História da Ciência e o Ensino de Astronomia

DE ÁTOMOS E ESTRELAS

Amâncio Friaça (IAG/USP)

Rasgar a tabela periódica é, para um químico, o mesmo que rasgar a bandeira

Roberto Nardi (IAG-USP,4/11/2013)

Tipos de tecnologia*

- Tecnologias de ação
- Tecnologias sensoriais
- Tecnologias da natureza
- Tecnologias intelectuais

*ver Jack Goody e Daniel Bell

Tecnologias de ação

estendem nossa força física, destreza ou resiliência

- arado
- agulha de costura
- máquina à vapor
- motor elétrico
- submarino
- avião a jato

Tecnologias sensoriais

estendem a faixa ou a sensibilidade de nossos sentidos

- telescópio
- microscópio
- termômetro
- barômetro
- amplificador
- contador Geiger

Tecnologias da natureza

remodelam e modificam a natureza

- reservatórios e canais
- agricultura e domesticação de animais
- tatuagens
- cirurgias
- pílula anticoncepcional
- organismos geneticamente modificados

Tecnologias intelectuais

estendem ou dão suporte às nossas habilidades mentais

- o mapa e o relógio
- a escrita
- o ábaco e a régua de cálculo
- o sextante e o globo
- a imprensa
- o livro e o jornal
- a escola e a biblioteca
- a máquina de escrever
- o computador e a internet

Ação das tecnologias no ser humano*

- Os efeitos da tecnologia não ocorrem no nível das opiniões ou conceitos. Antes, eles alteram os padrões de percepção continuamente e sem qualquer resistência.”
- Nossas ferramentas acabam “amortecendo” aquela nossa capacidade que elas “amplificam.”

*ver Marshall McLuhan, *Understanding Media: The Extensions of Man*

Tecnologias nos documentos do Ministério da Educação, BRASIL

(Menções de “tecnologia”/“tecnologias”)

- Parâmetros Curriculares Nacionais do Ensino Médio. 2000. Linguagens, Códigos e suas Tecnologias (163)
- _____. Ciências da Natureza, Matemática e suas Tecnologias (64)
- _____. Ciências Humanas e suas Tecnologias (51)
- Orientações Curriculares para o Ensino Médio. 2006. Linguagens, Códigos e suas Tecnologias (52)
- _____. Ciências da Natureza, Matemática e suas Tecnologias (83)
- _____. Ciências Humanas e suas Tecnologias (31)
- Base Nacional Comum Curricular. Apresentação. 2013. (132)
- Base Nacional Comum Curricular. 2018. (51)

PERIODIC TABLE OF THE ELEMENTS

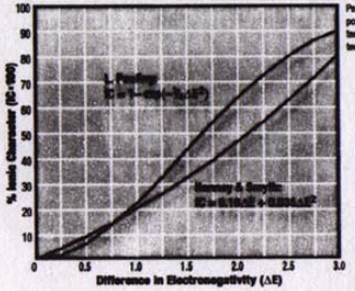
▼ Elementary Subatomic Particles

	Electron	Proton	Neutron	Photon	Neutrino
Symbol	e	P	n	γ	ν
Rest mass (kg)	9.1093897(54) x 10^{-31}	1.6726231(10) x 10^{-27}	1.6749286(10) x 10^{-27}	0	≈ 0
Molar mass (kg/mol)	5.48579903(13) x 10^{-7}	1.007276470(12) x 10^{-3}	1.008664904(14) x 10^{-3}	0	≈ 0
Particle-electron mass ratio	1	1836.152701(37)	1838.683662(40)	0	≈ 0
Particle-proton mass ratio	5.446170713(11) x 10^{-4}	1	1.001378404(9)	0	≈ 0
Particle-neutron mass ratio	5.438673x10^{-4}	0.998624	1	0	≈ 0
Specific charge (C/kg)	−1.75881962(53) x 10^{+11}	9.5788309(29) x 10^{+7}	0	0	0
Radius (m)	<1 x 10^{-18}	8 x 10^{-16}	8 x 10^{-16}	0	≈ 0
Spin quantum number	1/2	1/2	1/2	1	1/2
Compton wavelength (m)	2.42631058(22) x 10^{-12}	1.32141002(12) x 10^{-15}	1.3195911O(12) x 10^{-15}	–	–
Magnetic moment (J/T); μ	928.47701(31) x 10^{-26}	1.41060761(47) x 10^{-26}	0.96823707(40) x 10^{-26}	0	0
In Bohr magnetons; μ/μ_B	1.00115965219(10)	1.52103220(15) x 10^{-3}	1.04187563(25) x 10^{-3}	0	0
In nuclear magnetons; μ/μ_N	1838.282000(37)	2.792847386(63)	1.91304275(45)	0	0

Elementary particles are the fundamental constituents of energy and matter. The positron (e^+) is a positive-energy particle which has the same mass as an ordinary electron. The antineutrino ($\bar{\nu}$) has similar properties as that of a neutrino (ν) except its spin is directed along its direction of motion, whereas the neutrino's spin is always opposite to the direction of motion. Negative beta decay is the transformation of a neutron into a proton, a beta particle (negative electron) and a antineutrino ($n \rightarrow p + e^- + \bar{\nu}$). Positive beta decay involves the transformation of a proton into a neutron, a positron and a neutrino ($p \rightarrow n + \beta^+ + \nu$). The magnetic moment ($\mu$) of a particle can also be expressed as a dimensionless quantity by dividing it with either the Bohr magneton (μ_B = 9.2740154(31) x 10^{-24} J/T) or the nuclear magneton (μ_N = 5.0507866(17) x 10^{-27} J/T).

▼ % Ionic Character of a Single Chemical Bond

Difference in Electronegativity	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2
%IC (by L. Pauling)	0.2	1.0	2.2	3.9	6.1	8.6	12	15	18	22	26	30	34	39	43	47	51	56	59	63	67	70	73	76	79	82	84	86	88	89	91	92
%IC (by Hanney & Smyth)	1.0	3.3	5.1	7.0	8.9	11	13	15	17	20	22	24	27	29	32	35	37	40	43	46	49	52	55	59	62	65	69	72	76	80	83	87

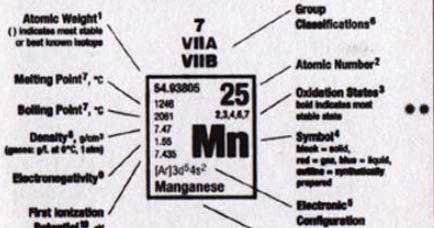


Percent ionic character describes the nature of a bond. Bonds possessing 50% or greater ionic character are commonly termed ionic; bonds with less than 50% ionic character are termed covalent. Pauling's equation was modified by Hanney & Smyth in order to achieve better agreement between experimental and calculated values. Transition from ionic to covalent binding is usually accompanied by a reduction in electrical conductance, melting point and boiling point.

