Click to verify



elements.This list is available for download as a CSV text file an printing. NUMBER SYMBOLELEMENT1HHydrogen2HeHelium	id as a PDF file. The PDF file is optimized for 3LiLithium4BeBeryllium5BBoron6CCarbon7NNitrogen8OOxygen9FFluorine10N	ts, arranged in order of increasing atomic number. The atomic number is the numbe VeNeon11NaSodium12MgMagnesium13AlAluminum14SiSilicon15PPhosphorus16SS	ulfur17ClChlorine18ArArgon19KPotassium20CaCalcium21Sc	scandium22TiTitanium23VVanadium24CrChromium25MnM	Manganese26FeIron27CoCobalt28NiNickel29CuCopper30	ZnZinc31GaGallium32GeGermanium33AsArsenic34SeSelenium3	BrBromine36KrKrypton37RbRubidium38SrStrontium	.39YYttrium40ZrZirconium41NbNiobium
you're learning the periodic table or preparing classroom mater name is approved. This name describes the atomic number of the atom and defines the element. Ordering elements by atomic nun- terms of the timeline of experimentation, the newest element is been identified and named officially by IUPAC. A chemical elem	rials, this list keeps essential element information at your fingertips. Right now, the element, followed by the -ium suffix. For example, element 120 has the tempor mber reveals repeating chemical properties — the basis of the periodic table. Each tennessine. Not yet. Scientists are working toward synthesis of element 119 and tent, often simply called an element, is a type of atom which has a specific number.	e list for memorizing element names, symbols, and atomic numbers for chemistry cla here are no blank spaces in the periodic table up to element 118. The present table! rary name of unbinilium. The temporary names are cumbersome, so it's perfectly ac ch element has a unique one- or two-letter symbol (like H for hydrogen or Fe for iron beyond.Ball, P. (2004). The Elements: A Very Short Introduction. Oxford University er of protons in its atomic nucleus (i.e., a specific atomic number, or Z).[1] The defin rotons in their atoms; it can also be organized by other properties, such as atomic w	has 7 periods. However, scientists are working on synthesizin ceptable to refer to an unverified element by its atomic numb), usually based on its English or Latin name. There are actual Press. ISBN 978-0-19-284099-8.Emsley, J. (2003). Nature's B itive visualisation of all 118 elements is the periodic table of the strength of the periodic table.	ng even heavier elements. Once a new element is synthesized per (e.g., element 122, element 145).An element is a pure che illy four elements that qualify as "newest." Nihonium (113), m Building Blocks: An A-Z Guide to the Elements. Oxford Univer the elements, whose history along the principles of the perior	d, the IUPAC reviews the research before approving new remical substance consisting of atoms with the same numb moscovium (115), tennessine (117), and oganesson (118) versity Press. ISBN 978-0-19-850340-8.IUPAC (1997). "Cheiodic law was one of the founding developments of modern	ame and symbol. The discoverer suggests a new name and symber of protons in their nuclei. This number is the atomic number a vere all officially recognized by the International Union of Pure a nical element." Compendium of Chemical Terminology (2nd ed.) chemistry. It is a tabular arrangement of the elements by their cl	ol, but the IUPAC has the final word. The systematic eld determines the element's identity. The atomic numb d Applied Chemistry (IUPAC) in December 2015, with the "Gold Book"). doi:10.1351/goldbook.C01022Relatemical properties that usually uses abbreviated chemi	element name is in use until a new per reflects the number of protons in an n their names approved in 2016. In led Posts 118 chemical elements have ical symbols in place of full element
Specificheatcapacity[f](J/g·K) Electronegativity[g] Abundancei 12.011 2.267 >4000 4300 0.709 2.55 200 primordial solid 7 N 1363 1.023 1.31 23300 primordial solid 13 Al Aluminium [x] 13 primordial gas 19 K Potassium [ad] 1 4 s-block 39.098 0.89 336 Manganese [aj] 7 4 d-block 54.938 7.21 1519 2334 0.479 1.55 9	n Earth'scrust[h](mg/kg) Origin[i] Phase[j] 1 H Hydrogen [k] 1 1 s-block 1.0080 (Nitrogen [r] 15 2 p-block 14.007 0.0012506 63.15 77.36 1.04 3.04 19 primordial 3 p-block 26.982 2.70 933.47 2792 0.897 1.61 82300 primordial solid 14 Si Sillic 53 1032 0.757 0.82 20900 primordial solid 20 Ca Calcium [ae] 2 4 s-block 40.07 050 primordial solid 26 Fe Iron [ak] 8 4 d-block 55.845 7.874 1811 3134 0.449 1.	colonis in their acoins; it can also be organized by other properties, such as aroline (0.00008988 14.01 20.28 14.304 2.20 1400 primordial gas 2 He Helium [1] 18 1 s-bloogas 8 O Oxygen [s] 16 2 p-block 15.999 0.001429 54.36 90.20 0.918 3.44 461000 pr on [y] 14 3 p-block 28.085 2.3290 1687 3538 0.705 1.9 282000 primordial solid 15 F is 115 1757 0.647 1.00 41500 primordial solid 21 Sc Scandium [af] 3 4 d-block 33 56300 primordial solid 27 Co Cobalt [al] 9 4 d-block 58.933 8.90 1768 3200 0.42: As Arsenic [ar] 15 4 p-block 74.922 5.727 1090[as] 887 0.329 2.18 1.8 primordial so	ck 4.0026 0.0001785 -[m] 4.22 5.193 - 0.008 primordial gas 3 imordial gas 9 F Fluorine [t] 17 2 p-block 18.998 0.001696 53 P Phosphorus [z] 15 3 p-block 30.974 1.823 317.30 550 0.769 k 44.956 2.985 1814 3109 0.568 1.36 22 primordial solid 22 T 1 1.88 25 primordial solid 28 Ni Nickel [am] 10 4 d-block 58.6	3 Li Lithium [n] 1 2 s-block 6.94 0.534 453.69 1560 3.582 0.9 3.53 85.03 0.824 3.98 585 primordial gas 10 Ne Neon [u] 18 3 2.19 1050 primordial solid 16 S Sulfur [aa] 16 3 p-block 32.0 fi Titanium [ag] 4 4 d-block 47.867 4.506 1941 3560 0.523 L. 693 8.908 1728 3186 0.444 1.91 84 primordial solid 29 Cu Co	98 20 primordial solid 4 Be Beryllium [o] 2 2 s-block 9.012 2 p-block 20.180 0.0009002 24.56 27.07 1.03 - 0.005 prim 06 2.07 388.36 717.87 0.71 2.58 350 primordial solid 17 C .54 5650 primordial solid 23 V Vanadium [ah] 5 4 d-block copper [an] 11 4 d-block 63.546 8.96 1357.77 2835 0.385 1	2 1.85 1560 2742 1.825 1.57 2.8 primordial solid 5 B Boron [p] 1 nordial gas 11 Na Sodium [v] 1 3 s-block 22.990 0.968 370.87 11 1 Chlorine [ab] 17 3 p-block 35.45 0.0032 171.6 239.11 0.479 3.1 50.942 6.11 2183 3680 0.489 1.63 120 primordial solid 24 Cr Ch .90 60 primordial solid 30 Zn Zinc [ao] 12 4 d-block 65.38 7.14 6	3 2 p-block 10.81 2.34 2349 4200 1.026 2.04 10 primo 66 1.228 0.93 23600 primordial solid 12 Mg Magnesiu: 6 145 primordial gas 18 Ar Argon [ac] 18 3 p-block 39. omium [ai] 6 4 d-block 51.996 7.15 2180 2944 0.449 1 02.88 1180 0.388 1.65 70 primordial solid 31 Ga Galliu	ordial solid 6 C Carbon [q] 14 2 p-block Im [w] 2 3 s-block 24.305 1.738 923 .95 0.001784 83.80 87.30 0.52 - 3.5 1.66 102 primordial solid 25 Mn um [ap] 13 4 p-block 69.723 5.91
961 0.363 0.82 90 primordial solid 38 Sr Strontium [ax] 2 5 s-bl Ru Ruthenium [bd] 8 5 d-block 101.07 12.45 2607 4423 0.238 2 [bj] 14 5 p-block 118.71 7.265 505.08 2875 0.228 1.96 2.3 prim 137.33 3.51 1000 2170 0.204 0.89 425 primordial solid 57 La L solid 62 Sm Samarium [bv] f-block groups 6 f-block 150.36 7.52 8.79 1734 2993 0.165 1.23 1.3 primordial solid 68 Er Erbium [c	lock \$7.62 \(\tilde{2}\).64 1050 1655 0.301 0.95 370 primordial solid 39 \(\tilde{Y}\) Yttrium [ay] 3 5 . \(\tilde{2}\).2 0.001 primordial solid 45 Rh Rhodium [be] 9 5 d-block 102.91 12.41 2237 396 ordial solid 51 Sb Antimony [bk] 15 5 p-block 121.76 6.697 903.78 1860 0.207 2. anthanum [bq] f-block groups 6 f-block 138.91 6.162 1193 3737 0.195 1.1 39 pri \(\tilde{1}\) 1345 2067 0.197 1.17 7.05 primordial solid 63 Eu Europium [bw] f-block groups \(\tilde{1}\) b] f-block groups 6 f-block 167.26 9.066 1802 3141 0.168 1.24 3.5 primordial solid	d-block 88.906 4.472 1799 3609 0.298 1.22 33 primordial solid 40 Zr Zirconium [az] 80 0.243 2.28 0.001 primordial solid 46 Pd Palladium [bf] 10 5 d-block 106.42 12.023 0.5 0.2 primordial solid 52 Te Tellurium [bl] 16 5 p-block 127.60 6.24 722.66 1261 0 mordial solid 58 Ce Cerium [br] f-block groups 6 f-block 140.12 6.770 1068 3716 0.1 6 f-block 151.96 5.244 1099 1802 0.182 1.2 2 primordial solid 64 Gd Gadolinium [bl id 69 Tm Thulium [cc] f-block groups 6 f-block 168.93 9.32 1818 2223 0.16 1.25 0.5	[4 5 d-block 91.224 6.52 2128 4682 0.278 1.33 165 primordia 3 1828.05 3236 0.244 2.20 0.015 primordial solid 47 Ag Silver 202 2.1 0.001 primordial solid 53 I Iodine [bm] 17 5 p-block 192 1.12 66.5 primordial solid 59 Pr Praseodymium [bs] f-bloc xox f-block groups 6 f-block 157.25 7.90 1585 3546 0.236 1.2 ox 22 primordial solid 70 Yb Ytterbium [cd] f-block groups 6 f-blo	al solid 41 Nb Niobium [ba] 5 5 d-block 92,906 8.57 2750 501 r r [bg] 11 5 d-block 107.87 10.49 1234.93 2435 0.235 1.93 0.0 126.90 4.933 386.85 457.4 0.214 2.66 0.45 primordial solid 5 ck groups 6 f-block 140.91 6.77 1208 3793 0.193 1.13 9.2 prinordial solid 65 Tb Terbium [by] f-block groups 6 f-block 140.91 6.75 1.13 3.2 primordial solid 67 block 173.05 6.90 1097 1469 0.155 1.1 3.2 primordial solid 71	17 0.265 1.6 20 primordial solid 42 Mo Molyhdenum [bb] 075 primordial solid 48 Cd Cadmium [bh] 12 5 d-block 11: 54 Xe Xenon [bn] 18 5 p-block 131.29 0.005894 161.4 165 imordial solid 60 Nd Neodymium [bt] f-block groups 6 f-bl ock 158.93 8.23 1629 3503 0.182 1.2 1.2 primordial solid Lu Lutetium [ce] 3 6 d-block 174.97 9.841 1925 3675 0.15	5 5 d-block 95.95 10.28 2896 4912 0.251 2.16 1.2 primordial soli 2.41 8.65 594.22 1040 0.232 1.69 0.159 primordial solid 49 In Im .03 0.158 2.60 3×10-5 primordial gas 55 Cs Caesium [bo] 1 6 s- ock 144.24 7.01 1297 3347 0.19 1.14 41.5 primordial solid 61 Pm 66 Dy Dysprosium [bz] f-block groups 6 f-block 162.50 8.540 168 4 1.27 0.8 primordial solid 72 Hf Hafnium [cf] 4 6 d-block 178.45	 1 43 Tc Technetium [bc] 7 5 d-block [97] 11 2430 4538 1 1 1 2 5 p-block 114.82 7.31 429.75 2345 0.233 1 1 2 2 3 1 2 2 3 1 2 2 3 1 2 2 3 1 2 2 3 2 3	8 – 1.9 ~ 3×10-9 from decay solid 44 1.78 0.25 primordial solid 50 Sn Tin solid 56 Ba Barium [bp] 2 6 s-block 1315 3273 – 1.13 2×10-19 from decay [ca] f-block groups 6 f-block 164.93 antalum [cg] 5 6 d-block 180.95 16.69
primordial solid 80 Hg Mercury [cn] 12 6 d-block 200.59 13.534 decay unknown phase 86 Rn Radon [ct] 18 6 p-block [222] 0.00 15.37 1841 4300 - 1.5 1.4×10-6 from decay solid 92 U Uraniun f-block groups 7 f-block [247] 14.78 1259 2900 - 1.3 - synthetic unknown phase 103 Lr Lawrencium [dk] 3 7 d-block [266] (14.4	1 234.43 629.88 0.14 2.00 0.085 primordial liquid 81 Tl Thallium [co] 13 6 p-bloc 973 202 211.3 0.094 2.2 4×10–13 from decay gas 87 Fr Francium [cu] 1 7 s-bloc m [cz] f-block groups 7 f-block 238.03 19.1 1405.3 4404 0.116 1.38 2.7 primordia s solid 98 Cf Californium [df] f-block groups 7 f-block [251] 15.1 1173 (1743)[b] - 2) (1900) 1.3 - synthetic unknown phase 104 Rf Rutherfordium [dl] 4 7 d-block	ci] 7 6 d-block 186.21 21.02 3459 5869 0.137 1.9 7×10-4 primordial solid 76 Os Osr k 204.38 11.85 577 1746 0.129 1.62 0.85 primordial solid 82 Pb Lead [cp] 14 6 p-block [223] (2.48) 281 890 -> 0.79[5] ~ 1×10-18 from decay unknown phase 88 Ra Ra al solid 93 Np Neptunium [da] f-block groups 7 f-block [237] 20.45 917 4273 - 1.36 = 1.3 - synthetic solid 99 Es Einsteinium [dg] f-block groups 7 f-block [252] 8.84 1133 (267) (17) (2400) (5800) synthetic unknown phase 105 Db Dubnium [dm] 5 7 Roentgenium [ds] 11 7 d-block [282] (22-24) synthetic unknown phase 112 0	ock 207.2 11.34 600.61 2022 0.129 1.87 (2+)2.33 (4+) 14 prindium [cv] 2 7 s-block [226] 5.5 973 2010 0.094 0.9 9×10-7 f s 3×10-12 from decay solid 94 Pu Plutonium [db] f-block gros (1269) - 1.3 - synthetic solid 100 Fm Fermium [dh] f-block g d-block [268] (21.6) synthetic unknown phase 106 Sg	mordial solid 83 Bi Bismuth [cq] 15 6 p-block 208.98 9.78 54 from decay solid 89 Ac Actinium [cw] f-block groups 7 f-block oups 7 f-block [244] 19.85 912.5 3501 - $1.28 \le 3 \times 10 - 11$ from groups 7 f-block [257] (9.7)[b] (1125)[6](1800)[7] 1.3 - syn Seaborgium [dn] 6 7 d-block [267] (23-24) synthetic	14.7 1837 0.122 2.02 0.009 primordial solid 84 Po Polonium k [227] 10 1323 3471 0.12 1.1 5.5×10-10 from decay solid m decay solid 95 Am Americium [dc] f-block groups 7 f-blon thetic unknown phase 101 Md Mendelevium [di] f-block groups c unknown phase 107 Bh Bohrium [do] 7 7 d-block [270] (2	n [cr] 16 6 p-block [209][a] 9.196 527 1235 - 2.0 2×10-10 from 190 Th Thorium [cx] f-block groups 7 f-block 232.04 11.7 2115 5: ck [243] 12 1449 2880 - 1.13 - synthetic solid 96 Cm Curium [dd groups 7 f-block [258] (10.3) (1100) 1.3 - synthetic unknown p 6-27) synthetic unknown phase 108 Hs Hassium [dp] 8 7	lecay solid 85 At Astatine [cs] 17 6 p-block [210] (8.91 61 0.113 1.3 9.6 primordial solid 91 Pa Protactinium [f-block groups 7 f-block [247] 13.51 1613 3383 - 1.28 nase 102 No Nobelium [dj] f-block groups 7 f-block [25 d-block [271] (27-29) synthetic unknown pha	1-8.95) 575 610 - 2.2 3×10-20 from [cy] f-block groups 7 f-block 231.04 8 - synthetic solid 97 Bk Berkelium [de] 59] (9.9) (1100) - 1.3 - synthetic use 109 Mt Meitnerium [dq] 9 7 d-block
(700) (1400) – – – synthetic unknown phase 116 Lv Livermorium kelvin (K) (sources) ^ Boiling point in kelvin (K) (sources) ^ He mineral (from Arabic: bawraq, Middle Persian: *bōrag) ^ Latin argós 'idle' (it is inert) ^ Neo-Latin potassa 'potash', from pot + ^ Latin Gallia 'France' ^ Latin Germania 'Germany' ^ Middle E	n [dx] 16 7 p-block [293] (12.9) (700) (1100) synthetic unknown phase 117 T at capacity (sources) ^ Electronegativity by Pauling (source) ^ Abundance of ele carbo 'coal' ^ Greek nítron + -gen, 'niter-forming' ^ Greek oxy- + -gen, 'acid-for ash ^ Latin calx 'lime' ^ Latin Scandia 'Scandinavia' ^ Titans, children of Gaia a inglish, from Middle French arsenic, from Greek arsenikón 'yellow arsenic' (influ	(a) I 7 7 p-block [204] (7.1-7.3) (700) (883) synthetic unknown piase II.7 (a) (883) synthetic unknown piements in Earth's crust ^ Primordial (=Earth's origin), from decay, or synthetic ^ Phiming' ^ Latin fluo 'to flow' ^ Greek néon 'new' ^ Coined by Humphry Davy who first and Ouranos ^ Vanadis, a name for Norse goddess Freyja ^ Greek chróma 'colour' enced by arsenikós 'masculine, virile'), from a West Asian wanderword ultimately frow 'lead', due to confusion with lead ore galena (PbS) ^ Greek tekhnētós 'artificial' ^ N	hase 118 Og Oganesson [dz] 18 7 p-block [294] (7) (325±15) nase at Standard state (25°C [77°F], 100 kPa) ^ Greek roots h t isolated it, from English soda (specifically caustic soda), via ^ Corrupted from magnesia negra; see magnesium ^ English, om Old Persian: *zarniya-ka, lit. 'golden' ^ Arsenic sublimes a	(450±10) synthetic unknown phase ^ a b Standard aton hydro- + -gen, 'water-forming' ^ Greek hélios 'sun' ^ Melting Italian from Arabic sudās' 'headache' ^ Magnesia region, eas , from Proto-Celtic *isarnom 'iron', from a root meaning 'bloo tt 1 atmosphere pressure. ^ Greek selénē 'moon' ^ Greek brő	mic weight or År°(É) 1.0080': abridged value, uncertainty g point: helium does not solidify at a pressure of 1 atmosp stern Thessaly, Greece ^ Alumina, from Latin alumen (go dd' ^ German Kobold, 'goblin' ^ Nickel, a mischievous spr ômos 'stench' ^ Greek kryptós 'hidden' ^ Latin rubidus 'd	ignored here'[97]', [] notation: mass number of most stable isoto here. Helium can only solidify at pressures above 25 atm. ^ Gree h. aluminis) 'bitter salt, alum' ^ Latin silex 'flint' (originally siliciu ite in German miner mythology ^ English, from Latin cuprum, af heep red' ^ Strontian, a village in Scotland, where it was found ^	pe ^ a b c d e Values in () brackets are predictions ^: Lithos 'stone' ^ Beryl, mineral (ultimately after Belur m) ^ Greek phōsphóros 'light-bearing' ^ Latin ^ Gree er Cyprus ^ Most likely German Zinke, 'prong, tooth', tterby, Sweden, where it was found; see terbium, erb	Density (sources) ^ Melting point in , Karnataka, India?)[4] ^ Borax, ek chlōrós 'greenish yellow' ^ Greek , but some suggest Persian sang 'stone' bium, ytterbium ^ Zircon, mineral, from
from Proto-Germanic ^ Latin antimonium, of unclear origin: foll Titan ^ Samarskite, a mineral named after V. Samarsky-Bykhov 'Copenhagen' (from Danish havn, harbor) ^ King Tantalus, fath-Arabic from Greek psimúthion 'white lead' ^ Latin Polonia 'Pola Pluto, dwarf planet, then considered a planet ^ Americas, wher physicist from New Zealand ^ Dubna, Russia, where it was disc	k etymologies suggest Greek antí 'against' + mónos 'alone', or Old French anti-m rets, Russian mine official ^ Europe ^ Gadolinite, a mineral named after Johan G er of Niobe in Greek myth; see niobium ^ Swedish tung sten 'heavy stone' ^ Lati and', home country of discoverer Marie Curie ^ Greek ástatos 'unstable'; it has no re the element was first synthesized, by analogy with its homolog europium ^ Pie covered in JINR ^ Glenn Seaborg, American chemist ^ Niels Bohr, Danish physic	noine 'monk's bane', but could be from or related to Arabic 'itmid 'antimony' ^ Latin iadolin, Finnish chemist, physicist and mineralogist ^ Ytterby, Sweden, where it was in Rhenus 'Rhine' ^ Greek osmê 'smell' ^ Iris, Greek goddess of rainbow ^ Spanish o stable isotopes ^ Radium emanation, originally the name of 222Rn ^ France, hom erre and Marie Curie, physicists and chemists ^ Berkeley, California, where it was ficist ^ Neo-Latin Hassia 'Hesse', a state in Germany ^ Lise Meitner, Austrian physicis	tellus 'ground, earth' ^ French iode, from Greek ioeidés 'violis found; see yttrium, erbium, ytterbium ^ Greek dysprósitos 'l platina 'little silver', from plata 'silver' ^ English, from same ie country of discoverer Marguerite Perey ^ Coined in French rst synthesized ^ California, where it was first synthesized in st ^ Darmstadt, Germany, where it was first synthesized in the	et' ^ Greek xénon, neuter of xénos 'strange, foreign' ^ Latin hard to get' ^ Neo-Latin Holmia 'Stockholm' ^ Ytterby, when Proto-Indo-European root as 'yellow' ^ Mercury, Roman god n by discoverer Marie Curie, from Latin radius 'ray' ^ Greek a LBNL ^ Albert Einstein, German physicist ^ Enrico Fermi, I de GSI labs ^ Wilhelm Röntgen, German physicist ^ Nicolaus	a caesius "sky-blue" ^ Greek barýs 'heavy' ^ Greek lanthán re it was found; see yttrium, terbium, ytterbium ^ Thule, t l of commerce, communication, and luck, known for his sa aktís 'ray' ^ Thor, the Norse god of thunder ^ English pre Italian physicist ^ Dmitri Mendeleev, Russian chemist wh s Copernicus, Polish astronomer ^ Japanese Nihon 'Japan'	ein 'to lie hidden' ^ Ceres (dwarf planet), then considered a plan he ancient name for an unclear northern location ^ Ytterby, whe seed and mobility ^ Greek thallós 'green shoot / twig' ^ English, f fix proto- (from Greek prôtos 'first, before') + actinium; protactin o proposed the periodic table ^ Alfred Nobel, Swedish chemist a , where it was first synthesized in Riken ^ Flerov Laboratory of N	et ^ Greek prásios dídymos 'green twin' ^ Greek néos e it was found; see yttrium, terbium, erbium ^ Latin I com Proto-Celtic *φloudom, from a root meaning 'flow' ium decays into actinium. ^ Uranus, the seventh plan- id engineer ^ Ernest Lawrence, American physicist ^ uclear Reactions, part of JINR, where it was synthesiz	dídymos 'new twin' ^ Prometheus, a Lutetia 'Paris' ^ Neo-Latin Hafnia ' ^ German Wismut, via Latin and tet ^ Neptune, the eighth planet ^ Ernest Rutherford, chemist and zed; itself named after Georgy Flyorov,
