

Periodic Table

TABELLE II

REIHE	GRUPPE I. — R ² O	GRUPPE II. — RO	GRUPPE III. — R ² O ₃	GRUPPE IV. RH ⁴ RO ₂	GRUPPE V. RH ³ R ² O ₅	GRUPPE VI. RH ² RO ₃	GRUPPE VII. RH R ² O ₇	GRUPPE 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	Mu=96	—=100	Ru=104, Rh=104, Pd=106, Ag=108.
7	(Ag=108)	Cd=112	In=113	Sn=118	Sb=122	Tc=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	—	— — — —

Intro

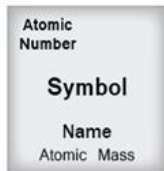
OUTCOME QUESTION(S):

S1-2-06

How is the Periodic Table organized for the elements and what trends (patterns) exist?

Periodic Table of the Elements

1 IA 1A																	18 VIIIA 8A						
1 H Hydrogen 1.008																	2 He Helium 4.003						
3 Li Lithium 6.941	4 Be Beryllium 9.012																	5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 VIII 8	9 VIII 8	10 VIII 8	11 IB 1B	12 IIB 2B	13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948						
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 84.798						
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.711	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.294						
55 Cs Cesium 132.905	56 Ba Barium 137.328	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.085	79 Au Gold 196.967	80 Hg Mercury 200.592	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018						
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [293]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown						



Lanthanide Series	57 La Lanthanum 138.905	58 Ce Cerium 140.116	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.243	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.055	71 Lu Lutetium 174.967
Actinide Series	89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]



Elemental symbols originated from a *Greek* or *Latin* root word

Element	Modern Symbols	Alchemist Symbols	Dalton Symbols
Antimony	Sb		
Arsenic	As		
Bismuth	Bi		
Carbon	C		
Copper	Cu		
Gold	Au		
Iron	Fe		
Lead	Pb		
Mercury	Hg		
Silver	Ag		
Sulphur	S		
Tin	Sn		
Zinc	Zn		

1870 – Dmitri Mendeleev

- Russian scientist and professor
- He arranged the 63 elements by atomic mass
- He noticed a repetition of properties (or periodicity)
- He called this *pattern* of properties “Periodic Law”



	Gruppe I. R'O	Gruppe II. RO	Gruppe III. R'O ³	Gruppe IV. RH ⁴ RO ⁷	Gruppe V. RH ³ R'O ⁵	Gruppe VI. RH ³ RO ³	Gruppe VII. RH R ² O ⁷	Gruppe VIII. — RO ⁴
1	H = 1							
2	Li = 7	Be = 9.4	B = 11	C = 12	N = 14	O = 16	F = 19	
3	N = 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 = 60, 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 = 56	— = 100	Ru = 104, Rh = 104, Pd = 106, Ag = 104.
7	(Ag = 104)	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	—	— — — —

Mendeleev's Periodic Table of 1871, redrawn by J. O. Moran, 2013

	Gruppe I. R ¹ O	Gruppe II. RO	Gruppe III. R ¹ O ³	Gruppe IV. RH ⁴ RO ⁷	Gruppe V. RH ³ R ² O ⁵	Gruppe VI. RH ³ RO ³	Gruppe VII. RH R ² O ⁷	Gruppe VIII. — RO ⁴
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4	K = 39	Ca = 40	Sc = 44	Ti = 48	V = 51	Cr = 52	Mn = 55	Fe = 56 Co = 59 Ni = 60, Cu = 63.
5	(Cu = 63)	Zn = 65	Ga = 68	Ge = 72	As = 75	Se = 78	Br = 80	
6	Rb = 85	Sr = 87	?Yt = 88	Zr = 90	Nb = 94	Mo = 96	Tc = 100	Ru = 104, Rh = 104, Pd = 106, Ag = 104.
7	(Ag = 104)	Cd = 112	In = 113	Sn = 118	Sb = 122	Te = 125	J = 127	
8	Cs = 133	Ba = 137	?Di = 138	?Ce = 140	—	—	—	— — — —
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11	(Au = 199)	Hg = 200	Tl = 204	Pb = 207	Bi = 208	—	—	
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Mendeleev's Periodic Table of 1871, redrawn by J. O. Moran, 2013

Mendeleev correctly predicted the mass of elements yet to be discovered and left spaces open for them! [Video](#)

Moseley (1913)

Experiments showed proton number was a better method to **organize** the elements.

