

Isaac Newton's Alchemical Symbols

Digital Library Brown Bag Presentation

Wally Hooper & Tim Bowman

March 24, 2009



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Project Overview

- The Chymistry of Isaac Newton Project is producing a scholarly online edition of the alchemical manuscripts of Isaac Newton.
- William R. Newman, General Editor
John A. Walsh, Technical Lead
- The Chymistry of Isaac Newton is affiliated with The Newton Project, based at University of Sussex in the U.K., which is focused on Newton's theological writings.



Progress Report

- At this point, over 85% of the alchemical manuscripts, about 2000 of 2300 pages, have been transcribed and encoded, including the large number of works in the Keynes collection, Kings College Library, Cambridge University, and Newton's most important laboratory notebook, Additional Ms. 3975, Cambridge University Library.
- Over 500 pages, or about a quarter of Newton's alchemical writings, have been released to the public with introductions in spring 2007.
- Now, a further 117 unreleased documents are undergoing editorial review.
- In fall 2007, work began on developing digital tools to accompany the manuscript collection.



Web Interface

- Web interface provides browsing and searching, and reference materials, including images and video clips.
- Manuscripts are represented in diplomatic and normalized transcriptions, derived from a single source XML/TEI document.
- New scholarly introductions, commentary, translations, and supplementary pedagogical and reference materials are provided for the collection.



THE CHYMISTRY OF ISAAC NEWTON



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Isaac Newton, like Albert Einstein, is a quintessential symbol of the human intellect and its ability to decode the secrets of nature. Newton's fundamental contributions to science include the quantification of gravitational attraction, the discovery that white light is actually a mixture of immutable spectral colors, and the formulation of the calculus. Yet there is another, more mysterious side to Newton that is imperfectly known, a realm of activity that spanned some thirty years of his life, although he kept it largely hidden from his contemporaries and colleagues. We refer to Newton's involvement in the [discipline of alchemy](#), or as it was often called in seventeenth-century England, "chymistry."

Newton wrote and transcribed about a million words on the subject of alchemy, of which only a tiny fraction has today been published. Newton's alchemical manuscripts include a rich and diverse set of document types, including [laboratory notebooks](#), [indices](#) of alchemical substances, and Newton's [transcriptions](#) from other sources.

With the support of the [National Science Foundation](#) and the [National Endowment for the Humanities](#), *The Chymistry of Isaac Newton* is producing a scholarly online edition as one part of an integrated project that includes new research on Newton's chymistry. Currently, the project focus is to build a repository of searchable transcriptions with page images. Our ultimate goal is to provide complete annotations for each manuscript and comprehensive interactive tools for working with the texts. To date, about seven hundred pages have been transcribed and encoded in TEI XML. Of these, roughly six hundred have been edited and are available online, including Newton's [Most Complete Laboratory Notebook](#).

Featured Manuscript

Newton's Theory of Everything - [Of Natures obvisious laws & processes in vegetation](#)

New

View [Chymical Experiment Products](#)



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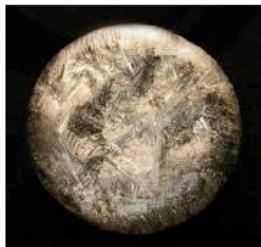
This material is based upon work supported by the National Science Foundation under Grant Nos. 0324310 and 0620868 and by the National Endowment for the Humanities under Grant No. RZ-50798. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation or the National Endowment for the Humanities.



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The Chymistry of Isaac Newton: ...

Star regulus of antimony



Antimony metal can be made to form a visibly crystalline structure by slowly cooling the molten antimony beneath a thick layer of slag. The antimony is reduced from stibnite (Sb_2S_3) by heating it with iron and saltpeter until fusion ensues. The antimony initially reduced must be further purified by repeated fusion with additional saltpeter before the star can be produced.

"The Net"



This purple alloy of metallic antimony and copper appears in many of Newton's chymical notes along with detailed recipes. The basic mode of production works by first refining antimony from stibnite by means of iron and then adding copper. Both the product and the general process for making it descend from Eirenaeus Philalethes, the pen-name of the American alchemist George Starkey. Starkey named this alloy "the net" because of the minute, regular crystals on its surface, which he interpreted as network. He argued that it was this alloy that the Roman poet Ovid really had in mind when he described how the blacksmith god Vulcan ensnared the lovers Mars and Venus in flagrante delictu in a finally wrought bronze net and left them on public display for the mockery of the other Olympians. To Starkey and Newton, the gods Mars and Venus were encoded terms for iron and copper, both of which metals were to be employed in making "the net."

Silica garden



Although Newton gives no clear recipe for a silica garden among the notes that we have transcribed so far, he does frequently refer to metallic "vegetation," a term used in the seventeenth century to cover a broad spectrum of dendrites and amorphous formations grown from metals or metal salts. In the mid-seventeenth century the German chymist Johann Rudolph Glauber popularized a method of growing silica gardens from iron dissolved in "spirit of salt" (hydrochloric acid) and then boiled dry, which was then added to a solution of "oil of sand" or "oil of glass" (potassium silicate). This procedure was very widely known in seventeenth century England, thanks to the popularization of Glauber's work during and after the Interregnum.





Browse

[Long Display](#)

Dibner Collection MS. 1031B, Dibner Library for the History of Science and Technology, Smithsonian Institution

[Introduction](#) | [Normalized Transcription](#) | [Diplomatic Transcription](#)

Title: Of Natures obvious laws & processes in vegetation.

Description: Usually called Of Natures obvious laws & processes in vegetation after the first words in the text, the Dibner Collection MS. 1031B is an eleven-page tract representing Newton's attempt to provide a synopsis of his early alchemical reading, and to come up with what is, essentially, a "theory of everything," namely a physical theory that unifies and accounts for all known natural phenomena. The English text is followed in the manuscript by a short text in Latin, written upside-down and from the other end of the fascicle. A distinct treatise, the Latin section of the text begins with the phrase "Humores minerales continuo decidunt," and is possibly a preliminary and fragmentary working out of the ideas that Newton would develop further in the English part of the manuscript.

Keynes MS. 30/1, King's College Library, Cambridge University

[Introduction](#) | [Normalized Transcription](#) | [Diplomatic Transcription](#)

Title: Index Chemicus

Description: The heading 'Index Chemicus' was assigned by Newton to three texts, all presently collected under the shelfmark Keynes MS. 30, at the King's College Library, Cambridge. Among them, the lengthiest and most finished version is referred to as Keynes MS 30/1. This manuscript, here transcribed and publicly released for the first time, is an elaborate alphabetical index and reference guide to the literature of alchemy.

Keynes MS. 30/2, King's College Library, Cambridge University



THE CHYMISTRY OF ISAAC NEWTON

Dibner Collection MS. 1031B, Dibner Library for the History of Science and Technology, Smithsonian Institution

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[Manuscript Information](#) | [Reference Tools](#)

< 1 r >
[page image]

1 Of Natures obvious laws & processes in vegetation.

2 That ~~the~~ vegetation of metals is described to be done by the same laws by y^e universall consent of the magi

2 That metals vegetate after the same laws. ^{As}Proved transitionly fr^om y^e circumstances observed by miners, ^{As}more fully from The consent of y^e Sophy wth one another & wth natures processe, & y^e strange distractions of all other chymists from both nature & one another. And y^e corruptibility of all things

3 That ~~vegetation may be~~ ~~through~~ ~~promoted by art is naturall.~~

4 That ~~the~~ natures process in vegetation is best understood in y^e simplest p

3 A description of their vegetation in the earth

4 A description of their vegetation in a glasse. & that this is as much naturall as tother

5 The circumstances in w^{ch} they agree wth plants & animalls. And of met trees by nature & Art

6 That vegetation ~~proceede from~~ y^e is y^e sole effect of a latent spt & that this

spt is y^e same in all things only discriminated by its degrees of maturity & the rude matter

Thus instanced in metall's &c. In fermentation of wines in Autumn, in Antipathys in y^e contagiousnes of putrefaction

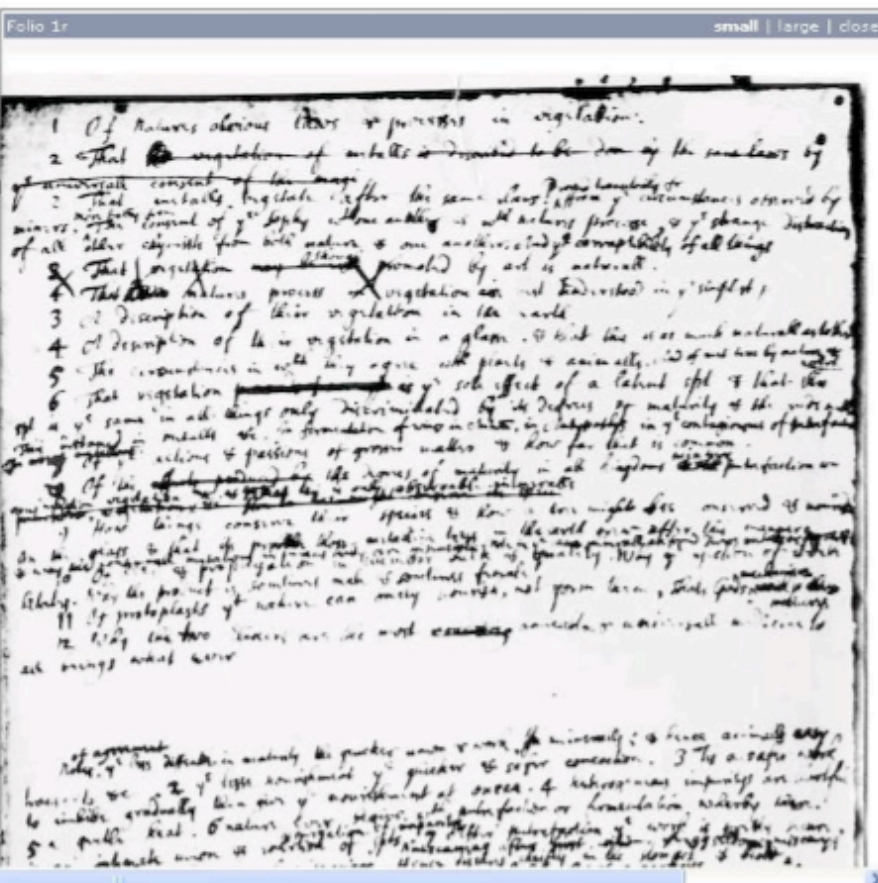
In crocus metallorū.



