

Margherita Venturi

Dipartimento di Chimica "G. Ciamician"
Università degli Studi di Bologna

E-mail: margherita.venturi@unibo.it



Gli elementi chimici
una lunga storia iniziata dal Big Bang

Il punto di vista dei chimici

Faenza, 3 maggio 2019

1 H	fusione all'epoca del big bang 					fissione prodotta da raggi cosmici 					2 He						
3 Li	4 Be	merging di stelle di neutroni 					esplosione di stelle di grande massa 					5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg	morte di stelle di piccola massa 					esplosione di nane bianche 					13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
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
37 Rb	38 Sr	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
55 Cs	56 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
87 Fr	88 Ra																
		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												

IUPAC Periodic Table of the Elements

IUPAC Periodic Table of the Elements

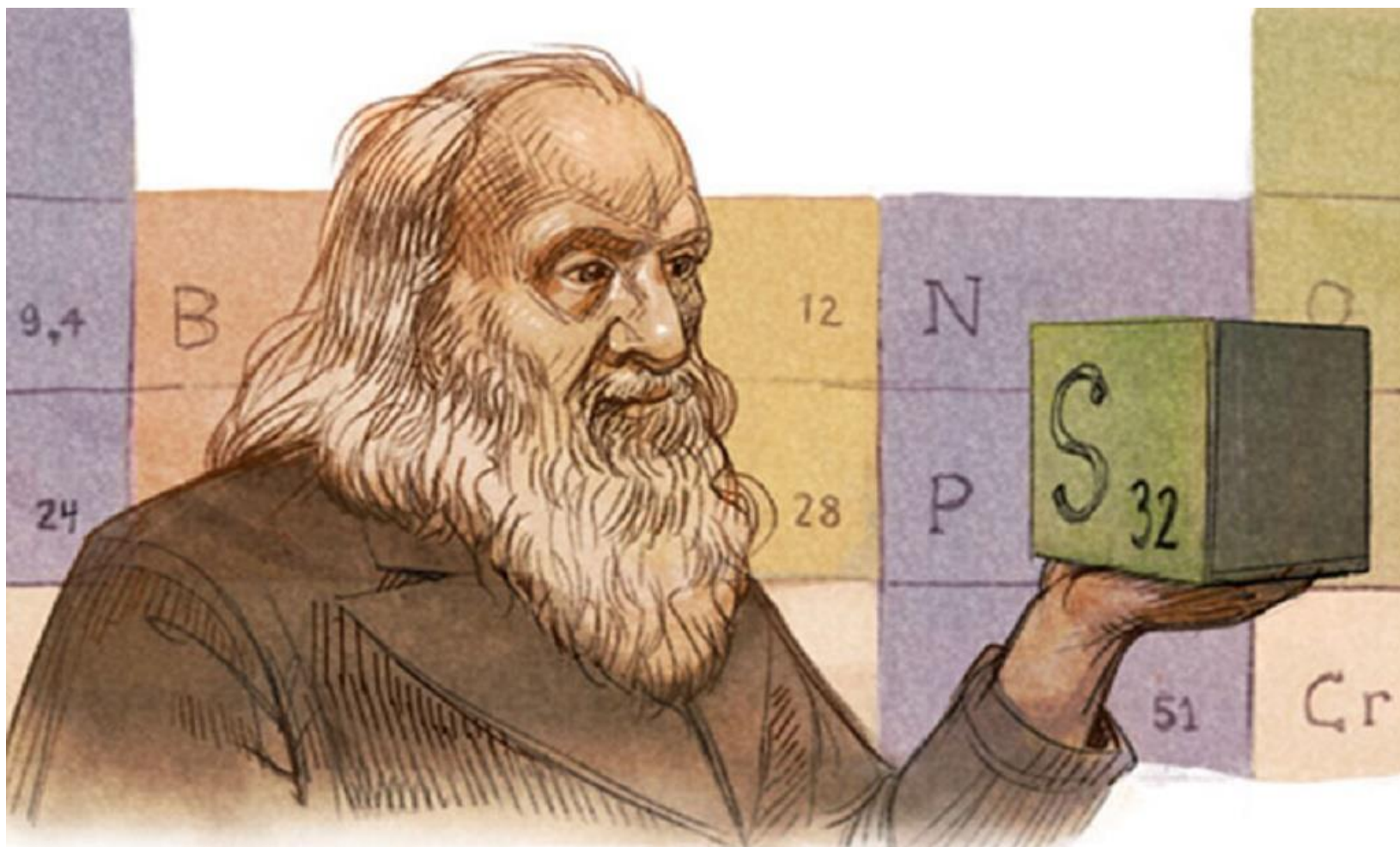
1 H hydrogen 1.008 [1.0078, 1.0082]																	2 He helium 4.0026						
3 Li lithium 6.94 [6.938, 6.997]		4 Be beryllium 9.0122																13 B boron 10.81 [10.806, 10.821]	14 C carbon 12.011 [12.009, 12.012]	15 N nitrogen 14.007 [14.006, 14.008]	16 O oxygen 15.999 [15.999, 16.000]	17 F fluorine 18.998	18 Ne neon 20.180
11 Na sodium 22.990		12 Mg magnesium 24.305 [24.304, 24.307]																13 Al aluminium 26.982	14 Si silicon 28.085 [28.084, 28.086]	15 P phosphorus 30.974	16 S sulfur 32.06 [32.059, 32.076]	17 Cl chlorine 35.45 [35.446, 35.457]	18 Ar argon 39.948
19 K potassium 39.098	20 Ca calcium 40.078(4)	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(2)	27 Co cobalt 58.933	28 Ni nickel 58.693	29 Cu copper 63.546(3)	30 Zn zinc 65.38(2)	31 Ga gallium 69.723	32 Ge germanium 72.630(8)	33 As arsenic 74.922	34 Se selenium 78.971(8)	35 Br bromine 79.904 [79.901, 79.907]	36 Kr krypton 83.798(2)						
37 Rb rubidium 85.468	38 Sr strontium 87.62	39 Y yttrium 88.906	40 Zr zirconium 91.224(2)	41 Nb niobium 92.906	42 Mo molybdenum 95.95	43 Tc technetium 101.07(2)	44 Ru ruthenium 101.07(2)	45 Rh rhodium 102.91	46 Pd palladium 106.42	47 Ag silver 107.87	48 Cd cadmium 112.41	49 In indium 114.82	50 Sn tin 118.71	51 Sb antimony 121.76	52 Te tellurium 127.60(3)	53 I iodine 126.90	54 Xe xenon 131.29						
55 Cs caesium 132.91	56 Ba barium 137.33	57-71 lanthanoids	72 Hf hafnium 178.49(2)	73 Ta tantalum 180.95	74 W tungsten 183.84	75 Re rhenium 186.21	76 Os osmium 190.23(3)	77 Ir iridium 192.22	78 Pt platinum 195.08	79 Au gold 196.97	80 Hg mercury 200.59	81 Tl thallium 204.38 [204.38, 204.39]	82 Pb lead 207.2	83 Bi bismuth 208.98	84 Po polonium	85 At astatine	86 Rn radon						
87 Fr francium	88 Ra radium	89-103 actinoids	104 Rf rutherfordium	105 Db dubnium	106 Sg seaborgium	107 Bh bohrium	108 Hs hassium	109 Mt meitnerium	110 Ds darmstadtium	111 Rg roentgenium	112 Cn copernicium	113 Nh nihonium	114 Fl flerovium	115 Mc moscovium	116 Lv livermorium	117 Ts tennessine	118 Og oganesson						

57 La lanthanum 138.91	58 Ce cerium 140.12	59 Pr praseodymium 140.91	60 Nd neodymium 144.24	61 Pm promethium	62 Sm samarium 150.36(2)	63 Eu europium 151.96	64 Gd gadolinium 157.25(3)	65 Tb terbium 158.93	66 Dy dysprosium 162.50	67 Ho holmium 164.93	68 Er erbium 167.26	69 Tm thulium 168.93	70 Yb ytterbium 173.05	71 Lu lutetium 174.97
89 Ac actinium	90 Th thorium 232.04	91 Pa protactinium 231.04	92 U uranium 238.03	93 Np neptunium	94 Pu plutonium	95 Am americium	96 Cm curium	97 Bk berkelium	98 Cf californium	99 Es einsteinium	100 Fm fermium	101 Md mendelevium	102 No nobelium	103 Lr lawrencium



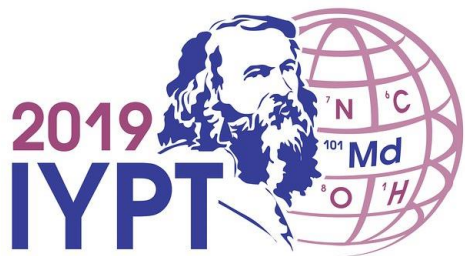
INTERNATIONAL UNION OF
PURE AND APPLIED CHEMISTRY

For notes and updates to this table, see www.iupac.org. This version is dated 28 November 2016.
Copyright © 2016 IUPAC, the International Union of Pure and Applied Chemistry.



Dmitry Mendeleev è considerato il padre della Tavola Periodica (che lui chiamò Sistema Periodico)

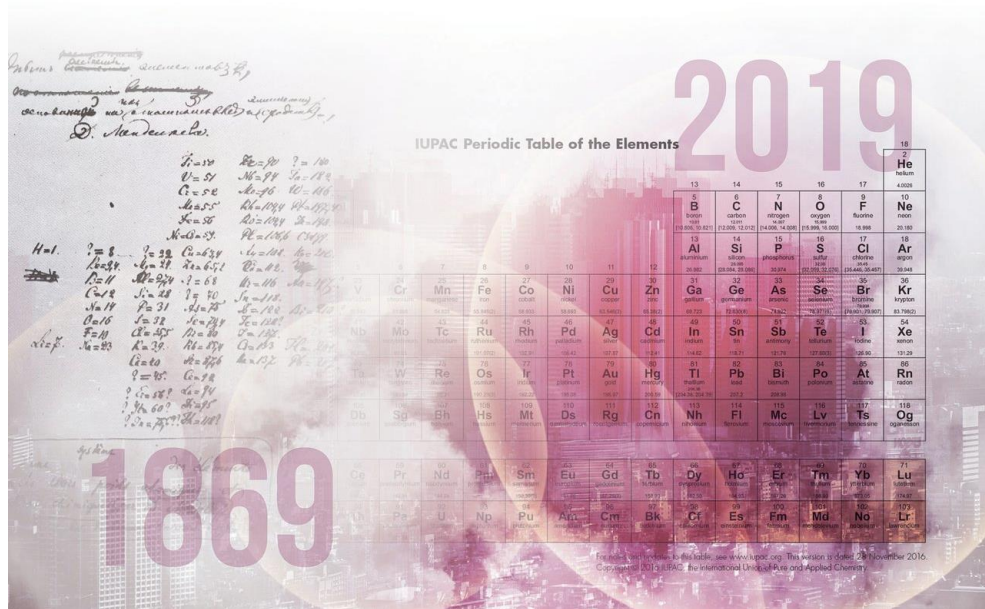
International Year
of the Periodic Table of Chemical Elements



SCIENCE – SOCIETY – WORLD – SUSTAINABLE DEVELOPMENT

Tavola Periodica

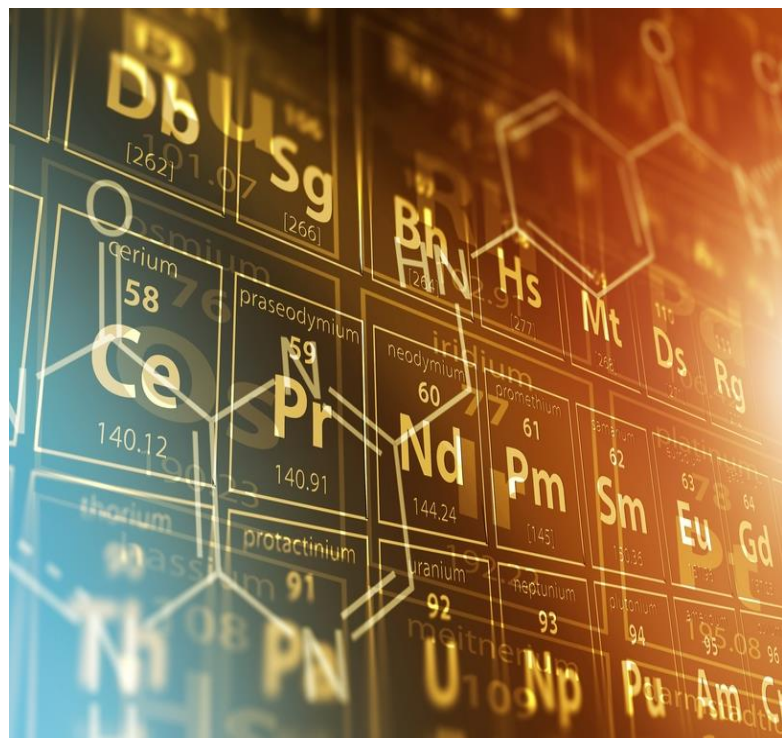
PARTNERS



The initiative of the International Year of the Periodic Table of Chemical Elements is supported by the International Union of Pure and Applied Chemistry (IUPAC), International Union of Pure and Applied Physics (IUPAP), European Association for Chemical and Molecular Sciences (EuCheMS), The International Council for Science (ICSU), International Astronomical Union (IAU), The International Union of History and Philosophy of Science and Technology (IUHPS).



Nel 2019 ricorre il 150° anniversario della scoperta della Tavola Periodica avvenuta nel 1869



La Tavola Periodica degli Elementi Chimici

Un documento che permette agli scienziati di capire e predire le proprietà della materia sulla Terra e nell'Universo

Uno dei più importanti risultati della scienza in grado di "catturare" l'essenza non solo della chimica e delle altre discipline scientifiche, ma della Natura stessa

La Tavola Periodica è il linguaggio della Natura

L'importanza di una scoperta scientifica può essere valutata in base alle diverse "platee" interessate: i ricercatori che lavorano nella disciplina scientifica specifica della scoperta; i ricercatori che lavorano in altre discipline scientifiche affini e il pubblico non direttamente coinvolto nella scienza

La Tavola Periodica può sicuramente essere considerata una scoperta scientifica molto importante

La sua forma è usata per ordinare ogni tipo di "cose"

U.S. Presidents Periodic Table

[illegible]

- ◆ Dynastic president: related to another president
- \$ Presidents appearing on (currently circulated) paper U.S. currency
- i Impeached (but acquitted)
- × Resigned from office
- ↑ Ascended to presidency without being elected to presidency or vice presidency

THE PERIODIC TABLE OF EDUCATION TECHNOLOGY

 Social Networks
 Online Learning
 Multimedia
 Coding
 Classroom Tech
 Hardware

Education Conferences

Please feel free to share but attribute to <http://dailygenius.com/periodic-table>. Thanks!

La sua forma è usata per ordinare ogni tipo di "cose"

The Periodic Table of Meat

1 B  Bacon																	2 H  Hamburger	
3 P  Pork chops	4 Bb  Baby back ribs																	10 Sg  Sausage
11 Pl  Pork loin	12 Sr  Spare ribs																	18 Sj  Sloppy joe
19 Cu  Pork cutlet	20 Hh  Hamhock	21 Ha  Sliced ham	22 Ca  Capicola	23 Cd  Corned beef	24 Tp  Beef tri-tip	25 Bs  Beef sausage	26 R  Beef ribs	27 Kb  Kobe	28 Rt  Pot roast	29 Cr  Crab	30 Tu  Tuna	31 Lb  Lobster	32 Pg  Chicken parmigiana	33 Tm  Chicken tempura	34 Fg  Chicken fingers	35 Ng  Chicken nuggets	36 Fr  Fried chicken	
37 Ro  Pork roast	38 Cz  Chorizo	39 Ch  Christmas ham	40 Mr  Mortadella	41 Rb  Roast beef	42 He  Head cheese	43 Td  Beef tenderloin	44 S  T-bone steak	45 Fm  Filet Mignon	46 Sf  Stroganoff	47 St  Beef stew	48 Cb  Chicken cordon bleu	49 C  Grilled chicken	50 Gt  General Tso's chicken	51 Ty  Teriyaki chicken	52 Jm  Jamaican jerk	53 W  Buffalo wings	54 Q  BBQ chicken	
55 Pp  Pulled pork	56 Ap  Al pastor	57 Z  Zungenwurst	58 Rs  Prosciutto	59 Pm  Pastrami	60 Cw  Cow tongue	61 Pr  Pepper steak	62 Tt  Steak Tartare	63 Si  Strip steak	64 Md  Mandarin beef	65 Bt  Brisket	66 Cs  Chicken casserole	67 Re  Robbiano chicken	68 Tr  Tandoori	69 K  Kabobs	70 Gb  Gumbo	71 Sp  Spam	72 Pe  Pepperoni	
73 Gr  Ground pork	74 Ct  Carnitas	75 Fe  Pig's feet	76 Pt  Pancetta	77 Gy  Gyro	78 Fi  Steak fingers	79 Sy  Salisbury steak	80 Cf  Chicken fried steak	81 Ry  Ribeye	82 Sw  Shawarma	83 J  Beef jerky	84 D  Duck	85 Th  Thanksgiving turkey	86 T  Sliced turkey	87 Sm  Summer sausage	88 Bg  Bologna	89 Lf  Pimento loaf	90 Hd  Hot dogs	

Key Meat Facts:

- Bacon is the "meat of life." Without bacon, life on earth as we know it could not exist
- Noble Meats are named as such because they rate the highest on the Glamburg "Yumminess Scale." Lowest-ranking meats include Pig's feet, Spam and Roadkill
- Meats occur in two basic forms: boned and boneless
- Basic chemical formulas: H_2B = Bacon Double Cheeseburger; $ThReD$ = Turducken; $HaRbT$ = Cold Cut Trio; $HdQH$ = A Barbeque, $FrCiB$ = Heart attack

91 Bn Bison	92 Ek Elk	93 L Lamb	94 Go Goat	95 Kl Roadkill	96 Bh Bushmeat
97 Dr Deer	98 Ra Rabbit	99 Wb Wild boar	100 O Ostrich	101 E Emu	102 G Gator

La sua forma è usata per ordinare ogni tipo di "cose"

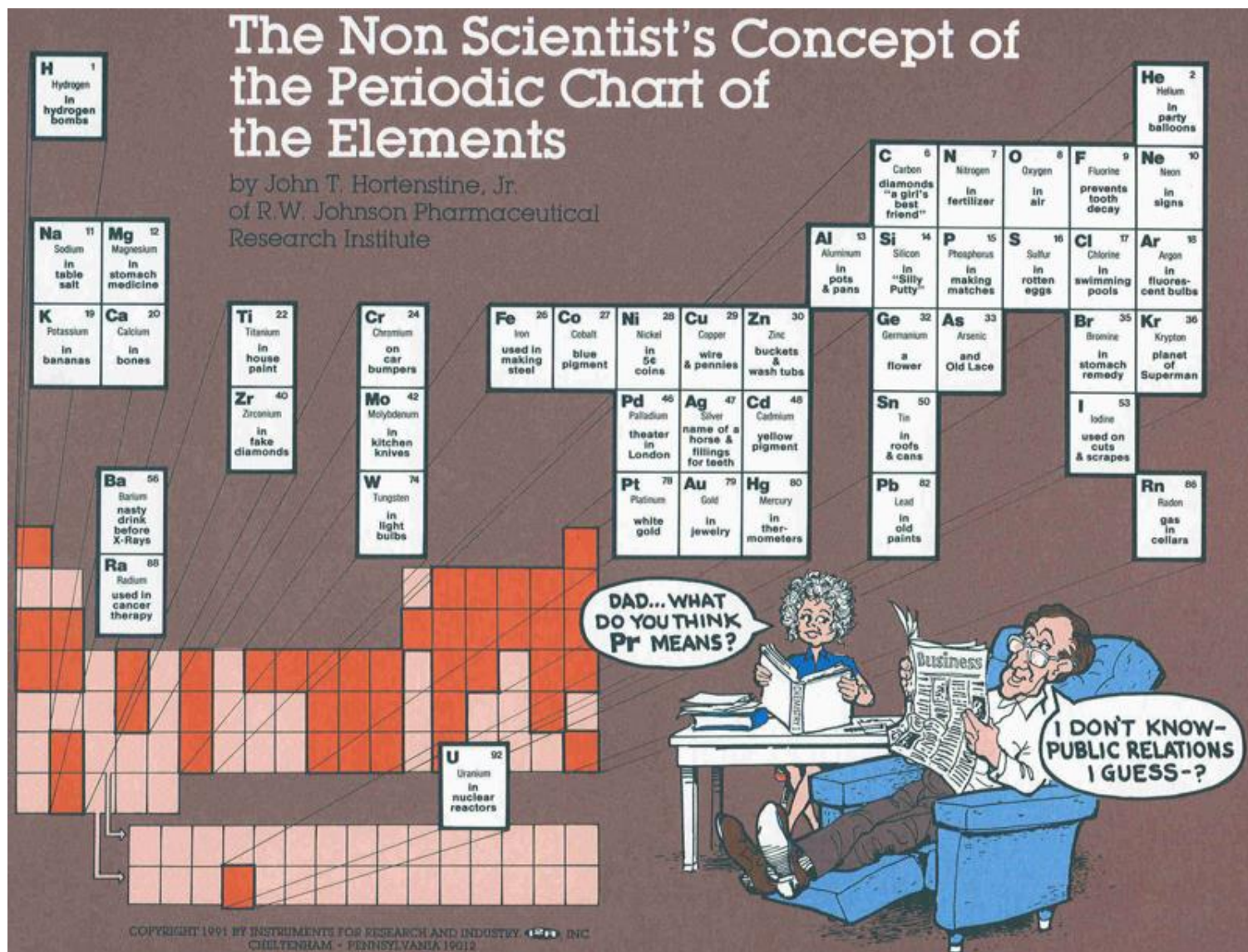
PERIODIC TABLE OF AIRLINES																																																							
Compiled from eDreams customers reviews since 2009																																																							
1	4,49																											2	4,40																										
SQ																												F7																											
RANKING OF AIRLINE — 1 4,49 — OVERALL RATING																																																							
IATA CODE																																																							
3	4,40	4	4,36																									5	4,35																										
TG		HG																										EY																											
10	4,26	11	4,24																									12	4,21																										
TK		NT																										LX																											
17	4,15	18	4,13	19	4,12	20	4,12	21	4,12	22	4,09	23	4,08	24	4,08	25	4,07	26	4,06	27	4,05	28	4,05	29	4,04	30	4,04	13	4,19																										
LH		OA		RJ		IF		VN		4U		KU		I9		AY		S4		V3		B2		RO		XK		OS																											
31	4,03	32	4,03	33	4,02	34	4,02	35	4,01	36	4,00	37	3,99	38	3,99	39	3,97	40	3,97	41	3,97	42	3,97	43	3,96	44	3,96	14	4,18																										
9U		9W		JP		OU		OK		LO		KL		TA		AV		FB		PS		MH		TP		BA		15	4,18																										
45	3,95	46	3,94	47	3,94	48	3,93	49	3,93	50	3,92	51	3,90	52	3,88	53	3,87	54	3,87	55	3,84	56	3,83	57	3,83	58	3,82	16	4,17																										
BD		AF		AZ		JJ		AP		ZI		AM		LY		MS		LA		SK		FI		TX		QS		17	4,15																										
59	3,82	60	3,82	61	3,82	62	3,82	63	3,80	64	3,78	65	3,77	66	3,77	67	3,75	68	3,74	69	3,73	70	3,72	71	3,69	72	3,67	18	4,13																										
FV		SN		AC		S7		EI		SA		JU		ET		YM		UX		SS		HV		SU		ZB		19	4,12																										
73	3,67	74	3,61	75	3,59	76	3,58	77	3,58	78	3,56	79	3,54	80	3,54															20	4,12																								
VS		IG		DL		DE		IB		TU		VY		IV																21	4,12																								
																														22	4,09																								
																														23	4,08																								
																														24	4,08																								
																														25	4,07																								
																														26	4,06																								
																														27	4,05																								
																														28	4,05																								
																														29	4,04																								
																														30	4,04																								
																															31	4,03																							
																															32	4,03																							
																															33	4,02																							
																															34	4,02																							
																															35	4,01																							
																															36	4,00																							
																															37	3,99																							
																															38	3,99																							
																															39	3,97																							
																															40	3,97																							
																															41	3,97																							
																															42	3,97																							
																															43	3,96																							
																															44	3,96																							
																																45	3,95																						
																																46	3,94																						
																																47	3,94																						
																																48	3,93																						
																																49	3,93																						

eDreams

81	3,54	82	3,54	83	3,54	84	3,52	85	3,51	86	3,46	87	3,45	88	3,45	89	3,41	90	3,40
UA		CZ		TS		GF		BE		PU		MU		VV		AA		BV	
91	3,40	92	3,38	93	3,38	94	3,33	95	3,31	96	3,27	97	3,23	98	3,17	99	3,11	100	2,74
US		BT		AR		AT		U2		CA		5L		FR		AH		S3	

