History of Chemistry

Atoms & Acids

Molecule of Water

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Wine tells two stories

Back Story (knowledge)

Main Event (blind tasting)

L'Absinthe
Edgar Degas

Stimulants

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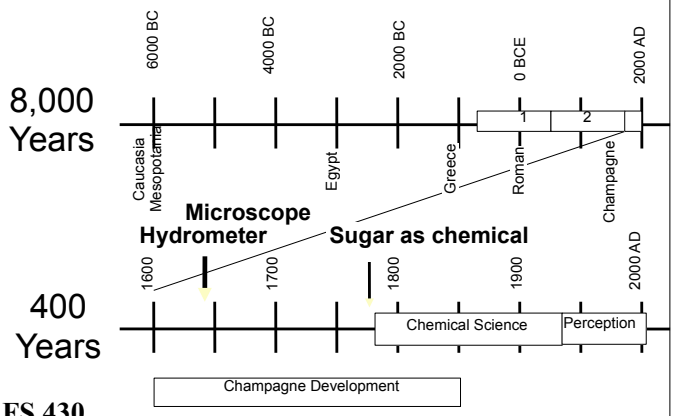
Timeline for Wine History



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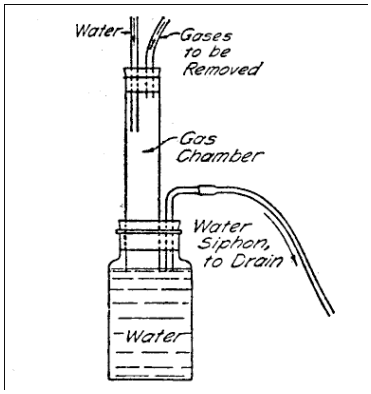

Chemistry
1600 -1800

Glass
Cork

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Tartaric acid

From wine

recrystallized

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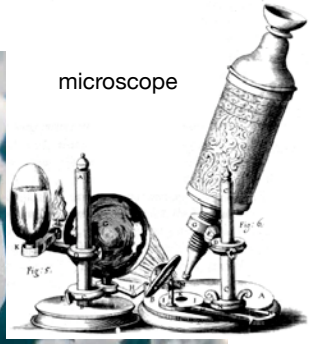
Sugar

microscope



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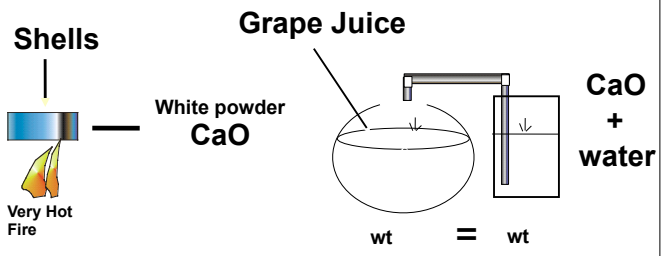
1775 A 18th Century experiment - conducted by a Hellene.



Matter can't be created or destroyed

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1775 Conservation of Mass

Joseph Priestly - Antoine & Laurent Lavoisier

Modern Example: A flash bulb weighs the same before and after it is flashed. Chemical change in a closed system will not change the mass of the system.

Early Example: The vapor and gases from a wine fermentation weighs exactly the same as the loss in weight of the grape juice as it became wine....

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1803 Fermentation: a Chemical transformation

$$C_6H_{12}O_6 \longrightarrow 2C_2H_6O + 2CO_2$$

Sugar — Alcohol — Gas

A chemical reaction

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First Laws of Chemistry ~ 1775 - 1805

1774 Conservation of Mass - Priestley, Lavoisier

1799 Definite Composition - Proust
also isolated glucose from grapes

1803 Multiple Proportions - Dalton
-> Atomic Theory -> Molecular Theory

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1799 Definite Composition

Joseph Proust:
isolated sugar (glucose) from grapes.

If you examine the composition of:

100 g of sugar isolated from grapes

40 g of carbon (C)
60 g of water (H_2O)

H_2O = 7 g of hydrogen (H)
53 g of oxygen (O).

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1799 Definite Composition

Three wine components (100g).

	C	H	O
sugar -	40.0	6.7	53.3
tartaric acid -	41.3	3.4	55.2
carbon dioxide -	27.3	0.0	72.7

Pure chemicals, sugar, salt, water, etc. composed of elements, C, H, O, etc., in a definite formulation!!