Dibner Collection MS. 1031B, Dibner Library for the History of Science and Technology, Smithsonian Institution

[Introduction](#) | [Normalized Transcription](#) | [Diplomatic Transcription](#) | [Manuscript Information](#) | [Reference Tools](#)

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[page image]
- 1 Of Natures obvious laws & processes in ve
 - 2 That *<illeg>* vegetation of metals is descri
 - y^e universall consent of the magi
 - 2 That metals vegetate after the same laws. miners, more fully from The consent of y^e So
 - of all other chymists from both nature & one
 - 3 That vegetation may be *<illeg>* though peo
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Chymistry of Isaac Newton : Nor...

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< 17 >
[page image]

- 1 Of Natures obvious laws & processes in vegetation:
- 2 That
- 2 That metalls vegetate after the same laws. Proved transitionly fr From the circumstances observed by miners, more fully from The consent of the Sophy with one another & with natures processe, & the strange distractions of all other chymists from both nature & one another. And the corruptibility of all things
- 3 A description of their vegetation in the earth
- 4 A description of their vegetation in a glasse. & that this is as much naturall as tother
- 5 The circumstances in which they agree with plants & animalls. And of met trees by nature & Art
- 6 That vegetation is the sole effect of a latent spint & that this spirit is the same in all things only discriminated by its degrees of maturity & the rude matter Thus instanced in metalls etc. In fermentation of wines in Autumn, in Antipathys in the contagiousnes of putrefaction In crocus metallorum.
- 7 Of the actions & passions of grosser matter & how far that is common.
- 8 Of the the degrees of maturity in all kingdoms mixture putrefaction conjunction vegetation etc. & that this is only observable mineralls



Keyword Search

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Keyword | [Advanced](#)

Search Tips

Keyword search will match manuscripts that contain **all words** in the full text. To search descriptive information about the manuscript (e.g. title, author, language) use the advanced search form.

- *binding proteus* will be interpreted as binding **AND** proteus

Use an asterisk (*) to find word variations:

- *mercur** will find mercury, mercurial, mercurius, mercurium

Search for exact phrases with double-quotes (""):

- "*Spirit of hartshorne*"

URL: <http://webapp1.dlib.indiana.edu/newton/>

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[Modify Search](#) | [Search Again](#)

Your search for **green** in the field **and lion** in the field in the full text was found in **3** documents.

[Long Display](#)

1. Keynes MS. 52, King's College Library , Cambridge University (Total Matches: 1)


[Introduction](#) | [Normalized Transcription](#) | [Diplomatic Transcription](#)

Title: Sr George Ripley His Epistle to K Edward
Description: Cambridge University, King's College, Keynes MS. 52 is mostly a copy in Newton's hand of a version of Eirenaeus Philalethes (George Starkey), Sir George Ripley, *As Epistle to King Edward Unfolded*. The work was printed in Newton's lifetime in two different versions. The text in Keynes 52 is followed by notes in Latin and English.

Matches in Context:

A the external or accidental proportion. The accidental mercury is called the **green lion** by the philosophers, by another , then points out the little woman, whose weight should...

2. Portsmouth Collection Add. MS. 3973, Cambridge University Library , Cambridge University (Total Matches: 5)

[Introduction](#) | [Normalized Transcription](#) | [Diplomatic Transcription](#) 

Title: <Notes evidently on Newton's own laboratory experiments>
Description: Unbound fascicles and sheets describing Newton's chymical experimentation and bearing dates ranging from 10 December 1678 to February 1696. The experiments are closely related to those found in Cambridge University MS. Additional 3975, and sometimes partly identical.

Matches in Context:

A 2. Digested with 5 ounces 20 grains of filings of venus, it yielded 10 grains of the **green lion** and 180 or 200 grains of vitriol, but this vitriol emitted no philosophical sal...

A ore + 2 of antimony mixed together by melting and sublimated and precipitated, ground and sublimed with 7 grains of the **green lion** left 3 1/3 grains in the bottom. This again...

A victus, Vinculum ij . Dissolve volatile **green lion** in the central salt of venus and distill



THE CHYMISTRY OF ISAAC NEWTON

Portsmouth Collection Add. MS. 3973, Cambridge University Library, Cambridge University

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Search Results

[[Introduction Hits](#) | [Normalized Hits](#) | [Diplomatic Hits](#)]

5 occurrences of **green lion** in full text.
Go to: [First Hit](#) | [Clear Hits](#) | [Return to Results](#)

< 1 >
[page image]

1 ADD 3973

1a

1 Experiments

Dec 10 1678. Crude unmelted & finely powdered δ ^{one part} 240 grains * ^{one as} ^{part} much well mixed, by sublimation left 130 grains below. The sublimate looked very red.

Dec 11. ~~Iron~~ This sublimate 180 grains wth powdered Iron ore 240 grains left 250 grains in y^e bottom.

Dec 12. δ 1 part δ 2 p^{ts}. conjunction <illeg> 360 grains * 240 gr left 228 grains.

Item Tin one part & tinglass one part, [^]melted together made a more fusible metal then Tin one part & Tinglas two parts

Dec 13 I put y^e 228 grains together wth 150 grains of fresh matter & 525 grains of * & their remained 176 grains. That is



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Dissolve ♀ vir. volat. in sale centrali veneris et destilla. hic spiritus est ♀ vir, sanguis ♀ Vir. Venus, Draco Babylonicus omnia veneno interficiens, a Columbis tamen Dianæ mulcendovictus, Vinculum ♀.

<Translation: Dissolve volatile **green lion** in the central salt of venus and distill. This Spirit is the **green lion**, the blood of the **green lion**, Venus, the Babylonian dragon killing all things with its venom, but conquered by the soothing of Diana's doves, the bond of mercury.>

Neptunus cum tridente inducit Phos in hort. soph. Ergo Neptunus est menstruum aqueum minerale ac tridens fermentum aque simile caduceo ♀ quocum ♀ fermentatur. vizt Columbæ duæ aridæ, cum venere arida martiali.

<Translation: Neptune with his trident leads the philosopher into the garden of the wise. Neptune therefore is the watery, mineral menstruum and the trident the ferment of water similar to the caduceus of mercury, with which mercury is fermented, namely the two dry doves with dry, martial venus.>

Certe ♀ Caduceus est ☉ duplex fermentans ☿ crudum album. Hæc enim principia metallica ^{tenera non fusa} sunt, et affinia tam is ibi ipsis (ut ex reg ☿ ^{& toti} patet) quam ♀ (ut ex fermentatione Reg cum ♀ patet)

<Translation: The caduceus of mercury is certainly a double vitriol fermenting crude, white antimony. For these ^{tender} metallic principles are ^{not fused}, and it both has an affinity with them (as is evident from regulus martis ^{and the rest}) as with mercury (as is evident from the fermentation of regulus with mercury).>

<The remainder of this page is blank.>

<13r>
[page image]

4 ADD 3973

13a

4 Experiments Aug. 1682.

I had in volatil salt of ☿ 1, ♀ 1, ♀ 1, ♀ 12. ∇ 12 dissolved 4 of ♀ 1 ♀ 9 ♀ 3 colliquefacta <Translation: melted together>. The solution I



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Chymistry of Isaac Newton : Adv... x

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Advanced Search

[Help](#)

[Keyword](#) | [Advanced](#)

Keyword and

Keyword and

Keyword

Search Tips

More than one term typed per search field will be interpreted as a Boolean AND search. Use the Boolean menu to select AND/OR; typed into the search fields, these operators will be ignored.