version: (2006-) "chemical element". doi:10.1351/goldbook.C01 Compounds. I. The Lanthanide and Actinide Metals". Journal of the free encyclopediaHydrogen is a chemical element with chen boiling and melting points are the lowest among all the element earth metal and is part of group 2 (alkaline earth metal). Berylli	022 ^ "Periodic Table - Royal Society of Chemistry". www.rsc.org. ^ "Online Ety Physical and Chemical Reference Data. doi:10.1063/1.3474238. ^ "Fermium". R nical symbol H and atomic number 1. With an atomic weight of 1.00794 u, hydro is. Page 4 From Wikipedia, the free encyclopediaLithium (from Greek:\doc) ditho ium is solid at room temperature. Lithium Periodic table Boron SymbolBeAtomic	1. ^ Tennessee, US, home to ORNL ^ Yuri Oganessian, Russian physicist List of peopymology Dictionary". etymonline.com. ^ "beryl". Merriam-Webster. Archived from the ISC. Atoms made thinkable, an interactive visualisation of the elements allowing phyogen is the lightest element on the periodic table. Its monatomic form (H) is the most ss, "stone") is a chemical element with the symbol Li and atomic number 3. It is a soft number4Group2 (Alkaline earth metal)Period2BlocksClassificationAlkaline Earth M tt9.01218 u Melting point1540 K1286.85 °C2348.33 °FBoiling point2742 K2468.85 °C	ne original on 9 October 2013. Retrieved 27 January 2014. ^ (sical and chemical properties of the elements to be compared t abundant chemical substance in the Universe, constituting r t, silver-white metal belonging to the alkali metal group of ch etal AppearanceWhite-gray metallicColor SlateGray Number	Originally assessed as 0.7 by Pauling but never revised after it Retrieved from "Here's a list of all of the chemical elements roughly 75% of all baryonic mass. Page 3 From Wikipedia, the lemical elements. Under standard conditions it is the lightest of protons4 p+Number of neutrons5 n0Number of electrons5	other elements' electronegativities were updated for prects of the periodic table ordered by increasing atomic number free encyclopediaHelium is a chemical element with synt metal and the least dense solid element. Page 5 Beryllium is 4 e- From Wikipedia, the free encyclopediaBeryllium is a	ision. Predicted to be higher than that of caesium. ^ Konings, Ruer. Click on the column header to sort the table by that column cabol He and atomic number 2. It is a colorless, odorless, tasteless is a chemical element of the periodic table with chemical symbol beand atomic number 4. It is created by the chemical element with symbol Be and atomic number 4. It is created by the chemical element with symbol Be and atomic number 4. It is created by the chemical element with symbol Be and atomic number 4. It is created by the chemical element with symbol Be and atomic number 4. It is created by the chemical element with symbol Be and atomic number 4. It is created by the chemical element with symbol Be and atomic number 4. It is created by the chemical element with symbol Be and atomic number 4. It is created by the chemical element with symbol Be and atomic number 4. It is created by the chemical element with symbol Be and atomic number 4. It is created by the chemical element with symbol Be and atomic number 4. It is created by the chemical element with symbol Be and atomic number 4. It is created by the chemical element with symbol Be and atomic number 4. It is created by the chemical element with symbol Be and atomic number 4. It is created by the chemical element with symbol Be and atomic number 4. It is created by the chemical element with symbol Be and atomic number 4. It is created by the chemical element with symbol Be and atomic number 4. It is created by the chemical element with symbol Be and atomic number 4. It is created by the chemical element with symbol Be and atomic number 4. It is created by the chemical element with symbol Be and atomic number 4. It is created by the chemical element with	dy J. M.; Benes, Ondrej. "The Thermodynamic Propert c click on an element name to get detailed facts about non-toxic, inert, monatomic gas that heads the noble l Be and atomic number 4 with an atomic weight of 9. ted through stellar nucleosynthesis and is a relatively	ties of the f-Elements and Their the element. Page 2 From Wikipedia, gas group in the periodic table. Its .01218 u and is classed as alkaline rare element in the universe. It is a
2s2 Electron configuration chartElectrons per shell2, 2Valence emerald ("smaragdus") were similar. The Papyrus Graecus Holf also formed sweet salts. The name "beryllium" was first used by symbols of elements have Latin roots. An example for this is silv provided below: 118 Elements and Their Symbols and Atomic N element is a substance that can not be decomposed into simpler	electrons 2Valency electrons 2Bohr modelElectron shell for Beryllium, created by miensis, written in the third or fourth century CE, contains notes on how to prepar Wöhler in 1828. CAS Number7440-41-7ChemSpider ID4573986EC number231-ver which is denoted by Ag from its Latin name "Argentum". Another such examg lumbers Recommended Videos Periodic Table in 60 seconds The list of 118 Elem r substances by ordinary chemical processes. It is the fundamental unit of the ma	yy Injosoft ABBeFigure: Shell diagram of Beryllium (Be) atom. Orbital Diagram Discorare artificial emerald and beryl. In a 1798 paper read before the Institut de France, '-150-7PubChem CID Number5460467 The periodic table of elements is widely used ple would be the symbol 'Fe' which is used to denote Iron and can be traced to the Lents and their symbols and atomic numbers will prove useful to beginners in chemis atter. There is a total of 118 elements present in the modern periodic table. A chemica	weryLouis Nicolas Vauquelin (1798)First isolationFriedrich W Vauquelin reported that he found a new "earth" by dissolving in the field of Chemistry to look up chemical elements as they atin word for iron, "Ferrum". It could prove difficult for a beg stry. To learn more about how elements are classified in the p al symbol is a notation of one or two letters denoting a chemic	Onler, Antoine Bussy (1828)Discovery of berylliumThe minera aluminium hydroxide from emerald and beryl in an additional y are arranged in a manner that displays periodic trends in the pinner in chemistry to learn the names of all the elements in the the riodic table, visit BYJU'S. Related Topics Also, check = Chencal cal element. Example: The symbol of chlorine is Cl.The first learners.	ral beryl, which contains beryllium, has been used at least al alkali. The editors of the journal Annales de Chimie et c the chemical properties of the elements. However, the Peri the periodic table because these symbols do not always co emistry Concept Questions and Answers The atomic numb letter is always capitalised for writing the chemical symbol	since the Ptolemaic dynasty of Egypt. In the first century CE, Ro e Physique named the new earth "glucine" for the sweet taste of odic table generally displays only the symbol of the element and prespond to the English names of the elements. Practise more or er of an atom is equivalent to the total number of electrons prese of of an element, while the second letter is small. Chemical symbol	nan naturalist Pliny the Elder mentioned in his encycle some of its compounds. Klaproth preferred the name " not its entire name. Most of the symbols are similar to Interactive Periodic Table A list of 118 elements and it in a neutral atom or the total number of protons pre play a crucial role in easing the writing. It is universe	opedia Natural History that beryl and "beryllina" due to the fact that yttria the name of the element but some their symbols and atomic numbers is esent in the nucleus of an atom.An al, i.e. identical throughout the
out of 0 arewrong 0 out of 0 are correct 0 out of 0 are Unattem til innbyggere eller virksomheter på en sikker måte med bruk a Elements for behandling. Modulen saksbehandler også deler av Publikum Publiseringsløsning for offentlige dokumenter i tråd n arbeidsflater og samtidig hente frem saker og arkivere dokume	pted View Quiz Answers and Analysis Don't like ads? No problem! Ptable will alw v KS FIKS. eFormidling Med Elements eFormidling kan statlige etater og helseft forespørslene automatisk basert på informasjon som er kjent i systemet. Elemen ned Offentlighetsloven. Presentere postjournal og utvalgsbehandling slik at innby ntene direkte. All enkel saksbehandling kan gjøres direkte fra Microsoft Office. A	h a radius of 298 pm.Yes, there is an isotope of the hydrogen atom, protium, which haves be free for everyone. Find yourself here daily? Consider either unblocking the storetak kommunisere med andre virksomheter på en sikker måte fra Elements tile intensivente its Innsynskrav er tett integrert med elnnsyn fra Digitaliseringsdirektoratet og beny yggere, journalister og andre interesserte enkelt får innsyn. Detaljert og avansert starbeidsflaten er bygget opp av ulike elementer som viser den informasjonen som er i	ingle ad banner, donating \$1 a month (donor log in), or buyin grasjonspunktet for eFormidling til Difi eSignering Brukerver itter også integrasjonspunktet til å ta imot innsynskravene. In øk Publisere sladdede (offentlige) versjoner ved skjermet innl mest relevant for saksbehandler. Skjemaadministrator Enkle	ng a poster or wallet card, order number Analytics Dynamisk innlig, sikker og praktisk håndtering av dokumenter som krev unbygger og næringsliv kan bestille innsyn direkte i eInnsyn r hold Fulltekstpublisering som valg Innsynsforespørsler Office rre behandling av utfylte skjema ved direkte overføring av skj	styringsverktøy for økt innsikt og målrettede tiltak. Hent ver signatur fra innbyggere gjennom Difi sin nasjonale fell med en enkel bestillingsfunksjon. Elements Innsynskrav e Toolbox Enkelt å arkivere direkte fra Outlook, Word, Ex- gjemafelt og metadata fra skjemaløsning til Elements. Redu	ut oversikter over aktiviteter og arbeidsbelastning for virksomhe estjeneste for elektronisk signatur – eSignering. Les mer om eSig an også benyttes for å bestille innsyn i dokumenter fra Elements ele, PowerPoint, SharePoint og Teams. Med Elements Office Tool iserer manuelle prosesser og dobbeltarbeid med registrering ved	, avdeling og saksbehandler. Digital forsendelse Send nering Innsyn Sikrer at innsynskrav mottatt av virksor Publikum. Innsynsløsningene, eInnsyn og Elements Pu oxox blir arkivet tett integrert med Office-produktene o at Skjemaadministrator tar tak i ferdig utfylte skjema	l utgående post fra organisasjonen imheten importeres automatisk til ublikum kan brukes side om side. og saksbehandler kan arbeide i kjente u virksomheten har tilrettelagt på sine
saksbehandlingen til mer avansert behandling, raskere kunne for om ting man må huske på å utføre i systemet. Med Elements Va chemistry and physics. For other uses, see Periodic table (disan of elements Naming and etymology for people for places contro noble gas By other characteristics Coinage metals Platinum-gro	ore til riktige beslutninger. Standardiserte veivisere gjør også at offentlig virksor ursling har virksomheten mulighet til å sette opp standard varsler for roller. Hver biguation). Periodic table of the chemical elements showing the most or more conversies (in East Asia) Systematic element names Sets of elements By periodic tall sup metals Precious metals Refractory metals Heavy metals Light metals Native in the support of the suppor	ng for tilrettelagt for kunder som benytter skjemaløsning fra Acos eller Metafocus. W mheter får bedre likebehandling av de ulike forespørsler og skjema som virksomhete e enkelt medarbeider kan også sette opp signe egne varslinger. Sammenstilling av d ommonly named sets of elements (in periodic tables), and a traditional dividing line ble structure Groups (1-18) 1 (alkali metals) 2 (alkaline earth metals) 3 4 5 6 7 8 9 1 metals Noble metals Main-group elements Rare-earth elements Transuranium eleme Electronegativity Hardness Heat capacity / of fusion / of vaporization Ionization ene	en behandler. Sladding Sikker digital sladding med PixView p lokumenter Med denne modulen kan virksomheten sammenst between metals and nonmetals. The f-block actually fits betw 0 11 12 13 14 15 (pnictogens) 16 (chalcogens) 17 (halogens) ents Major, minor and trans- actinides Elements List of chemi-	rogramvare. Den tryggeste og mest tidsbesparende måten å tille alt innhold i en sak eller i en journalpost med bokmerker een groups 2 and 3; it is usually shown at the foot of the table 18 (noble gases) Periods (1-7,) 1 2 3 4 5 6 7 8 + Blocks (s, cal elements by abundance (in human body) by atomic prope	skjerme informasjon ved innsyn. Hjelp og kontroll gjenno r og sidetall som gir medarbeider god oversikt over innhol le to save horizontal space. Part of a series on thePeriodic , p, d, f,) Atomic orbitals Aufbau principle By metallic cl erties by isotope stability by symbol Properties of element:	m avansert tekstsøk og AI/KI. Les mer om PixView her (ekstern le det og gir virksomheten en enkel funksjon for innsyn i hele saker table Periodic table forms 18-column 32-column Alternative and sistification Metals alkali alkaline earth transition post-transition Relative atomic mass Crystal structure Electron affinity configu	nke) Varsling I en travel hverdag er det hensiktsmess: Tabular arrangement of the chemical elements This a extended forms Periodic table history D. Mendeleev 1& anthanide actinide Metalloids dividing metals and non ation Electronegativity (Allen, Pauling) Goldschmidt c	ig med varslinger på e-post eller sms article is about the table used in 871 table 1869 predictions Discovery nmetals Nonmetals nonmetal halogen classification Nutrition Valence Data
periodic table is widely used in physics and other sciences. It is increases going from the bottom left of the periodic table to the explained early in the 20th century, with the discovery of atomi number 94 exist;[a] to go further, it was necessary to synthesize known part of the table. Some scientific discussion also continu	a depiction of the periodic law, which states that when the elements are arrange top right. The first periodic table to become generally accepted was that of the common common and associated pioneering work in quantum mechanics, both ideas seenew elements in the laboratory. By 2010, the first 118 elements were known, these regarding whether some elements are correctly positioned in today's table. Meaning the common com	ed in order of their atomic numbers an approximate recurrence of their properties is Russian chemist Dmitri Mendeleev in 1869; he formulated the periodic law as a depriving to illuminate the internal structure of the atom. A recognisably modern form ohereby completing the first seven rows of the table; [1] however, chemical characteriany alternative representations of the periodic law exist, and there is some discussions aluminium 13Al26.982 Silicon14Si28.085 Phosphorus 15P30.974 Sulfur16S32.06 Cl	s evident. The table is divided into four roughly rectangular as endence of chemical properties on atomic mass. As not all ele if the table was reached in 1945 with Glenn T. Seaborg's disco ization is still needed for the heaviest elements to confirm tha on as to whether there is an optimal form of the periodic table	reas called blocks. Elements in the same group tend to show ements were then known, there were gaps in his periodic tablo overy that the actinides were in fact f-block rather than d-blo at their properties match their positions. New discoveries will e. vtePeriodic table Group 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	similar chemical characteristics. Vertical, horizontal and ole, and Mendeleev successfully used the periodic law to p ock elements. The periodic table and law are now a centra ll extend the table beyond these seven rows, though it is n 15 16 17 18 Hydrogen &alkali metals Alkaline earth meta	diagonal trends characterize the periodic table. Metallic characterize to some properties of some of the missing elements. The peri land indispensable part of modern chemistry. The periodic table to yet known how many more elements are possible; moreover, the Striels Tetrels Pnictogens Chalcogens Halogens Noblegases Periodic Management of the Priodic Striels Tetrels Pnictogens Chalcogens Halogens Noblegases Periodic Management of the Priodic Striels Tetrels Pnictogens Chalcogens Halogens Noblegases Periodic Management of the Priodic Management of the Priodic Striel Striels Tetrels Pnictogens Chalcogens Halogens Noblegases Periodic Management of the Priodic Management of the Priodic Striel Striels Tetrels Pnictogens Chalcogens Halogens Noblegases Periodic Management of the Priodic Management of the Priodic Striel Stri	r increases going down a group and from right to left dic law was recognized as a fundamental discovery in continues to evolve with the progress of science. In na leoretical calculations suggest that this unknown region and 1 Hydrogen1H1.0080 Helium2He4.0026 2 Lithium	across a period. Nonmetallic character a the late 19th century. It was ature, only elements up to atomic on will not follow the patterns of the n3Li6.94 Beryllium4Be9.0122 Boron5B