Copyright (C) 2012 Vacaciones eDreams

Tavole Periodiche per ogni gusto



Tavole Periodiche per ogni gusto

The Periodic Table in pictures

Periods		The Periodic Table in pictures																Noble Gases																			
↓		Alkali Metals Group 1																		Group 18																	
1	1	H Hydrogen  Sun and Stars																		He Helium  Balloons																	
2	2	Li Lithium  Batteries		Be Beryllium  Emeralds																		Ne Neon  Advertising Signs															
3	3	Na Sodium  Salt		Mg Magnesium  Chlorophyll																		Ar Argon  Light Bulbs															
		Transition Metals																																			
		3 4 5 6 7 8 9 10 11 12																																			
4	4	K Potassium  Fruits and Vegetables		Ca Calcium  Shells and Bones		Sc Scandium  Bicycles		Ti Titanium  Aerospace		V Vanadium  Springs		Cr Chromium  Stainless Steel		Mn Manganese  Earthmovers		Fe Iron  Steel Structures		Co Cobalt  Magnets		Ni Nickel  Coins		Cu Copper  Electric Wires		Zn Zinc  Brass Instruments		Ga Gallium  Light-Emitting Diodes (LEDs)		Ge Germanium  Semiconductor Electronics		As Arsenic  Poison		Se Selenium  Copiers		Br Bromine  Photography Film		Kr Krypton  Flashlights	
5	5	Rb Rubidium  Global Navigation		Sr Strontium  Fireworks		Y Yttrium  Lasers		Zr Zirconium  Chemical Pipelines		Nb Niobium  Mag Lev Trains		Mo Molybdenum  Cutting Tools		Tc Technetium  Radioactive Diagnosis		Ru Ruthenium  Electric Switches		Rh Rhodium  Searchlight Reflectors		Pd Palladium  Pollution Control		Ag Silver  Jewelry		Cd Cadmium  Paint		In Indium  Liquid Crystal Displays (LCDs)		Sn Tin  Plated Food Cans		Sb Antimony  Car Batteries		Te Tellurium  Thermoelectric Coolers		I Iodine  Disinfectant		Xe Xenon  High-Intensity Lamps	
6	6	Cs Cesium  Atomic Clocks		Ba Barium  X-Ray Diagnosis		<div colspan="2">57 - 71</div> <div>Rare Earth Metals</div>		Hf Hafnium  Nuclear Submarines		Ta Tantalum  Mobile Phones		W Tungsten  Lamp Filaments		Re Rhenium  Rocket Engines		Os Osmium  Pen Points		Ir Iridium  Spark Plugs		Pt Platinum  Labware		Au Gold  Jewelry		Hg Mercury  Thermometers		Tl Thallium  Low-Temperature Thermometers		Pb Lead  Weights		Bi Bismuth  Fire Sprinklers		Po Polonium  Anti-Static Brushes		At Astatine  Radioactive Medicine		Rn Radon  Surgical Implants	
7	7	Fr Francium  Laser Atom Traps		Ra Radium  Luminous Watches		<div colspan="2">89 - 103</div> <div>Actinide Metals</div>		Rf Rutherfordium  Radioactive Waste		Db Dubnium  Nuclear Power		Sg Seaborgium  Radioactive Waste		Bh Bohrium  Nuclear Power		Hs Hassium  Radioactive Waste		Mt Meitnerium  Nuclear Weapons		Ds Darmstadtium  Smoke Detectors		Rg Roentgenium  Mineral Analyzers		Cn Copernicium  Radioactive Waste		Nh Nihonium  Mineral Analyzers		Fl Flerovium  Radioactive Waste		Mc Moscovium  Radioactive Waste		Lv Livermorium  Radioactive Waste		Ts Tennessine  Radioactive Waste		Og Oganesson  Radioactive Waste	
8	8	radioactive, never found in nature, no uses except atomic research																																			
		Superheavy Elements																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			
		radioactive, never found in nature, no uses except atomic research																																			

Tavole Periodiche per ogni gusto

The Alchemical Table of Symbols

quintessence 																				essence 															
universal seed 		stone 																		borax 		carbon 		nitre 		oxygen 		amalgam 		spirit 					
sodium 		magnesium 																		alum 		anreal 		phosphorus 		sulfur 		salt 		sal ammoniac 					
potassium 		chalc 		lime 		sand 		glass 		clay 		rust 		iron 		cobalt 		nickel 		copper 		zinc 		burnt alum 		brass 		arsenic 		arsenic sulfur 		seasalt 		rock salt 	
vinegar 		distilled vinegar 		quicklime 		caustic lime 		wood 		fumes 		embers 		steel 		marchasite 		verdigris 		silver 		cinnabar 		spirit tin 		tin 		antimony 		sulfuric acid 		aqua fortis 		aqua regia 	
oil 		oil of vitriol 		vitriol 		egg shell 		corpuscule 		wick 		tallow 		soap 		soapstone 		platinum 		gold 		mercury 		spirits mercury 		lead 		bismuth 		realgar 		aqua vitae 		water bath 	
retort 		crucible 		pinch 		pint 		scruple 		dram 		ounce 		pound 		hour 		day 		night 		week 		month 		year 		spring 		summer 		autumn 		winter 	

Elements

fire 	water 
air 	earth 

Zodiac Signs
and Processes

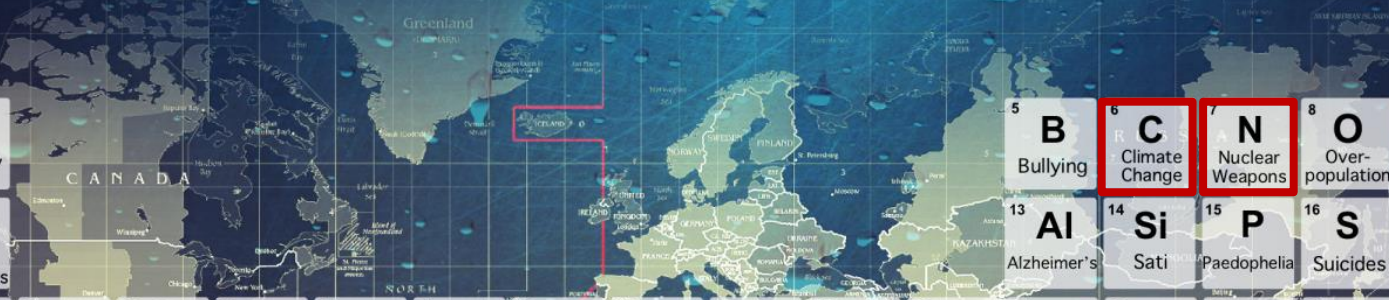
Other
Processes

aries 	taurus 	gemini 	cancer 	leo 	virgo 	libra 	scorpio 	sagittarius 	capricorn 	aquarius 	pisces 
calcination 	congelation 	fixation 	solution 	digestion 	distillation 	sublimation 	separation 	ceration 	fermentation 	multiplication 	projection 
compose 	rot 	boil 	solve 	amalgamation 	tube 	purify 	distill 	filter 	precipitate 	sublimate 	pulverize 

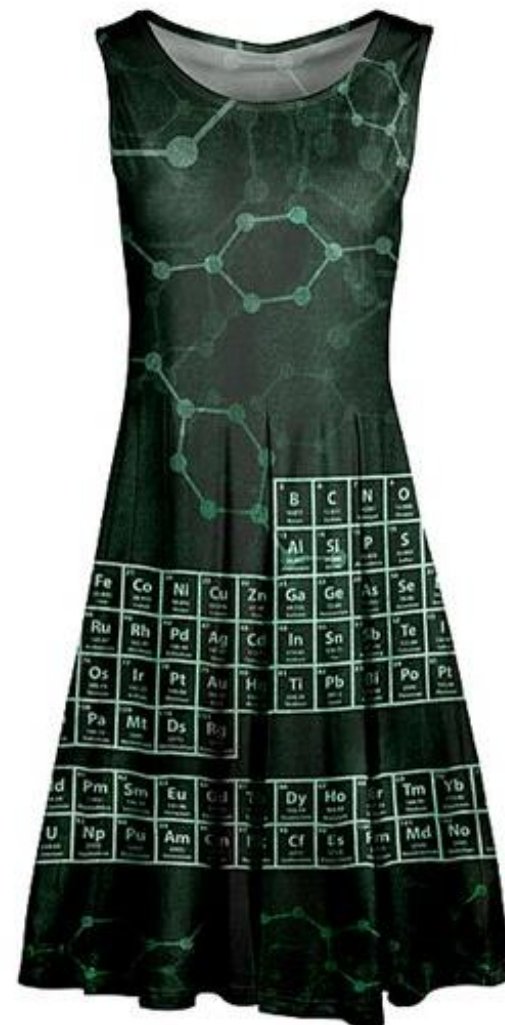
Design by Aristotle Pramagioulis www.egregoredesign.com

Tavole Periodiche per ogni gusto

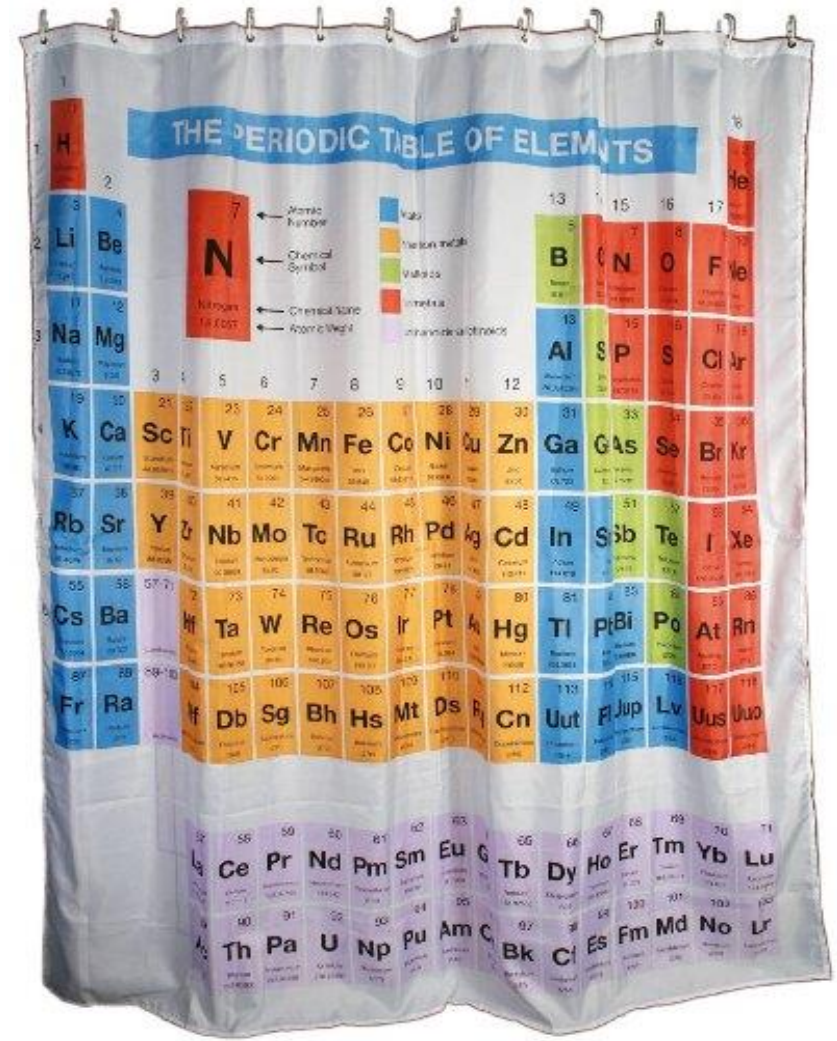
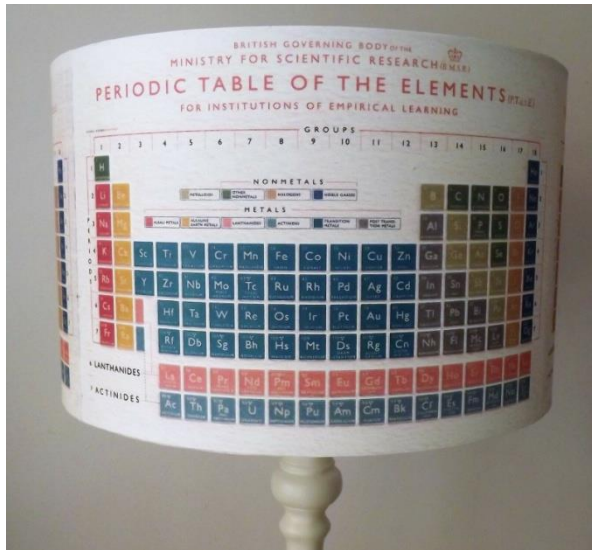
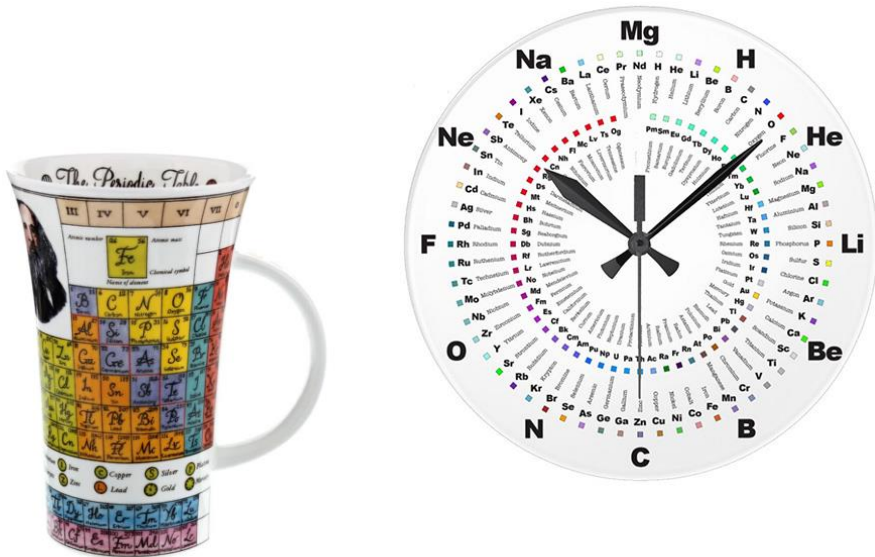
The Periodic Table by Inserting 90 Global Issues created by Kaanchi Chopra:
each symbol abbreviates a relevant social problem affecting the world today

1 H Honour Killing																	2 He Health Hazards				
3 Li Lies	4 Be Beggary															5 B Bullying	6 C Climate Change	7 N Nuclear Weapons	8 O Over-population	9 F Female Foeticide	10 Ne Net Neutrality
11 Na Natural Disasters	12 Mg Micro-agressions															13 Al Alzheimer's	14 Si Sati	15 P Paedophilia	16 S Suicides	17 Cl Child Labour	18 Ar Air Pollution
19 K Killing of girl child	20 Ca Crony Capitalism	21 Sc Skin Colour Discrimination	22 Ti Terrorism	23 V Violence	24 Cr Corruption	25 Mn Malnutrition	26 Fe Famine	27 Co Cloud Hacking	28 Ni Nepotism	29 Cu Child Abuse	30 Zn Zinc Toxicity	31 Ga Global Warming	32 Ge Gender Inequality	33 As AIDS	34 Se Slavery	35 Br Bulimia Nervosa	36 Kr Kidnapping and Ransom				
37 Rb Robbery	38 Sr Sex Ratio	39 Y Youth Unrest	40 Zr Zero Rated services	41 Nb Non-Binary Gender	42 Mo Molestation	43 Tc Tobacco-related health issues	44 Ru Reproductive Rights	45 Rh Racial Disparities in Healthcare	46 Pd Pay Discrimination	47 Ag Age-based Stereotypes	48 Cd Child Marriage	49 In Infectious Diseases	50 Sn Status of Sanitation	51 Sb Substance Abuse	52 Te Texting while driving	53 I Illiteracy	54 Xe Xenophobia				
55 Cs Caste System	56 Ba Body Shaming	71 Lu Legal understaffing	72 Hf Hungry Families	73 Ta Teen Pregnancy	74 W Water Crisis	75 Re Religious Zealotry	76 Os Orthodox Beliefs	77 Ir Intolerance	78 Pt Prostitution of children	79 Au Animal Abuse	80 Hg Human Trafficking	81 Tl Traffic Fatalities	82 Pb Police Brutality	83 Bi Binge Drinking	84 Po Poverty	85 At Airport Security	86 Rn Airborne Diseases				
87 Fr Fraud	88 Ra Rape	103 Lr LGBT Rights	104 Rf Regional Conflicts	105 Db Debt Bondage	106 Sg Same-sex Marriages	107 Bh Biological Hazards	108 Hs Hate Speech	109 Mt Mental Health	110 Ds Dowry System	111 Rg Religious Conflicts	112 Cn Chemical Weapons	113 Uut Un-touchability	114 Fl Forced Labour	115 Uup Un-employment	116 Lv Lack of universal design	117 Uus Under Utilization of Technology	118 Uuo Union Busting				

Oggetti che riproducono la Tavola Periodica

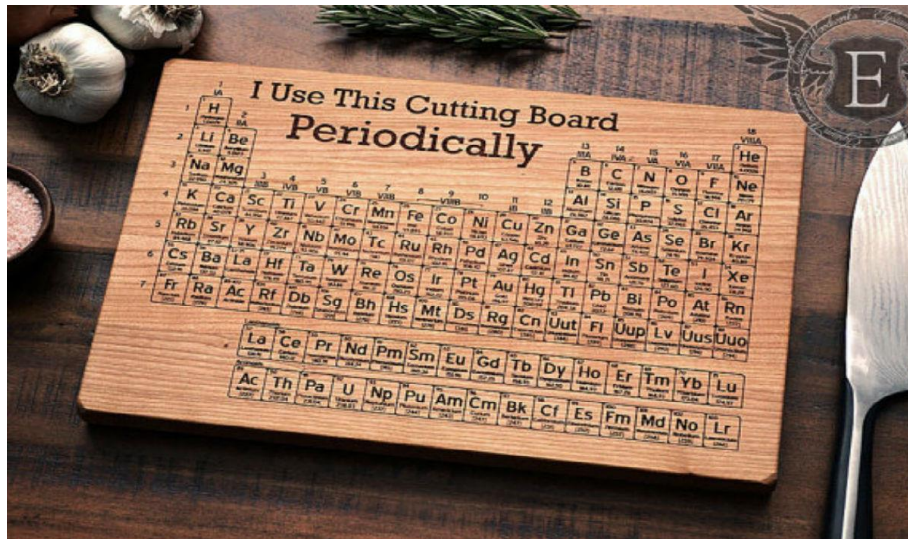


Oggetti che riproducono la Tavola Periodica

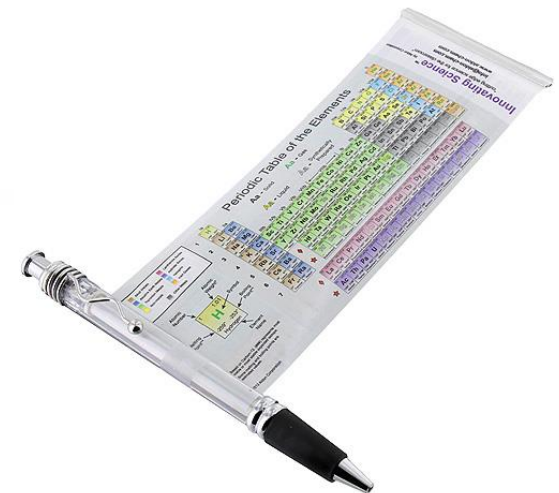
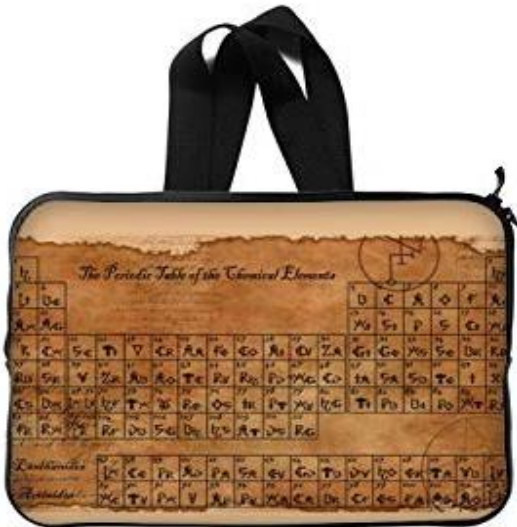
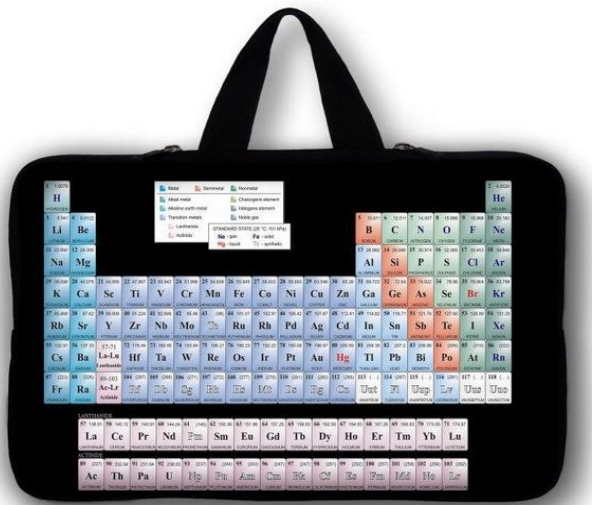
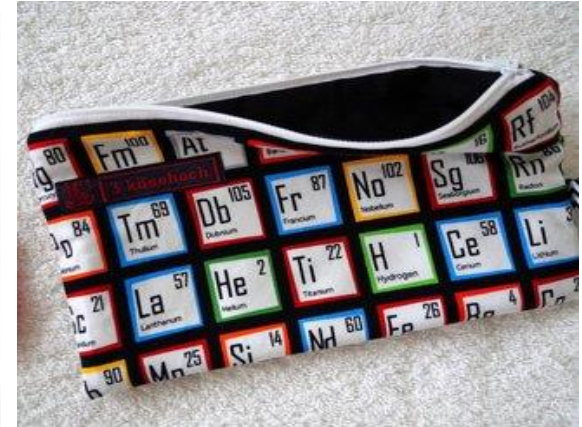
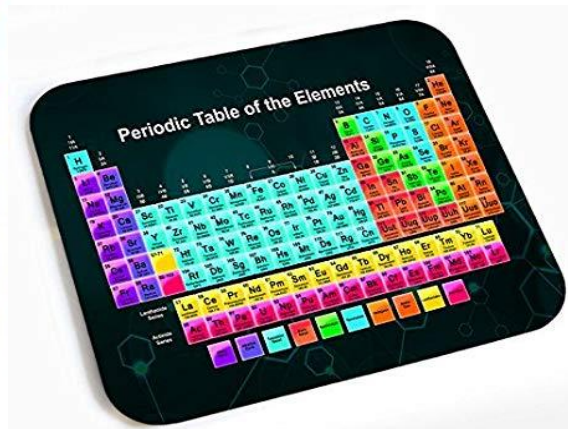


