

Alchemist symbols

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The symbols used by alchemists served as *aide memoir* for the researchers themselves and for communication, even across language barriers. At the same time, however, their meaning was hidden except to a small group of specially trained practitioners. A list of alchemist symbols can be found on [1] and even more extensive ones in [2–4]. A few are standardised in unicode as miscellaneous symbols ("2600 – "26FF (astrology) and "1F700 – "1F77F (alchemy)) [5]. A list of synonyms for old chemical names in several languages can be found in [6], a dictionary of alchemical terms in [7].

The biggest difficulty understanding alchemist manuscripts is the inconsistent chemical nomenclature: the same name and symbol was used for different things (homonyms, for example, magnesia usually means MgO, but could also mean metallic bismuth), and many different trivial names and symbols existed for the same chemical (synonyms). I am sure, this resulted in the occasional lab explosion... In addition, orthography was, uhm, creative before it became standardised in the 19th century (in Germany with [8]).

Hermetic symbols are often derived from a few basic archetypes that were combined (see fig. 1). GETTINGS [3, pp. 324–410] tries to systematise the symbols by first counting the number of strokes (1–5) and then subdivide each of these groups on geometric grounds. However, what constitutes one or several strokes seems somewhat arbitrary. Also, for more than 3 strokes, the number of possible subdivisions explodes.

For this collection, I have left out symbols closely related to those included, for example, by addition or removal of serifs or by rotation. Of course, this choice is somewhat arbitrary.



Figure 1: Archetypes for hermetic symbols.

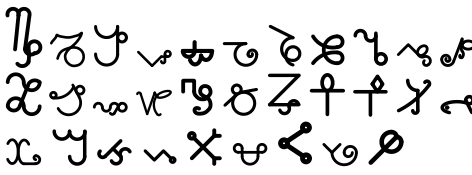
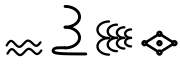
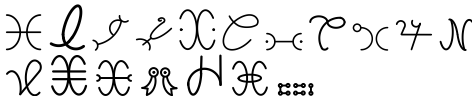

1 Astrology and astronomy

1.1 Zodiac signs

Western zodiac signs originate from the Babylonians (“Chaldea” in Greek terms, in today’s form ≈ 400 BC) and also have hellenistic influences. The constellations are located near the solar ekliptic (from Gr. ἐκλειπτική τροχιά ekleiptikē trochiá), the path that the sun apparently moves on during the year. Each of the signs occupies 30° of celestial longitude, due to the earth’s orbital eccentricity corresponding to 20.4 d for Capricorn to 31.4 d for cancer.

Character	Name	Description
	Aries (Ram)	from the first day of spring (vernal equinox) 21.03. to 20.04.
	Taurus	20.04. – 21.05.
	Gemini	21.05. – 21.06.

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Character	Name	Description
	Capricorn	22.12. – 20.01.
	Aquarius	20.01. – 19.02.
	Pisces	19.02. – 21.03.
	Ophiuchus Orion	Serpent-bearer, 30.11. – 17.12.










1.2 Solar system

1.2.1 Planets

Since planets correspond to metals (Mercury – Mercury, Venus – Copper, Mars – Iron *etc.*), the symbols for the planet may be used for the metal and *vice versa*.

Character	Name	Description
	Mercury	
	Venus	

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Character	Name	Description
	(1866) Sisyphus	
	(2060) Chiron	
	(2062) Aten	
	(2100) Ra-Shalom	
	(2101) Adonis	
	(2340) Hathor	
	(3753) Cruinthne	
	(4179) Toutatis	
	(69230) Hermes	
	(99942) Apophis	near-earth passage 2029-04-13
	(367943) Duende	near-earth passage 2013-02-15

1.2.3 Planetoids of the KUIPER belt

The most well-known object of this class is Pluto, which is officially no longer a planet.

Character	Name	Description
	(136199) Eris	
	(225088) Gonggong	
	(136108) Haumea	

continued on next page

Character	Name	Description
𐌆𐌆	(136472) Makemake	
☉ 𐌵	(90482) Orcus	
◊	(50000) Quaoar	
𐌶	(90377) Sedna	

1.3 Important stars

Character	Name	Description
✕	Aldebaran	
✕ 𐌵𐌵	<i>alpha coronae borealis</i> , Alphecca	
✕ 𐌶𐌶	<i>Alpha aurigae</i> , Amalthea, Hircus, Capella, Alayoch	
𐌶𐌶 𐌶𐌶	<i>alpha Bootis</i> , Arcturus, Alchameth	
𐌶𐌶𐌶 𐌶𐌶𐌶 𐌶𐌶𐌶	<i>β Persei</i> , <i>caput algol</i>	
𐌶𐌶𐌶 𐌶𐌶𐌶	<i>Canis major</i> , Sirius	
𐌶𐌶𐌶	<i>Canis minor</i> , Procyon	
𐌶𐌶	<i>Cauda Capricorni</i> , <i>δ Capricorni</i> , <i>Deneb Algedi</i>	
𐌶𐌶 𐌶𐌶 𐌶𐌶 𐌶𐌶	<i>Cauda leonis</i> , <i>finis Leonis et principis Virginis</i> , <i>β leonis</i> , <i>الاسد ذنب</i> <i>ḏanab al-asad</i> (lion's tail), Denebola	

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Character	Name	Description
○○ ○○○ ○○○ 𐌶𐌵	<i>Cauda scorpionis, finis Scorpionis et caput Sagittarii, λ Scorpii, الشولاء al-šawlā, Shaula</i>	
𐌶𐌵 𐌶𐌵 𐌶𐌵	<i>α Ursae Minoris, Stella Polaris, Cynosura</i>	Pole star
𐌶𐌵 𐌶𐌵 𐌶𐌵	<i>Cor Leonis, α Leonis, 'the little king'</i>	
𐌶𐌵 𐌶𐌵 𐌶𐌵	<i>Cor Scorpionis, α Scorpii, Antares</i>	
𐌶𐌵 𐌶𐌵 𐌶𐌵	Regulus	brightest star system (apparent magnitude of +1.35) in the constellation Leo (α Leonis).
𐌶𐌵	<i>δ corvi, Ala corvi, Algorab</i>	double star
𐌶𐌵 𐌶𐌵 𐌶𐌵	Pleiades	
𐌶𐌵	Spica (α virginis)	

1.4 Other

According to [9], the angle between two objects as seen by an observer on earth are described by the following terms (see also fig. 2):

Conjunction 𐌶𐌵 angle of $\frac{0}{12} 360^\circ = 0^\circ$. Objects appear close together on the celestial sphere (within $\pm 10^\circ$). The minimal distance is called *appulse*. With respect to the sun, an object – as seen from earth – can be in

superior conjunction it appears to be behind the sun

inferior conjunction it appears to be in front of the sun

At new moon, the moon is in inferior conjunction with the sun. There are special sigils for planetary conjunctions:

Jupiter and Saturn 𐌶𐌵 𐌶𐌵 is called *great conjunction*, the one in 7 BC may be the *Star of Bethlehem* (Mt. 2₂).

Saturn and Mars 𐌶𐌵 𐌶𐌵

Jupiter, Saturn and Mars 𐌶𐌵 𐌶𐌵 𐌶𐌵

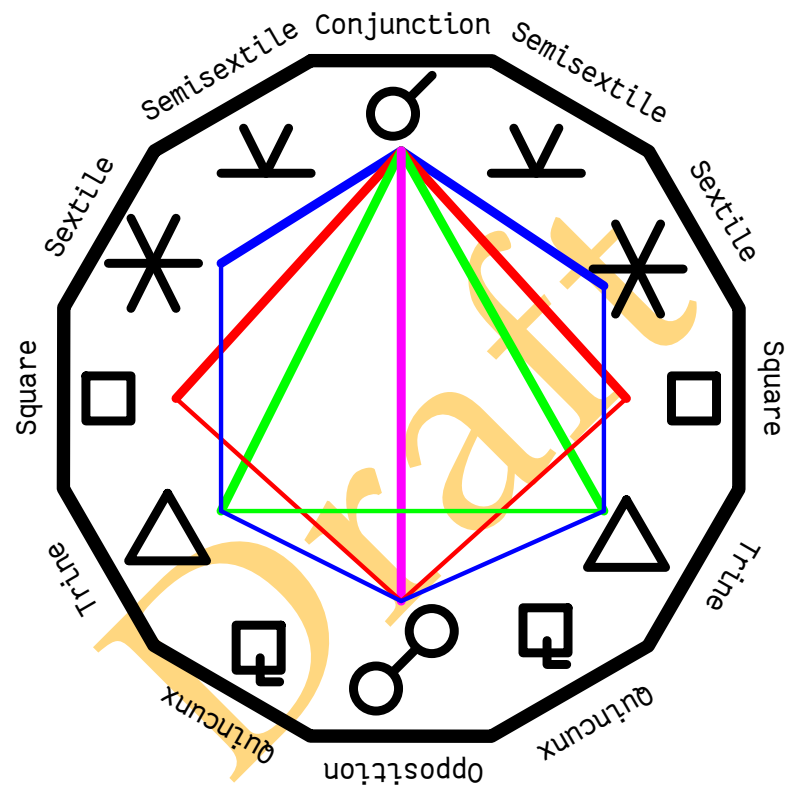


Figure 2: Ptolemaic aspects. For details see text.