- *binding proteus* will be interpreted as binding **AND** proteus

Use an asterisk (*) to find word variations:

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Use double-quotes (") to conduct an exact phrase search:

- *"spirit of hartshorne"*

URL: <http://webapp1.dlib.indiana.edu/newton/>

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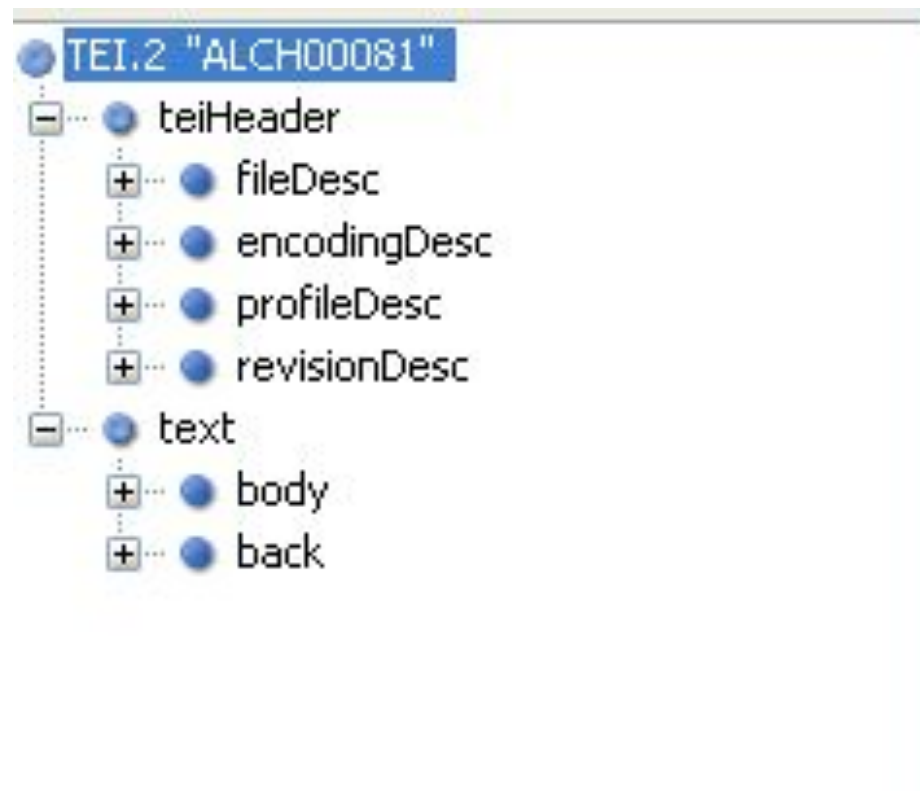


Architecture & Standards

- Software for the project is developed in Java, using Java Servlet technology, Java Server Pages, and the Apache Struts Java Web application framework.
 - eXtensible Text Framework (XTF) developed by the California Digital Library (<http://xtf.sourceforge.net/>) includes crossQuery, dynaXML, Text Engine, and Indexer components.
 - HTML / CSS / JavaScript (jQuery Library)/ Flash
-
- TEI P4 w/ P5 Ms. Description elements added as a P4 extension
 - heavily encoded w/ additions, deletions, abbreviations/ expansions.
 - Use of <c> element to represent alchemical symbols, many of which are unique to Newton.
 - TEI documents for The Chymistry of Isaac Newton are encoded using the most commonly supported Unicode encoding, UTF-8.

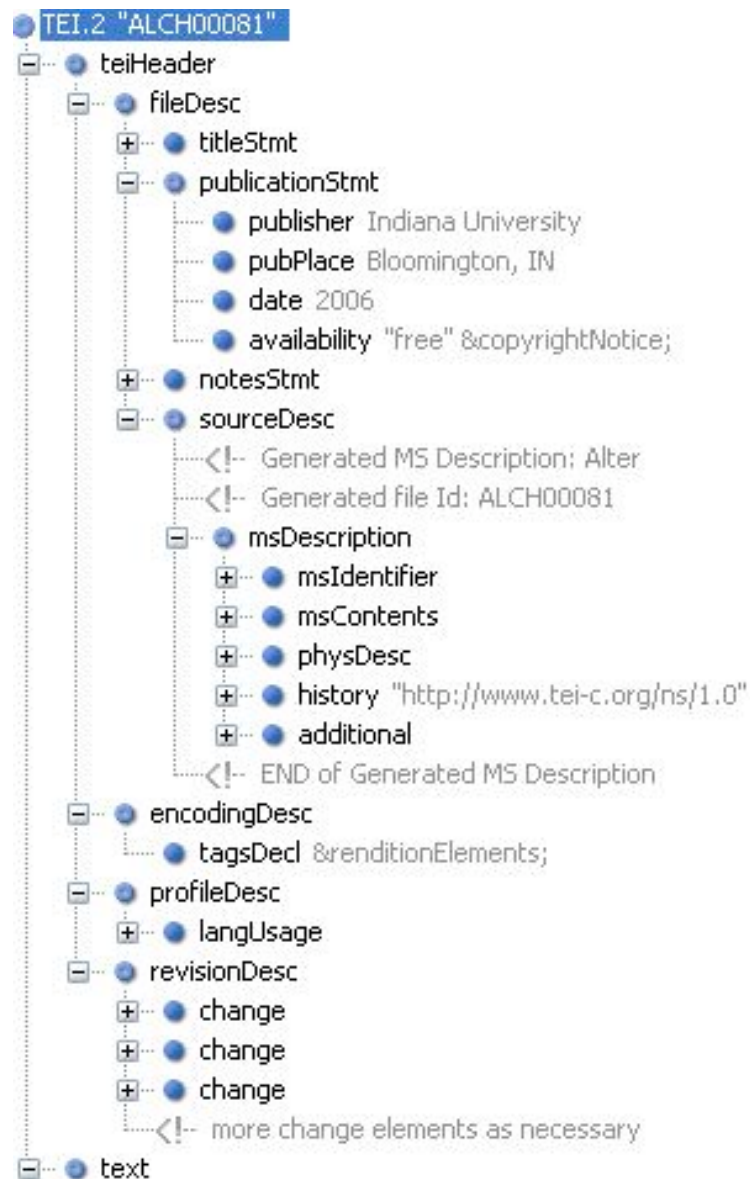


Structure of a TEI Document





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Textual Features

Newton's alchemical manuscripts are very complex documents, featuring:

- Abbreviations
- Foreign Passages
- Deletions and Additions
- Regularization of Spellings
- Catchwords
- Alchemical Symbols
- Formulas
- Graphics
- Verse



Chymistry of Isaac Newton : Dipl... x



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< 1 r >
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1 Of Natures obvious laws & processes in vegetation.

2 That ~~<illig>~~vegetation of metallis is described to be don by the same laws by y^e universall consent of the magi

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3 That ~~vegetation may be~~ ~~<illig>~~ ~~through~~ promoted by art is naturall.

4 That ~~<illig>~~ natures process in vegetation is best understood in y^e simplest p

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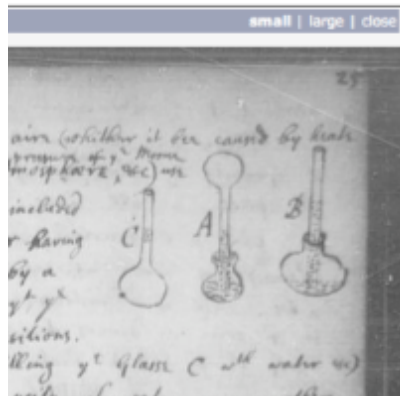
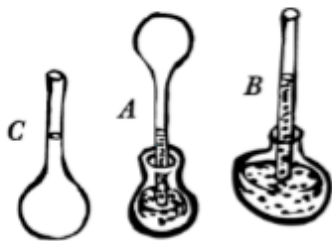
Thus instanced in metallis &c. In fermentation of wines in Autumn, in Antipathys in y^e contagiousnes of putrefaction

In crocus metallorū.



Graphics, Deletions, Additions

ate



Chymistry of Isaac Newton : Diplomatic Manuscript

... y^e ... of the nerves, ...

...ples, w^{ch} are a little prominent, especially if the illeg nerve be pressed or warmed at a candle. And these shoot into y^e very eye & may be seen wth in side where y^e retina grows to y^e nerve: and they also continue to fill y^e very juncture EFGH. But at this juncture they end on a sudden into a more tender white pap like the interior part of the braine & soe y^e nerve continues after y^e juncture into y^e braine filld wth a white tender pap in w^{ch} can be seen noe distinction of parts as betwixt y^e said juncture & y^e eye.