Shower curtain

Oggetti che riproducono la Tavola Periodica



Oggetti che riproducono la Tavola Periodica



Oggetti che riproducono la Tavola Periodica



Oggetti che riproducono la Tavola Periodica



Playing cards

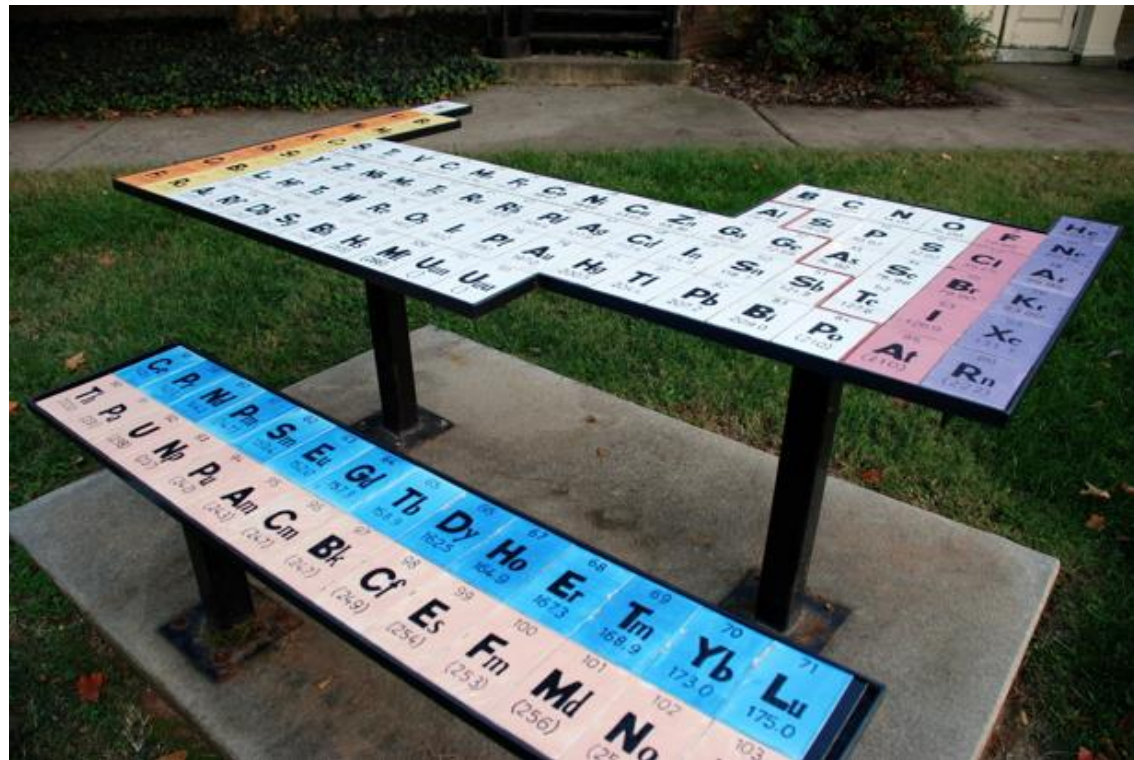


Oggetti che riproducono la Tavola Periodica

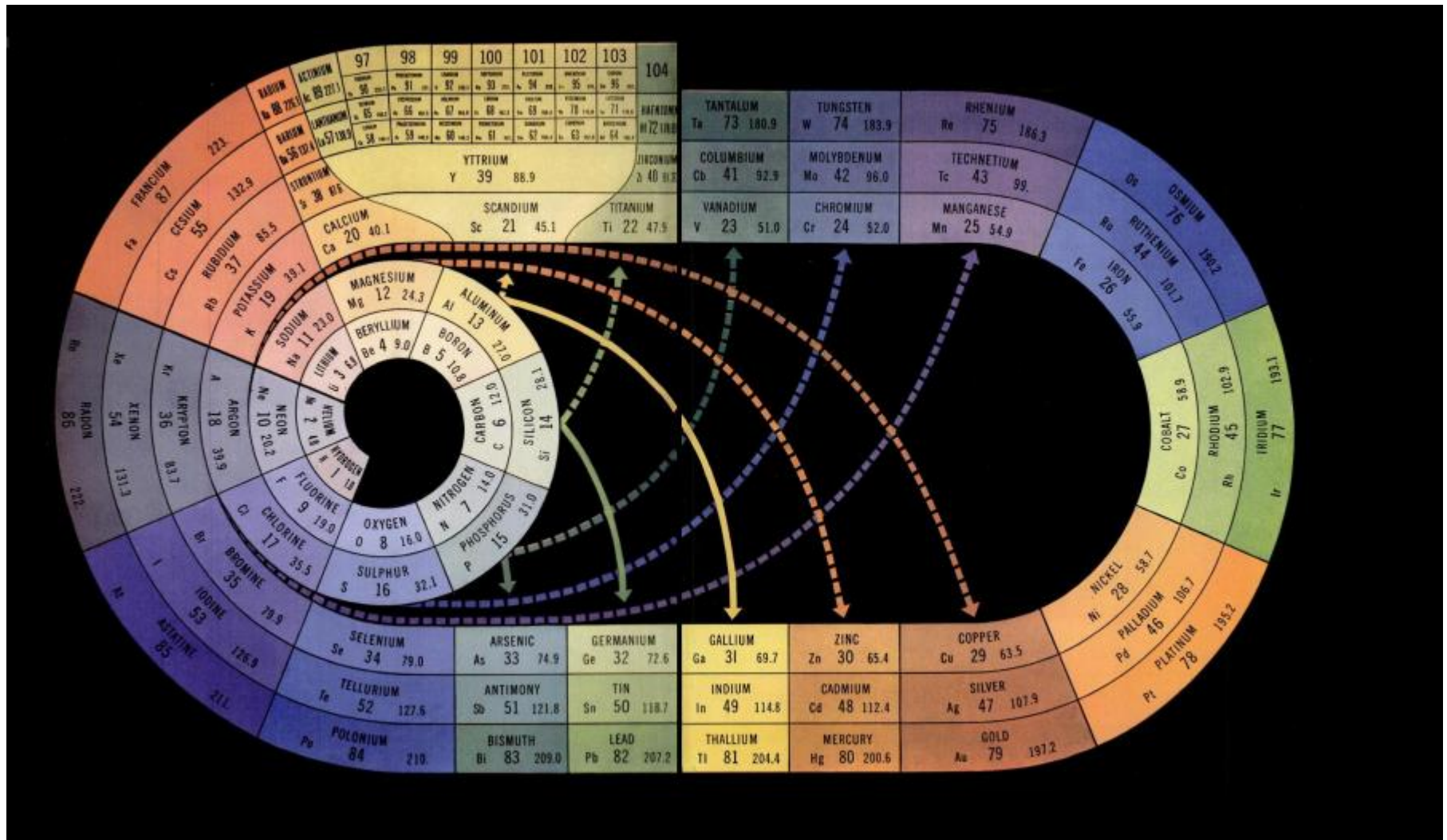


Una "dolce" Tavola Periodica da mangiare

Una Tavola Periodica su cui mangiare



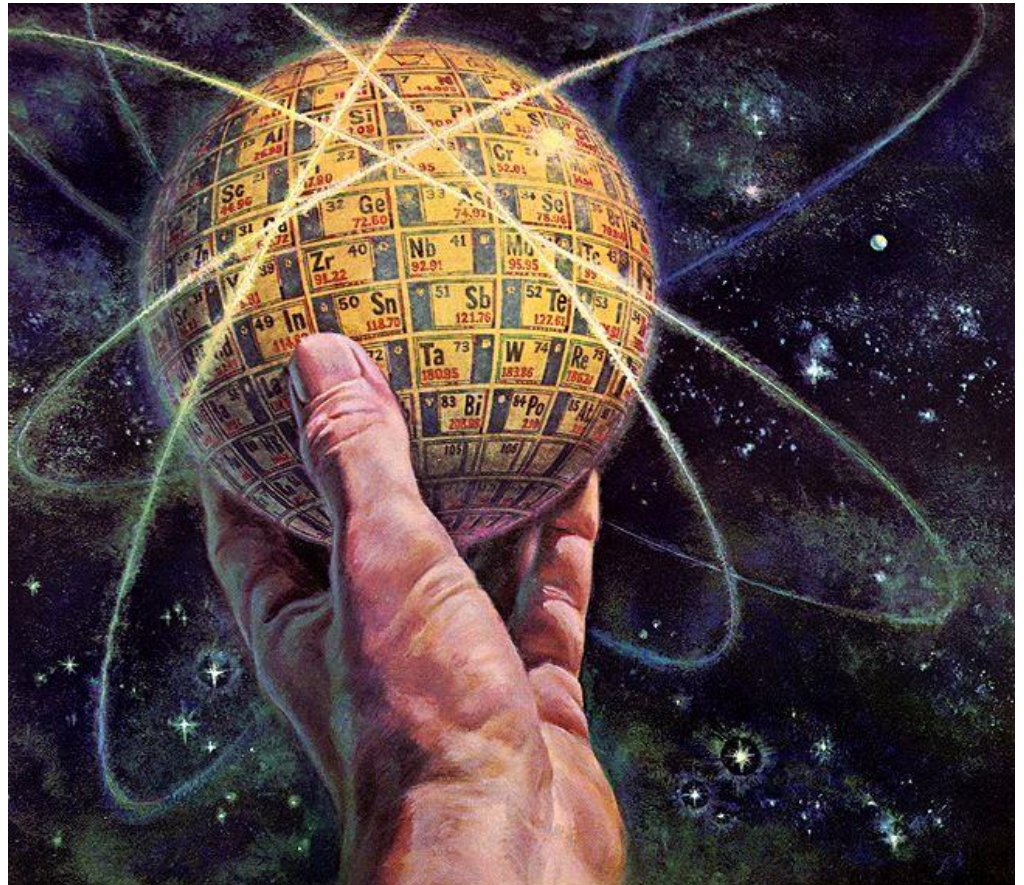
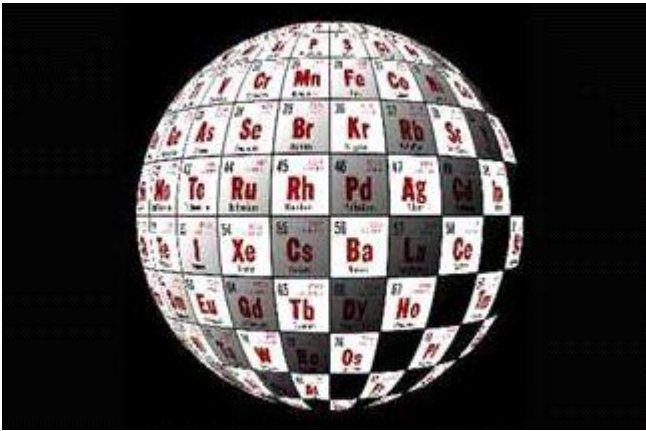
Tavole Periodiche non tradizionali



Tavole Periodiche non tradizionali

Una Tavola Periodica Sferica

Questa bella versione elaborata dalla Union Carbide nel 1960 purtroppo non "funziona": secondo gli autori è impossibile "arrotolare" la Tavola Periodica in una sfera



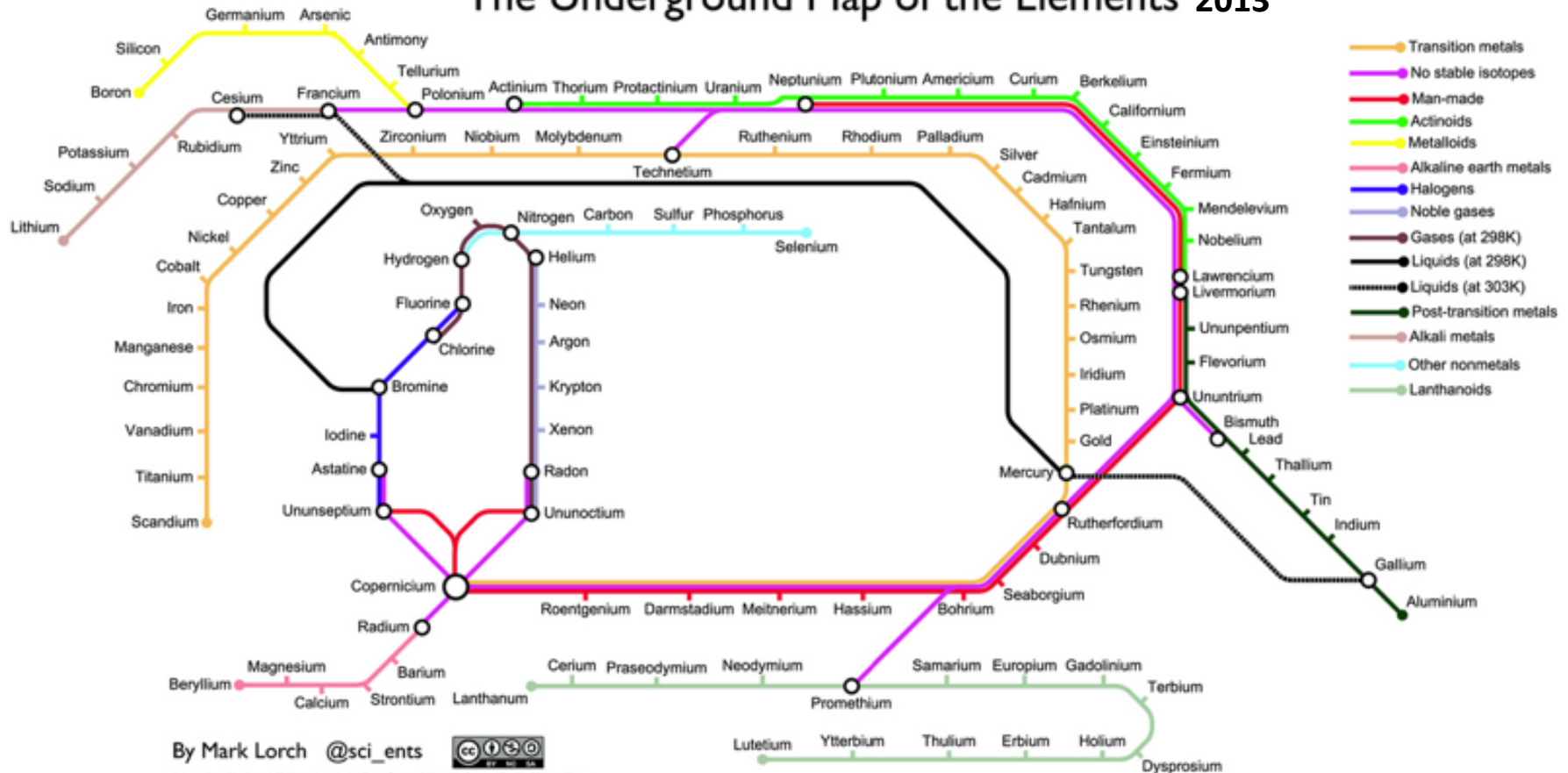
Tavole Periodiche non tradizionali

Pyramidal periodic table 2012

Alkali metals	1 H 3 Li 11 Na 19 K 37 Rb 55 Cs 87 Fr	2 He 4 Be 12 Mg 20 Ca 38 Sr 56 Ba 88 Ra	Halogens												
Alkaline earth metals			Noble gases												
Nonmetals			D block metals												
Metalloids			Lanthanides												
P block metals			Actinides												
	5 B 13 Al 31 Ga 49 In 81 Tl 113 Uut	6 C 14 Si 32 Ge 50 Sn 82 Pb 114 Fl	7 N 15 P 33 As 51 Sb 83 Bi 115 Uup	8 O 16 S 34 Se 52 Te 84 Po 116 Lv	9 F 17 Cl 35 Br 53 I 85 At 117 Uus	10 Ne 18 Ar 36 Kr 54 Xe 86 Rn 118 Uuo									
	21 Sc 39 Y 71 Lu 103 Lr	22 Ti 40 Zr 72 Hf 104 Rf	23 V 41 Nb 73 Ta 105 Db	24 Cr 42 Mo 74 W 106 Sg	25 Mn 43 Tc 75 Re 107 Bh	26 Fe 44 Ru 76 Os 108 Hs	27 Co 45 Rh 77 Ir 109 Mt	28 Ni 46 Pd 78 Pt 110 Ds	29 Cu 47 Ag 79 Au 111 Rg	30 Zn 48 Cd 80 Hg 112 Cn					
	57 La 89 Ac	58 Ce 90 Th	59 Pr 91 Pa	60 Nd 92 U	61 Pm 93 Np	62 Sm 94 Pu	63 Eu 95 Am	64 Gd 96 Cm	65 Tb 97 Bk	66 Dy 98 Cf	67 Ho 99 Es	68 Er 100 Fm	69 Tm 101 Md	70 Yb 102 No	

Tavole Periodiche non tradizionali

The Underground Map of the Elements 2013



Tavole Periodiche che mostrano gli elementi in diretta



University of Iowa (USA)

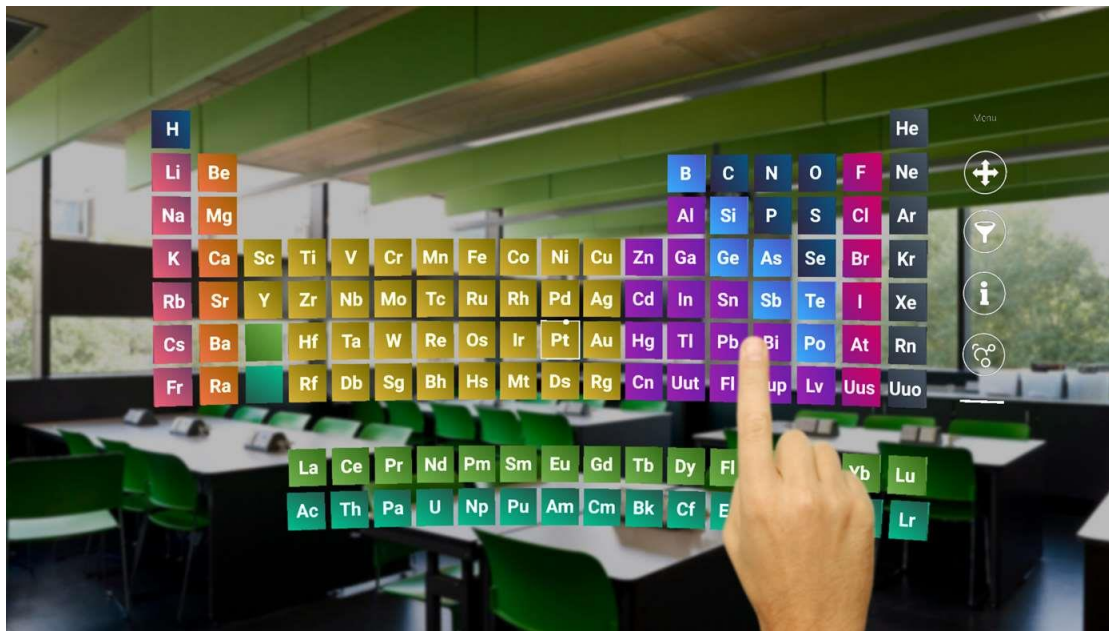
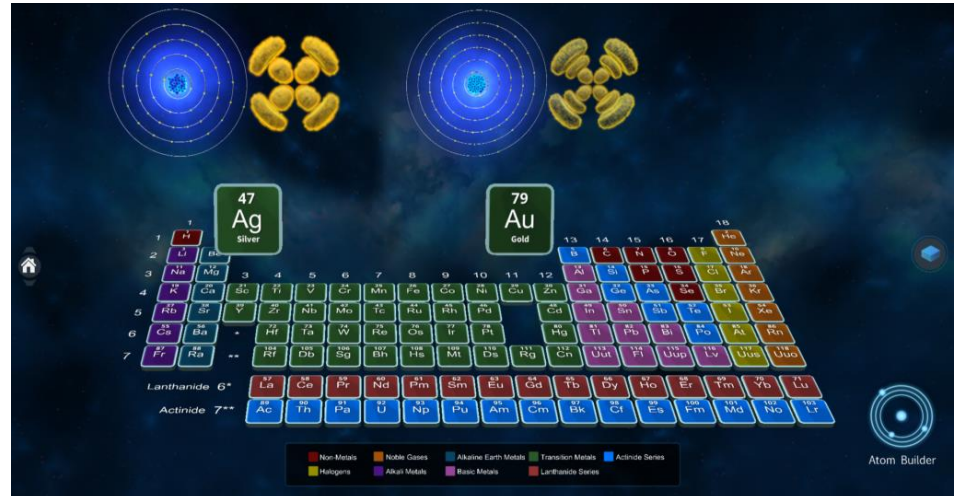
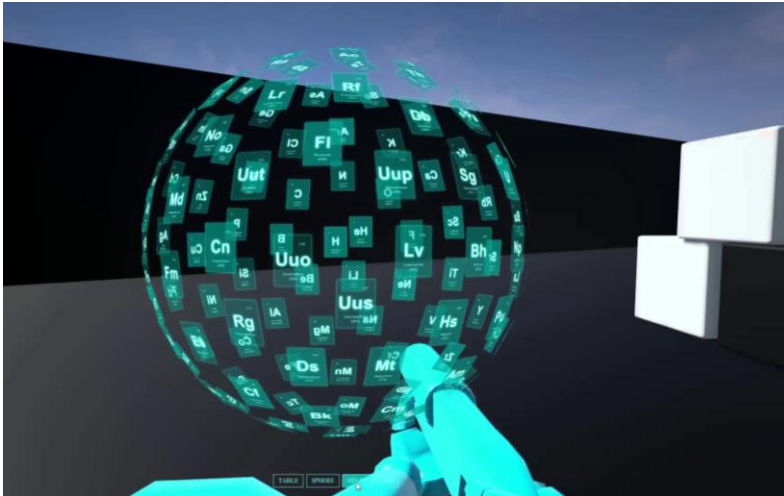
Tavole Periodiche che mostrano gli elementi in diretta



DePauw University, Indiana (USA)



Tavole Periodiche touch

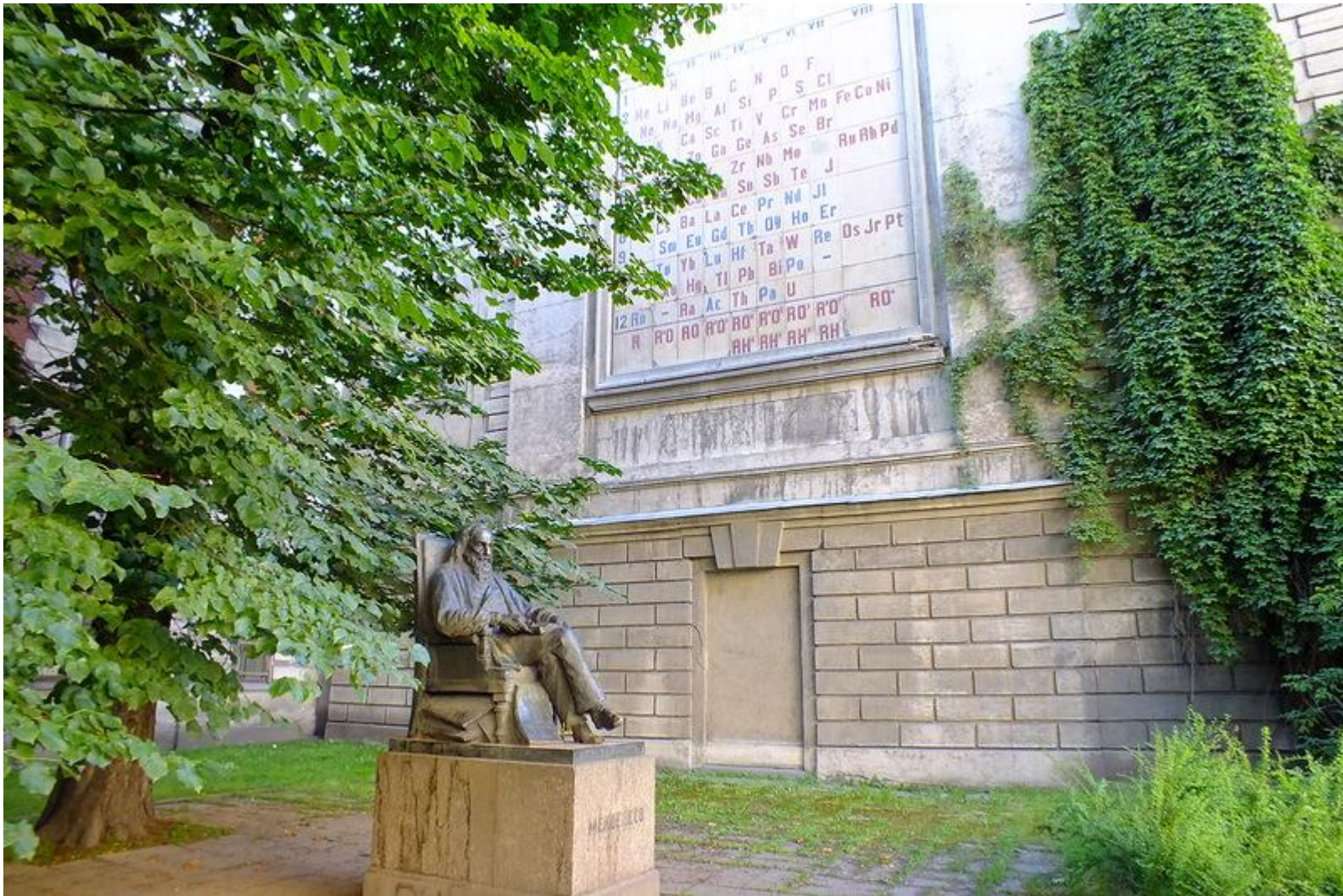


Tavole Periodiche "umane"



Lisbona (Portogallo)

Monumenti dedicati alla Tavola Periodica



San Pietroburgo

Monumenti dedicati alla Tavola Periodica



Bratislava, Slovacchia

Tavole Periodiche grandissime



Murcia (Spagna)

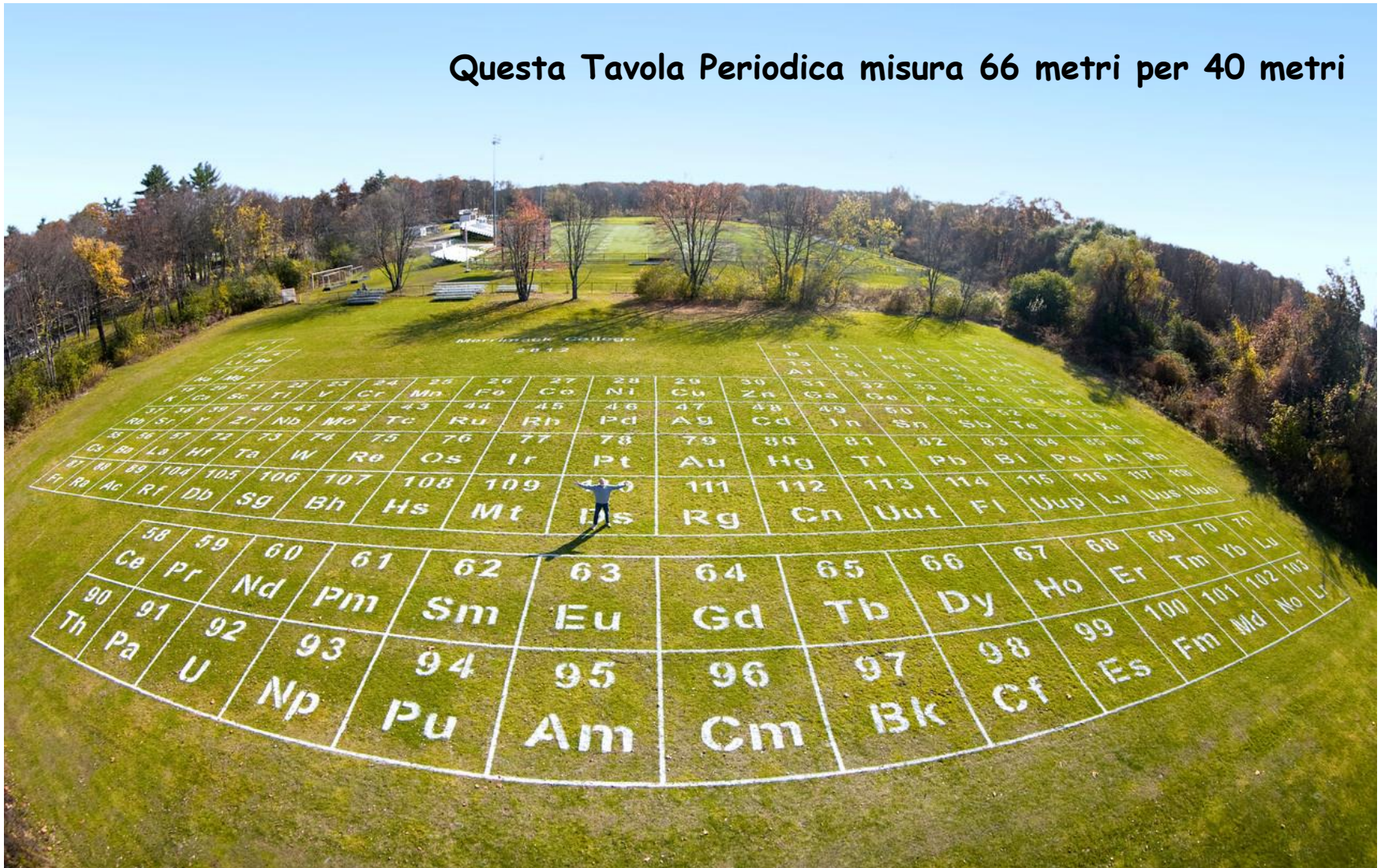
Tavole Periodiche grandissime



Daley Center, Chicago (USA)

Tavole Periodiche grandissime

Questa Tavola Periodica misura 66 metri per 40 metri



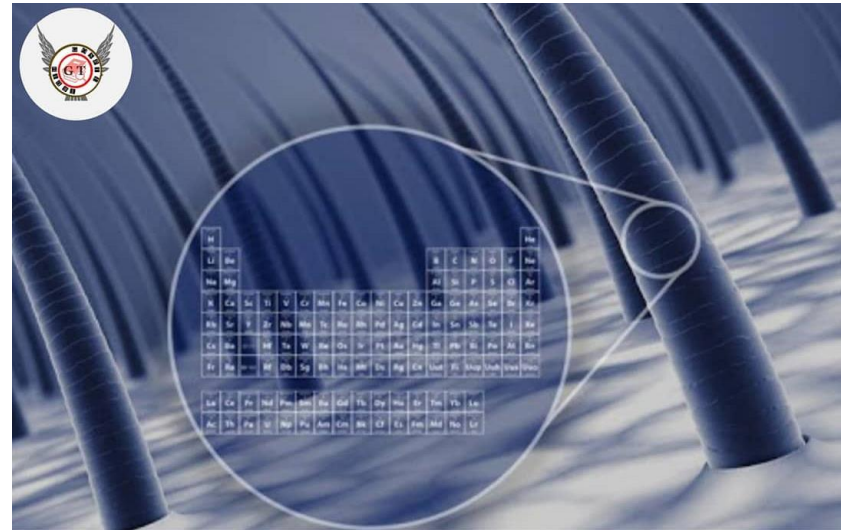
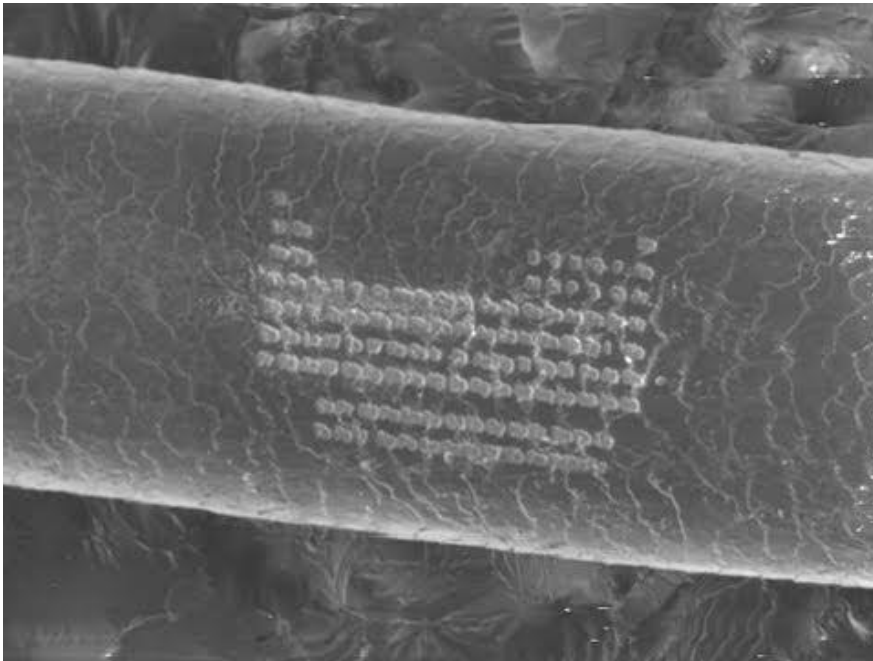
Merrimack College, North Andover, MA (USA)



Una Tavola Periodica molto piccola

La Tavola Periodica più piccola al mondo è stata realizzata nel dicembre 2010: un regalo per il compleanno del Prof. Martyn Poliakoff.