Semisextile $\searrow \bowtie \swarrow \cong$ angle of $\frac{1}{12}360^\circ = 30^\circ$

Sextile \bowtie angle of $\frac{2}{12}360^\circ = 60^\circ$

Semisquare $\square \perp$ angle of $1/2 \frac{3}{12}360^\circ = 45^\circ$, *tetragonum*

Square $\square \sqsupset$ angle of $\frac{3}{12}360^\circ = 90^\circ$

Trine \triangle angle of $\frac{4}{12}360^\circ = 120^\circ$

Quincunx $\nwarrow \square \searrow \bowtie$ angle of $\frac{5}{12}360^\circ = 150^\circ$

Opposition \oslash angle of $\frac{6}{12}360^\circ = 180^\circ$ earth is exactly between the objects.

Eclipse one object moves into the shadow of another during an opposition (e.g., the moon into the shadow of the earth during a lunar eclipse).

Transit an apparently smaller object moves in front of a larger during conjunction. For example, Venus or Mercury may pass in front of the sun as black spots.

Occultation \bullet during conjunction, an apparently larger object moves in front of a smaller and hides it. For example, in a solar eclipse the moon passes between earth and sun, hiding it. The moon is much smaller than the sun, but also much closer to earth, so that both appear to have about the same diameter. Occultation of planets by the moon also occur relatively frequently.

Aspects introduced by other authors include

Decile, angle of $\frac{1}{10}360^\circ = 36^\circ \perp$

Octile angle of $\frac{1}{8}360^\circ = 45^\circ \angle$

Septile angle of $\frac{1}{7}360^\circ = 45^\circ 25' 0''$ ✧ ✨

Quintile angle of $\frac{1}{5}360^\circ = 72^\circ$ Q

Bisquintile, sesquiquintile angle of $\frac{3}{10}360^\circ = 72^\circ + 36^\circ = 108^\circ$ bQ ± ✂

Trioctile, sesquiquadrate angle of $\frac{3}{8}360^\circ = 90^\circ + 45^\circ = 135^\circ$ ☐ ☐ ☐ ☐

Bisquintile angle of $\frac{2}{5}360^\circ = 144^\circ$ bQ ±

A horoskop (from Gr. ὥρα σκοπεῖν hōra skorpein = marker of the hour [of birth]) or natal chart was based on the theory that the movement of heavenly objects was causally linked to the events on earth (“like above, so below”). For this purpose were determined the

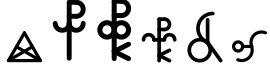


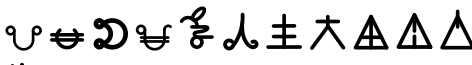



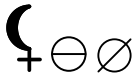


- *prima domus* (first house, ascendant), intersection of ekliptic and horizon, east angle
- *medium coeli* (midheaven, 10th house), intersection of meridian and ekliptic, north angle
- Descendant, setting sign, west angle
- *imum coeli* (opposite of *medium coeli*), south angle

as function of time and place of birth, using the geocentric perspective. Together, these form a cross.

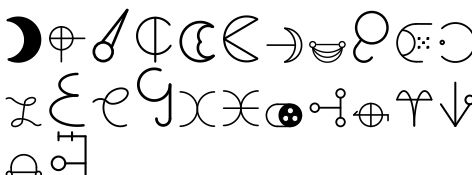
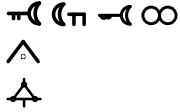
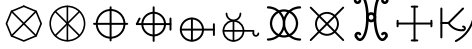
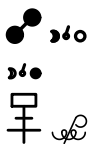

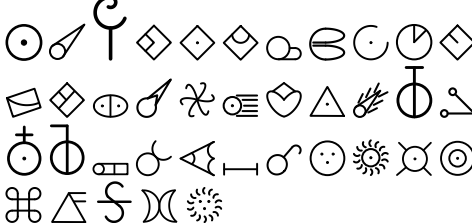
If the plane defined by the orbit of a celestial body has an angle (inclination) $\neq 0$ to a reference plane, then the orbit intersects the reference plane in two points. The one crossed by the north-moving body is called the ascending node (Latin *caput draconis* = dragon’s head or Greek αναβιβάζων anabibazōn). The node of the south-moving body is called descending node (*cauda draconis* = dragon’s tail or καταβιβάζων katabibazōn). In astrology, these terms refer to the crossings of the orbit of the moon with the apparent orbit of the sun across the sky.

The orbit of a celestial body around another is an ellipse and as such has two focal points. One is occupied by the heavier (resting) body, the second is called the *lilith*. It is empty and of no significance in astronomy. In astrology, however, the second focal point of the moon’s orbit around earth is called *black moon lilith*.


In extensive scientific studies, if proper blinding is used, there is no significant (beyond what is expected randomly) connection between a horoskop and the character or biography of a person [10–12]. In particular, statements about personality are so vague and general that most people will believe they were tailored to them [13] (BARNUM-effect, named after showman PHINEAS TAYLOR BARNUM, 1810–1891).

Character	Name	Description
	<i>prima domus</i> = first house, ascendant	the zodiacal sign and degree that is ascending on the eastern horizon at the specific time and location
	Ascending node	
	Descendant, setting sign, west angle of a horoscope	
	Descending Node	
	Comet	
	Fixed star	
	Horoskope	
	black moon lilith	second focal point of elliptical moon orbit around earth
	First quarter moon, waxing moon	
	Last quarter moon, wanning moon	

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Character	Name	Description
	Moon	
	Fool hook Cardinality Cardinal cross	last full moon before birth
	Lot of fortune	four planets with square (90°) aspect or lucky point (Lat. <i>Pars Fortunae</i>), hypothetical point occupied by the Moon when the Sun is on the ascendant. If other bodies than the sun are meant, their sign is placed next to the pars sign.
	Lunar eclipse Eclipse of the sun	
	<i>Medium coeli</i> , midheaven	culminating degree of ecliptic in a horoscope
	Sun	also gold


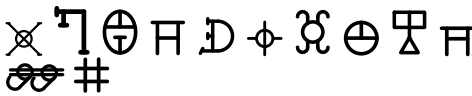

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Character	Name	Description
	Transpluto	

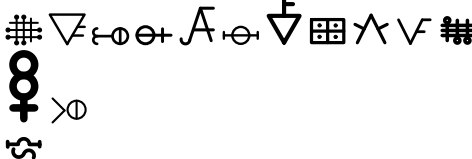

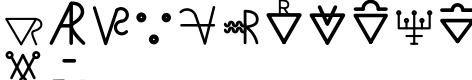


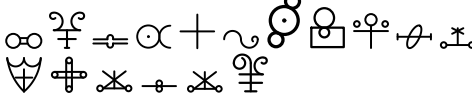

2 Compounds

In general, *crocus of* or *saffron of* means a yellow compound, *magistery of* a compound purified by precipitation, *magistry of* a compound synthesised from the element and hence without impurities. *Flores* or *flower of* means substances purified by sublimation. *Mercury of* refers to philosophical mercury and can mean anything. *Spiritus* refers to volatile compounds, *dead* substances are those where the spiritus (life) has been removed by heating. *Hepar* = liver are brownish substances, often containing sulphur. *Calx* = ashes are substances that have been heated until they glowed. A regulus is a metal drop after smelting.

Vitriol are sulphates, often named by their colour: green – iron, blue – copper, white – zinc, red – cobalt. Also named by their origin: roman – iron, cyprian – copper. Hungarian vitriol was originally copper sulphate, but as the copper in the mines was depleted in the 18th century, it contained more and more iron.

Character	Name	Description
	Acid	
	<i>æs viride, flores virides æris, æris crystalli ærugo, Spanish green, crystallised verdigris, Hoganit</i>	Copper(II) acetate
	<i>Alumen, Alum</i>	Double salt of a Metal(I) and a Metal(III) sulphate, usually $KAl(SO_4)_2 \times 12H_2O$


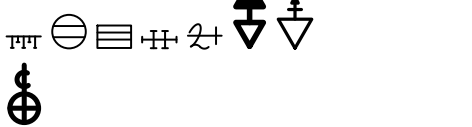
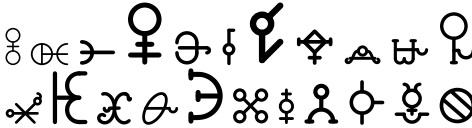
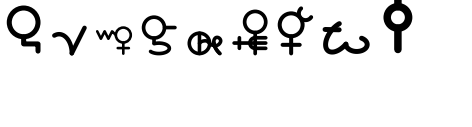


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Character	Name	Description
	<i>Aqua forte, spiritus nitri</i>	Nitric acid HNO_3
	<i>Aqua gradaria</i>	solvent that removes base metals from the surface of precious metal alloys. Various mixtures of nitric acid, hydrochloric acid and potassium dichromate, depending on the metal to be tested.
	<i>Aqua regia, aqua regis, aqua caesaris</i>	1 part nitric, 3 parts hydrochloric acid, gives NOCl that can attack gold and platinum group metals
	<i>Acidum arsenici, Arsenic acid</i>	$\text{AsO}(\text{OH})_3$
	<i>Arsenicum sulphurum, arsenic sulphate</i>	$\text{As}_2(\text{SO}_4)_3$
	Gr. ἄρσενικόν arsenikón <i>Auripigmentum, arsenicum flavum, arsenicum citrinum</i>	Orpiment, royal yellow As_2S_3
	<i>Aurum fulminans</i>	explosive gold hydrazide $\text{Au}^{3+} + 2\text{NH}_3 \rightarrow \text{Au}^{(I)}\text{NH}-\text{NH}_2 + 3\text{H}^+$ formed when the aqua regia is produced with salmiak instead of hydrochloric acid. Used as red pigment for porcelain and enamel.

