Extended tier onlySulfuric acid is synthesised by the Contact processConcentrated sulfuric acid is used in car batteries, making fertilisers, soaps and detergentsStage 1The first stage is the production of sulfur dioxideThe oxygen for this stage is obtained from the airThe sulfur for this stage is obtained by:Burning sulfur to oxidise the sulfursulfur + oxygen sulfur dioxideS + O2 SO2metal sulfide + oxygen metal oxide + sulfur dioxideStage 2The main stage is the oxidation of sulfur dioxide to sulfur trioxide using a vanadium(V) oxide, V2O5,catalystsulfur dioxide + oxygen sulfur trioxide2SO2+ O2 2SO3The oxygen used in this stage is obtained from airThe conditions for this main stage of production are:A temperature of 450 CA pressure of 2 atm (200 kPa)Once sulfur trioxide is formed, it undergoes more processes to produce sulfuric acidStage 3The sulfur trioxide is absorbed into a solution of 98% sulphuric acid to produce a thick liquid calledoleum (disulfuric acid):SO3+ H2SO4 H2S2O7sulfur trioxide + sulfuric acid disulfuric acidIt is not absorbed into water because a fine mist of sulfuric acid would be produced and this would be difficult to condense and is also highly dangerousOleum is added to water to form concentrated sulfuric acid:H2O + H2S2O7 2H2SO4water + disulfuric acid sulfuric acidPage 2Exam code: 0620 & 0971Did this video help you?Extended tier onlyAmmonia is manufactured in an exothermic reaction called the Haber process which occurs in five stages:Stage 1H2 is obtained from methaneN2 is obtained from the airThey are pumped into the compressor through a pipeStage 2Inside the compressor, the gases are compressed to around 20 000 kPa or 200 atmospheresStage 3The pressurised gases are pumped into a tank containing layers of an iron catalyst at a temperature of 450 CSome of the hydrogen and nitrogen react to form ammonia:N2 (g) + 3H2 (g) 2NH3 (g)Stage 4Unreacted H2 and N2 and the ammonia product pass into a cooling tankThe ammonia is liquefied and removed to pressurised storage vesselsStage 5The unreacted H2 and N2 gases are recycled back into the system and start over againThe production of ammonia by the Haber processAmmonia is produced during the Haber Process. The reaction is summarised in the diagram below.Name gas A.Name catalyst B used and state why it is usedAnswer:Gas A is hydrogen / H2.Catalyst B is iron, which is used to speed up the reaction / increase the rate of reaction.Examiners comment that students often know:That nitrogen and hydrogen are needed for the Haber processWhat the purpose of the catalyst isBut, that students do not:Know where the nitrogen and hydrogen come fromKnow the name of the catalyst and confuse it with other catalysts like 'vanadium oxide' and 'enzymes'.You should know where the nitrogen and hydrogen come from as well as the conditions of the Haber process:Pressure = 200 atmospheresTemperature = 450oCCatalyst = ironExtended tier onlyChemists' knowledge of the energy changes and factors affecting reaction rates can be used to predict the best possible conditions to make the most ammonia in the fastest possible timeHowever, sometimes those conditions are contradictory and choices have to be made between factors that improve the yield of ammonia and those that speed up the reactionThe graph below illustrates the effects of changing temperature and pressure on the yield of ammonia obtainedThe yield of ammonia produced changes with changes made to temperature and pressureFrom the graph:As the pressure increases, the percentage yield increasesThis is shown by following any of the curved linesAs the temperaturedecreases, the percentage yield increasesThis is shown by following any vertical line upwards from the x-axisthatThe actual conditions used must be chosen depending on a number of economical, chemical and practical considerationsLike all industries, companies that manufacture and sell chemical goods do so to make a profitPart of the industrial process is the economic decision on how and where to design and implement a manufacturing siteThe availability and cost ofraw materialsis a major consideration which must be studied well before any decisions are takenIn the Haber Process the raw materials are readily available and inexpensive to purify:Nitrogen- from theairHydrogen- fromnatural gasIf the cost of extraction of raw materials is too high or they are unavailable then the process is no longereconomically viableMany industrial processes require huge amounts ofheatandpressurewhich is very expensive to maintainProduction energy costs are also a factor to be considered carefully and alongside the raw materials issueTemperature: 450CHigh temperature favours the reverse reaction as it is endothermicSo, a higher yield of reactants will be madeLow temperature favours the forward reaction as it is exothermicSo, a higher yield of products will be madeHowever, at low temperature the rate of reaction is very slowSo, 450 C is a compromise temperature between having a lower yield of products but being made more quicklyPressure: 200 atmLow pressure favours the reverse reaction as there are more moles of gaseous reactantSo, a higher yield of reactants will be madeHigh pressure favours the forward reaction as there are fewer moles of gaseous productSo, a higher yield of products will be madeHowever, high pressure can be dangerous and very expensive equipment is neededSo, 200 atmospheres is a compromise pressure between a lower yield of products being made safely and economicallyCatalyst:IronThe presence of a catalyst doesnotaffect the position of equilibrium but it does increase therateat which equilibrium is reachedThis is because the catalyst increases the rate ofboththe forward and backward reactions by the same amount (by providing an alternative pathway requiringlower activation energy)As a result, theconcentrationof reactants and products is nevertheless thesameat equilibrium as it would be without the catalyst.So a catalyst is used as it helps the reaction reach equilibrium quickerIt allows for an acceptable yield to be achieved at alower temperatureby lowering the activation energy requiredWithout it the process would have to be carried out at an evenhigher temperature, increasingcostsand decreasingyieldas the higher temperaturedecomposesmore of the NH3moleculesThe reaction conditions chosen for the Haber process are not ideal in terms of the yield but do provide balance between product yield, reaction rate and production cost.These are calledcompromise conditionsas they are chosen to give a good compromise between the yield, rate and cost.Did this page help you?Sulfuric acid is manufactured by the contact process, which involves the following three steps.1) Roasting in air: Sulfur or sulfide ore (iron pyrites) on burning or roasting in air produces sulfur dioxide.i) \[\ce{\underset{\text{Sulfur}}{S_{(s)}} + O_{2(g)} ->[] \underset{\text{Sulfur dioxide}}{SO_{2(g)}}}\]ii) \[\ce{\underset{\text{Iron sulfide}}{4FeS_{2(s)}} + 11O_{2(g)} ->[] 2Fe2O_{3(s)} +\underset{\text{Sulfur dioxide}}{8SO_{2(g)}}}\]2) Catalytic oxidation of sulfur dioxide: i) Sulfur dioxide is oxidised catalytically with oxygen to sulfur trioxide, in the presence of V2O5 catalyst.\[\ce{\underset{\text{Sulfur dioxide}}{2SO_{2(g)}} + O_{2(g)}->[V2O5] \underset{\text{Sulfur trioxide}}{2SO_{3(g)}}}\]ii) The reaction is exothermic and reversible and the forward reaction leads to decrease in volume. Therefore, low temperature (720K) and high pressure (2 bar) are favourable conditions for maximum yield of SO3.3) Absorption, followed by dilution of sulfur trioxide gas:i) Sulfur trioxide gas (from the catalytic converter) is absorbed in concentrated H2SO4 to produce oleum.\[\ce{\underset{\text{Sulfur trioxide}}{SO3} + H2SO4 -> \underset{\text{Oleum}}{H2S2O7}}\]ii) Dilution of oleum with water gives sulfuric acid of desired concentration.\[\ce{\underset{\text{Oleum}}{H2S2O7} + H2O -> \underset{\text{Sulfuric acid}}{2H2SO4}}\]iii) The sulfuric acid obtained by contact process is 96-98 % pure. 3. Why is sulfuric acid such a useful material? How is it made? What is the Contact Process? Because sulfuric acid has so many uses the industrial development of a country is sometimes measured by the amount of sulfuric acid that is used each year. How is sulfuric acid made? What is the Contact Process? Sulfuric acid is made starting from the element sulfur which is found in the Earth's crust. What are the uses of sulfuric acid? USES of SULFURIC ACID Sulfuric acid is an important chemical produced in large quantities in the chemical industry. Sulfuric acid is used as the lead-acid battery, the manufacture of detergents, dyes (dyestuffs), explosives, artificial fibres, pigments like white titanium dioxide and is used to make fertilisers (supplies the element sulfur for plant growth), MANUFACTURE of SULFURIC ACID by the CONTACT PROCESS The raw materials and other factors requiring decisions in manufacturing sulfuric acid You need to know and find the raw materials that you can convert into a chemical feedstock that becomes the starting point for the synthesis of the chemical compound - the desired product, in this case sulfur trioxide and sulfuric acid. The phrase chemical feedstock means the actual reactant molecules that are fed into the reactor chamber e.g. sulfur dioxide and oxygen. The raw material usually requires processing e.g. purifying or chemically modifying it to produce a purer starting feedstock material - sometimes this involves molecules than can poison a catalyst, reducing its efficiency. There are several factors to be taken into consideration before choosing the starting raw materials - that is assuming there is a choice e.g. The cost of extracting, separating and purifying the starting chemicals of sulfur, oxygen and water from which to make the product. Is the process economically viable and the product ultimately profitable - sulfuric acid is made on a huge scale - reduces costs, especially if the process is continuous and not a batch process. What are the energy costs like - can you operate the chemical process efficiently using the minimum energy - lower temperatures and pressure conditions use less energy and engineering costs are lower too - it should be taken into account that the oxides of sulfur are very corrosive gases. The conditions chosen must be carefully controlled