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Development of the Periodic Table

- Properties of elements were known to be similar EX: KCl, NaCl
- atomic masses were different
K=39.10, Na=22.99

How could sense be made of this?
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Mendeleev's Periodic Table

Row	Group I R ₂ O	Group II RO	Group III R ₂ O ₃	Group IV RH ₄ RO ₂	Group V RH ₅ R ₂ O ₅	Group VI RH ₆ RO ₃	Group VII RH R ₂ O ₇	Group VIII RO ₄
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	Se = 78	Br = 80	
6	Rb = 85	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	I = 127	
8	Cs = 133	Ba = 137	?Di = 138	?Ce = 140				
9								
10			?Er = 178	?La = 180	Ta = 182	W = 184		O ₃ = 195, Ir = 197, Pt = 198, Au = 199
11	(Au = 199)	Hg = 200	Tl = 204	Pb = 207	Bi = 208			
12				Th = 231		U = 240		

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The Modern Periodic Table

Periodic Law- When elements are arranged in the order of their *atomic numbers* their chemical and physical properties show repeatable, or periodic trends.

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The *Atomic Number* Indicates the Number of Protons

- Always a whole (non-decimal) number
- Indicates the number of protons in an atom

${}^6_6\text{C}$
Carbon
The number of protons determines what element the atom is.
An atom contains an equal number of protons and electrons

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The *Mass Number* Indicates the Mass of the Atom

${}^{12}_6\text{C}$ or ${}^{12}\text{C}$
Carbon-12

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Atomic Number and Mass Number Are Used to Determine Number of Neutrons

Atomic number- indicates the number of protons
Mass number- the mass of the atom

${}^{12}_6\text{C}$ ${}^{13}_6\text{C}$ ${}^{14}_6\text{C}$
12-6= 6 neutrons 13-6= 7 neutrons

Isotopes- atoms of the same element having different numbers of neutrons.

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Atomic Mass and Atomic Weight

Atomic Weight- the average mass of the isotopes of an element

EX: ^{20}Ne ^{21}Ne ^{22}Ne
 90.92% 0.26% 8.82%

$$(0.9092)(20) + (0.0026)(21) + (0.0882)(22)$$

$$= 18.184 + 0.0546 + 1.9404$$

$$= 20.179$$

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Ne
20.179

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Sample Test Question

1. How many protons, neutrons and electrons are in an atom of ^{41}Ca ?

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The Modern Periodic Table, cont.

- Bigger
- Groups- vertical columns of elements, have similar chemistry
- Periods- horizontal rows of elements, have principal energy level in common
- metals, metalloids and nonmetals

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FAQs

Do we have to memorize the periodic table?
 Do we have to know that there are 17 nonmetal elements?

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Metals and Nonmetals: Dividing Line

IIIB	IIIA	IVB	IVB	VIB	VIA	VIB	VIA	1.00794 ^Δ
5	6	7	8	9				
B	C	N	O	F				
10.811 ^Δ	12.011	14.0067	15.9994 [†]	18.998403				
13	14	15	16	17				
Al	Si	P	S	Cl				
26.98154	28.0855 [†]	30.97376	32.066 ^Δ	35.453				
31	32	33	34	35				
Ga	Ge	As	Se	Br				
69.723 ^Δ	72.59 [†]	74.9216	78.96 [†]	79.904				
49	50	51	52	53				
In	Sn	Sb	Te	I				
114.82	118.710 ^Δ	121.75 [†]	127.60 [†]	126.9045				
81	82	83	84	85				
Tl	Pb	Bi	Po	At				
204.383	207.2	208.9804	(209)	(210)				

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Properties of Metals and Nonmetals

Metal	<i>Metalloid</i>	Nonmetal
solid		liquid or gas
shiny	<i>intermediate</i>	dull
malleable/ductile	<i>properties</i>	brittle
conductive	<i>semiconductors</i>	insulators

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Groups vs. Periods

Periodic Chart of the Elements

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Group	Name
IA	Alkali metals
IIA	Alkaline earth metals
IIIA	
IVA	
VA	
VIA	(Chalcogens)
VIIA	Halogens
VIIIA	Noble gases

Transition Elements
Lanthanides
Actinides

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Periods

- Question: Why are they different lengths?
- Short answer: Because of electron configurations.

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Physical Periodicity

- size
 - ionization energy- the amount of energy it takes to remove an electron from an atom
 - electronegativity- how tightly an atom pulls on another atoms electrons
 - melting point/boiling point
- Know these four trends!

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Sample Test Question

Rank the following elements in order of increasing size: F, La, Cu

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The Periodic Table and Chemical Behavior

- Groups react chemically in similar fashions.
- React the way they do because of *valence electrons*.

Valence Electrons- e^- in the outer shell of an atom, no matter what principle energy level.

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Group	Name	valence e ⁻
IA	Alkali metals	1
IIA	Alkaline earth metals	2
IIIA		3
IVA		4
VA		5
VIA	Chalcogens	6
VIIA	Halogens	7
VIIIA	Noble gases	8
	Transition Elements	2*

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Oxidation State

Oxidation State- The charge that develops on an atom due to loss or gain of e⁻.

Atoms A and B, while strolling idly down the street, broke into the following exchange:

Atom A : "I think I've lost an electron."

Atom B : "Are you sure?"

Atom A : "I'm positive!"

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Group	Name	valence e ⁻	oxidation state
IA	Alkali metals	1	+1
IIA	Alkaline earth metals	2	+2
IIIA		3	+3
IVA		4	±4
VA		5	-3
VIA	Chalcogens	6	-2
VIIA	Halogens	7	-1
VIIIA	Noble gases	8	0
	Transition Elements	2*	+1,+2,+3

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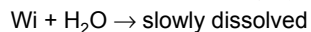
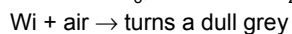
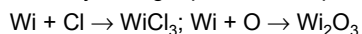
Chemical Properties of Main-Group Elements

- Noble gases are nonreactive
- Alkali metals/Alkaline earth metals
 - rxn with water
 - rxn with air
 - rxn with halogens
 - rxn with oxygen

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Sample Test Question

Eden Advance members, charting planet G889, discover a rock which glows in the dark. It is discovered it glows because of an element they symbolize Wi. Where would Wi be placed on our periodic table, if it has the following properties? (Pick an element that would be approximately the right place and explain why)



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Other Important Main-Group Elements

- B- used metallurgically, glass
- Al
- C- life
- Si, Ge- computer chips
- N₂, O₂ - atmosphere
- P- fertilizer

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Properties of Transition Group Elements

- Difficult because of d electrons
 - Fe: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$
- Oxidation state harder to predict
 - (Fe +2, **+3**)
- More than one compound can form
 - FeCl_2 , **FeCl_3**
- React like elements not just within groups, but also across groups
 - **CoCl_2** , CoCl_3

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Important Transition Group Elements

- Ag, Au, Pt, Pd- the precious metals
- Ti- tanks
- Cr- faucets
- Fe, Cu
- Zn- galvanized metal
- W- light bulb filaments
- Ni, Cd, Zn- batteries

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Sample Test Questions

1. Which is larger, an atom of He or Fe?
2. Name two groups of the periodic table.
3. What is the e^- configuration of the following: He Be^{2+} F^-
4. What is the Lewis dot structure for Cl? for Cl^- ?