180.95 Tungsten74W183.84 Rhenium75Re186.21 Osmium76Os [286] Flerovium114FI[289] Moscovium115Mc[290] Livermorium nium94Pu[244] Americium95Am[243] Curium96Cm[247] Berke higher are not shown) Each chemical element has a unique ator symbol; those for hydrogen, helium, and lithium are respectively	s190.23 Iridium77Ir192.22 Platinum78Pt195.08 Gold79Au196.97 Mercury80Hg2 n116Lv[293] Tennessine117Ts[294] Oganesson118Og[294] Lanthanum57La138. slium97Bk[247] Californium98Cf[251] Einsteinium99Es[252] Fermium100Fm[25' mic number (Z— for "Zahl", German for "number") representing the number of pr y H, He, and Li.[6] Neutrons do not affect the atom's chemical identity, but do af	006 Zirconium40Zr91.224 Niobium41Nb92.906 Molybdenum42Mo95.95 Technetium 00.59 Thallium81Tl204.38 Lead82Pb207.2 Bismuth83Bi208.98 Polonium84Po[209]. 9.91 Cerium58Ce140.12 Praseodymium59Pr140.91 Neodymium60Nd144.24 Prometh 7] Mendelevium101Md[258] Nobelium102No[259] Primordial From decay Synth rotons in its nucleus.[4] Each distinct atomic number therefore corresponds to a clareffect its weight. Atoms with the same number of protons but different numbers of ne	Astatine85At[210] Radon86Rn[222] 7 Francium87Fr[223] Raium61Pm[145] Samarium62Sm150.36 Europium63Eu151.96 letic Border shows natural occurrence of the element Stands so of atom: these classes are called the chemical elements.[5] utrons are called isotopes of the same chemical element.[6] N	dium88Ra[226] Lawrencium103Lr[266] Rutherfordium104Rf Gadolinium64Cd157.25 Terbium65Tb158.93 Dysprosium66E ard atomic weight Ar, std(E)[2] Ca: 40.078 — Abridged value The chemical elements are what the periodic table classifies Vaturally occurring elements usually occur as mixes of differe	tf[267] Dubnium105Db[268] Seaborgium106Sg[269] Bohri Dy162.50 Holmium67H0164.93 Erbium68Er167.26 Thuliu e (uncertainty omitted here)[3] Po: [209] — mass number is and organizes. Hydrogen is the element with atomic nur cent isotopes; since each isotope usually occurs with a cha	um107Bh[270] Hassium108Hs[271] Meitnerium109Mt[278] Dar. m69Tm168.93 Ytterbium70Yb173.05 Actinium89Ac[227] Thoriv of the most stable isotope s-block f-block d-block p-block 3D view other 1; helium, atomic number 2; lithium, atomic number 3; and acteristic abundance, naturally occurring elements have well-de	nstadtium110Ds[281] Roentgenium111Rg[282] Coper. m90Th232.04 Protactinium91Pa231.04 Uranium92U2 of some hydrogen-like atomic orbitals showing proba o on. Each of these names can be further abbreviated ined atomic weights, defined as the average mass of a	micium112Cn[285] Nihonium113Nh 138.03 Neptunium93Np[237] Pluto- ability density and phase (g orbitals and l by a one- or two-letter chemical a naturally occurring atom of that
isotopes occur naturally in significant quantities, the mass of th in the outermost p-subshell). Elements with similar chemical pr synthesized in laboratories. Of the 94 naturally occurring eleme astatine; francium (element 87) has been only photographed in the Earth's formation.[c] The remaining eleven natural element.	e most stable isotope usually appears, often in parentheses.[8] In the standard poperties generally fall into the same group in the periodic table, although in the introduced in the same group in the periodic table, although in the introduced in the same group in the periodic table, although in the same group in the primarily of groups and introduced in the same group in the same groups are same groups. The same groups in the same groups in the same groups are same groups and in the same groups are same groups. The same groups in the same groups are same groups and in the same groups in the periodic same groups. The same groups in the periodic same groups. The periodic same groups in the perio	bon has three naturally occurring isotopes: all of its atoms have six protons and most eriodic table, the elements are listed in order of increasing atomic number. A new f-block, and to some respect in the d-block, the elements in the same period tend to . A few of the latter are so rare that they were not discovered in nature, but were synents, eighty have a stable isotope and one more (bismuth) has an almost-stable isot being constantly regenerated as intermediate products of the decay of thorium and numerals were followed by either an "A" if the group was in the s- or p-block, or a "B	ow (period) is started when a new electron shell has its first end have similar properties, as well. Thus, it is relatively easy to period in the laboratory before it was determined that they ope (with a half-life of 2.01×1019 years, over a billion times turanium. [d] All 24 known artificial elements are radioactive. [electron. Columns (groups) are determined by the electron co predict the chemical properties of an element if one knows th y exist in nature: technetium (element 43), promethium (elem the age of the universe).[15][b] Two more, thorium and urani [6] Under an international naming convention, the groups are	onfiguration of the atom; elements with the same number he properties of the elements around it.[9] Today, 118 element 61), astatine (element 85), neptunium (element 93), ium, have isotopes undergoing radioactive decay with a have numbered numerically from 1 to 18 from the leftmost co	of electrons in a particular subshell fall into the same columns (e ments are known, the first 94 of which are known to occur nature and plutonium (element 94).[12] No element heavier than einstei: lf-life comparable to the age of the Earth. The stable elements pl lumn (the alkali metals) to the rightmost column (the noble gases	g. oxygen, sulfur, and selenium are in the same colum lly on Earth.[10][a] The remaining 24, americium to or ium (element 99) has ever been observed in macrosco is bismuth, thorium, and uranium make up the 83 prir J. The f-block groups are ignored in this numbering.[2]:	an because they all have four electrons ganesson (95–118), occur only when opic quantities in its pure form, nor has mordial elements that survived from (2] Groups can also be named by their
to be treated as one triple-sized group, known collectively in bo IVA VA VIA VIIA VIIIB IB IIB IIB IVB VB VIB VIB VIB O Trivial nam Fe Co Ni Cu Zn Ga Ge As Se Br Kr Period 5 Rb Sr Y Zr Nb Mo T groups (columns) do not have a group number.c The correct cor considered it incorrect in 1948.[26] Arguments can still occasio table. Later (1902), Mendeleev accepted the evidence for their	th notations as group VIII. In 1988, the new IUPAC (International Union of Pure her H and alkali metals alkaline earth metals triels tetrels pnictogens chalcogens c Ru Rh Pd Ag Cd In Sn Sb Te I Xe Period 6 Cs Ba La-Yb Lu Hf Ta W Re Os Ir Pt mposition of group 3 is scandium (Sc), yttrium (Y), lutetium (Lu), and lawrencium nally be encountered in the contemporary literature purporting to defend it, but existence, and they could be placed in a new "group 0", consistently and without	and Applied Chemistry) naming system (1-18) was put into use, and the old group n halogens noble gases Name by elementr lithium group beryllium group scandium g. Au Hg Tl Pb Bi Po At Rn Period 7 Fr Ra Ac-No Lr Rf Db Sg Bh Hs Mt Ds Rg Cn Nh In (Lr), as shown here: this is endorsed by 1988[23] and 2021[24] IUPAC reports on t most authors consider them logically inconsistent.[27][28][29] Some sources follow breaking the periodic table principle.r Group name as recommended by IUPAC. Hy	names (I-VIII) were deprecated.[23] vteGroups in the periodic roup titanium group vanadium group chromium group manga FI Mc Lv Ts Og a Group 1 is composed of hydrogen (H) and the the question. General inorganic chemistry texts often put scar a compromise that puts La-Lu and Ac-Lr as the f-block rows drogen Helium Lithium Beryllium Boron Carbon Nitrogen Ox	table IUPAC group 1a 2 —b 3c 4 5 6 7 8 9 10 11 12 13 14 15 anese group iron group cobalt group nickel group copper grothe alkali metals. Elements of the group have one s-electron in dium (Sc), yttrium (Y), lanthanum (La), and actinium (Ac) in (despite that giving 15 f-block elements in each row, which cygen Fluorine Neon Sodium Magnesium Aluminium Silicon P	5 16 17 18 Mendeleev (I-VIII) IA IÍA IIIB IVB VB VIB VIIB vup zinc group boron group carbon group nitrogen group in the outer electron shell. Hydrogen is not considered to be a group 3, so that Ce-Lu and Th-Lr become the f-block bet contradicts quantum mechanics), leaving the heavier men Phosphorus Sulfur Chlorine Argon Potassium Calcium Sca	VIIIB IB IIB IIIB IVB VB VIB VIIB d CAS (US, A-B-A) IA IÏA IIÏB I' oxygen group fluorine group helium or neon group Period 1 H H he an alkali metal as it is not a metal, though it is more analogous ween groups 3 and 4; this was based on incorrectly measured ele bhers of group 3 ambiguous.[24] See also Group 3 element#Com; dium Titanium Vanadium Chromium Manganese Iron Cobalt Nic	B VB VIB VIIB VIIIB IB IIB IIIA IVA VA VIA VIIA VI	A Old IUPAC (Europe, A-B) IA IIA IIIA 'S Cl Ar Period 4 K Ca Sc Ti V Cr Mn somewhat exceptional.b The 14 f-block u and Evgeny Lifshitz already ered at the time of Mendeleev's original n Bromine Krypton Rubidium
Americium Curium Berkelium Californium Einsteinium Fermium Gallium Germanium Arsenic Selenium Bromine Krypton Rubidit Moscovium Livermorium Tennessine Oganesson Lanthanum Cenumber of element columns from 32 to 18.[30] Both forms reprethe composition of group 3, the options can be shown equally (u	n Mendelevium Nobelium Lawrencium Rutherfordium Dubnium Seaborgium Boh um Strontium Yttrium Zirconium Niobium Molybdenum Technetium Ruthenium I erium Praseodymium Neodymium Promethium Samarium Europium Gadolinium esent the same periodic table.[6] The form with the f-block included in the main l unprejudiced) in both forms.[35] Periodic tables usually at least show the elemen	n Iodine Xenon Caesium Barium Lanthanum Cerium Praseodymium Neodymium Pro rivium Hassium Meitnerium Darmstadtium Roentgenium Copernicium Nihonium Fler Rhodium Palladium Silver Cadmium Indium Tin Antimony Tellurium Iodine Xenon Ca Terbium Dysprosium Holmium Erbium Thulium Ytterbium Actinium Thorium Protac body is sometimes called the 32-column[6] or long form;[33] the form with the f-bloc tst's symbols; many also provide supplementary information about the elements, eithe fain article: Electron configuration The periodic table is a graphic description of the	rovium Moscovium Livermorium Tennessine Oganesson 32 co aesium Barium Lutetium Hafnium Tantalum Tungsten Rheniu tinium Uranium Neptunium Plutonium Americium Curium Be ck cut out the 18-column[6] or medium-long form.[33] The 32- er via colour-coding or as data in the cells. The above table sh	Dlumns Hydrogen Helium Lithium Beryllium Boron Carbon Ni Im Osmium Iridium Platinum Gold Mercury (element) Thalliun Frkelium Californium Einsteinium Fermium Mendelevium Nol -column form has the advantage of showing all elements in th lows the names and atomic numbers of the elements, and also	litrogen Oxygen Fluorine Neon Sodium Magnesium Alumin Im Lead Bismuth Polonium Astatine Radon Francium Radi bbelium 18 columns For reasons of space,[30][31] the peri cheir correct sequence, but it has the disadvantage of requ so their blocks, natural occurrences and standard atomic v	nium Silicon Phosphorus Sulfur Chlorine Argon Potassium Calciu: um Lawrencium Rutherfordium Dubnium Seaborgium Bohrium Fodic table is commonly presented with the f-block elements cut on iring more space.[34] The form chosen is an editorial choice, and reights. For the short-lived elements without standard atomic we	n Scandium Titanium Vanadium Chromium Manganes assium Meitnerium Darmstadtium Roentgenium Cope t and positioned as a distinct part below the main bod does not imply any change of scientific claim or stater ghts, the mass number of the most stable known isoto	se Iron Cobalt Nickel Copper Zinc ernicium Nihonium Flerovium dy.[32][30][23] This reduces the ment. For example, when discussing ope is used instead. Other tables may
An electron can be thought of as inhabiting an atomic orbital, we up to two electrons: they are distinguished by a quantity known 1s 2 n = 2 2s 2p 8 n = 3 3s 3p 3d 18 n = 4 4s 4p 4d 4f 32 n = 5 shell contains one 3s orbital, three 3p orbitals, and five 3d orbit principal quantum number ℓ	hich characterizes the probability it can be found in any particular region around as spin, conventionally labelled "up" or "down" [40][f] In a cold atom (one in its 5s 5p 5d 5f 5g 50 n = 6 6s 6p 6d 6f 6g 6h 72 n = 7 7s 7p 7d 7f 7g 7h 7i 98 Subslicals, and thus has a capacity of $2\times1+2\times3+2\times5=18$. The fourth shell contains (the orbital type), the orbital magnetic quantum number $m\ell$, and the spin magne	d the atom. Their energies are quantised, which is to say that they can only take disk ground state), electrons arrange themselves in such a way that the total energy they hell capacity $(4t+2) \ 2 \ 6 \ 10 \ 14 \ 18 \ 22 \ 26 \ Elements are known with up to the first severage one 4s orbital, three 4p orbitals, five 4d orbitals, and seven 4f orbitals, thus leading stic quantum number ms.[39] Idealized order of subshell filling according to the Mac 5 \ 2p \ 3s \ 3p \ 4s \ 3d \ 4p \ 5s \ 4d \ 5p \ 6s \ 4f \ 5d \ 6p \ 7s \ 5f \ 6g \ 6g \ 7s \ 5g \ 6g \ 6g \ 6g \ 6g \ 6g \ 6g \ 6g$	crete values. Furthermore, electrons obey the Pauli exclusion y have is minimized by occupying the lowest-energy orbitals a en shells occupied. The first shell contains only one orbital, a y to a capacity of $2\times 1 + 2\times 3 + 2\times 5 + 2\times 7 = 32$.[30] Higher stelled in y the sequence in which the subshells are filled is y .	principle: different electrons must always be in different sta available.[42] Only the outermost electrons (valence electrons spherical s orbital. As it is in the first shell, this is called the shells contain more types of orbitals that continue the patterr given in most cases by the Aufbau principle, also known as the	ates. This allows classification of the possible states an ele ns) have enough energy to break free of the nucleus and p 1s orbital. This can hold up to two electrons. The second n, but such types of orbitals are not filled in the ground st ne Madelung or Klechkovsky rule (after Erwin Madelung a	ctron can take in various energy levels known as shells, divided in tricipate in chemical reactions with other atoms. The others are shell similarly contains a 2s orbital, and it also contains three dur tates of known elements.[45] The subshell types are characterized and Vsevolod Klechkovsky respectively). This rule was first observ	ato individual subshells, which each contain one or mo- called core electrons. [43] $\ell = 0.12.34.56$ Shell capac libbell-shaped 2p orbitals, and can thus fill up to eight by the quantum numbers. Four numbers describe an ed empirically by Madelung, and Klechkovsky and late	ore orbitals. Each orbital can contain city $(2n2)[44]$ Orbital s p d f g h i n = 1 electrons $(2\times1+2\times3=8)$. The third orbital in an atom completely: the er authors gave it theoretical
and atomic charge.[52][h] Starting from the simplest atom, this shell is full, so its third electron occupies a 2s orbital, giving a 1 second 2p orbital; and with nitrogen (1s2 2s2 2p3) all three 2p elements. The eleventh electron begins the filling of the third st lithium through neon, and is the basis for the periodicity of cher	lets us build up the periodic table one at a time in order of atomic number, by co s2 2s1 configuration. The 2s electron is lithium's only valence electron, as the 1s orbitals become singly occupied. This is consistent with Hund's rule, which state hell by occupying a 3s orbital, giving a configuration of 1s2 2s2 2p6 3s1 for sodiu mical properties that the periodic table illustrates:[39] at regular but changing in	ce the periodic table is usually drawn to begin each row (often called a period) with onsidering the cases of single atoms. In hydrogen, there is only one electron, which is subshell is now too tightly bound to the nucleus to participate in chemical bonding is that atoms usually prefer to singly occupy each orbital of the same type before fillium. This configuration is abbreviated [Ne] 3s1, where [Ne] represents neon's configuration to the properties of the chemical elements approximately represents neon's configuration.	must go in the lowest-energy orbital 1s. This electron configu- to other atoms: such a shell is called a "core shell". The 1s st ing them with the second electron. Oxygen (1s2 2s2 2p4), fluc- uration. Magnesium ([Ne] 3s2) finishes this 3s orbital, and the repeat.[36] The first 18 elements can thus be arranged as the	uration is written 1s1, where the superscript indicates the nu- ubshell is a core shell for all elements from lithium onward. To orine (1s2 2s2 2p5), and neon (1s2 2s2 2p6) then complete the e following six elements aluminium, silicon, phosphorus, sulfu- start of a periodic table. Elements in the same column have	umber of electrons in the subshell. Helium adds a second e The 2s subshell is completed by the next element beryllium he already singly filled 2p orbitals; the last of these fills th Fur, chlorine, and argon fill the three 3p orbitals ([Ne] 3s2 the same number of valence electrons and have analogou	lectron, which also goes into 1s, completely filling the first shell in (1s2 2s2). The following elements then proceed to fill the 2p sules escond shell completely.[39][58] Starting from element 11, sod 3p1 through [Ne] 3s2 3p6).[39][58] This creates an analogous ses valence electron configurations: these columns are called group	and giving the configuration 1s2.[39][58][i] Starting from the shell. Boron (1s2 2s2 2p1) puts its new electron in a 2 um, the second shell is full, making the second shell a ies in which the outer shell structures of sodium throws. The single exception is helium, which has two valents.	rom the third element, lithium, the first 2p orbital; carbon (1s2 2s2 2p2) fills a core shell for this and all heavier ugh argon are analogous to those of noe electrons like beryllium and
