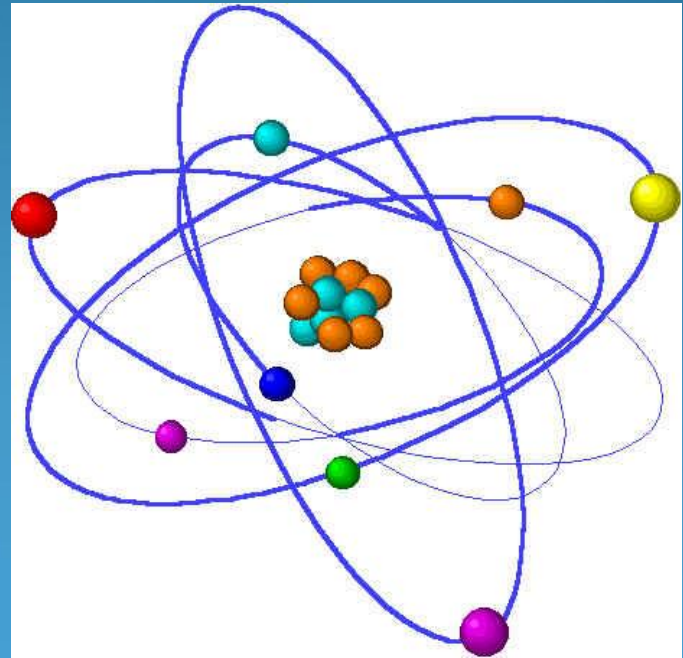


Ch 5 Atomic Structure and the Periodic Table

5.1 Atoms are the
smallest form of elements



All matter is made of atoms

- Same type of atoms = element
- There are approximately 100 elements known today

Atomic number

Symbol

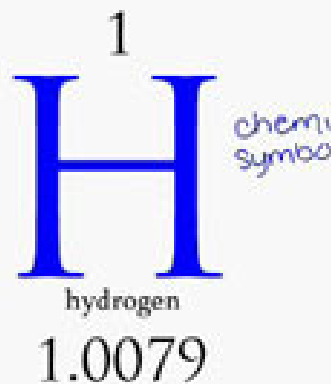
Atomic weight

■ Metal
■ Semimetal
■ Nonmetal

1 H 1.008	2 He 4.003											13 B 10.81	14 C 12.01	15 N 14.01	16 O 16.00	17 F 19.00	18 Ne 20.18												
3 Li 6.941	4 Be 9.012											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
11 Na 22.99	12 Mg 24.31	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 98.91	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										
19 K 39.10	20 Ca 40.08	55 Cs 132.9	56 Ba 137.3	71 Lu 175.0	72 Hf 178.5	73 Ta 180.9	74 W 183.8	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 210.0	85 At 210.0	86 Rn 222.0										
37 Rb 85.47	38 Sr 87.62	87 Fr 223.0	88 Ra 226.0	103 Lr 262.1	104 Rf 261.1	105 Db 262.1	106 Sg 263.1	107 Bh 264.1	108 Hs 265.1	109 Mt 268	110 Uun 269	111 Uuu 272	112 Uub 277	113 Uut 289	114 Uuq 289	115 Uup 289	116 Uuh 289	117 Uus 289	118 Uuo 293										
		57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm 146.9	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														
		89 Ac 227.0	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.0	94 Pu 244.1	95 Am 243.1	96 Cm 247.1	97 Bk 247.1	98 Cf 251.1	99 Es 252.0	100 Fm 257.1	101 Md 258.1	102 No 259.1														

(c)1998
Kromer Paul

- Each element has its own symbol & properties
 - Hydrogen is the most abundant in the universe
 - Oxygen is the most abundant in the Earth's crust



8



Oxygen
15.999



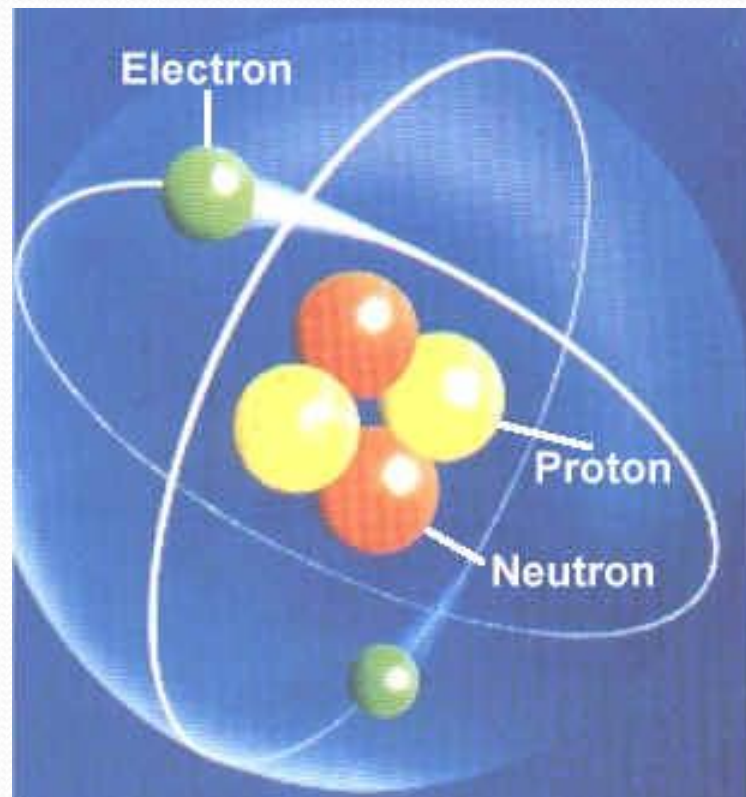
John Dalton is famous for studies involving atoms (early 1800s)

His work helped contribute
To the modern-day atomic
Theory.

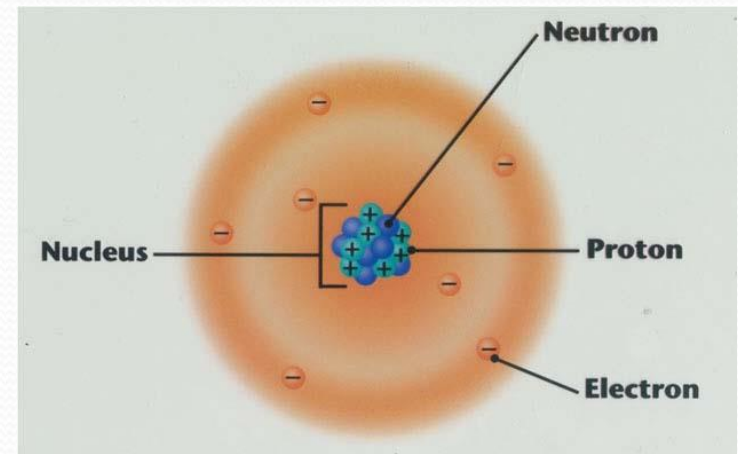


Each element is made of a different atom

- Atoms are made of 3 different particles (subatomic particles)
 - Protons, + charge
 - Neutrons, 0 charge (neutral)
 - Electrons, - charge