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Character	Name	Description
⚗ ⚗	Cinnabar of antimony	produced by heating of stibnite (antimony trisulfide) with corrosive sublimate (mercuric chloride) in a retort. This would produce butter of antimony (antimony trichloride) first, then a red sublimate that is actually cinnabar (HgS).
⚗ ⚗ ⚗	red vitriol	cobalt(II) sulphate $\text{CoSO}_4 \times 7\text{H}_2\text{O}$, intermediate of Co-extraction from ore, also used for blue colour of glass and porcelain. Naturally as bieberite (heptahydrate), moorhouseite (hexahydrate), aplowite (tetrahydrate) and cobaltkieserite (monohydrate).
⚗ ⚗ ⚗	crocus	bright yellow compounds. For the botanical meaning look for "saffron" in the plants section
⚗	<i>Crocus antimonii</i> , antimony orange, golden sulfur of antimony	non-stoichiometric antimontrisulfid (approximate formula $2\text{Sb}_2\text{S}_3 \times \text{Sb}_2\text{O}_3$), used as orange pigment in textile printing and as photoconductor in vidicon cameras. Prepared by reacting antimony trichloride (SbCl_3) with sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$).

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Character	Name	Description
	<i>Crocus martis, mars saffron, ferrum oxydatum fuscum, magisterium vitrioli martis</i> = Crocus of iron	Rust, $\text{Fe}_2\text{O}_3 \times \text{H}_2\text{O}$
	<i>Crocus metallorum, stibium oxidatum fuscum</i>	potassium thioantimonite $\text{Sb}_2\text{O}_3 \times 2\text{KSbO}_2 \times \text{KSbS}_2$
	<i>Crocus veneris, æs ustum, calx veneris</i> crocus of copper, burned copper	yellow copper oxyde Cu_2O (æs used here as “copper” rather than “brass”). Sometimes also Cu_2S .
	<i>Crocus solis, gold meta hydroxyde, auryl(III) hydroxyde</i>	gold hydroxyde oxyde $\text{Au}^{\text{III}}\text{O}(\text{OH})$ obtained by drying $\text{Au}(\text{OH})_3$ over phosphorous pentoxyde.
	<i>Crystalli lunae, argentum nitricum, magisterium argenti, magisterium hydragogum, lapis infernalis, lunar caustic</i>	silver nitrate AgNO_3
	Copper antimonate <i>Cuprum arsenicatum, Swedish green, SCHEELÉ's green</i>	CuSb_2O_6 mixture of copper arsenites of approximate composition CuHAsO_3

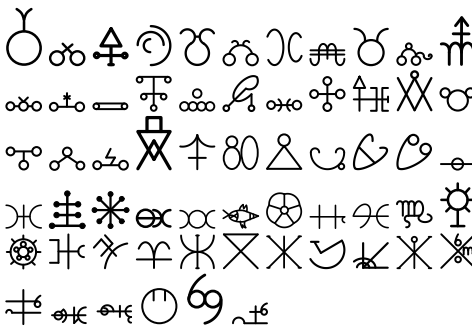

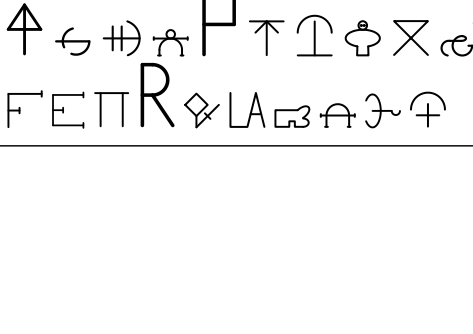

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Character	Name	Description
⊕ ⊕+	<i>Chalcanthum</i> ; blue, hungarian (or cyprian) vitriol	copper(II) sulphate $\text{CuSO}_4 \times 5\text{H}_2\text{O}$
☹	Calcinated vitriol	The first two mol of crystal water leave $\text{CuSO}_4 \times 5\text{H}_2\text{O}$ at 30 °C, two at 110 °C, the last at 250 °C, leaving the white anhydride CuSO_4
⚗	<i>Tartarus stibiatus</i> , <i>tartarus emeticus</i> , emetic tartar	obtained by boiling solutions of cream of tartar (potassium bitartrate $\text{KOOOC-CHOH-CHOH-COOH}$) with antimony(III) oxyde (Sb_2O_3) to get potassium antimonyl tartrate $\text{K}_2\text{Sb}_2(\text{C}_4\text{H}_2\text{O}_6)_2 \times 3\text{H}_2\text{O}$. First synthesised by PARACELsus. Was used as emetic, to treat schistosomiasis and leishmaniasis and as aversive therapy against alcoholism. No longer in use because of severe side effects.

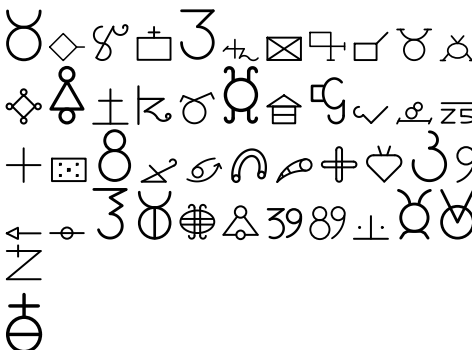
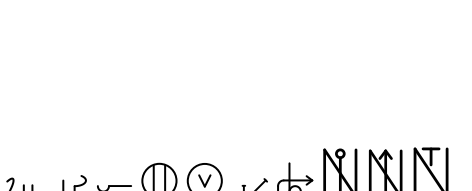

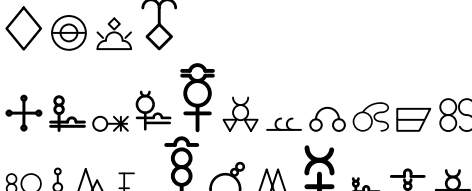


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Character	Name	Description
	<i>Hepar antimonii</i>	sulphantimonites $\text{Me}_3^+\text{SbS}_3$ obtained by fusing together antimony sulphide with alkaline sulphides, occur naturally as pearceite in Colorado
	<i>Hepar calcis, hepar sulphuris calcareum, CANTON's phosphorus</i>	CaS by calcination of burned lime (from oyster shells) and sulphur, shows phosphorescence.
	<i>Hepar magnesia</i>	MgS
	<i>Hepar terraepond, Lithrophosphorus, lapis solaris</i>	BaS obtained by calcination of BaSO_4 , shows phosphorescence.
	<i>Acidum fluoris mineralis</i>	hydrofluoric acid HF
	<i>Acidum salis, muratic acid</i>	hydrochloric acid HCl
	<i>Vitriolium romanum, sal (vitrioli) martis, iron vitriol, green vitriol, copperas</i>	Iron(II) sulphate $\text{FeSO}_4 \times 7\text{H}_2\text{O}$
	<i>Calx saturni, sal saturni, saccharum saturni, calcinated lead, lead salt</i>	lead foil kept in a warm place in a sealed vessel over distilled vinegar. It slowly turns into lead acetate $\text{Pb}(\text{CH}_3\text{COO})_2 \times 3\text{H}_2\text{O}$. Because of its sweet taste this compound was used to adulterate wine (lead sugar). L. VAN BEETHOVEN's death is thought to have resulted from lead poisoning by this route!

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Character	Name	Description
	Gr. <i>σανδαράκη</i> (<i>sandarákē</i>), Lat. <i>arsenicum rubrum</i> , sandarac, red arsenic, ruby of arsenic, ruby of sulphur, red orpiment	realgar As_4S_4
	<i>Sal ammoniaci</i> , salmiak	ammonium chloride NH_4Cl
	<i>sal nitri</i> , <i>sal nitrum</i> , nitre, saltpetre	KNO_3 (sometimes also wall saltpetre $\text{Ca}(\text{NO}_3)_2$). In the very early literature may also refer to potash, as the difference between these compounds was not understood.
	<i>Sal alkalinus</i> from Arabic <i>القالية</i> al-qalya = potash, Lat. <i>lixivium</i>	a mixture of K_2CO_3 and Na_2CO_3 from the ashes of marine plants, in particular saltworts (aka glassworts, various genera in the family of Amaranthaceae) or seaweeds.

continued on next page

Character	Name	Description
	<i>Sal gemmae</i> , rock salt	Sodium chloride NaCl
	Salt of antimony salt of hartshorn	Antimony sulphate $\text{Sb}_2(\text{SO}_4)_3$ Ammonium carbonate $(\text{NH}_4)_2\text{CO}_3$ (see also <i>sal volatile</i>) The aqueous solution is called <i>spiritus cornu cervi</i> = spirit of hartshorn
	<i>Natrum carbonicum</i> , <i>natrum præparatum</i> , <i>crystalli sodæ</i> , <i>sal sodæ</i> , <i>sal alkali minerale</i> , soda	sodium carbonate Na_2CO_3 . Historically mined in the soda lakes in Egypt and used for mummification and glass making. Also used to name other sodium salts, <i>i.e.</i> , soda of <acid>
	Salt water	
	Soap	sodium salt of mixed fatty acids
	<i>Mercurius sublimatus corrosivus</i> , sublimate of mercury	mercury(II) chloride HgCl_2

continued on next page

Character	Name	Description
𐤆𐤌𐤁𐤏𐤕𐤕𐤍	<i>Cerussa, plumbum hydrocarbonicum, flos plumbi, magisterium saturni, white lead, lead flower</i>	basic lead carbonate $\text{Pb}(\text{CO}_3)_2 \times \text{Pb}(\text{OH})_2$
○	zinc oxyde <i>Atramentum album, white vitriol</i>	ZnO zinc sulphate ZnSO_4

3 Concepts

Greek cosmology is described in the Τίμαιος (Tímaios) by Πλάτων ΠΛΑΤΩΝ (ca. 428–348 BC) [14], but goes back to earlier philosophers (Έμπεδοκλής Empedoklés ca. 490–430 BC, Δημόκριτος Dēmókritos ca. 460–370 BC). Assume a cube of some material, say, iron. This cube could be cut in halves, those halves into halves again, and so on. However, this is not possible *ad infinitum*, but at some point one would reach a limit, where further division is no longer possible. These smallest possible particles are called atoms (from Greek ἄτομος átomos = undividable). There are 4 kinds of atoms, shaped like those PLATONIC bodies constructed from triangles: tetrahedron, octahedron, icosahedron and cube. These different atomic shapes correspond to the 4 elements: the atoms of fire are tetrahedrons (prickly), soil cubes (tessellates Euclidean space and causes the solidity of the soil), water icosahedras (flows out of the hands like little balls) and air octahedrons (smooth, can hardly be felt). Each of those elements embodies a particular combination of the primary qualities hot – cold and wet – dry: air is hot and wet, fire hot and dry, soil dry and cold and water wet and cold. Air is gaseous, water liquid and soil solid, fire is consuming. Fire represents the male, water the female principle, air and soil are transition elements.