to allow an efficient rate of product production (economically acceptable rate) and maximise the yield of sulfur trioxide e.g. by control of reactant concentrations, reactor pressure, reactor temperature and appropriate catalyst. Sulfuric acid is manufactured from the raw materials sulfur, air and water and involves the production of sulfur trioxide in the Contact Process. (1) Sulfur is burned in air to form sulfur dioxide (exothermic). In the reaction the sulfur is oxidised (O gain) (1a) S(s) + O2(g) ====> SO2(g) Sulfur dioxide can also be indirectly obtained from the process of extracting copper from copper sulfide ores e.g. in a copper smelter: (1b) Cu2S(s) + O2(g) ====> 2Cu(l) + SO2(g) Note: Sulfur dioxide itself is a useful chemical in its own right: It is used as a bleach in the manufacture of wood pulp for paper manufacture and its toxic nature makes it useful as a food preservative by killing bacteria. (2) In the reactor, the sulfur dioxide is mixed with sufficient air (to give the required SO2:O2 2:1 ratio). The mixture is passed over a catalyst of vanadium(V) oxide V205 (vanadium pentoxide) at a high temperature (about 450C) and at a pressure of between one and two atmospheres - a high pressure isn't needed, which reduces engineering costs. It is a 2nd exothermic oxidation reaction and is known as the Contact Process. In the reactor the sulfur dioxide is oxidised in the reversible exothermic reaction ... (2) 2SO2(g) + O2(g) 2SO3(g) The reaction forms sulfur trioxide and the equilibrium is very much to the right hand side ... The reaction is favoured by low temperature Because it is an exothermic reaction, a lower temperature removes the heat energy and moves the equilibrium to the right-hand side, SO3 formation. BUT, despite the reaction being exothermic (95 kJ released per mole of SO3), a relatively high temperature is used to ensure a reasonable rate of reaction (despite the fact that it favours reverse reaction R to L, from the energy change equilibrium rule, inc. T. favours endothermic direction). The reaction is favoured by high pressure This is from the pressure equilibrium rule, 3 => 2 gas molecules, LHS ==> RHS, the equilibrium moves in the direction of minimising the effect of increased pressure), see Chatelier's Principle. In fact, only a small increase in pressure is needed to give high yields of sulfur trioxide, because the formation of SO3 on the right hand side is so energetically favourable (approx. 99% yield, i.e. only about 1% SO2 unreacted). Using higher pressures might seem favourable, but it raises engineering costs and increases the rate of corrosion of piping because sulfur trioxide is a very corrosive gas! The use of the V2O5 catalyst The use of vanadium pentoxide catalyst ensures a fast reaction without having to use too a higher temperature which would favour the left hand side and reduce the yield BUT it does not change the % of sulfur trioxide formed, you simply get to equilibrium position of maximum yield faster. More GCSE notes on reversible reactions and equilibrium rules. (3) The sulfur trioxide is dissolved in concentrated sulfuric acid to form fuming sulfuric acid (oleum). (3) SO3(g) + H2SO4(l) ====> H2S2O7(l) (4) Water is then carefully added to the oleum to produce concentrated sulfuric acid (98%). (4) H2S2O7(l) + H2O(l) ====> 2H2SO4(l) If the sulfur trioxide is added directly to water an acid mist forms which is difficult to contain because the reaction to form sulfuric acid solution is very exothermic! If you 'add' equations (3) + (4) you get (5) SO3(g) + H2O(l) ====> H2SO4(l) which is how it is usually written in GCSE textbooks, so learn equations (1a), (2) and (5) for the manufacture of sulfuric acid from sulfur. Good anti-pollution measures need to be in place since the sulfur oxides are harmful and would cause local acid rain! To help this situation AND help the economics of the process, any unreacted sulfur dioxide is recycled through the reactor. EXPERIMENTS with concentrated sulfuric acid Concentrated sulfuric acid can be used in the laboratory as a dehydrating agent. Dehydration is the removal of water or the elements of water from a compound and can be described as an elimination reaction. Usually and adjacent H and OH in a molecule are removed to form the water. When added to some organic compounds containing hydrogen and oxygen, e.g. sugar, concentrated sulfuric acid removes the elements of water from the compound leaving a 'spongy' black carbon residue. If alcohols are heated with conc. sulfuric acid, they are dehydrated to alkenes e.g. ethanol ====> ethene + water CH3CH2OH ====> CH2=CH2 + H2O When added to blue copper sulfate crystals concentrated sulfuric acid removes the water of crystallisation leaving white anhydrous copper sulfate. In this case the water already exists BUT not in a mixture and so the following reaction is classified as a chemical change. CuSO4.5H2O(s) CuSO4(s) + 5H2O (water absorbed into the H2SO4 which it reacts with) Conc. H2SO4 catalyses the reaction between an alcohol and carboxylic acid to form an pleasant smelling ester liquid but it isn't considered a dehydration reaction (H comes from one molecule and OH from the other). e.g. the esterification reaction: ethanoic acid + ethanol ==> ethyl ethanoate + water CH3COOH + CH3CH2OH ====> CH3COOCH2CH3 + H2O Concentrated sulfuric acid can be used as a drying agent e.g. in the preparation of gases. The prepared gas is bubbled through a dreschel/dreschler bottle (illustrated on the right), containing the concentrated sulfuric acid. In this case the water vapour is just a component in a gaseous mixture. Most gases can be dried in this way except the alkaline gas ammonia which will exothermically react to form a solid salt. In this case the water vapour is just a component in a gaseous mixture. What next? Associated Pages (Where next?) 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Electrolysis of brine (NaCl(aq)) for the production of chlorine, hydrogen and sodium hydroxide Website content Dr Phil Brown 2000+. All copyrights reserved on Doc Brown's Chemistry revision notes, images, quizzes, worksheets etc. Copying of website material is NOT permitted. Exam revision summaries & references to science course specifications are unofficial. What next? Associated Pages Sulphuric acid is widely used chemical in industries. It is used in the manufacture of fertilizers, drugs, dyes, polymers, etc. thousands of tons of sulphuric acid is manufactured every year worldwide. So it is called king of chemicals. Manufacture of sulphuric acid(H2SO4) by contact process In early days, sulphuric acid used to be maniufactured by lead chamber process.Contact process is modern method. The acid obtained is pure(free from impurities) and is quite concentrated (96-99%). The contact process, its name is mainly from the fact that the conversion of sulphur dioxide into sulphur trioxide is carried out in contact with surface of catalyst.Principle :1. Production of sulphur dioxide : Sulphur dioxide gas can be prepared either by burning sulphur or roasting of iron pyrites. 2. Catalytic oxidation of sulphur dioxide : Sulphur dioxide is oxidized to sulphur trioxide in presence of catalyst vanadium pentoxide at about 4500C temperature and 2 atm pressure. 3. Conversion of SO3 into H2SO4 : sulphur trioxide obtained is absorbed in 98% H2SO4 to produce oleum or fuming sulphuric acid. The oleum is diluted with calculated amount of water to get desired concentration of H2SO4. Conditions for optimum yield of H2SO4 :Formation of SO2 to SO3 is one of the must important steps in the manufacture of sulphuric acid. The production of H2SO4 entirely depends on the amount of SO3 formed. As reaction is reversible, exothermic and proceeds with decrease in volume, Le- Chateliers principle can be applied for the maximum yield of sulphur trioxide.Low temperature : This reaction is exothermic . So, low temperature is required for maximum yield. But too low temperature is too slow to attain equilibrium. So an optimum temperature of about 4500C is supplied.High concentration of reactants : High concentration of SO2 and O2 is used for more production of SO3 .High pressure : High pressure favours the reaction because the product formed has less volume than reactant . But the acid resistant tower which are able to withstand high pressure are difficult to build. Hence, an optimum pressure of about 2 atm is applied.Use of catalyst : Rate of reaction is increased by the use of positive catalyst . So, vanadium pentoxide is used as catalyst for higher yield of H2SO4.Details of the plant or process :[I] Sulphur or pyrite burner : SO2 gas is obtained by burning sulphur or iron pyrite with air in sulphur or pyrite burner. [II] Purification unit : The impure SO2 gas obtained is purified by the purification unit.Electrical dust precipitator : Dust particles present in sulphur dioxide gas is precipitated in electrical dust precipitator by the influence of high potential difference applied between the metallic conductors fitted in the chamber.Steam chamber : The lighter dust particles are settled down by using steam in steam chamber.Cooler : The gases coming out from the steam chamber are passed through cooler. The gases get cooled down to about 1000C.Washing tower(scrubber) : The cooled SO2 gas is then passed into a tower called scrubber which is packed with quartz and water is sprayed from the top. The water soluble impurities are washed away.Drying tower : The moisture present in sulphur dioxide is absorbed by the spray of conc.H2SO4 in drying tower.Arsenic purifier : arsenous oxide (As2O3) present in gas is absorbed by ferric hydroxide(because it may causes catalytic poisoning).[III] Testing box : The purity of sulphur dioxide is checked in testing box by passing through a darkened box.[IV] Preheater : The purified mixture of SO2 and O2 is heated upto 4500C.[V] Contact chamber : The SO2 gas is catalytically oxidized to sulphur trioxide (SO3) in the presence of V2O5 as catalyst at 4500C temperature and 2 atm pressure.