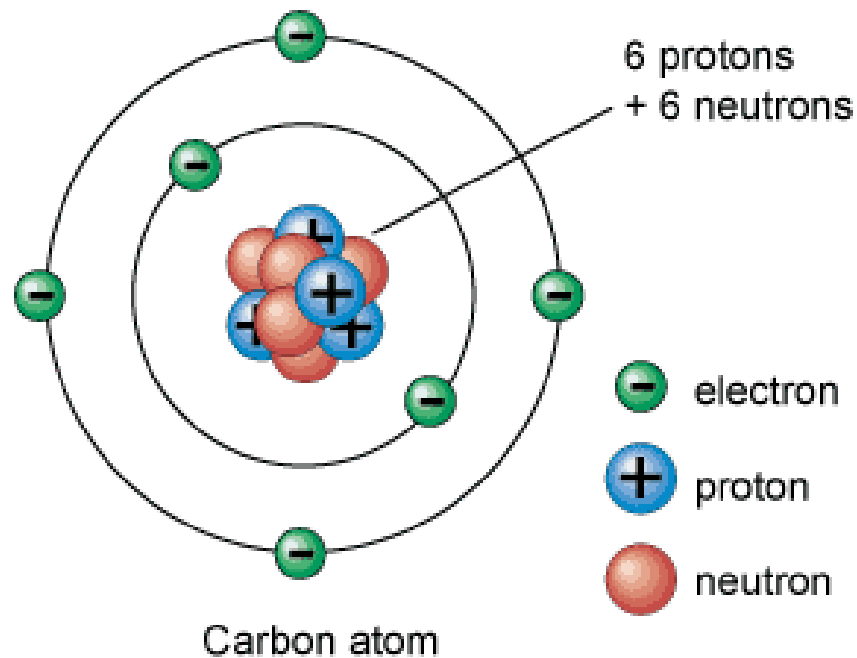
- Nucleus—center of the atom; contains the protons & neutrons
- Electron cloud (or energy levels)—contains the electrons which orbit the nucleus
 - Electrons are 2000x smaller than the protons & neutrons



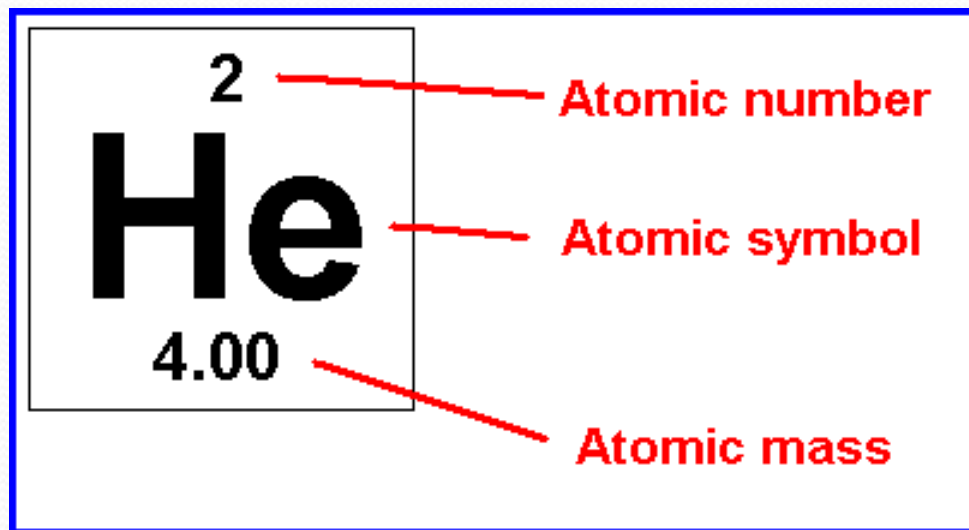
*Mass of electrons is considered to be negligible

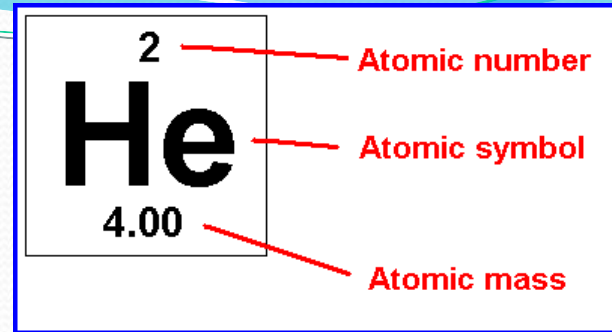
**** # Energy Levels → Period or Row #**
(# of rings to draw around nucleus)

Carbon has 2 energy levels



- Atomic #--number of protons and total # of electrons in an atom

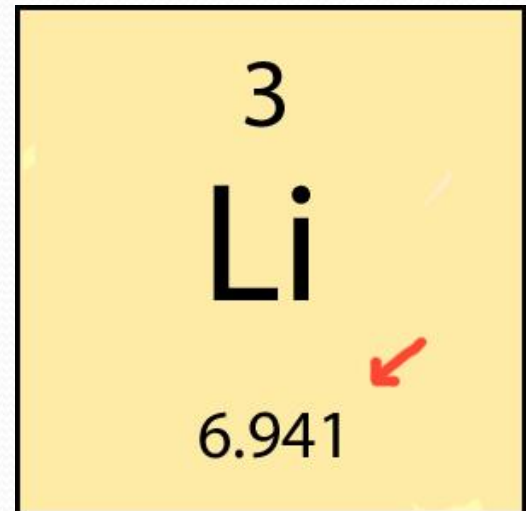




- Atomic mass --

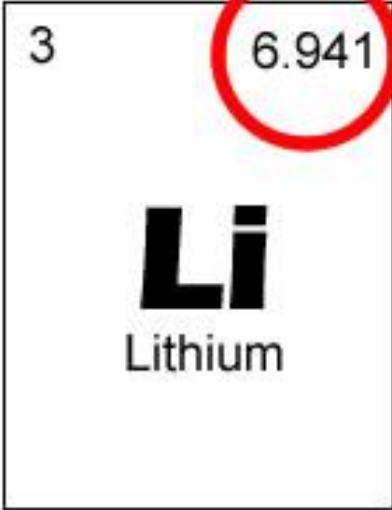
- # of protons & neutrons combined

- Avogadro's # = 6.022×10^{23} power
- 7 grams of Lithium would have Avogadro's # of atoms in it
- This is also considered to be 1 mol



Neutrons = Atomic mass – atomic

Atomic Mass = Protons + Neutrons



3 6.941

Li
Lithium

Calculating the Number of Neutrons

1st - round atomic mass to a whole number
6.941 rounds to 7

2nd - subtract 3 (# of protons) from 7
(# of protons + neutrons)
7 - 3 = 4

Number of Neutrons = 4

The Nuclei of the Three Isotopes of Hydrogen

Protium



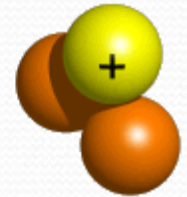
1 proton

Deuterium



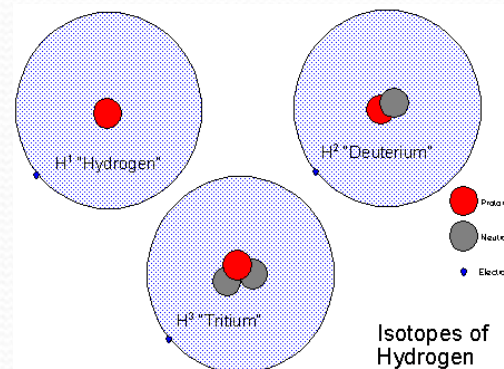
1 proton
1 neutron

Tritium



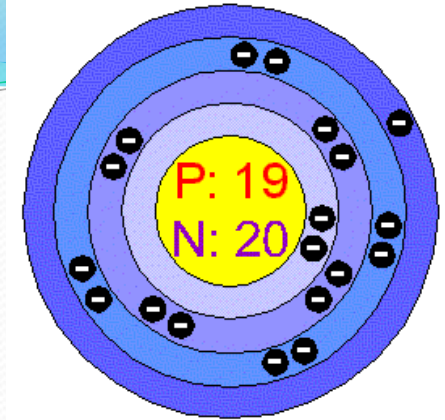
1 proton
2 neutrons

- Isotopes—atoms of the same element with different #s of neutrons
 - Atomic mass # on periodic table is the ave. # of all isotopes
 - An isotope is written with a numeral after the name; the numeral represents the atomic mass