1 IA IA													13 IIIB IIIA	14 IVB IVA	15 VB VA	16 VIB VIA	17 VIIB VIIA	18 VIII 0
1.00794 –259.34 –252.87 0.0899 2.20 13.598 $1s^1$ **1 H** Hydrogen	2 IIA IIA																	4.002602 –272.2[26 atm] –268.93 0.1785 – 24.587 $1s^2$ **2 He** Helium
6.941 180.5 1342 0.534 0.98 5.392 [He]$2s^1$ **3 Li** Lithium	9.012182 1287 2471 1.8477 1.57 9.322 [He]$2s^2$ **4 Be** Beryllium												10.811 2075 4000 2.31 2.04 8.298 [He]$2s^2p^1$ **5 B** Boron	12.011 4492° 3825° 2.25 2.55 11.260 [He]$2s^2p^2$ **6 C** Carbon	14.00674 –210.00 –195.79 2.,±3,4,5 1.25046 3.04 14.534 [He]$2s^2p^3$ **7 N** Nitrogen	15.9994 –218.79 –182.95 1.429 3.44 13.618 [He]$2s^2p^4$ **8 O** Oxygen	18.9984032 –219.62 –188.12 –1 1.69 3.98 17.422 [He]$2s^2p^5$ **9 F** Fluorine	20.1797 –248.59 –246.08 0.9002 – 21.564 [He]$2s^2p^6$ **10 Ne** Neon
22.989768 97.72 883 0.97 0.93 5.139 [Ne]$3s^1$ **11 Na** Sodium	24.3050 650 1090 1.74 1.31 7.646 [Ne]$3s^2$ **12 Mg** Magnesium												26.981539 660.32 2519 2.702 1.61 5.986 [Ne]$3s^2p^1$ **13 Al** Aluminum	28.0855 1414 3265 2.33 1.90 8.151 [Ne]$3s^2p^2$ **14 Si** Silicon	30.973762 44.15 277 ±3,4,5 1.82 2.19 10.486 [Ne]$3s^2p^3$ **15 P** Phosphorus	32.066 115.21 444.60 ±2,4,6 2.07 2.58 10.360 [Ne]$3s^2p^4$ **16 S** Sulfur	35.4527 –101.5 –34.04 ±1,3,5,7 3.214 3.16 12.967 [Ne]$3s^2p^5$ **17 Cl** Chlorine	39.948 –189.35 –185.86 1.784 – 15.759 [Ne]$3s^2p^6$ **18 Ar** Argon
39.0983 63.38 759 0.86 0.82 4.341 [Ar]$4s^1$ **19 K** Potassium	40.078 842 1484 1.54 1.00 6.113 [Ar]$4s^2$ **20 Ca** Calcium	44.955910 1541 2830 2.989 1.36 6.54 [Ar]$3d^14s^2$ **21 Sc** Scandium	47.88 1668 3287 4.5 1.54 6.82 [Ar]$3d^24s^2$ **22 Ti** Titanium	50.9415 1910 3407 5.96 1.63 5.74 [Ar]$3d^34s^2$ **23 V** Vanadium	51.9961 1907 2671 7.20 1.66 6.766 [Ar]$3d^54s^1$ **24 Cr** Chromium	54.93805 1246 2061 7.47 1.55 7.435 [Ar]$3d^54s^2$ **25 Mn** Manganese	55.847 1538 2861 7.86 1.83 7.870 [Ar]$3d^64s^2$ **26 Fe** Iron	58.93320 1495 2927 8.92 1.88 7.86 [Ar]$3d^74s^2$ **27 Co** Cobalt	58.6934 1455 2913 8.90 1.91 7.635 [Ar]$3d^84s^2$ **28 Ni** Nickel	63.546 1084.62 2562 8.94 1.90 7.726 [Ar]$3d^{10}4s^1$ **29 Cu** Copper	65.39 419.53 907 7.14[25°C] 1.65 9.394 [Ar]$3d^{10}4s^2$ **30 Zn** Zinc	69.723 29.76 2204 6.095 1.81 5.999 [Ar]$3d^{10}4s^24p^1$ **31 Ga** Gallium	72.61 938.25 2833 5.35 2.01 7.899 [Ar]$3d^{10}4s^24p^2$ **32 Ge** Germanium	74.92159 817* 614* 5.727[25°C] 2.18 9.81 [Ar]$3d^{10}4s^24p^3$ **33 As** Arsenic	78.96 221 685 4.81 2.55 9.752 [Ar]$3d^{10}4s^24p^4$ **34 Se** Selenium	79.904 –7.2 58.8 3.119 2.96 11.814 [Ar]$3d^{10}4s^24p^5$ **35 Br** Bromine	83.80 –157.36 –153.22 3.74 – 13.999 [Ar]$3d^{10}4s^24p^6$ **36 Kr** Krypton
85.4678 39.31 688 1.532 0.82 4.177 [Kr]$5s^1$ **37 Rb** Rubidium	87.62 777 1382 2.6 0.95 5.695 [Kr]$5s^2$ **38 Sr** Strontium	88.90585 1526 3336 4.469 1.22 6.38 [Kr]$4d^15s^2$ **39 Y** Yttrium	91.224 1855 4409 6.49 1.33 6.84 [Kr]$4d^25s^2$ **40 Zr** Zirconium	92.90638 2477 4744 8.57 1.6 6.9 [Kr]$4d^45s^1$ **41 Nb** Niobium	95.94 2623 4639 10.2 2.16 7.099 [Kr]$4d^55s^1$ **42 Mo** Molybdenum	(97.9072) 2157 4265 11.5 1.9 7.28 **43 Tc** Technetium [Kr]$4d^55s^2$	101.07 2334 4150 12.3 2.2 7.37 [Kr]$4d^75s^1$ **44 Ru** Ruthenium	102.90550 1964 3695 12.4 2.28 7.46 [Kr]$4d^85s^1$ **45 Rh** Rhodium	106.42 1554.9 2963 12.02 2.20 8.34 [Kr]$4d^{10}$ **46 Pd** Palladium	107.8682 961.78 2162 10.5 1.93 7.576 [Kr]$4d^{10}5s^1$ **47 Ag** Silver	112.411 321.07 767 8.642 1.69 8.993 [Kr]$4d^{10}5s^2$ **48 Cd** Cadmium	114.818 156.60 2072 7.30 1.78 5.786 [Kr]$4d^{10}5s^25p^1$ **49 In** Indium	118.710 231.93 2602 7.28 1.96 7.344 [Kr]$4d^{10}5s^25p^2$ **50 Sn** Tin	121.757 630.63 1587 ±3,5 6.684[25°C] 2.05 8.641 [Kr]$4d^{10}5s^25p^3$ **51 Sb** Antimony	127.60 449.51 988 6.25 2.1 9.009 [Kr]$4d^{10}5s^25p^4$ **52 Te** Tellurium	126.90447 113.7 184.4 4.93 2.66 10.451 [Kr]$4d^{10}5s^25p^5$ **53 I** Iodine	131.29 –111.75 –108.04 5.89 – 12.130 [Kr]$4d^{10}5s^25p^6$ **54 Xe** Xenon
132.90543 28.44 671 1.879 0.79 3.894 [Xe]$6s^1$ **55 Cs** Cesium	137.327 727 1897 3.594 0.89 5.212 [Xe]$6s^2$ **56 Ba** Barium	138.9055 920 3455 • 3 6.146 1.10 5.577 [Xe]$5d^16s^2$ **57 La** Lanthanum	178.49 2233 4603 13.31 1.3 7.0 [Xe]$4f^{14}5d^26s^2$ **72 Hf** Hafnium	180.9479 3017 5458 16.6 1.5 7.89 [Xe]$4f^{14}5d^36s^2$ **73 Ta** Tantalum	183.84 3422 5555 19.35 2.36 7.98 [Xe]$4f^{14}5d^46s^2$ **74 W** Tungsten	186.207 3186 5596 20.5 1.9 7.88 [Xe]$4f^{14}5d^56s^2$ **75 Re** Rhenium	190.23 3033 5012 22.61 2.2 8.7 [Xe]$4f^{14}5d^66s^2$ **76 Os** Osmium	192.22 2446 4428 22.65 2.20 9.1 [Xe]$4f^{14}5d^76s^2$ **77 Ir** Iridium	195.08 1768.4 3825 21.45 2.28 9.0 [Xe]$4f^{14}5d^96s^1$ **78 Pt** Platinum	196.96654 1064.18 2856 19.31 2.54 9.225 [Xe]$4f^{14}5d^{10}6s^1$ **79 Au** Gold	200.59 –38.83 356.73 13.546 2.00 10.437 [Xe]$4f^{14}5d^{10}6s^2$ **80 Hg** Mercury	204.3833 304 1473 11.85 2.04 6.108 [Xe]$4f^{14}5d^{10}6s^26p^1$ **81 Tl** Thallium	207.2 327.46 1749 11.34 2.33 7.416 [Xe]$4f^{14}5d^{10}6s^26p^2$ **82 Pb** Lead	208.98037 271.40 1564 9.78 2.02 7.289 [Xe]$4f^{14}5d^{10}6s^26p^3$ **83 Bi** Bismuth	(208.9824) 254 962 9.196 2.0 8.42 [Xe]$4f^{14}5d^{10}6s^26p^4$ **84 Po** Polonium	(209.9871) 302 337 – 2.2 – [Xe]$4f^{14}5d^{10}6s^26p^5$ **85 At** Astatine	(222.0176) –71 –61.7 9.73 – 10.748 [Xe]$4f^{14}5d^{10}6s^26p^6$ **86 Rn** Radon
(223.0197) 27 677 – 0.7 – [Rn]$7s^1$ **87 Fr** Francium	(226.0254) 700 <1140 5.8 0.9 5.279 [Rn]$7s^2$ **88 Ra** Radium	(227.0278) 1051 3196 10.07 1.1 6.9 [Rn]$6d^17s^2$ **89 Ac** Actinium	(261.11) – – – – – **104** Unq Unnilquadium	(262.114) – – – – – **105** Unp Unnilpentium	(263.118) – – – – – **106** Unh Unnilhexium	(262.12) – – – – – **107** Uns Unnilseptium	(265) – – – – – **108** Uno Unniloctium	(266) – – – – – **109** Une Unnilennium	(272) – – – – – **110** Uun Ununnunium																		