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1803 Multiple Proportions - John Dalton -

Small whole numbers!!!

Atoms have a minimum unit weight called atomic weight and combine in "small whole numbers" to define molecules. For example, grape sugar has the empirical formula.

$$C_6H_{12}O_6$$

where the unit weights (called atomic weights) are C = 12, H = 1, and O = 16.

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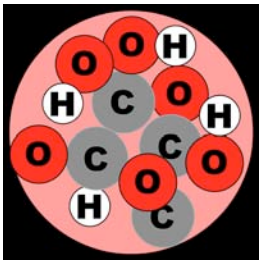
The idea of a molecule

$C_4H_4O_6$



Tartaric Acid

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Water 80 - 90 %

EtOH 10 - 20 %

Sugar 0 - 10 %

Acid 0.5 - 1 %

Phenols 0.02 - 0.15 %

(200 - 1,500 mg/L)

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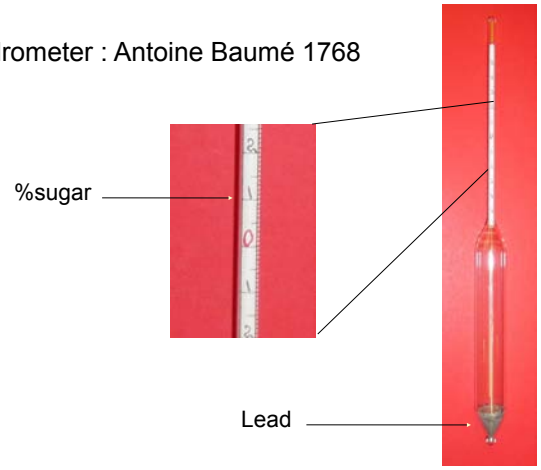
Hydrometer : Antoine Baumé 1768



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Measurement of Acid

Titration w/ strong base: Sodium Hydroxide

$$C_4H_6O_6 + 2NaOH \underset{k_2}{\overset{k_1}{\rightleftharpoons}} C_4H_4O_6Na_2 + 2H_2O$$

tartaric acid — sodium tartrate

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Acree 00

Measurement of alcohol Ebuliometer

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Reversible Reactions

A ⟷ B

B ⟷ A

Berthollet 1803

Equilibrium

A ⇌ B

Le Chatelier 1884

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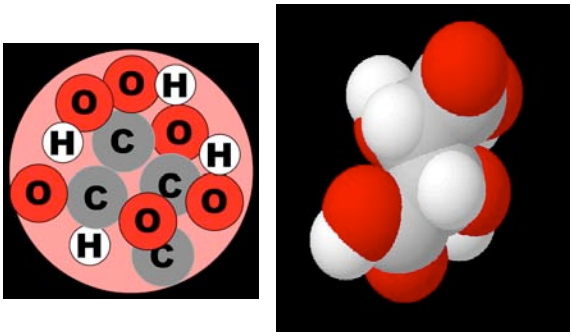

Tartaric Acid

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Dissociation Reaction (weak acids)

$- \log(k_2/k_1) = pK_a$

$C_4H_6O_6$ (tartaric acid) $\underset{k_2}{\overset{k_1}{\rightleftharpoons}}$ $C_4H_5O_6^-$ (bitartrate ion) + H^+ (hydrogen ion) 2.98

$C_4H_5O_6^-$ (bitartrate ion) $\underset{k_4}{\overset{k_3}{\rightleftharpoons}}$ $C_4H_4O_6^{-2}$ (tartrate ion) + H^+ (hydrogen ion) 4.32

$H_2T = HT^- + H^+$, 2.98

$HT^+ = T^{-2} + H^+$, 4.32

$pH = pKa_1 + \log[T^-]/[HT]$

Henderson-Hasselbach Equation

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Dissociation Reaction (weak acids)

	HA (acid)		A^- (salt)			k_2/k_1
tartaric acid	$C_4H_6O_6$	$\underset{k_2}{\overset{k_1}{\rightleftharpoons}}$	$C_4H_5O_6^-$	+	H^+	2.98, 4.32
malic acid	$C_4H_6O_5$	⇌	$C_4H_5O_5^-$	+	H^+	3.40, 5.05
lactic acid	$C_3H_6O_3$	⇌	$C_3H_5O_3^-$	+	H^+	3.08
acetic acid	$C_2H_4O_2$	⇌	$C_2H_3O_2^-$	+	H^+	4.75
citric acid	$C_6H_8O_7$	⇌	$C_6H_7O_7^-$	+	H^+	3.14, 4.77, 6.39