Examples of Isotopes

Potassium Bohr Model



Potassium 39 = 20 neutrons

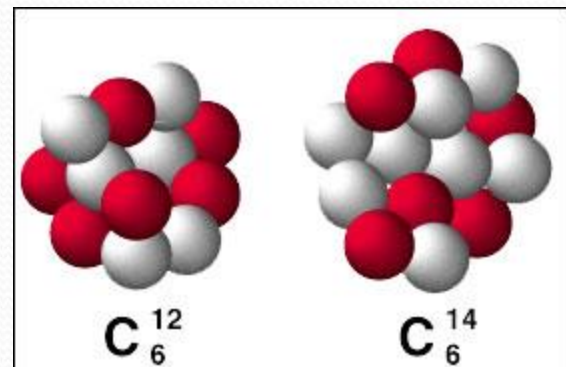
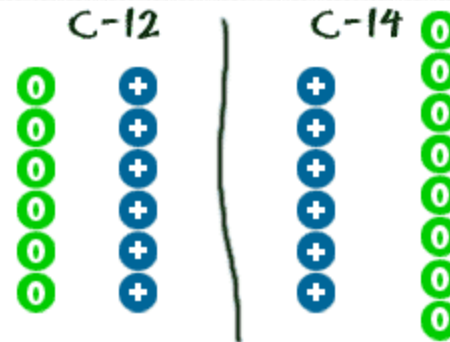
39 is the atomic mass

atomic mass – atomic #

$$39 - 19 = 20$$

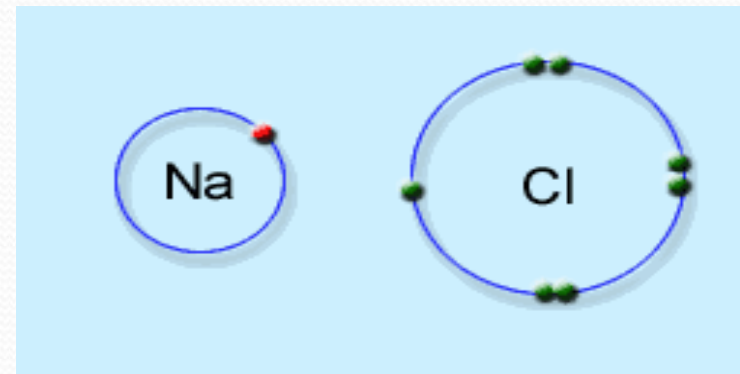
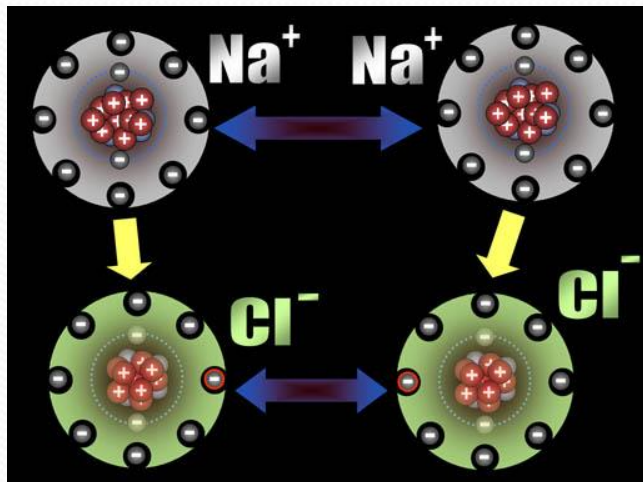
Potassium 41 = 22 neutrons