The data for this reference guide were obtained from the latest scientific and government sources (IUPAC, CODATA, National Bureau of Standards, etc.). Estimated values and/or inconsistent data are marked with an asterisk (*).
1. Ratio of the average mass per atom of the element to 1/12 of the mass of an atom of ^{12}C. Round brackets indicate atomic weight of the most stable or best known isotope. **2.** Number of protons in the nucleus of each atom of an element. **3.** Number of charges an atom would have in a molecule (or an ionic compound) if electrons were transferred completely. **4.** Names and symbols of elements 104-110 are those recommended by the International Union of Pure and Applied Chemistry (IUPAC)—alternative names have been proposed by other groups. **5.** Distribution of electrons among the various atomic orbitals. **6.** Two older group classifications systems still in use today rely on an A/B coding scheme to categorize periodic properties. Because of the potential for confusion between these two systems (i.e., VIIA in one scheme is equal to VIIB in the other), IUPAC recommends the use of an unambiguous 1-18 group classification system. **7.** Melting point: temperature at which solid and liquid phases coexist in equilibrium. Boiling point: temperature at which the vapor pressure of a liquid is equal to the external atmospheric pressure. Unless otherwise stated values are at 1 atm; SP = sublimation point at 1 atm; TP = triple point. **8.** Mass of the substance divided by its volume (g/cm³ at 20°C; for gases: g/L at 0°C, 1 atm). **9.** Relative measure of the attraction of an atom in a chemical bond for the shared electrons. **10.** Minimum energy to remove an electron from an isolated atom in its ground state (1eV = 96.487 kJ/mol).