Now I conceive that y^e every point in the retina of one eye hath its correspondent point in y^e other, ... w^{ch} two pipes very slender pipes ... filld wth a most limpid liquor doe very even & regular wth out either interruption or any other unevenesse or irregularity in their processe, goe along the optick nerves illeg to y^e juncture EFGH where they meete y^e one halfe ... either twist GF y^e other twist or FH, & there unite to one pipe as big as both of them, & so continue in one ... passing either twist IL or MK into y^e braine where they are terminated perhaps at y^e next meeting of y^e nerves twist y^e Cerebrum & cerebellū, in y^e same order that their extremitys were scizure in the Retinae. And so there are a most multitud



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<text>

<body>
  <pb n="1"/>
  <milestone unit="folio" n="1 r"/>
  <div>
    <p>1 Of Natures obvious laws &amp; processes in vegetation:</lb/>
    </p>
    <p>2 That &blotch3;<del rend="strike">vegetation of metalls is described to be don by the same laws by </lb/>
      &the; universall consent of the magi</del></lb/>
    </p>
    <p>2 That metalls vegetate after the same laws. <add place="supralinear" rend="caret">Proved transitorily fr</add> <ori
      miners, <add place="supralinear" rend="caret">more fully from</add> The consent of &the; Sophy &with; one another
      of all other chymists from both nature &amp; one another. And &the; corruptibility of all things</lb/>
    </p>
    <p><del rend="strike">3 That vegetation <del rend="overdash">may be </del>&blotch3; <add place="supralinear">thou;
    </del></p>
    <p><del rend="strike">4 That &blotch5; natures process in vegetation is<!-- "are" overwritten to "is" -jv --> best understo
    </del></p>
    <p>3 A description of their vegetation in the earth</lb/>
    </p>
    <p>4 A description of their vegetation in a glasse. &amp; that this is as much naturall as tother</lb/>
    </p>
    <p>5 The circumstances in &which; they agree &with; plants &amp; animalls. And of met trees by nature &amp; <add pl
    </p>
    <p>6 That vegetation <del rend="strike">proceeds from &the;</del> is &the; sole effect of a latent <abbr expan="spirit"><
    <abbr expan="spirit">spt</abbr> is &the; same in all things only discriminated by its degrees of maturity &amp; th
    Thus instanced in metalls &etc;. In fermentation of wines in Autumn, in Antipathys in &the; contagiousnes of putrefa
    In crocus <abbr expan="metallorum">metallor&u-macron;</abbr>. </lb/>
  </p>

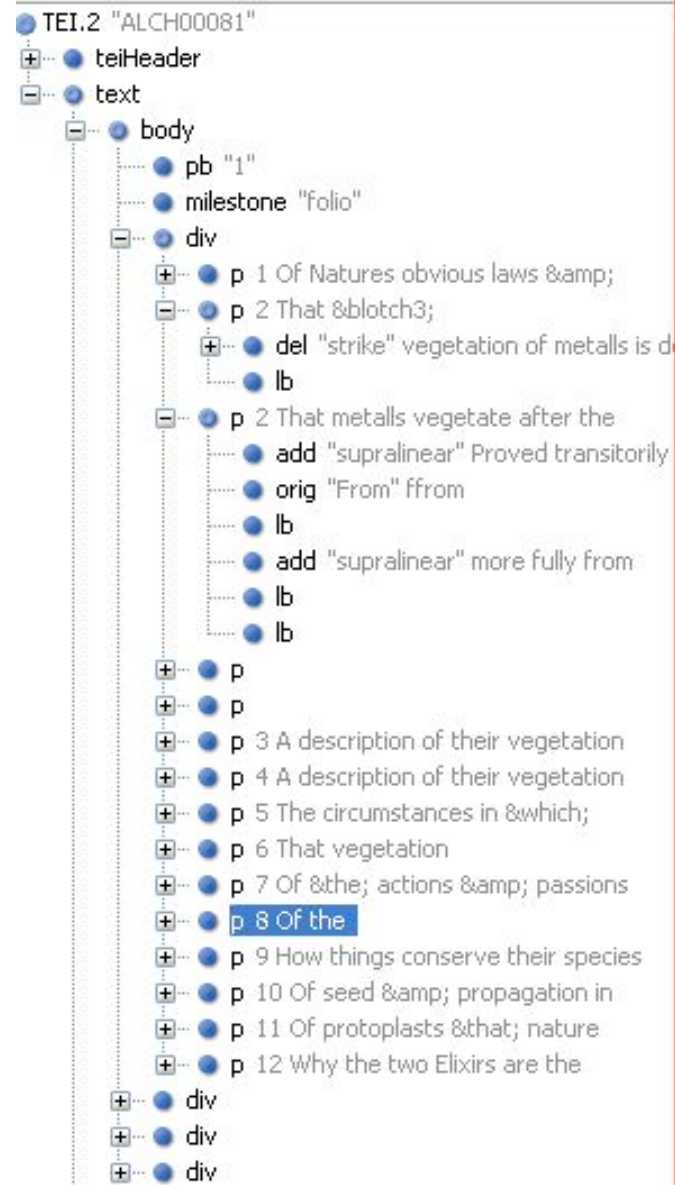
  <p>7 Of &the; actions &amp; passions of grosser matter &amp; how far that is common.</lb/>

  </p>

  <p>8 Of the <del rend="strike">effects produced by</del> the degrees of maturity in all kingdoms &blotch5; <add place=
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Symbols

Chymistry of Isaac Newton : Diplomatic Manuscript

<42r>
[page image]

81

To make Regulus of δ , σ , η , or φ &c. Take of
 δ 12 $\bar{3}$ of σ 4 $\frac{1}{2}$ or $5 \frac{1}{4}$ or φ 6 or $6 \frac{1}{4}$, or of η 8 $\frac{1}{2}$ or proportionably
 more to y^e δ if it will beare it. When they are melted
 pour them of & you will have a Reg. You may when
 they are molten throw 2 or 3 $\bar{3}$ of \circ on them
 which having done working pour them of. If y^e scoria

Folio 42r small | large | close

To make Regulus of δ , σ , η , or φ &c. Take of 81
 δ 12 $\bar{3}$ of σ 4 $\frac{1}{2}$ or $5 \frac{1}{4}$ or φ 6 or $6 \frac{1}{4}$, or of η 8 $\frac{1}{2}$ or proportionably
 more to y^e δ if it will beare it. When they are melted
 pour them of & you will have a Reg. You may when
 they are molten throw 2 or 3 $\bar{3}$ of \circ on them
 which having done working pour them of. If y^e scoria
 of η be full of small even rays there is too little
 η in proportion. If any reg swells much in the
 midst of the upper surface it argues too much
 δ if it be flat it argues too little. The better
 y^e proportions are the brighter & bristler will y^e Reg
 be & y^e darker y^e scoria & the easier will they
 part: And also y^e more perfect the star, unlesse



Serving Up Symbols

- Possible solutions for delivering symbols included:
 - Developing a Newton font
 - Serving up images for all symbols
 - A combination of fonts and images
- How many symbols do we have?
- Can we enumerate Newton's symbol set before we've encoded everything?
- Are there resources or guidelines for alchemical symbols within Unicode or other sources?
- Are there open-source alchemical fonts available?



History of Alchemy and Alchemical Symbols

- Newton started by copying and paraphrasing contemporary alchemical authors
- He owned a very large collection of alchemical books and created indexes and practical glossaries derived from them
- He corresponded with other natural philosophers and experimenters interested in alchemy, including Robert Boyle, the Sceptical Chymist



Origins of Alchemy

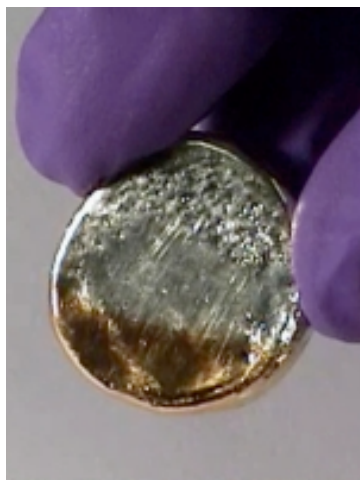
- Dyes, inks, paint pigments—color change
- Smelting, metallurgy, jewelry
- Medicine and pharmacopeia
- Greek matter theory
- Astrology
- First alchemy texts appeared in Greece, Egypt, and Syria, ca. 600 CE but roots went back millennia and ideas came from many places—China and India.



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Transmutation

Video clips on www.chymistry.org :



- Plating versus real change
- Philosopher's stone and elixirs
- Search for spiritual enlightenment

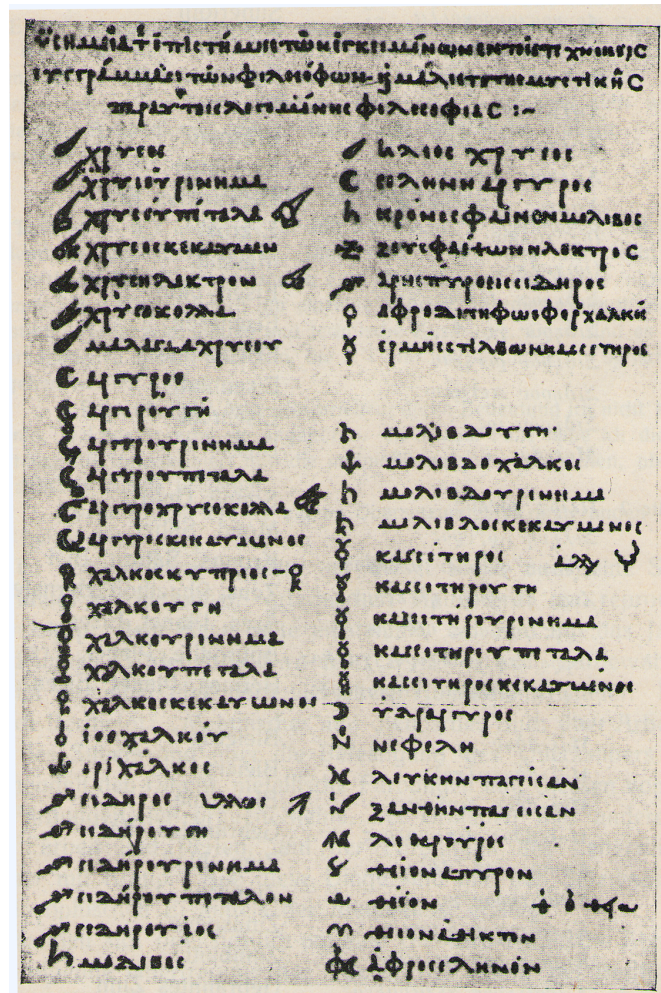


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| | | | | | |
|----|--------------|--|----------------|--|-------------|
| | Air | | Gold – Sun | | Mercury |
| | Fire | | Silver - Moon | | Sulfur |
| | Earth | | Copper - Venus | | Salt |
| | Water | | Iron – Mars | | Niter |
| QE | Quintessence | | Tin – Jupiter | | Vitriol |
| | | | Lead - Saturn | | Borax |
| | | | | | Auripigment |