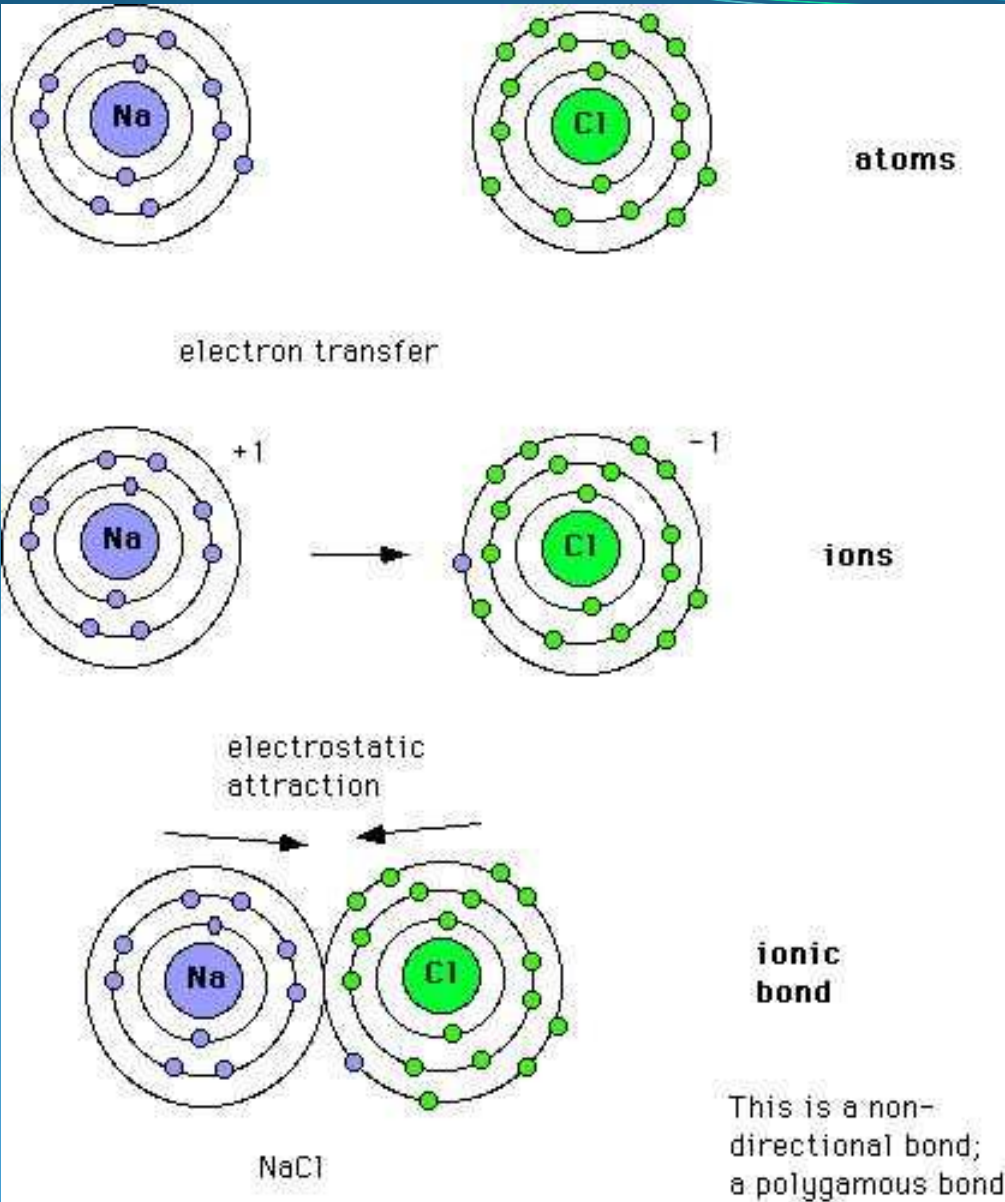
Potassium 42 = 23 neutrons



Atoms form ions

- Ions form when atoms gain or lose electrons
- Electrons have a negative charge
 - Gaining = negative ions (anions)
 - Losing = positive ions (cations)





Families & Ions/Oxidation #s

Family 1 = +1

Family 2 = +2

Family 13 = +3

Family 14 = +4

Family 15 = -3

Family 16 = -2

Family 17 = -1

Family 18 = 0

THE PERIODIC TABLE

1 IA	2 IIA											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
H 1 1.008 Hydrogen																	He 2 4.00 Helium
Li 3 6.94 Lithium	Be 4 9.01 Beryllium																Ne 10 20.18 Neon
Na 11 22.99 Sodium	Mg 12 24.31 Magnesium																Ar 18 39.95 Argon
K 19 39.10 Potassium	Ca 20 40.08 Calcium	Sc 21 44.96 Scandium	Ti 22 47.88 Titanium	V 23 50.94 Vanadium	Cr 24 52.00 Chromium	Mn 25 54.94 Manganese	Fe 26 55.85 Iron	Co 27 58.93 Cobalt	Ni 28 58.69 Nickel	Cu 29 63.55 Copper	Zn 30 65.39 Zinc	Ga 31 69.72 Gallium	Ge 32 72.61 Germanium	As 33 74.92 Arsenic	Se 34 78.96 Selenium	Br 35 79.90 Bromine	Kr 36 83.80 Krypton
Rb 37 85.47 Rubidium	Sr 38 87.62 Strontium	Y 39 88.91 Yttrium	Zr 40 91.22 Zirconium	Nb 41 92.91 Niobium	Mo 42 95.94 Molybdenum	Tc 43 97.9 Technetium	Ru 44 101.07 Ruthenium	Rh 45 102.91 Rhodium	Pd 46 106.42 Palladium	Ag 47 107.87 Silver	Cd 48 112.41 Cadmium	In 49 114.82 Indium	Sn 50 118.71 Tin	Sb 51 121.76 Antimony	Te 52 127.60 Tellurium	I 53 126.90 Iodine	Xe 54 131.29 Xenon
Cs 55 132.91 Cesium	Ba 56 137.33 Barium	La 57 138.91 Lanthanum	Hf 72 178.49 Hafnium	Ta 73 180.95 Tantalum	W 74 183.85 Tungsten	Re 75 186.21 Rhenium	Os 76 190.2 Osmium	Ir 77 192.22 Iridium	Pt 78 195.08 Platinum	Au 79 196.97 Gold	Hg 80 200.59 Mercury	Tl 81 204.38 Thallium	Pb 82 207.2 Lead	Bi 83 208.98 Bismuth	Po 84 (209) Polonium	At 85 (210) Astatine	Rn 86 (222) Radon
Fr 87 223.02 Francium	Ra 88 226.03 Radium	Ac 89 227.03 Actinium	Rf 104 (261) Rutherfordium	Db 105 (262) Dubnium	Sg 106 (263) Seaborgium	Bh 107 (262) Bohrium	Hs 108 (265) Hassium	Mt 109 (266) Meitnerium	Unnamed Discovery 110 Nov. 1994	Unnamed Discovery 111 Nov. 1994	Unnamed Discovery 112 1996	Unnamed Discovery 114 1999	Unnamed Discovery 116 1999	Unnamed Discovery 118 1999	Unnamed Discovery 119 1999	Unnamed Discovery 120 1999	Unnamed Discovery 121 1999
ALKALI METALS		ALKALI EARTH METALS		LANTHANIDES										HALOGENS		NOBLE GASES	
				Ce 58 140.12 Cerium	Pr 59 140.91 Praseodymium	Nd 60 144.24 Neodymium	Pm 61 (145) Promethium	Sm 62 150.36 Samarium	Eu 63 152.07 Europium	Gd 64 157.25 Gadolinium	Tb 65 158.93 Terbium	Dy 66 162.50 Dysprosium	Ho 67 164.93 Holmium	Er 68 167.26 Erbium	Tm 69 168.93 Thulium	Yb 70 173.04 Ytterbium	Lu 71 174.97 Lutetium
				Th 90 232.04 Thorium	Pa 91 231.04 Protactinium	U 92 238.03 Uranium	Np 93 (240) Neptunium	Pu 94 (240) Plutonium	Am 95 243.06 Americium	Cm 96 (247) Curium	Bk 97 (248) Berkelium	Cf 98 (251) Californium	Es 99 252.08 Einsteinium	Fm 100 257.10 Fermium	Md 101 (257) Mendelevium	No 102 259.10 Nobelium	Lr 103 262.11 Lawrencium



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Draw Concept Map...

Periodic Table

1A												8A						
1 H 1.008	2A										3A	4A	5A	6A	7A	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	3B	4B	5B	6B	7B	8B				1B	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
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	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 226.0	89 Ac 227.0	104 Rf (261)	105 Ha (262)	106 Unh (263)	107 Uns (262)				109 Uue (267)								

Lanthanides	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
Actinides	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)

