Sulfuric acid (American spelling and the preferred IUPAC name) or **sulphuric acid** (Commonwealth spelling), known in antiquity as **oil of vitriol**, is a mineral acid composed of the elements Sulphur, oxygen, and hydrogen, with the molecular formula H_2SO_4. It is a colourless, odourless, and viscous liquid that is miscible with water.

Pure sulfuric acid does not occur naturally due to its strong affinity to water vapor; it is hygroscopic and readily absorbs water vapor from the air. Concentrated sulfuric acid is highly corrosive towards other materials, from rocks to metals, since it is an oxidant with powerful dehydrating properties. Phosphorus pentoxide is a notable exception in that it is not dehydrated by sulfuric acid but, to the contrary, dehydrates sulfuric acid to sulphur trioxide. Upon addition of sulfuric acid to water, a considerable amount of heat is released; thus, the reverse procedure of adding water to the acid should not be performed since the heat released may boil the solution, spraying droplets of hot acid during the process. Upon contact with body tissue, sulfuric acid can cause severe acidic chemical burns and even secondary thermal burns due to dehydration. Dilute sulfuric acid is substantially less hazardous without the oxidative and dehydrating properties; however, it should still be handled with care for its acidity.

Sulfuric acid is a very important commodity chemical; a country's sulfuric acid production is a good indicator of its industrial strength. Many methods for its production are known, including the contact process, the wet sulfuric acid process, and the lead chamber process. Sulfuric acid is also a key substance in the chemical industry. It is most commonly used in fertilizer manufacture but is also important in mineral processing, oil refining, wastewater processing, and chemical synthesis. It has a wide range of end applications, including in domestic acidic drain cleaners, as an electrolyte in lead-acid batteries, in dehydrating a compound, and in various cleaning agents. Sulfuric acid can be obtained by dissolving Sulphur trioxide in water.

Physical properties

Grades of sulfuric acid

Although nearly 100% sulfuric acid solutions can be made, the subsequent loss of SO_3 at the boiling point brings the concentration to 98.3% acid. The 98.3% grade, which is more stable in storage, is the usual form of what is described as "concentrated sulfuric acid". Other concentrations are used for different purposes. Some common concentrations are:

Mass fraction H_2SO_4	Density (kg/L)	Concentration (mol/L)	Common name
<29%	1.00-1.25	<4.2	diluted sulfuric acid
29–32%	1.25–1.28	4.2–5.0	battery acid (used in lead–acid batteries)
62–70%	1.52–1.60	9.6–11.5	chamber acid fertilizer acid
78–80%	1.70–1.73	13.5–14.0	tower acid Glover acid

93.2%	1.83	17.4	66 °Bé ("66-degree Baumé") acid
98.3%	1.84	18.4	concentrated sulfuric acid

"Chamber acid" and "tower acid" were the two concentrations of sulfuric acid produced by the lead chamber process, chamber acid being the acid produced in the lead chamber itself (<70% to avoid contamination with nitrosylsulfuric acid) and tower acid being the acid recovered from the bottom of the Glover tower. They are now obsolete as commercial concentrations of sulfuric acid, although they may be prepared in the laboratory from concentrated sulfuric acid if needed. In particular, "10 M" sulfuric acid (the modern equivalent of chamber acid, used in many titrations), is prepared by slowly adding 98% sulfuric acid to an equal volume of water, with good stirring: the temperature of the mixture can rise to 80 °C (176 °F) or higher.

Sulfuric acid

Sulfuric acid contains not only H_2SO_4 molecules, but is actually an equilibrium of many other chemical species, as it is shown in the table below.

Equilibrium of pure sulfuric acid[15]

Species	mMol/kg
HSO^-_4	15.0
$H_3SO^+_4$	11.3
H_3O^+	8.0
$HS_2O^-_7$	4.4
$H_2S_2O_7$	3.6
H_2O	0.1

Sulfuric acid is a colourless oily liquid, and has a vapor pressure of <0.001 mmHg at 25 °C and 1 mmHg at 145.8 °C, and 98% sulfuric acid has a vapor pressure of <1 mmHg at 40 °C.