La Tavola Periodica è stata incisa su un capello di Poliakoff usando un fascio di ioni e un microscopio ad elettroni: misura 89.67 micron in larghezza e 46.39 micron in altezza

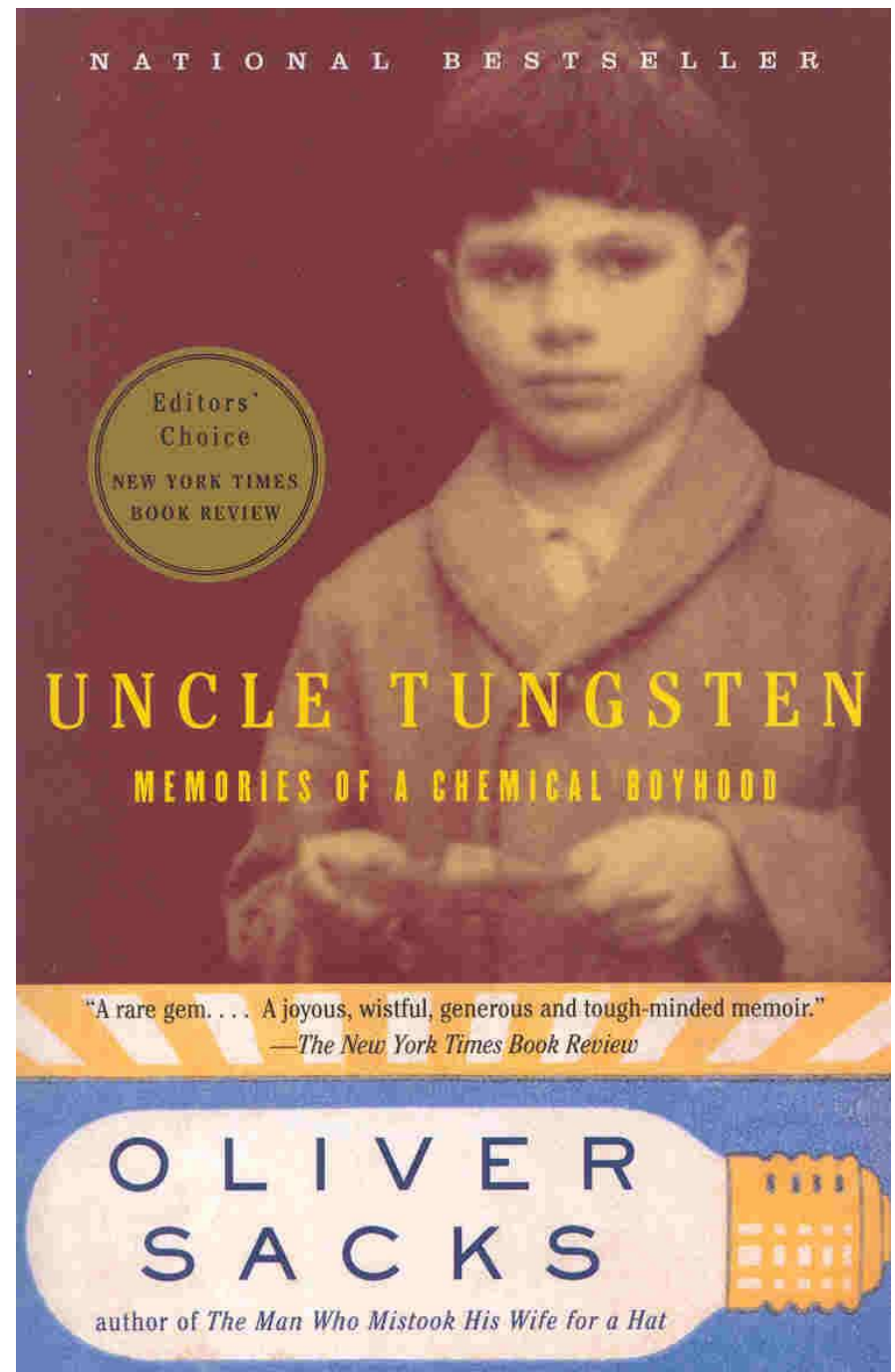


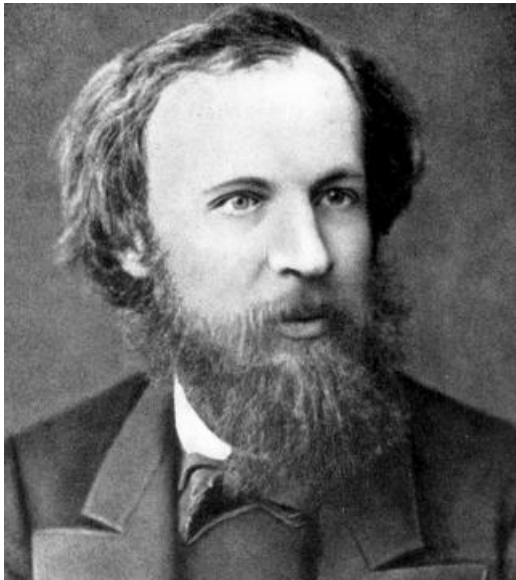
World's smallest periodic table was created on a strand of hair at the University of Nottingham. In this periodic table, each symbol measures about 4 millionths of a meter across.

Oliver Sacks ha detto

*"La Tavola Periodica
è la scoperta più
importante nella
storia della Scienza:
ogni cosa al suo
posto*

New York Times, April 18, 1999





1868: Mendeleev
produce una prima
bozza, scritta a mano,
della Tavola Periodica
ordinando gli elementi
in funzione del peso
atomico

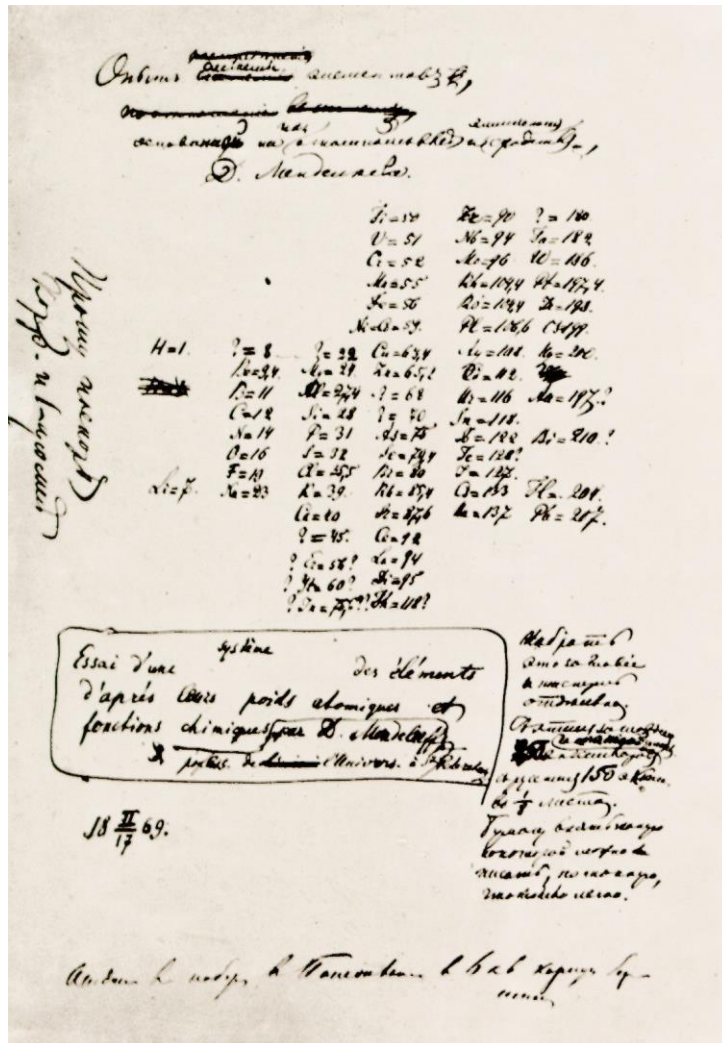
Tabella Periodica

42,5
17,5
110

2. 20,5
3. 60?
4. 56?
5. 74
6. 92
7. 104
8. 116
9. 128
10. 140
11. 152
12. 164
13. 176
14. 188
15. 200
16. 212
17. 224
18. 236
19. 248
20. 260
21. 272
22. 284
23. 296
24. 308
25. 320
26. 332
27. 344
28. 356
29. 368
30. 380
31. 392
32. 404
33. 416
34. 428
35. 440
36. 452
37. 464
38. 476
39. 488
40. 500
41. 512
42. 524
43. 536
44. 548
45. 560
46. 572
47. 584
48. 596
49. 608
50. 620
51. 632
52. 644
53. 656
54. 668
55. 680
56. 692
57. 704
58. 716
59. 728
60. 740
61. 752
62. 764
63. 776
64. 788
65. 800
66. 812
67. 824
68. 836
69. 848
70. 860
71. 872
72. 884
73. 896
74. 908
75. 920
76. 932
77. 944
78. 956
79. 968
80. 980
81. 992
82. 1004
83. 1016
84. 1028
85. 1040
86. 1052
87. 1064
88. 1076
89. 1088
90. 1100
91. 1112
92. 1124
93. 1136
94. 1148
95. 1160
96. 1172
97. 1184
98. 1196
99. 1208
100. 1220
101. 1232
102. 1244
103. 1256
104. 1268
105. 1280
106. 1292
107. 1304
108. 1316
109. 1328
110. 1340
111. 1352
112. 1364
113. 1376
114. 1388
115. 1400
116. 1412
117. 1424
118. 1436
119. 1448
120. 1460
121. 1472
122. 1484
123. 1496
124. 1508
125. 1520
126. 1532
127. 1544
128. 1556
129. 1568
130. 1580
131. 1592
132. 1604
133. 1616
134. 1628
135. 1640
136. 1652
137. 1664
138. 1676
139. 1688
140. 1700
141. 1712
142. 1724
143. 1736
144. 1748
145. 1760
146. 1772
147. 1784
148. 1796
149. 1808
150. 1820
151. 1832
152. 1844
153. 1856
154. 1868
155. 1880
156. 1892
157. 1904
158. 1916
159. 1928
160. 1940
161. 1952
162. 1964
163. 1976
164. 1988
165. 2000
166. 2012
167. 2024
168. 2036
169. 2048
170. 2060
171. 2072
172. 2084
173. 2096
174. 2108
175. 2120
176. 2132
177. 2144
178. 2156
179. 2168
180. 2180
181. 2192
182. 2204
183. 2216
184. 2228
185. 2240
186. 2252
187. 2264
188. 2276
189. 2288
190. 2300
191. 2312
192. 2324
193. 2336
194. 2348
195. 2360
196. 2372
197. 2384
198. 2396
199. 2408
200. 2420
201. 2432
202. 2444
203. 2456
204. 2468
205. 2480
206. 2492
207. 2504
208. 2516
209. 2528
210. 2540
211. 2552
212. 2564
213. 2576
214. 2588
215. 2600
216. 2612
217. 2624
218. 2636
219. 2648
220. 2660
221. 2672
222. 2684
223. 2696
224. 2708
225. 2720
226. 2732
227. 2744
228. 2756
229. 2768
230. 2780
231. 2792
232. 2804
233. 2816
234. 2828
235. 2840
236. 2852
237. 2864
238. 2876
239. 2888
240. 2900
241. 2912
242. 2924
243. 2936
244. 2948
245. 2960
246. 2972
247. 2984
248. 2996
249. 3008
250. 3020
251. 3032
252. 3044
253. 3056
254. 3068
255. 3080
256. 3092
257. 3104
258. 3116
259. 3128
260. 3140
261. 3152
262. 3164
263. 3176
264. 3188
265. 3200
266. 3212
267. 3224
268. 3236
269. 3248
270. 3260
271. 3272
272. 3284
273. 3296
274. 3308
275. 3320
276. 3332
277. 3344
278. 3356
279. 3368
280. 3380
281. 3392
282. 3404
283. 3416
284. 3428
285. 3440
286. 3452
287. 3464
288. 3476
289. 3488
290. 3500
291. 3512
292. 3524
293. 3536
294. 3548
295. 3560
296. 3572
297. 3584
298. 3596
299. 3608
300. 3620
301. 3632
302. 3644
303. 3656
304. 3668
305. 3680
306. 3692
307. 3704
308. 3716
309. 3728
310. 3740
311. 3752
312. 3764
313. 3776
314. 3788
315. 3800
316. 3812
317. 3824
318. 3836
319. 3848
320. 3860
321. 3872
322. 3884
323. 3896
324. 3908
325. 3920
326. 3932
327. 3944
328. 3956
329. 3968
330. 3980
331. 3992
332. 4004
333. 4016
334. 4028
335. 4040
336. 4052
337. 4064
338. 4076
339. 4088
340. 4100
341. 4112
342. 4124
343. 4136
344. 4148
345. 4160
346. 4172
347. 4184
348. 4196
349. 4208
350. 4220
351. 4232
352. 4244
353. 4256
354. 4268
355. 4280
356. 4292
357. 4304
358. 4316
359. 4328
360. 4340
361. 4352
362. 4364
363. 4376
364. 4388
365. 4400
366. 4412
367. 4424
368. 4436
369. 4448
370. 4460
371. 4472
372. 4484
373. 4496
374. 4508
375. 4520
376. 4532
377. 4544
378. 4556
379. 4568
380. 4580
381. 4592
382. 4604
383. 4616
384. 4628
385. 4640
386. 4652
387. 4664
388. 4676
389. 4688
390. 4700
391. 4712
392. 4724
393. 4736
394. 4748
395. 4760
396. 4772
397. 4784
398. 4796
399. 4808
400. 4820
401. 4832
402. 4844
403. 4856
404. 4868
405. 4880
406. 4892
407. 4904
408. 4916
409. 4928
410. 4940
411. 4952
412. 4964
413. 4976
414. 4988
415. 5000
416. 5012
417. 5024
418. 5036
419. 5048
420. 5060
421. 5072
422. 5084
423. 5096
424. 5108
425. 5120
426. 5132
427. 5144
428. 5156
429. 5168
430. 5180
431. 5192
432. 5204
433. 5216
434. 5228
435. 5240
436. 5252
437. 5264
438. 5276
439. 5288
440. 5300
441. 5312
442. 5324
443. 5336
444. 5348
445. 5360
446. 5372
447. 5384
448. 5396
449. 5408
450. 5420
451. 5432
452. 5444
453. 5456
454. 5468
455. 5480
456. 5492
457. 5504
458. 5516
459. 5528
460. 5540
461. 5552
462. 5564
463. 5576
464. 5588
465. 5600
466. 5612
467. 5624
468. 5636
469. 5648
470. 5660
471. 5672
472. 5684
473. 5696
474. 5708
475. 5720
476. 5732
477. 5744
478. 5756
479. 5768
480. 5780
481. 5792
482. 5804
483. 5816
484. 5828
485. 5840
486. 5852
487. 5864
488. 5876
489. 5888
490. 5900
491. 5912
492. 5924
493. 5936
494. 5948
495. 5960
496. 5972
497. 5984
498. 5996
499. 6008
500. 6020
501. 6032
502. 6044
503. 6056
504. 6068
505. 6080
506. 6092
507. 6104
508. 6116
509. 6128
510. 6140
511. 6152
512. 6164
513. 6176
514. 6188
515. 6200
516. 6212
517. 6224
518. 6236
519. 6248
520. 6260
521. 6272
522. 6284
523. 6296
524. 6308
525. 6320
526. 6332
527. 6344
528. 6356
529. 6368
530. 6380
531. 6392
532. 6404
533. 6416
534. 6428
535. 6440
536. 6452
537. 6464
538. 6476
539. 6488
540. 6500
541. 6512
542. 6524
543. 6536
544. 6548
545. 6560
546. 6572
547. 6584
548. 6596
549. 6608
550. 6620
551. 6632
552. 6644
553. 6656
554. 6668
555. 6680
556. 6692
557. 6704
558. 6716
559. 6728
560. 6740
561. 6752
562. 6764
563. 6776
564. 6788
565. 6800
566. 6812
567. 6824
568. 6836
569. 6848
570. 6860
571. 6872
572. 6884
573. 6896
574. 6908
575. 6920
576. 6932
577. 6944
578. 6956
579. 6968
580. 6980
581. 6992
582. 7004
583. 7016
584. 7028
585. 7040
586. 7052
587. 7064
588. 7076
589. 7088
590. 7100
591. 7112
592. 7124
593. 7136
594. 7148
595. 7160
596. 7172
597. 7184
598. 7196
599. 7208
600. 7220
601. 7232
602. 7244
603. 7256
604. 7268
605. 7280
606. 7292
607. 7304
608. 7316
609. 7328
610. 7340
611. 7352
612. 7364
613. 7376
614. 7388
615. 7400
616. 7412
617. 7424
618. 7436
619. 7448
620. 7460
621. 7472
622. 7484
623. 7496
624. 7508
625. 7520
626. 7532
627. 7544
628. 7556
629. 7568
630. 7580
631. 7592
632. 7604
633. 7616
634. 7628
635. 7640
636. 7652
637. 7664
638. 7676
639. 7688
640. 7700
641. 7712
642. 7724
643. 7736
644. 7748
645. 7760
646. 7772
647. 7784
648. 7796
649. 7808
650. 7820
651. 7832
652. 7844
653. 7856
654. 7868
655. 7880
656. 7892
657. 7904
658. 7916
659. 7928
660. 7940
661. 7952
662. 7964
663. 7976
664. 7988
665. 8000
666. 8012
667. 8024
668. 8036
669. 8048
670. 8060
671. 8072
672. 8084
673. 8096
674. 8108
675. 8120
676. 8132
677. 8144
678. 8156
679. 8168
680. 8180
681. 8192
682. 8204
683. 8216
684. 8228
685. 8240
686. 8252
687. 8264
688. 8276
689. 8288
690. 8300
691. 8312
692. 8324
693. 8336
694. 8348
695. 8360
696. 8372
697. 8384
698. 8396
699. 8408
700. 8420
701. 8432
702. 8444
703. 8456
704. 8468
705. 8480
706. 8492
707. 8504
708. 8516
709. 8528
710. 8540
711. 8552
712. 8564
713. 8576
714. 8588
715. 8600
716. 8612
717. 8624
718. 8636
719. 8648
720. 8660
721. 8672
722. 8684
723. 8696
724. 8708
725. 8720
726. 8732
727. 8744
728. 8756
729. 8768
730. 8780
731. 8792
732. 8804
733. 8816
734. 8828
735. 8840
736. 8852
737. 8864
738. 8876
739. 8888
740. 8900
741. 8912
742. 8924
743. 8936
744. 8948
745. 8960
746. 8972
747. 8984
748. 8996
749. 9008
750. 9020
751. 9032
752. 9044
753. 9056
754. 9068
755. 9080
756. 9092
757. 9104
758. 9116
759. 9128
760. 9140
761. 9152
762. 9164
763. 9176
764. 9188
765. 9200
766. 9212
767. 9224
768. 9236
769. 9248
770. 9260
771. 9272
772. 9284
773. 9296
774. 9308
775. 9320
776. 9332
777. 9344
778. 9356
779. 9368
780. 9380
781. 9392
782. 9404
783. 9416
784. 9428
785. 9440
786. 9452
787. 9464
788. 9476
789. 9488
790. 9500
791. 9512
792. 9524
793. 9536
794. 9548
795. 9560
796. 9572
797. 9584
798. 9596
799. 9608
800. 9620
801. 9632
802. 9644
803. 9656
804. 9668
805. 9680
806. 9692
807. 9704
808. 9716
809. 9728
810. 9740
811. 9752
812. 9764
813. 9776
814. 9788
815. 9800
816. 9812
817. 9824
818. 9836
819. 9848
820. 9860
821. 9872
822. 9884
823. 9896
824. 9908
825. 9920
826. 9932
827. 9944
828. 9956
829. 9968
830. 9980
831. 9992
832. 10004
833. 10016
834. 10028
835. 10040
836. 10052
837. 10064
838. 10076
839. 10088
840. 10100
841. 10112
842. 10124
843. 10136
844. 10148
845. 10160
846. 10172
847. 10184
848. 10196
849. 10208
850. 10220
851. 10232
852. 10244
853. 10256
854. 10268
855. 10280
856. 10292
857. 10304
858. 10316
859. 10328
860. 10340
861. 10352
862. 10364
863. 10376
864. 10388
865. 10400
866. 10412
867. 10424
868. 10436
869. 10448
870. 10460
871. 10472
872. 10484
873. 10496
874. 10508
875. 10520
876. 10532
877. 10544
878. 10556
879. 10568
880. 10580
881. 10592
882. 10604
883. 10616
884. 10628
885. 10640
886. 10652
887. 10664
888. 10676
889. 10688
890. 10700
891. 10712
892. 10724
893. 10736
894. 10748
895. 10760
896. 10772
897. 10784
898. 10796
899. 10808
900. 10820
901. 10832
902. 10844
903. 10856
904. 10868
905. 10880
906. 10892
907. 10904
908. 10916
909. 10928
910. 10940
911. 10952
912. 10964
913. 10976
914. 10988
915. 11000
916. 11012
917. 11024
918. 11036
919. 11048
920. 11060
921. 11072
922. 11084
923. 11096
924. 11108
925. 11120
926. 11132
927. 11144
928. 11156
929. 11168
930. 11180
931. 11192
932. 11204
933. 11216
934. 11228
935. 11240
936. 11252
937. 11264
938. 11276
939. 11288
940. 11300
941. 11312
942. 11324
943. 11336
944. 11348
945. 11360
946. 11372
947. 11384
948. 11396
949. 11408
950. 11420
951. 11432
952. 11444
953. 11456
954. 11468
955. 11480
956. 11492
957. 11504
958. 11516
959. 11528
960. 11540
961. 11552
962. 11564
963. 11576
964. 11588
965. 11600
966. 11612
967. 11624
968. 11636
969. 11648
970. 11660
971. 11672
972. 11684
973. 11696
974. 11708
975. 11720
976. 11732
977. 11744
978. 11756
979. 11768
980. 11780
981. 11792
982. 11804
983. 11816
984. 11828
985. 11840
986. 11852
987. 11864
988. 11876
989. 11888
990. 11900
991. 11912
992. 11924
993. 11936
994. 11948
995. 11960
996. 11972
997. 11984
998. 11996
999. 12008
1000. 12020
1001. 12032
1002. 12044
1003. 12056
1004. 12068
1005. 12080
1006. 12092
1007. 12104
1008. 12116
1009. 12128
1010. 12140
1011. 12152
1012. 12164
1013. 12176
1014. 12188
1015. 12200
1016. 12212
1017. 12224
1018. 12236
1019. 12248
1020. 12260
1021. 12272
1022. 12284
1023. 12296
1024. 12308
1025. 12320
1026. 12332
1027. 12344
1028. 12356
1029. 12368
1030. 12380
1031. 12392
1032. 12404
1033. 12416
1034. 12428
1035. 12440
1036. 12452
1037. 12464
1038. 12476
1039. 12488
1040. 12500
1041. 12512
1042. 12524
1043. 12536
1044. 12548
1045. 12560
1046. 12572
1047. 12584
1048. 12596
1049. 12608
1050. 12620
1051. 12632
1052. 12644
1053. 12656
1054. 12668
1055. 12680
1056. 12692
1057. 12704
1058. 12716
1059. 12728
1060. 12740
1061. 12752
1062. 12764
1063. 12776
1064. 12788
1065. 12800
1066. 12812
1067. 12824
1068. 12836
1069. 12848
1070. 12860
1071. 12872
1072. 12884
1073. 12896
1074. 12908
1075. 12920
1076. 12932
1077. 12944
1078. 12956
1079. 12968
1080. 12980
1081. 12992
1082. 13004
1083. 13016
1084. 13028
1085. 13040
1086. 13052
1087. 13064
1088. 13076
1089. 13088
1090. 13100
1091. 13112
1092. 13124

1869: Mendeleev elabora una nuova versione della Tavola Periodica

(gli elementi sono ordinati in funzione del peso atomico crescente da sinistra a destra e dall'alto verso il basso)



ОПЫТЪ СИСТЕМЫ ЭЛЕМЕНТОВЪ, ОСНОВАННОЙ НА ИХЪ АТОМНОМЪ ВѢСѢ И ХИМИЧЕСКОМЪ СХОДСТВѢ.