Each of the basic elements is also associated with one of the 4 bodily fluids that must be in balance to avoid disease, they also correspond to temperaments: blood – air – sanguinic, black gall – soil – melancholic, yellow gall – fire – choleric and slime – water – phlegmatic (humoral pathology, Ιπποκράτης Hippokrates 460–370 BC, Γαληνός GALENOS, 129–199 AD, أبو الحسين بن عبد الله ابن سينا Abū Alī al-Husain ibn Abd Allāh ibn Sīnā (Avicenna) 980–1037 AD).

The fifth platonic body – dodecaeder – is not composed of triangles, is considered the most noble and represents the cosmos or the spirit.

Alchemy had three goals:

- the preparation of chemicals, often in the context of practical purposes (e.g., metals and dyes). This is now handled

by chemistry.

- the preparation of medicines that can cure diseases. This is now dealt with by pharmacology.
- the transmutation of base metals (like lead) into noble metals like silver and gold (Gr. χρῦσός *chrūsós* = gold and ποιέω *poēia* = I make: *chrysopoeia* = gold making; ἄργυρος *árgyros* = silver: *argyropoeia* = silver making). Today we understand that this requires the transformation of elements (nuclei with different number of protons), which is not possible by chemistry. Nuclear physics can do so in particle accelerators by bombarding bismuth with high energy atoms to kick out 4 protons and 6–9 neutrons from the $^{209}_{83}\text{Bi}$ -nuclei to produce a variety of $^{79}_{79}\text{Au}$ -isotopes, of which only $^{197}_{79}\text{Au}$ is not radioactive [15]. Also, the process requires vast amounts of energy (worth about US\$ 5000 per h, for 1 d to produce a few thousand gold atoms) and is thus not cost effective. For true alchemists, however, transmutation was only a symbol for obtaining spiritual enlightenment by liberating ones essence from the worldly personality.

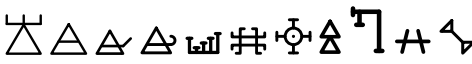







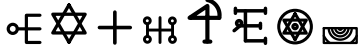
A good impression of alchemist working methods and chemical knowledge of the late 16th century gives [16], which should be read with the explanations in [17]. The alchemical work of the “last of the magicians”, ISAAC NEWTON, is discussed in [18]. For an extensive discussion of the laboratories and equipment used in various periods, see [19]. Direct translation of these old recipes into modern terminology, however, may not yield the expected result. The chemicals available to alchemists were often impure, and these impurities often formed a vital ingredient [20]!

Later authors added the quintessence, an eternal substance that forms the basis of the other elements. PHILIPPUS THEOPHRASTUS AUREOLUS BOMBAST VON HOHENHEIM (PARACELSUS) 1493–1541 [21] replaced the 4 elements from antiquity with the *tria prima* (original trias) mercury (volatile), sulfur (burning) and salt (stabilising). He didn’t mean the substances we take from the lab shelf, but their “philosophical” equivalent. Key to this was a hypothetical universal solvent, the *liquor alchahest*, which could extract philosophical elements from everyday material, which could then be purified and made available for recombination [22]. JOAN BAPTISTA VAN HELMONT (1579–1644) developed this idea further, before it eventually fell into disfavour. How would one contain a solvent that dissolved literally everything? The difference between dissolution and decomposition was shady before modern atomic theory!

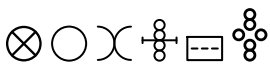

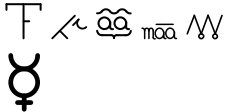


PARACELSUS based medicine on observation rather than philosophical book wisdom and explored the pharmaceutical use of minerals, complementing the plants suggested by GALENOS. He introduced the concept that substances toxic in higher doses may be curative in low (*dosis sola facit venenum* [23], only the dose makes the poison) and is the father of modern toxicology. In particular, he experimented with mercury against the “French disease” (syphilis), but the results were, at best, variable. It is thus not surprising that PARACELSUS died from chronic exposure to mercury vapours as attested by the Hg-concentration in his bones.

Note that philosophical sulphur, salt and mercury have nothing to do with the chemicals we know under those names. For example, according to FRATER ALBERTUS SPARGYRICUS (worldly name ALBERT RICHARD RIEDEL, 1911–1984), all three can be isolated from sage leaves (“mountain sage”, genus *Salvia* L. (Lamiaceae), unclear exactly which of the 900 species is meant). The leaves are first subjected to steam distillation to get the essential oil (= alchemical sulphur), the leaves are then fermented and the alcohol formed rectified (= alchemical mercury). The remainder is calcinated, extracted with water and crystallised to get potash (= alchemical salt).









Production of the philosopher’s stone goes through phases distinguished by their colour: black (*caput corvi* = raven head), iridescent (*cauda pavonis* = peacock tail), white (*albedo*, the product is now able to transmute base metals to silver), yellow (*citrinalis*) and finally scarlet red (*rubedo*, *sol filosoforum*, phoenix). Before use, the phoenix should be diluted with thousand-times the amount of gold by melting them together, lest it be too strong.

Character	Name	Description
	Air	“Invisible Air which existed before the descent of Lucifer”
	Amen	word of power
	Aleph, beginning	
	Black gall	4-fluid theory
	Blood	4-fluid theory
	Death	
	Dry	
	Duality	
	<i>Elementum</i> = element	all 4 classical elements (Fire, air, soil and water) together

continued on next page

Character	Name	Description
	<i>Materia prima</i>	first, yet unformed principle, source of all matter
	Matrimony	the pact between the four elements underlying the phenomena of nature. Alchemists create a different marriage by their art.
	<i>Materia</i> , matter philosophical mercury	<i>Azoth</i> , mercury from the <i>tria prima</i> sulphur, mercury and salt. Combines the properties “liquid” and “metal” in ideal form.
	<i>Monas</i> , Monad	founding principle. The monad is for numbers what the point is in geometry [24]
	Gr. Οὐροβόρος <i>ourábóros</i> , self-eater	snake of eternity, circle of the alchemist processes heat, evaporate, cool, condensate. The Miðgarðsormr (Jörmungandr, world serpent) of Germanic cosmology and the Kirtimukha in India may go back to the same very ancient myths.

continued on next page

Character	Name	Description
	<i>Aqua pluvialis</i> , rain water <i>Aqua rorida</i>	used instead of distilled water dew water
	Sea water	
	<i>Oleum talci</i> , oil of talc	intermediate (white) stage of producing the philosophers stone, can transmute base metals to silver
	Humidity	
	Seven metals of alchemy	copper/venus, gold/sun, iron/mars, lead/saturn, mercury, silver/moon, tin/jupiter
	<i>Sulphur philosophicum</i> , wise man's sulphur	sulphur from the <i>tria prima</i> sulphur, mercury and salt
	Red sulphur	hypothetical compound that represents the union of the male (philosophical sulphur) and female (philosophical mercury) principles to reach completeness
	Yellow gall	4-fluid theory

4 Elements

The alchemist's idea about elements (atoms shaped like different PLATONIC bodies) was very different from ours (different number of protons in the nucleus). In the following, we list elements in our modern understanding. Even then, however, there can be misunderstandings. "Regulus of antimony" is quite clear, a drop of antimony left after purification. However, "regulus of iron" and "regulus of copper" also mean antimony, but made by reducing antimony oxyde with iron or copper,

Character	Name	Description
Ⓐ Ⓢ	<i>Niccolum</i> , nickel	derived from the word for devil, as nickel look like copper ores, deceiving miners
Ⓢ	Phlogisticated air, nitrogen	
Ⓢ	Oxygen	
Ⓢ	Phosphorus	
Ⓢ	Platinum	
Ⓢ	Potassium	
Ⓢ	<i>Regulus martis</i>	Antimony prepared by reduction with iron
Ⓢ	Silicon	
Ⓢ	Lat. <i>argentum</i> , <i>corpus album</i> , <i>fermentum album</i> , <i>lumen minus</i> , <i>mater</i> , <i>Diana</i> , <i>uxor odoriter</i> = silver	
Ⓢ	Silver filings	
Ⓢ	silver leaf	
Ⓢ	Silver splint	
Ⓢ	Sodium	

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Character	Name	Description
⊕	Strontium	
⚱	Sulphur	
⚱	<i>Sulphur vivum, sulphur virgineum</i> , natural sulphur	naturally occurring sulphur, considered “alive”
⚱	<i>Sulphur sublimatum, flores sulphuris</i> , Flowers of sulphur	sulphur purified by sublimation as opposed to <i>sulphur vivum</i>
♁	Tellur	
♁	<i>Stannum, plumbum stridens</i> , Tin	

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Character	Name	Description
𐎲𐎠𐎧𐎺𐎠	Tin filings	
𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠	Tin leaf (staniol), tin sheet	
⊕	Yttrium	
𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠	Zinc	
𐎲𐎠𐎧𐎺𐎠	Zirconium	