*indicates approximate values and/or inconsistent literature data.



*	140.115 799 3424 6.770 1.12 5.466 [Xe]$4f^15d^16s^2$ **58 Ce** Cerium	140.90765 931 3510 6.773 1.13 5.422 [Xe]$4f^36s^2$ **59 Pr** Praseodymium	144.24 1016 3066 7.00 1.14 5.489 [Xe]$4f^46s^2$ **60 Nd** Neodymium	(144.9127) 1042 3000 7.264 1.13 5.554 [Xe]$4f^56s^2$ **61 Pm** Promethium	150.36 1072 1790 7.536 1.17 5.631 [Xe]$4f^66s^2$ **62 Sm** Samarium	151.965 822 1596 5.244 1.2 5.666 [Xe]$4f^76s^2$ **63 Eu** Europium	157.25 1314 3264 7.901 1.20 6.141 [Xe]$4f^75d^16s^2$ **64 Gd** Gadolinium	158.92534 1359 3221 8.230 1.2 5.842 [Xe]$4f^96s^2$ **65 Tb** Terbium	162.50 1411 2561 8.551 1.22 5.927 [Xe]$4f^{10}6s^2$ **66 Dy** Dysprosium	164.93032 1472 2694 8.80 1.23 6.018 [Xe]$4f^{11}6s^2$ **67 Ho** Holmium	167.26 1529 2862 9.066 1.24 6.101 [Xe]$4f^{12}6s^2$ **68 Er** Erbium	168.93421 1545 1946 9.321 1.25 6.18436 [Xe]$4f^{13}6s^2$ **69 Tm** Thulium	173.04 824 1194 6.966 1.1 6.25394 [Xe]$4f^{14}6s^2$ **70 Yb** Ytterbium	174.967 1663 3393 9.84 1.27 5.42589 [Xe]$4f^{14}5d^16s^2$ **71 Lu** Lutetium
**	232.0381 1750 4788 11.72 1.3 6.08 [Rn]$6d^27s^2$ **90 Th** Thorium	231.03588 1572 – 15.37 1.5 5.89 [Rn]$5f^26d^17s^2$ **91 Pa** Protactinium	238.0289 1135 4131 19.05±0.02 1.38 6.05 [Rn]$5f^36d^17s^2$ **92 U** Uranium	(237.0482) 644 – 20.45 1.36 6.19 [Rn]$5f^46d^17s^2$ **93 Np** Neptunium	(244.0642) 640 3228 19.816 1.28 5.8 [Rn]$5f^67s^2$ **94 Pu** Plutonium	(243.0614) 1176 2607 13.67 1.3 5.993 [Rn]$5f^77s^2$ **95 Am** Americium	(247.0703) 1345 – 13.51 1.3 6.02 [Rn]$5f^76d^17s^2$ **96 Cm** Curium	(247.0703) 1050 – 14.78 1.3 6.23 [Rn]$5f^97s^2$ **97 Bk** Berkelium	(251.0796) 900 – 1.3 6.30 [Rn]$5f^{11}7s^2$ **98 Cf** Californium	(252.083) 860 – 1.3 6.42 [Rn]$5f^{11}7s^2$ **99 Es** Einsteinium	(257.0951) 1527 – 1.3 6.50 [Rn]$5f^{12}7s^2$ **100 Fm** Fermium	(258.10) 827 – 1.3 6.58 [Rn]$5f^{13}7s^2$ **101 Md** Mendelevium	(259.1009) 827 – 1.3 6.65 [Rn]$5f^{14}7s^2$ **102 No** Nobelium	(262.11) 1627 – – – – [Rn]$5f^{14}6d^17s^2$ **103 Lr** Lawrencium

PAPERTECH

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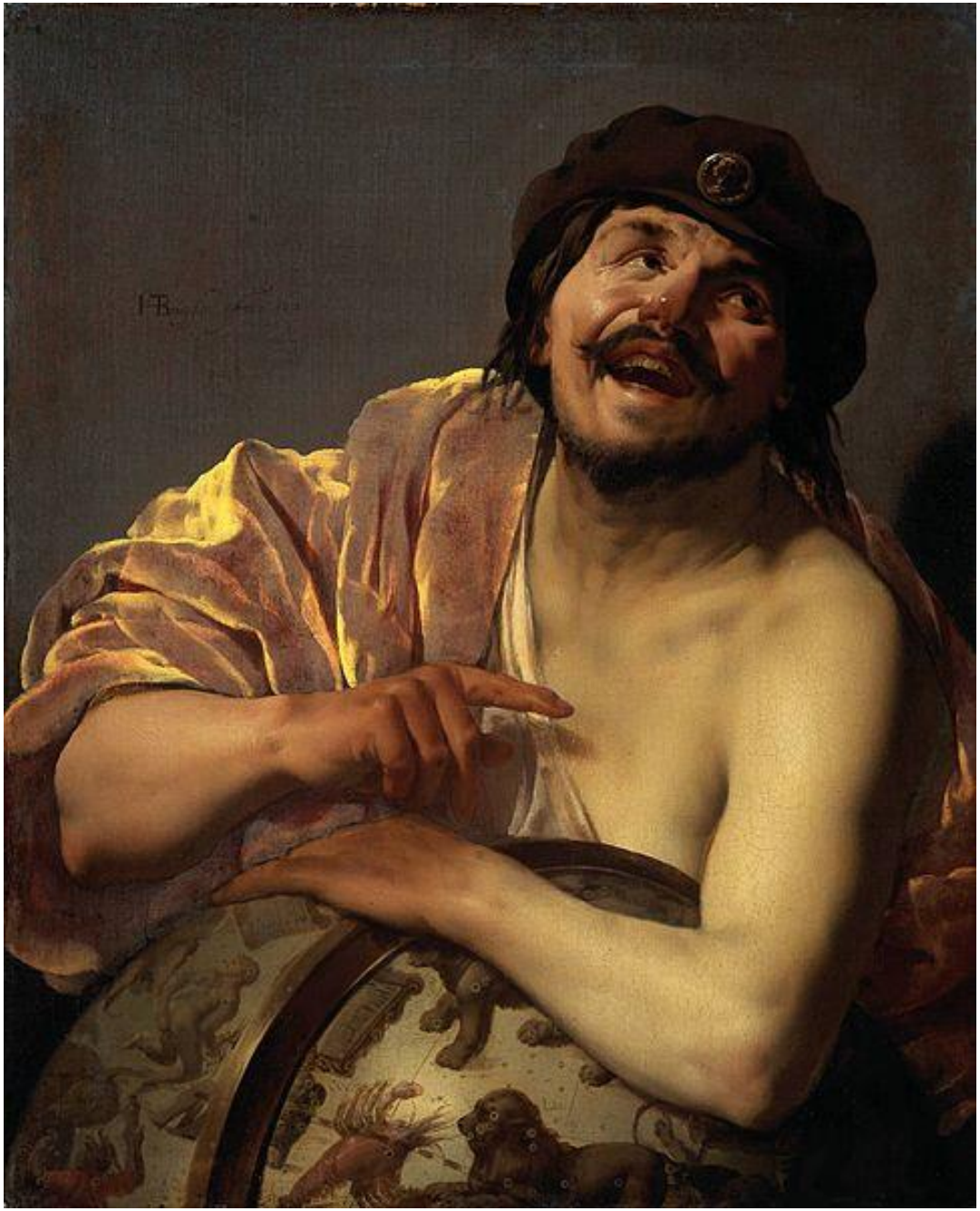
Os Elementos no *Timeu* de Platão