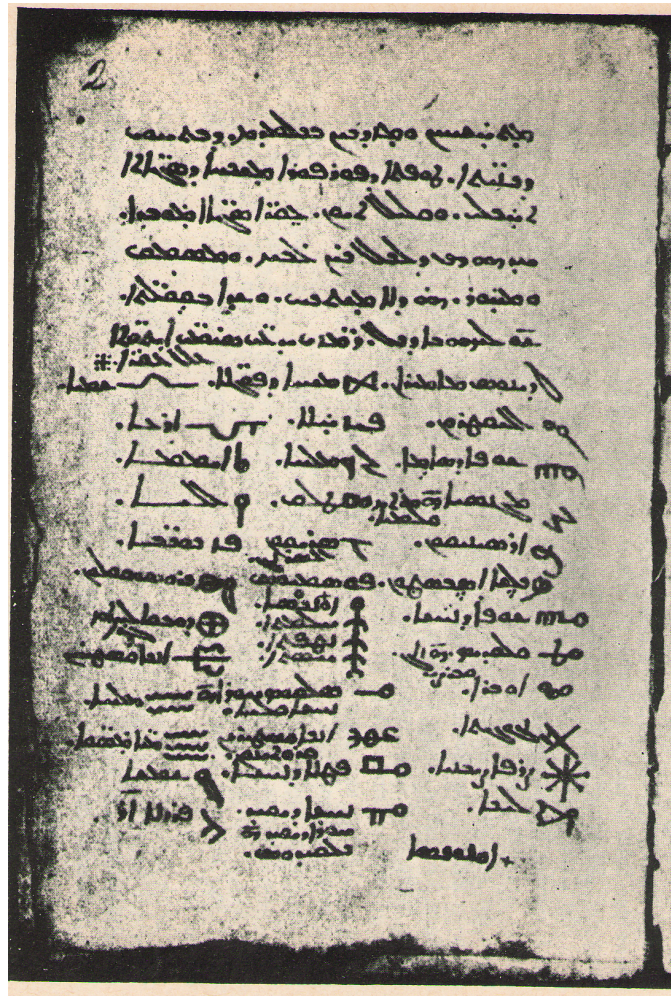


Alchemical Symbols in Greek Texts





Alchemical Symbols in Syriac





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Apothecary Jars





Alchemical Symbol Tables in the Seventeenth Century

| Charact. Vocabulorum Chymicorum. | | Charact. Vocabulorum Chymicorum. | |
|----------------------------------|----------------|----------------------------------|----------------|
| Aqua fortis, | ☉. ☽. ∇. ♁. | Calx viva. | ☉. ☽. ☉. ☽. ☉. |
| Aqua regis, | ☉. ☽. ☉. ☽. ☉. | Calx ovorum, | ☉. |
| Aqua vitæ, | ☉. ☽. ☉. ☽. ☉. | Cancer, | ♋. |
| Arsenicum, | ☉. ☽. ☉. ☽. ☉. | Caper, | ♃. |
| Sublimatum, | ☉. ☽. ☉. ☽. ☉. | Caput mortuum, | ☉. ☽. ☉. ☽. ☉. |
| Atramentum, | ☉. ☽. ☉. ☽. ☉. | Cementare, | ☉. ☽. ☉. ☽. ☉. |
| Auripigmentum, | ☉. ☽. ☉. ☽. ☉. | Cera, | ☉. ☽. ☉. ☽. ☉. |
| Aurum, | ☉. ☽. ☉. ☽. ☉. | Cetussa, | ☉. ☽. ☉. ☽. ☉. |
| Aurum possibile, | ☉. ☽. ☉. ☽. ☉. | Chalibe, | ☉. ☽. ☉. ☽. ☉. |
| Autumnus, | ☉. ☽. ☉. ☽. ☉. | Cineres. | ☉. ☽. ☉. ☽. ☉. |
| Arcitenens, | ☉. ☽. ☉. ☽. ☉. | Cineres clavellati, | ☉. ☽. ☉. ☽. ☉. |
| Aurichalcum. | ☉. ☽. ☉. ☽. ☉. | Cinnabaris. | ☉. ☽. ☉. ☽. ☉. |
| B | | Coagulare, | ☉. ☽. ☉. ☽. ☉. |
| Baln. Mar. f. Maris. | ☉. ☽. ☉. ☽. ☉. | Coagulum. | ☉. ☽. ☉. ☽. ☉. |
| gal. vapor. f. Roris. | ☉. ☽. ☉. ☽. ☉. | Colcothar, | ☉. ☽. ☉. ☽. ☉. |
| Bolus communis. | ☉. ☽. ☉. ☽. ☉. | Cristallus. | ☉. ☽. ☉. ☽. ☉. |
| Bolus Armen. | ☉. ☽. ☉. ☽. ☉. | Crocus, | ☉. ☽. ☉. ☽. ☉. |
| Borax. | ☉. ☽. ☉. ☽. ☉. | Coculus albus, | ☉. ☽. ☉. ☽. ☉. |
| C | | Coculus Rubeus. | ☉. ☽. ☉. ☽. ☉. |
| Calx, | ☉. ☽. ☉. ☽. ☉. | Crocibulum Tigil. | ☉. ☽. ☉. ☽. ☉. |

From William Johnson, Lexicon Chymicum (London, 1652-3)

| Explanation of the Chymical Characters | | | P. 491 |
|----------------------------------------|-------|-----------------------------------------------|--------|
| Steele iron or mass. | ☉. ☽. | celestial signe | ☉. ☽. |
| Leadstone. | ♋. | Cancer | ♋. |
| Ayre. | ♋. | another. | ♋. |
| Lymbeck. | ♋. | Ashes. | ♋. |
| Allom. | ♋. | Pot Ashes. | ♋. |
| Amalgama. | ♋. | Calx. | ☉. |
| Antimony. | ♋. | quick lime. | ☉. |
| Aquarius a signe of the zodiack. | ♋. | Cinnabar or Vermillion. | ☉. |
| Silver or Luna. | ♋. | Waxe. | ☉. |
| Quicksilver or Mercury. | ♋. | Crucible. | ☉. |
| Aries another. | ♋. | Calcinated copper as usbt. or crocus veneris. | ☉. |
| celestial signe. | ☉. | Notes of Distillation. | ☉. |
| Arsenick. | ☉. | Water. | ☉. |
| Balneum. | ☉. | Aqua fortis. | ☉. |
| Balneum. | ☉. | aqua Regalis. | ☉. |
| Maris. | ☉. | Spirit. | ☉. |
| Vaporous. | ☉. | Libra another celestial signe. | ☉. |
| Bath. | ☉. | Borax. | ☉. |
| Bricks. | ☉. | Bricks. | ☉. |
| capricornus another | ☉. | Fire. | ☉. |
| Gumme. | ☉. | Crocus. | ☉. |
| Flower. | ☉. | martis. | ☉. |
| Oyle. | ☉. | Sagurini celestial sign. | ☉. |
| Day. | ☉. | Soap. | ☉. |
| Gemini a celestial signe. | ☉. | Scorpius a celestial sign. | ☉. |
| Leo another signe. | ☉. | Salt alkali. | ☉. |
| Scorpius sign strati or lay upon lay. | ☉. | Armeniac Salt. | ☉. |
| Marcaffite. | ☉. | Common Salt. | ☉. |
| Precipitate of Quicksilver. | ☉. | Sulphur. | ☉. |
| Sublimate. | ☉. | Brims of sulphur. | ☉. |
| Moneth. | ☉. | Black sulphur. | ☉. |
| Niter or Saltpeter. | ☉. | Philosophers sulphur. | ☉. |
| Night. | ☉. | Tellur. | ☉. |
| Gold or Sol. | ☉. | Tartar. | ☉. |
| Auripigmentum. | ☉. | Tellur a celestial signe. | ☉. |
| Lead or Saturne. | ☉. | Earth. | ☉. |
| Pyces a celestial signe. | ☉. | Caput Mortuum. | ☉. |
| Powder. | ☉. | Tuty. | ☉. |
| To precipitate. | ☉. | Glasse. | ☉. |
| To purify. | ☉. | Vitriol. | ☉. |
| Quintessency. | ☉. | Vinogar. | ☉. |
| Realgar. | ☉. | Distilled Vinogar. | ☉. |
| Retorte. | ☉. | Vitriol. | ☉. |
| Sand. | ☉. | Urine. | ☉. |

From Nicaise Le Fevre, A Compleat Body of Chymistry (London, 1670)



In the Early Phases of the Project

- Newton group starts with open-source alchemical font
- Exports images from font editor as GIFs for Web
 - *FontLab Studio* editor is used to add new characters and symbols
- Use of GIF images satisfies common web dictum of not relying on non-standard font
- Entities are used in the XML/XSLT to manage encoding and rendering