5 Measures

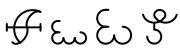


Units for weights and volumes were variable between countries and even cities within a country. The following may be used as approximate guidelines [25]:

Character	Name	Description
𐎲𐎠𐎧𐎺𐎠	Dram	1 dram \approx 3.6 mL
𐎲𐎠𐎧𐎺𐎠	Half-Dram	
𐎲𐎠𐎧𐎺𐎠	Gutta, drop	considered 1 grain in weight
𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠	libra, pound	1 pound = 16 ounces = 480 g
𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠	libra semissis = half a pound	
𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠 𐎲𐎠𐎧𐎺𐎠	uncia, ounce	1 ounce = 2 Lot = 8 drachma = 30 g

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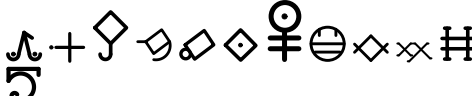

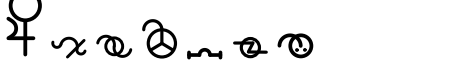
Character	Name	Description
℥	Half-Ounce	
℥	drachma	1 drachma = 3 scruple = 3.75 g
ʒ	scrupulus, scruple	1 scruple = 20 grain = 1.25 g
gr	grain	1 grain = 62.5 mg
℥	pugilum, pinch	what can be held between thumb and two fingers, ≈ 1 g
℥	ana, equal parts	
℥	Grade	
℥	Part	as in one part of A and two parts of B
℥	Pint	between ≈ 250 mL and > 2 L depending on country. In Britain 1/8 of a gallon.
℥	Quantum satis, quantum sufficiens, enough, sufficient	
℥	Quantum vis, as much as you wish	
℥	half	
℥	manipule	handfull, with the open hand

continued on next page

Character	Name	Description
	<i>poignée</i> <i>fascicule</i> = bundle, armfull	fistfull, with a closed hand what can be carried with both arms
	<i>Sextarius</i>	Roman measure of volume, 1/48 of a cubic foot 1 ft \approx 29.6 cm \rightarrow 540.3 mL
	Spoonful	

6 Metals

Note that many alchemists did not strictly differentiate between copper, brass and bronze (similar to the outdated English term 'latten'). Thus, the signs for these, and even the Latin word *æs*, may simply mean "metal".

Character	Name	Description
	<i>Amalgama</i> , amalgame	alloy containing mercury
	Gr. <i>ορείχαλκος</i> <i>oreíchalkos</i> from <i>ὄρος</i> <i>chalkós</i> = mountain ore, Lat. <i>aurichalcum</i> , pinch beck, Prince Rupert's metal, bath metal, primus metal, princes metal	brass from 4 parts copper and 1 part zinc, used for coins because of its golden colour
	brass	alloy of copper and zinc
	Bronze	alloy of copper and tin

continued on next page

Character	Name	Description
♀	bell metal	Simple bell metal is is a bronze of 78 % copper (Discriminating) and 22 % tin (All-Accomplishing), the alloy has low internal damping and sound velocity. Other metals may be added in small amounts: Zinc (mirror-Like), iron (equality), lead, gold and silver (absolute and relative Truth).
♂	crude metal	
⚗	Electrum	naturally occurring alloy of gold and 10–30 % silver plus copper, iron and other components
♂	<i>Ferrum auretteum</i>	
♀	Gilded copper	
♂	Gilded silver	
♂	Magnesia of gold	brittle amalgame formed when gold foil is hung over mercury.
♂	Magnesia of silver	silver amalgame
⚗	Metal	
⚗	μόλυβδοχαλκος molybdochalkos	alloy of 10 % copper and 90 % lead already used in ancient Egypt. Used on striking surfaces, where the soft lead acts as grease.

continued on next page

Character	Name	Description
⚡ ⚡ ⚡	<i>Cornu cerui ustum</i> , calcinated hartshorn	horn of male deer hung over boiling water until they softened (philosophical calcination).
⊖ ♂	Conch	
⊖ ⊞ ♀	Coral	from Gr. κοράλλιον korállion
< ⦿ ∩ ⊖ □	Egg shell	
‡ ∞ ⦿ ⊖ ⊕ ♀ ⊙ ∞	Egg white, albumen	also Lat. <i>album</i> = white, with the usual connotation of cleanliness and purity.
⚡ ⊞ ♂ ∞ ♀ ∞	Lat. <i>vitellus</i> = egg yolk	
⦿ ⦿ ⦿ ⊞ ⊕ ∞ ∞ ∞ ∞ ∞ ∞	Honey	
⦿ ⊞ ∞		
♀ ⦿ ⦿ ⦿ ⦿ ⦿ ⦿ ⦿ ⦿ ⦿ ⦿	<i>Fimus equi</i> = horse dung	used to keep samples warm, also leftover of an experiment
E ⊞	Milk	
∪ R	Pearl	
∪ ⊖	Skull	especially human
⊞	<i>Urina</i> , u rine	
⦿ ∇ ⦿ ∇ ∞ ∇ ∞ ∇ ∞ ∇ ∞	Lat. <i>Cera</i> = wax	

continued on next page

Character	Name	Description
♀♂	Wool	

7.2 Of mineral origin

7.2.1 Ores

Character	Name	Description
♂	Antimony ore	stibnite Sb_2S_3 from Lat. <i>stibium</i>
♀	Bismuth ore	bismuthinite Bi_2S_3 or bismite Bi_2O_3 ?
♀♂	<i>æs vel cuprum</i> Copper ore copper pyrite	
♀♂	<i>Marcasita cobrena</i> , iron copper ore	chalcopyrite CuFeS_2
♂	Iron ore	
♂♀	<i>Colcotharum Paracelsi</i> , hæmatite, blood-stone, jeweler's rouge, Falu red	iron(III) oxyde Fe_2O_3 , either of natural origin or the calx left after distilling oil of vitriol (sulphuric acid) from green vitriol (iron sulphate).
♀	<i>Lapis calaminaris</i> , <i>silex calaminaris</i> (for the finely ground material), calamine (outdated). Corrupted from Gr. $\kappa\alpha\delta\mu\acute{\iota}\alpha$ (kad-míā).	old name for either smithsonite (ZnCO_3) or hemimorphite ($\text{Zn}_4(\text{Si}_2\text{O}_7)(\text{OH})_2 \times \text{H}_2\text{O}$), which often occur together. For the pharmaceutical use of 'calamine' see table 7.4



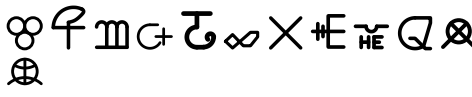

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Character	Name	Description
▽	Absorbent earth, diatomaceous earth, cel- ite or kieselgur	
⊗	Agate	semiprecious stone, used to make mortars and pestells
𐌰𐌶	Amber	fossile tree resin
✚	Amethyst	Quartz (SiO ₂) coloured purple by Fe ⁴⁺ - defects
⚡	Gr. ἄσβεστος asbestos = indestructible	fibrous mineral Me ₇ ²⁺ Si ₈ O ₂₂ (OH) ₂ , with Me = Fe, Mg, Ca, some of the metal may be replaced by Na ⁺ or Fe ³⁺
△	<i>Asphaltum</i> , bitumen	sticky, black, highly viscous liquid or semi-solid form of petroleum
⚡	<i>Sulphur nigrum</i> , black sulphur	residue left after (volcanic) sulphur was sublimated away (brimstone)
⚡	<i>Bolus armenus</i> , <i>bole armoniac</i> , <i>rubrica syn-</i> <i>opica</i>	Armenian bole. Red clay from Armenia, used medically, also for tooth cleaning, ceramics painting and as base for the gild- ing of books.
⚡	Bole	Bole = medicinal earth. Adheres to the tongue when applied dry. Coloured yel- low and red by iron oxide.




continued on next page

Character	Name	Description
♀♀	<i>Lapis prunellae</i> , Chinese saltpetre	potassium nitrate KNO_3 from fossil bat guano, often contaminated with the sulphate. Mined, but also synthetically produced by reacting wall saltpetre ($\text{Ca}(\text{NO}_3)_2$, from rotted dung heaps) with potash (K_2CO_3).
⊙	<i>Lapis pumex</i> , <i>spuma maris</i> , pumice	volcanic glass with air bubbles (2/3 – 3/4 by volume), composed mostly of silicates. Finely powdered used as abrasive to remove calluses, as exfoliant or for toothpaste. Officinal was the light-coloured variety.
◦◦ ✂ ✂	<i>Lapis silex</i> , flint stone	sedimentary cryptocrystalline form quartz, used to make stone tools
⚔ ◦◦	<i>Lapis silex ustus</i> , heated flint stone	flintstone slowly heated to 150–250 °C and then allowed to cool over night. Prevents flint tools from shattering easily.
✂	from Gr. ὤχρος (<i>ōkhrós</i>) = 'pale', ochre	clay stained yellowish to brown to red by different amounts of iron, the darker siena and umbra contain in addition manganese.
— ㄣ ㄣ ㄣ ㄣ ㄣ	Yellow ochre	hydrated ferric oxide ($\text{Fe}_2\text{O}_3 \times \text{H}_2\text{O}$)
☾	Gr. ὄνυξ onyx = finger nail	parallel banded variety of chalcedony, a silicate (SiO_2). Gems from onyx were worn to give eloquence or help mothers in childbirth.