block (coloured yellow) are filling p orbitals. [30] 1H 2He $2 \times 1 =$ approximately the same energy and they compete for filling the one. A similar anomaly occurs at copper, whose atom has a [Ar] are completely filled with a total of ten electrons. [39][58] Next elements (or transition metals, since they are all metals). [61] The	$\overset{\circ}{2}$ elements 1s 0p 3Li 4Be 5B 6C 7N 8O 9F 10Ne 2×(1+3) = 8 elements 2s 2p 111 electrons, and so the occupation is not quite consistently filling the 3d orbitals of 3d10 4s1 configuration rather than the expected [Ar] 3d9 4s2.[39] These are vic come the 4p orbitals, completing the row, which are filled progressively by gallius ne next 18 elements fill the 5s orbitals (rubidium and strontium), then 4d (yttrium).	on even this single exception, preferring to consistently follow the valence configura $Na 12Mg 13Al 14Si 15P 16S 17Cl 18Ar 2×(1+3) = 8$ elements 3s 3p Starting the nex one at a time. The precise energy ordering of 3d and 4s changes along the row, and is collisions of the Madelung rule. Such anomalies, however, do not have any chemical sum ([Ar] 3d10 4s2 4p1) through krypton ([Ar] 3d10 4s2 4p6), in a manner analogous in through cadmium, again with a few anomalies along the way), and then 5p (indium $Zr 41Nb 42Mc 43Tc 44Ru 45Rb 46Pd 47Ag 48Cd 49In 50Sn 51Sb 52Te 53l 54Xe 2×$	t row, for potassium and calcium the 4s subshell is the lowest also changes depending on how many electrons are removed ignificance: [52] most chemistry is not about isolated gaseous to the previous p-block elements. [39] [58] From gallium onwan through xenon). [30] [58] Again, from indium onward the 4d of the substance of the	t in energy, and therefore they fill it.[39][58] Potassium adds from the atom. For example, due to the repulsion between th atoms,[60] and the various configurations are so close in energy ards, the 3d orbitals form part of the electronic core, and no l orbitals are in the core.[58][62] Hence the fifth row has the s	s one electron to the 4s shell ([Ar] 4s1), and calcium then one and electrons and the 4s ones, at chromium the 4s energy to each other[50] that the presence of a nearby atom longer participate in chemistry.[57] The s- and p-block elesame structure as the fourth.[30] 1H 2He 2×1 = 2 element	completes it ([Ar] 4s2). However, starting from scandium ([Ar] 3d yy level becomes slightly higher than 3d, and so it becomes more can shift the balance.[39] Therefore, the periodic table ignores wents, which fill their outer shells, are called main-group elements 1s 0d 0p 3Li 4Be 5B 6C 7N 8O 9F $10Ne 2 \times (1+3) = 8$ elements	1 4s2) the 3d subshell becomes the next highest in ener profitable for a chromium atom to have a [Ar] 3d5 4s1 nem and considers only idealized configurations [38] 4 ts; the d-block elements (coloured blue below), which is 0d 2p 11Na 12Mg 13Al 14Si 15P 16S 17Cl 18Ar 2×	ergy. The 4s and 3d subshells have I configuration than an [Ar] 3d4 4s2 At zinc ([Ar] 3d10 4s2), the 3d orbitals fill an inner shell, are called transition (1+3) = 8 elements3s 0d 3p 19K 20Ca
subshells at similar energies, competition occurs once again will electrons; thereafter, a series of ten transition elements (lutetiu the core,[58] and probably the 6d orbitals join the core starting was made.[76] (However, the first element to be discovered by 29Cu 30Zn 31Ga 32Ge 33As 34Se 35Br 36Kr 2x(1+3+5) = 18 of 106Sg 107Bh 108Hs 109Mt 110Ds 111Rg 112Cn 113Nh 114Fl	th many irregular configurations; [50] this resulted in some dispute about where an through mercury) follows, [58] [66] [67] [68] and finally six main-group elements from nihonium. [58] [71] [j] Again there are a few anomalies along the way: [30] for synthesis rather than in nature was technetium in 1937.) The row was completed elements 4s of 3d 4p 37Rb 38Sr 39Y 40Zr 41Nb 42Mo 43Tc 44Ru 45Rh 46Pd 47A 115Mc 116Lv 117Ts 118Og $2\times(1+3+5+7) = 32$ elements 7s 5f 6d 7p This completed and 115Mc 116Lv 117Ts 118Og $2\times(1+3+5+7) = 32$ elements 7s 5f 6d 7p This completed and 115Mc 116Lv 117Ts 118Og $2\times(1+3+5+7) = 32$ elements 7s 5f 6d 7p This completed and 115Mc 116Lv 117Ts 118Og $2\times(1+3+5+7) = 32$ elements 7s 5f 6d 7p This completed and 115Mc 116Lv 117Ts 118Og $2\times(1+3+5+7) = 32$ elements 7s 5f 6d 7p This completed and 115Mc 11	exactly the f-block is supposed to begin, but most who study the matter agree that it is (thallium through radon) complete the period. [58] [69] From lutetium onwards the or example, as single atoms neither actinium nor thorium actually fills the 5f subshid with the synthesis of tennessine in $2010[77]$ (the last element oganesson had alreatly $48Cd$ $49In$ $50Sn$ $51Sb$ $52Te$ $53I$ $54Xe$ $2x(1+3+5) = 18$ elements $50Sh$ $64Sh$	starts at lanthanum in accordance with the Aufbau principle 4f orbitals are in the core,[58][65] and from thallium onward: I, and lawrencium does not fill the 6d shell, but all these subs duy been made in 2002),[78] and the last elements in this seve 56Ba 57La 58Ce 59Pr 60Nd 61Pm 62Sm 63Eu 64Gd 65Tb 66 The following table shows the electron configuration of a new	:.[63] Even though lanthanum does not itself fill the 4f subshes so are the 5d orbitals.[58][57][70] The seventh row is analoshells can still become filled in chemical environments.[73][7enth row were given names in 2016.[79] 1H 2He $2\times1=2$ eleidby 67Ho 68Er 69Tm 70Yb 71Lu 72Hf 73Ta 74W 75Re 760s tural gas-phase atom of each element. Different configuration	ell as a single atom, because of repulsion between electro ogous to the sixth row: 7s fills (francium and radium), thei '41 75 For a very long time, the seventh row was incomple ments1s 0f 0d 0p 3Li 4Be 5B 6C 7N 8O 9F 10Ne 2×(1+3) '77Ir 78Pt 79Au 80Hg 81Tl 82Pb 83Bi 84Po 85At 86Rn 2× ons can be favoured in different chemical environments.[52]	ns,[52] its 4f orbitals are low enough in energy to participate in one of the constitution of the constitu	nemistry.[64][53][65] At ytterbium, the seven 4f orbita and finally 7p (nihonium to oganesson).[58] Starting the ments beyond uranium started to be synthesized in the Ar 2×(1+3) = 8 elements3s of 0d 3p 19K 20Ca 21Sc 2 192U 93Np 94Pu 95Am 96Cm 97Bk 98Cf 99Es 100Fm trations; the transition and inner transition elements s	als are completely filled with fourteen from lawrencium the 5f orbitals are in he laboratory in 1940, when neptunium 22Ti 23V 24Cr 25Mn 26Fe 27Co 28Ni n 101Md 102No 103Lr 104Rf 105Db show twenty irregularities due to the
15P23 16S24 17Cl25 18Ar26 [Ar]4s:3d:4p: 19K1 20Ca2 2ĨŠc 70Yb214 71Lu2141- 72Hf2142- 73Ta2143- 74W2144- 75Re214 116Lv214104 117Ts214105 118Og214106 s-block f-block d-bloc gases.[6] The debate has to do with conflicting understandings hydrides, in which it gains an electron, brings it close to the pro	221-22Ti22-23V23-24Cr15-25Mn25-26Fe26-27Co27-28Ni28-29Cu110-30Zn: 45-76Os2146-77Ir2147-78Pt1149-79Au11410-80Hg21410-81Tl214101 82Pb2 ck p-block Main article: Period 1 element Although the modern periodic table is of the extent to which chemical or electronic properties should decide periodic table preties of the halogens which do the same[84] (though it is rarer for hydrogen to the same of the halogens which do the same of the later of the halogens which do the same of the later of the halogens which do the same of the later of the halogens which do the same of the later of the halogens which do the same of the later of t	therefore calculated configurations have been shown instead.[81] Completely filled: 210-31Ga2101 32Ge2102 33As2103 34Se2104 35Br2105 36Kr2106 [Kr]5s:4d:5p: 3 214102 83Bi214103 84Po214104 85At214105 86Kn214106 [Rn]7s:5f:6d:7p: 87Fr1standard today, the placement of the period 1 elements hydrogen and helium remainable placement.[82] Like the group 1 metals, hydrogen has one electron in its outern of form H- than H+).[85] Moreover, the lightest two halogens (fluorine and chlorine ne rarer arrangements show either hydrogen in group 17,[86] duplicate hydrogen in	7Rb1 38Sr2 39Y2Ĭ- 40Zr22- 41Nb14- 42Mo15- 43Tc25- 44 - 88Ra2 89Ac2-1- 90Th2-2- 91Pa221- 92U231- 93Np241- 94 ns an open issue under discussion, and some variation can be most shell[83] and typically loses its only electron in chemical) are gaseous like hydrogen at standard conditions.[84] Some	Ru17- 45Rh18- 46Pd-10- 47Ag110- 48Cd210- 49In2101 50Sn Pu26 95Am27 96Cm271- 97Bk29 98Cf210 99Es211 10 found.[57][82] Following their respective s1 and s2 electron I reactions.[84] Hydrogen has some metal-like chemical prope properties of hydrogen are not a good fit for either group: h	n2102 51Sb2103 52Te2104 53I2105 54Xe2106 [Xe]6s:4f::5 00Fm212 101Md213 102No214 103Lr214-1 104Rf214 n configurations, hydrogen would be placed in group 1, an perties, being able to displace some metals from their salt: hydrogen is neither highly oxidizing nor highly reducing a	d:6p: 55Cs156Ba257La2-1-58Ce211-59Pr2360Nd24-61 2-105Db2143-106Sg2144-107Bb2145-108Hs2146-109Mt214'i t helium would be placed in group 2.[57] The group 1 placement .[84] But it forms a diatomic nonmetallic gas at standard conditi di is not reactive with water.[85] Hydrogen thus has properties c	Pm25 62Sm26 63Eu27 64Gd271- 65Tb29 66Dy2: - 110Ds2148- 111Rg2149- 112Cn21410- 113Nh21410 of hydrogen is common, but helium is almost always p ns, unlike the alkali metals which are reactive solid m prresponding to both those of the alkali metals and the	110-67Ho211-68Er212-69Tm213- 11 114Fl214102 115Mc214103 blaced in group 18 with the other noble letals. This and hydrogen's formation of e halogens, but matches neither group
that routinely occupies a position in the periodic table that is no [57] a proposal to move helium to group 2 was rejected by IUPA less inertness than neon and to form (HeO)(LiF)2 with a structuhas additionally been cited to support moving helium to group 2 group 18: on the other hand, neon, which would be the first gro	ot consistent with its electronic structure. It has two electrons in its outermost shall be also for these reasons [23] Nonetheless, helium is still occasionally placed ure similar to the analogous beryllium compound (but with no expected neon analy. It arises because the first orbital of any type is unusually small, since unlike its up 18 element if helium was removed from that spot, does exhibit those anomali	nell, whereas the other noble gases have eight; and it is an s-block element, whereas in group 2 today,[91] and some of its physical and chemical properties are closer to logue), have resulted in more chemists advocating a placement of helium in group 2 is higher analogues, it does not experience interelectronic repulsion from a smaller ess.[93] The relationship between helium and beryllium is then argued to resemble the close to neon, and the large difference characteristic between the first two elements	all other noble gases are p-block elements. However it is un the group 2 elements and support the electronic placement. I. This relates to the electronic argument, as the reason for ne rbital of the same type. This makes the first row of elements is that between hydrogen and lithium, a placement which is muc	reactive at standard conditions, and has a full outer shell: the [83][57] Solid helium crystallises in a hexagonal close-packed son's greater inertness is repulsion from its filled p-shell that in each block unusually small, and such elements tend to exhibit more commonly accepted.[94] For example, because of this	ese properties are like the noble gases in group 18, but no d structure, which matches beryllium and magnesium in g t helium lacks, though realistically it is unlikely that helium hibit characteristic kinds of anomalies for their group. Son is trend in the sizes of orbitals, a large difference in atomi	t at all like the reactive alkaline earth metals of group 2. For the roup 2, but not the other noble gases in group 18.[92] Recent the n-containing molecules will be stable outside extreme low-temper the chemists arguing for the repositioning of helium have pointed cradii between the first and second members of each main group.	e reasons helium is nearly universally placed in group oretical developments in noble gas chemistry, in whic ature conditions (around 10 K).[93][94][95][96] The fin out that helium exhibits these anomalies if it is placed is seen in groups 1 and 13-17: it exists between neon	o 18[6] which its properties best match; th helium is expected to show slightly irst-row anomaly in the periodic table in group 2, but not if it is placed in a and argon, and between helium and
Bromine Krypton Rubidium Strontium Yttrium Zirconium Niobiu Uranium Neptunium Plutonium Americium Curium Berkelium C Vanadium Chromium Manganese Iron Cobalt Nickel Copper Zir Thallium Lead Bismuth Polonium Astatine Radon Francium Rad block elements in group 3, and Ce-Lu and Th-Lr form the f-bloc	um Molybdenum Technetium Ruthenium Rhodium Palladium Silver Cadmium Inc Zalifornium Einsteinium Fermium Mendelevium Nobelium Lawrencium Rutherfor nc Gallium Germanium Arsenic Selenium Bromine Krypton Rubidium Strontium Y lium Actinium Thorium Protactinium Uranium Neptunium Plutonium Americium ck. Thus the d-block is split into two very uneven portions. This is a holdover from	groups may rarely be encountered.[89][57][58] Main article: Group 3 element § Cor dium Tin Antimony Tellurium Iodine Xenon Caesium Barium Lanthanum Cerium Pra- rdium Dubnium Seaborgium Bohrium Hassium Meitnerium Darmstadtium Roentgen Yttrium Zirconium Niobium Molybdenum Technetium Ruthenium Rhodium Palladium Curium Berkelium Californium Einsteinium Fermium Mendelevium Nobelium Lawren n early mistaken measurements of electron configurations; modern measurements a	seodymium Neodymium Promethium Samarium Europium Ga ium Copernicium Nihonium Flerovium Moscovium Livermorin n Silver Cadmium Indium Tin Antimony Tellurium Iodine Xeno encium Rutherfordium Dubnium Seaborgium Bohrium Hassiu re more consistent with the form with lutetium and lawrenciu	adolinium Terbium Dysprosium Holmium Erbium Thulium Ytt um Tennessine Oganesson Correct depiction of Group 3 Grou on Caesium Barium Lanthanum Cerium Praseodymium Neod ım Meitnerium Darmstadtium Roentgenium Copernicium Nih um in group 3, and with La-Yb and Ac-No as the f-block.[25][terbium Lutetium Hafnium Tantalum Tungsten Rhenium C up 3: Sc, Y, La, Ac Hydrogen Helium Lithium Beryllium Br dymium Promethium Samarium Europium Gadolinium Ter nonium Flerovium Moscovium Livermorium Tennessine Oc [100] The 4f shell is completely filled at ytterbium, and for	Ismium Iridium Platinum Gold Mercury (element) Thallium Lead ron Carbon Nitrogen Oxygen Fluorine Neon Sodium Magnesium bium Dysprosium Holmium Erbium Thulium Ytterbium Lutetium anesson Incorrect depiction of Group 3 In many periodic tables, that reason Lev Landau and Evgeny Lifshitz in 1948 considered	Bismuth Polonium Astatine Radon Francium Radium A Aluminium Silicon Phosphorus Sulfur Chlorine Argon Iafnium Tantalum Tungsten Rhenium Osmium Iridium he f-block is shifted one element to the right, so that I t incorrect to group lutetium as an f-block element.[26]	Actinium Thorium Protactinium Potassium Calcium Scandium Titanium n Platinum Gold Mercury (element) lanthanum and actinium become d- 6] They did not yet take the step of