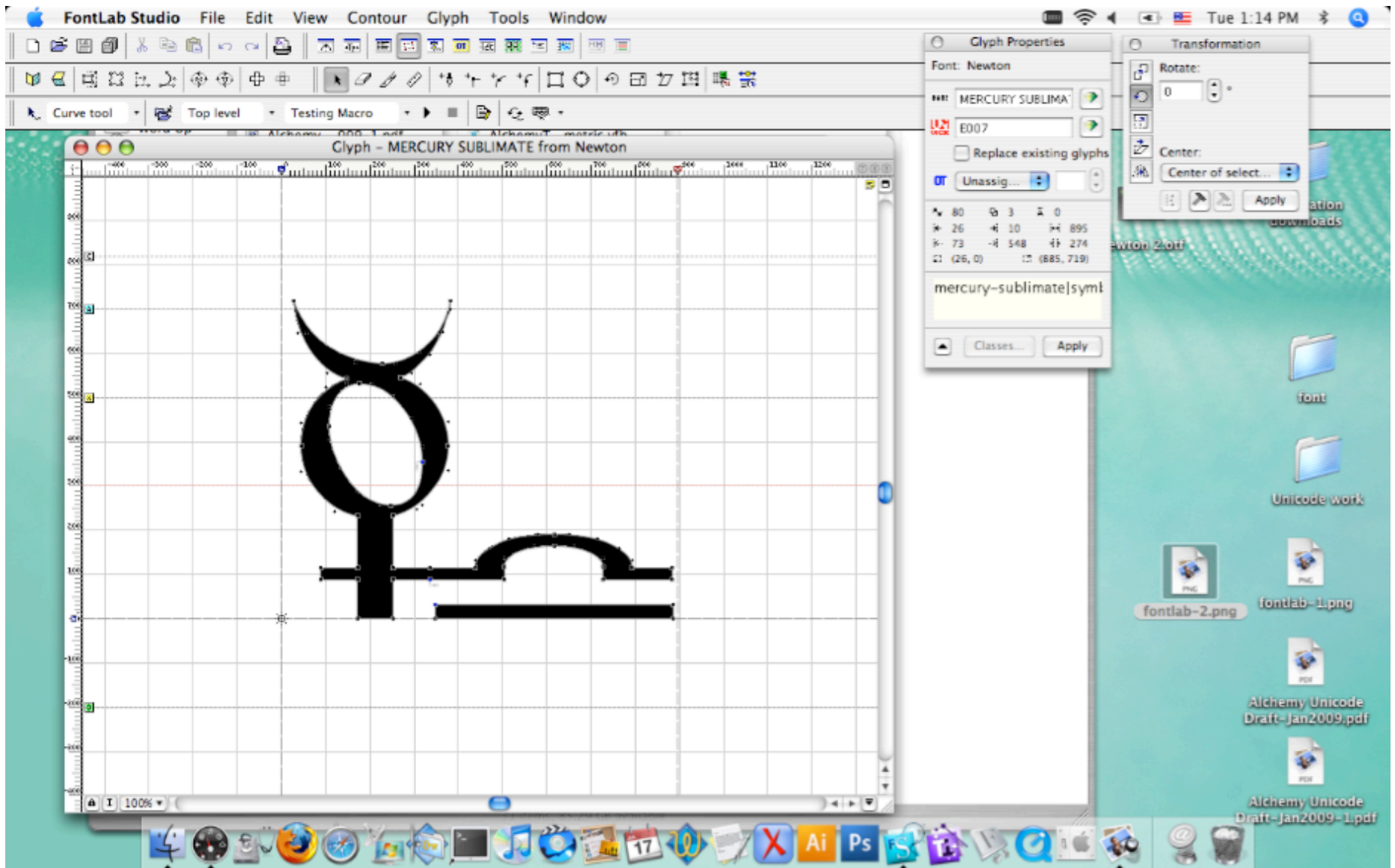


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The screenshot displays the FontLab Studio application window. The main area shows a grid of glyphs for the font 'Newton'. The grid is organized by Unicode code points, with columns labeled from 007E to E089. The glyphs include various characters, some of which are highlighted in green. The 'Glyph Properties' panel is open on the right, showing the font name 'Newton' and various settings. The 'Transformation' panel is also open, showing a 'Rotate' field set to 0 and a 'Center' dropdown menu set to 'Center of select...'. The desktop background is a teal color with a pattern of white dots. There are several icons on the desktop, including a folder named 'font', a folder named 'Unicode work', and two PDF files named 'Alchemy Unicode Draft-Jan2009.pdf' and 'Alchemy Unicode Draft-Jan2009-1.pdf'. The dock at the bottom contains various application icons, including the system clock, Finder, Safari, and several Adobe Creative Suite applications like Photoshop and Illustrator.



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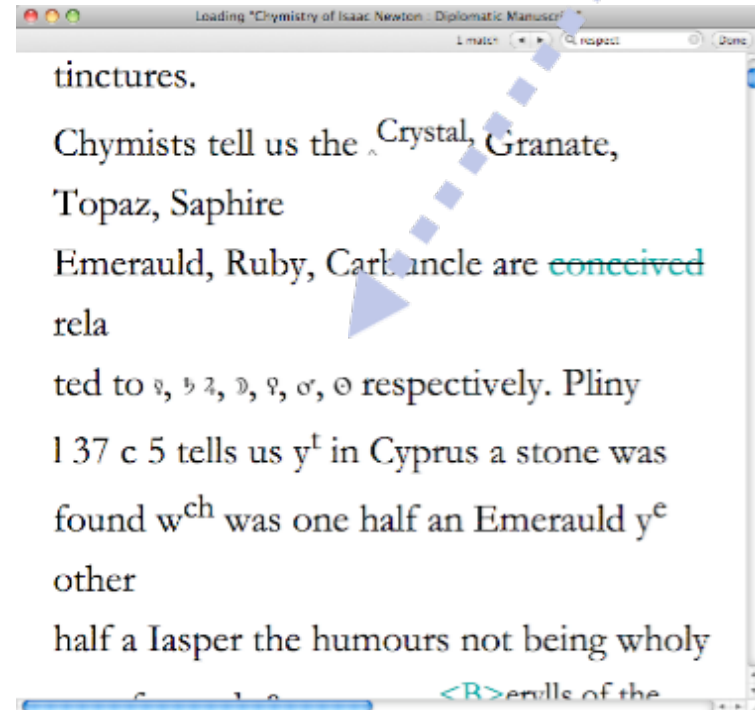




Accumulation of Problems with Symbol GIFs

- GIF symbols don't kern
- GIF symbols don't scale
- GIF symbols take forever to load and to print

- For scholarly readers, these are serious problems





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Another Look at Fonts

- Fonts can kern and scale
- Fonts can change color and be styled via CSS
- We could organize a Unicode proposal
 - To standardize future work



Delivery of Fonts on the Web

- Either Fonts, or GIFs, or *both* can be delivered to the visitor
 - Through XSLT we can choose which to deliver cutting down on load time and overall file size
-
- Main Problem:
 - **How can we tell if the user has downloaded our Newton font and if it is available to us *BEFORE* we deliver the page to the visitor?**



Detecting Visitor's Installed Fonts

- **Security:** Client-Side solutions such as JavaScript and HTML can not directly access a visitor's font set
- **Server-Side Solution:** We could make use of JAVA, but we would need to build an extension for SAXON
- **Other Client-Side Solutions:**
 - JavaScript String Width Comparison
 - JavaScript @font-face CSS 2/3 Rule
 - Adobe Flash/JavaScript Hack



We Have Font Detection Methods, Now What?

- **Initial Solution:** We detect font at each page request, after page load we use JavaScript (jQuery Library) to search through the DOM and change all tags to <div> tags displaying font.
 - We have VERY large documents, and changing DOM after load places tremendous stress on browser resources
 - Visitor may start browsing page before switch and can be confused or frustrated by delay
- **Current Solution:** We detect the visitor's fonts on their initial visit to the chymistry.org site using Adobe Flash and jQuery AJAX.
 - The font detection page is loaded and a call is made via AJAX to the FLASH movie. The FLASH movie returns the entire list of fonts on the visitor's machine. JavaScript then parses the array and looks for the Newton font. A cookie is then set identifying a success or failure.



Combining Font Detection and XSLT

- Within the XTF framework, XSLT transforms XML to HTML. Most XML elements have templates that direct transformation from XML to HTML. XTF does have session tracking, but it is not well documented and doesn't seem to be available to us.
- Our “c” XSL Template: Newton symbols are initially encoded as entities and transformed to `<c>` elements during the web site build. XSLT is then used to transform the `<c>` element into HTML for delivery to the web site.
 - It is easy for us to deliver either fonts or images within the “c” template using standard logic.
 - Our problem was getting XTF to set a variable indicating if the font was installed during the entire visitor session.
- **Solution:** Using the Flash/JavaScript script, we are able to set a variable within XTF using our cookie data that is available during the entire visitor session. This XTF variable is a flag that the “c” template uses to decide which HTML element to serve to the user: the `` tag or the `<div>` tag.