continued on next page

Character	Name	Description
	from Sanskrit उपल <i>úpala</i> = “precious stone” over Gr. ὀπάλλιος <i>opállios</i> = “to see a change in colour” to Lat. <i>opalus</i> , opal	hydrated amorphous form of silica ($\text{SiO}_2 \times n \text{H}_2\text{O}$), the play of colour is caused by diffraction and interference on the regular layers of 150–300 nm silica beads in cubic closed packing. Strain causes double refraction.
	Ophite, <i>verde antico</i> , <i>marmor thessalicum</i>	breccia from serpentine, calcite, dolomite and magnesite. Takes a high polish and is used as facing stone in construction, also for statues.
	Lat. <i>Crystallus</i> , quartz	Finely ground it was used orally against dysentery, bowel obstruction, bladder and kidney stones and to increase milk production in lactating females. None of these effects is clinically proven.
	<i>Rubeus</i> = ruby	red variety of corund (aluminium oxyde, Al_2O_3). The red colour is caused by Cr^{3+} replacing several % of the smaller Al^{3+} ions, thus the d-d transitions require more energy than usual for chromium, shifting the colour from green to red. In UV-light, rubies fluoresce red. The ruby is associated with the blood of Christ and considered the “stone of stones”, which combines the magical power of all other stones. Ruby was the first material used for lasers [27].






continued on next page

Character	Name	Description
	<p>Talcum</p> <p><i>Terra lemnia, lemnia sphragis, limnia miltos, terra sigillata, lemnian earth, sealed earth</i></p>	<p>Soil from the island of Lemnos prepared by slurring and settling to separate the soil from sand and gravel. The soil was dried and cut into small troches, each carrying the seal of Artemis. Used as universal antidote, to accelerate wound healing and against parasites. According to modern investigations, it contains no healing components.</p>
	<p>Terrestrial</p> <p>from Gr. Τοπάζιος <i>Topázios</i> via Lat. <i>Topazius</i> = St. John's Island in the Red Sea, where a precious stone now believed to be olivine was mined. Alternatively Sanskrit तपस् <i>tapas</i> = fire. Topaz</p>	<p>island silicate (no Si-O-Si-bonds) $Al_2SiO_4(F, OH)_2$.</p>
	<p>Turquoise</p>	<p>$CuAl_6(PO_4)_4(OH)_8 \times 4H_2O$, forms a solid solution with chalcociderite, where the Al is replaced by Fe. Gem stone highly priced in several ancient cultures as lucky charm.</p>

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Character	Name	Description
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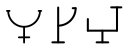

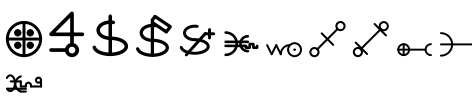



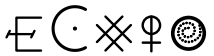
7.3 Of plant origin

Character	Name	Description
 	Anise from Gr. ἄνηθον (anēthon) = scent dyer's alkannet (bugloss)	<i>Pimpinella anisum</i> L. (Apiaceae) root of <i>Alkanna tinctoria</i> (L.) 1753 Tausch 1824, (Boraginaceae)
	Balm	oily or resinous liniment containing essential oils. May also refer to plants of either genus <i>Melissa</i> or <i>Monarda</i> . Sometimes also used for the <i>elixir of life</i> that can heal all diseases and even resuscitate the dead.
	<i>Oleum Christi Palmi</i> , castor oil	fatty oil pressed from the seeds of the castor bean or palm of Christ (<i>Palma Christi</i> , <i>Ricinus communis</i> L., Euphorbiaceae) and traditionally used as laxative. The cake left-over from pressing is highly toxic (ricin)!
	Celandine	Plant, unclear whether this means the greater celandine or swallowwort (<i>Chelidonium majus</i> L., Papaveraceae) used against warts or the lesser celandine or pilewort (<i>Ficaria verna</i> HUDS. 1762, Ranunculaceae), used against hæmorrhoids

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Character	Name	Description
☞	<i>Sanguis draconis</i> , dragon blood	deep red resin from various plants of the genera <i>Dracaena</i> , <i>Daemonorops</i> , <i>Croton</i> or <i>Pterocarpus</i>
⌘	Essential oil	volatile component from plants that smells like the plant itself. Often obtained by steam distillation.
☺	Flour, meal	ground edible parts of grains and pulses; may also refer to any fine powder
⌘	Gr. ζιγγίβερις zingiberis probably from Sanskrit śṛṅgavera, Lat. <i>gingiber</i> , Ginger	<i>Zingiber officinale</i> ROSCÖE, Zingiberaceae, officinel is the root <i>Zingiberis rhizoma</i>
☞	Gum arabic	hardened sap of either the gum acacia (<i>Senegalia senegal</i> (L.) BRITTON 1930) or the red acacia, (<i>Vachellia seyal</i> (DELILE 1813) P.J.H.HURTER), both Fabaceae. Consists of a complex mixture of glycoproteins and polysaccharides, predominantly polymers of arabinose and galactose.
☞	Heliotrope, valerian	<i>Valeriana officinalis</i> L., Caprifoliaceae. Preparations of the root (<i>Valerianae radix</i>) are said to have sedative and anxiolytic effects.
☞	Horseradish oil	The root of horseradish plant (<i>Armoracia rusticana</i> (L.) G.GAERTN., B.MEY. & SCHERB. 1800, Brassicaceae), when injured, produces allyl isothiocyanate from sinigrin. This mustard oil irritates mucous membranes.




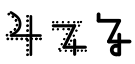

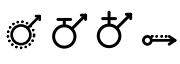

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Character	Name	Description
   	<p><i>Radix</i> = root</p> <p>rose colour</p> <p>Rubber</p> <p>Arabic زعفران; za'farān, Lat. <i>safranum</i>, <i>Crocus aromaticus</i>, saffron</p>	<p>stigma and styles (threads) of the saffron crocus <i>Crocus sativus</i> L., Iridaceae), coloured bright yellow by crocin (a carotinoid) and flavoured by picrocrocin and safranal (monoterpenes). These signs refer to the botanical term, for the alchemical see "crocus" in the compound section 2. 2</p>
 	<p>sap</p> <p>Gr. τερέβινθος terebinthos, crude turpentine</p>	<p>juice of plants</p> <p>oleoresin of the turpentine tree <i>Pistacia terebinthus</i> L. (Anacardiaceae), the volatile components are the turpentine oil, the non-volatile rosin (Κολοφωνία ρητίνη <i>Kolophōnía rhētínē</i> colophony).</p>
	<p><i>Lignum</i> = wood</p>	
7.4 Other		
Character	Name	Description
	<p><i>Cineres</i>, ash</p>	

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Character	Name	Description
⚞ Δ N √	<i>Plumbum ustum</i> , ashes of lead, burnbed lead	“Lead suboxyde” Pb_2O formed on molten lead exposed to air is actually a mixture of lead and its oxyde. Further oxydation leads to PbO used for lead glass and translucent ceramics glazing.
Λ	ashes of tin	SnO_2 used for glazed pottery (faience) obtained by adding SnO_2 to PbO glazing, turning it opaque and white.
Ⓔ	ashes of wood	mineral components of plants
♀ ⚔ ⊕ ☿ ✂	<i>Aurum potabile</i> , drinkable gold, extract of gold	Either colloidal gold produced from $AuCl_3$ and a reducing substance like hydroxymethylfurfural obtained by pyrolysis of honey. Particle size and colour of the colloid depends on reactant concentration. Alternatively, a menstruum that contains the “soul” (colour) of gold, but no longer its “body” (metal), that is, the alchemist gets the unchanged gold back after the operation is completed. Quack medicine.

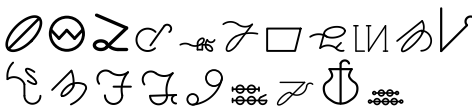



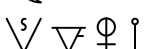

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Character	Name	Description
	<i>Lapis bezoardicus occidentalis</i>	bezoar in the llama (<i>Camelus glama</i> L. 1758, (Camelidae)), consists mostly of calcium phosphate
	<i>Lapis bezoardicus orientalis</i>	bezoar found in the bezoar ibex (<i>Capra aegagrus aegagrus</i> ERXLEBEN 1777, (Bovidae)), which occurs in the Caucasus and the Zagros Mountains. Consists mostly of organic acids from plants. Bezoars were so valuable that the export of the ibex was punished by death!
	<i>Bezoardicum minerale</i>	Antimon(III,V)-oxyde Sb_2O_4 produced by the action of aqua fortis (nitric acid) on butter of antimony (antimony trichloride) without additions. Has a diaphoretic effect thought to cleanse the body from poison.
	<i>Bezoardicum joviale</i>	<i>Bezoardicum minerale</i> with addition of tin oxyde
	<i>Bezoardicum lunare</i>	<i>Bezoardicum minerale</i> with addition of silver oxyde
	<i>Bezoardicum martiale</i>	<i>Bezoardicum minerale</i> with addition of iron oxyde
	<i>Bezoardicum solare</i>	<i>Bezoardicum minerale</i> with addition of gold.