	Ti=50	Zr=90	?=180.
	V=51	Nb=94	Ta=182.
	Cr=52	Mo=96	W=186.
	Mn=55	Rh=104,4	Pt=197,1.
	Fe=56	Ru=104,4	Ir=198.
	Ni=Co=59	Pd=106,6	Os=199.
H=1	Cu=63,4	Ag=108	Hg=200.
Be=9,4	Mg=24	Zn=65,2	Cd=112
B=11	Al=27,3	?=68	Ur=116
C=12	Si=28	?=70	Sn=118
N=14	P=31	As=75	Sb=122
O=16	S=32	Se=79,4	Te=128?
F=19	Cl=35,5	Br=80	I=127
Li=7	Na=23	K=39	Rb=85,4
		Ca=40	Sr=87,6
		?=45	Ce=92
		?Er=56	La=94
		?Yt=60	Di=95
		?In=75,6	Th=118?

Д. Менделѣевъ

1871: l'ultima versione della Tavola Periodica di Mendeleev

Reihen	Gruppe I. — R^1O	Gruppe II. — RO	Gruppe III. — R^2O^3	Gruppe IV. RR^4 RO^2	Gruppe V. RR^3 R^2O^3	Gruppe VI. RR^2 RO^3	Gruppe VII. RR R^2O^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	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	?Co=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	—	— — — —

1871: l'ultima versione della Tavola Periodica di Mendeleev

ЕСТЕСТВЕННАЯ СИСТЕМА ЭЛЕМЕНТОВЪ Д. МЕНДЕЛѢЕВА.

	Группа I. R'O H=1 H ⁺ , NH, HCl, H ⁺ N, H ⁺ C, ROH.	Группа II. R'O ² или RO Be=9, ¹ BeCl ₂ , BeO, Be ⁺ Al ² Si ² O ⁴	Группа III. R'O ³ B=11 BCl ₃ , B ⁺ O, BN, B ⁺ Na ⁺ O, BF ₃	Группа IV. R'O ⁴ или RO ² RH ⁴ C=12 CH ₄ , C ⁺ H ⁺ , CO, CO ₂ , CO ⁺ M ⁺	Группа V. R'O ⁵ RH ⁵ N=14 NH ₃ , NH ⁺ Cl, N ⁺ O, NO, NO ⁺ M, CNM ⁺	Группа VI. R'O ⁶ или RO ³ RH ⁶ O=16 OH ⁺ O ⁺ C, O ₃ , O ₄ , OM ⁺ O ⁺ R, HOH ⁺	Группа VII. R'O ⁷ RH ⁷ F=19 FH, BF ₃ , SiF ₄ , CaF ₂ , KF, KHF ₂	Группа VIII. (переходъ къ I) R'O ⁸ или RO ⁴ H=1 HX				
Периодъ 1-й. Периодъ 2-й. Периодъ 3-й. Периодъ 4-й. Периодъ 5-й.	Li=7 LiCl, LiOH, Li ⁺ O, LiX, Li ⁺ CO ₂	Be=9, ¹ BeCl ₂ , BeO, Be ⁺ Al ² Si ² O ⁴	B=11 BCl ₃ , B ⁺ O, BN, B ⁺ Na ⁺ O, BF ₃	C=12 CH ₄ , C ⁺ H ⁺ , CO, CO ₂ , CO ⁺ M ⁺	N=14 NH ₃ , NH ⁺ Cl, N ⁺ O, NO, NO ⁺ M, CNM ⁺	O=16 OH ⁺ O ⁺ C, O ₃ , O ₄ , OM ⁺ O ⁺ R, HOH ⁺	F=19 FH, BF ₃ , SiF ₄ , CaF ₂ , KF, KHF ₂	* Тяло твърдо, малоразтворимо въ водъ. ^ Тяло газообразно или летуно. M=K, Ag... M²=Ca, Pb... X=Cl, O, NO, OH, OM... X²=SO, CO⁺, O₃...				
Рядъ 1.	Na=23 NaCl, NaHO, Na ⁺ O, Na ⁺ SO ⁺ Na ⁺ CO ²	Mg=24 MgCl ₂ , MgO, MgCO ₂ , MgSO ⁺ Mg ⁺ NH ⁺ PO ²	Al=27, ³ Al ⁺ Cl ₃ , Al ⁺ O ₂ , KAIS ⁺ O ⁺ 12H ⁺ O.	Si=28 SiH ₄ , SiCl ₄ , SiH ⁺ F ⁺ , KAIS ⁺ O ⁺ SiO ²	P=31 PH ₃ , PCl ₃ , PCl ₅ , P ⁺ O ⁺ P ⁺ O ⁺ , Ca ⁺ P ⁺ O ⁺	S=32 SH ₂ , SM ⁺ SM ⁺ , SO ⁺ SO ⁺ X ⁺ Ba ⁺ SO ⁺	Cl=35, ⁵ ClH, ClM, ClCl, ClOH, ClO ⁺ H, AgCl ₂					
Рядъ 2.	K=39 KCl, KOH, K ⁺ O, KNO ⁺ K ⁺ PO ⁺ K ⁺ SiF ⁺	Ca=40 CaSO ⁺ CaO, SiO ⁺ , CaCl ⁺ CaO, CaCO ⁺	Zn=65 ZnCl ⁺ ZnO, ZnCO ₂ , ZnSO ⁺ ZnEt ⁺	Ti=48(50) ⁷ TiCl ⁺ TiO ⁺ TiO ⁺ , FeTiO ⁺ TiOSO ⁺	V=51 VOCl ⁺ V ⁺ O ⁺ VO ⁺ , Pb ⁺ V ⁺ O ⁺ VO ⁺	Cr=52 CrCl ⁺ CrCl ⁺ Cr ⁺ O ⁺ , CrO ⁺ K ⁺ CrO ⁺ CrO ⁺ Cl ⁺	Mn=55 MnK ⁺ O ⁺ MnK ⁺ O ⁺ , MnCl ⁺ MnO, MnO ⁺	Fe=56 FeK ⁺ O ⁺ FeS ⁺ , FeO ⁺ FeO ⁺ , FeK ⁺ Cy ⁺	Co=59 CoX ⁺ CoX ⁺ , CoX ⁺ 5NH ⁺ , CoK ⁺ Cy ⁺	Ni=59 NiX ⁺ SiO ⁺ , NiSO ⁺ NH ⁺ , NiK ⁺ Cy ⁺	Cu=63 CuX ⁺ CuX ⁺ , Cu ⁺ O, CuO ⁺ , CuKCy ⁺	
Рядъ 3.	Cu=63 CuX ⁺ CuX ⁺				As=75 AsH ⁺ AsCl ⁺ As ⁺ O ⁺ , As ⁺ O ⁺ As ⁺ S ⁺	Se=78 SeH ⁺ SeO ⁺ SeO ⁺ , SeM ⁺ SeM ⁺ O ⁺	Br=80 BrH, BrM, BrO ⁺ M, BrAg ⁺					
Рядъ 4.	Rb=85 RbCl, RbOH, Rb ⁺ PtCl ⁺	Sr=87 SrCl ⁺ SrO, SrH ⁺ O ⁺ , SrSO ⁺ SrCO ⁺	In=113 InCl ⁺ In ⁺ O ⁺	Sn=118 SnCl ⁺ SnCl ⁺ SnO ⁺ , SnX ⁺ SnNa ⁺ O ⁺	Sb=122 SbH ⁺ SbCl ⁺ Sb ⁺ O ⁺ , Sb ⁺ O ⁺ Sb ⁺ S ⁺ 2S ⁺ OX	Mo=96 MoCl ⁺ MoS ₂ MoO ₂ , M ⁺ Mo ⁺ O ⁺ nMo ⁺ O ⁺		Ru=104 RuO ⁺ RuCl ⁺ , RuO ⁺ RuCl ⁺ , RuK ⁺ Cy ⁺	Rh=104 RhCl ⁺ RhCl ⁺ , Rh ⁺ O ⁺ RhX ⁺ , RhK ⁺ Cy ⁺	Pd=106 PdH, PdO ⁺ , PdCl ⁺ PdCl ⁺ , PdK ⁺ ty ⁺	Ag=108 AgNO ⁺ AgX ⁺ , AgCl ⁺ Ag ⁺ O ⁺ , AgKCy ⁺	
Рядъ 5.	Ag=108 AgX, AgCl ₂	Cd=112 CdCl ⁺ CdO, CdS ₂ , CdSO ⁺										
Рядъ 6.	Cs=133 CsCl, CsOH, Cs ⁺ PtCl ⁺	Ba=137 BaCl ⁺ BaH ⁺ O ⁺ BaO ⁺ , BaSO ⁺ BaSiF ⁺	Ce=140(135) ⁷ CeCl ⁺ Ce ⁺ O ⁺ CeO ⁺ , CeX ⁺ CeX ⁺ CeK ⁺ X ⁺									
Рядъ 7.												
Рядъ 8.					Ta=182 TaCl ⁺ Ta ⁺ O ⁺ , TaK ⁺	W=184 WCl ⁺ WCl ⁺ WO ₂ , K ⁺ W ⁺ O ⁺ nWO ⁺		Os=193 OsO ⁺ OsH ⁺ O ⁺ , OsCl ⁺ OsCl ⁺ , OsK ⁺ Cy ⁺	Ir=195 K ⁺ IrCl ⁺ IrCl ⁺ , IrCl ⁺ Ir ⁺ O ⁺ , IrK ⁺ Cy ⁺	Pt=197 PtCl ⁺ PtO ⁺ , PtCl ⁺ Pt ⁺ X ⁺ , PtK ⁺ Cy ⁺	Au=197 AuCl ⁺ AuCl ⁺ , Au ⁺ O ⁺ Au ⁺ O ⁺ , AuKCy ⁺	
Рядъ 9.	Au=197 AuX, AuX ⁺	Hg=200 HgCl ⁺ HgCl ⁺ Hg ⁺ O ⁺ , HgO, HgX ⁺ nHgO	Tl=204 TlCl ⁺ Tl ⁺ O ⁺ Tl ⁺ O ⁺ , Tl ⁺ SO ⁺ TlCl ⁺	Pb=207 PbCl ⁺ PbO, PbO ⁺ , PbEt ⁺ PbSO ⁺ PbK ⁺ O ⁺	Bi=208 BiCl ⁺ BiO ⁺ BiO ⁺ TH ⁺ , BiX ⁺ BiOX ⁺ BiNO ⁺ (HO ⁺)							
Рядъ 10.			Th=231 ThCl ⁺ ThO ₂ , ThX ⁺ ThSO ⁺		U=240 UCl ⁺ UO ₂ UO ⁺ X ⁺ , UO ⁺ M ⁺ UO ⁺							

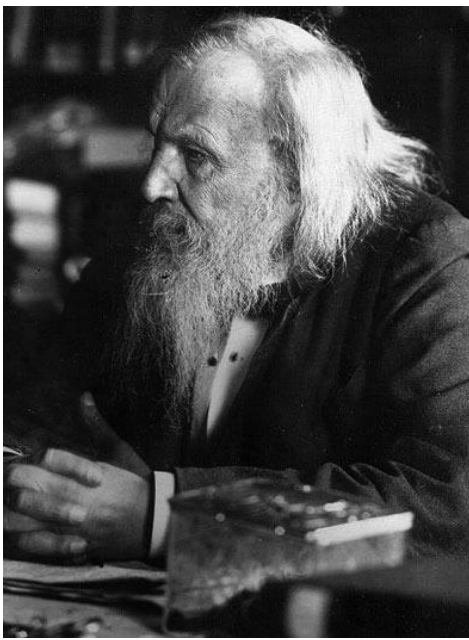
Li	Be	B	C	N	O	F	H	Na	Mg	Al	Si	P	S	Cl
K	Ca	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Br	
Rb	Sr	Yt ²	Zr	Nb	Mo	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te
Cs	Ba	Dip	Ce											I
		Er ²	La ²	Ta	W	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	
		Th												

Prima stampa dell'ultima versione della Tavola Periodica conservata nella Casa-Museo di Mendeleev a San Pietroburgo



Dmitry Mendeleev è considerato il padre della Tavola Periodica

Ha usato la sua tavola per predire l'esistenza e le proprietà di elementi a quel tempo sconosciuti inserendo delle caselle vuote in opportune posizioni; per esempio aveva predetto l'esistenza di un elemento che avrebbe dovuto occupare la posizione sotto il silicio: lo chiamò ekasilicio e ne predisse le proprietà. Questo elemento è stato in effetti scoperto: si tratta del germanio che ha esattamente le proprietà previste da Mendeleev



Dmitry Mendeleev è considerato il padre della Tavola Periodica

Nel pensare alla sua Tavola Periodica Mendeleev non ha seguito pedissequamente l'ordine predetto dal peso atomico: in alcuni casi, infatti, ha invertito la posizione di certi elementi

L'ordine che Mendeleev ha seguito, anche se inconsciamente, è quello dettato dal "numero atomico" che oggi sappiamo essere la vera "grandezza ordinatrice" della Tavola Periodica

Gli elementi sono ordinati nella Tavola Periodica in funzione del numero atomico (numero dei protoni = numero degli elettroni)

Gli elementi sono raccolti in righe verticali (gruppi) e righe orizzontali (periodi) in base alla ripetitività della distribuzione degli elettroni attorno al nucleo (configurazione elettronica):

inizia un nuovo periodo quando si ha la stessa distribuzione degli elettroni esterni

group

1

1

1.00794

1312.0

2.20

1

H

Hydrogen

1s¹

2

6.941

900.3

0.98

3

Li

Lithium

1s² 2s¹

3

9.012182

999.5

1.57

4

Be

Beryllium

1s² 2s²

11

22.98976

495.8

0.93

1

Na

Sodium

[Ne] 3s¹

12

24.3050

737.7

1.31

2

Mg

Magnesium

[Ne] 3s²

19

39.0983

418.8

0.82

1

K

Potassium

[Ar] 4s¹

20

40.078

589.8

1.00

2

Ca

Calcium

[Ar] 4s²

37

85.4678

403.0

0.82

1

Rb

Rubidium

[Kr] 5s¹

38

87.62

549.5

0.95

2

Sr

Strontium

[Kr] 5s²

55

132.9054

375.7

0.79

1

Cs

Cesium

[Xe] 6s¹

56

137.327

502.9

0.89

2

Ba

Barium

[Xe] 6s²

87

(223)

380.0

0.70

1

Fr

Francium

[Rn] 7s¹

88

(226)

500.3

0.90

2

Ra

Radium

[Rn] 7s²

21

44.95591

633.1

1.36

3

Sc

Scandium

[Ar] 3d¹ 4s²

22

47.867

658.8

1.54

4

Ti

Titanium

[Ar] 3d² 4s²

39

88.90585

680.0

1.22

3

Y

Yttrium

[Kr] 4d¹ 5s²

40

91.224

744.1

1.33

4

Zr

Zirconium

[Kr] 4d² 5s²

71

174.968

523.5

1.27

3

Lu

Lutetium

[Xe] 4f¹⁴ 5d¹ 6s²

72

178.49

549.5

1.30

4

Hf

Hafnium

[Xe] 4f¹⁴ 5d² 6s²

103

(262)

590.0

1.28

3

Lr

Lawrencium

[Rn] 5f¹⁴ 6d¹ 7s²

104

(261)

590.0

1.28

4

Rf

Rutherfordium

[Rn] 5f¹⁴ 6d² 7s²

23

50.9415

650.9

1.63

3

V

Vanadium

[Ar] 3d³ 4s²

24

51.9962

652.9

1.66

4

Cr

Chromium

[Ar] 3d⁵ 4s¹

41

92.90638

710.0

1.50

3

Nb

Niobium

[Kr] 4d⁴ 5s¹

42

95.96

744.1

1.53

4

Mo

Molybdenum

[Kr] 4d⁵ 5s¹

73

180.9478

761.0

1.50

3

Ta

Tantalum

[Xe] 4f¹⁴ 5d³ 6s²

74

183.84

770.0

1.50

4

W

Tungsten

[Xe] 4f¹⁴ 5d⁴ 6s²

105

(262)

590.0

1.28

3

Db

Dubnium

[Rn] 5f¹⁴ 6d¹ 7s²

106

(266)

590.0

1.28

4

Sg

Seaborgium

[Rn] 5f¹⁴ 6d² 7s²

25

54.93804

717.3

1.55

3

Mn

Manganese

[Ar] 3d⁵ 4s²

26

55.845

762.5

1.83

4

Fe

Iron

[Ar] 3d⁶ 4s²

43

(98)

98.00

1.90

3

Tc

Technetium

[Kr] 4d⁵ 5s²

44

101.07

710.2

2.20

4

Ru

Ruthenium

[Kr] 4d⁷ 5s¹

75

186.207

770.0

1.90

3

Re

Rhenium

[Xe] 4f¹⁴ 5d⁵ 6s²

76

190.23

780.0

2.20

4

Os

Osmium

[Xe] 4f¹⁴ 5d⁶ 6s²

107

(264)

590.0

1.28

3

Bh

Bohrium

[Rn] 5f¹⁴ 6d¹ 7s²

108

(277)

590.0

1.28

4

Hs

Hassium

[Rn] 5f¹⁴ 6d² 7s²

27

58.93319

760.4

1.91

3

Co

Cobalt

[Ar] 3d⁷ 4s²

28

58.9332

760.4

1.91

4

Ni

Nickel

[Ar] 3d⁸ 4s²

45

102.9055

710.2

2.28

3

Rh

Rhodium

[Kr] 4d⁸ 5s¹

46

106.42

710.2

2.28

4

Pd

Palladium

[Kr] 4d¹⁰

77

192.217

780.0

2.20

3

Ir

Iridium

[Xe] 4f¹⁴ 5d⁷ 6s²

78

195.084

780.0

2.28

4

Pt

Platinum

[Xe] 4f¹⁴ 5d⁹ 6s¹

109

(268)

590.0

1.28

3

Mt

Meitnerium

[Rn] 5f¹⁴ 6d¹ 7s²

110

(271)

590.0

1.28

4

Ds

Darmstadtium

[Rn] 5f¹⁴ 6d² 7s²

29

63.546

745.5

1.90

3

Cu

Copper

[Ar] 3d¹⁰ 4s¹

30

65.38

745.5

1.90

4

Zn

Zinc

[Ar] 3d¹⁰ 4s²

47

107.8682

710.2

2.28

3

Ag

Silver

[Kr] 4d¹⁰ 5s¹

48

112.411

710.2

2.28

4

Cd

Cadmium

[Kr] 4d¹⁰ 5s²

79

196.9665

780.0

2.28

3

Au

Gold

[Xe] 4f¹⁴ 5d¹⁰ 6s¹

80

200.59

780.0

2.28

4

Hg

Mercury

[Xe] 4f¹⁴ 5d¹⁰ 6s²

111

(272)

590.0

1.28

3

Rg

Roentgenium

[Rn] 5f¹⁴ 6d¹ 7s²

112

(285)

590.0

1.28

4

Cn

Copernicium

[Rn] 5f¹⁴ 6d² 7s²

5

10.811

800.6

2.04

3

B

Boron

1s² 2s² 2p¹

6

12.0107

1086.5

2.55

4

C

Carbon

1s² 2s² 2p²

13

26.98153

577.5

1.61

3

Al

Aluminium

[Ne] 3s² 3p¹

14

28.0855

786.5

1.90

4

Si

Silicon

[Ne] 3s² 3p²

31

69.723

578.8

1.81

3

Ga

Gallium

[Ar] 3d¹⁰ 4s² 4p¹

32

72.64

762.0

2.01

4

Ge

Germanium

[Ar] 3d¹⁰ 4s² 4p²

51

114.818

559.3

1.79

3

In

Indium

[Kr] 4d¹⁰ 5s² 5p¹

52

118.710

708.0

1.96

4

Sn

Tin

[Kr] 4d¹⁰ 5s² 5p²

81

204.3833

589.4

1.62

3

Tl

Thallium

[Xe] 4f¹⁴ 5d¹⁰ 6s² 6p¹

82

207.2

589.4

1.62

4

Pb

Lead

[Xe] 4f¹⁴ 5d¹⁰ 6s² 6p²

113

(284)

590.0

1.28

3

Nh

Nihonium

[Rn] 5f¹⁴ 6d¹ 7s²

114

(289)

590.0

1.28

4

Fl

Flerovium

[Rn] 5f¹⁴ 6d² 7s²

7

14.0067

1402.3

3.04

3

N

Nitrogen

1s² 2s² 2p³

8

15.9994

1313.9

3.44

4

O

Oxygen

1s² 2s² 2p⁴

15

30.97396

1011.8

2.19

3

P

Phosphorus

[Ne] 3s² 3p³

16

32.065

999.6

2.58

4

S

Sulfur

[Ne] 3s² 3p⁴

33

74.92160

547.0

2.18

3

As

Arsenic

[Ar] 3d¹⁰ 4s² 4p³

34

78.96

547.0

2.18

4

Se

Selenium

[Ar] 3d¹⁰ 4s² 4p⁴

53

126.9045

529.3

2.05

3

I

Iodine

[Kr] 4d¹⁰ 5s² 5p⁵

54

127.60

529.3

2.05

4

Xe

Xenon

[Kr] 4d¹⁰ 5s² 5p⁶

9

18.998403

1681.0

3.98

3

F

Fluorine

1s² 2s² 2p⁵

10

20.1797

1681.0

3.98

4

Ne

Neon

1s² 2s² 2p⁶

17

35.453

1251.2

3.16

3

Cl

Chlorine

[Ne] 3s² 3p⁵

18

39.948

1520.6

3.16

4

Ar

Argon

[Ne] 3s² 3p⁶

35

79.904

1139.9

2.96

3

Br

Bromine

[Ar] 3d¹⁰ 4s² 4p⁵

36

83.798

1350.8

3.00

4

Kr

Krypton

[Ar] 3d¹⁰ 4s² 4p⁶

55

131.293

1170.4

2.60

3

I

Iodine

[Kr] 4d¹⁰ 5s² 5p⁵

56

131.293

1170.4

2.60

4

Xe

Xenon

[Kr] 4d¹⁰ 5s² 5p⁶

85

(210)

1200.0

2.20

3

At

Astatine

[Xe] 4f¹⁴ 5d¹⁰ 6s² 6p⁵

86

(222)

1200.0

2.20

4

Rn

Radon

[Xe] 4f¹⁴ 5d¹⁰ 6s² 6p⁶

117

(289)

590.0

1.28

3

Ts

Tennessine

[Rn] 5f¹⁴ 6d¹ 7s²

118

(294)

590.0

1.28

4

Og

Oganesson

[Rn] 5f¹⁴ 6d² 7s²

atomic mass
or most stable mass number

1st ionization energy
in kJ/mol

chemical symbol

name

electron configuration

55.845

762.5

1.83

26

Fe

Iron

[Ar] 3d⁶ 4s²

alkali metals

alkaline metals

other metals

transition metals

lanthanoids

actinoids

metalloids

nonmetals

halogens

noble gases

unknown elements

radioactive elements have
masses in parentheses

group

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

period

1

2

3

4

5

6

7

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

26

27

28

29

30

31

32

33

34

35

36

37

38

39

40

41

42

43

44

45

46

47

48

49

50

51

52

53

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

101

102

103

104

105

106

107

108

109

110

111

112

113

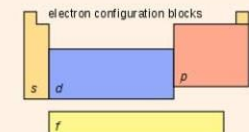
114

115

116

117

118



notes

- 1 kJ/mol = 96.485 eV.
- all elements are implied to have an oxidation state of zero.