[VI] Absorption tower : This tower is packed with quartz (or acid proof stone) in which 98% H2SO4 is sprayed from the top of the tower. Concentrated H2SO4 absorbs sulphur trioxide to form oleum(or pyrosulphuric acid). Oleum is then treated with calculated amount of water to form sulphuric acid of desired concentration. Physical Properties of H2SO4: It is colourless, hygroscopic, syrupy liquid.It is highly soluble in water (due to formation of intermolecular hydrogen bond). It dissolves in water with the liberation of large quantity of heat(19Kcal/mol) which may causes the explosion or spurt the acid out of the container. H2SO4 + nH2O H2SO4.nH2O + HeatTherefore, sulphuric acid is diluted by adding the acid slowly to water with constant stirring and not by adding water to the acid.Its melting point is 100C and boiling point is 3380C.Pure H2SO4 is covalent compound and bad conductor of electricity. However aqueous H2SO4 conducts electricity.Litmus test : Sulphuric acid is covalent compound. In pure state it does not change the colour of the blue litmus paper. However, aqueous acid gets ionized and produces hydrogen(or hydronium) ion into solution. Due to which it can change the colour of blue litmus paper to red. Chemical properties of H2SO4 : 1. Decomposition of H2SO4 :On heating H2SO4 decomposes into SO2, H2O and O2. 2. Acidic nature of H2SO4:H2SO4 is a strong dibasic (diprotic) acid and ionizes in two steps. It gives two series of salts like bisulphate and sulphate when reacted with base.Eg. 3. H2SO4 as an oxidizing agent :i. Action with metals : More electropositive metals (i.e. metals lying above hydrogen in electrochemical series) like Zn, Fe, Mg, Al, etc. react with dil H2SO4 to produce hydrogen gas. Here H2SO4 reduces to H2 and metals oxidize to metal sulphates. Conc. H2SO4 oxidizes Zn, Cu, Ag, Hg, etc. to respective metal sulphates and H2SO4 gets reduced to SO2. ii. Action with non metals :Carbon is oxidized to carbondioxide. Sulphur is oxidized to sulphurdioxide. Phosphorus is oxidized to phosphoric acid. iii. Action with some other reducing agents :H2SO4 oxidizes H2S to S and itself reduces to SO2. HBr and HI are oxidized to Br2 and I2 respectively. {Note : HCl can not be oxidized to Cl2 because of strong bond.}4. Sulphuric acid as dehydrating agent :H2SO4 is a good dehydrating agent. It absorbs water molecules from sugar, cellulose, copper sulphate crystals, etc.With sugar (charring action) : When conc. H2SO4 is treated with sugar, wood, paper, etc. it absorbs water and a black mass of carbon is formed. This process is called charring. With copper sulphate crystals : It removes water of crystallization from hydrated salts. With oxalic acid crystals and formic acid: Structure : Lewis structure of H2SO4 Uses of sulphuric acid : It is used for the manufacture of fertilizers.It is used in manufacture of HCl, HNO3, H3PO4, etc.It is used as an oxidizing agent.It is used as a drying and dehydrating agent. Test of H2SO4 : Sulphuric acid gives H+ ions and SO4 ions in aqueous solution. The presence of H+ ion can be detected by litmus paper. The presence of SO4 can be detected by BaCl2 solution which gives white precipitate. Sodium thiosulphate(hypo) : Molecular formula : Na2S2O3. 5H2OIt is commonly called hypo.Uses of sodium thiosulphate(hypo) :It is used as a fixer in photography. { i.e. for fixing silver bromide in photographic plate}It is used in (iodometric) titration for the estimation of iodine.It is used as an antichlor agent to remove excess of chlorine from bleached textiles/fibers. REFERENCES : Lee, j. D., Concise Inorganic Chemistry, Fifth Edition, Joh, Wiley and Sons, Inc., 2007.Cotton, F. A., and Wilkinson, G., Advanced Inorganic Chemistry, Fifth edition, John Wily and Sons, Singapore, 1995.Day, C.M., Selbin, J., Theoritical inorganic Chemistry, second edition, Affiliated East-West Press Pvt. Ltd., New Delhi, 2002.Mitra, L.A. , A Text Book of Inorganic Chemistry, Ghos and Company, 61st edition, 1996. //www.sciencedirect.com/topics/earth-and-planetary-sciences/sulphuric-acid Share copy and redistribute the material in any medium or format for any purpose, even commercially. 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During the early stages of World WarII, he was the commander of Army Ground Forces, and played the leading role in the organization, equipping, and training of Army units before they departed for overseas combat. He was killed on 25July 1944 while in France as commander of the fictitious First United States Army Group, part of Operation Quicksilver, a deception plan for the invasion of Normandy. McNair died when the US Eighth Air Force attempted to use heavy bombers in support of ground combat troops, and several planes dropped payloads short of their targets. He received a posthumous promotion to general. 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These individual ride listings consist mainly of carousels, but also include roller coasters, trains, and other ride types. Many NRHP-listed rides operate within amusement parks, with more than one present in Cedar Point, Lagoon, and Santa Cruz Beach Boardwalk. There are also high concentrations in New York City, the Greater Binghamton area in New York state, and Portland, Oregon. The first NRHP amusement ride listing was added in 1975 for the Idora Park Merry-Go-Round (delisted in 1985). The listing for the Crescent Park Looff Carousel was added in 1976 and is the ride that has existed on the NRHP the longest. The listing for the Portland Zoo Railway Historic District was created in 2020 and is the newest ride entry on the NRHP. Several NRHP-listed rides, including the Leap-the-Dips roller coaster, have a higher National Historic Landmark status. Of the nearly 100,000 NRHP listings, fewer than 100 are for amusement rides. (Fulllist...)Recently featured: One Direction discographyKerivoulinesAccolades received by InceptionArchiveMore featured listsHudson Yards is a 28-acre (11-hectare) real-estate development located in Hudson Yards, a neighborhood of the New York City borough of Manhattan. It is situated on the waterfront of the Hudson River, on a platform built over the West Side Yard, a storage depot for the Long Island Rail Road. Related Companies and Oxford Properties are the primary developers and major equity partners in the project, with the master plan designed by the architectural firm Kohn Pedersen Fox. Construction began in 2012 and the first phase opened in 2019, with completion of the second phase expected by 2032. Major office tenants in the development include Warner Bros. Discovery, L'Oral, and Wells Fargo among others. This photograph shows the skyscrapers of Hudson Yards, viewed across the Hudson River from Weehawken, New Jersey, in 2021.Photograph credit: Tony JinRecently featured: Emperor angelfishAmlia RodriguesAtari video game burialArchiveMore featured picturesCommunity portal The central hub for editors, with resources, links, tasks, and announcements.Village pump Forum for discussions about Wikipedia itself, including policies and technical issues.Site news Sources of news about Wikipedia and the broader Wikimedia movement.Teahouse Ask basic questions about using or editing Wikipedia.Help desk Ask questions about using or editing Wikipedia.Reference desk Ask research questions about encyclopedic topics.Content portals A unique way to navigate the encyclopedia.Wikipedia is written by volunteer editors and hosted by the Wikimedia Foundation, a non-profit organization that also hosts a range of other volunteer projects: CommonsFree media repository MediaWikiWiki software development Meta-WikiWikimedia project coordination WikibooksFree textbooks and manuals WikidataFree knowledge base WikinewsFree-content news WikiquoteCollection of quotations WikisourceFree-content library WikispeciesDirectory of species WikiversityFree learning tools WikivoyageFree travel guide WiktionaryDictionary and thesaurusThis Wikipedia is written in English. Many other Wikipedias are available; some of the largest are listed below. 1,000,000+ articles DeutschEspaolFranaisItalianoNederlandsPolskiPortugusSvenskaTing Vit 250,000+ articles Bahasa IndonesiaBahasa MelayuBn-lm-gCataletinaDanskEestiEsperantoEuskaraMagyarNorsk bokmlRomnSimple EnglishSloveninaSrpskiSrpskohrvatskiSuomiTrkeOzbekcha 50,000+ articles AsturianuAzrbaycancaBosanskiFryskGaeilgeGalegoHrvatskiKurdLatvieuLietuviNorsk nynorskShqipSlovenninaRetrieved from " 2Calendar yearYearsMillennium2ndmillenniumCenturies12thcentury13thcentury 14thcenturyDecades1240s1250s1260s 1270s1280sYears1258125912601261 126212631264vte1261 by topicLeadersPolitical entitiesState leadersReligious leadersBirth and death categoriesBirths DeathsEstablishments and disestablishments categoriesEstablishments DisestablishmentsArt and literature1261 in poetryvte1261 in various calendarsGregorian calendar1261MCCLXIAb urbe condita2014Armenian calendar710 Assyrian calendar6011Balinese saka calendar11821183Bengali calendar667668Berber calendar2211English Regnal year45Hen.346Hen.3Buddhist calendar1805Burmese calendar623Byzantine calendar67696770Chinese calendar (MetalMonkey)3958 or 3751to (MetalRooster)3959 or 3752Coptic calendar977978Discordian calendar2427Ethiopian calendar12531254Hebrew calendar50215022Hindu calendars-Vikram Samvat13171318- Shaka Samvat11821183- Kali Yuga43614362Holocene calendar11261Igbo calendar261262Iranian calendar639640Islamic calendar659660Japanese calendarBun' 2 / Kch 1()Javanese calendar11701171Julian calendar1261MCCLXIKorean calendar3594Minguo calendar651 before ROC651Nanakshahi calendar207Thai solar calendar18031804Tibetan calendar(male Iron-Monkey)1387 or 1006 or 234to(female Iron-Bird)1388 or 1007 or 235Michael VIII Palaiologos (12231282)Year 1261 (MCCLXI) was a common year starting on Saturday of the Julian calendar.March 13 Treaty of Nymphaeum: Emperor Michael VIII Palaiologos signs a trade and defense agreement with the Republic of Genoa, to counterweight the Venetian presence in the region. Genoa agrees to ally with the Empire of Nicaea, by providing a fleet of up to 50 galleys during the projected Nicaean siege of Constantinople, while 16 galleys are to be immediately sent against the Latin Empire.[1]July Michael sends his general Alexios Strategopoulos with a small advance force of 800 soldiers, most of them Cumans, to keep watch on the Bulgarians and scout the defending positions of the Latin forces in the surroundings of Constantinople. When they reach the village of Selymbria, Strategopoulos is informed by local farmers that the entire Latin garrison and the Venetian fleet, are absent conducting a raid against the Nicaean island of Daphnousia. He decides not to lose such a golden opportunity and makes plans (without the consent of Michael) to retake the capital.