$k_2 > k_1$ $pH = pK_a + \log[A^-]/[HA]$

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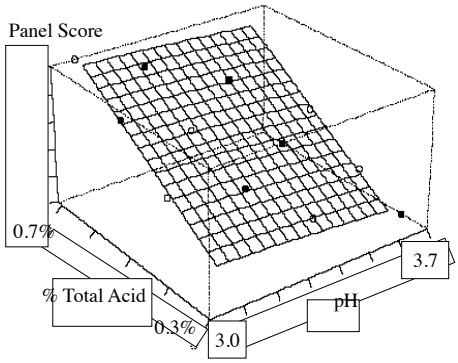
Total Acidity

	pH*	mg/L	mMolarity	mNormality
tartaric acid	3.0	7.0	47	94
malic acid	3.0	6.3	47	94
lactic acid	3.0	4.8	47	47
citric acid	3.0	9.9	47	142

FS 430 *pH adjusted with 5N NaOH

Sensory Score = f(chemistry)

Plane



FS 430 Acid Index = TA (total acid as tartrate) - pH

$C_4H_6O_6$ $\underset{k2}{\overset{k1}{\rightleftharpoons}}$ $C_4H_5O_6^-$ + H^+ 2.98

tartaric acid — bitartrate ion — hydrogen ion

$C_4H_5O_6^-$ + $C_4H_4O_6K_2$ $\underset{k4}{\overset{k3}{\rightleftharpoons}}$ $C_4H_5O_6K$

bitartrate ion — Potassium tartrate — Potassium bitartrate

soluble soluble Insoluble

"Cream of tartar"

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Chemical Structure in 3D

1815 Biot - tartrate optical activity

1831 Berzelius - racemic acid (grapes)

1841 Pasteur - hemihedral crystals

Tartaric Acid

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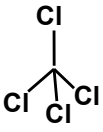
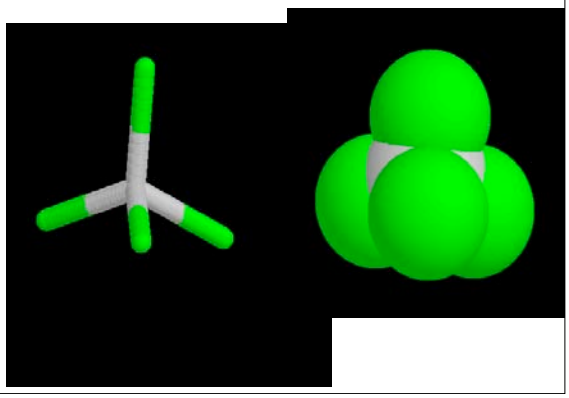
1874 Van't Hoft & Le Bel - tetrahedral carbon bonds





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Dr. Prof. Kolbe 1877

"A Dr. J. H. van't Hoff, of the Veterinary School at Urecht, has no liking, it seems, for exact chemical investigation. He has considered it more convenient to mount Pegasus (apparently borrowed from the Veterinary School) and to proclaim in his La chimie dans l'espace how the atoms appear to him to be arranged in space, when he is on the chemical Mt. Parnassus which he has reached by bold flight."

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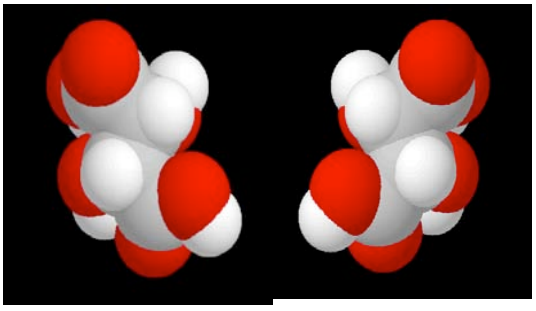
1874 Van't Hoft & Le Bel - tetrahedral C

Tartaric Acid



D or + L or -

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Fox Run Rsv Chard 06
Fetzer Valley Oaks SB
Kim Crawford SB
Martin Codax Albarino

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