				
Tetraedro	Octaedro	Icosaedro (20)	Hexaedro (Cubo)	Dodecaedro (12)
Fogo	Ar	Água	Terra	Universo



Demócrito de Abdera (c. 460 a.C- c. 370 a.C.)

Atomistic Cosmology
- atoms, infinite and void

Moreover, the universe as a whole is infinite, for whatever is limited has an outermost edge to limit it, and such an edge is defined by something beyond. Since the universe does not have an edge, it has no limit; and since it lacks a limit, it is infinite and unbounded. Moreover, the universe is infinite both in the number of its atoms and in the extent of its void. (42a) If, on the one hand, the void were infinite and matter finite, the atoms would not remain anywhere but would be carried away and scattered through the infinite void, since there would be no atoms from without to support them and hold them together by striking them. If, on the other hand, the void were finite, there would not be room in it for an infinite number of atoms.

Letter to Herodotus
Epicurus (341 – 270 BCE)

A teoria atomista da Via Láctea em Dante: “Os céus são ciências” (*Convito*)

I say that the Starry Heaven may be compared to Physics because of three properties, and to Metaphysics because of three others.

And because of the Milky Way, this Heaven has a great similitude with Metaphysics.

What Aristotle may have said of this is not so easy to learn, because his opinion is not found to be the same in one translation as in the other; and I believe that it might be due to the error of the translators, for in the new one he seems to say that the Galaxy is a collection of vapours under the stars of that part which always attract them; and this does not seem to be the true reason. In the old translation he says that the Galaxy is no other than a multitude of fixed stars in that part, so small that we cannot distinguish them from here below, but that they cause the whiteness which we call the Milky Way.

... Therefore, since the Galaxy is an effect of those stars which we cannot see, if we understand those things by their effect alone, and Metaphysics treats of the first substances, which we cannot similarly understand except by their effects, it is evident that the Starry Heaven has a great similitude to Metaphysics.

Elementos
- Antiguidade e Idade Média

- Metais “planetários”: Au, Ag, Hg, Cu, Fe, Sn, Pb
- Fogos (incêndios, vulcões): C, S
- Bronzes e Latões: As, Zn
- Pigmentos: Sb, Bi

Planetas como metais e modalidades da luz

- Sol: Au (Ouro), Ἥλιος (Hélios)
- Lua: Ag (Prata), Σελήνη (Selene)
- Mercúrio: Hg (Mercúrio), Στιλβων (Stilbon) brilhante, cintilante
- Vênus: Cu (Cobre), Φωσφοροσ (Fosforos) portador da luz
- Marte: Fe (Ferro), Πυροεισ (Pyroies) ígneo
- Júpiter: Sn (Estanho), Φαεθων (Faethon) brilhante. fulgurante
- Saturno: Pb (Chumbo), Φαινων (Fainon) brilhante, evidente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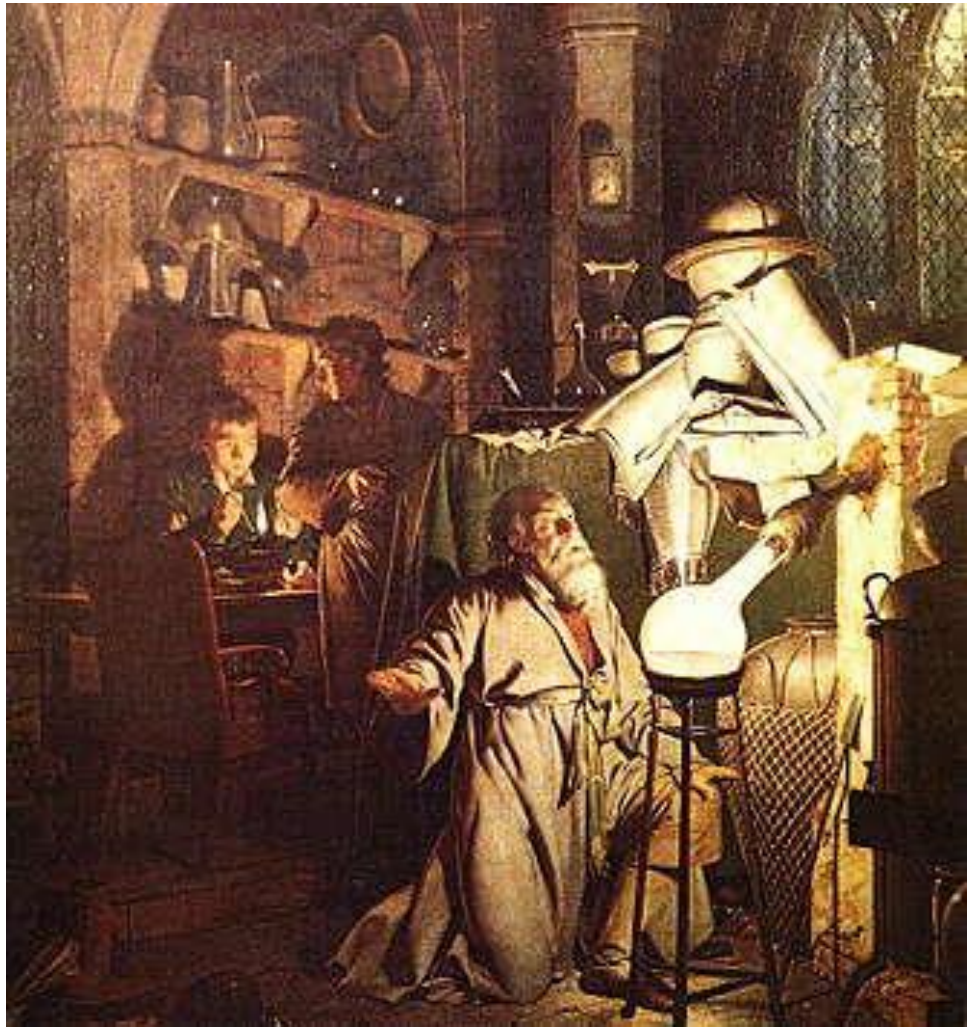
Elementos – Início da Química Moderna