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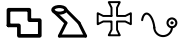

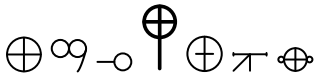


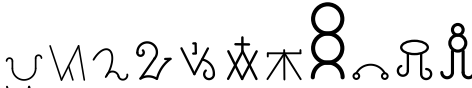




Character	Name	Description
	<i>Bezoardicum saturninum</i>	<i>Bezoardicum minerale</i> with addition of lead.
	<i>Bezoardicum venereum, turbith minerale</i>	bright yellow basic mercury sulphate $\text{HgSO}_4 \times 2\text{HgO}$
	Blackmal, niello	used for painting on silver and gold. A mixture of Ag, Cu, Pb, S was molten; the resulting mixed sulphide ground, wetted with ammonia and added into engravings in the metal. After firing (lower melting point of mixtures!) the ornament was polished.
	Black soap (<i>ose-dudu</i>)	soap made with plant ash for saponification, from West Africa
	Brick	
	<i>Later cibratus, farina laterum</i>	powdered brick
	Calamine	either zinc oxyde ZnO or basic zinc carbonate $2 \text{ZnCO}_3 \times 3 \text{Zn(OH)}_2$ used as cosmetic. There is an addition of about 2 % iron(III) oxide to give a colour like skin. The effect is covering, astringent and antiseptic. Also available wetted with water as lotion. For the mineral calamine/kad-mia see table 7.2.1

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Character	Name	Description
	<i>Lutum sapientiae, lutum philosophorum</i> = philosophical glue	used to hermetically seal reaction vessels (lutation). Also used for alchemy as “hermetic art”.
	Gold paint	gold or, more commonly, brass particles in varnish. Not to be mixed up with <i>aurum musivum</i>
	Ink	
	Liquor	
	<i>Menstruum</i>	liquid solvent that is able to dissolve solid substances or extract an active component or principle from it. A <i>menstruum particularia</i> is a specific solvent for one particular solute, a <i>menstruum universale</i> dissolves everything.
	<i>Mercurius soli, mercurius auri</i> , mercury of gold	gold was dissolved in <i>aqua regia</i> , the solution of $\text{HAu}^{\text{III}}\text{Cl}_4$ evaporated to oily consistency (conc. $\text{Au}^{\text{III}}\text{Cl}_3$), some of which decomposes to $\text{Au}^{\text{I}}\text{Cl} + \text{Cl}_2$. The mixture (gold(I, III) chloride Au_4Cl_8) is red, almost black (black stage) and on further heating decomposes to amorphous Au^0 . Reduction of gold chlorides (for example with hydroxymethylfurfural from the pyrolysis of honey) produces colloidal gold solution of various colours (red stage), this corresponds to <i>aurum potable</i> [17, 29]. The name <i>Mercurius soli</i> is used for both the $\text{Au}^{\text{III}}\text{Cl}_3$ and to the colloidal gold, but only the latter can be consumed safely.

Character	Name	Description
☿ ♀	<i>Mercurius vitae (antimonii)</i> , mercury of life	mixture of antimony oxy-chloride and antimony oxides (Sb_2O_3 ; Sb_2O_4 , Sb_2O_5 , SbOCl).
♂ ☿ ♀ ☿	<i>Mercurius lunae</i> , mercury of silver red oil of antimony	AgCl or Ag_2CO_3 antimony glass dissolved in distilled acetic acid and hydrolysed with water, yielding insoluble antimony oxyde. However, iron present as impurity forms iron acetate, which dissolves in spiritus vini with red colour. The “oil” is analytically free of antimony and probably the only “antimony” preparation that can be ingested without danger for life and limb [20].
♂ ☿ ♀ ☿	oil of gold	preparation, that still has the spirit (colour) of gold, but no longer the body (metal). Was prepared with gold as catalyst, but that gold was quantitatively recovered. Quack medicine.

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Character	Name	Description
	Smoke	
	<i>Fuligo</i> = soot	finely distributed carbon
	<i>Sulphur tartaris, tinctura sulphuris</i>	Alcoholic extract of sulphur. Quack medicine, as sulphur is insoluble in ethanol.
	<i>ærugo, æs viride, verdigris, Spanish green</i>	green patina on weather-exposed copper: cupric oxyde, hydroxyde, acetate, chloride. Used for illuminating books.
	<i>Vinum</i> , wine	used for any pottable fluid produced by fermentation
	<i>Vinum rubrum</i> , red wine	
	<i>Vinum album</i> , white wine	
	boiling wine	
	Spanish wine	
	<i>vinum Hippocraticum</i> , Hippocras	red or whitze wine, heated with spices and sugar, then filtered through a conical sleeve, the <i>manicum hippocraticum</i> .
	<i>Vinum adustum</i> , sugar cane juice (<i>caldo</i>) fermented to make <i>garapo</i> and “burned” (distilled)	Rum

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Character	Name	Description
☉ ☽ ↓	<i>Vinum circulatum</i> Lat. <i>Vinum coctum</i> , Fr. <i>vin cuit</i> , Turkish <i>Üzüm pekmezi</i>	grape juice, reduced to 1/2 – 1/4 of the original volume, used to spice gravy and to make sweets
☿	<i>Vinum medicatum</i> medicated wine	often with bitter herbs (<i>Cinchona spec.</i> (Rubiaceae, fever trees), <i>Marsdenia condurango</i> (Apocynaceae, condurango), <i>Cinnamomum spec.</i> (Lauraceae), <i>Gentiana spec.</i> (Gentianaceae, gentian) to increase appetite, but also with other herbs.
♊ ♋	<i>Vinum laxativum</i> , purgative wine	

8 Process

As mentioned, the *opus magnum* of gold making is really only an allegory of the journey to self-knowledge and, yes, eventually also to god [30, 31]. It required moral characteristics like faith, devotedness, diligence and discreteness, but beyond that also an accreditation by God [32]. For various authors the *opus magnum* would take 7 days (like creation), 9 months (like pregnancy) or one year (like the cycle of nature).

Calcination exposure of a sample to high, dry heat in the absence of oxygen /roasting is the equivalent with air access). Many substances under these condition loose weight, turn white and become easy to grind. First (black) stage of the *opus magnum*. The colour black represents chaos and death, and that what is hidden or buried, the *materia prima* from which all other things may be obtained. Spiritually, calcination means burning off our attachments to the world: the desire for status, fame, wealth and identity. Our preconceived notions about ourself are put to the test by fire, in an existential crisis, in the *dark night of the soul*. However, calcination cannot only be achieved by an actual, but also by a potential (corrosive chemicals) or philosophical fire (materials hung over boiling water until they softened).)

Decoction boiling of chopped, hard plant materials (wood, bark, roots), usually in water, for about 1–2 h. From Lat. *decoquere* "to boil down". If the boiling water is merely poured over the plant material and left to soak for 5–10 min, we

speak of *infusions*, this is used for soft plant material like flowers or leaves. *Percolation* means that the boiling water is filtered through the (often ground) material. In either case, about 1 teaspoon of material is used per cup.

Dissolution forming a solution. In the *opus magnum*, the ashes obtained during calcination are extracted with water, the symbol of the unconscious or hidden. In European alchemy this is seen in analogy to the creation report in Gen 1₂: *And the Spirit of God moved upon the face of the waters*. Spiritually, we free ourselves from our inauthentic and acquired traits. The dissolution stage involves freeing repressed emotions from traumatic events that we have pushed down into our subconsciousness (dissolution of the ego [31]), and can be a cathartic step.

Separation is the 3rd stage of the *opus magnum*, where the products of dissolution are filtered and separated. Whilst the first stages were associated with the elements fire and water, this one is associated with air. The pure essence is extracted from the mixture. Spiritually, we leave our acquired personality in form of engrained thought processes and emotional triggers to become our true, essential self. Collect all the things in you that are helpful for yourself and for others, and let go of everything else. After the turmoil of the first steps, we can now enjoy the stillness of being removed from all that is inauthentic and artificial.

Conjunction means bringing together the elements purified in the first three stages by fire, water and air in the sign of the soil. Spiritually, we bring what is left of us together to form a new, authentic personality. The conflict of dualities like body and soul, spirit and matter, conscious and unconscious are resolved. Feminine qualities like emotion and intuition join male like intellect and logic.

Fermentation exposure to microorganisms for longer time to achieve a chemical reaction and remove what is no longer needed.

Putrefaction leaving a sample undisturbed, often after adding the desired material (seed). Both fermentation and putrefaction form the 5th stage of the *opus magnum*: the removal of the old, unauthentic self. This process can be painful, but we cannot see dawn before we have gone through the darkest of nights.

Distillation process of vaporising and then condensing a substance. The different boiling points of the components of a mixture are used for purification of the essence. In spiritual alchemy, our core identity is freed from any inferior elements. The ego is no longer dominating, so that the soul can be heard.

Coagulation old term for crystallisation. The result is the philosopher's stone. Spiritually, the self comes together in a healing process. This is called *rubedo*. This word also refers to the state achieved by the mage where he is fully attuned to the *anima mundi*, the fountainhead of creation and source of the *prima materia*.

Apart from the processes involved in the *opus magnum*, the following methods were used by alchemists:

Ceration allowing a hard, dry substance to absorb water while it is heated (imbibition) for the purpose of softening it (from Latin *cera* = wax).

Circulation The sample is heated, any vapours produced are condensed and drip back into the reaction vessel.

Cohobation A sample is distilled, the collected volatile components are added back to the residue and the process is repeated. Not used in modern chemistry.

Cupellation Separation of noble from base metals. The sample is molten in a crucible from calcareous material like bone ash to oxydise base metals, the molten oxydes are wicked away by the crucible and a regulus of the pure noble metal remains. The process may also be used to assay the noble metal content of a sample.

Digestion heating a sample in an open vessel for long times, but without boiling it.

Disposition

Dissolve disperse a solute in a solvent to make a solution. Contrary to dissolution, it is expected that the solute is (at least almost) completely soluble in the solvent (if enough solvent is added), whilst dissolution intends to separate the sample into a soluble and insoluble fraction.

dulcify remove soluble, in particular acidic, components by extraction with water

Fixation turning a volatile compound into a solid that does not lose weight in fire

Lixivation extraction to separate soluble and insoluble material. The soluble product is the *lixivium*

macerate soften by steeping in liquid, with or without heat

Multiplication increasing the potency of an elixir or philosopher's stone, often by repeating the process by which it was originally obtained

Precipitation letting a solid form from a solution and collecting it.

Projection process of transmuting base metals to gold using the philosopher's stone

Purify increasing the concentration of a particular substance, if possible close to 100 %.