Encoding Example

```
<!ENTITY mercury "<c function='unicode' n='MERCURY' type='symbol'>UNx263f</c>">  
<!ENTITY saturn "<c function='unicode' n='LEAD (SATURN)' type='symbol'>UNx2644</c>">  
<!ENTITY jupiter "<c function='unicode' n='TIN (JUPITER)' type='symbol'>UNx2643</c>">
```

to `&mercury;`, `&saturn;`, `&jupiter;`, `&backward-moon;`, `&venus;`, `&mars;`, `&sun;` respectively.

```
to <a id="dd403618e1541"></a>, <a id="dd403618e1544"></  
a> <a id="dd403618e1547"></a>, ....
```

```
to <a id="dd87427e1541"></a><div class="NSymbolFontShow" title="MERCURY" n="263f"> ☿ </  
div>, <a id="dd87427e1544"></a><div class="NSymbolFontShow" title="LEAD (SATURN)" n="2644"> ♄ </  
div> <a id="dd87427e1547"></a><div class="NSymbolFontShow" title="TIN (JUPITER)" n="2643"> ♃ </  
div>, ...
```



Symbol Search

- Using XTF framework and javascript/jQuery, we can search symbols based on attributes.
- XTF is an inverted indexing tool—all words in a corpora are indexed and queries and browser requests can be answered rapidly.
- How do we get XTF to see our symbols?
- TEI's <c> element can be indexed by XTF and we can search for them by using their attributes, title="sulfur" or n="UNxE001". That part is pretty easy.
- Displaying the symbols on the Results and Snippets pages presented a much bigger challenge than the actual documents. XTF includes non-TEI elements and attributes in the code stream it returns for Results and Snippets and our XSLT has to handle those elements—much new construction.
- The remaining challenge is to provide an intuitive interface that lets the visitor initiate the search—using "UNx2640" to find Copper (Venus) ♀ won't do.



Symbols Search

[Keyword](#) | [Symbols](#) | [Advanced](#)

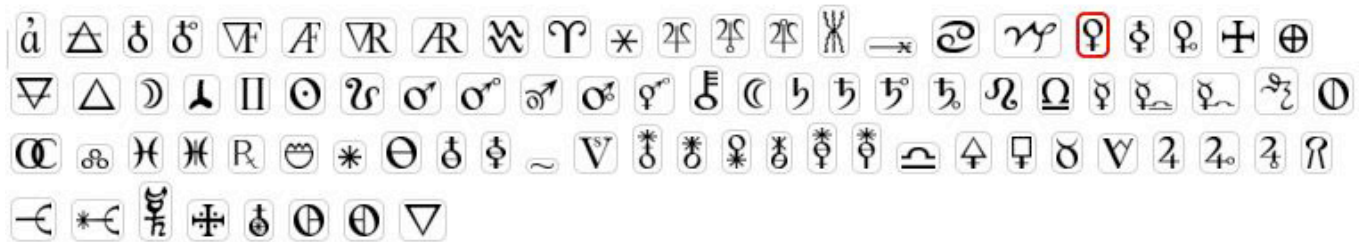
[Help](#)

Search for:

♀

search

clear



Measures and weights:



Paleographic:



Typographic:





Search Results

[Modify Search](#) | [Search Again](#)

Your search for: ♀ in full text was found in 40 documents.

Page: 1 2 3 4

[Long Display](#)

1. Add. Mss 44888, The British Library , British Library (Total Matches: 7)

[Introduction](#) | [Normalized Transcription](#) | [Diplomatic Transcription](#)

Title: 'Basilius Valentinus & Iodochus a Rhe': abstracts from these authors (the latter is more usually called Johannes Rhenanus) on minerals, transmutation of metals, vitriol, etc., in English, c. 6,000 words, 14 pp.

Description:

Matches in Context:

- [A](#) Therefore ♂ & ♀ are penetrated & tinged with...
- [A](#) from all metals especially from ♂ & ♀...
- [A](#) out of ♂ & ♀ may be made an excellent Vitriol containing all...
- [A](#) it turneth to ♀ then to Lead then to ♀ & ♀ then to Iron & Thus...
- [A](#) 127, 128. Red fiery souls & goldish sulphurs are found most effectual in ♂ & ♀, as also in vitriol. And both ♂ & ♀ are reducible into a most effectual...

2. Babson Don b.15, Bodleian library , Oxford University (Total Matches: 6)

[Introduction](#) | [Normalized Transcription](#) | [Diplomatic Transcription](#)

Title: Dictionary of Alchemical Terms

Description: From UK catalog: Entries run alphabetically from 'Abstraction' to 'Vrinous Salt'. In some cases the headword is followed only by a ran in which to insert the



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Chymistry of Isaac Newton : Nor...

place more shall be spoken of. However none is this much dignified in its worthiness that the said philosophick stone could be made of it as this vitriol is. Therefore the ancients have concealed this mineral as much as they could & would not reveal the same to their own children, but kept it secret though they published that such preparation is made out of one thing & out of one body, which hath the nature of ☉ & ☽ & containeth also the ♀. But here you must set your thoughts wholly on metalline vitriols because as I told you that out of ☉ & ☽ ♀ may be made an excellent Vitriol containing all the three principles, so those principles ly hid in a mineral vitriol as in a mineral it self. Understand this according to the several natures of Vitriol For the best & most effectual by my experience is that which is broken & digged in Hungary of a very deep degre of tincture not very unlike unto a fair blew Sapphire having little of humidities & other additional or strange Oars. The oftener it is dissolved & coagulated the more it is exalted in its deep tinging colour, & is beheld with great admiration. This high graduated Vitriol is found crude in those pces where Gold Copper & Iron is digged, & is abundantly transported from thence into foriegne parts, so as sometimes to make a scarcity of it there. Though the Vulgar call it only Copper water, yet the ancient Philosophers for its unspeakable virtue & dignity extolld it & called it Vitriolum, because its' spiritual oyle containeth all the three principles of all the triumphing qualities. l 3. p 132, 133.



Standardization with Unicode Group

- Before we saw all of the Newton manuscripts we didn't know how large the problem was.
- Other projects doing similar things will have the same problem.
- Unicode has some alchemical symbols but only because other symbols—astrology, gender—have alchemical meanings or equivalents
- Why not expand Unicode to include more alchemical symbols?



Unicode Proposal

- Working with Unicode staff members to develop an draft proposal for alchemical symbols.
- Creating the LudyTenger font—3695 symbols
- Selecting the symbols to include—relying on the authors of alchemy textbooks, 1620–1720
- Creating the Alchemy Textbook font—asserting copyright



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TAFEL 1

| | | | |
|--|---------------------------------------------------|--|---------------------------|
| | Alumen, Aurum, Ol. commune, Nox, Antimonii vitrum | | Sol, Aurum |
| | Fimus equinus, Ol. coctum, Nix, Arsenicum album | | Sol, Aurum |
| | Ovum | | Regulus |
| | Alumen | | Sol, Aurum, Auri calx. |
| | Alumen | | Crocus solis |
| | Autumnus | | Aurum |
| | Aurum | | Crocus Auri |
| | Arsenicum, Antimonii vitrum | | Aurichalcum |
| | Alumen plumosum | | Aurum |
| | Lapis calaminaris | | Sal Urinae |
| | Aurum | | Sal marinum |
| | Urina | | Auripigmentum |
| | Urina | | Bezoardicum solare, Aurum |
| | Operatorium | | Auripigmentum |
| | Urina | | Aurum foliatum |

TAFEL 2

| | | | |
|--|--------------------------------------|--|----------------------------------------------------|
| | Venus | | Arsenicum album |
| | Venus | | Annus |
| | Nitrum commune | | Sal Tartari fix |
| | Caput mortuum, Sal ammoniatum | | Cuprum caldarium |
| | Sal Urinae | | Sal Tartari fix |
| | Cuprum caldarium | | Albumen, Ol. Tartari, Ol. destillatum |
| | Vinum mortuum | | Ol. commune |
| | Caput mortuum | | Ignis Reverberii, Ignis Rotae, Ignis circulatorius |
| | Calx, Farina, Aurum, Calx metallorum | | Argentum |
| | Vinum adustum | | Vinum circulatum |
| | Limatura | | Coagulatum |
| | Bezoar orientale | | Coagulatum |
| | Bezoar occidentale | | Alumen plumosum |
| | Aurum | | Alumen plumosum |
| | Arsenicum album | | Cinnabaris |



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Alchemical Symbol Tables in the Seventeenth Century