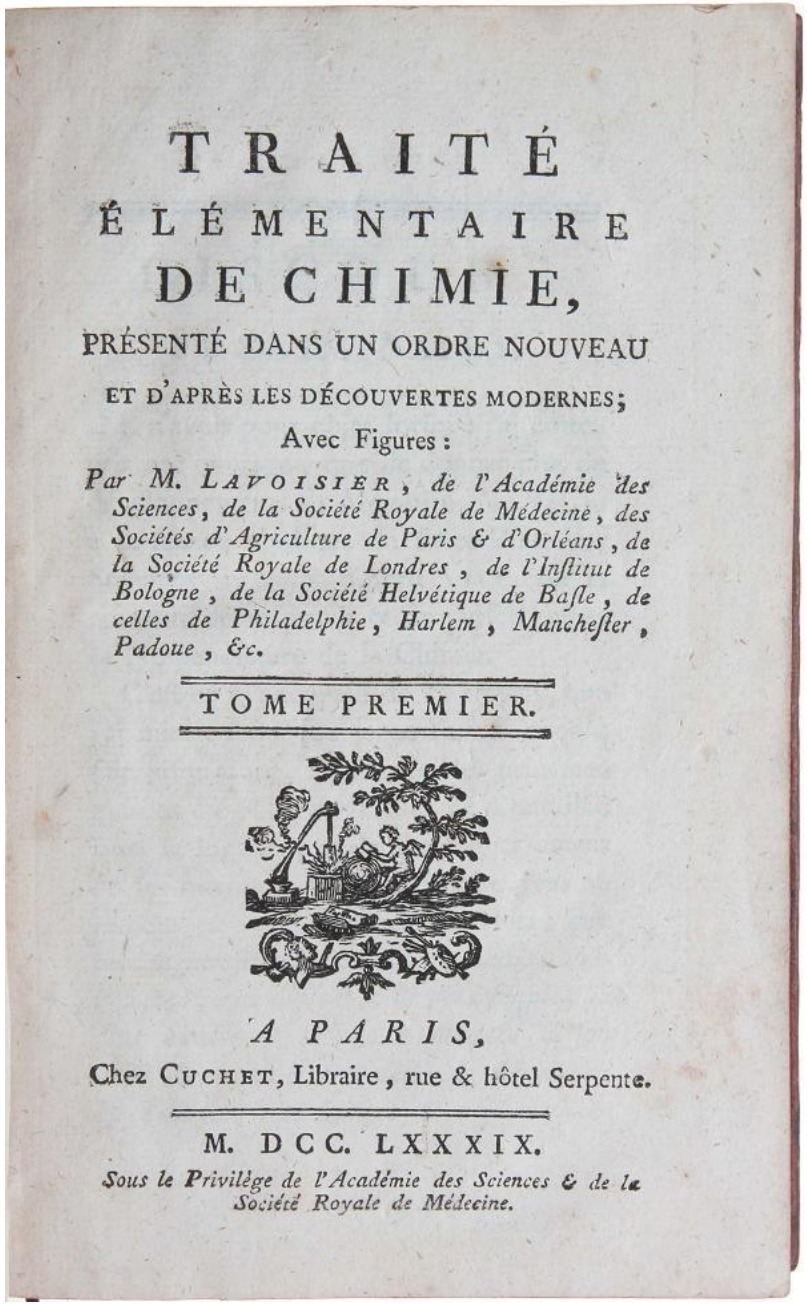
- Hennig Brand (1649): descoberta do fósforo
- Robert Boyle (1661): definição de elemento
- Boyle (1680): redescoberta do fósforo



Elementos - Iluminismo

- Descoberta do nitrogênio: Daniel Rutherford (Edinburgh), 1772. (Termo devido a Jean-Antoine Chaptal, 1780)
- Descoberta do oxigênio: Carl Wilhelm Scheele (Uppsala) 1773 Joseph Priestley (Wiltshire) 1774. (Termo devido a Lavoisier, 1777)
- Descoberta do hidrogênio: Henry Cavendish (London) 1776 (Termo devido a Lavoisier, 1788)
- *Traité Élémentaire de Chimie* (Antoine de Lavoisier 1789)

Traité Élémentaire de Chimie (1789)



TRAITÉ
ÉLÉMENTAIRE
DE CHIMIE,
PRÉSENTÉ DANS UN ORDRE NOUVEAU
ET D'APRÈS LES DÉCOUVERTES MODERNES;
Avec Figures :

Par M. LAVOISIER, de l'Académie des Sciences, de la Société Royale de Médecine, des Sociétés d'Agriculture de Paris & d'Orléans, de la Société Royale de Londres, de l'Institut de Bologne, de la Société Helvétique de Basle, de celles de Philadelphie, Harlem, Manchester, Padoue, &c.

TOME PREMIER.

A PARIS,
Chez CUCHET, Libraire, rue & hôtel Serpente.