lawrencium to group 3 was supported by IUPAC reports dating an f-subshell.[24] There is moreover some confusion in the liter focusing on superheavy elements since clarified that the "15th e [109] but they have been challenged as being logically inconsist have it.[111] Not only are such exceptional configurations in the	from 1988 (when the 1-18 group numbers were recommended)[23] and 2021.[2 ature on which elements are then implied to be in group 3.[24][33][102][103][10 entry of the f-block represents the first slot of the d-block which is left vacant to itent.[63][28][29] For example, it has been argued that lanthanum and actinium ce minority,[111] but they have also in any case never been considered as relevan	activity of its 4f shell.[101] In 1965, David C. Hamilton linked this observation to its 14] The variation nonetheless still exists because most textbook writers are not awardly While the 2021 IUPAC report noted that 15-element-wide f-blocks are supported indicate the place of the f-block inserts", which would imply that this form still has leannot be f-block elements because as individual gas-phase atoms, they have not beg the for positioning any other elements on the periodic table: in gaseous atoms, the d-sists are in the core, and cannot be used for chemical reactions, 1651[1131] Thus the relations of the core is the core and cannot be used for chemical reactions, 1651[1131] Thus the relations of the core is the	e of the issue.[25] A third form can sometimes be encountered by some practitioners of a specialized branch of relativistic q utetium and lawrencium (the 15th entries in question) as d-bl pun to fill the f-subshells.[110] But the same is true of thorium hells complete their filling at copper, palladium, and gold, bu	d in which the spaces below yttrium in group 3 are left empty uantum mechanics focusing on the properties of superheavy ook elements in group 3.[105] Indeed, when IUPAC publicatin which is never disputed as an f-block element,[24][25] and to tit is universally accepted by chemists that these configurations.	y, such as the table appearing on the IUPAC web site,[6] It elements, the project's opinion was that such interest-dej ions expand the table to 32 columns, they make this clear this argument overlooks the problem on the other end: this ons are exceptional and that the d-block really ends in ac	ut this creates an inconsistency with quantum mechanics by mal bendent concerns should not have any bearing on how the period and place lutetium and lawrencium under yttrium in group 3.[10 at the f-shells complete filling at ytterbium and nobelium, matchi cordance with the Madelung rule at zinc, cadmium, and mercury	ing the f-block 15 elements wide (La-Lu and Ac-Lr) event table is presented to "the general chemical and scients of Sc-Y-La-Ac can get the Sc-Y-Lu-Lr form, and not at lutetium and lawrer [33] The relevant fact for placement [38] [66] is that later that the second scient of the second scient for placement [38] [66] is that later that the second scient for placement [38] [66] is that later that the second scient for placement [38] [66] is that later that the second scient for placement for	ven though only 14 electrons can fit in intific community".[24] Other authors is be encountered in the literature,[108] nicium as the Sc-Y-La-Ac form would inthanum and actinium (like thorium)
the periodic table and the periodic law. These periodic recurrer Thomson in 1904, often called the plum-pudding model.[118] At kainosymmetry or primogenic repulsion:[120] the 1s, 2p, 3d, an and must expand to avoid this. This makes significant difference charge across the series and the increased number of inner elec	nces were noticed well before the underlying theory that explains them was deve tomic radii (the size of atoms) are dependent on the sizes of their outermost orbii dd 4f subshells have no inner analogues. For example, the 2p orbitals do not expe es arise between the small 2p elements, which prefer multiple bonding, and the l ctrons for shielding somewhat compensate each other, so the decrease in radius	figurations may be expected to react similarly and form compounds with similar propositioned [116][117] Historically, the physical size of atoms was unknown until the early tals. [97] They generally decrease going left to right along the main-group elements prience strong repulsion from the 1s and 2s orbitals, which have quite different angularger 3p and higher p-elements, which do not. [97] Similar anomalies arise for the 1s smaller. [119] The 4p and 5d atoms, coming immediately after new types of transitions.	y 20th century. The first calculated estimate of the atomic rad because the nuclear charge increases but the outer electrons llar charge distributions, and hence are not very large; but the s, 2p, 3d, 4f, and the hypothetical 5g elements:[121] the degr tion series are first introduced, are smaller than would have !	dius of hydrogen was published by physicist Arthur Haas in 1: s are still in the same shell. However, going down a column, to a 3p orbitals experience strong repulsion from the 2p orbital: ree of this first-row anomaly is highest for the s-block, is mode been expected,[123] because the added core 3d and 4f subsh	1910 to within an order of magnitude (a factor of 10) of the the radii generally increase, because the outermost electrols, which have similar angular charge distributions. Thus letrate for the p-block, and is less pronounced for the d-annulles provide only incomplete shielding of the nuclear charge.	e accepted value, the Bohr radius (~0.529 Å). In his model, Haas ons are in higher shells that are thus further away from the nucluigher s-, p-, d-, and f-subshells experience strong repulsion from d f-blocks.[122] In the transition elements, an inner shell is filling ge for the outer electrons. Hence for example gallium atoms are	used a single-electron configuration based on the class sus.[32][119] The first row of each block is abnormally their inner analogues, which have approximately the s but the size of the atom is still determined by the out slightly smaller than aluminium atoms.[97] Together w	sical atomic model proposed by J. J. y small, due to an effect called same angular distribution of charge, ter electrons. The increasing nuclear with kainosymmetry, this results in an
stay at +3.[122][124] A similar situation holds for the d-block, we the effect of the nucleus on the electron cloud. These relativistic very strong in the late seventh period, potentially leading to a celements normally differ in charge. Ions with the same electron V4+, V5+.[132] Graph of first ionisation energies of the element	with lutetium through tungsten atoms being slightly smaller than yttrium through c effects result in heavy elements increasingly having differing properties compa ollapse of periodicity. [129] Electron configurations are only clearly known until configuration decrease in size as their atomic number rises, due to increased at its in electronvolts (predictions used for elements 109–118) The first ionisation en	have smaller atomic radii and prefer to lose fewer electrons, while elements in odd p in molybdenum atoms respectively.[125][126] Liquid mercury. Its liquistate at stan- tred to their lighter homologues in the periodic table. Spin-orbit interaction splits the element 108 (hassium), and experimental chemistry beyond 108 has only been done traction from the more positively charged nucleus: thus for example ionic radii deen nergy of an atom is the energy required to remove an electron from it. This varies we red and thus interelectronic repulsion makes it easier to remove than expected.[133]	dard conditions is the result of relativistic effects.[127] Thallie p subshell: one p orbital is relativistically stabilized and shr for elements 112 (copernicium) through 115 (moscovium), so ease in the series Se2-, Br-, Rb+, Sr2+, Y3+, Zr4+, Nb5+, ith the atomic radius: ionisation energy increases left to right	um and lead atoms are about the same size as indium and tin runken (it fills in thallium and lead), but the other two (filling o the chemical characterization of the heaviest elements rema Mo6+, Tc7+. Ions of the same element get smaller as more e t and down to up, because electrons that are closer to the nu	n atoms respectively, but from bismuth to radon the 6p at y in bismuth through radon) are relativistically destabilized lains a topic of current research.[130][131] The trend that electrons are removed, because the attraction from the nu icleus are held more tightly and are more difficult to remo	oms are larger than the analogous 5p atoms. This happens becau I and expanded [97] Relativistic effects also explain why gold is g atomic radii decrease from left to right is also present in ionic re cleus begins to outweigh the repulsion between electrons that ca we. Ionisation energy thus is minimized at the first element of each	we when atomic nuclei become highly charged, special olden and mercury is a liquid at room temperature.[12 dii, though it is more difficult to examine because the uses electron clouds to expand: thus for example ionic h period – hydrogen and the alkali metals – and then g	relativity becomes needed to gauge 27][128] They are expected to become most common ions of consecutive radii decrease in the series V2+, V3+, generally rises until it reaches the
ionisation energies stay mostly constant, though there is a smal nucleus more strongly, and especially if there is an available pa with enough kinetic energy, but these inevitably and rapidly aut repulsion from the already present ones. For the nonmetallic el- simple binary hydride, or as twice the number of oxygen atoms which is the formal charge left on an element when all other ele	I increase especially at the end of each transition series. [134] As metal atoms ter trially filled outer orbital that can accommodate it. Therefore, electron affinity to todetach: for example, the lifetime of the most long-lived He-level is about 359 ements, electron affinity likewise somewhat correlates with reactivity, but not per that can combine with it to form a simple binary oxide (that is, not a peroxide or ements in a compound have been removed as their ions. [114] The electron config	nd to lose electrons in chemical reactions, ionisation energy is generally correlated wands to increase down to up and left to right. The exception is the last column, the microseconds.][137] The noble gases, having high ionisation energies and no electror effectly since other factors are involved. For example, fluorine has a lower electron a superoxide).[111] The valences of the main-group elements are directly related to juration suggests a ready explanation from the number of electrons available for bor	with chemical reactivity, although there are other factors invo oble gases, which have a full shell and have no room for anoth on affinity, have little inclination towards gaining or losing ele affinity than chlorine (because of extreme interelectronic repu the group number: the hydrides in the main groups 1-2 and ading;[114] indeed, the number of valence electrons starts at	olved as well.[134] Trend in electron affinities The opposite p her electron. This gives the halogens in the next-to-last colum ectrons and are generally unreactive.[32] Some exceptions to ulsion for the very small fluorine atom), but is more reactive.[13-17 follow the formulae MH, MH2, MH3, MH4, MH3, MH 1 in group 1, and then increases towards the right side of the	property to ionisation energy is the electron affinity, which mn the highest electron affinities.[32] Some atoms, like the othe trends occur: oxygen and fluorine have lower electro.[135] Lead(II) oxide (PbO2, left) and lead(IV) oxide (PbO2, 12, and finally MH. The highest oxides instead increase in the periodic table, only resetting at 3 whenever each new b	is the energy released when adding an electron to the atom.[13: noble gases, have no electron affinity: they cannot form stable of n affinities than their heavier homologues sulfur and chlorine, be right), the two stable oxides of lead The valence of an element ca- ralence, following the formulae M2O, MO, M2O3, MO2, M2O5, M cock starts. Thus in period 6, Cs-Ba have 1-2 valence electrons; I] A passing electron will be more readily attracted to as-phase anions.[136] (They can form metastable reso cause they are small atoms and hence the newly adden be defined either as the number of hydrogen atoms to 03, M207.[1] Today the notion of valence has been exa-Yb have 3-16; Lu-Hg have 3-12; and Tl-Rn have 3-8.	an atom if it feels the pull of the onances if the incoming electron arrives and electron would experience significant that can combine with it to form a stended by that of the oxidation state, 8.[113] However, towards the right
Pm7 Sm8 Eu9 Gd10 Tb11 Dy12 Ho13 Er14 Tm15 Yb16 Lu3 Hf4 because the latter would spontaneously disproportionate into M form. For similar reasons, the common oxidation states of the h common oxidation states, and the hollow dots show possible but subshells, their oxidation states tend to vary by steps of 1 instead	Ta5 W6 Re7 Os8 Ir9 Pt10 Au11 Hg12 Tl3 Pb4 Bi5 Po6 At7 Rn8 7 Fr1 Ra2 Ac3 T Ig0 and Mg2+ cations. This is because the enthalpy of hydration (surrounding th eavier p-block elements (where the ne electrons become lower in energy than the tunlikely states. For transition metals, common oxidation states are nearly alway ad.[141] The lanthanides and late actinides generally show a stable +3 oxidation	n affects oxygen, fluorine, and the light noble gases up to krypton. [139] Number of v hi4 Pa5 U6 Np7 Pu8 Am9 Cm10 Bk11 Cf12 Es13 Fm14 Md15 No16 Lr3 Rf4 Db5 Sg6 le cation with water molecules) increases in magnitude with the charge and radius of end to vary by steps of 2, because that is necessary to uncover an inner subshys at least +2 for similar reasons (uncovering the next subshell); this holds even for state, removing the outer s-electrons and then (usually) one electron from the (n-2 netal groups. The highest formal oxidation state thus increases from +3 at the begin	Bh7 Hs8 Mt9 Ds10 Rg11 Cn12 Nh3 Fl4 Mc5 Lv6 Ts7 Og8 A ff the ion. In Mg+, the outermost orbital (which determines io nell and decrease the ionic radius (e.g. Tl+ uncovers 6s, and T the metals with anomalous dx+1s1 or dx+2s0 configurations)f orbitals, that are similar in energy to ns.[144] The common	full explanation requires considering the energy that would had radius) is still 3s, so the hydration enthalpy is small and it fl3+ uncovers 5d, so once thallium loses two electrons it tend (except for silver), because repulsion between d-electrons me and maximum oxidation states of the d- and f-block elements.	be released in forming compounds with different valences insufficient to compensate the energy required to remove ds to lose the third one as well). Analogous arguments baseans that the movement of the second electron from the stated to depend on the ionisation energies. As the energy	rather than simply considering electron configurations alone. [14] the electron; but ionizing again to Mg2+ uncovers the core 2p st ed on orbital hybridization can be used for the less electronegation to the d-subshell does not appreciably change its ionisation energifference between the $(n-1)d$ and no orbitals rises along each	0] For example, magnesium forms Mg2+ rather than bashell, making the hydration enthalpy large enough to be p-block elements.[141][m] Oxidation states of the trogy.[143] Because ionizing the transition metals further ansition series, it becomes less energetically favoural.	Mg+ cations when dissolved in water, o allow magnesium(II) compounds to ransition metals. The solid dots show er does not uncover any new inner able to ionize further electrons. Thus,
plutonium can reach +7.[111][143][144] The very last actinides and form a very homogeneous class of elements: they are all sof maximum and minimum oxidation states (e.g. sulfur and selenit covalent bonds to each other by sharing electrons in pairs, crea electronegative one, though this is a simplification. The bond th	go further than the lanthanides towards low oxidation states: mendelevium is m ft and reactive metals. However, there are many factors involved, and groups can am in group 16 both have maximum oxidation state +6, as in SO3 and SeO3, and ting an overlap of valence orbitals. The degree to which each atom attracts the s ten binds two ions, one positive (having given up the electron) and one negative (nore easily reduced to the +2 state than thulium or even europium (the lanthanide w n often be rather heterogeneous. For instance, hydrogen also has one valence electr minimum oxidation state -2, as in sulfides and selenides); but not always (e.g. oxyg shared electron pair depends on the atom's electronegativity[146] - the tendency of (having accepted it), and is termed an ionic bond.[32] Electronegativity depends on l gative reactive atom (fluorine) is given electronegativity 4.0, and the least electrone	ith the most stable +2 state, on account of its half-filled f-she on and is in the same group as the alkali metals, but its chem jen is not known to form oxidation state +6, despite being in tan atom towards gaining or losing electrons.[32] The more elhow strongly the nucleus can attract an electron pair, and so	or it exhibits a similar variation to the other properties already	by tterbium.[54] As elements in the same group share the sup 14 comprise a nonmetal (carbon), two semiconductors tential map of a water molecule, where the oxygen atom here, and the less electronegative (or more electropositive) or discussed: electronegativity tends to fall going up to dow	ame valence configurations, they usually exhibit similar chemica silicon and germanium), and two metals (tin and lead); they are as a more negative charge (red) than the positive (blue) hydroge ne will attract it less. In extreme cases, the electron can be though, and rise going left to right. The alkali and alkaline earth metal	behaviour. For example, the alkali metals in the first onetheless united by having four valence electrons.[1-n atoms Another important property of elements is the ht of as having been passed completely from the more are among the most electropositive elements, while t	group all have one valence electron, 45] This often leads to similarities in eir electronegativity. Atoms can form e electropositive atom to the more the chalcogens, halogens, and noble