5.2 The periodic table organizes the atoms of the elements by properties & atomic

THE PERIODIC TABLE

	THE PERIODIC TABLE																		
	1 <i>IA</i>											13 <i>IIIA</i>	14 <i>IVA</i>	15 <i>VA</i>	16 <i>VIA</i>	17 <i>VIIA</i>	18 <i>VIIIA</i>		
1	H 1 1.008 Hydrogen																He 2 4.00 Helium		
2	Li 3 6.94 Lithium	Be 4 9.01 Beryllium											B 5 10.81 Boron	C 6 12.01 Carbon	N 7 14.01 Nitrogen	O 8 16.00 Oxygen	F 9 19.00 Fluorine	Ne 10 20.18 Neon	
3	Na 11 22.99 Sodium	Mg 12 24.31 Magnesium	H 1 1.008 Hydrogen											Al 13 26.98 Aluminum	Si 14 28.09 Silicon	P 15 30.97 Phosphorus	S 16 32.07 Sulfur	Cl 17 35.45 Chlorine	Ar 18 39.95 Argon
4	K 19 39.10 Potassium	Ca 20 40.08 Calcium	Sc 21 44.96 Scandium	Ti 22 47.88 Titanium	V 23 50.94 Vanadium	Cr 24 52.00 Chromium	Mn 25 54.94 Manganese	Fe 26 55.85 Iron	Co 27 58.93 Cobalt	Ni 28 58.69 Nickel	Cu 29 63.55 Copper	Zn 30 65.39 Zinc	Ga 31 69.72 Gallium	Ge 32 72.61 Germanium	As 33 74.92 Arsenic	Se 34 78.96 Selenium	Br 35 79.90 Bromine	Kr 36 83.80 Krypton	
5	Rb 37 85.47 Rubidium	Sr 38 87.62 Strontium	Y 39 88.91 Yttrium	Zr 40 91.22 Zirconium	Nb 41 92.91 Niobium	Mo 42 95.94 Molybdenum	Tc 43 (97.9) Technetium	Ru 44 101.07 Ruthenium	Rh 45 102.91 Rhodium	Pd 46 106.42 Palladium	Ag 47 107.87 Silver	Cd 48 112.41 Cadmium	In 49 114.82 Indium	Sn 50 118.71 Tin	Sb 51 121.76 Antimony	Te 52 127.60 Tellurium	I 53 126.90 Iodine	Xe 54 131.29 Xenon	
6	Cs 55 132.91 Cesium	Ba 56 137.33 Barium	La 57 138.91 Lanthanum	Hf 72 178.49 Hafnium	Ta 73 180.95 Tantalum	W 74 183.85 Tungsten	Re 75 186.21 Rhenium	Os 76 190.2 Osmium	Ir 77 192.22 Iridium	Pt 78 195.08 Platinum	Au 79 196.97 Gold	Hg 80 200.59 Mercury	Tl 81 204.38 Thallium	Pb 82 207.2 Lead	Bi 83 208.98 Bismuth	Po 84 (209) Polonium	At 85 (210) Astatine	Rn 86 (222) Radon	
7	Fr 87 223.02 Francium	Ra 88 226.03 Radium	Ac 89 227.03 Actinium	Rf 104 (261) Rutherfordium	Db 105 (262) Dubnium	Sg 106 (263) Seaborgium	Bh 107 (262) Bohrium	Hs 108 (265) Hassium	Mt 109 (266) Meitnerium	Unnamed Discovery 110 Nov. 1994	Unnamed Discovery 111 Nov. 1994	Unnamed Discovery 112 1996		Unnamed Discovery 114 1999		Unnamed Discovery 116 1999		Unnamed Discovery 118 1999	

SYMBOL
 ATOMIC NUMBER
 ATOMIC WEIGHT
 NAME
 () = ESTIMATES

ALKALI METALS
 ALKALI EARTH METALS

HALOGENS
 NOBLE GASES

Ce 58 140.12 Cerium	Pr 59 140.91 Praseodymium	Nd 60 144.24 Neodymium	Pm 61 (145) Promethium	Sm 62 150.36 Samarium	Eu 63 152.97 Europium	Gd 64 157.25 Gadolinium	Tb 65 158.93 Terbium	Dy 66 162.50 Dysprosium	Ho 67 164.93 Holmium	Er 68 167.26 Erbium	Tm 69 168.93 Thulium	Yb 70 173.04 Ytterbium	Lu 71 174.97 Lutetium
Th 90 232.04 Thorium	Pa 91 231.04 Protactinium	U 92 238.03 Uranium	Np 93 237.05 Neptunium	Pu 94 (240) Plutonium	Am 95 243.06 Americium	Cm 96 (247) Curium	Bk 97 (248) Berkelium	Cf 98 (251) Californium	Es 99 252.08 Einsteinium	Fm 100 257.10 Fermium	Md 101 (257) Mendelevium	No 102 259.10 Nobelium	Lr 103 262.11 Lawrencium



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Elements make up the periodic table

- Elements can be organized by similarities
- Mendeleev made the 1st periodic table
 - He ordered the elements according to atomic masses

THE PERIODIC TABLE

Legend:
 H — SYMBOL
 1 — ATOMIC NUMBER
 1.008 — ATOMIC WEIGHT
 Hydrogen — NAME
 () = ESTIMATES

1 IA H 1.008 Hydrogen	2 IIA He 4.00 Helium																
3 1 Li 6.94 Lithium	4 2 Be 9.01 Beryllium											13 3 B 10.81 Boron	14 4 C 12.01 Carbon	15 5 N 14.01 Nitrogen	16 6 O 16.00 Oxygen	17 7 F 19.00 Fluorine	18 8 Ne 20.18 Neon
11 3 Na 22.99 Sodium	12 4 Mg 24.31 Magnesium	3 3 IIIB	4 4 IVB	5 5 VB	6 6 VIB	7 7 VIIB	8 8 VIIIB	9 9 VIIIB	10 10 VIIIB	11 11 IB	12 12 IIB	13 13 Al 26.98 Aluminum	14 14 Si 28.09 Silicon	15 15 P 30.97 Phosphorus	16 16 S 32.07 Sulfur	17 17 Cl 35.45 Chlorine	18 18 Ar 39.95 Argon
19 4 K 39.10 Potassium	20 2 Ca 40.08 Calcium	21 3 Sc 44.96 Scandium	22 4 Ti 47.88 Titanium	23 5 V 50.94 Vanadium	24 6 Cr 52.00 Chromium	25 7 Mn 54.94 Manganese	26 8 Fe 55.85 Iron	27 9 Co 58.93 Cobalt	28 10 Ni 58.69 Nickel	29 11 Cu 63.55 Copper	30 12 Zn 65.39 Zinc	31 13 Ga 69.72 Gallium	32 14 Ge 72.61 Germanium	33 15 As 74.92 Arsenic	34 16 Se 78.96 Selenium	35 17 Br 79.90 Bromine	36 18 Kr 83.80 Krypton
37 5 Rb 85.47 Rubidium	38 4 Sr 87.62 Strontium	39 3 Y 88.91 Yttrium	40 4 Zr 91.22 Zirconium	41 5 Nb 92.91 Niobium	42 6 Mo 95.94 Molybdenum	43 7 Tc (97.9) Technetium	44 8 Ru 101.07 Ruthenium	45 9 Rh 106.42 Rhodium	46 10 Pd 106.91 Palladium	47 11 Ag 107.87 Silver	48 12 Cd 112.41 Cadmium	49 13 In 114.82 Indium	50 14 Sn 118.71 Tin	51 15 Sb 121.76 Antimony	52 16 Te 127.60 Tellurium	53 17 I 126.91 Iodine	54 18 Xe 131.29 Xenon
55 6 Cs 132.91 Cesium	56 2 Ba 137.33 Barium	57 3 La 138.91 Lanthanum	58 4 Hf 178.49 Hafnium	59 5 Ta 180.95 Tantalum	60 6 W 183.85 Tungsten	61 7 Re 186.21 Rhenium	62 8 Os 190.2 Osmium	63 9 Ir 192.22 Iridium	64 10 Pt 195.08 Platinum	65 11 Au 196.97 Gold	66 12 Hg 200.59 Mercury	67 13 Tl 204.38 Thallium	68 14 Pb 207.2 Lead	69 15 Bi 208.98 Bismuth	70 16 Po (209) Polonium	71 17 At (210) Astatine	72 18 Rn (222) Radon
87 7 Fr 223.02 Francium	88 2 Ra 226.02 Radium	89 3 Ac 227.03 Actinium	90 4 Rf 104 Rutherfordium	91 5 Db 105 Dubnium	92 6 Sg 106 Seaborgium	93 7 Bh (263) Bohrium	94 8 Hs (265) Hassium	95 9 Mt (266) Meitnerium	96 10 Unlabeled 110 Nov. 1994	97 11 Unlabeled 111 Nov. 1994	98 12 Unlabeled 112 1996	99 13 Unlabeled 114 1999	100 14 Unlabeled 116 1999	101 15 Unlabeled 118 2009	102 16 Unlabeled (210) Copernicium	103 17 Unlabeled (211) Darmstadtium	104 18 Unlabeled (212) Roentgenium
ALKALI METALS ALKALI EARTH METALS HALOGENS NOBLE GASES																	
LANTHANIDES																	
59 Ce 140.12 Cerium	60 Pr 140.91 Praseodymium	61 Nd 144.24 Neodymium	62 Pm (145) Promethium	63 Sm 150.36 Samarium	64 Eu 152.07 Europium	65 Gd 157.25 Gadolinium	66 Tb 158.93 Terbium	67 Dy 162.50 Dysprosium	68 Ho 164.93 Holmium	69 Er 167.26 Erbium	70 Tm 168.93 Thulium	71 Yb 173.04 Ytterbium	72 Lu 174.97 Lutetium				
ACTINIDES																	
89 Th 232.04 Thorium	90 Pa 231.04 Protactinium	91 U 238.03 Uranium	92 Np 237.05 Neptunium	93 Pu (240) Plutonium	94 Am 243.06 Americium	95 Cm (247) Curium	96 Bk (248) Berkelium	97 Cf (251) Californium	98 Es 252.08 Einsteinium	99 Fm 257.10 Fermium	100 Md (257) Mendelevium	101 No 259.10 Nobelium	102 Lr 262.11 Lawrencium				