[2]July 25 Reconquest of Constantinople: Alexios Strategopoulos and his men hide at a monastery near the city gates, before entering through a secret passage. After a short struggle, the guards who are completely taken by surprise are killed and the Venetian quarter is set ablaze. Panic spreads through the capital and Emperor Baldwin II rushes out to save his life, evacuating along with many other Latins with the help of the Venetian fleet. Baldwin manages to escape to the still Latin-held parts of Greece, but Constantinople is lost for good.[3]August 15 Michael enters Constantinople in triumph and is crowned as emperor of the Byzantine Empire at the Hagia Sophia. To solidify his claim, the legitimate ruler, John IV Laskaris, is blinded on Michael's orders on December 25, his 11th birthday. Michael banishes him to a monastery and marries his two sisters to lesser Latin and Bulgarian nobles in an attempt to wipe out the Laskarid dynasty.[4]Kublai Khan releases 75 Chinese merchants who were captured along the border of the Mongol Empire. By doing this, Kublai hopes to bolster his popularity and depend on the cooperation of his Chinese subjects to ensure that his army receives more resources.[5]June 13 Al-Mustansir II becomes the first Abbasid ruler in Cairo (after his escape during the Siege of Baghdad). He is sent with an army by Sultan Baibars to recover Baghdad, but is killed in a Mongol ambush near Anbar (modern Iraq), on November 28. The Abbasid caliphs continue as religious figureheads for the Mamluks in Egypt until the 16th century.[6]June 12 King Henry III of England obtains a papal bull to absolve himself from his oath to maintain the Provisions of Oxford. He hires an army of 300 French knights as a bodyguard and takes up position in the Tower of London. He dismisses the baronial officials (led by Simon de Montfort) who wish the royal power to be modified by the principle of representation. This sets the stage for the Second Barons' War.[7]August Battle of Callann in Ireland: Norman forces under John FitzThomas are defeated by a Gaelic army led by King Fnghin Mac Carthaigh. John FitzGerald is killed during the fighting.[8]February The Japanese Bun' era ends and the Kch era begins during the reign of the 11-year-old Emperor Kameyama (until 1264).Early Following disputes, northern academics from the University of Cambridge in England set up a University of Northampton by royal charter but it is suppressed by the Crown in 1265.[9]The earliest extant Chinese illustration of "Pascal's Triangle" is from Yang Hui's (or Qianguang's) book Xiangjie Jiuzhang Suanfa, published this year.May 25 Pope Alexander IV dies after a pontificate of 6-years at Viterbo. He is succeeded by Urban IV as the 182nd pope of the Catholic Church.August 29 Urban IV offers the crown of Sicily to Charles of Anjou, youngest son of King Louis VIII of France, hoping to strengthen his position.Wurmsbach Abbey (located in Bollingen) is established by Count Rudolf V of Rapperswil in Switzerland.February 1 Walter de Stapledon, English bishop of Exeter (d. 1326)February 11 Otto III, Duke of Bavaria, king of Hungary and Croatia (d. 1312)February 28 Margaret of Scotland, queen consort of Norway (d. 1283)March 1 Hugh Despenser the Elder, English chief adviser (d. 1326)July 25 Arthur II, Breton nobleman (House of Dreux) (d. 1312)October 9 Denis I ("the Poet King"), king of Portugal (d. 1325)Abu Abdallah ibn al-Hakim, Andalusian vizier and poet (d. 1309)November 'Ala' al-Dawla Simnani, Persian Sufi mystic and writer (d. 1336)Albertino Mussato, Paduan statesman, poet and chronicler (d. 1329)Constantine Palaiologos, Byzantine prince and general, son of Michael VIII (d. 1306)Daniel of Moscow (Aleksandrovich), Russian prince (d. 1303)Zangpo Pal, Tibetan religious leader (d. 1323)Elizabeth of Sicily, queen consort of Hungary (House of Anjou) (d. 1303)Konoe Iemoto, Japanese nobleman (kugy) and regent (d. 1296)Pier Saccone Tarlati di Pietramala, Italian nobleman and condottiero (d. 1356)Wadysaw I okietek ("Elbow-High"), king of Poland (d. 1333)February 28 Henry III ("the Good"), duke of Brabant (b. 1230)April 1 Ahi Evran, Bektashi Sufi preacher and poet (b. 1169)May 25 Alexander IV, pope of the Catholic Church (b. 1199)July 8 Adolf IV of Holstein, German nobleman (House of Schaumburg)July 25 Nicephorus II of Constantinople, Byzantine patriarchAugust John FitzThomas, 1st Baron Desmond, Norman Irish nobleman, killed in battleAugust 24 Ela of Salisbury, English noblewoman (b. 1187)September 18 Konrad von Hochstaden, German archbishopSeptember 22/27 Plaisance of Antioch, queen consort of Cyprus (b. 1235)October 27 Sancho of Castile, Spanish archbishop (b. 1233)November 2 Bettisia Gozzadini, Bolognese noblewoman and academic lawyer (b. 1209)November 9 Sanchia of Provence, Queen of the Romans, German queen consort (b. 1225)November 26 Hj Shigetoki, Japanese samurai (b. 1198)November 27 Athanasius III of Alexandria, Egyptian popeNovember 28 Al-Mustansir II, Abbasid ruler (caliph) of Cairo, killedAbu Bakr Ibn Sayyid al-Ns, Andalusian theologian (b. 1200)An-Nasir Dawud, Kurdish ruler, Ayyubid ruler (emir) of Damascus (b. 1206)Benedict II of Esztergom, Hungarian chancellor, governor and archbishopConrad I, Burgrave of Nuremberg ("the Pious"), German nobleman and knight (b. 1186)Qin Jiushao, Chinese mathematician and writer (b. 1202)Sayf al-Din Bakharzi, Persian poet and sheikh (b. 1190)Stephen of Bourbon, French Dominican preacher (b. 1180)^ Steven Runciman (1952). A History of The Crusades. Vol III: The Kingdom of Acre, p. 240. ISBN978-0-241-29877-0.^ Bartusis, Mark C. (1997). The Late Byzantine Army: Arms and Society, 12041453, pp. 4041. University of Pennsylvania Press. ISBN0-8122-1620-2.^ Nicol, Donald M. (1993). The Last Centuries of Byzantium, 12611453, p. 35 (Second ed.). Cambridge: Cambridge University Press. ISBN978-0-521-43991-6.^ Hackel, Sergei (2001). The Byzantine Saint, p. 71 (2001 ed.). St. Vladimir's Seminary Press. ISBN0-88141-202-3.^ Rossabi, Morris (1988). Khubilai Khan: His Life and Times, p. 51. Los Angeles: University of California Press. ISBN978-0-520-06740-0.^ Lock, Peter (2013). The Routledge Companion to the Crusades. Routledge. p.112. ISBN9781135131371.^ Williams, Hywel (2005). Cassell's Chronology of World History. London: Weidenfeld & Nicolson. pp.144146. ISBN0-304-35730-8.^ BBC History, July 2011, p. 12.^ Lawrence, C. H. (1984). "The University in State and Church". In Aston, T. H.; Catto, J. I. (eds.). The History of the University of Oxford. Vol.1. Oxford University Press.Retrieved from " 3One hundred years, from 1101 to 1200See also: Renaissance of the 12th centuryMillennia2ndmillenniumCenturies11thcentury12thcentury13thcenturyTimelines11thcentury12thcentury13thcenturyState leaders11thcentury12thcentury13thcenturyDecades1100s1110s1120s1130s1140s1150s1160s1170s1180s1190sCategories:Births Deaths Establishments DisestablishmentsvteEastern Hemisphere at the beginning of the 12th centuryThe 12th century is the period from 1101 to 1200 in accordance with the Julian calendar. In the history of European culture, this period is considered part of the High Middle Ages and overlaps with what is often called the "'Golden Age' of the Cistercians". The Golden Age of Islam experienced significant development, particularly in Islamic Spain.In Song dynasty China, an invasion by Jurchens caused a political schism of north and south. The Khmer Empire of Cambodia flourished during this century, while the Fatimids of Egypt were overtaken by the Ayyubid dynasty. Following the expansions of the Ghaznavids and Ghurid Empire, the Muslim conquests in the Indian subcontinent took place at the end of the century.Main article: 1100sThe Ghurid Empire converted to Islam from Buddhism.1101: In July, the Treaty of Alton is signed between Henry I of England and his older brother Robert, Duke of Normandy in which Robert agrees to recognize Henry as king of England in exchange for a yearly stipend and other concessions. The agreement temporarily ends a crisis in the succession of the Anglo-Norman kings.11011103: David the Builder takes over Kakheti and Hereti (now parts of Georgia).1102: King Coloman unites Hungary and Croatia under the Hungarian Crown.1102: Muslims conquer Seoro de Valencia.11031104: A church council is convened by King David the Builder in Urbnisi to reorganize the Georgian Orthodox Church.1104: In the Battle of Ertsukhi, King David the Builder defeats an army of Seljuks.1104: King Jayawarsa of Kadiri (on Java) ascends to the throne.[citation needed]1106: Battle of Tinchebray.11071111: Sigurd I of Norway becomes the first Norwegian king to embark on a crusade to the Holy Land. He fights in Lisbon and on various Mediterranean isles and helps the King of Jerusalem to take Sidon from the Muslims.1108: By the Treaty of Devol, signed in September, Bohemond I of Antioch has to submit to the Byzantine Empire, becoming the vassal of Alexius I.1109: On June 10, Bertrand of Toulouse captures the County of Tripoli (northern Lebanon/western Syria).1109: In the Battle of Nako, Boleslaus III Wrymouth defeats the Pomeranians and re-establishes Polish access to the sea.1109: On August 24, in the Battle of Hundsfeld, Boleslaus III Wrymouth defeats Emperor Henry V of Germany and stops German expansion eastward.Main article: 1110s1111: On April 14, during Henry V's first expedition to Rome, he is crowned Holy Roman Emperor.1113: Paramavishnulok is crowned as King Suryavarman II in Cambodia. He expands the Khmer Empire and builds Angkor Wat during the first half of the century. He establishes diplomatic relations with China.1115: The Georgian army occupies Rustavi in the war with the Muslims.1115: In Java, King Kamesvara of Kadiri ascends to the throne. Janggala ceases to exist and comes under Kadiri domination, highly possible under royal marriage. During his reign, Mpu Dharmaja writes Kakawin Smaradahana, a eulogy for the king which become the inspiration for the Panji cycle tales, which spread across Southeast Asia.