M. DCC. LXXXIX.
Sous le Privilège de l'Académie des Sciences & de la Société Royale de Médecine.

Antoine Laurent de Lavoisier
(1743-1794)

23 elementos

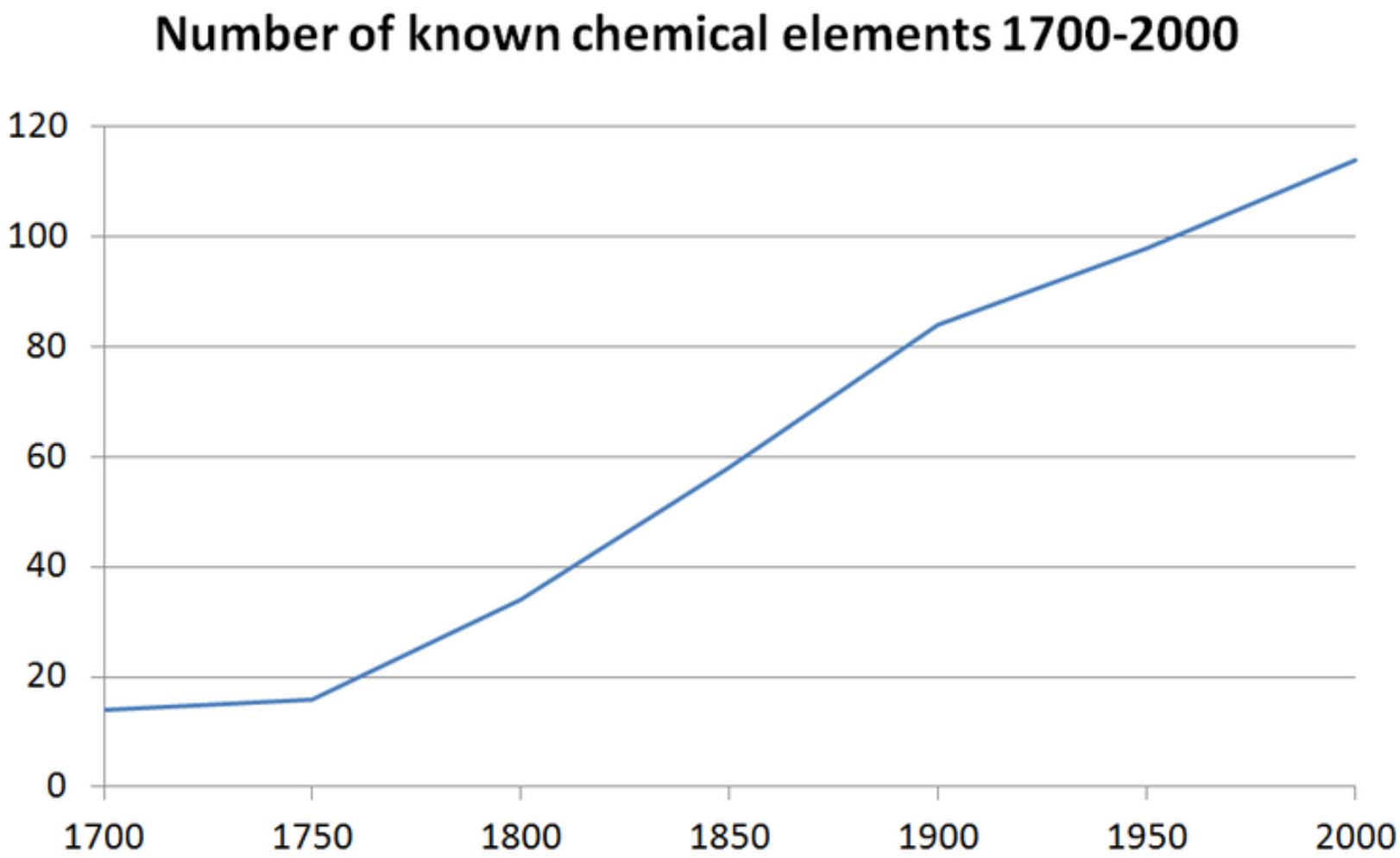

Number of known chemical elements 1700-2000
120
100
80
60
40
20
0
1700
1750
1800
1850
1900
1950
2000

Tabela Periódica (1869)

			Ti = 50	Zr = 90	? = 180	
			V = 51	Nb = 94	Ta = 182	
			Cr = 52	Mo = 96	W = 186	
			Mn = 55	Rh = 104,4	Pt = 197,4	
			Fe = 56	Ru = 104,4	Ir = 198	
			Ni = Co = 59	Pd = 106,6	Os = 199	
H = 1			Cu = 63,4	Ag = 108	Hg = 200	
	Be = 9,4	Mg = 24	Zn = 65,2	Cd = 112		
	B = 11	Al = 27,4	? = 68	Ur = 116	Au = 197?	
	C = 12	Si = 28	? = 70	Sn = 118		
	N = 14	P = 31	As = 75	Sb = 122	Bi = 210?	
	O = 16	S = 32	Se = 79,4	Te = 128?		
	F = 19	Cl = 35,5	Br = 80	J = 127		
Li = 7	Na = 23	K = 39	Rb = 85,4	Cs = 133	Tl = 204	
		Ca = 40	Sr = 87,6	Ba = 137	Pb = 207	
		? = 45	Ce = 92			
		?Er = 56	La = 94			
		?Yt = 60	Di = 95			
		?In = 75,6	Th = 118?			

63 elementos

Dmitri Ivanovich Mendeleev (1834-1907)

Observações:

1) Prevê a existência de elementos ainda não descobertos (ex. eka-alumínio = gálio)

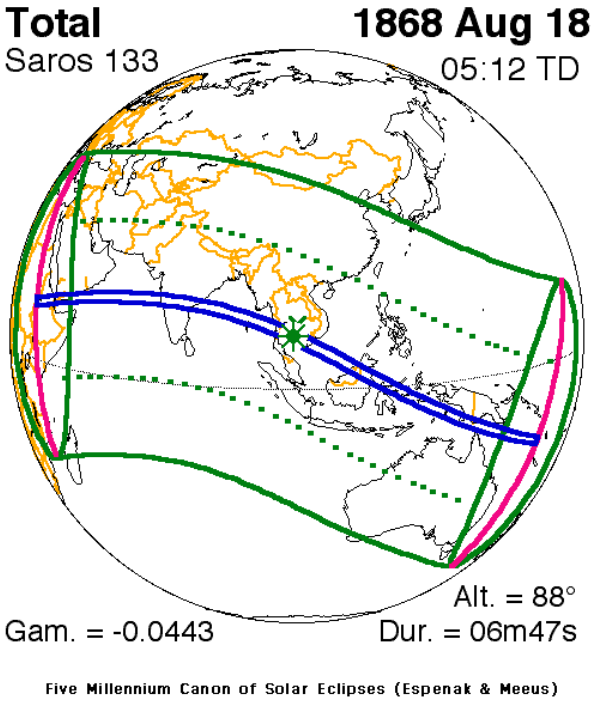
2) Não inclui os gases nobres (ainda não descobertos), entre eles o hélio