- Repetition of properties (**periodicity**) became *more clear*

Moseley's Periodic Table

Group 0	I		II		III		IV		V		VI		VII		VIII	
	a	b	a	b	a	b	a	b	a	b	a	b	a	b		
	H 1															
He 2	Li 3		Be 4		B 5		C 6		N 7		O 8		F 9			
Ne 10	Na 11		Mg 12		Al 13		Si 14		P 15		S 16		Cl 17			
Ar 18	K 19		Ca 20		Sc 21		Ti 22		V 23		Cr 24		Mn 25		Fe 26, Co 27, Ni 28	
Kr 36	Rb 37		Sr 38		Y 39		Zr 40		Nb 41		Mo 42		-		Ru 44, Rh 45, Pd 46	
	Ag 47		Cd 48		In 49		Sn 50		Sb 51		Te 52		I 53			
Xe 54	Cs 55		Ba 56		57-71*		Hf 72		Ta 73		W 74		Re 75		Os 76, Ir 77, Pt 78	
	Au 79		Hg 80		Tl 81		Pb 82		Bi 83		Po 84		-			
Rn 86	-		Ra 88		Ac 89		Th 90		Pa 91		U 92					



Modern Periodic Law:

“The properties of elements are a periodic function of increasing atomic number”

Group 0	I		II		III		IV		V		VI		VII		VIII
	a	b	a	b	a	b	a	b	a	b	a	b	a	b	
	H 1														
He 2	Li 3		Be 4		B 5		C 6		N 7		O 8		F 9		
Ne 10	Na 11		Mg 12		Al 13		Si 14		P 15		S 16		Cl 17		
Ar 18	K 19 Cu 29		Ca 20 Zn 30		Sc 21 Ga 31		Ti 22 Ge 32		V 23 As 33		Cr 24 Se 34		Mn 25 Br 35		Fe 26, Co 27, Ni 28
Kr 36	Rb 37 Ag 47		Sr 38 Cd 48		Y 39 In 49		Zr 40 Sn 50		Nb 41 Sb 51		Mo 42 Te 52		- I 53		Ru 44, Rh 45, Pd 46
Xe 54	Cs 55 Au 79		Ba 56 Hg 80		57-71* Tl 81		Hf 72 Pb 82		Ta 73 Bi 83		W 74 Po 84		Re 75 -		Os 76, Ir 77, Pt 78
Rn 86	-		Ra 88		Ac 89		Th 90		Pa 91		U 92				

We know now that most element **properties** are due to the number of **valence electrons**

Periodic Table of the Elements

1 IA 1A H Hydrogen 1.008	2 IIA 2A He Helium 4.003																	13 IIIA 3A B Boron 10.811	14 IVA 4A C Carbon 12.011	15 VA 5A N Nitrogen 14.007	16 VIA 6A O Oxygen 15.999	17 VIIA 7A F Fluorine 18.998	18 VIIIA 8A Ne Neon 20.180
3 Li Lithium 6.941	4 Be Beryllium 9.012																	5 Al Aluminum 26.982	6 Si Silicon 28.086	7 P Phosphorus 30.974	8 S Sulfur 32.066	9 Cl Chlorine 35.453	10 Ar Argon 39.948
11 Na Sodium 22.990	12 Mg Magnesium 24.305	3 IIIB Sc Scandium 44.956	4 IVB Ti Titanium 47.867	5 VB V Vanadium 50.942	6 VIB Cr Chromium 51.996	7 VIIB Mn Manganese 54.938	8 Fe Iron 55.845	9 VIII 8 Co Cobalt 58.933	10 VIII 8 Ni Nickel 58.693	11 IB Cu Copper 63.546	12 IIB Zn Zinc 65.38	13 Ga Gallium 69.723	14 Ge Germanium 72.631	15 As Arsenic 74.922	16 Se Selenium 78.971	17 Br Bromine 79.904	18 Kr Krypton 83.798						
19 K Potassium 39.098	20 Ca Calcium 40.078																	31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 83.798
																		49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.294
																		82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018	
																		114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [298]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown	

Non-metals

Metals

Lanthanide Series	57 La Lanthanum 138.905	58 Ce Cerium 140.116	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.243	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.055	71 Lu Lutetium 174.967
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- Alkali Metal
- Alkaline Earth
- Transition Metal
- Basic Metal
- Semimetal
- Nonmetal
- Halogen
- Noble Gas
- Lanthanide
- Actinide

An updated Periodic Table contains ALL **118 elements** – separated into metal and non-metal atoms that make up **EVERYTHING** in the **Universe!**

The **rows** of the periodic table are called **periods**.