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Group (or family)—Column of elements with similar properties

THE PERIODIC TABLE

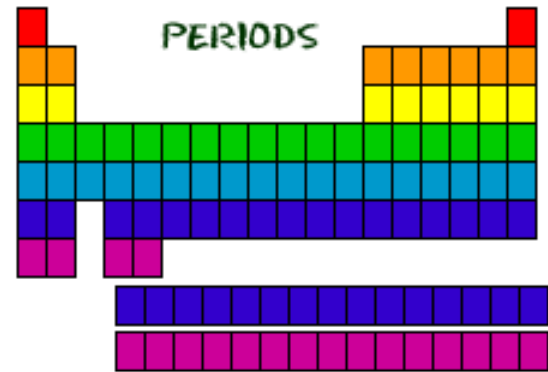
	THE PERIODIC TABLE																		
	1 <i>IA</i>											13 <i>IIIA</i>	14 <i>IVA</i>	15 <i>VA</i>	16 <i>VIA</i>	17 <i>VIIA</i>	18 <i>VIIIA</i>		
1	H 1 1.008 Hydrogen											B 5 10.81 Boron	C 6 12.01 Carbon	N 7 14.01 Nitrogen	O 8 16.00 Oxygen	F 9 19.00 Fluorine	Ne 10 20.18 Neon		
2	Li 3 6.94 Lithium	Be 4 9.01 Beryllium											Al 13 26.98 Aluminum	Si 14 28.09 Silicon	P 15 30.97 Phosphorus	S 16 32.07 Sulfur	Cl 17 35.45 Chlorine	Ar 18 39.95 Argon	
3	Na 11 22.99 Sodium	Mg 12 24.31 Magnesium	3 <i>IIIB</i>	4 <i>IVB</i>	5 <i>VB</i>	6 <i>VIB</i>	7 <i>VII B</i>	8 <i>VIIIB</i>	9 <i>VIIIB</i>	10 <i>VIIIB</i>	11 <i>IB</i>	12 <i>IIB</i>	Ga 31 69.72 Gallium	Ge 32 72.61 Germanium	As 33 74.92 Arsenic	Se 34 78.96 Selenium	Br 35 79.90 Bromine	Kr 36 83.80 Krypton	
4	K 19 39.10 Potassium	Ca 20 40.08 Calcium	Sc 21 44.96 Scandium	Ti 22 47.88 Titanium	V 23 50.94 Vanadium	Cr 24 52.00 Chromium	Mn 25 54.94 Manganese	Fe 26 55.85 Iron	Co 27 58.93 Cobalt	Ni 28 58.69 Nickel	Cu 29 63.55 Copper	Zn 30 65.39 Zinc	Ga 31 69.72 Gallium	Ge 32 72.61 Germanium	As 33 74.92 Arsenic	Se 34 78.96 Selenium	Br 35 79.90 Bromine	Kr 36 83.80 Krypton	
5	Rb 37 85.47 Rubidium	Sr 38 87.62 Strontium	Y 39 88.91 Yttrium	Zr 40 91.22 Zirconium	Nb 41 92.91 Niobium	Mo 42 95.94 Molybdenum	Tc 43 (97.9) Technetium	Ru 44 101.07 Ruthenium	Rh 45 102.91 Rhodium	Pd 46 106.42 Palladium	Ag 47 107.87 Silver	Cd 48 112.41 Cadmium	In 49 114.82 Indium	Sn 50 118.71 Tin	Sb 51 121.76 Antimony	Te 52 127.60 Tellurium	I 53 126.90 Iodine	Xe 54 131.29 Xenon	
6	Cs 55 132.91 Cesium	Ba 56 137.33 Barium	La 57 138.91 Lanthanum	Hf 72 178.49 Hafnium	Ta 73 180.95 Tantalum	W 74 183.85 Tungsten	Re 75 186.21 Rhenium	Os 76 190.2 Osmium	Ir 77 192.22 Iridium	Pt 78 195.08 Platinum	Au 79 196.97 Gold	Hg 80 200.59 Mercury	Tl 81 204.38 Thallium	Pb 82 207.2 Lead	Bi 83 208.98 Bismuth	Po 84 (209) Polonium	At 85 (210) Astatine	Rn 86 (222) Radon	
7	Fr 87 223.02 Francium	Ra 88 226.03 Radium	Ac 89 227.03 Actinium	Rf 104 (261) Rutherfordium	Db 105 (262) Dubnium	Sg 106 (263) Seaborgium	Bh 107 (262) Bohrium	Hs 108 (265) Hassium	Mt 109 (266) Meitnerium	Unnamed Discovery 110 Nov. 1994	Unnamed Discovery 111 Nov. 1994	Unnamed Discovery 112 1996	Unnamed Discovery 114 1999	Unnamed Discovery 116 1999	Unnamed Discovery 118 1999	Unnamed Discovery 119 1999	Unnamed Discovery 120 1999	Unnamed Discovery 121 1999	
	ALKALI METALS		ALKALI EARTH METALS										HALOGENS					NOBLE GASES	