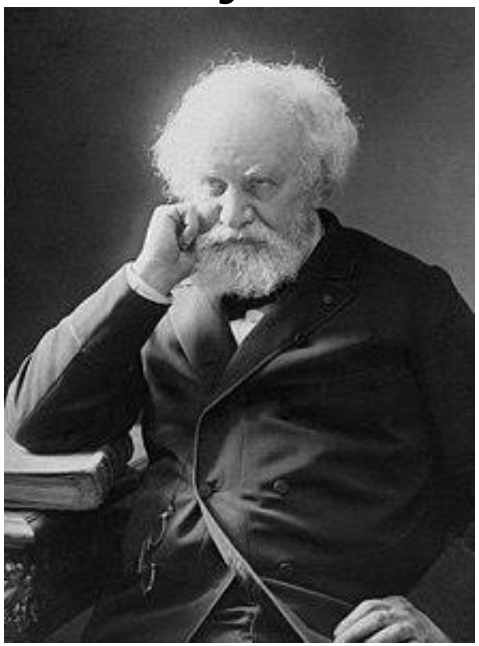
Tabela Periódica (1898)

0	I	II	III	IV	V	VI	VII	
He 4	Li 7	Be 9·1	B 11	C 12	N 14	O 16	F 19	—
Ne 20	Na 23	Mg 24·4	Al 27·1	Si 28·4	P 31·0	S 32·1	Cl 35·5	—
Ar 40	K 39·1	Ca 40	Sc 44·1	Ti 48·1	V 51·2	Cr 52.1	Mn 55·0	Fe 56, Ni 58·7, Co 59
Kr > 45	Cu 63·6	Zn 65·4	Ga 70	Ge 72	As 75	Se 79·1	Br 80·0	—
X > 65	Rb 85·4	Sr 87·6	Y 89	Zr 90·6	Nb 94	Mo 96·0	—	Ru 102, Rh 103, Pd 106
—	Ag 107·9	Cd 112	In 114	Sn 118·5	Sb 120	Te 127	J 126·9	—
—	Cs 133	Ba 137·4	La 138 etc.	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	Yb 173	—	Ta 183	W 184	—	Os 191, Ir 193, Pt 195
—	Au 197·2	Hg 200·3	Tl 204·1	Pb 206·9	Bi 208	—	—	—
—	—	—	—	Th 232	—	U 240	—	—

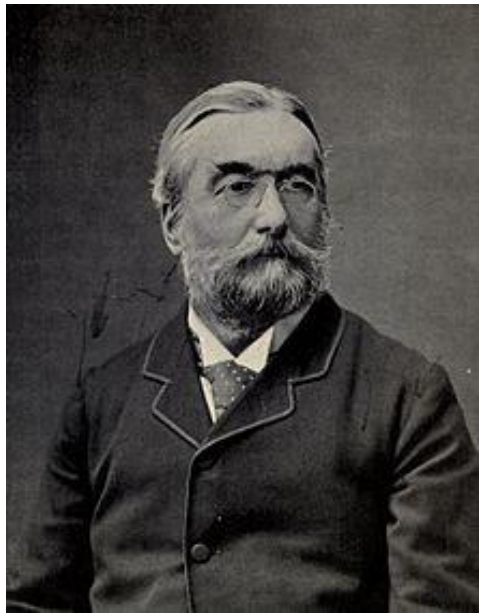
Descoberta do Hélio

- Eclipse solar de 18/8/1868: linha espectral desconhecida (D_3, Secci) (P. Janssen, N. Lockyer)
- "a new element X": 3/4/1871(Lockyer) "Helium": 3/8/1971 (Kelvin)
- Hélio em laboratório: 1895 (Ramsay; Cleve & Lunglet)





Pierre Janssen (1824-1907)



Norman Lockyer (1836-1920)

Considérations philosophiques sur l'ensemble de la science astronomique.

L'astronomie est jusqu'ici la seule branche de la philosophie naturelle dans laquelle l'esprit humain se soit enfin rigoureusement affranchi de toute influence théologique et métaphysique, directe ou indirecte; ce qui rend particulièrement facile de présenter avec netteté son vrai caractère philosophique. Mais, pour se faire une juste idée générale de la nature et de la composition de cette science, il est indispensable, en sortant des définitions vagues qu'on en donne encore habituellement, de commencer par circonscrire avec exactitude le véritable champ des connaissances positives que nous pouvons acquérir à l'égard des astres.

Parmi les trois sens propres à nous faire apercevoir l'existence des corps éloignés, celui de la vue est évidemment le seul qui puisse être employé relativement aux corps célestes; en sorte qu'il ne saurait exister aucune astronomie pour des espèces aveugles, quelque intelligentes qu'on voulût d'ailleurs les imaginer; et, pour nous-mêmes, les astres obscurs, qui sont peut-être plus nombreux que les astres visibles, échappent à toute étude réelle, leur existence pouvant tout au plus être soupçonnée par induction. Toute recherche qui n'est point finalement réductible à de simples observations visuelles nous est donc nécessairement interdite au sujet des astres, qui sont ainsi de tous les êtres naturels ceux que nous pouvons connaître sous les rapports les moins variés. Nous concevons la possibilité de déterminer leurs formes, leurs distances, leurs grandeurs et leurs mouvemens; tandis que nous ne saurions jamais étudier par aucun moyen leur composition chimique, ou leur structure minéralogique, et, à plus forte raison, la nature des corps organisés qui vivent à leur surface, etc. En un mot, pour employer immédiatement les expressions scientifiques les plus précises, nos connaissances positives par rapport aux astres sont nécessairement limitées à leurs seuls phénomènes géométriques et mécaniques, sans pouvoir nullement embrasser les autres recherches physiques, chimiques, physiologiques, et même sociales, que comportent les êtres accessibles à tous nos divers moyens d'observation.

Auguste Comte, 1835. *Cours de Philosophie Positive, 19éme leçon*

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