138.9054 57 La Lanthanum [Xe] 5d ¹ 6s ²	140.116 58 Ce Cerium [Xe] 4f ¹ 5d ¹ 6s ²	140.9076 59 Pr Praseodymium [Xe] 4f ³ 6s ²	144.242 60 Nd Neodymium [Xe] 4f ⁴ 6s ²	(145) 61 Pm Promethium [Xe] 4f ⁵ 6s ²	150.36 62 Sm Samarium [Xe] 4f ⁶ 6s ²	151.964 63 Eu Europium [Xe] 4f ⁷ 6s ²	157.25 64 Gd Gadolinium [Xe] 4f ⁷ 5d ¹ 6s ²	158.9253 65 Tb Terbium [Xe] 4f ⁹ 6s ²	162.500 66 Dy Dysprosium [Xe] 4f ¹⁰ 6s ²	164.9303 67 Ho Holmium [Xe] 4f ¹¹ 6s ²	167.259 68 Er Erbium [Xe] 4f ¹² 6s ²	168.9342 69 Tm Thulium [Xe] 4f ¹³ 6s ²	173.054 70 Yb Ytterbium [Xe] 4f ¹⁴ 6s ²
(227) 89 Ac Actinium [Rn] 6d ¹ 7s ²	232.0380 90 Th Thorium [Rn] 6d ² 7s ²	231.0358 91 Pa Protactinium [Rn] 5f ² 6d ¹ 7s ²	238.0289 92 U Uranium [Rn] 5f ³ 6d ¹ 7s ²	(237) 93 Np Neptunium [Rn] 5f ⁴ 6d ¹ 7s ²	(244) 94 Pu Plutonium [Rn] 5f ⁶ 7s ²	(243) 95 Am Americium [Rn] 5f ⁷ 7s ²	(247) 96 Cm Curium [Rn] 5f ⁷ 7s ²	(247) 97 Bk Berkelium [Rn] 5f ⁹ 7s ²	(251) 98 Cf Californium [Rn] 5f ¹⁰ 7s ²	(252) 99 Es Einsteinium [Rn] 5f ¹¹ 7s ²	(257) 100 Fm Fermium [Rn] 5f ¹² 7s ²	(258) 101 Md Mendelevium [Rn] 5f ¹³ 7s ²	(259) 102 No Nobelium [Rn] 5f ¹⁴ 7s ²

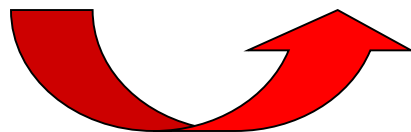
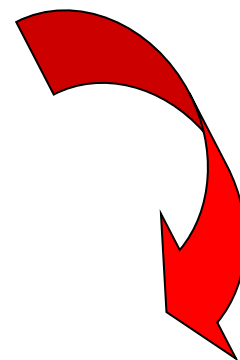
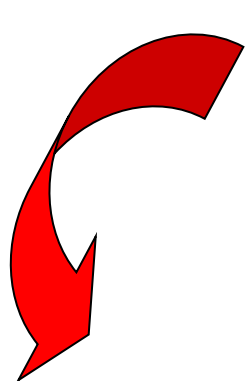
Nella Tavola Periodica coesistono i tre livelli che caratterizzano la Chimica: macroscopico, ultramicroscopico e simbolico

La chimica: una disciplina che lavora a tre livelli

macroscopico
(i fatti tangibili)

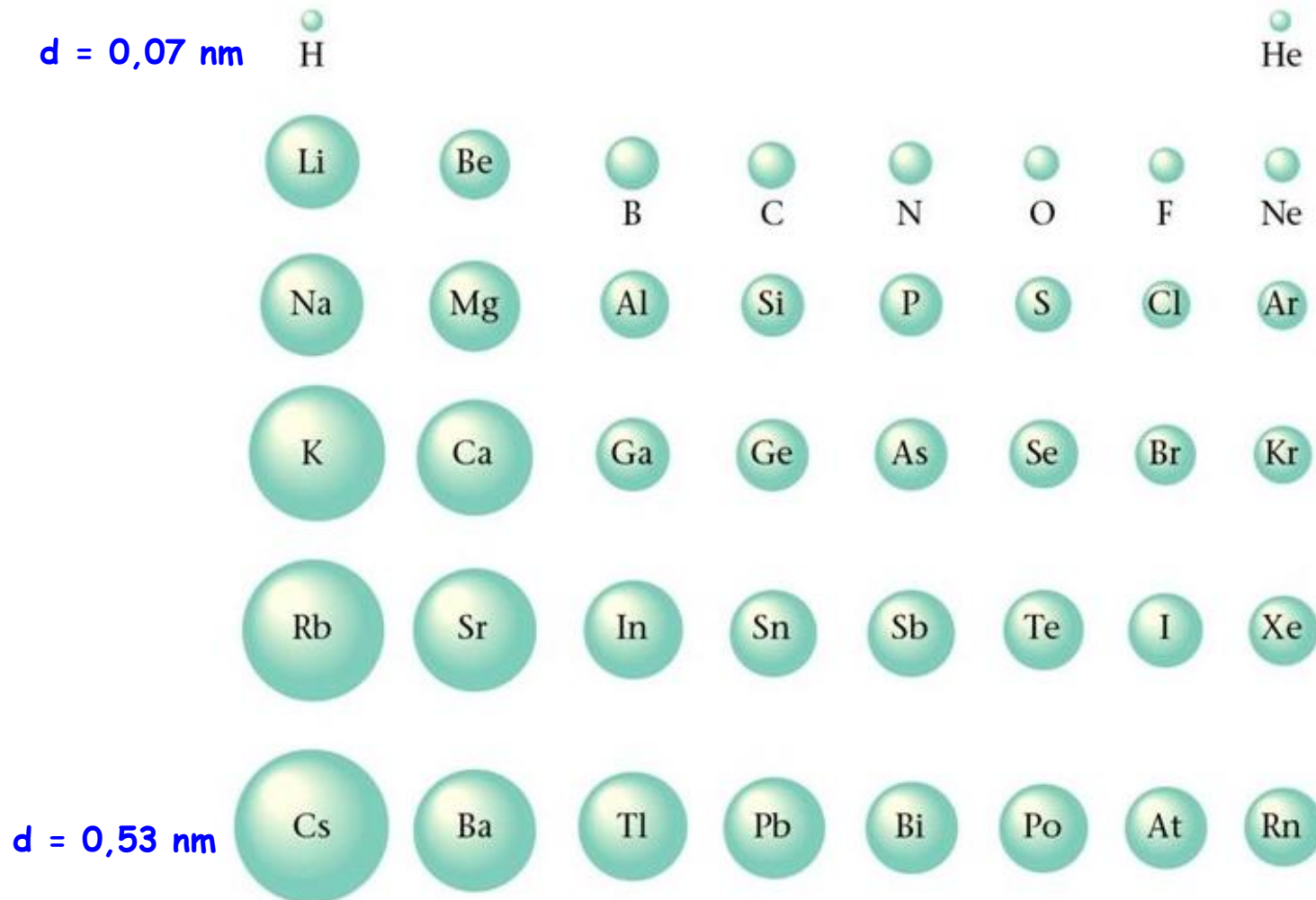
ultramicroscopico
(atomi e molecole)

simbolico
(linguaggio chimico)



Il peso atomico, PA , è espresso con un'unità di misura speciale dell'ordine di 10^{-24} g (u)

Gli atomi sono particelle a forma sferica di dimensioni variabili, ma sempre molto piccole: centesimi o decimi di nanometro (10^{-9} m)



Quanto sono piccoli gli atomi

La punta di una matita è fatta di grafite, un solido formato da atomi di carbonio

Una riga lunga 3,5 cm e spessa 0,7 cm tracciata con la matita



lascia sul foglio 5 milioni di file allineate le une vicine alle altre e formate ciascuna da 250 milioni di atomi

Un maxi-esercito formato da circa 1 milione di miliardi di soldatini invisibili: quasi 150.000 volte l'attuale popolazione del mondo

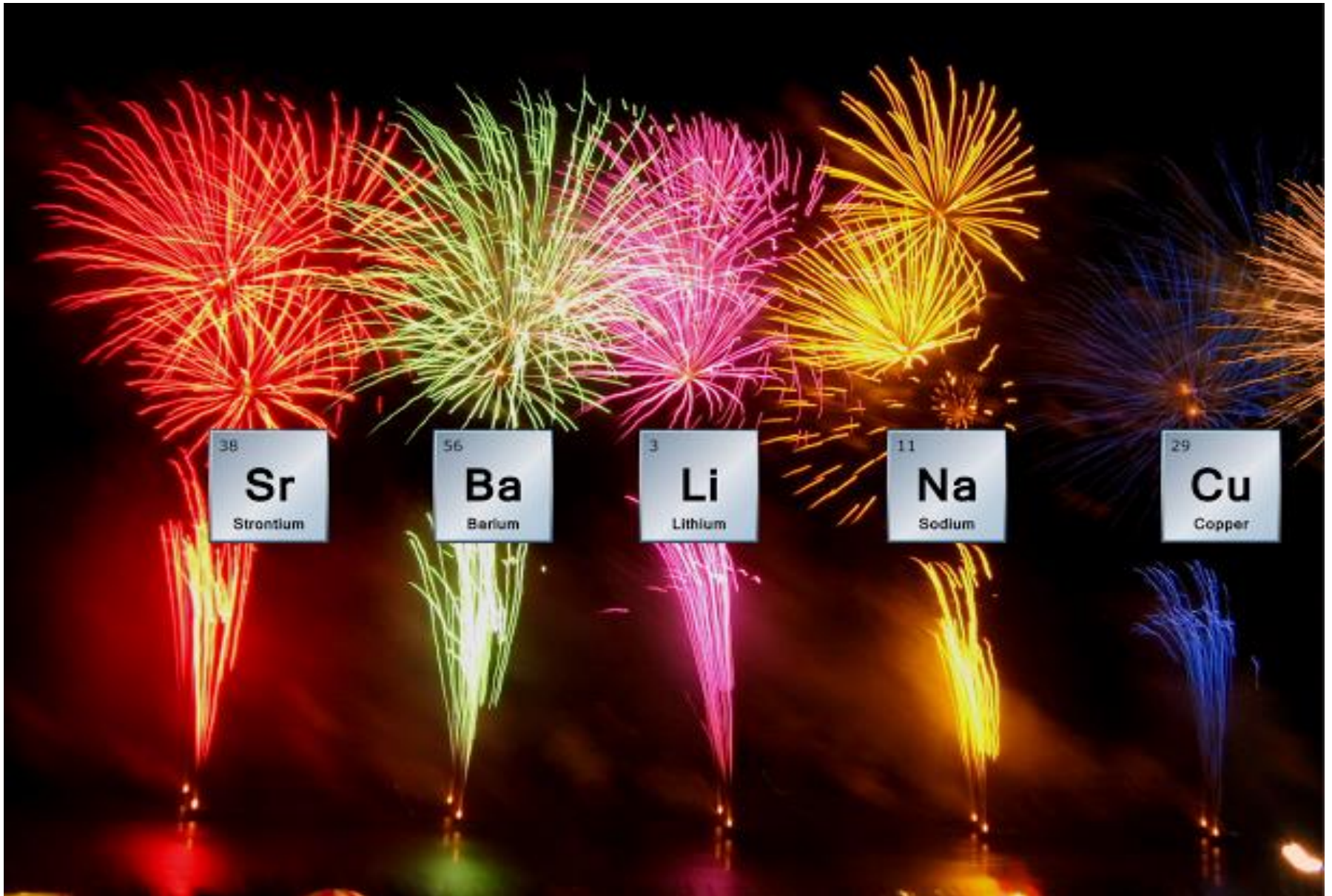
Gli atomi sono molto piccoli e invisibili

**I chimici però sanno “vederli” e
“riconoscerli” dal colore della fiamma
che si genera quando vengono
incendiati**

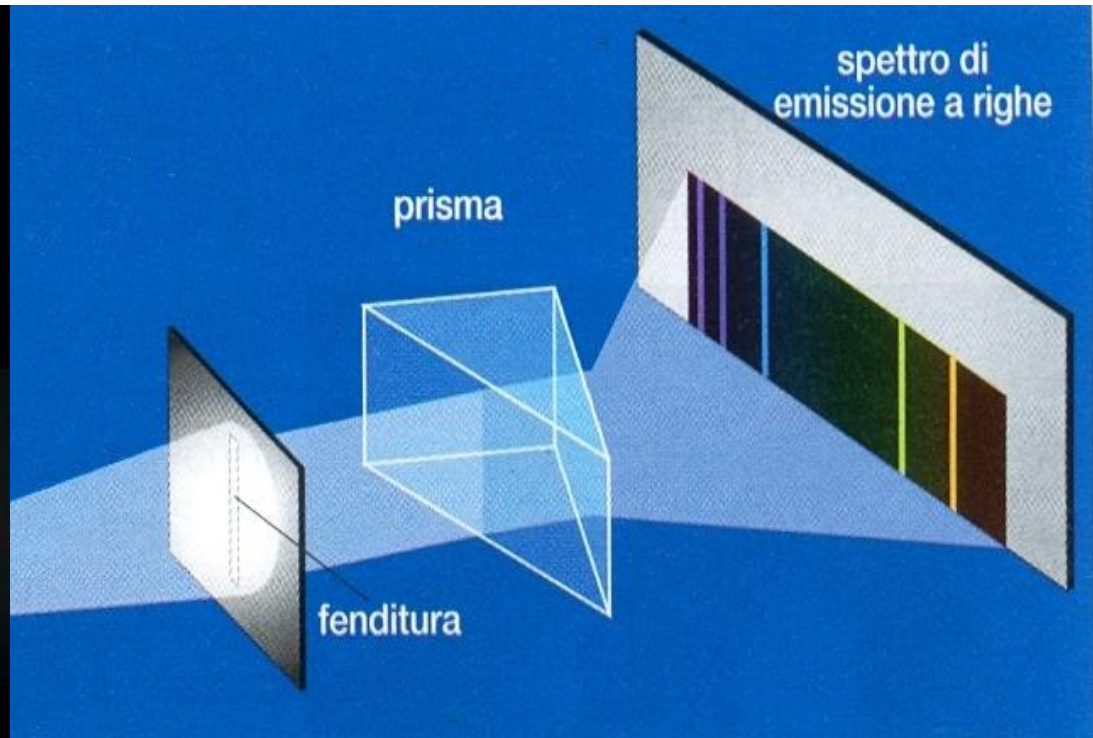
Qualche esempio



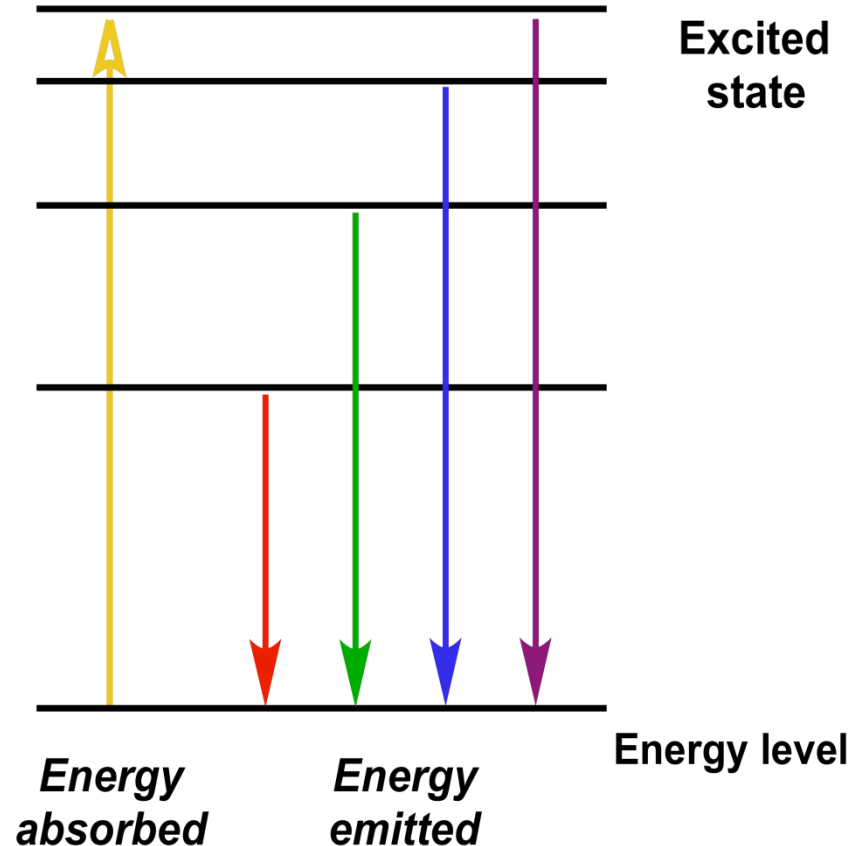
I fuochi d'artificio



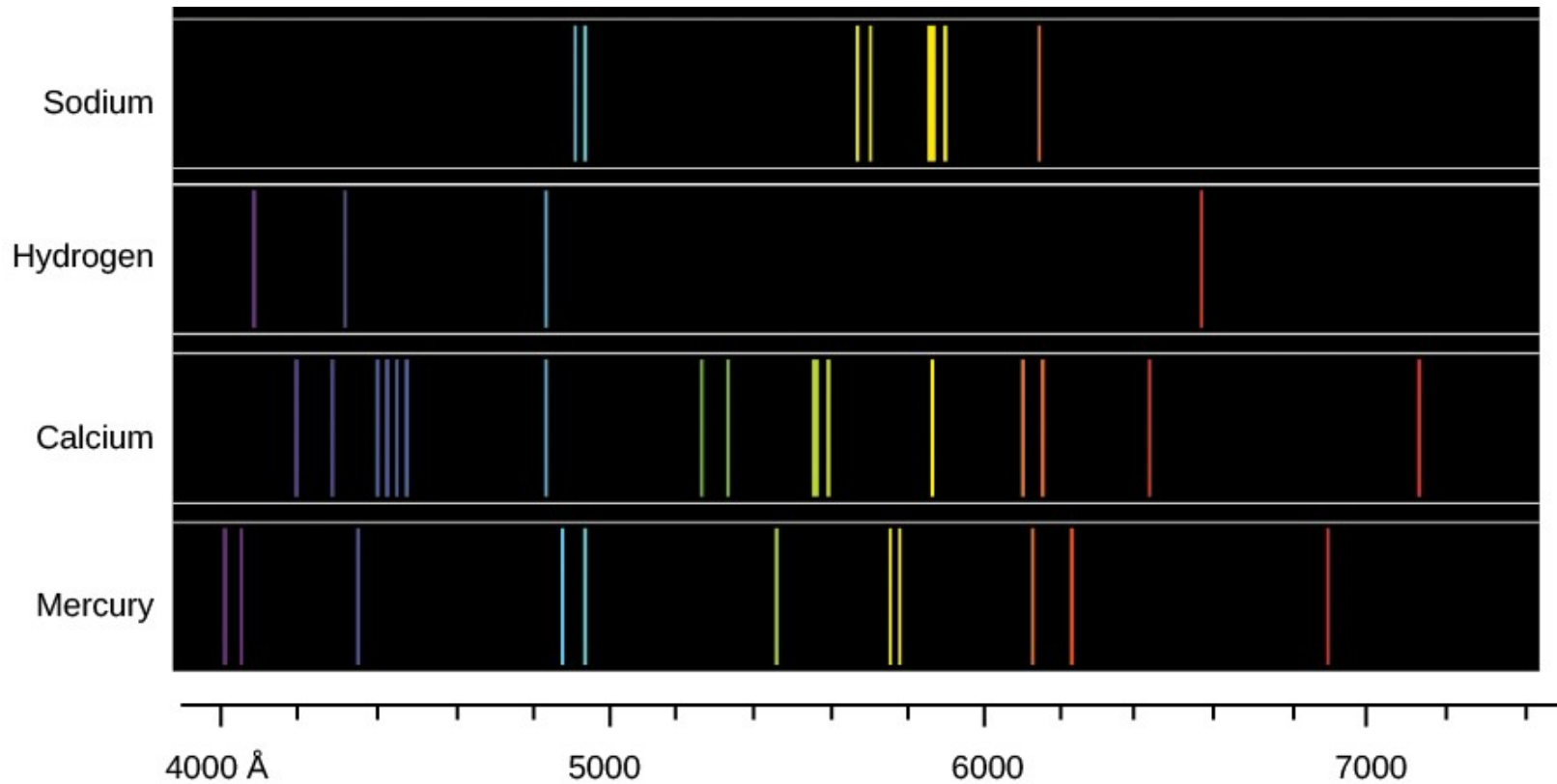
Analizzando le fiamme con uno strumento: spettrografo



**Gli elettroni possono occupare solo
certi livelli energetici caratteristici
per ogni elemento**

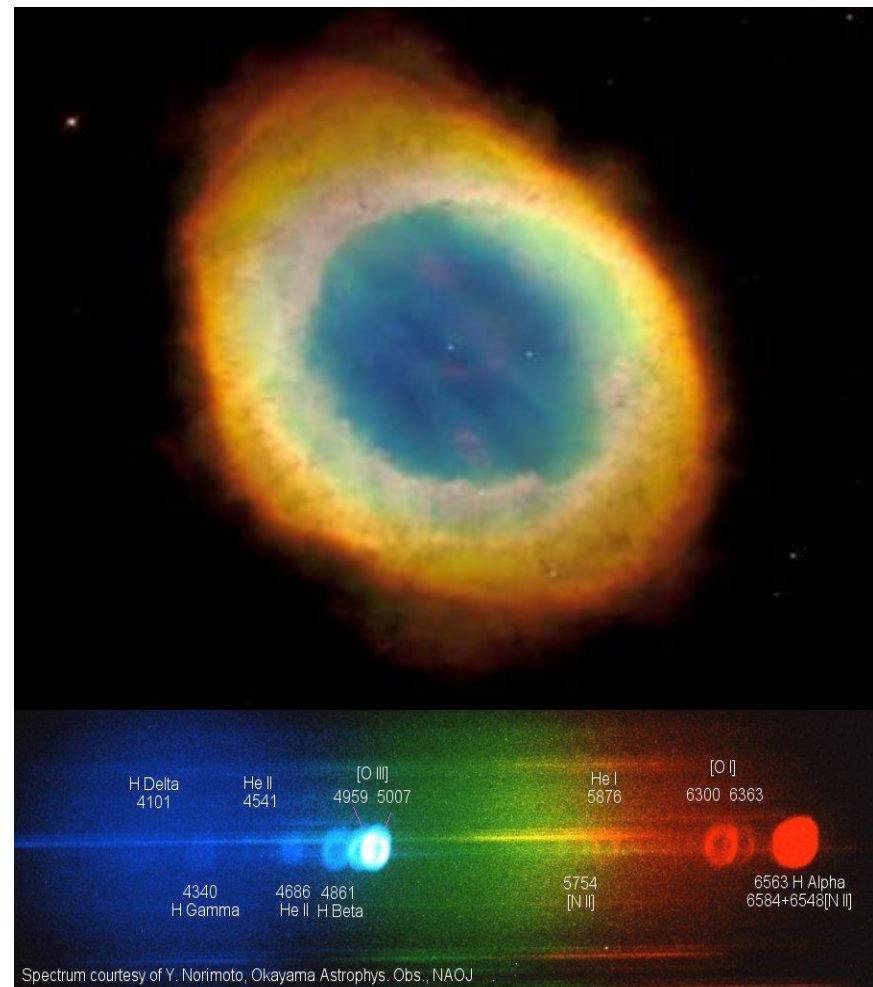


Spettri di emissione

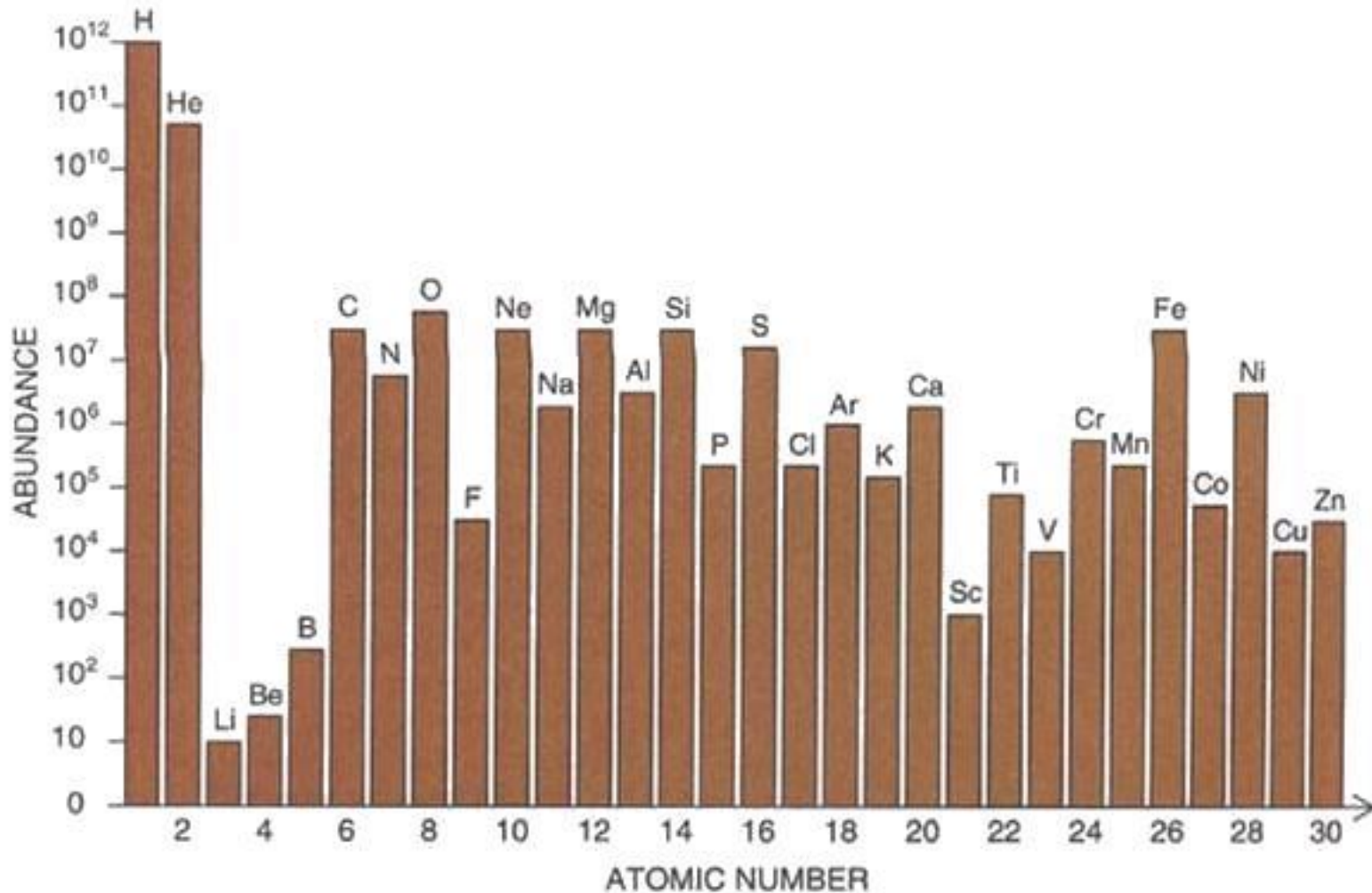


Ogni elemento ha uno spettro caratteristico

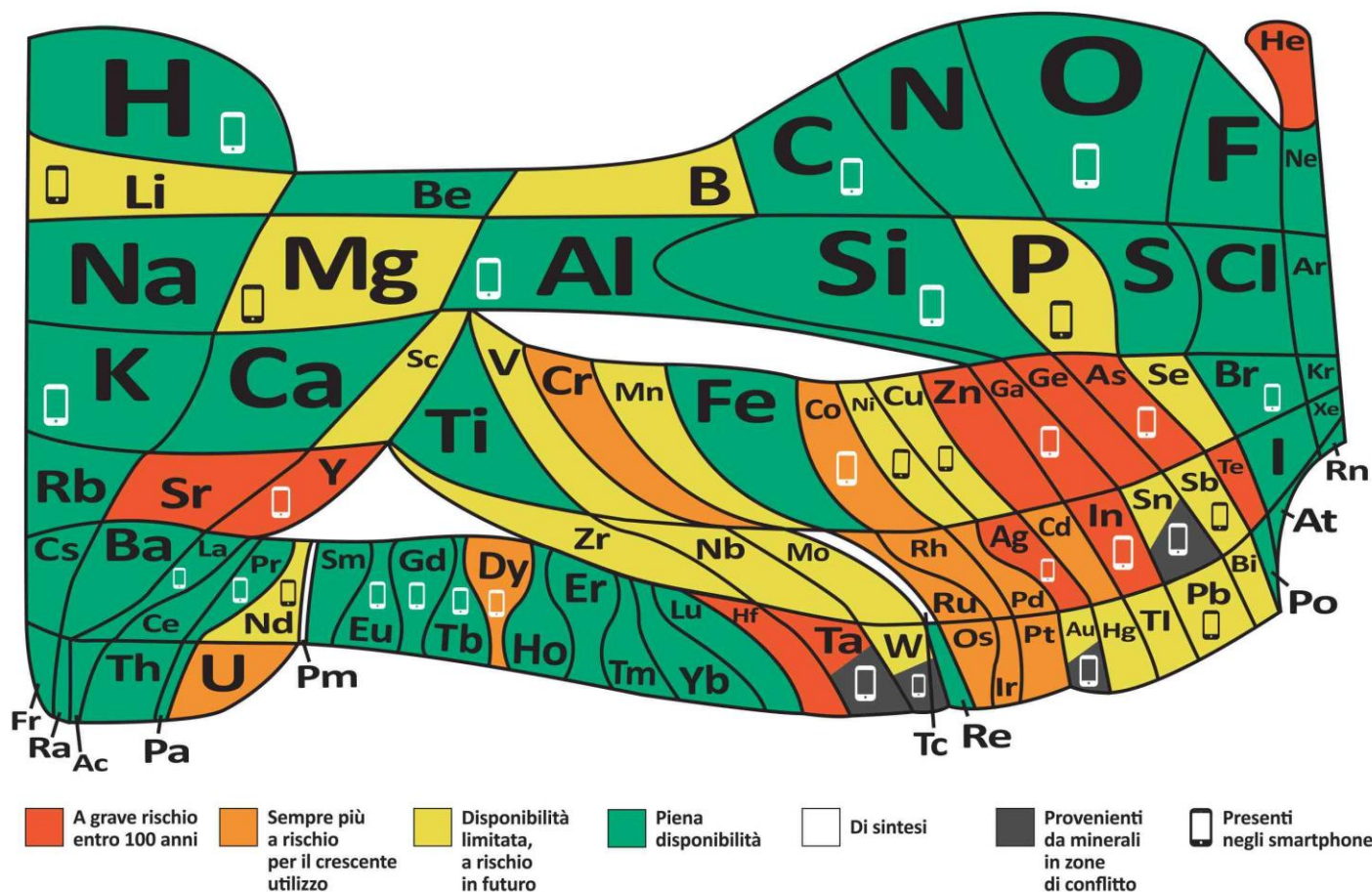
Analizzando la luce delle stelle è possibile capire da quali elementi sono formate



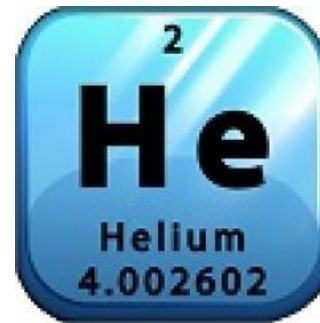
L'abbondanza degli elementi nell'universo



90 elementi chimici e la loro disponibilità relativa sulla Terra. Ci basteranno?