[1]1116: The Byzantine army defeats the Turks at Philomelion.1116: Death of doa Jimena Daz, governor of Valencia from 1099 to 1102.c. 1119: The Knights Templar are founded to protect Christian pilgrims in Jerusalem.Main article: 1120sA Black and White Photo of the 12th century Cuenca Cathedral (built from 1182 to 1270) in Cuenca, Spain1120: On January 16, the Council of Nablus, a council of ecclesiastic and secular lords in the crusader Kingdom of Jerusalem, establishes the first written laws for the kingdom.1120: On November 25, William Adelin, the only legitimate son of King Henry I of England, drowns in the White Ship Disaster, leading to a succession crisis which will bring down the Norman monarchy of England.1121: On August 12, in the Battle of Didgori, the greatest military victory in Georgian history, King David the Builder with 45,000 Georgians, 15,000 Kipchak auxiliaries, 500 Alan mercenaries and 100 French Crusaders defeats a much larger Seljuk-led Muslim coalition army.1121: On December 25, St. Norbert and 29 companions make their solemn vows in Premontre, France, establishing the Premonstratensian Order.1122: The Battle of Beroia (Modern-day Stara Zagora, Bulgaria) results in the disappearance of the Pechenegs Turkish tribe as an independent force.1122: On September 23, the Concordat of Worms (Pactum Calixtinum) is drawn up between Emperor Henry V and Pope Calixtus II bringing an end to the first phase of the power struggle between the papacy and the Holy Roman Empire.1122: King David the Builder captures Tbilisi and declares it the capital city of Georgia, ending 400 years of Arab rule.1123: The Jurchen dynasty of China forces Koryo (now Korea) to recognize their suzerainty.1124: In April or May, David I is crowned King of the Scots.1125: On June 11, in the Battle of Azaz, the Crusader states, led by King Baldwin II of Jerusalem, defeat the Seljuk Turks.1125: In November, the Jurchens of the Jin dynasty declare war on the Song dynasty, beginning the JinSong wars.1125: Lothair of Supplinburg, duke of Saxony, is elected Holy Roman Emperor instead of the nearest heir, Frederick of Swabia, beginning the great struggle between Guelphs and Ghibellines.1127: The Northern Song dynasty loses power over northern China to the Jin dynasty.1128: On June 24, the Kingdom of Portugal gains independence from the Kingdom of Len at the Battle of So Mamede; (recognised by Len in 1143).Main article: 1130sThe temple complex of Angkor Wat, built during the reign of Suryavarman II in Cambodia of the Khmer Era.11301180: 50-year drought in what is now the American Southwest.11301138: Papal schism, Pope Innocent II vs. Antipope Anacletus II.1130: On March 26, Sigurd I of Norway dies. A golden era of 95 years comes to an end for Norway as civil wars between the members of Harald Fairhair's family line rage for the remainder of the century.1130: On Christmas Day, Roger II is crowned King of Sicily, the royal title being bestowed on him by Antipope Anacletus II.1132: The Southern Song dynasty establishes China's first permanent standing navy, although China had a long naval history prior. The main admiral's office is at the port of Dinghai.11321183: the Chinese navy increases from a mere 3,000 to 52,000 marine soldiers stationed in 20 different squadrons. During this time, hundreds of treadmill-operated paddle wheel craft are assembled for the navy to fight the Jin dynasty in the north.1135: King Jayabaya of Kadiri ascends to the throne.[2]11351154: The Anarchy takes place, during a period of civil war in England.1136: Suger begins rebuilding the abbey church at St Denis north of Paris, which is regarded as the first major Gothic building.1137: On July 22, the future King Louis VII of France marries Eleanor, the Duchess of Aquitaine.1138: On October 11, the 1138 Aleppo earthquake devastates much of northern Syria.1139: in April, the Second Lateran Council ends the papal schism.1139: On July 5, in the Treaty of Mignano, Pope Innocent II confirms Roger II as King of Sicily, Duke of Apulia, and Prince of Capua and invests him with his titles.1139: On July 25, the Portuguese defeat the Almoravids led by Ali ibn Yusuf in the Battle of Ourique; Prince Afonso Henriques is acclaimed King of Portugal by his soldiers.Main article: 1140sAverroes in a 14th-century painting by Andrea di Bonaiuto11401150: Collapse of the Ancestral Puebloan culture at Chaco Canyon (modern-day New Mexico).1141: The Treaty of Shaoxing ends the conflict between the Jin dynasty and Southern Song dynasty, legally establishing the boundaries of the two countries and forcing the Song dynasty to renounce all claims to its former territories north of the Huai River. The treaty reduces the Southern Song into a quasi-tributary state of the Jurchen Jin dynasty.1143: Manuel I Komnenos is crowned as Byzantine emperor after the death of John II Komnenos.1143: Afonso Henriques is proclaimed King of Portugal by the cortes.1143: The Treaty of Zamora recognizes Portuguese independence from the Kingdom of Len. Portugal also recognizes the suzerainty of the pope.1144: On December 24, Edessa falls to the Atabeg Zengi.11451148: The Second Crusade is launched in response to the fall of the County of Edessa.1147: On October 25, the four-month-long Siege of Lisbon successfully brings the city under definitive Portuguese control, expelling the Moorish overlords.1147: A new Berber dynasty, the Almohads, led by Emir Abd al-Mu'min, takes North Africa from the Almoravides and soon invades the Iberian Peninsula. The Almohads began as a religious movement to rid Islam of impurities.1147: The Wendish Crusade against the Polabian Slavs (or "Wends") in what is now northern and eastern Germany.Main article: 1150s1150: Ramon Berenguer IV, Count of Barcelona marries Petronilla, the Queen of Aragon.1151: The Treaty of Tudiln is signed by Alfonso VII of Len and Raymond Berengar IV, Count of Barcelona, recognizing the Aragonese conquests south of the Jcar and the right to expand in and annex the Kingdom of Murcia.1153: The Treaty of Wallingford, ends the civil war between Empress Matilda and her cousin King Stephen of England fought over the English crown. Stephen acknowledges Matilda's son Henry of Anjou as heir.1153: The First Treaty of Constance is signed between Emperor Frederick I and Pope Eugene III, by the terms of which, the emperor is to prevent any action by Manuel I Comnenus to reestablish the Byzantine Empire on Italian soil and to assist the pope against his enemies in revolt in Rome.1154: the Moroccan-born Muslim geographer Muhammad al-Idrisi publishes his Geography.1154: On December 27, Henry II is crowned King of England at Westminster Abbey.1155: Pope Adrian IV grants overlordship of Ireland to Henry II of England in the bull Laudabiliter.1156: On June 18, the Treaty of Benevento is entered into by Pope Adrian IV and the Norman Kingdom of Sicily. After years of turbulent relations, the popes finally settles down to peace with the Hauteville kings. The kingship of William I is recognized over all Sicily, Apulia, Calabria, Campania, and Capua. The tribute to the pope of 600 schifati agreed upon by Roger II in 1139 at Mignano is affirmed and another 400 shift is added for the new lands.1158: The Treaty of Sahagn ends the war between Castile and Len.Main article: 1160sThe Liuhe Pagoda of Hangzhou, China, 11651161: the Song dynasty Chinese navy, employing gunpowder bombs launched from trebuchets, defeats the enormous Jin dynasty navy in the East China Sea in the Battle of Tangdao and on the Yangtze River in the Battle of Caishi.1161: Kilij Arslan II, Sultan of Rum, makes peace with the Byzantine Empire, recognizing the emperor's primacy.1161: In the siege of Ani, troops from the Kingdom of Georgia take control over the city, only to have it sold for the second time to the Shaddadids, a Kurdish dynasty.1162: Genghis Khan, the founder of the Mongol Empire, is born as Temjin in present-day Mongolia.1163: The Norwegian Law of Succession takes effect.11651182: Tensions and disputes between the Pagan Empire and the Kingdom of Polonnaruwa causes the Sinhalese under Parakramabahu the Great to raid Burma.1168: King Valdemar I of Denmark conquers Arkona on the Island of Rgen, the strongest pagan fortress and temple in northern Europe.1169: Political disputes within the Pandya Empire sparks the decade-long Pandyan Civil War.1169: On May 1, the Norman invasion of Ireland begins. Richard fitzGilbert de Clare ('Strongbow') allies with the exiled Irish chief, Dermot MacMurrough, to help him recover his kingdom of Leinster.Main article: 1170sThe defense of the Carroccio during the battle of Legnano (1176) by Amos Cassioli (18321891)1170: The Treaty of Sahagn is signed by Alfonso VIII of Castile and Alfonso II of Aragon. Based on the terms of the accord, Alfonso VIII agrees to provide Alfonso II with three hostages, to be used as tribute payments owed by Ibn Mardan of Valencia and Murcia.1170: On December 29, Thomas Becket is murdered in Canterbury Cathedral.1171: Saladin deposes the last Fatimid Caliph Al-'id and establishes the Ayyubid dynasty.1171: On November 11, Henry II of England lands in Ireland to assert his claim as Lord of Ireland.1172: The Pandyan city of Madurai is sacked by the Sinhalese army due to an attempt to drive off the rival throne claimant, Kulasekara Pandyan.1173: Sinhalese king Parakramabahu the Great gains a decisive victory by invading the Chola Empire as an ally of the Pandyas in the Pandyan Civil War.1174: On July 12, William I of Scotland is captured by the English in the Battle of Alnwick. He accepts the feudal overlordship of the English crown and pays ceremonial allegiance at York.1175: Hnen Shnin (Genk) founds the Jdo sh (Pure Land) sect of Buddhism.1175: The Treaty of Windsor is signed by King Henry II of England and the High King of Ireland, Ruaidr Ua Conchobair.1176: On May 29, Frederick Barbarossa's forces are defeated in the Battle of Legnano by the Lombard League which results in the emperor's acknowledgment of the pope's sovereignty over the Papal States and Alexander acknowledging the emperor's overlordship of the imperial Church.1176: On September 17, The Battle of Myriokephalon (Myriocephalum; Turkish: Miryakefalon Sava) is fought between the Byzantine Empire and the Seljuk Turks in Phrygia. It is a serious reversal for the Byzantine forces and will be the final, unsuccessful, effort by the Byzantines to recover the interior of Anatolia from the Seljuk Turks.1177: The Treaty or Peace of Venice is signed by