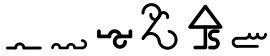
Regulus formation getting the pure form of a metal (especially antimony) out of an ore. The left-over is called *scoria* or *slag*.

Solution one component (solute) is homogenously dispersed in a second component (solvent, usually, but not necessarily, a liquid).

Sublimation heating a substance to turn it from the solid directly into the gaseous state and back, without forming a liquid first. The sublimate is called "flower".

Tincture extract in alcohol.

Trituration grinding several substances together to obtain a homogeneous powder with reduced particle size. For example, hormones are often effective in very small doses that cannot be handled. Triturating them with a several hundred- or even thousand-fold excess of an inert material, say sugar, solves that problem.

Character	Name	Description
	Abstract	
	Annealing	often used synonymous with calcination, but may mean "fusing together" (e.g., enamel) or "change the microstructure" (e.g., metallurgy) or "remove stress" (e.g., glass)

continued on next page

Character	Name	Description
Ÿ M	Together	
W	Transform	
Ÿ	Trituration	

9 Time

Character	Name	Description
Ÿ M 24	Autumn	
Ÿ M 24	Day (as in daylight hours)	
Ÿ M 24	Day and night (24h)	
Ÿ M 24	Evening, sunset	
Ÿ M 24	Hour	
Ÿ M 24	Minute	
Ÿ M 24	Month	

continued on next page

Character	Name	Description
♂	Morning	
♀	Night	
♂ ♀	Spring	
♂ ♀ ♀ ♀	Summer	
☐	Week	
☐	Winter	
♂ ♀ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Year	
♂ ♀ ☐ ☐	<i>Annus philosophicus</i> philosophical year	equals an <i>mensis vulgaris</i> = ordinary month

10 Tools

Alembic from Greek ἄμβιξ ambix = beaker over Arabic الإنبيق al-inbīq is a distillation apparatus consisting of two vessels connected by a bridge with downward-sloping tube (σωλήν sōlēn). In the fist (cucurbit from βῆκος bēkos) a sample was heated, the second (receiver, from φιάλη phialē over Arabic قَابِلَة qābila) received the vapours condensed in a connecting tube. Its invention is attributed to MARIA PROPHETISSA of Alexandria in the 1st century AD (variously also called MARIA THE JEWESS or MARIA THE COPT). The bridge of modern chemical glassware is the closest equivalent. The pot still used in modern alcohol production is derived from the alembic.

Athanor furnace with three chambers, for ash, fire and sample. They were constructed from bricks held together by clay. From the 16th century onward, the temperature could be regulated by variable slits for air, the *Piger Henricus* (Lazy Henry) had an opening from which the charcoal could drop into the fire chamber automatically, so that the alchemist did not have to tend the fire every few hours.

Balneum mariæ hot water bath allegedly invented by MARIA PROPHETISSA and still used to keep food warm in refectories and the like (*bain de Marie*). It consists of an outer vessel half-filled with a hot fluid (usually water) and an inner vessel

that is filled with the material to be kept warm and immersed in the fluid of the outer vessel. The material in the inner vessel is kept at a constant temperature, without hot or cold spots. Sometimes also called by the malapropisms *balneum maris*, *balneum virginis*.

Balneum roris, balneum vaporosum steam bath. Used for medical purposes to evaporate essential oils to be breathed by the patient, but also for temperatures in between the water bath (*balneum mariæ*) and the sand bath (*balneum arenæ*, constructed like the *balneum mariæ* but with sand instead of water).

Caduceus is the staff of Hermes (Gr.) = Mercury (Lat., god of traders and thieves) with two snakes and wings. It should not be mixed up with the staff of Asclepios (Son of Apollo) with one snake and no wings, which is a symbol of medicine. The astrological/alchemy sign of Mercury is an older version of the caduceus, with the snakes protruding from the staff (originally two branches wound together by envoys, similar to our *white flag*).



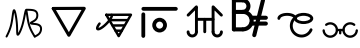






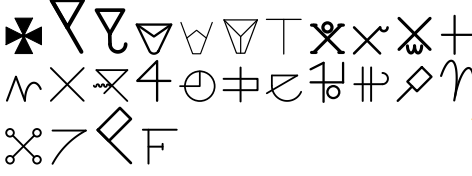
Matrass glass flask with a round body and a long neck

Retort (from Lat. *retortus* = curved backward) glass vessel used by alchemists. Heating it was an art in itself, as the soda-lime glasses available at the time were liable to crack when heated unevenly. In the modern chemical industry, vessels of any shape and material used for pyrolysis are still called retort (production of shale oil, charcoal, recovery of Hg in gold mining). In the laboratory, the LIEBIG condenser has largely replaced the retort.


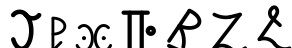

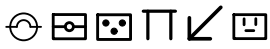







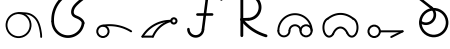

Reverberatory furnace metallurgical oven where the fire and sample chamber are side-by-side. The heat and flue gasses are reflected into the sample chamber and from there into the flue. This separates the sample from the fuel (unlike the blast furnace), but not the flue gasses and fly ash. The SIEMENS-MARTIN oven is a special kind of reverberatory furnace, where oxydising flue gasses are used to remove the carbon and thus convert pig iron to steel (puddling).

Scepter of Jove or bident, a pitchfork-like instrument with two prongs, was used in Roman time for the consecration of a place struck by lightning. It is probably a symbol for Jupiter's lightning bolt. The name may be derived from the young sheep sacrificed in the ritual (so young as to have only two teeth). The bident is also the symbol for Hades (Pluto), the god of the underworld.

Staff of Asclepios Staff with a snake (allegedly a Aesculapian adder *Zamenis longissimus* (LAURENTI, 1768), Colubridae) wound around it. Originally, the "snake" is probably a Guinea worm (*Dracunculus medinensis* L., Dracunculidae), which already in ancient Egypt was removed from affected limbs by slowly pulling it out and winding it around a piece of wood.

Character	Name	Description
	Athananor	alchemistic oven for heating samples at moderate temperature for a long time.
	<i>Balneum arenæ</i>	Sand bath
	<i>Balneum mariae</i>	Water bath (bain marie)
	<i>Balneum vaporis</i>	Steam bath (for medical purposes)
	botarion	glass instrument shaped like a breast used as a receiver for an alembic
	<i>Ampulla</i> , bottle	
	Staff of Hermes	
	Casserole	
	Covered pot	
	<i>Crucibulum</i> , <i>tigilum</i> , crucible, melting pot	a heat resistant ceramic vessel used to heat substances in fire.

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Character	Name	Description
	Gr. βίκος <i>bikos</i> Cucurbit	vessel containing the sample to be distilled
	Lat. <i>Cupella</i> : diminutive to <i>cupa</i> = vessel	crucible used for the process of cupellation
	<i>Fixum</i> = fireproof	
	<i>Fornax</i> = forge, furnace	fire place used to heat metal until it can be worked
	<i>Furnus cupellatori</i>	
	<i>Furnus pubarion</i>	
	Lamp	
	<i>Librum</i> = book	
	<i>Ovum philosophicum</i> , philosophical egg	sealed container, in which a sample was heated
	<i>Phiola</i>	small glass bottle
	Receiver	part of a distillation apparatus
	Retort	curved glass vessel
	Reverberatory furnace	oven for smelting metal, the sample is heated by the flue gasses, not directly by the fire.

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Character	Name	Description
⌚ ⌚ ⌚	Sand cupel	
✱	Sceptre of Jove	
⌚ ⌚ ⌚ ⌚ ⌚ ⌚ ⌚ ⌚	Skillet	frying pan
⌚ ⌚	Test	large cupel used for refining gold and silver
⌚	Trident of Aquarius	
✱ ⌚	starred Trident	
⌚ ⌚ ⌚	Wind furnace	blast furnace operated by wind rather than a bellow

11 Medical terms













Character	Name	Description
⌚ ⌚	<i>Tumour</i> , swelling	
⌚	Ulcer	
⌚	VeneralDisease	
⌚	Wound	
⌚	<i>Sal ad calculum</i> = salt of calculi	Kidney- or gall stones

12 Symbols of unknown meaning

For several symbols I could not find out what they refer to. [6, 7] do not contain them, at least some of them may be based on misspellings and misconceptions.

Character	Name	Description
⚔	Lime of lead	
⚔⚔	Lime of Vitriol	
⚔⚔⚔	Lime of metal	
⚔⚔⚔	Magister of crocus	
⚔⚔	Magnesia of iron	ferropericlase (magnesiowüstite), a solid solution of FeO in MgO found near Mount Vesuvius? "Stones from Magnesia" from Anatolia contain MgO, MgCO ₃ and FeO and are magnetic.
⚔⚔	Mercury of antimony	
⚔⚔	Mercury of copper	
⚔⚔	Mercury of iron	
⚔⚔	<i>Metalum sulphuratum</i>	
⚔⚔	<i>Renovatio metallorum</i>	
⚔⚔⚔⚔⚔	Lat. <i>Reverberatio</i> = reverberation, echo	
⚔⚔	<i>Sal medius terrestris cum acido</i>	
⚔⚔	<i>Sal medius terrestris cum alcali</i>	

continued on next page

Character	Name	Description
	Salt of death's head	
	<i>Sal medius metallicus cum acido</i>	
	<i>Sal medius metallicus cum alcali</i>	
		
	Silver mercury	an amalgame or silver nitrate?
		
	Silver oil	
		
	<i>Sol mercurii</i>	
	Stagnated	
	Sulphurous matter	
	Tin spirit	volatile compound?

Appendix

12.1 Acronyms

RoHS Restriction of Hazardous Substances, directive 2011/65/EU

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