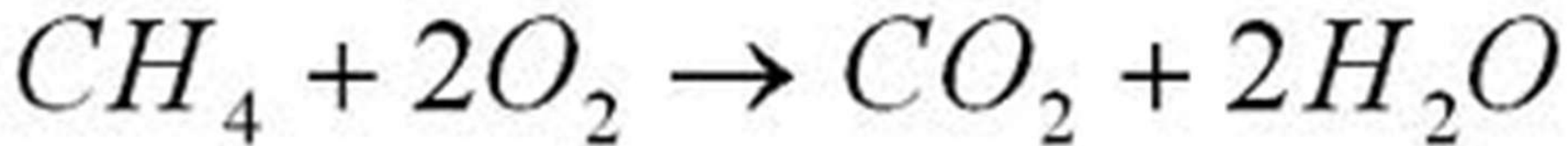
- The Law of Conservation of Mass states that mass (matter) can neither be created nor destroyed.
  - Therefore, atoms are never lost or created during a chemical reaction.
- Chemical equations must be balanced in order to show the same number of atoms for each element on the reactant & product side of the equation.







# Balancing an Equation



**C=1**

**H=4**

**O=4**

**=**

**C=1**

**H=4**

**O=4**



# **Chemistry of Matter**

## **Forming Acids & Bases**

**State Correlation 2b**



# Properties of Acids & Bases

- An acid is a compound that produces hydrogen ions in water ( $H^+$ )
  - The greater the concentration of H ions produced, the stronger the acid
    - Tastes sour
    - Reacts with non-metals
    - Have a  $pH < 7$
    - Turn blue litmus paper red
- Examples:  $HCl$ ,  $H_2SO_4$ ,  $HNO_3$



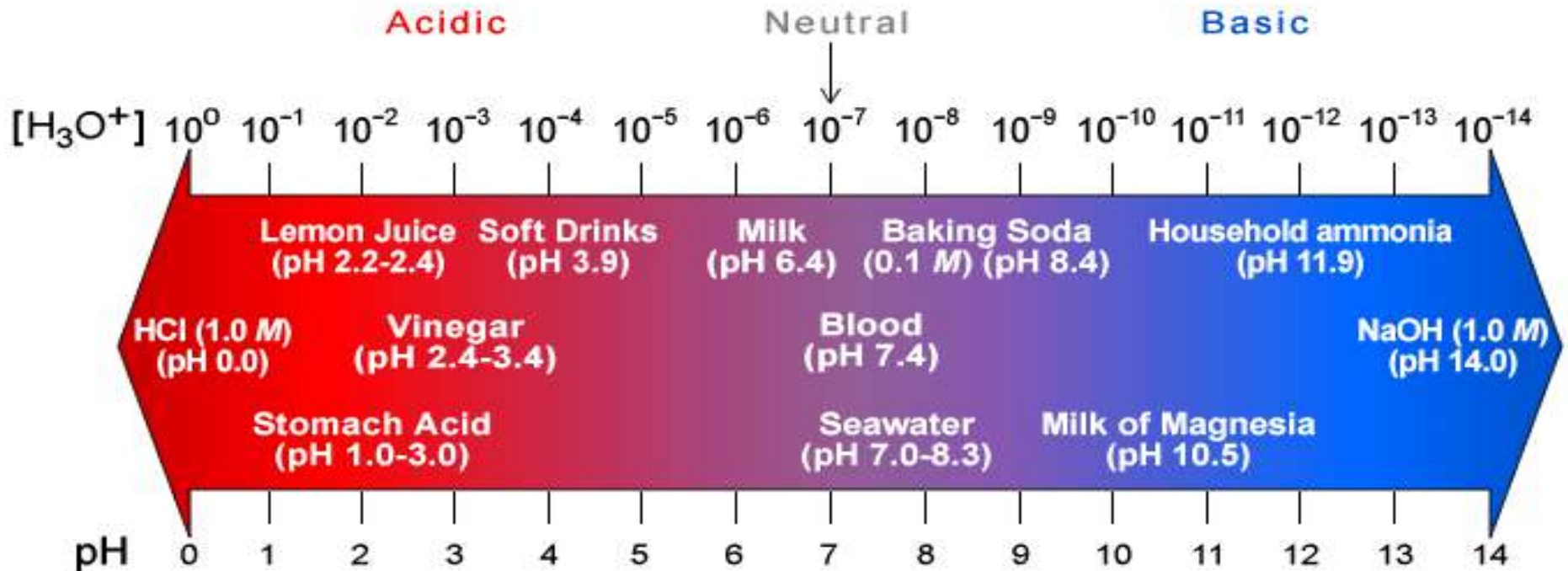
# Properties of Acids & Bases

- A base is any compound that produces hydroxide ions ( $\text{OH}^-$ ) in water.
  - The greater the concentration of  $\text{OH}^-$  produced, the stronger the base.
    - Taste bitter & feels slippery
    - Reacts with metals
    - Have a  $\text{pH} > 7$
    - Turn red litmus paper blue
- Examples:  $\text{NH}_3$ ,  $\text{NaOH}$ ,  $\text{NaHCO}_3$



# pH Scale

## pH Scale





# Predicting Acids & Bases using the Periodic Table

- Acids form when hydrogen chemically combines with certain nonmetals.
  - All halogens (group 17) form acids when combined with hydrogen
    - Ex. Fluorine & hydrogen (HF)

17
9
<b>F</b>
Fluorine
17
<b>Cl</b>
Chlorine
35
<b>Br</b>
Bromine
53
<b>I</b>
Iodine
85
<b>At</b>
Astatine



# Predicting Acids & Bases using the Periodic Table

- Bases form when a hydroxide ion ( $\text{OH}^-$ ) joins with a metal
- The metals in group 1 (alkali metals) and group 2 (alkaline earth metals) readily form bases with hydroxide ions
  - EX.  $\text{KOH}$
  - EX.  $\text{Ca}(\text{OH})_2$

1	2
3 Li Lithium	4 Be Beryllium
11 Na Sodium	12 Mg Magnesium
19 K Potassium	20 Ca Calcium
37 Rb Rubidium	38 Sr Strontium
55 Cs Cesium	56 Ba Barium
87 Fr Francium	88 Ra Radium