Names
IUPAC name Sulfuric acid
Other names Oil of vitriol Hydrogen sulphate

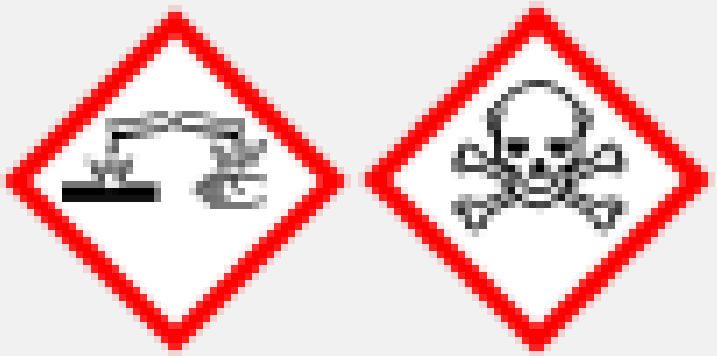
Identifiers	
CAS Number	• 7664-93-9
ChEBI	• CHEBI:26836
ChEMBL	• ChEMBL572964
ChemSpider	• 1086
ECHA InfoCard	100.028.763
EC Number	• 231-639-5
E number	E513
Gmelin Reference	2122
KEGG	• D05963
PubChem CID	• 1118
RTECS number	• WS5600000
UNII	• O40UQP6WCF

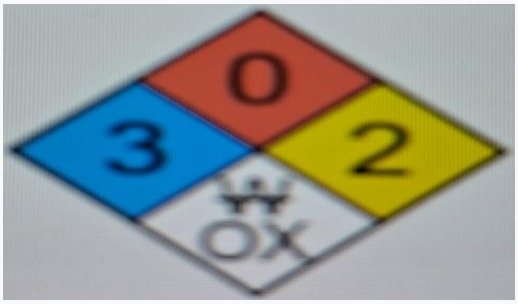
UN number	1830
CompTox Dashboard (EPA)	• DTXSID5029683

Properties	
Chemical formula	H_2SO_4, sometimes expressed $(HO)_2SO_2$
Molar mass	98.079 g/mol
Appearance	Colorless viscous liquid
Odor	Odorless
Density	1.8302 g/cm³, liquid
Melting point	10.31[1] °C (50.56 °F; 283.46 K)
Boiling point	337 °C (639 °F; 610 K) When sulfuric acid is above 300 °C (572 °F; 573 K), it gradually decomposes to SO_3 + H_2O
Solubility in water	miscible, exothermic
Vapor pressure	0.001 mmHg (20 °C)[2]
Acidity (pK_a)	pK_{a1} = −2.8 pK_{a2} = 1.99
Conjugate base	Bisulphate
Viscosity	26.7 cP (20 °C)

Structure	
Crystal structure	monoclinic
Space group	C2/c
Lattice constant	*a* = 818.1(2) pm, *b* = 469.60(10) pm, *c* = 856.3(2) pm α = 90°, β = 111.39(3) °, γ = 90°
Formula units (*Z*)	4

Thermochemistry	
Std molar entropy ($S^{\ominus}_{298}$)	157 J/(mol·K)
Std enthalpy of formation ($\Delta_f H^{\ominus}_{298}$)	−814 kJ/mol

Hazards	
GHS labelling:	
Pictograms	
Signal word	**Danger**

Hazard statements	H314
Precautionary statements	P260, P264, P280, P301+P330+P331, P303+P361+P353, P304+P340, P305+P351+P338, P310, P321, P363, P405, P501
NFPA 704 (fire diamond)	
Flash point	Non-flammable
Threshold limit value (TLV)	15 mg/m³ (IDLH), 1 mg/m³ (TWA), 2 mg/m³ (STEL)

Uses

Sulfuric acid is a very important commodity chemical, and indeed, a nation's sulfuric acid production is a good indicator of its industrial strength. World production in the year 2004 was about 180 million tonnes, with the following geographic distribution: Asia 35%, North America (including Mexico) 24%, Africa 11%, Western Europe 10%, Eastern Europe and Russia 10%, Australia and Oceania 7%, South America 7%. Most of this amount (≈60%) is consumed for fertilizers, particularly superphosphates, ammonium phosphate and ammonium sulphates. About 20% is used in chemical industry for production of detergents, synthetic resins, dyestuffs, pharmaceuticals, petroleum catalysts, insecticides and antifreeze, as well as in various processes such as oil well acidizing, aluminium reduction, paper sizing, and water treatment. About 6% of uses are related to pigments and include paints, enamels, printing inks, coated fabrics and paper, while the rest is dispersed into a multitude of applications such as production of explosives, cellophane, acetate and viscose textiles, lubricants, non-ferrous metals, and batteries.