H — SYMBOL
 1 — ATOMIC NUMBER
 1.008 — ATOMIC WEIGHT
 Hydrogen — NAME
 () = ESTIMATES

LANTHANIDES	Ce 58 140.12 Cerium	Pr 59 140.91 Praseodymium	Nd 60 144.24 Neodymium	Pm 61 (145) Promethium	Sm 62 150.36 Samarium	Eu 63 152.97 Europium	Gd 64 157.25 Gadolinium	Tb 65 158.93 Terbium	Dy 66 162.50 Dysprosium	Ho 67 164.93 Holmium	Er 68 167.26 Erbium	Tm 69 168.93 Thulium	Yb 70 173.04 Ytterbium	Lu 71 174.97 Lutetium
ACTINIDES	Th 90 232.04 Thorium	Pa 91 231.04 Protactinium	U 92 238.03 Uranium	Np 93 237.05 Neptunium	Pu 94 (240) Plutonium	Am 95 243.06 Americium	Cm 96 (247) Curium	Bk 97 (248) Berkelium	Cf 98 (251) Californium	Es 99 252.08 Einsteinium	Fm 100 257.10 Fermium	Md 101 (257) Mendelevium	No 102 259.10 Nobelium	Lr 103 262.11 Lawrencium



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- Period—row of elements
 - The # of energy levels an element has
 - The period # tells you how many rings to draw around the atom's nucleus
 - Properties like atomic size, density, & likelihood to form ions vary in regular ways up, down, & across the chart

5.3 Periodic Table is a map of the elements

- Periodic table has distinct regions
 - Position on the table reveals something about the element (like how reactive it is)
 - Groups 1 & 17 are the most reactive
 - Group 18 is the least reactive (they are stable)

THE PERIODIC TABLE

Legend:
 H: SYMBOL, ATOMIC NUMBER, ATOMIC WEIGHT, NAME
 () = ESTIMATES

1 1 1.008 Hydrogen	2 4 9.01 Helium											13 5 10.81 Boron	14 6 12.01 Carbon	15 7 14.01 Nitrogen	16 8 16.00 Oxygen	17 9 19.00 Fluorine	18 10 20.18 Neon								
3 11 6.94 Lithium	4 12 24.31 Magnesium	3 13 22.99 Sodium	4 14 28.09 Silicon	5 15 30.97 Phosphorus	6 16 32.07 Sulfur	7 17 35.45 Chlorine	8 18 39.95 Argon											13 13 26.98 Aluminum	14 14 28.09 Silicon	15 15 30.97 Phosphorus	16 16 32.07 Sulfur	17 17 35.45 Chlorine	18 18 39.95 Argon		
5 19 39.10 Potassium	6 20 40.08 Calcium	3 19 39.10 Potassium	4 20 40.08 Calcium	5 21 44.96 Scandium	6 22 47.88 Titanium	7 23 50.94 Vanadium	8 24 52.00 Chromium	9 25 54.94 Manganese	10 26 55.85 Iron	11 27 58.93 Cobalt	12 28 63.55 Nickel	13 29 65.39 Copper	14 30 69.72 Zinc	15 31 72.61 Gallium	16 32 74.92 Germanium	17 33 78.96 Arsenic	18 34 78.96 Selenium	19 35 79.90 Bromine	20 36 83.80 Krypton						
6 37 85.47 Rubidium	7 38 87.62 Strontium	4 37 85.47 Rubidium	5 38 87.62 Strontium	6 39 88.91 Yttrium	7 40 91.22 Zirconium	8 41 92.91 Niobium	9 42 95.94 Molybdenum	10 43 97.91 Technetium	11 44 101.07 Ruthenium	12 45 102.91 Rhodium	13 46 106.42 Palladium	14 47 107.87 Silver	15 48 112.41 Cadmium	16 49 114.82 Indium	17 50 118.71 Tin	18 51 121.76 Antimony	19 52 127.60 Tellurium	20 53 126.90 Iodine	21 54 131.29 Xenon						
7 55 132.91 Cesium	8 56 137.33 Barium	5 55 132.91 Cesium	6 56 137.33 Barium	7 57 138.91 Lanthanum	8 58 174.99 Cerium	9 59 176.49 Praseodymium	10 60 176.49 Neodymium	11 61 176.49 Promethium	12 62 186.21 Samarium	13 63 186.21 Europium	14 64 190.22 Gadolinium	15 65 190.22 Terbium	16 66 195.08 Dysprosium	17 67 197.04 Holmium	18 68 200.59 Erbium	19 69 200.59 Thulium	20 70 207.2 Lead	21 71 208.98 Bismuth	22 72 208.98 Polonium	23 73 209 Astatine	24 74 209 Radium				
8 87 223.02 Francium	9 88 226.03 Radium	6 87 223.02 Francium	7 88 226.03 Radium	8 89 227.03 Actinium	9 90 232.04 Thorium	10 91 231.04 Protactinium	11 92 238.03 Uranium	12 93 238.03 Neptunium	13 94 237.05 Plutonium	14 95 242.06 Americium	15 96 242.06 Curium	16 97 247.07 Berkelium	17 98 247.07 Californium	18 99 251.10 Einsteinium	19 100 252.08 Fermium	20 101 252.08 Mendelevium	21 102 258.10 Nobelium	22 103 262.11 Lawrencium	23 104 262.11 Rutherfordium	24 105 262.11 Dubnium	25 106 262.11 Seaborgium	26 107 262.11 Bohrium	27 108 262.11 Hassium	28 109 262.11 Tennessine	29 110 262.11 Oganesson

Regions:
 ALKALI METALS (Group 1), EARTH METALS (Groups 2-10), HALOGENS (Group 17), NOBLE GASES (Group 18), LANTHANIDES (Groups 3-10), ACTINIDES (Groups 8-10)

Most elements are metals

- Metals—usually shiny, conduct electricity & heat well, can be easily shaped (malleable) & drawn into a wire (ductility)



Metals

- 1. Reactive—families 1 & 2
 - Alkali metals (family 1)
 - Alkaline earth metals (family 2)
- 2. Transition—more stable than the reactive metals
- 3. Rare earth –referred to as the “lathanides”
- 4. Radioactive-”actinides”



Alkali metals & alkaline earth metals—at the left of the table & are very reactive

The periodic table is color-coded and labeled as follows:

- Alkali Metals:** Group 1 (Li, Na, K, Rb, Cs, Fr)
- Alkaline Earth:** Group 2 (Be, Mg, Ca, Sr, Ba, Ra)
- Transition Metals:** Groups 3-10 (Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, Hf, Ta, W, Re, Os, Ir, Pt, Au, Hg)
- Halogens:** Groups 17 (F, Cl, Br, I, At)
- Noble Gases:** Group 18 (He, Ne, Ar, Kr, Xe, Rn)

H																	He
Li	Be	Transition Metals										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	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub						
Lanthanides		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
Actinides		Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr		

Transitions metals—near the center & include copper, gold, silver, iron
Alloy—mixture of metals

The periodic table is color-coded and labeled as follows:

- Alkali Metals:** Group 1 (red)
- Alkaline Earth:** Group 2 (orange)
- Transition Metals:** Groups 3-10 (various colors: yellow, green, light green, cyan)
- Halogens:** Groups 17-18 (purple)
- Noble Gases:** Group 18 (pink)

H																	He
Li	Be	Transition Metals										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	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub						
Lanthanides		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
Actinides		Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr		

- Rare earth metals—next to bottom row (Lanthanides)
- Radioactive—bottom row (Actinides)
- Bottom 2 rows—separated from the table to save space

Periodic Table of the Elements

1	2											18	19	20											36	37	38	39	40											54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100																																																																																																																											
H	He											B	C	N	O	F	Ne											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	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn											Fr	Ra	Rf	Db	Sg	Bh	Hs	Ta	Hf	Tl	Pb	Bi	Po	At	Rn											La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu											Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Mn	Nb	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn											Lr										
LANTHANIDE SERIES																ACTINIDE SERIES																																																																																																																																																																																																	

- **Common Properties of the Rare Earths**
- These common properties apply to both the lanthanides and actinides.
- The rare earths are silver, silvery-white, or gray metals.
- The metals have a high luster, but tarnish readily in air.
- The metals have high electrical conductivity.
- The rare earths share many common properties. This makes them difficult to separate or even distinguish from each other.
- There are *very* small differences in solubility and complex formation between the rare earths.