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| Aqua regis, | ☉. ☿. ☽. ☿. | Calx ovorum, | ☉. |
| Aqua vitæ, | ☉. ☿. ☽. ☿. | Cancer, | ♋. |
| Arsenicum, | ☉. ☿. ☽. ☿. | Caper, | ♁. |
| Sublimatum, | ☉. ☿. ☽. ☿. | Caput mortuum, | ☉. ☿. ☽. ☿. |
| Atramentum, | ☉. ☿. ☽. ☿. | Cementare, | ☉. ☿. ☽. ☿. |
| Auripigmentum, | ☉. ☿. ☽. ☿. | Cera, | ☉. ☿. ☽. ☿. |
| Aurum, | ☉. ☿. ☽. ☿. | Cerussa, | ☉. ☿. ☽. ☿. |
| Aurum possibile, | ☉. ☿. ☽. ☿. | Chalibe, | ☉. ☿. ☽. ☿. |
| Autumnus, | ☉. ☿. ☽. ☿. | Cineres, | ☉. ☿. ☽. ☿. |
| Arcitenens, | ☉. ☿. ☽. ☿. | Cineres clavellati, | ☉. ☿. ☽. ☿. |
| Aurichalcum, | ☉. ☿. ☽. ☿. | Cinnabaris, | ☉. ☿. ☽. ☿. |
| B | | Coagulare, | ☉. ☿. ☽. ☿. |
| Bain. Mar. f. Maris. | ☉. ☿. ☽. ☿. | Coagulum, | ☉. ☿. ☽. ☿. |
| gal. vapor. f. Roris. | ☉. ☿. ☽. ☿. | Colcothar, | ☉. ☿. ☽. ☿. |
| Bolus communis, | ☉. ☿. ☽. ☿. | Cristallus, | ☉. ☿. ☽. ☿. |
| Bolus Armen. | ☉. ☿. ☽. ☿. | Crocus, | ☉. ☿. ☽. ☿. |
| Borax. | ☉. ☿. ☽. ☿. | Coculus albus, | ☉. ☿. ☽. ☿. |
| C | | Coculus Rubeus, | ☉. ☿. ☽. ☿. |
| Calx, | ☉. ☿. ☽. ☿. | Crocibulum Tigil. | ☉. ☿. ☽. ☿. |

From William Johnson, *Lexicon Chymicum* (London, 1652-3)

| Explanation of the Chymical Characters | | f. 491 | |
|----------------------------------------|---|---------------------------------------------|---|
| Steele iron or mass | ☉ | celestial signe | ☉ |
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| Ayre | ☉ | another | ☉ |
| Lymbeck | ☉ | Ashes | ☉ |
| Allom | ☉ | Pot Ashes | ☉ |
| Amalgama | ☉ | Calx | ☉ |
| Antimony | ♁ | quick lime | ☉ |
| Aquarius a signe of the zodiack | ♒ | Cinnabar or Vermillion | ☉ |
| Silver or Luna | ♃ | Waxe | ☉ |
| Quicksilver or Mercury | ☿ | Crucible | ☉ |
| Aries another celestial signe | ♈ | Calcinated copper as usbt or crocus veneris | ☉ |
| Arsenick | ♁ | Notes of Distillation | ☉ |
| Balneum | ☉ | Water | ☉ |
| Balneum | ☉ | Aqua fortis | ☉ |
| Maris | ☉ | aqua Regalis | ☉ |
| Vaporous | ☉ | Spirit | ☉ |
| Bath | ☉ | Libra another celestial signe | ☉ |
| Borax | ☉ | Borax | ☉ |
| Bricks | ☉ | Time of Jupiter | ☉ |
| capricornus another | ♏ | Powder of Bricks | ☉ |
| | | Fire | ☉ |
| Gumme | ☉ | Crocus | ☉ |
| Flower | ☉ | martis | ☉ |
| Oyle | ☉ | Sagittari celestial sign | ♐ |
| Day | ☉ | Soap | ☉ |
| Gemini a celestial signe | ♊ | Scorpi a celestial sign | ♏ |
| Leo another signe | ♌ | Salt alkali | ☉ |
| Libra sign strati or lay upon lay | ♎ | Armeniac Salt | ☉ |
| Marcaffite | ☉ | Common Salt | ☉ |
| Precipitate of Quicksilver | ☉ | Sulphur | ☉ |
| Sublimate | ☉ | Brims of sulphur | ☉ |
| Moneth | ☉ | Black sulphur | ☉ |
| Niter or Saltpeter | ☉ | Philosophers sulphur | ☉ |
| Night | ☉ | To sublimate | ☉ |
| Gold or Sol | ☉ | Talk | ☉ |
| Auripigmentum | ☉ | Tartar | ☉ |
| Lead or Saturne | ♄ | Taur a celestial signe | ♉ |
| Pyces a celestial signe | ☉ | Caput Mortuum | ☉ |
| Powder | ☉ | Tuty | ☉ |
| To precipitate | ☉ | Glaife | ☉ |
| To purify | ☉ | Ven horis or flower of copper | ☉ |
| Quintessency | ☉ | Vinagar | ☉ |
| Realgar | ☉ | Distilled Vinagar | ☉ |
| Retorte | ☉ | Vitriol | ☉ |
| Sand | ☉ | Urine | ☉ |

From Nicaise Le Fevre, *A Compleat Body of Chymistry* (London, 1670)

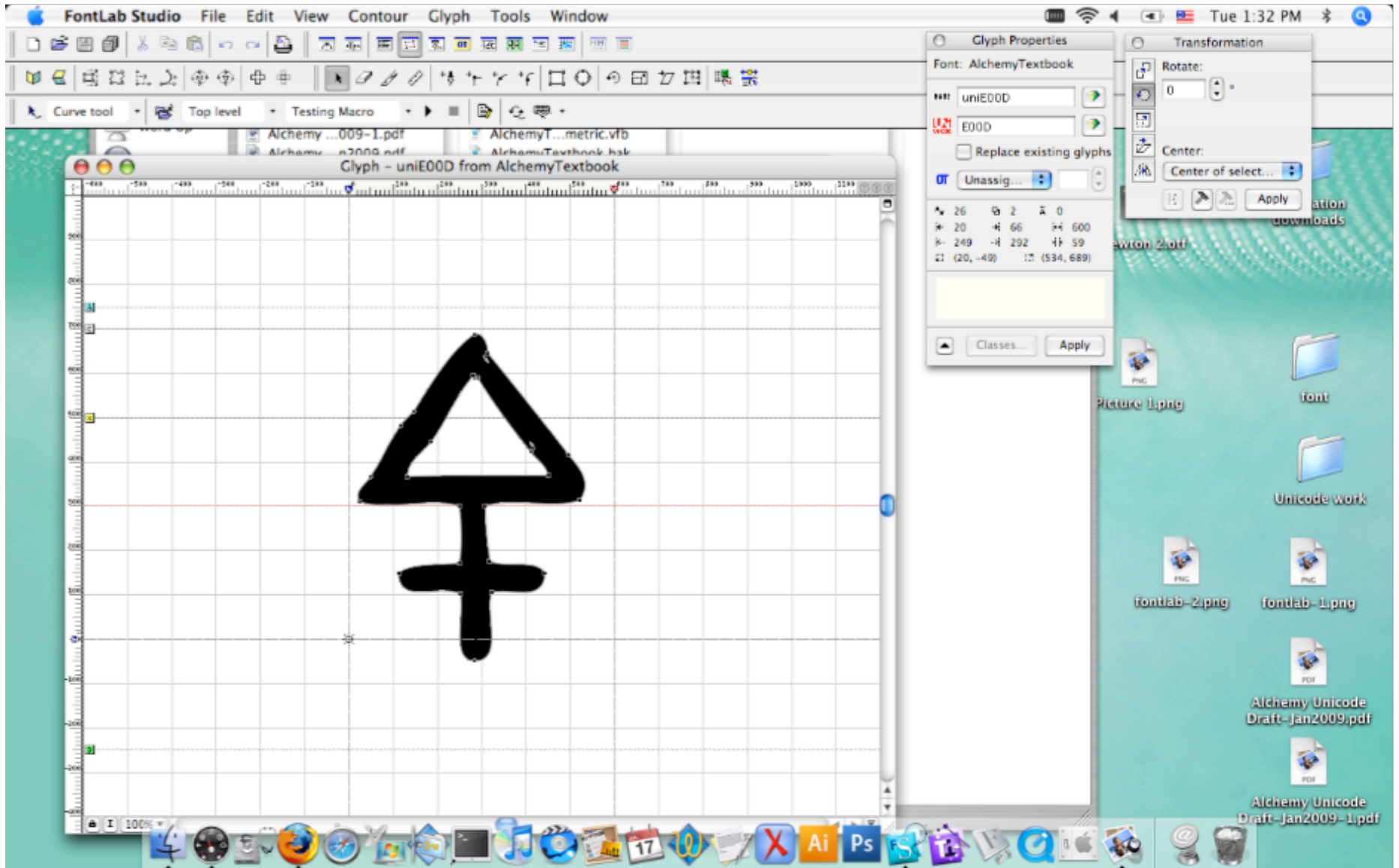


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The screenshot displays the FontLab Studio application window. The main area is a grid of glyphs, with the first row showing characters from the 'Unicode' set, specifically '0000 CO Controls and Basic Latin'. The grid includes characters like 'Z', '[', '\', ']', '^', '_', '`', 'a', 'b', 'c', 'd', 'e', 'f', 'g', 'h', 'i', 'j', 'k' in the first row, and continues through various symbols and ligatures in subsequent rows. On the right side, there are two panels: 'Glyph Properties' and 'Transformation'. The 'Glyph Properties' panel shows the font name 'AlchemyTextbook' and options like 'Replace existing glyphs' and 'Unassign...'. The 'Transformation' panel shows 'Rotate: 0' and 'Center: Center of select...'. The desktop background is a green patterned wallpaper with several icons: a folder named 'font', a folder named 'Unicode work', and several PDF files including 'fontlab-2.png', 'fontlab-1.png', 'Alchemy Unicode Draft-Jan2009.pdf', and 'Alchemy Unicode Draft-Jan2009-1.pdf'. The dock at the bottom contains various application icons like Safari, Mail, iTunes, and Adobe Creative Suite applications.



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Thank You!

- Wally Hooper, DLP
 - Tim Bowman, SLIS
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