• Elements in periods **do not** have similar properties

• The period number tells us how many electron orbits, or energy levels, the atoms have.

periods
PERIOD

1	IA	-----																VIII	
1	H																	2	
2	Li	IIA																	10
3	Na	Mg																	18
4	K	Ca	Sc	III A	IVA	VA	VIA	VIIA	VIIIA	IB	IIB	III B	IV B	VB	VIB	VII B	Ar		
5	Rb	Sr	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe		
6	Cs	Ba	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn		
7	Fr	Ra	Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub								
			57	58	59	60	61	62	63	64	65	66	67	68	69	70	71		
			La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
			89	90	91	92	93	94	95	96	97	98	99	100	101	102	103		
			Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr		

The columns of the periodic table are called **groups**.

• Elements in groups have **similar** properties

A **family** is a group with a *specific name*:

The following families you will need to be able to recognize are:

- Alkali metals
- Alkaline Earth metals
- Halogens
- Noble gases

Periodic Table of the Elements

GROUP		PERIODIC TABLE OF THE ELEMENTS																		GROUP																													
IA												IIB		IIB		VIII																																	
1	H											5	B	6	C	7	N	8	O	9	F	10	He																										
2	Li	4	Be											13	Al	14	Si	15	P	16	S	17	Cl	18	Ar																								
3	Na	12	Mg											19	K	20	Ca	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	K	Ca	Sc	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	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe																															
6	Cs	Ba											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							
7	Fr	Ra											104	Rf	105	Db	106	Sg	107	Bh	108	Hs	109	Mt	110	Uun	111	Uuu	112	Uub																			
		57	La	58	Ce	59	Pr	60	Nd	61	Pm	62	Sm	63	Eu	64	Gd	65	Tb	66	Dy	67	Ho	68	Er	69	Tm	70	Yb	71	Lu																		
		89	Ac	90	Th	91	Pa	92	U	93	Np	94	Pu	95	Am	96	Cm	97	Bk	98	Cf	99	Es	100	Fm	101	Md	102	No	103	Lr																		

Metals and Non-metals

Elements change from metals to non-metals as you go from left to right on the Periodic Table

Metal

Element with the following properties:

hard, shiny, malleable, ductile, conducts electricity.

Non-metal

Element with the following properties:

brittle, dull, cannot conduct electricity.

Hydrogen*

- Hydrogen is placed in Group 1 but is a *non-metal gas*
- *Simplest* atomic structure - *only 1 e⁻ and 1 p⁺*
- *Highly* chemically reactive

The **placement** of hydrogen is **only** because of its **structure** - 1 proton... Sometimes a table will have it raised above the Alkali Metals to avoid confusion

The image shows two versions of a periodic table. The top version shows Hydrogen (H) placed in Group 1, above Lithium (Li). The bottom version shows Hydrogen (H) placed above the Alkali Metals (Li, Na) in Group 1, and above the Alkaline Earth Metals (Be, Mg) in Group 2.

lements

										VIII							
										2							
										He							
					IIIB	IVB	VB	VIB	VIIIB								
5	B	6	C	7	N	8	O	9	F	10	Ne						
13	Al	14	Si	15	P	16	S	17	Cl	18	Ar						
28	Ni	29	Cu	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr
46	Pd	47	Ag	48	Cd	49	In	50	Sn	51	Sb	52	Te	53	I	54	Xe
78	Pt	79	Au	80	Hg	81	Tl	82	Pb	83	Bi	84	Po	85	At	86	Rn
108	Jun	111	Uuu	112	Uub												
63	Eu	64	Gd	65	Tb	66	Dy	67	Ho	68	Er	69	Tm	70	Yb	71	Lu
95	Am	96	Cm	97	Bk	98	Cf	99	Es	100	Fm	101	Md	102	No	103	Lr

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- Lanthanide
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What trends (“periodicity”) have you found?



CAN YOU ANSWER THESE QUESTIONS?

S1-2-06

How is the Periodic Table organized for the elements and what trends exist?

Vocabulary & Concepts

Mendeleev

Period

Group

Family

Alkali metals

Earth metals

Transition Metals

Halogens

Noble gases