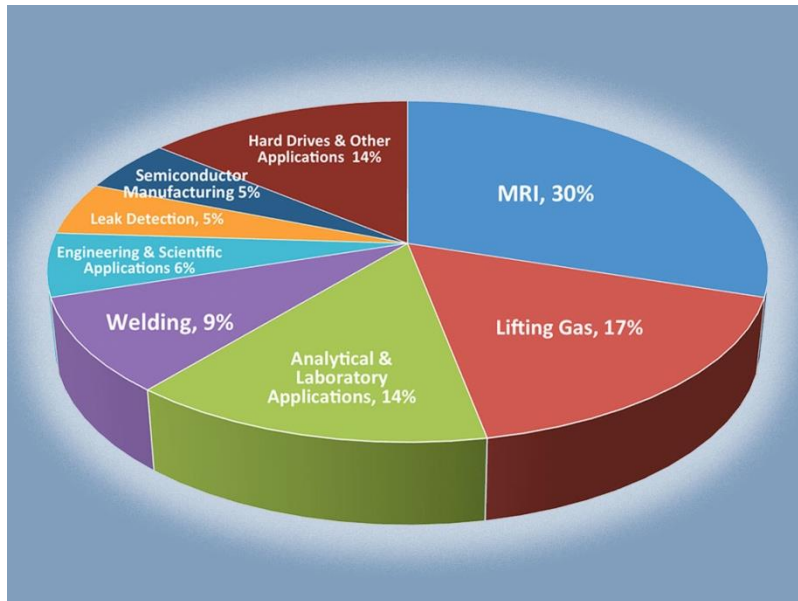
H	He																										
Li	Be	B	C	N	O	F	Ne																				
Na	Mg	Al	Si	P	S	Cl	Ar																				
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr										
Rb	Sr	Y	Zr	Nb	Mo	Rh	Ag	Cd	In	Sn	Sb	Te	I	Xe													
Cs	Ba	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W	Os	Pt	Au	Hg	Tl	Pb	Bi	Po
Fr	Ra	Ac	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Mn	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr				



Proprietà fisiche uniche:

punto di ebollizione: $-268,93\text{ }^{\circ}\text{C}$; punto di fusione: $-272,20\text{ }^{\circ}\text{C}$

Secondo elemento più abbondante nell'universo; molto raro sulla Terra



Liquido di raffreddamento per NMR



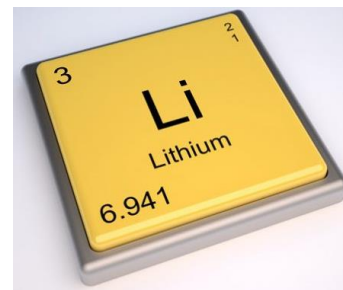
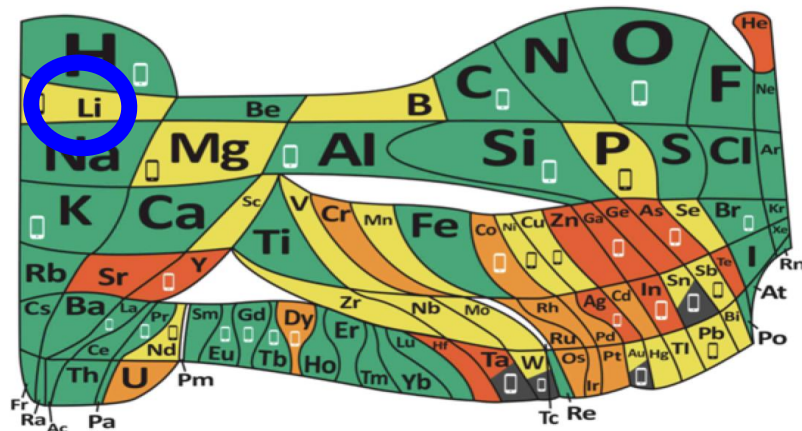
Gas nelle miscele per immersioni profonde



Gas di riempimento per areostati e palloni sonda

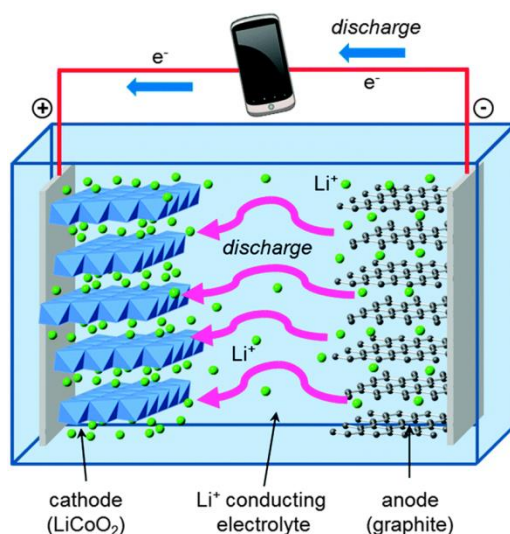


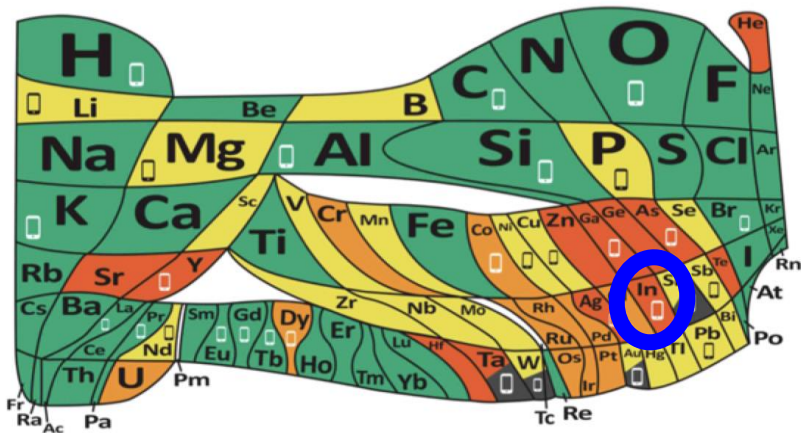
Gas protettivo per la saldatura ad arco



Il metallo più leggero e più piccolo e con uno dei più elevati potenziali elettrochimici

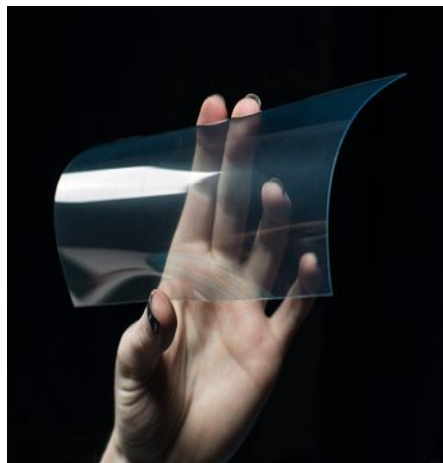
Ideale per le batterie





Metallo tenero, stabile in aria e acqua
Nessuna applicazione fino a 20 anni fa

Il composto ternario indio-stagno-ossigeno (ITO)
è trasparente, conduttore, si lega molto bene al vetro



Metalli di transizione

1

H

1,008

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

1

H

1,008

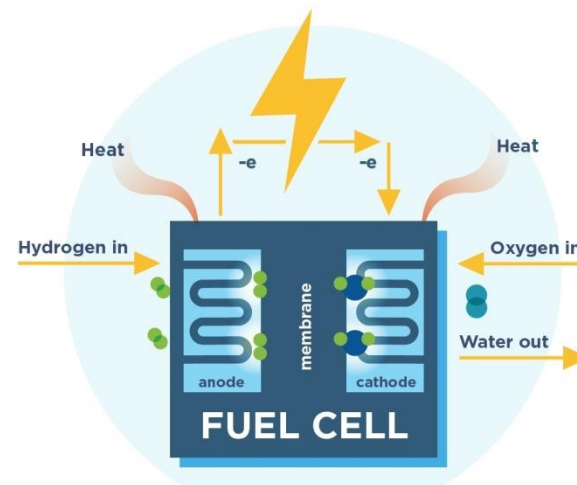
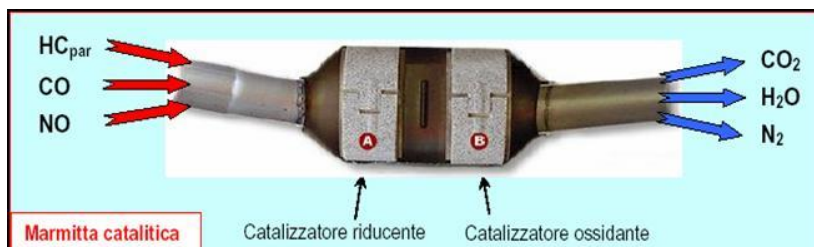
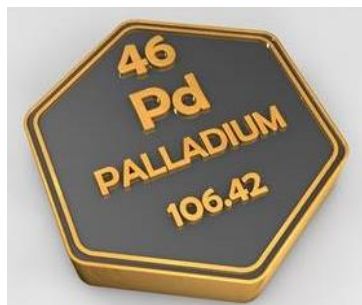
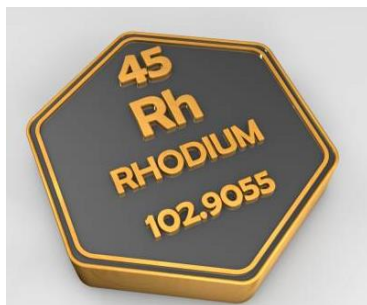
3

4

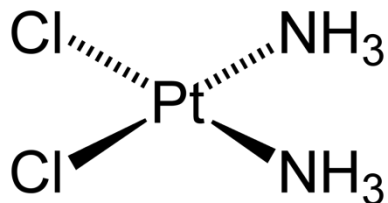
5

Alcuni metalli di transizione hanno proprietà uniche fra tutti i metalli: Pt è uno dei migliori conduttori elettrici, Ir è il metallo più resistente alla corrosione, Os è il metallo più denso, Au è il metallo più duttile e malleabile, Ag è il migliore conduttore di calore

Proprietà catalitiche speciali



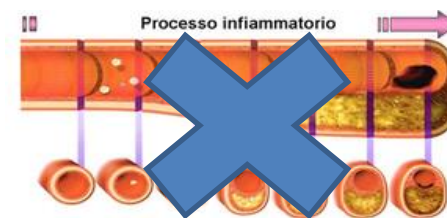
Ambito medico



Cis-platino: chemioterapico



Ag colloidale: antibatterico



Au colloidale: antinfiammatorio

Elementi delle Terre Rare

1

H

1,008

2

3

Li

6,94

4

Be

9,012

11

Na

23,00

12

Mg

24,30

19

K

39,10

20

Ca

40,08

37

Rb

85,47

38

Sr

87,6

1

H

1,008

Numero atomico

Simbolo

Peso atomico

Solidi

Liquidi

Gassosi

Preparati artificialmente

55

Cs

132,91

56

Ba

137,33

57

La

138,91

58

Ce

140,12

59

Pr

140,91

60

Nd

144,2

61

Pm

145

62

Sm

150,3

63

Eu

151,96

64

Gd

157,2

65

Tb

158,93

66

Dy

162,5

67

Ho

164,93

68

Er

167,26

69

Tm

168,93

70

Yb

173,04

71

Lu

174,97

72

Hf

178,49

73

Ta

180,95

74

W

183,8

75

Re

186,21

76

Os

190,2

77

Ir

192,22

78

Pt

195,08

79

Au

196,97

80

Hg

200,59

81

Tl

204,38

82

Pb

207

83

Bi

208,98

84

Po

209

85

At

210

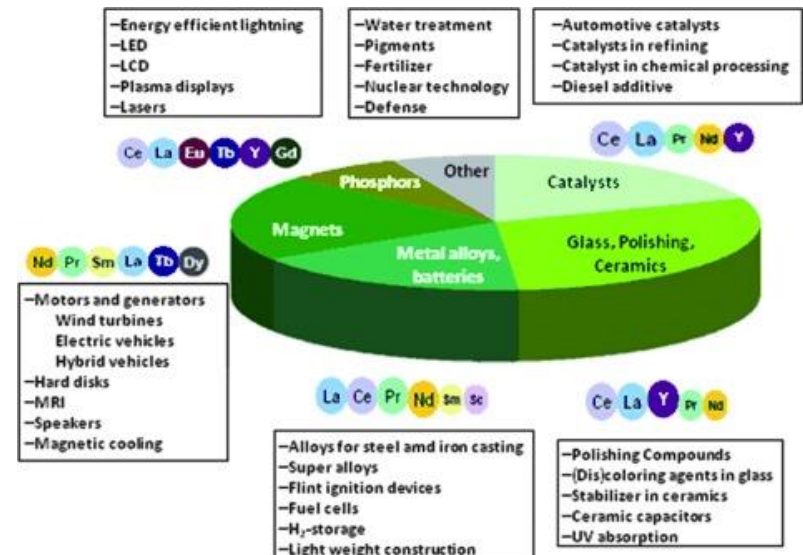
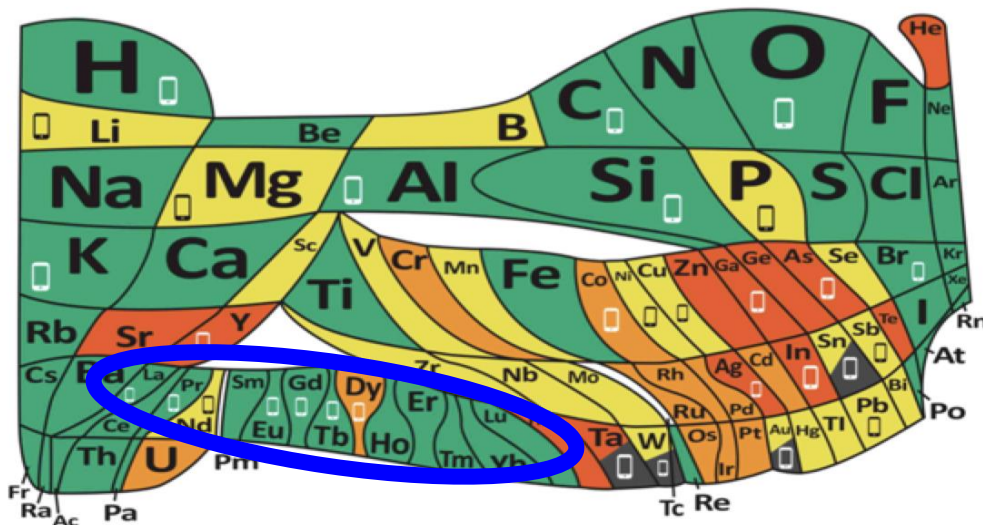
86

Rn

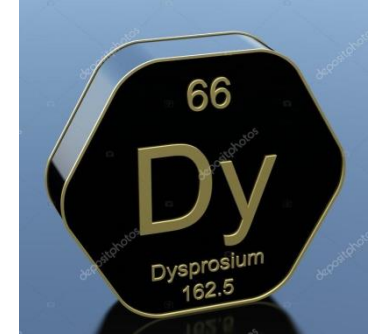
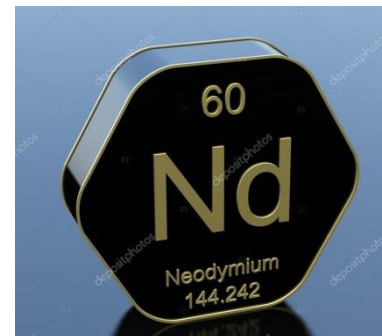
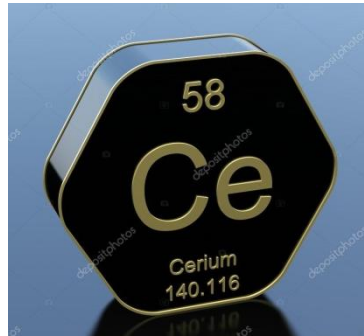
222

Terre Rare

Atinidi



Proprietà ottiche, magnetiche, catalitiche e luminescenti speciali per la presenza di elettroni "spaiati"



Usi: batterie, pale eoliche, motori ibridi e LED



Principale produttore delle Terre Rare: la Cina

Monumento alle Terre Rare nel campo eolico di Damao, Cina



La casa delle Terre Rare ti dà il benvenuto

Quanti elementi usiamo

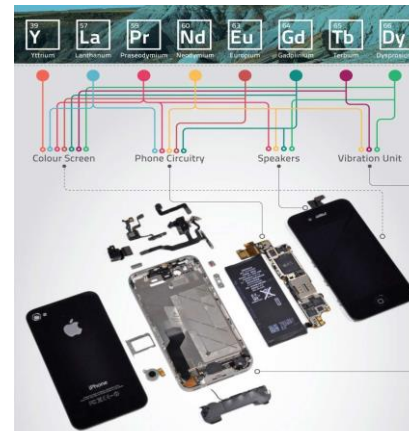
Una casa prima del 1950



1990: meno di 20 elementi in un'intera casa



2019: ca. 40 elementi chimici sul palmo di una mano



<http://www.rareelementresources.com>

Anche l'attuale sviluppo
tecnologico deve far i conti
con la Tavola Periodica

La Tavola Periodica è un documento "vivo" che continua a crescere: nuovi elementi vengono scoperti e/o creati

Series	Zero Group	Group I	Group II	Group III	Group IV	Group V	Group VI	Group VII				
0	π											
1	ν	Hydrogen H=1.008										
2	Helium He=4.0	Lithium Li=7.03	Beryllium Be=9.1	Boron B=11.0	Carbon C=12.0	Nitrogen N=14.04	Oxygen O=16.00	Fluorine F=19.0				
3	Neon Ne=19.9	Sodium Na=23.05	Magnesium Mg=24.1	Aluminium Al=27.0	Silicon Si=28.4	Phosphorus P=31.0	Sulphur S=32.06	Chlorine Cl=35.45	Group VIII			
4	Argon Ar=38	Potassium K=39.1	Calcium Ca=40.1	Scandium Sc=44.1	Titanium Ti=48.1	Vanadium V=51.4	Chromium Cr=52.1	Manganese Mn=55.0	Iron Fe=55.9	Cobalt Co=59	Nickel Ni=59	(Cu)
5		Copper Cu=63.6	Zinc Zn=65.4	Gallium Ga=70.0	Germanium Ge=72.3	Arsenic As=75.0	Selenium Se=79	Bromine Br=79.95				
6	Krypton Kr=81.8	Rubidium Rb=85.4	Strontium Sr=87.6	Yttrium Y=89.0	Zirconium Zr=90.6	Niobium Nb=94.0	Molybdenum Mo=96.0		Ruthenium Ru=101.7	Rhodium Rh=103.0	Palladium Pd=106.5	(Ag)
7		Silver Ag=107.9	Cadmium Cd=112.4	Indium In=114.0	Tin Sn=119.0	Antimony Sb=120.0	Tellurium Te=127	Iodine I=127				
8	Xenon Xe=128	Cesium Cs=132.9	Barium Ba=137.4	Lanthanum La=139	Cerium Ce=140				—	—	—	(—)
9												
10				Ytterbium Yb=173		Tantalum Ta=183	Tungsten W=184		Osmium Os=191	Iridium Ir=193	Platinum Pt=194.9	(Au)
11		Gold Au=197.2	Mercury Hg=200.0	Thallium Tl=204.1	Lead Pb=206.9	Bismuth Bi=208						
12			Radium Ra=224		Thorium Th=232		Uranium U=239					

Nel 1904 Mendeleev inserisce i gas nobili nella sua tavola

La "Tavola Periodica" ha
cominciato a "popolarsi" a
partire dal 1718, anno in cui
furono scoperti i primi elementi:
è una storia che copre 300 anni

Un video che dura 99 secondi:
<https://youtu.be/7kCCWWtCrpA>

300 years of element discovery

1718

Count: 13

Completion: 11%

26
Fe
3500
BCE

29
Cu
Ancient

47
Ag
3000
BCE

79
Au
3000
BCE

80
Hg
1500

6
C
Ancient

15
P
1669

16
S
Ancient

33
As
1250

50
Sn
2100
BCE

51
Sb
1600
BCE

82
Pb
Ancient

83
Bi
1500

Post-transition metals

Metalloids

Other non-metals

Transition metals

300 years of element discovery

1800

Count: 33

Completion: 28%

1
H
1766

4
Be
1797

12
Mg
1775

22
Ti
1791

38
Sr
1790

39
Y
1794

40
Zr
1789

24
Cr
1798

25
Mn
1774

26
Fe
3500 BCE

27
Co
1739

28
Ni
1751

29
Cu
Ancient

30
Zn
1746

42
Mo
1781

74
W
1783

47
Ag
3000 BCE

78
Pt
1750

79
Au
3000 BCE

80
Hg
1500

6
C
Ancient

7
N
1772

8
O
1774

15
P
1669

16
S
Ancient

17
Cl
1774

33
As
1250

50
Sn
2100 BCE

51
Sb
1600 BCE

52
Te
1783

82
Pb
Ancient

83
Bi
1500

92
U
1789

Alkaline earth metals

Lanthanides

Transition metals

Post-transition metals

Metalloids

Other non-metals

Halogens

300 years of element discovery

1869

Count: 63

Completion: 53%

1 H 1766		1869																5 B 1808		6 C Ancient		7 N 1772		8 O 1774							
3 Li 1817		4 Be 1797		Count: 63 Completion: 53%																13 Al 1825		14 Si 1824		15 P 1669		16 S Ancient		17 Cl 1774			
11 Na 1807		12 Mg 1775		22 Ti 1791		23 V 1801		24 Cr 1798		25 Mn 1774		26 Fe 3500 BCE		27 Co 1739		28 Ni 1751		29 Cu Ancient		30 Zn 1746				33 As 1250		34 Se 1817		35 Br 1826			
19 K 1807		20 Ca 1808		39 Y 1794		40 Zr 1789		41 Nb 1801		42 Mo 1781		44 Ru 1844		45 Rh 1803		46 Pd 1803		47 Ag 3000 BCE		48 Cd 1817		49 In 1863		50 Sn 2100 BCE		51 Sb 1600 BCE		52 Te 1783		53 I 1811	
55 Cs 1860		56 Ba 1808				73 Ta 1802		74 W 1783		75 Re 1825		76 Os 1803		77 Ir 1803		78 Pt 1750		79 Au 3000 BCE		80 Hg 1500		81 Tl 1861		82 Pb Ancient		83 Bi 1500					

Alkali metals

Alkaline earth metals

Lanthanides

Actinides

Transition metals

Post-transition metals

Metalloids

Other non-metals

Halogens

300 years of element discovery

1910

Count: 86

Completion: 73%

1910 Count: 86Completion: 73%																					

Alkali metals

Alkaline earth metals

Lanthanides

Actinides

Transition metals

Post-transition metals

Metalloids

Other non-metals

Halogens

Noble gases

300 years of element discovery

1937

Count: 89

Completion: 75%

1 H 1766																	2 He 1895	
3 Li 1817	4 Be 1797																	10 Ne 1898
11 Na 1807	12 Mg 1775																	18 Ar 1894
19 K 1807	20 Ca 1808	21 Sc 1879	22 Ti 1791	23 V 1801	24 Cr 1798	25 Mn 1774	26 Fe 3500 BCE	27 Co 1739	28 Ni 1751	29 Cu Ancient	30 Zn 1746	31 Ga 1875	32 Ge 1886	33 As 1250	34 Se 1817	35 Br 1826	36 Kr 1898	
37 Rb 1861	38 Sr 1790	39 Y 1794	40 Zr 1789	41 Nb 1801	42 Mo 1781	43 Tc 1937	44 Ru 1844	45 Rh 1803	46 Pd 1803	47 Ag 3000 BCE	48 Cd 1817	49 In 1863	50 Sn 2100 BCE	51 Sb 1600 BCE	52 Te 1783	53 I 1811	54 Xe 1898	
55 Cs 1860	56 Ba 1808		72 Hf 1923	73 Ta 1802	74 W 1783	75 Re 1825	76 Os 1803	77 Ir 1803	78 Pt 1750	79 Au 3000 BCE	80 Hg 1500	81 Tl 1861	82 Pb Ancient	83 Bi 1500	84 Po 1898		86 Rn 1900	
88 Ra 1898																		

1937

Count: 89Completion: 75%

57 La 1839	58 Ce 1803	59 Pr 1885	60 Nd 1885
89 Ac 1899	90 Th 1829	91 Pa 1913	92 U 1789

62 Sm 1879	63 Eu 1901	64 Gd 1880	65 Tb 1843	66 Dy 1886	67 Ho 1878	68 Er 1843	69 Tm 1879	70 Yb 1878	71 Lu 1907
------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------

Alkali metals	Alkaline earth metals	Lanthanides	Actinides	Transition metals
Post-transition metals	Metalloids	Other non-metals	Halogens	Noble gases