the papacy and its allies, and Frederick I, Holy Roman Emperor. The Norman Kingdom of Sicily also participates in negotiations and the treaty thereby determines the political course of all of Italy for the next several years.1178: Chinese writer Zhou Qufei, a Guangzhou customs officer, writes of an island far west in the Indian Ocean (possibly Madagascar), from where people with skin "as black as lacquer" and with frizzy hair were captured and purchased as slaves by Arab merchants.1179: The Treaty of Cazola (Cazorla) is signed by Alfonso II of Aragon and Alfonso VIII of Castile, dividing Andalusia into separate zones of conquest for the two kingdoms, so that the work of the Reconquista would not be stymied by internecine feuding.Main article: 1180s1180: The Portuguese Navy defeats a Muslim fleet off the coast of Cape Espichel.11801185: the Genpei War in Japan.1181: Parakramabahu the Great conducts a large-scale raid on Burma, after a ship transporting a Sinhalese princess to the Khmer Empire is attacked by Burmese naval fleets.1182: Religious reformations of Theravada Buddhism in Pagan Burma under the patronage of Narapatisithu are continued with the end of the Polonnaruwa-Pagan War.1182: Revolt of the people of Constantinople against the Latins, whom they massacre, proclaiming Andronicus I Comnenus as co-emperor.1183: On January 25, the final Peace of Constance between Frederick Barbarossa, the pope and the Lombard towns is signed, confirming the Peace of Venice of 1177.1183: On September 24, Andronicus I Comnenus has his nephew Alexius II Comnenus strangled.1184: On March 24, Queen Tamar, King of Georgia, accedes to the throne as sole ruler after reigning with her father, George III, for six years.1184: Diet of Pentecost organised by Emperor Frederick I in Mainz.1185: The Uprising of Asen and Peter against the Byzantine Empire leads to the restoration of the Bulgarian Empire.1185: Andronicus I Comnenus is deposed and, on September 12, executed as a result of the Norman massacre of the Greeks of Thessalonika.1185: The cathedral school (Katedralskolan) in Lund, Sweden, is founded. The school is the oldest in northern Europe and one of the oldest in all of Europe.1185: Beginning in this year the Kamakura shogunate deprives the emperor of Japan of political power.1186: On January 27, the future Holy Roman Emperor Henry VI marries Constance of Sicily, the heiress to the Sicilian throne.1187: On July 4, in the Battle of Hattin, Saladin defeats the king of Jerusalem.1187: In August, the Swedish royal and commercial center Sigtuna is attacked by raiders from Karelia, Couronia, and/or Estonia.[3]1188: The Riah were introduced into the Habt and south of Tetouan by the Almohad caliph, Abu Yusuf Yaqub al-Mansur, and Jochem and Acem were introduced in Tamesna.[4]1189: On September 3, Richard I is crowned King of England at Westminster.1189: On November 11, William II of Sicily dies and is succeeded by his illegitimate cousin Tancred, Count of Lecce instead of Constance.11891192: The Third Crusade is an attempt by European leaders to wrest the Holy Land from Saladin.Main articles: 1190s and 1200sRichard I of England, or Richard the Lionheart.1190: On June 10, Emperor Frederick Barbarossa drowns in the River Salef, leaving the Crusader army under the command of the rivals Philip II of France and Richard I of England, which ultimately leads to the dissolution of the army.1191: Holy Roman Emperor Henry VI attacked the Kingdom of Sicily from May to August but fails and withdrawn, with Empress Constance captured (released 1192).1191: On September 7, Saladin is defeated by Richard I of England at the Battle of Arsuf.1192: In April, Isabella I begins her reign as Christian Queen of the Kingdom of Jerusalem1192: In the Battle of Jaffa, King Richard the Lionheart defeats Saladin.1192: In June, the Treaty of Ramla is signed by Saladin and Richard Lionheart. Under the terms of the agreement, Jerusalem will remain under Muslim control. However, the city will be open to Christian pilgrims. The Latin Kingdom is reduced to a coastal strip that extends from Tyre to Jaffa.1192: Minamoto no Yoritomo is appointed Sei-i Taishgun, "barbarian-subduing great general", shgun for short, the first military dictator to bear this title.1192: Sultan Shahbuddin Muhammad Ghori establishes the first Muslim empire in India for 14 years (11921206) by defeating Prithviraj Chauhan.1193: Nalanda, the great Indian Buddhist educational centre, is destroyed.1194: Emperor Henry VI conquers the Kingdom of Sicily.1195: On June 16, the struggle of Shamqori. Georgian forces annihilate the army of Abu Baqar.1198: The brethren of the Crusader hospital in Acre are raised to a military order of knights, the Teutonic Knights, formally known as the Order of the Knights of the Hospital of St. Mary of the Teutons in Jerusalem.1199: Pope Innocent III writes to Kaloyan, inviting him to unite the Bulgarian Church with the Roman Catholic Church.1200: Construction begins on the Grand Village of the Natchez near Natchez, Mississippi. This ceremonial center for the Natchez people is occupied and built until the early 17th century.[5]Eastern Hemisphere at the end of the 12th centuryChina is under the Northern Song dynasty. Early in the century, Zhang Zeduan paints Along the River During the Qingming Festival. It will later end up in the Palace Museum, Beijing.In southeast Asia, there is conflict between the Khmer Empire and the Champa. Angkor Wat is built under the Hindu king Suryavarman II. By the end of the century, the Buddhist Jayavarman VII becomes the ruler.Japan is in its Heian period. The Chj-jinbutsu-giga is made and attributed to Toba Sj. It ends up at the Kzan-ji, Kyoto.In Oceania, the Tui Tonga Empire expands to a much greater area.Europe undergoes the Renaissance of the 12th century. The blast furnace for the smelting of cast iron is imported from China, appearing around Lapphyttan, Sweden, as early as 1150.Alexander Neckam is the first European to document the mariner's compass, first documented by Shen Kuo during the previous century.Christian humanism becomes a self-conscious philosophical tendency in Europe. Christianity is also introduced to Estonia, Finland, and Karelia.The first medieval universities are founded. Pierre Abelard teaches.Middle English begins to develop, and literacy begins to spread outside the Church throughout Europe.[6] In addition, churchmen are increasingly willing to take on secular roles. By the end of the century, at least a third of England's bishops also act as royal judges in secular matters.[7]The Ars antiqua period in the history of the medieval music of Western Europe begins.The earliest recorded miracle play is performed in Dunstable, England.Gothic architecture and trouvre music begin in France.During the middle of the century, the Cappella Palatina is built in Palermo, Sicily, and the Madrid Skylitzes manuscript illustrates the Synopsis of Histories by John Skylitzes.Fire and plague insurance first become available in Iceland, and the first documented outbreaks of influenza there happens.The medieval state of Serbia is formed by Stefan Nemanja and then continued by the Nemanji dynasty.By the end of the century, both the

Capetian dynasty and the House of Anjou are relying primarily on mercenaries in their militaries. Paid soldiers are available year-round, unlike knights who expected certain periods off to maintain their manor lifestyles.[8]In India, Hoysala architecture reaches its peak.In the Middle East, the icon of Theotokos of Vladimir is painted probably in Constantinople. Everything but the faces will later be retouched, and the icon will go to the Tretyakov Gallery of Moscow.The Georgian poet Shota Rustaveli composes his epic poem The Knight in the Panther's Skin.Shahab al-Din Suhrawardi founds his "school of illumination".In North Africa, the kasbah of Marrakesh is built, including the city gate Bab Agnaou and the Koutoubia mosque.In sub-Saharan Africa, Kente cloth is first woven.In France, the first piedfort coins were minted.The city of Tula burns down, marking the end of the Toltec EmpireIn West Africa the Ife Empire is established.See also: Timeline of historic inventions 12th century1104: The Venice Arsenal of Venice, Italy, is founded. It employed some 16,000 people for the mass production of sailing ships in large assembly lines, hundreds of years before the Industrial Revolution.1106: Finished building of Gelati.1107: The Chinese engineer Wu Deren combines the mechanical compass vehicle of the south-pointing chariot with the distance-measuring odometer device.1111: The Chinese Donglin Academy is founded.1165: The Liuhe Pagoda of Hangzhou, China, is built.1170: The Roman Catholic notion of Purgatory is defined.[9]1185: First record of windmills.Wikimedia Commons has media related to 12th century.^ Soekmono, R, Drs., Pengantar Sejarah Kebudayaan Indonesia 2, 2nd ed. Penerbit Kanisius, Yogyakarta, 1973, 5th reprint edition in 1988 p.57^ Britannica, T. Editors of Encyclopaedia (1998, July 20). Kairi. Encyclopedia Britannica.^ Enn Tarvel (2007). Sigtuna hukkumine. Archived 2017-10-11 at the Wayback Machine Haridus, 2007 (7-8), p 3841^ Notice sur les Arabes hilaliens. Ismal Hamet. p.248.^ Francine Weiss and Mark R. 