whose structure is even more metallic.) A simple substance is a the molecules, such as the London dispersion force: as electron structure of molecular orbitals extending over all the atoms.[15 metallic or covalent bonding, they create both bonding and anti structures where all atoms take equivalent positions, and so alm	substance formed from atoms of one chemical element. The simple substances of smove within the molecules, they create momentary imbalances of electrical chall This negatively charged "sea" pulls on all the ions and keeps them together in thonding molecular orbitals of equal capacity, with the antibonding orbitals of high nost all of them metallise. The exceptions are hydrogen and boron, which have to	a large difference: lead in the +2 oxidation state has electronegativity 1.87 on the Pt of the more electronegative atoms tend to share electrons (form covalent bonds) with large, which induce similar imbalances on nearby molecules and create synchronized a metallic bond. Elements forming such bonds are often called metals; those which gher energy. Net bonding character occurs when there are more electrons in the bon on high an ionisation energy. Hydrogen thus forms a covalent H2 molecule, and bord tween atoms. When far apart (right side of graph) all the atoms have discrete valence.	h each other. They form either small molecules (like hydroger I movements of electrons across many neighbouring molecule do not are often called nonmetals.[32] Some elements can fo nding orbitals than there are in the antibonding orbitals. Met on forms a giant covalent structure based on icosahedral B12	n or oxygen) or giant structures stretching indefinitely (like cas.[150] Graphite and diamond, two allotropes of carbon The rm multiple simple substances with different structures: thesallic bonding is thus possible when the number of electrons of clusters. In a metal, the bonding and antibonding orbitals ha	carbon or silicon). The noble gases simply stay as single at e more electropositive atoms tend to instead lose electrons see are called allotropes. For example, diamond and graph delocalized by each atom is less than twice the number of ave overlapping energies, creating a single band that elect	oms, as they already have a full shell.[32] Substances composed, creating a "sea" of electrons engulfing cations.[32] The outer or te are two allotropes of carbon.[145][n] The metallicity of an electrorbitals contributing to the overlap. This is the situation for elemrons can freely flow through, allowing for electrical conduction.[of discrete molecules or single atoms are held together pitals of one atom overlap to share electrons with all it nent can be predicted from electronic properties. Whe ents in groups 1 through 13; they also have too few va .53] Graph of carbon atoms being brought together to	or by weaker attractive forces between ts neighbours, creating a giant en atomic orbitals overlap during alence electrons to form giant covalent to form a diamond crystal,
together in energy so the orbitals can be considered a continuous atomic radius and thus the nucleus has more of a hold on the el (Boron is also a semiconductor at ambient conditions.) The band (as more electrons may be excited to cross the gap).[154] Eleme (e.g. red phosphorus, grey selenium, tellurium) or layered structure.	us energy band. At the actual diamond crystal cell size (denoted by a), two bands ectrons. Therefore, the bonding orbitals that result are much lower in energy the d gap disappears in tin, so that tin and lead become metals.[153] As the tempera ents in groups 15 through 17 have too many electrons to form giant covalent mol tures (e.g. carbon as graphite, black phosphorus, grey arsenic, antimony, bismul	when the part (right state of graph) at the atoms have discrete values as are formed, called the valence and conduction bands, separated by a 5.5 eV band g an the antibonding orbitals, and there is no overlap, so electrical conduction become ture rises, all nonmetals develop some semiconducting properties, to a greater or le lecules that stretch in all three dimensions. For the lighter elements, the bonds in sr th) that only extend in one or two rather than three dimensions. Both kinds of struct a arsenic, grey selenium, tellurium, and iodine are semiconductors; grey arsenic, ant	gap. (Here only the valence 2s and 2p electrons have been illuss impossible: carbon is a nonmetal. However, covalent bondings ser extent depending on the size of the band gap. Thus metanall diatomic molecules are so strong that a condensed phase were can be found as allotropes of phosphorus, arsenic, and s	istrated; the 1s orbitals do not significantly overlap, so the bar ng becomes weaker for larger atoms and the energy gap betvals and nonmetals may be distinguished by the temperature do is is disfavoured: thus nitrogen (N2), oxygen (O2), white phost delenium, although the long-chained allotropes are more stable.	ands formed from them are much narrower.) In group 14, tween the bonding and antibonding orbitals decreases. The dependence of their electrical conductivity: a metal's conductivity: a metal's conductivity and yellow arsenic (P4 and As4), sulfur and red seple in all three. As these structures do not use all their orb	both metallic and covalent bonding become possible. In a diamosprefore, silicon and germanium have smaller band gaps and are suctivity lowers as temperature rises (because thermal motion makenium (S8 and Se8), and the stable halogens (F2, Cl2, Br2, and Itals for bonding, they end up with bonding, nonbonding, and ant	d crystal, covalent bonds between carbon atoms are semiconductors at ambient conditions: electrons can crive the semiconductors at ambient conditions: electrons can crive with semigroup to the electrons to flow freely), we can consider the condition of the cond	strong, because they have a small ross the gap when thermally excited. whereas a nonmetal's conductivity rises he heavier ones tend to form long chains y to group 14, the band gaps shrink for
metalloids.[32] The term "semimetal" used in this sense should are held together by weaker van der Waals forces. The noble ga 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 Group → ↓ Period substances in the periodic table. If there are several, the most s dimensions. Similarly, they conduct heat, which is transferred b	not be confused with its strict physical sense having to do with band structure: hases are coloured in violet: their molecules are single atoms and no covalent bond 1 H He 2 Li Be B C N O F Ne 3 Na Mg Al Si P S Cl Ar 4 K Ca Sc Ti V Cr Mn Fe C stable allotrope is considered. Iron, a metal Sulfur, a nonmetal Arsenic, an elemery the electrons as extra kinetic energy: they move faster. These properties persi	allicity tends to be correlated with electropositivity and the willingness to lose electrismuth is physically a semimetal, but is generally considered a metal by chemists, dining occurs. Greyed-out cells are for elements which have not been prepared in sufficiency. On Cu Zn Ga Ge As Se Br Kr 5 Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te Intoften called a semi-metal or metalloid Generally, metals are shiny and dense. [32] st in the liquid state, as although the crystal structure is destroyed on melting, the administration of the control o	56] The following table considers the most stable allotropes a cicient quantities for their most stable allotropes to have been Xe 6 Cs Ba La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu They usually have high melting and boiling points due to the thoms still touch and the metallic bond persists, though it is w	at standard conditions. The elements coloured yellow form sincharacterized in this way. Theoretical considerations and cuits of the William of the Hight of the Metallic bond, and are often malleable and diveakened.[167] Metals tend to be reactive towards nonmetals.	imple substances that are well-characterised by metallic harrent experimental evidence suggest that all of those eler Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr Rf Db Sg Bh Huctile (easily stretched and shaped) because the atoms cas.[32] Some exceptions can be found to these generalization.	onding. Elements coloured light blue form giant network covaler nents would metallise if they could form condensed phases,[153] s Mt Ds Rg Cn Nh Fl Mc Lv Ts Og Metallic Network covalent Mo n move relative to each other without breaking the metallic bond ons: for example, beryllium, chromium,[85] manganese,[168] ant	structures, whereas those coloured dark blue form si except perhaps for oganesson.[157][p] vteBonding of se ecular covalent Single atoms Unknown Background or [167] They conduct electricity because their electrons mony,[169] bismuth,[170] and uranium are brittle (not	mail covalently bonded molecules that simple substances in the periodic table olor shows bonding of simple s are free to move in all three t an exhaustive list);[85] chromium is
or gases at room temperature.[32] Nonmetals are often dull-loo an insulating red allotrope; arsenic has a metallic grey allotrope literature for precisely which elements should be so designated generally, the other p-block metals in its physical and chemical between elements that are not in the same group, such as the d	king. They tend to be reactive towards metals, except for the noble gases, which e, a semiconducting black allotrope, and an insulating yellow allotrope (though the When such a category is used, silicon, germanium, arsenic, and tellurium are al behaviour. On this basis some authors have argued that it is better classified as liagonal relationships between elements that are diagonally adjacent (e.g. lithium	chemically very inert.[172][173] Nonmetals exhibit different properties. Those form a rer inert towards most substances.[32] They are brittle when solid as their atoms a he last is unstable at ambient conditions).[154] Again there are exceptions; for exam lmost always included, and boron and antimony usually are; but most sources includ a metal than as a metalloid.[85][181][154] On the other hand, selenium has some se and magnesium).[122] Some similarities can also be found between the main grouj imum oxidation states, but not the same minimum oxidation states. For example, ch	are held tightly in place. They are less dense and conduct electiple, diamond has the highest thermal conductivity of all know le other elements as well, without agreement on which extra dimiconducting properties in its most stable form (though it also ps and the transition metal groups, or between the early actir	tricity poorly,[32] because there are no mobile electrons.[17] wn materials, greater than any metal.[176] It is common to de elements should be added, and some others subtract from this so has insulating allotropes) and it has been argued that it shouldes and early transition metals, when the elements have the	75] Near the borderline, band gaps are small and thus mar esignate a class of metalloids straddling the boundary bet his list instead.[r] For example, unlike all the other elemen hould be considered a metalloid[181] - though this situation the same number of valence electrons. Thus uranium somes	y elements in that region are semiconductors, such as silicon, ge ween metals and nonmetals, as elements in that region are intern ts generally considered metalloids or nonmetals, antimony's only in also holds for phosphorus,[154] which is a much rarer inclusion what resembles chromium and tungsten in group 6,[122] as all th	manium,[175] and tellurium.[153] Selenium has both nediate in both physical and chemical properties.[32] I stable form has metallic conductivity. Moreover, the namong the metalloids.[r] There are some other relate have six valence electrons.[182] Relationships between the constant of the constant	a semiconducting grey allotrope and However, no consensus exists in the element resembles bismuth and, more ionships throughout the periodic table ween elements with the same number
they usually have similar minimum but not maximum oxidation can be observed by comparing hydrides, oxides, sulfides, halide show some commonly used sets of similar elements. The catego divide the p-block elements from groups 13 to 16 by metallicity, grounds of their sometimes quite different chemical properties, Th-Lr),[22] although variation of properties in this set is much or the properties in the the	states. For example, hydrogen and chlorine both have -1 as their minimum oxidis, and so on. [146] Chemical properties are more difficult to describe quantitative ries and their boundaries differ somewhat between sources. [177] Lutetium and J. [179] [177] although there is neither an IUPAC definition nor a precise consensubut this is not a universal practice [185] and IUPAC does not presently mention igreater than within the lanthanides. [52] IUPAC recommends the names lanthanion.	lation state (in hydrides and chlorides), but hydrogen's maximum oxidation state is + ely, but likewise exhibit their own periodicities. Examples include the variation in th lawrencium in group 3 are also transition metals.[58] Many terms have been used in so on exactly which elements should be considered metals, nonmetals, or semi-metals it as allowable in its Principles of Chemical Nomenclature.[186] The lanthanides are bids and actinoids to avoid ambiguity, as the side suffix typically denotes a negative in	-1 (e.g. H2O) while chlorine's is +7.[58] Many other physical e acidic and basic properties of the elements and their comport the literature to describe sets of elements that behave simile s (sometimes called metalloids).[179][177][22] Neither is their considered to be the elements La-Lu, which are all very similon; however lanthanides and actinides remain common.[22] V	properties of the elements exhibit periodic variation in accorbunds, the stabilities of compounds, and methods of isolating arrly. The group names alkali metal, alkaline earth metal, triel are a consensus on what the metals succeeding the transition lar to each other: historically they included only Ce-Lu, but I. With the increasing recognition of lutetium and lawrencium a	rdance with the periodic law, such as melting points, boiling the elements. [114] Periodicity is and has been used very all, tetrel, pnictogen, chalcogen, halogen, and noble gas are metals ought to be called, with post-transition metal and lanthanum became included by common usage. [22] The reas d-block elements, some authors began to define the lan	ng points, heats of fusion, heats of vaporization, atomisation ener widely to predict the properties of unknown new elements and ne acknowledged by IUPAC; the other groups can be referred to by poor metal being among the possibilities having been used. Some are earth elements (or rare earth metals) add scandium and yttricthanides as La-Yb and the actinides as Ac-No, matching the f-blo	yy, and so on. Similar periodic variations appear for the wompounds, and is central to modern chemistry. [18 their number, or by their first element (e.g., group 6 i advanced monographs exclude the elements of group m to the lanthanides. [22] The actinides are considered: k. [57] [25] [187] [188] [189] [190] The transactinides or	ne compounds of the elements, which 33] A periodic table colour-coded to is the chromium group).[22][184] Some o 12 from the transition metals on the d to be the elements Ac-Lr (historically superheavy elements are the short-
are widely used, but without any very formal definition, such as behaviour of the lighter elements of the group. Since calculation Timeline of chemical element discoveries In 1817, German phys identify more and more relationships between small groups of e positions in different groups, and he pointed out that each eight	"heavy metal", which has been given such a wide range of definitions that it has ns generally predict that oganesson should not be particularly inert due to relative sicist Johann Wolfgang Döbereiner began one of the earliest attempts to classify elements. However, they could not build one scheme that encompassed them all. [the element starting from a given one is in this arrangement a kind of repetition o	92][193][194] Many more categorizations exist and are used according to certain dis s been criticized as "effectively meaningless".[197] The scope of terms varies significe vistic effects, and may not even be a gas at room temperature if it could be produced the elements.[201] In 1829, he found that he could form some of the elements into g [205] Newlands's table of the elements in 1866. John Newlands published a letter in if the first, like the eighth note of an octave in music (The Law of Octaves).[206] How sitive elements would appear at the peaks of the curve in the order of their atomic w	can'tly between authors. For example, according to IUPAC, the d in bulk, its status as a noble gas is often questioned in this of groups of three, with the members of each group having relate the Chemical News in February 1863 on the periodicity amon wever, Newlands's formulation only worked well for the main-	e noble gases extend to include the whole group, including the context. [199] Furthermore, national variations are sometimes ed properties. He termed these groups triads. [202] [203] Chloing the chemical elements. [206] In 1864 Newlands published group elements, and encountered serious problems with the	he very radioactive superheavy element oganesson.[198] I se encountered: in Japan, alkaline earth metals often do no lorine, bromine, and iodine formed a triad; as did calcium, d an article in the Chemical News showing that if the elem e others.[58] German chemist Lothar Meyer noted the sequ	Nowever, among those who specialize in the superheavy elements include beryllium and magnesium as their behaviour is differen strontium, and barium; lithium, sodium, and potassium; and sulf ents are arranged in the order of their atomic weights, those hav lences of similar chemical and physical properties repeated at pe	, this is not often done: in this case "noble gas" is typic from the heavier group 2 metals. [200] Main article: Fur, selenium, and tellurium. [204] Various chemists con gronsecutive numbers frequently either belong to the riodic intervals. According to him, if the atomic weight	cally taken to imply the unreactive History of the periodic table See also: ntinued his work and were able to he same group or occupy similar ts were plotted as ordinates (i.e.