300 years of element discovery

2018

Count: 118

Completion: 100%

1 H 1766	2018 Count: 118 Completion: 100%																2 He 1895	
3 Li 1817	4 Be 1797																	10 Ne 1898
11 Na 1807	12 Mg 1775																	18 Ar 1894
19 K 1807	20 Ca 1808	21 Sc 1879	22 Ti 1791	23 V 1801	24 Cr 1798	25 Mn 1774	26 Fe 3500 BCE	27 Co 1739	28 Ni 1751	29 Cu Ancient	30 Zn 1746	31 Ga 1875	32 Ge 1886	33 As 1250	34 Se 1817	35 Br 1826	36 Kr 1898	
37 Rb 1861	38 Sr 1790	39 Y 1794	40 Zr 1789	41 Nb 1801	42 Mo 1781	43 Tc 1937	44 Ru 1844	45 Rh 1803	46 Pd 1803	47 Ag 3000 BCE	48 Cd 1817	49 In 1863	50 Sn 2100 BCE	51 Sb 1600 BCE	52 Te 1783	53 I 1811	54 Xe 1898	
55 Cs 1860	56 Ba 1808		72 Hf 1923	73 Ta 1802	74 W 1783	75 Re 1825	76 Os 1803	77 Ir 1803	78 Pt 1750	79 Au 3000 BCE	80 Hg 1500	81 Tl 1861	82 Pb Ancient	83 Bi 1500	84 Po 1898	85 At 1940	86 Rn 1900	
87 Fr 1939	88 Ra 1898		104 Rf 1964	105 Db 1968	106 Sg 1974	107 Bh 1981	108 Hs 1984	109 Mt 1982	110 Ds 1994	111 Rg 1994	112 Cn 1996	113 Nh 2004	114 Fl 1999	115 Mc 2010	116 Lv 2000	117 Ts 2010	118 Og 2006	

57 La 1839	58 Ce 1803	59 Pr 1885	60 Nd 1885	61 Pm 1945	62 Sm 1879	63 Eu 1901	64 Gd 1880	65 Tb 1843	66 Dy 1886	67 Ho 1878	68 Er 1843	69 Tm 1879	70 Yb 1878	71 Rb 1907
89 Ac 1899	90 Th 1829	91 Pa 1913	92 U 1789	93 Np 1940	94 Pu 1940	95 Am 1944	96 Cm 1944	97 Bk 1949	98 Cf 1950	99 Es 1952	100 Fm 1953	101 Md 1955	102 No 1963	103 Lr 1965

Alkali metals

Alkaline earth metals

Lanthanides

Actinides

Transition metals

Post-transition metals

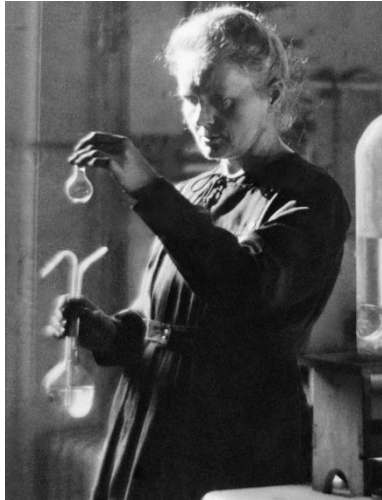
Metalloids

Other non-metals

Halogens

Noble gases

Alcune scienziate che hanno contribuito ad aggiungere nuovi elementi nella Tavola Periodica



Marie Curie
(radio e polonio)



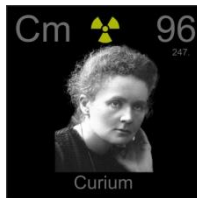
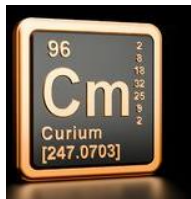
Lise Meitner
(protoattinio)



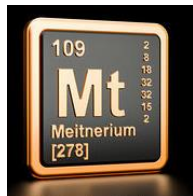
Harriet Brooks
(radon)



Berta Karlik
(astato)



in onore dei coniugi Curie



in onore di Lisa Meitner



Ida Noddack
(renio)



Marguerite Perey
(francio)



Contents lists available at ScienceDirect

Polyhedron

journal homepage: www.elsevier.com/locate/poly



Review

Row 7 of the periodic table complete: Can we expect more new elements; and if so, when?

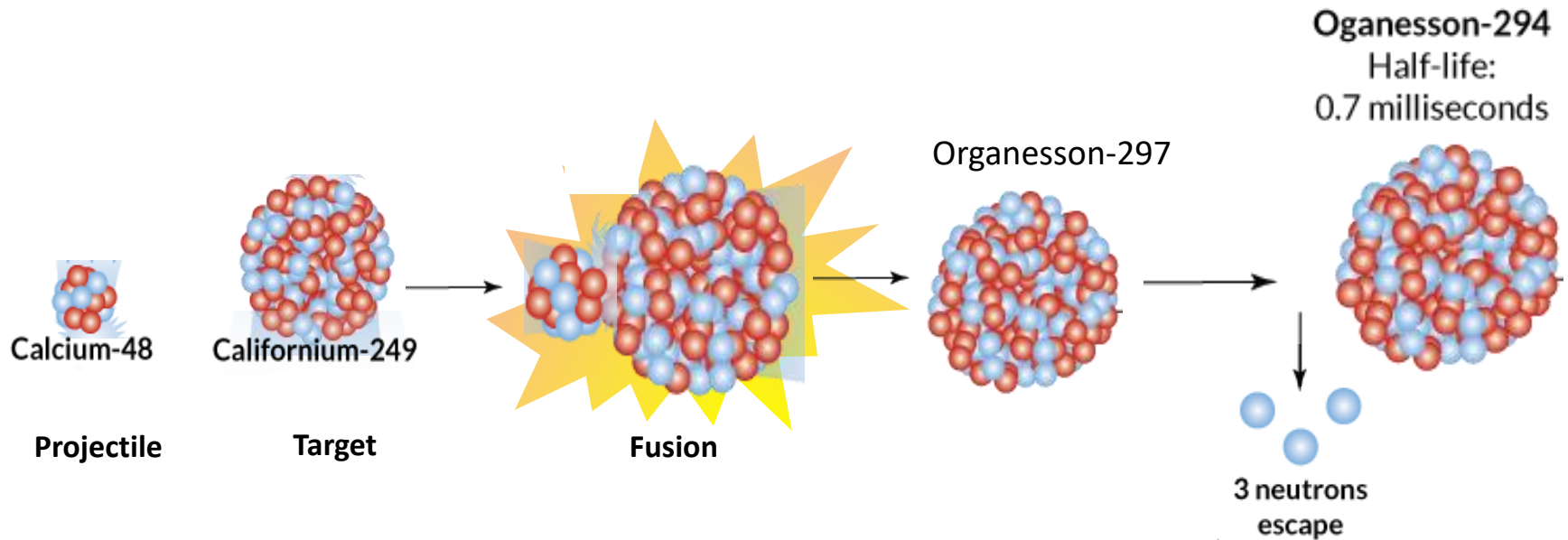
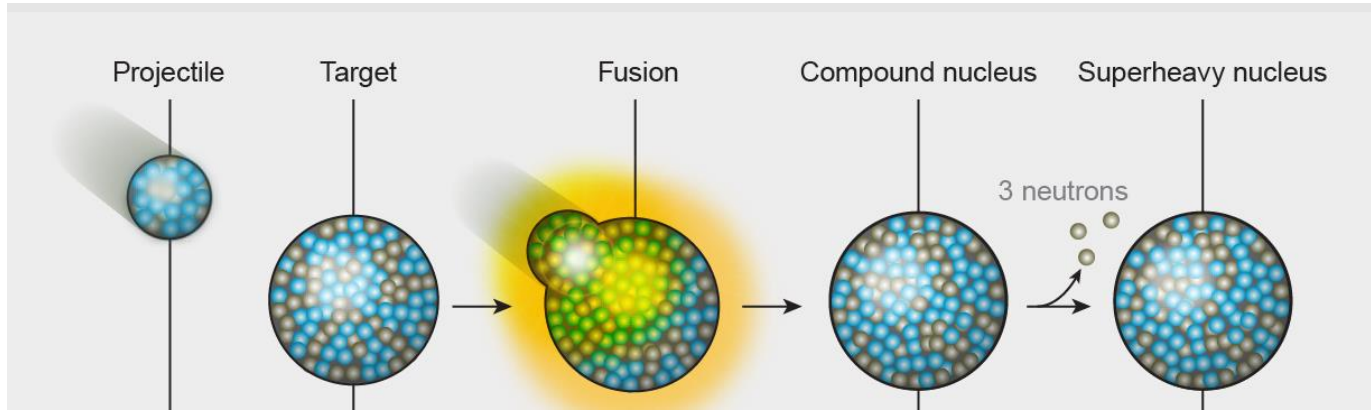


Jan Reedijk

Gli scienziati si stanno domandando:

Quanti altri elementi possono essere aggiunti? La Tavola Periodica è un documento "senza fine"?

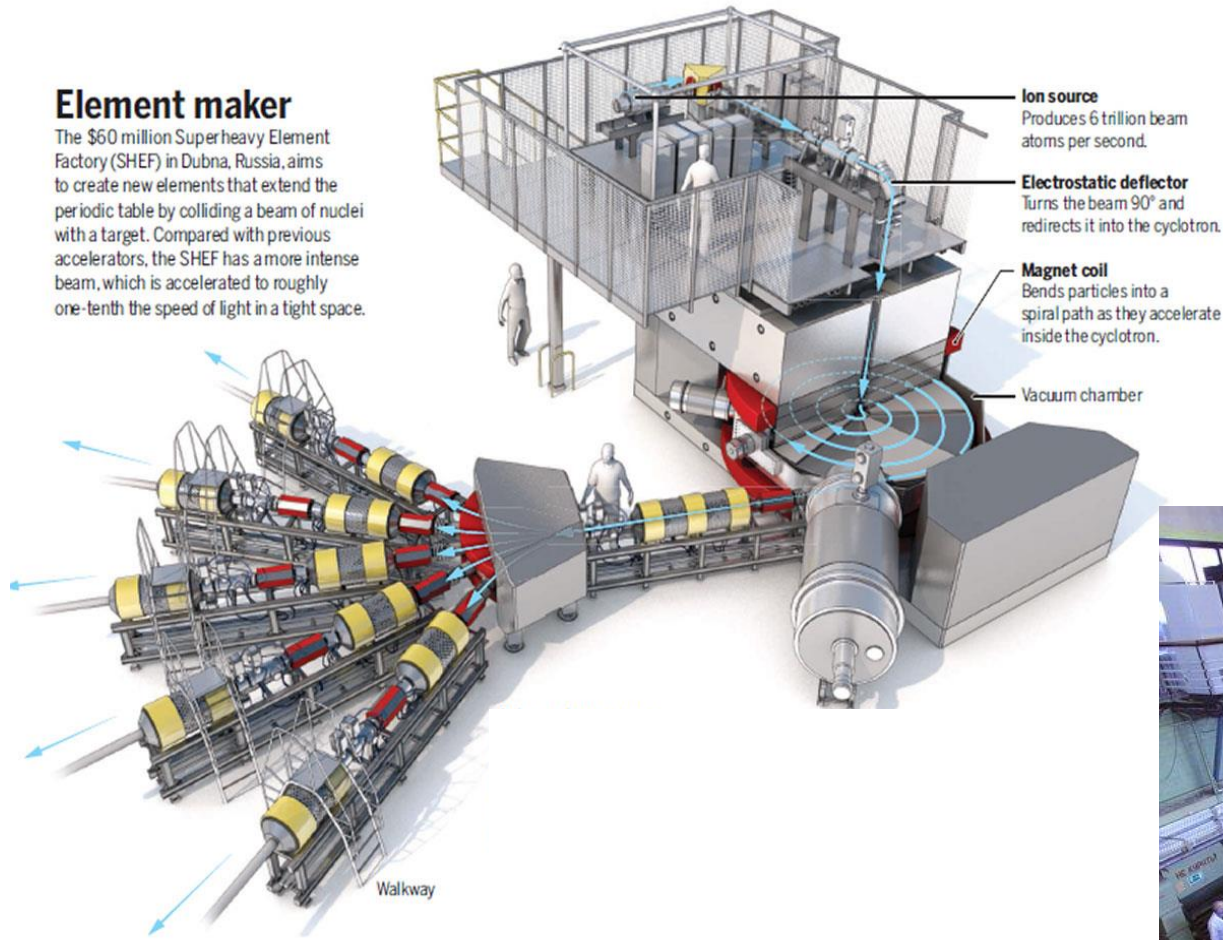
Come si ottengono gli elementi superpesanti



Per accelerare il proiettile

Element maker

The \$60 million Superheavy Element Factory (SHEF) in Dubna, Russia, aims to create new elements that extend the periodic table by colliding a beam of nuclei with a target. Compared with previous accelerators, the SHEF has a more intense beam, which is accelerated to roughly one-tenth the speed of light in a tight space.



Creation, separation, and detection

The beam is split and redirected toward the target, separator, and detector in another room (right).



Un nuovo elemento non prima di 5 anni

Gli ultimi elementi creati hanno proprietà molto diverse da quelle degli elementi che li precedono nello stesso gruppo; ha senso mantenere l'attuale concetto di periodicità e di Tavola Periodica?

group 1

period 1

1

H

Hydrogen

1.00794

1.008

1s¹

2

Li

Lithium

6.941

6.9

2s¹

3

Na

Sodium

22.98976

23.0

3s¹

4

K

Potassium

39.0983

39.1

4s¹

5

Rb

Rubidium

85.4678

85.5

5s¹

6

Cs

Cesium

132.9054

133

6s¹

7

Fr

Francium

(223)

223

7s¹

2

Be

Beryllium

9.012182

9.01

2s²

3

B

Boron

10.811

10.8

2s² 2p¹

4

C

Carbon

12.0107

12.0

2s² 2p²

5

N

Nitrogen

14.0067

14.0

2s² 2p³

6

O

Oxygen

15.9994

16.0

2s² 2p⁴

7

F

Fluorine

18.998403

19.0

2s² 2p⁵

8

Ne

Neon

20.1797

20.2

2s² 2p⁶

9

He

Helium

4.002602

4.003

1s²

10

Mg

Magnesium

24.3050

24.3

3s²

11

Al

Aluminum

26.981538

27.0

3s² 3p¹

12

Si

Silicon

28.0855

28.1

3s² 3p²

13

P

Phosphorus

30.973762

31.0

3s² 3p³

14

S

Sulfur

32.065

32.1

3s² 3p⁴

15

Cl

Chlorine

35.453

35.5

3s² 3p⁵

16

Ar

Argon

39.948

40.0

3s² 3p⁶

17

Kr

Krypton

83.798

84.0

4s² 4p⁶

18

Xe

Xenon

131.29

131

5s² 5p⁶

19

Rn

Radon

(222)

222

6s² 6p⁶

20

Ca

Calcium

40.078

40.1

4s²

21

Sc

Scandium

44.95591

45.0

3d¹ 4s²

22

Ti

Titanium

47.867

47.9

3d² 4s²

23

V

Vanadium

50.9415

51.0

3d³ 4s²

24

Cr

Chromium

51.9962

52.0

3d⁵ 4s¹

25

Mn

Manganese

54.93804

55.0

3d⁵ 4s²

26

Fe

Iron

55.845

55.8

3d⁶ 4s²

27

Co

Cobalt

58.93319

58.9

3d⁷ 4s²

28

Ni

Nickel

58.6934

58.7

3d⁸ 4s²

29

Cu

Copper

63.546

63.5

3d¹⁰ 4s¹

30

Zn

Zinc

65.38

65.4

3d¹⁰ 4s²

31

Ga

Gallium

69.723

69.7

4s² 4p¹

32

Ge

Germanium

72.64

72.6

4s² 4p²

33

As

Arsenic

74.92160

75.0

4s² 4p³

34

Se

Selenium

78.96

79.0

4s² 4p⁴

35

Br

Bromine

79.904

80.0

4s² 4p⁵

36

Kr

Krypton

83.798

84.0

4s² 4p⁶

37

Rb

Rubidium

85.4678

85.5

5s¹

38

Sr

Strontium

87.62

87.6

5s²

39

Y

Yttrium

88.90585

89.0

4d¹ 5s²

40

Zr

Zirconium

91.224

91.2

4d² 5s²

41

Nb

Niobium

92.90638

93.0

4d⁴ 5s¹

42

Mo

Molybdenum

95.94

96.0

4d⁵ 5s¹

43

Tc

Technetium

(98)

98

4d⁵ 5s²

44

Ru

Ruthenium

101.07

101

4d⁷ 5s¹

45

Rh

Rhodium

102.9055

103

4d⁸ 5s¹

46

Pd

Palladium

106.42

106.4

4d¹⁰

47

Ag

Silver

107.8682

108

4d¹⁰ 5s¹

48

Cd

Cadmium

112.411

112.4

4d¹⁰ 5s²

49

In

Indium

114.818

115

5s² 5p¹

50

Sn

Tin

117.905

118

5s² 5p²

51

Sb

Antimony

121.757

122

5s² 5p³

52

Te

Tellurium

127.603

128

5s² 5p⁴

53

I

Iodine

126.905

127

5s² 5p⁵

54

Xe

Xenon

131.29

131

5s² 5p⁶

55

Cs

Cesium

132.9054

133

6s¹

56

Ba

Barium

137.327

137

6s²

57

La

Lanthanum

138.905

139

5d¹ 6s²

58

Ce

Cerium

140.12

140

4f¹ 5d¹ 6s²

59

Pr

Praseodymium

140.9076

141

4f³ 6s²

60

Nd

Niodymium

144.242

144

4f⁴ 6s²

61

Pm

Promethium

(145)

145

4f⁵ 6s²

62

Sm

Samarium

150.36

150

4f⁶ 6s²

63

Eu

Europium

151.964

152

4f⁷ 6s²

64

Gd

Gadolinium

157.25

157

4f⁷ 5d¹ 6s²

65

Tb

Terbium

158.9253

159

4f⁹ 6s²

66

Dy

Dysprosium

162.50

163

4f¹⁰ 6s²

67

Ho

Holmium

164.9303

165

4f¹¹ 6s²

68

Er

Erbium

167.259

167

4f¹² 6s²

69

Tm

Thulium

168.9348

169

4f¹³ 6s²

70

Yb

Ytterbium

173.054

173

4f¹⁴ 6s²

71

Lu

Lutetium

174.967

175

4f¹⁴ 5d¹ 6s²

72

Hf

Hafnium

178.49

178

5d² 6s²

73

Ta

Tantalum

180.948

181

5d³ 6s²

74

W

Tungsten

183.84

184

5d⁴ 6s²

75

Re

Rhenium

186.207

186

5d⁵ 6s²

76

Os

Osmium

190.23

190

5d⁶ 6s²

77

Ir

Iridium

192.22

192

5d⁷ 6s²

78

Pt

Platinum

195.084

195

5d⁹ 6s¹

79

Au

Gold

196.967

197

5d¹⁰ 6s¹

80

Hg

Mercury

200.59

201

5d¹⁰ 6s²

81

Tl

Thallium

204.383

204

6s² 6p¹

82

Pb

Lead

207.2

207

6s² 6p²

83

Bi

Bismuth

208.980

209

6s² 6p³

84

Po

Polonium

(209)

209

6s² 6p⁴

85

At

Astatine

(210)

210

6s² 6p⁵

86

Rn

Radon

(222)

222

6s² 6p⁶

87

Fr

Francium

(223)

223

7s¹

88

Ra

Radium

(226)

226

7s²

89

Ac

Actinium

(227)

227

6d¹ 7s²

90

Th

Thorium

232.038

232

6d² 7s²

91

Pa

Protactinium

231.036

231

5f² 6d¹ 7s²

92

U

Uranium

238.029

238

5f³ 6d¹ 7s²

93

Np

Neptunium

(237)

237

5f⁴ 6d¹ 7s²

94

Pu

Plutonium

(244)

244

5f⁶ 7s²

95

Am

Americium

(243)

243

5f⁷ 7s²

96

Cm

Curium

(247)

247

5f⁷ 6d¹ 7s²

97

Bk

Berkelium

(247)

247

5f⁹ 7s²

98

Cf

Californium

(251)

251

5f¹⁰ 7s²

99

Es

Einsteinium

(252)

252

5f¹¹ 7s²

100

Fm

Fermium

(257)

257

5f¹² 7s²

101

Md

Mendelevium

(258)

258

5f¹³ 7s²

102

No

Nobelium

(259)

259

5f¹⁴ 7s²

103

Lr

Lr

(260)

260

5f¹⁴ 7s² 7p¹

104

Rf

Rf

(261)

261

5f¹⁴ 6d¹ 7s²

105

Db

Db

(262)

262

5f¹⁴ 6d² 7s²

106

Sg

Sg

(266)

266

5f¹⁴ 6d³ 7s²

107

Bh

Bh

(264)

264

5f¹⁴ 6d⁴ 7s²

108

Hs

Hs

(277)

277

5f¹⁴ 6d⁵ 7s²

109

Mt

Mt

(268)

268

5f¹⁴ 6d⁶ 7s²

110

Ds

Ds

(271)

271

5f¹⁴ 6d⁷ 7s²

111

Rg

Rg

(272)

272

5f¹⁴ 6d⁸ 7s²

112

Cn

Cn

(285)

285

5f¹⁴ 6d¹⁰ 7s²

113

Nh

Nh

(284)

284

5f¹⁴ 6d¹⁰ 7s² 7p¹

114

Fl

Fl

(289)

289

5f¹⁴ 6d¹⁰ 7s² 7p²

115

Mc

Mc

(288)

288

5f¹⁴ 6d¹⁰ 7s² 7p³

116

Lv

Lv

(292)

292

5f¹⁴ 6d¹⁰ 7s² 7p⁴

117

Ts

Ts

(294)

294

5f¹⁴ 6d¹⁰ 7s² 7p⁵

118

Og

Og

(294)

294

5f¹⁴ 6d¹⁰ 7s² 7p⁶

electron configuration blocks

s

d

p

f

notes

1 kJ/mol = 96.485 eV

all elements are implied to have an oxidation state of zero.

atomic mass

or most stable mass number

1st ionization energy in kJ/mol

chemical symbol

name

electron configuration

55.845

762.5

1.83

Fe

Iron

[Ar] 3d⁶ 4s²

atomic number

electronegativity

oxidation states most common are bold

26

-1

alkali metals

alkaline metals

other metals

transition metals

lanthanoids

actinoids

metalloids

nonmetals

halogens

noble gases

unknown elements

radioactive elements have masses in parentheses

13

14

15

16

17

18

B

C

N

O

F

Ne

Boron

Carbon

Nitrogen

Oxygen

Fluorine

Neon

10.811

12.0107

14.0067

15.9994

18.998403

20.1797

2.04

2.95

3.04

3.44

3.98

1s² 2s² 2p¹

1s² 2s² 2p²

1s² 2s² 2p³

1s² 2s² 2p⁴

1s² 2s² 2p⁵

1s² 2s² 2p⁶

Al

Si

P

S

Cl

Ar

Aluminum

Silicon

Phosphorus

Sulfur

Chlorine

Argon

26.981538

28.0855

30.973762

32.065

35.453

39.948

1.41

1.90

2.19

2.58

3.16

1s² 3s² 3p¹

1s² 3s² 3p²

1s² 3s² 3p³

1s² 3s² 3p⁴

1s² 3s² 3p⁵

1s² 3s² 3p⁶

Ga

Ge

As

Se

Br

Kr

Gallium

Germanium

Arsenic

Selenium

Bromine

Krypton

69.723

72.64

74.92160

78.96

79.904

83.798

3.0

2.01

2.55

2.55

2.96

3.00

1s² 3d¹⁰ 4s¹

1s² 3d¹⁰ 4s²

1s² 3d¹⁰ 4s² 4p¹

1s² 3d¹⁰ 4s² 4p²

1s² 3d¹⁰ 4s² 4p³

1s² 3d¹⁰ 4s² 4p⁴

In

Sn

Sb

Te

I

Xe

Indium

Tin

Antimony

Tellurium

Iodine

Xenon

114.818

117.905

121.757

127.603

126.905

131.29

1.78

2.02

2.05

2.26

2.54

2.80

1s² 4d¹⁰ 5s¹

1s² 4d¹⁰ 5s²

1s² 4d¹⁰ 5s² 5p¹

1s² 4d¹⁰ 5s² 5p²

1s² 4d¹⁰ 5s² 5p³

1s² 4d¹⁰ 5s² 5p⁴

Pb

Bi

Po

At

Rn

Lead

Bismuth

Polonium

Astatine

Radon

207.2

208.980

(209)

(210)

(222)

2.2

2.02

2.02

2.2

2.2

1s² 4d¹⁰ 5s² 5p²

1s² 4d¹⁰ 5s² 5p³

1s² 4d¹⁰ 5s² 5p⁴

1s² 4d¹⁰ 5s² 5p⁵

1s² 4d¹⁰ 5s² 5p⁶

Tl

Pb

Bi

Po

At

Rn

Thallium

Lead

Bismuth

Polonium

Astatine

Radon

204.383

207.2

208.980

(209)

(210)

(222)

1.62

2.02

2.02

2.2

2.2

2.2

1s² 4d¹⁰ 5s² 5p¹

1s² 4d¹⁰ 5s² 5p²

1s² 4d¹⁰ 5s² 5p³

1s² 4d¹⁰ 5s² 5p⁴

1s² 4d¹⁰ 5s² 5p⁵

1s² 4d¹⁰ 5s² 5p⁶

Nh

Fl

Mc

Lv

Ts

Og

Nihonium

Flerovium

Moscovium

Livermorium

Tennesse

Oganesson

284

289

(288)

(292)

(294)

(294)

1.1

1.1

1.1

1.1

1.1

1.1

1s² 5f¹⁴ 6d¹⁰ 7s²

1s² 5f¹⁴ 6d¹⁰ 7s² 7p¹

1s² 5f¹⁴ 6d¹⁰ 7s² 7p²

1s² 5f¹⁴ 6d¹⁰ 7s² 7p³

1s² 5f¹⁴ 6d¹⁰ 7s² 7p⁴

1s² 5f¹⁴ 6d¹⁰ 7s² 7p⁵

Mendeleev ha detto:

Negli elementi, che scopriamo ovunque
attorno a noi e senza i quali neanche il
cielo stellato esisterebbe, noi ritroviamo
al tempo stesso le loro peculiarità
individuali, la loro molteplicità infinita e
la sottomissione alla generale armonia
della Natura

È la chiara dimostrazione
dell'intelligenza della Natura