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ISBN9780520036437. {{cite book}}: ISBN / Date incompatibility (help)Retrieved from " 4The following pages link to 12th century External tools(link counttransclusion countsorted list) See help page for transcluding these entriesShowing 50 items.View (previous 50 | next 50) (20 | 50 | 100 | 250 | 500)Antisemitism in Christianity (links | edit)Catharism (links | edit)List of decades, centuries, and millennia (links | edit)Dialect (links | edit)House of Habsburg (links | edit)House of Hohenzollern (links | edit)History of Mali (links | edit)Maimonides (links | edit)Passport (links | edit)Sumba (links | edit)Taoism (links | edit)Weregild (links | edit)Zanzibar (links | edit)20th century (links | edit)1040 (links | edit)15th century (links | edit)16th century (links | edit)17th century (links | edit)18th century (links | edit)14th century (links | edit)1st century (links | edit)13th century (links | edit)4th century (links | edit)11th century (links | edit)1282 (links | edit)7th century (links | edit)10th century (links | edit)9th century (links | edit)8th century (links | edit)6th century (links | edit)5th century (links | edit)3rd century (links | edit)2nd century (links | edit)4th century BC (links | edit)1st century BC (links | edit)2nd century BC (links | edit)3rd century BC (links | edit)5th century BC (links | edit)6th century BC (links | edit)21st century BC (links | edit)11th century BC (links | edit)1000s (decade) (links | edit)1040s (links | edit)1299 (links | edit)1154 (links | edit)1163 (links | edit)1160s (links | edit)1141 (links | edit)1135 (links | edit)1204 (links | edit)View (previous 50 | next 50) (20 | 50 | 100 | 250 | 500)Retrieved from " WhatLinksHere/12th_century"Industrial method of sulfuric acid productionFor the stochastic process used to model population, see Contact process (mathematics).This article includes a list of general references, but it lacks sufficient corresponding inline citations. Please help to improve this article by introducing more precise citations. (May 2020) (Learn how and when to remove this message)The contact process is a method of producing sulfuric acid in the high concentrations needed for industrial processes. Platinum was originally used as the catalyst for this reaction; however, because it is susceptible to reacting with arsenic impurities in the sulfur feedstock, vanadium(V) oxide (V2O5) has since been preferred.[1]This process was patented in 1831 by British vinegar merchant Peregrine Phillips.[2][3][4] In addition to being a far more economical process for producing concentrated sulfuric acid than the previous lead chamber process, the contact process also produces sulfur trioxide and oleum.In 1890 John Brown Francis Herreshoff developed a form of the contact catalytic process for the company of which he was a partner.[5]In 1901 Eugen de Han patented the basic process involving combining sulfur dioxide and oxygen in the presence of vanadium oxides, producing sulfur trioxide which was easily absorbed into water, producing sulfuric acid.[6] This process was improved remarkably by shrinking the particle size of the catalyst (e.g. 5000 microns), a process discovered by two chemists of BASF in 1914.[7][8][9]The process can be divided into four stages:Combining of sulfur and oxygen (O2) to form sulfur dioxide, then purify the sulfur dioxide in a purification unitAdding an excess of oxygen to sulfur dioxide in the presence of the catalyst vanadium pentoxide at 450C and 1-2atmThe sulfur trioxide formed is added to sulfuric acid which gives rise to oleum (disulfuric acid)The oleum is then added to water to form sulfuric acid which is very concentrated. Since this process is an exothermic reaction, the reaction temperature should be as low as possible.Purification of the air and sulfur dioxide (SO2) is necessary to avoid catalyst poisoning (i.e. removing catalytic activities). The gas is then washed with water and dried with sulfuric acid.To conserve energy, the mixture is heated by exhaust gases from the catalytic converter by heat exchangers.Sulfur dioxide and dioxygen then react as follows:2 SO2(g) + O2(g) 2 SO3(g): H = -197kJmol1According to the Le Chatelier's principle, a lower temperature should be used to shift the chemical equilibrium towards the right, hence increasing the percentage yield. However too low of a temperature will lower the formation rate to an uneconomical level. Hence to increase the reaction rate, high temperatures (450C), medium pressures (1-2atm), and vanadium(V) oxide (V2O5) are used to ensure an adequate (>95%) conversion. The catalyst only serves to increase the rate of reaction as it does not change the position of the thermodynamic equilibrium. The mechanism for the action of the catalyst comprises two steps:Oxidation of SO2 into SO3 by V5+:2SO2 + 4V5+ + 2O2 2SO3 + 4V4+Oxidation of V4+ back into V5+ by dioxygen (catalyst regeneration):4V4+ + O2 4V5+ + 2O2Hot sulfur trioxide passes through the heat exchanger and is dissolved in concentrated H2SO4 in the absorption tower to form oleum.H2SO4 + SO3 H2S2O7Note that directly dissolving SO3 in water is impractical due to the highly exothermic nature of the reaction. Acidic vapor or mists are formed instead of a liquid.Oleum is reacted with water to form concentrated H2SO4.H2S2O7 + H2O 2 H2SO4This includes the dusting tower, cooling pipes, scrubbers, drying tower, arsenic purifier and testing box. Sulfur dioxide has many impurities such as vapours, dust particles and arsenous oxide. Therefore, it must be purified to avoid catalyst poisoning (i.e.: destroying catalytic activity and loss of efficiency). In this process, the gas is washed with water, and dried by sulfuric acid. In the dusting tower, the sulfur dioxide is exposed to a steam which removes the dust particles. After the gas is cooled, the sulfur dioxide enters the washing tower where it is sprayed by water to remove any soluble impurities. In the drying tower, sulfuric acid is sprayed on the gas to remove the moisture from it. Finally, the arsenic oxide is removed when the gas is exposed to ferric hydroxide.The next step to the contact process is double contact double absorption (DCDA). In this process the product gases (SO2) and (SO3) are passed through absorption towers twice to achieve further absorption and conversion of SO2 to SO3 and production of higher grade sulfuric acid.SO2-rich gases enter the catalytic converter, usually a tower with multiple catalyst beds, and are converted to SO3, achieving the first stage of conversion. The exit gases from this stage contain both SO2 and SO3 which are passed through intermediate absorption towers where sulfuric acid is trickled down packed columns and SO3 reacts with water increasing the sulfuric acid concentration. Though SO2 too passes through the tower it is unreactive and comes out of the absorption tower.This stream of gas containing SO2, after necessary cooling is passed through the catalytic converter bed column again achieving up to 99.8% conversion of SO2 to SO3 and the gases are again passed through the final absorption column thus achieving not only high conversion efficiency for SO2, but also enabling production of a higher concentration of sulfuric acid.The industrial production of sulfuric acid involves proper control of temperatures and flow rates of the gases as both the conversion efficiency and absorption are dependent on these.^ "History". Ravensdown. Archived from the original on May 23, 2010. Retrieved March 1, 2010.^ McDonald, Donald; Hunt, Leslie B. (January 1982). A History of Platinum and its Allied Metals. Johnson Matthey Plc. 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Your generated images will be more polished thanever.See What's NewExplore how consumers want to see climate stories told today, and what that means for yourvisuals.Download Our Latest VisualGPS ReportData-backed trends. Generative AI demos. Answers to your usage rights questions. Our original video podcast covers it allnow ondemand.Watch NowA brief summary of the Contact Process The Contact Process: makes sulphur dioxide; converts the sulphur dioxide into sulphur trioxide (the reversible reaction at the heart of the process); converts the sulphur trioxide into concentrated sulphuric acid. Making the sulphur dioxide This can either be made by burning sulphur in an excess of air: . . . or by heating sulphide ores like pyrite in an excess of air: In either case, an excess of air is used so that the sulphur dioxide produced is already mixed with oxygen for the next stage. Converting the sulphur dioxide into sulphur trioxide This is a reversible reaction, and the formation of the sulphur trioxide is exothermic. A flow scheme for this part of the process looks like this: The reasons for all these conditions will be explored in detail further down the page. Converting the sulphur trioxide into sulphuric acid This can't be done by simply adding water to the sulphur trioxide - the reaction is so uncontrollable that it creates a fog of sulphuric acid. Instead, the sulphur trioxide is first dissolved in concentrated sulphuric acid: The product is known as fuming sulphuric acid or oleum. This can then be reacted safely with water to produce concentrated sulphuric acid - twice as much as you originally used to make the fuming sulphuric acid. Explaining the conditions The proportions of sulphur dioxide and oxygen The mixture of sulphur dioxide and oxygen going into the reactor is in equal proportions by volume. Avogadro's Law says that equal volumes of gases at the same temperature and pressure contain equal numbers of molecules. That means that the gases are going into the reactor in the ratio of 1 molecule of sulphur dioxide to 1 of oxygen. That is an excess of oxygen relative to the proportions demanded by the equation. According to Le Chatelier's Principle, Increasing the concentration of oxygen in the mixture causes the position of equilibrium to shift towards the right. Since the oxygen comes from the air, this is a very cheap way of increasing the conversion of sulphur dioxide into sulphur trioxide. Why not use an even higher proportion of oxygen? This is easy to see if you take an extreme case. Suppose you have a million molecules of oxygen to every molecule of sulphur dioxide. The equilibrium is going to be tipped very strongly towards sulphur trioxide - virtually every molecule of sulphur dioxide will be converted into sulphur trioxide. Great! But you aren't going to produce much sulphur trioxide every day. The vast majority of what you are passing over the catalyst is oxygen which has nothing to react with. By increasing the proportion of oxygen you can increase the percentage of the sulphur dioxide converted, but at the same time decrease the total amount of sulphur trioxide made each day. The 1 : 1 mixture turns out to give you the best possible overall yield of sulphur trioxide. The temperature Equilibrium considerations You need to shift the position of the equilibrium as far as possible to the right in order to produce the maximum possible amount of sulphur trioxide in the equilibrium mixture. The forward reaction (the production of sulphur trioxide) is exothermic. According to Le Chatelier's Principle, this will be favoured if you lower the temperature. The system will respond by moving the position of equilibrium to counteract this - in other words by