inaccurate measurements of the atomic weights.[207] In 1868, [209] On 17 February 1869 (1 March 1869 in the Gregorian cal incorrectly, or that there was a missing element yet to be discos knowledge of Mendeleev's prediction, discovered a new elemen element, which he named scandium: it turned out to be eka-bor noble gases at the close of the 19th century, which Mendeleev I	he revised his table, but this revision was published as a draft only after his deat endar), Mendeleev began arranging the elements and comparing them by their a vered.[58] In 1871, Mendeleev published a long article, including an updated for it in a sample of the mineral sphalerite, and named it gallium. He isolated the ele on. Eka-silicon was found in 1886 by German chemist Clemens Winkler, who name had not predicted, fitted neatly into his scheme as an eighth main group.[215] M.	ch.[208] Mendeleev's 1869 periodic tableMendeleev's 1871 periodic table The definit atomic weights. He began with a few elements, and over the course of the day his sym of his table, that made his predictions for unknown elements explicit. Mendeleev ment and began determining its properties. Mendeleev, reading de Boisbaudran's pend it germanium. The properties of gallium, scandium, and germanium matched whendeleev nevertheless had some trouble fitting the known lanthanides into his scher	tive breakthrough came from the Russian chemist Dmitri Mer stem grew until it encompassed most of the known elements. predicted the properties of three of these unknown elements sublication, sent a letter claiming that gallium was his predict hat Mendeleev had predicted.[213] In 1889, Mendeleev noted ne, as they did not exhibit the periodic change in valencies th	ndeleev. Although other chemists (including Meyer) had foun. After he found a consistent arrangement, his printed table as in detail: as they would be missing heavier homologues of bo ed eka-aluminium. Although Lecoq de Boisbaudran was initia I at the Faraday Lecture to the Royal Institution in London th hat the other elements did. After much investigation, the Czec	nd some other versions of the periodic system at about the appeared in May 1869 in the journal of the Russian Chemi oron, aluminium, and silicon, he named them eka-boron, e ally sceptical, and suspected that Mendeleev was trying that he had not expected to live long enough "to mention that he had so the support of the support of the chemist Bohuslav Brauner suggested in 1902 that the land to the support of t	same time, Mendeleev was the most dedicated to developing an cal Society. [210] When elements did not appear to fit in the syste ka-aluminium, and eka-silicon ("eka" being Sanskrit for "one"). [2 take credit for his discovery, he later admitted that Mendeleev v eir discovery to the Chemical Society of Great Britain as a confir anthanides could all be placed together in one group on the peric	defending his system, and it was his system that mos m, he boldly predicted that either valencies or atomic 0][211]:45 In 1875, the French chemist Paul-Émile Le ras correct.[212] In 1879, the Swedish chemist Lars Fi nation of the exactitude and generality of the periodic dic table. He named this the "asteroid hypothesis" as a	st affected the scientific community. weights had been measured ecoq de Boisbaudran, working without redrik Nilson discovered a new c law". [214] Even the discovery of the an astronomical analogy: just as there
Broek's published article he illustrated the first electronic perionuclear charge. [221] Nuclear charge is identical to proton coun and established that it was the element with the highest atomic 1925, when Walter Noddack, Ida Tacke, and Otto Berg indepensame chemical element. This furthermore clarified discrepancie	dic table showing the elements arranged according to the number of their electric and determines the value of the atomic number (Z) of each element. Using aton number then known (92).[222] Based on Moseley and Siegbahn's research, it was dently rediscovered it and gave it its present name, rhenium.)[223] The dawn of sex such as tellurium and iodine: tellurium's natural isotopic composition is weight	nides instead of just one element. [33] Periodic table of Antonius van den Broek After rons. [219] Rutherford confirmed in his 1914 paper that Bohr had accepted the view mic number gives a definitive, integer-based sequence for the elements. Moseley's r as also known which atomic numbers corresponded to missing elements yet to be for atomic physics also clarified the situation of isotopes. In the decay chains of the prir ted towards heavier isotopes than iodine's, but tellurium has a lower atomic number ased on a quantum atom. [227] Bohr called his electron shells "rings" in 1913; atomic	of van den Broek.[220] The same year, English physicist Hemesearch immediately resolved discrepancies between atomic und: 43, 61, 72, 75, 85, and 87.[216] (Element 75 had in fact mordial radioactive elements thorium and uranium, it soon be [224] The Danish physicist Niels Bohr applied Max Planck's	ry Moseley using X-ray spectroscopy confirmed van den Broe weight and chemical properties; these were cases such as tel already been found by Japanese chemist Masataka Ogawa in scame evident that there were many apparent new elements idea of quantization to the atom. He concluded that the energy	ek's proposal experimentally. Moseley determined the valuellurium and iodine, where atomic number increases but a 1908 and named nipponium, but he mistakenly assigned that had different atomic weights but exactly the same chargy levels of electrons were quantised: only a discrete set	te of the nuclear charge of each element from aluminium to gold comic weight decreases. [216] Although Moseley was soon killed it it as element 43 instead of 75 and so his discovery was not gener emical properties. In 1913, Frederick Soddy coined the term "iso of stable energy states were allowed. Bohr then attempted to und	and showed that Mendeleev's ordering actually places a World War I, the Swedish physicist Manne Siegbahn ally recognized until later. The contemporarily accepte cope" to describe this situation, and considered isotope erstand periodicity through electron configurations, su	s the elements in sequential order by a continued his work up to uranium, ed discovery of element 75 came in es to merely be different forms of the urmising in 1913 that the inner
be filled as follows: "rings of electrons will only join if they cont the work of Arnold Sommerfeld and Edmund Stoner discovered electrons, which are added further, should be put into concentr existence of "cells" which we now call orbitals, which could eacl elements now known as transition metals or transition elements simply purified lutetium (element 71).[237] Hafnium and rheniu	ain equal numbers of electrons; and that accordingly the numbers of electrons on more quantum numbers. [224] Bohr's electron configurations for light elements ic rings or shells, on each of which only a certain number of electrons—namely honly contain eight electrons each, and these were arranged in "equidistant lays s.[234] Bohr's theory was vindicated by the discovery of element 72: Georges UT in thus became the last stable elements to be discovered. [224] Prompted by Boh	n inner rings will only be 2, 4, 8." However, in larger atoms the innermost shell woul Element Electrons per shell 4 2,2 6 2,4 7 4,3 8 4,2,2 9 4,4,1 10 8,2 11 8,2,1 16 8,4,2 y, eight in our case—should be arranged. As soon as one ring or shell is completed, a ers" which we now call shells. He made an exception for the first shell to only contain bain claimed to have discovered it as the rare earth element celtium, but Bury and B Ir, Wolfgang Pauli took up the problem of electron configurations in 1923. Pauli exte	Id contain eight electrons: "on the other hand, the periodic sy ,2 18 8,8,2 The first one to systematically expand and correct a new one has to be started for the next element; the number n two electrons. [232] The chemist Charles Rugeley Bury sugg bohr had predicted that element 72 could not be a rare earth ended Bohr's scheme to use four quantum numbers, and form	istem of the elements strongly suggests that already in neon in the chemical potentials of Bohr's atomic theory was Walther of electrons, which are most easily accessible, and lie at the gested in 1921 that eight and eighteen electrons in a shell for element and had to be a homologue of zirconium. Dirk Coster ulated his exclusion principle which stated that no two electronium.	N = 10 an inner ring of eight electrons will occur." His pr or Kossel in 1914 and in 1916. Kossel explained that in the contermost periphery, increases again from element to ele- orm stable configurations. Bury proposed that the electron or and Georg von Hevesy searched for the element in zirco- rons could have the same four quantum numbers. This exp	oposed electron configurations for the atoms (shown to the right periodic table new elements would be created as electrons were ment and, therefore, in the formation of each new shell the chen configurations in transitional elements depended upon the valen nium ores and found element 72, which they named hafnium afte lained the lengths of the periods in the periodic table (2, 8, 18, a	mostly do not accord with those now known.[228][22 added to the outer shell. In Kossel's paper, he writes: ical periodicity is repeated.[230][231] In a 1919 paper se electrons in their outer shell.[233] He introduced the Bohr's hometown of Copenhagen (Hafnia in Latin).[2 ad 32), which corresponded to the number of electron.	19] They were improved further after This leads to the conclusion that the r, Irving Langmuir postulated the he word transition to describe the 235][236] Urbain's celtium proved to be is that each shell could occupy.[238] In
1925, Friedrich Hund arrived at configurations close to the moc increasing $n + \ell$) from the Thomas-Fermi model;[242] the comp. Thomsen in 1895, and the Swiss chemist Alfred Werner in 1905 lanthanum (the former two left an empty space below yttrium a elements breaking up the d-block between lanthanum and hafni low-temperature superconductivity,[101] This clarified the impo	dern ones.[239] As a result of these advances, periodicity became based on the n lolete rule was derived from a similar potential in 1971 by Yury N. Demkov and Va. Bohr used Thomsen's form in his 1922 Nobel Lecture; Werner's form is very sir s lutetium had not yet been discovered).[33][233] Hund assumed in 1927 that all ium.[25] But it was later discovered that this is only true for four of the fifteen la ortance of looking at low-lying excited states of atoms that can play a role in cher	umber of chemically active or valence electrons rather than by the valences of the e alentin N. Ostrovsky. [243][s] Periodic table of Alfred Werner (1905), the first appear milar to the modern 32-column form. In particular, this supplanted Brauner's asteroi I the lanthanide atoms had configuration [Xe]4f0-145d16s2, on account of their pre inthanides (lanthanum, cerium, gadolinium, and lutetium), and that the other lanthar mical environments when classifying elements by block and positioning them on the	lements.[58] The Aufbau principle that describes the electron rance of the long form[33] The quantum theory clarified the triddal hypothesis.[33] The exact position of the lanthanides, and vailing trivalency. It is now known that the relationship between the storm of the control of the cont	n configurations of the elements was first empirically observe ransition metals and lanthanides as forming their own separa if thus the composition of group 3, remained under dispute for een chemistry and electron configuration is more complicate completes the 4f shell and thus Soviet physicists Lev Landau this correction based on physical, chemical, and electronic co	ed by Erwin Madelung in 1926,[45] though the first to pub ate groups, transitional between the main groups, althoup or decades longer because their electron configurations we ad than that,[t][54] Early spectroscopic evidence seemed t a and Evgeny Lifshitz noted in 1948 that lutetium is correconcerns and applied it to all the relevant elements, thus m	lish it was Vladimir Karapetoff in 1930.[240][241] In 1961, Vsew home chemists had already proposed tables showing them this are initially measured incorrectly.[25][93] On chemical grounds I o confirm these configurations, and thus the periodic table was sitly regarded as a d-block rather than an f-block element;[26] that aking group 3 contain scandium, yttrium, lutetium, and lawrenci	lod Kiechkovsky derived the first part of the Madelung way before then: the English chemist Henry Bassett di assett, Werner, and Bury grouped scandium and yttric ructured to have group 3 as scandium, yttrium, lantha bulk lanthanum is an f-metal was first suggested by Ju m[64][23][93] and having lanthanum through ytterbiu	g rule (that orbitals fill in order of id so in 1892, the Danish chemist Julius um with lutetium rather than anum, and actinium, with fourteen fun Kondō in 1963, on the grounds of its um and actinium through nobelium as
and lawrencium and challenge the counterarguments as being i (astatine) were likewise produced artificially in 1945 and 1940 i 1941, and discovered that contrary to previous thinking, the ele cases of 99 (einsteinium) and 100 (fermium).[76] A significant of first adopted a hands-off approach, preferring to wait and see if	inconsistent. [63] Glenn T. Seaborg By 1936, the pool of missing elements from hyrespectively; element 87 (francium) became the last element to be discovered in ments from actinium onwards were congeners of the lanthanides rather than tracontroversy arose with elements 102 through 106 in the 1960s and 1970s, as confia consensus would be forthcoming. But as it was also the height of the Cold War	chemical placement. [33] In 1988, IUPAC released a report supporting this composition tydrogen to uranium had shrunk to four: elements 43, 61, 85, and 87 remained mission nature, by French chemist Marguerite Perey in 1939, [245] [u] The elements beyond ansition metals. [246] Bassett (1892), Werner (1905), and the French engineer Charle apetition arose between the LBNL team (now led by Albert Ghiorso) and a team of Sr, it became clear that this would not happen. As such, IUPAC and the International institutes in Germany (GSI) and Japan (Riken). [251] Currently, consideration of disco	ng. Element 43 eventually became the first element to be syn- uranium were likewise discovered artificially, starting with E es Janet (1928) had previously suggested this, but their ideas oviet scientists at the Joint Institute for Nuclear Research (JI Union of Pure and Applied Physics (IUPAP) created a Transfe	thesized artificially via nuclear reactions rather than discovered with McMillan and Philip Abelson's 1940 discovery of nepture did not then receive general acceptance. [33] Seaborg thus con NR) led by Georgy Flyorov. Each team claimed discovery, and the properties of the modernium Working Group (TWG, fermium being element 100) in the service of the modernium working Group (TWG, fermium being element 100) in the service of	ered in nature. It was discovered in 1937 by Italian chemis unium (via bombardment of uranium with neutrons).[76] 6 called them the actinides.[246] Elements up to 101 (name d in some cases each proposed their own name for the ele in 1985 to set out criteria for discovery,[248] which were p	ts Emilio Segrè and Carlo Perrier, who named their discovery ted lenn T. Seaborg and his team at the Lawrence Berkeley National Il mendelevium in honour of Mendeleev) were synthesized up to 1 ment, creating an element naming controversy that lasted decad sublished in 1991. [249] After some further controversy, these ele	hnetium, after the Greek word for "artificial".[244] Ele Laboratory (LBNL) continued discovering transuraniu 955, either through neutron or alpha-particle irradiati ss. These elements were made by bombardment of act nents received their final names in 1997, including se	ements 61 (promethium) and 85 Im elements, starting with plutonium in ion, or in nuclear explosions in the tinides with light ions.[247] IUPAC at eaborgium (106) in honour of Seaborg.