Periodic Table of Elements

	IA																		0
1	H																		2
2	Li	Be																	10
3	Na	Mg																	18
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	36
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	54
6	Cs	Ba	*La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	86
7	Fr	Ra	+Ac	Rf	Ha	106	107	108	109	110									

* Lanthanide Series
+ Actinide Series

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr


Legend - click to find out more...

H - gas	Li - solid	Br - liquid	Tc - synthetic
Non-Metals	Transition Metals	Rare Earth Metals	Halogens
Alkali Metals	Alkali Earth Metals	Other Metals	Inert Elements

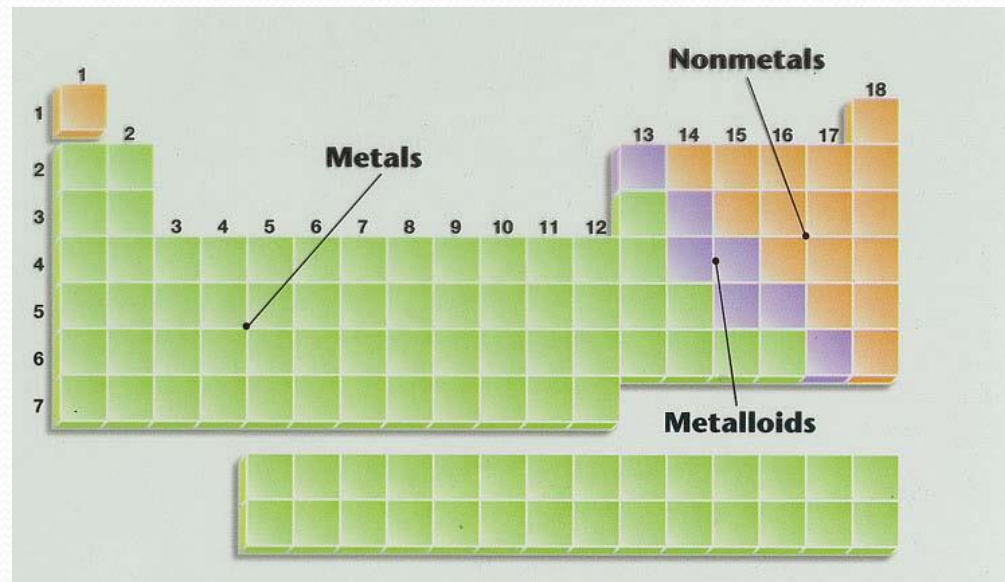


Noble Gases (inert = non reactive = stable)

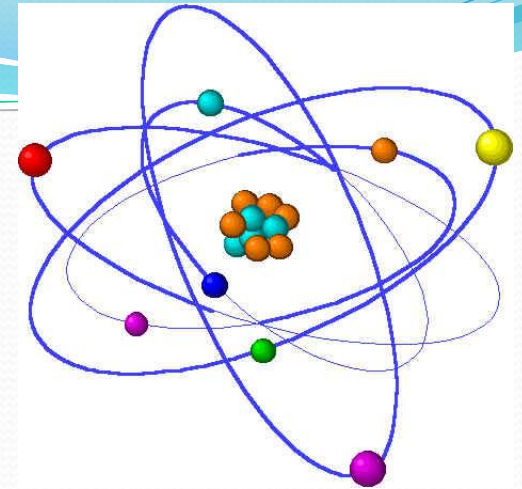
1	2											3	4	5	6	7	0
																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac															

 Noble gases

- Metalloids lie between metals & nonmetals—they have characteristics of BOTH metals & nonmetals
 - Make good semiconductors in electronic devices
(computer chips)

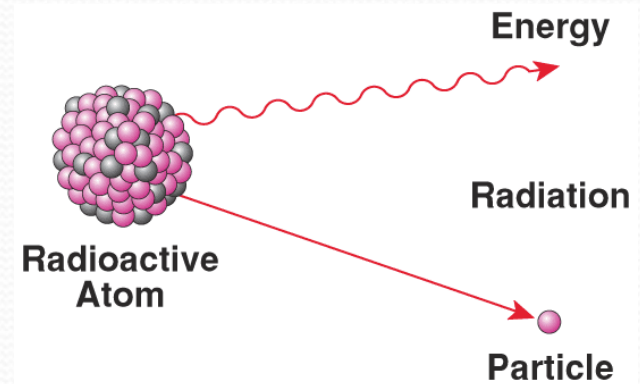


Some atoms can change their identities



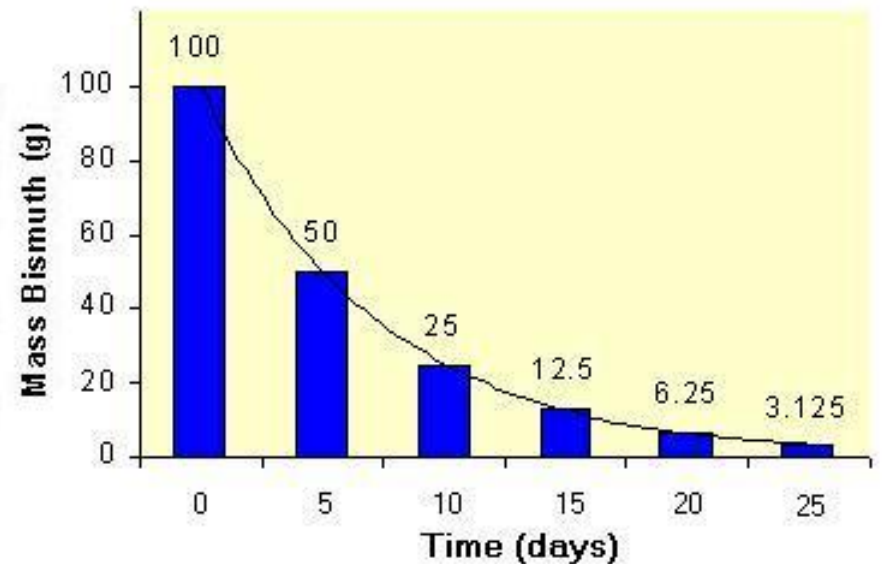
- Radioactive decay

- Atomic nucleus is held together by forces
- Sometimes there can be too many or too few neutrons so these forces cannot hold it together properly
- To regain stability, the nucleus will produce particles & eject them



Radioactivity

- Identity of radioactive atoms changes when the # of protons change
- Half life—amount of time needed for $\frac{1}{2}$ of the atoms in a particular sample to decay
 - Can be thousands or millions of years
 - NEVER decays to zero!!



If half life is 25 years...