producing more heat. In order to get as much sulphur trioxide as possible in the equilibrium mixture, you need as low a temperature as possible. However, 400 - 450C isn't a low temperature! Rate considerations The lower the temperature you use, the slower the reaction becomes. A manufacturer is trying to produce as much sulphur trioxide as possible per day. It makes no sense to try to achieve an equilibrium mixture which contains a very high proportion of sulphur trioxide if it takes several years for the reaction to reach that equilibrium. You need the gases to reach equilibrium within the very short time that they will be in contact with the catalyst in the reactor. The compromise 400 - 450C is a compromise temperature producing a fairly high proportion of sulphur trioxide in the equilibrium mixture, but in a very short time.The pressure Equilibrium considerations Notice that there are 3 molecules on the left-hand side of the equation, but only 2 on the right. According to Le Chatelier's Principle, if you increase the pressure the system will respond by favouring the reaction which produces fewer molecules. That will cause the pressure to fall again. In order to get as much sulphur trioxide as possible in the equilibrium mixture, you need as high a pressure as possible. High pressures also increase the rate of the reaction. However, the reaction is done at pressures close to atmospheric pressure! Economic considerations Even at these relatively low pressures, there is a 99.5% conversion of sulphur dioxide into sulphur trioxide. The very small improvement that you could achieve by increasing the pressure isn't worth the expense of producing those high pressures. The catalyst Equilibrium considerations The catalyst has no effect whatsoever on the position of the equilibrium. Adding a catalyst doesn't produce any greater percentage of sulphur trioxide in the equilibrium mixture. Its only function is to speed up the reaction. Rate considerations In the absence of a catalyst the reaction is so slow that virtually no reaction happens in any sensible time. The catalyst ensures that the reaction is fast enough for a dynamic equilibrium to be set up within the very short time that the gases are actually in the reactor.Froth flotation is a method for separating and concentrating ores by exploiting differences in surface properties between minerals.Metallurgy is the process of extracting metals from rocks. It's a fancy word for the process. We use chemicals and technology to separate the metal from the rock. Although different ways to do this depend on the metal, Hydrogen peroxide (H2O2) has a simple structure involving two hydrogen atoms and two oxygen atoms. Its chemical formula illustrates this...The term "hydrocarbon" is quite self-explanatory, referring to compounds composed solely of carbon and hydrogen atoms. Hydrocarbons hold a Bronsted Lowrys theory involves the concept of acids and bases beyond aqueous solutions and provides a broader understanding of acid-base reactions.The "s-block" in the periodic table refers to the two groups of elements located in the leftmost part of the periodic table: Group 1 and Group 2. Sulfur tetrafluoride (SF) is a chemical compound consisting of a sulfur atom bonded to four fluorine atoms. The molecule adopts a tetrahedral InChI=1S/H2O4S/c1-5(2,3)4/h(H2,1,2,3,4)InChIKeyInChIKey=QAOWNCQODCNURD-UHFFFAOYSA-NSMILESS(=O)(=O)(O)OCanonical SMILESO=S(=O)(O)OOther Names for this SubstanceSulfuric acidBOVDipping acidOil of vitriolSulphuric acidDeleted or Replaced CAS Registry Numbers119540-51-1, 127529-01-5, 140623-70-7, 1973539-23-9The contact process derives its name from the fact that the oxidation of SO2 to SO3 takes place only when the reactants come in contact with the surface of a catalyst.It is the most modern method.PrincipleSulphur dioxide is obtained by burning sulphur or iron pyrites.S + O2 SO24FeS2 + 11O2 2Fe2O3 + 8SO2The contact process for the manufacture of sulphuric acid is based on the catalytic oxidation of SO2 to SO3 by atmospheric oxygen.SO2 and air are passed over a catalyst (V2O5) heated to 450-500C.About 98% of the possible yield of sulphur trioxide is obtained.2SO2(g) + O2(g) 2SO3(g) + 45.0 kcalThe mechanism of oxidation of SO2 to SO3 by using V2O5 catalyst consists of two steps.Step 1: Oxidation of SO2 into SO3 by V5+2SO2 + 4V5++ 10O2- 2SO3 + 4V4- + 8O2-Step 2: Regeneration of catalyst by oxidation of V4+ to V5+ by Oxygen (O2).4V4+ + 8O2- + O2 4V5+ + 10O2-The sulphur trioxide can't be satisfactorily absorbed by water.A mist of fine drops of dilute sulphuric acid fill the factory if direct absorption is tried.Therefore, SO3 produced is absorbed in conc. H2SO4 and the fuming liquid called Oleum or pyro sulphuric acid, liquid is formed and it is diluted water to get sulphuric acid of required concentration.H2SO4 + SO3(g) H2S2O7(l) {Oleum}H2S2O7(l) + H2O(l) 2H2SO4(aq.)Thus, the manufacture of H2SO4 is nothing but getting SO3 in excess from air by the oxidation of SO2.Suitable Conditions for maximum yieldThe reaction 2SO2 + O2 2SO3 + 45 kcal is reversible, exothermic and proceeds with decrease in volume.Low temperatureLow temperature will favor the forward reaction because of its exothermic nature.High PressureHigh pressure favors the forward reaction.A pressure of 2-3 atms is sufficient to make steady flow of gases.Excess of OxygenA slight excess of oxygen in the reacting mixture helps to carry the reaction in the direction of the formation of sulphur trioxide.Use of Catalyst (V2O5)At the low temperature maintained, the velocity of reaction is very slow and in order to accelerate the formation of SO3, the use of a catalyst is extremely necessary.Purity of gasesAs the catalyst is open to poisoning, the mixture of SO2 and air of oxygen should be pure and dry and free from all types of impurities, particularly the dust.Flowsheet diagram of Manufacture of Sulphuric Acid by Contact Process Chemical compound (HSO)"Oil of vitriol" and "sulphuric acid" redirect here. For sweet oil of vitriol, see diethyl ether. For the novel by Amlie Nothomb, see Sulphuric Acid (novel).Sulfuric acidSpace-filling modelBall-and-stick modelbondlengthS=O 142.2pmSO 157.4pmOH 97pmNamesIUPAC nameSulfuric acidOther namesOil of vitriolHydrogen sulfateDihydrogen sulfateIdentifiersCAS Number7664-93-9Y3D model (JSmol)Interactive imageChEBICHEBI:26836YChEMBLChEMBL572964YChemSpider1086YECHA InfoCard100.028.763 EC Number231-639-5E numberE513 (acidity regulators, ...)Gmelin Reference2122KEGGD05963YPubChem CID1118RTECS numberWS5600000UNIIO40UQP6WCFYUN number1830CompTox Dashboard (EPA)DTXSID5029683 InChIInChI=1S/H2O4S/c1-5(2,3)4/h(H2,1,2,3,4)YKey:QAOWNCQODCNURD-UHFFFAOYSA-NYInChI=1/H2O4S/c1-5(2,3)4/h(H2,1,2,3,4)Key:QAOWNCQODCNURD-UHFFFAOYACSMILESOS(=O)(=O)OPropertiesChemical formulaH2SO4, sometimes expressed (HO)2SO2 Molar mass98.079 g/mol AppearanceColorless viscous liquidOdorOdorlessDensity1.8302 g/cm3, liquid[1]Melting point10.31[1]C (50.56F; 283.46K)Boiling point337[1]C (639F; 610K) When sulfuric acid is above 300 C (572 F; 573 K), it gradually decomposes to SO3 + H2OSolubility in watermiscible, exothermicVapor pressure0.001 mmHg (20C)[2]Acidity (pKa)pKa1 = 2.8pKa2 = 1.99Conjugate baseBisulfateViscosity26.7 cP (20C)Structure[3]Crystal structuremonoclinicSpace groupC2/cLattice constanta=818.1(2)pm, b=469.60(10)pm, c=856.3(2)pm=90, =111.39(3), =90Formula units (Z)4ThermochemistryStd molarentropy (S298)157J/(molK)[4]Std enthalpy offormation (fH298)814kJ/mol[4]Enthalpy of vaporization (fHvap)56 kJ/mol[5]HazardsGHS labelling:PictogramsSignal wordDangerHazard statementsH314Precautionary statementsP260, P264, P280, P301+P330+P331, P303+P361+P353, P304+P340, P305+P351+P338, P310, P321, P363, P405, P501NFPA 704 (firediamond)302WOXFlash pointNon-flammableThreshold limit value (TLV)15 mg/m3 (IDLH),1 mg/m3 (TWA),2 mg/m3 (STEL)Lethal dose or concentration (LD, LC):LD50 (median dose)2140 mg/kg (rat, oral)[6]LC50 (median concentration)50 mg/m3 (guinea pig, 8 hr)510 mg/m3 (rat, 2 hr)320 mg/m3 (mouse, 2 hr)18 mg/m3 (guinea pig)[6]LCLo (lowest published)87 mg/m3 (guinea pig, 2.75 hr)[6]NIOSH (US health exposure limits):PEL (Permissible)TWA 1 mg/m3[2]REL (Recommended)TWA 1 mg/m3[2]IDLH (Immediate danger)15 mg/m3[2]Related compoundsRelated strong acidsSelenic acidHydrochloric acidNitric acidPerchloric acidFluoroantimonic acidChromic acidRelated compoundsSulfurous acidPeroxymonosulfuric acidSulfur trioxideOleumExcept where otherwise noted, data are given for materials in their standard state (at 25C [77F], 100kPa).Nverify(what isYN?)Infobox referencesChemical compoundSulfuric 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 sulfur, oxygen, and hydrogen, with the molecular formula H2SO4. It is a colorless, odorless, and viscous liquid that is miscible with water.[7]Structure of sulfuric acidPure 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.[7] Concentrated sulfuric acid is a strong oxidant with powerful dehydrating properties, making it highly corrosive towards other materials, from rocks to metals. Phosphorus pentoxide is a notable exception in that it is not dehydrated by sulfuric acid but, to the contrary, dehydrates sulfuric acid to sulfur 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 is generally avoided 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 secondary thermal burns due to dehydration.[8][9] Dilute sulfuric acid is substantially less hazardous without the oxidative and dehydrating properties; though, it is handled with care for its acidity.Many methods for its production are known, including the contact process, the wet sulfuric acid process, and the lead chamber process.[10] Sulfuric acid is also a key substance in the chemical industry. It is most commonly used in fertilizer manufacture[11] but is also important in mineral processing, oil refining, wastewater treating, and chemical synthesis. It has a wide range of end applications, including in domestic acidic drain cleaners,[12] as an electrolyte in lead-acid batteries, as a dehydrating compound, and in various cleaning agents.Sulfuric acid can be obtained by dissolving sulfur trioxide in water.Although nearly 100% sulfuric acid solutions can be made, the subsequent loss of SO3 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:[13][14]Mass fractionH2SO4Density(kg/L)Concentration(mol/L)Common name