discoveries of elements beyond 106 were made possible by tech named flerovium in honour of his predecessor and mentor Flyor many processes relating to the periodic table: the recognition a f- is f5/2, f+ is f7/2, g- is g7/2, and g+ is g9/2.[257] The spacir in 1978, which directly relate to the atomic numbers (e.g. "unhe period 8 elements.[259][260][261][262][263][264] If the eighth	uniques devised by Yuri Óganessian at the JINR: cold fusion (hombardment of lea rov. [254] In celebration of the periodic table's 150th anniversary, the United Nat nd naming of new elements, recommending group numbers and collective names up of energy levels up to $Z=120$ is normal, and becomes normal again at $Z=15$ sexquadium" for element 164, derived from Latin unus "one", Greek hexa "six", La period followed the pattern set by the earlier periods, then it would contain fifty	and and bismuth by heavy ions) made possible the 1981-2004 discoveries of elements ions declared the year 2019 as the International Year of the Periodic Table, celebrat s, and the updating of atomic weights, [6] Main article: Extended periodic table See a top between them, a very different situation is observed. [258] The most recently nam thin quadra "four", and the traditional -ium suffix for metallic elements). [6] All attem relements, filling the 8s, 5g, 6f, 7d, and finally 8p subshells in that order. But by this	107 through 112 at GSI and 113 at Riken, and he led the JIN ting "one of the most significant achievements in science".[25 also: Island of stability Energy eigenvalues (in eV) for the out ned elements – nihonium (113), moscovium (115), tennessine in pts to synthesize such elements have failed so far. An attempt point, relativistic effects should result in significant deviation.	R team (in collaboration with American scientists) to discover 55] The discovery criteria set down by the TWG were updated the ermost electrons of elements with Z = 100 through 172, pred (117), and oganesson (118) - completed the seventh row of the tomake element 119 has been ongoing since 2018 at the Rins from the Madelung rule. Various different models have be	er elements 114 through 118 using hot fusion (bombardme d in 2020 in response to experimental and theoretical prog dicted using Dirac-Fock calculations. The — and + signs r the periodic table.[6] Future elements would have to begin tiken research institute in Japan. The LBNL in the United seen suggested for the configurations of eighth-period elem	out of actinides by calcium ions) in 1998–2010. [253] [254] The heaving ress that had not been foreseen in 1991. [256] Today, the periodic effer to orbitals with decreased or increased azimuthal quantum ran eighth row. These elements may be referred to either by their states, the JINR in Russia, and the Heavy Ion Research Facility in tents, as well as how to show the results in a periodic table. All as	viest known element, oganesson (118), is named in Og table is among the most recognisable icons of chemis umber from spin-orbit splitting respectively: p— is p1/ atomic numbers (e.g. "element 164"), or by the IUPA Lanzhou (HIRFL) in China also plan to make their ow ree that the eighth period should begin like the previc	ganessian's honour. Element 114 is stry.[82] IUPAC is involved today with /2, p+ is p3/2, d- is d3/2, d+ is d5/2, AC systematic element names adopted in attempts at synthesizing the first few ous ones with two 8s elements, 119 and
take into account the failure of the Madelung rule in this region	en the 5g, 6f, 7d, and 8p subshells means that they all begin to fill together, and i t, or if such exceptions should be ignored.[265] The shell structure may also be fe it it makes the biggest difference to the order for the neballs. It is likely that by	it is not clear how to separate out specific 5g and 6f series.[59][265][266][267][268] airly formal at this point: already the electron distribution in an oganesson atom is e	xpected to be rather uniform, with no discernible shell struct	ture.[269] The situation from elements 157 to 172 should retu	urn to normalcy and be more reminiscent of the earlier ro	ws.[258] The heavy p-shells are split by the spin-orbit interaction	ones, [129] Eric Scern has raised the question of whether one p orbital (p1/2) is more stabilized, and the other	two (p3/2) are destabilized. (Such

take into account the failure of the Madelung rule in this region, or if such exceptions should be ignored. [265] The shell structure may also be fairly formal at this point; already the electron distribution in an oganesson atom is expected to be rather uniform, with no discernible shell structure may also be fairly formal at this point in the account the failure of the splin-orbit interaction; one p orbital (p1/2) is more stabilized, and the other two (p3/2) are destabilized. (Such shifts in the quantum numbers happen for all types of shells, but it makes the biggest difference to the order for the p-shells.) It is likely that by element 157, the filled 8s and 8p1/2 orbitals in essence replace the 8s and 8p1/2 orbitals in essence replace the 8s and 8p1/2 orbitals in essence replace the 9s and 8p1/2 orbitals in essence replace the 8s and 8p1/2 orbitals in essence replace the 8s and 8p1/2 orbitals are 7d and 9s at similar energies, followed by 9p1/2 and 8p3/2 at similar energies, followed by 9p1/2 and 8p3/2 at similar energies, followed by 9p1/2 orbitals in essence replace the 8s and 8p1/2 orbitals in essence replace the 9p1/2 orbitals in essence replace the 9p1/2 orbitals in essence replace the 8s and 8p1/2 orbitals in essence replace the 8s and 8p1/2 orbitals in essence replace the 9p1/2 orbitals in essenc Nuclear stability will likely prove a decisive factor constraining the number of possible elements. It depends on the balance between the electric repulsion between the electric repulsion between the electric repulsion between the electrons, and so a closed shell can significantly increase stability; where superheave number of possible elements. It depends on the balance between the electrons, and so a closed shell can significantly increase stability, where superheave number of possible elements. It depends on the balance between the electrons, and so a closed shell can significantly increase stability.

proton shell closure beyond 126 does exist, then it probably occurs around 164;[276] thus the region of instability instead of an island. [280] 281] Other effects may come into play: for example, in very heavy elements the 1s electrons are likely to spend a significant amount of time so close to the nucleus is composed of freely flowing up and down quarks instead of binding them into protons and neutrons; this would create a continent of stability instead of an island. [280] Alternatively, quark matter may become stable at high mass numbers, in which the nucleus is composed of freely flowing up and down quarks instead of binding them is to proton a distribution of the section of instability instead of binding them is to proton and neutrons; this would create a continent of stability instead of binding them is to proton and neutrons; this would create a continent of stability instead of binding them is to proton a distribution of the section of the periodic table in the proton of the nucleus is composed of freely flowing up and down quarks instead of binding them is to proton of the periodic table and is a significant amount of time so close to the nucleus is composed of freely flowing up and down quarks instead of binding them is to proton of the periodic table and is a finite proton of the periodic table and is a finite proton of the nucleus is composed of freely flowing up and down quarks instead of binding them is to proton of the periodic table and is a finite proton of the periodic table and is a finite proton of the periodic table and is a finite proton of the periodic table and is a finite proton of the periodic table and is a finite proton of the periodic table and is a finite proton of the periodic table and the periodic table and the proton of the periodic table and the perio

questions of whether there is an optimal or definitive form of the periodic table, and if so, what it might be. There are no current consensus answers to either questions. [290] [289] Janet's left-step table is being increasingly discussed as a candidate for being the optimal or most fundamental form; Scerri has written in support of it, as it clarifies helium's nature as an s-block element, increases regularity by having all period lengths repeated, faithfully follows Madelung's rule by making each periodic table, and if so, what it might be. There are no current consensus answers to either questions. [290] [289] Janet's left-step table is being increasingly discussed as a candidate for being the optimal or most fundamental form; Scerri has written in support of it, as it clarifies helium's nature as an s-block element, increases regularity by having all period lengths repeated, faithfully follows Madelung's rule by making each periodic table, and if so, what it might be. There are no current consensus answers to either questions. [290] table in periodic table, and if so, what it might be. There are no current consensus answers to either questions. [290] table in periodic table, and if so, what it might be. There are no current consensus answers to either questions. [290] table in periodic table, and if so, what it might be. There are no current consensus answers to either questions. [290] table in periodic table, and if so, what it might be. There are no current consensus answers to either questions. [290] table in periodic table in periodic table in periodic table, and it is placed to the first-row anomaly trend. While he notes that it is placed to the first-row anomaly trend. While he notes that it is placed to the first-row anomaly trend. While he notes that it is placed to the first-row anomaly trend. While he notes that it is placed to the first-row anomaly trend. While he notes that it is placed to the first-row anomaly trend. While he notes that it is placed to the first-row anomaly trend. While he not ells are ideally filled according to the Madelung rule, as shown in the accompanying sequence in the left margin (read from top to bottom, left to right). The experimentally determined ground-state electron configurations of the elements shown, elements of the Madelung rule, as shown in the accompanying sequence in the left margin (read from top to bottom, left to right). The experimentally determined ground-state electron configurations of the elements differ from the configurations are always at least close to the ground-state electron configurations are always at least close to the ground-state electron configurations of the elements are always at least close to the ground-state. The last two elements are always at least close to the ground-state electron configurations of the elements are always at least close to the ground-state electron configurations are always at least close to the ground-state electron configurations are always at least close to the ground-state electron configurations are always at least close to the ground-state electron configurations are always at least close to the ground-state electron configurations are always at least close to the ground-state electron configurations are always at least close to the ground-state electron configurations are always at least close to the ground-state electron configurations are always at least close to the ground-state electron configurations are always at least close to the ground-state electron configurations are always at least close to the ground-state electron configurations are always at least close to the ground-state electron configurations are always at least close to the ground-state electron configurations are always at least close to the ground-state electron configuration are always at least close to the ground-state electron configuration are always at least close to the ground-state electron configuration are always at least close to the ground-state electron configuration are always at least close to the ground-state electron confi there are is quite complicated and is not fully resolved. The heaviest elements 92, uranium and plutonium in a fermion capture then occurs, but the great elements 93 and 94, neptunium and plutonium might produce even higher-numbered elements in a fermion capture then occurs, but the great elements 93 and 94, neptunium are formed via beta decay; [10] In the early Solar System, shorter-lived elements in a fermion capture then occurs, but the quantities would be too small to be observed. [10] In the early Solar System, shorter-lived element beyond the first 94, and is produced even higher-numbered elements beyond the first 94, and is produced in the resulting plutonium might produce even higher-numbered elements beyond the first 94, and is produced element beyond the first 94, and is produced in the resulting plutonium might produce even higher-numbered elements beyond the first 94, and is produced element beyond the first 94, and is produced element beyond the first 94, and is produced elements. Curium (element 96) is the longest-lived element beyond the first 94, and is produced elements in a fact more displayed to the resulting plutonium might produce even higher-numbered elements in a fact more displayed to the resulting plutonium are formed via beta decay; [10] In the first 94, and is produced elements in a fact more displayed to the resulting plutonium are formed via beta decay; [10] In the first 94, and is produced elements in a fact more displayed to the resulting plutonium are formed via beta decay; [10] In the first 94, and is produced elements in a fact more displayed to the first 94, and is produced elements in a fact more displayed to the first 94, and fractionally, the first 94, and fra

would decay within a month.[13] If instead they were sufficiently long-lived, they might similarly be brought to Earth via cosmic rays, but again none have been found.[10] ^ Some isotopes of elements 62 (samarium), 63 (europium), and all elements from 67 (holmium) onward are expected to be radioactive with extremely long half-lives: for instance, all the stable isotopes of elements 62 (samarium), 63 (europium), and all elements from 67 (holmium) onward are expected to undergo alpha decay of 204Bp to the ground state of 204Hg is specified to have a half-life ground state of 1012 years), and the decays have never been observed.[16][17] ^ The half-life of plutonium, [18] but a more recent is just long enough that it should alway for understance and in the Solar System, present expected to have a half-life ground state of 1012 years), and the decays have never been observed.[16][17] ^ The half-life of plutonium in the stable isotopes of elements 62 (samarium), 63 (europium), and all elements from 67 (holmium) onward are expected to be radioactive with extremely long definition.

If it is a stable isotopes of elements 62 (samarium), 63 (europium), and all elements from 67 (holmium) onward are expected to undergo alpha decay of 204Bp to 1012 years), and the decay of 204Bp to 1012 years, and the deca

ions, orbitals simply fill in the order of increasing n instead. There is a gradual transition between the limiting situations of highly charged ions (increasing n) and neutral atoms (Madelung's rule). [45] Thus for example, the energy order for the 55th electron outside the xenon core proceeds as follows in the isoelectronic series of homium (67 electrons); [53] Cs0: 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d < 4f La2+: 5d < 4f La2+: 5d < 4f < 6s < 6p < 7s < 4f La2+: 5d configurations may become so important that the result can no longer be well-described by a single configuration [59] ^ Compounds that would use the 6d orbitals of nihonium as valence orbitals have been theoretically investigated, but they are all expected to be too unstable to observe [72] ^ Properties of the p-block elements nevertheless do affect the succeeding s-block elements nevertheless potassium atoms to be larger than sodium atoms, the size difference is greater than usual.[97] There are many lower oxides as well: for example, so in [Cl3Ga-GaCl3]2- (gallium in the +2 oxidation states are actually mixed-valence compounds, such as \$5204\$, which contains both Sb(III) and Sb(V).[142] The boundary between dispersion forces and metallic bonding is gradual, like that between ionic and covalent bonding or special potassium atoms to be larger than sodium atoms, the size difference is greater than sodium atoms than the size difference is greater than sodium atoms, the size difference is greater than sodium atoms than the size di

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"Abundance of live 244Pu in deep-1018. As of e f g h Commendations 2005 (PDF). RSC Publishing 2431. Archived (PDF) from the original on 23 November 2018. Retrieved 26 November 2018. Retrieved 26 November 2018. Retrieved 26 November 2018. Pure Appl. Chem. 69 1 g h i Fluck, E. (1989). "New Notations in the Periodic Table" (PDF). Science 244Pu in deep-1018. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. Science 244Pu in deep-1018. As of e f g h i Fluck, E. (1989). "New Notations in the Periodic Table" (PDF). Chem. 60 (3): 431-436. doi: 10.1038/ncomms6956. ISSN 041-1733. PMC 43003418. PMID 25601. Science 25603. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. Science 25603. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. Science 25603. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. Science 25603. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. Science 25603. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. Science 25603. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. As of e f g h Commendations 2005 (PDF). RSC Publishing 25601. As of e f g h Commendations 2005 (PDF).

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Carbon as graphite shows metallic conduction parallel to its planes, but is a semiconductor perpendicular to them. Some computations predict conduction parallel to its extreme instability, this has never been experimentally confirmed. Copernicium and flerovium are expected to be liquids,[160][161] but the most recent experiments on them suggest that they are metallic.[162][163][164] Astatine is calculated to metallics at standard conditions, [165] so presumably true of francium, but due to its extreme instability, this has never been experimentally confirmed. Copernicium and flerovium are expected to be liquids,[160][161] similar to mercury, and experimental evidence suggests that they are metalls.[162][163][164] Astatine is calculated to metallics at standard conditions, [165] so presumably true of francium, but due to its extreme instability, this has never been experimentally confirmed. Copernicium and flerovium are expected to be liquids,[160][161] similar to mercury, and experimental evidence suggests that they are metalls.[162][163][164] Astatine is calculated to metallics. In the most recent experimental experimental experiments on them suggest that they are metallic.[162][163][164] Astatine is calculated to metallics at standard conditions, [165] so presumably true of francium, but due to its extreme instability, this has never been experimentally confirmed. Copernicium and flerovium are expected to be liquids,[160][161] similar to mercury, and experimental experimen {4}}R^{2}N(N+1)}, where N = n + 1 {\displaystyle N=n+1}, the zero-energy and that value of N {\displaystyle N} arises at zero energy and that the sorbitals (with 1 = 0 {\displaystyle N=n+1}, the zero-energy and that the sorbitals (with 1 = 0 {\displaystyle N=n+1}).

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