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Chapter 1 : Dress dye analysis points to fast-moving fashion in 19th century | Research | Chemistry World

*Chemistry and the Chemical Industry in the 19th Century: The Henrys of Manchester and Other Studies (Variorum Collected Studies) [Wilfred Vernon Farrar, Richard L. Hills] on www.nxgvision.com *FREE* shipping on qualifying offers.*

A large number of soaperies existed throughout Britain and each soapery produced soap on a small scale; indeed some households produced a soap-like material for their own domestic use. The manufacture of soap goes back for many centuries. It is essentially a simple process. Soap is produced by boiling fat with alkali. Fat was obtained easily in the form of tallow from animals. Alkali was more of a problem. It was usually obtained from the ashes of burnt vegetable matter. Traditionally wood ash was used. To produce hard soap, other vegetable materials had to be used. It should be understood that, at the time, the chemistry of soap manufacture was not known. Soap was produced in a traditional manner by methods which had evolved over a long period of time through trial and error. Indeed it was not until , which happened to be the year of foundation of the first successful soapery in Runcorn, that John Dalton outlined his atomic theory, the basis for the new science of chemistry, in a lecture in Manchester. We now know that wood ashes produce a potassium-containing alkali and that an alkali containing sodium is needed for hard soap. In the late 18th century sodium-containing alkali was obtained for commercial soap-making purposes from two main vegetable sources, the ashes of barilla and of kelp. Barilla was made from a member of the goosegrass family of plants which grew mainly on the shores of the Mediterranean. Kelp was produced from the ashes of seaweed which grew around the coasts of the western Scottish islands and Ireland. Towards the end of the 18th century the production of alkali from vegetable sources was beginning to cause problems. The demand was beginning to outstrip the supply. This was compounded in France by international conflicts which blocked the imports of the substance. The French Academy of Science established a competition to discover a method for the production of alkali by artificial means from sodium chloride, common salt. The problem was eventually solved in France by Nicholas Leblanc who took out a patent for his method in The production of alkali from salt by the Leblanc process takes place in two stages. First, salt is heated with sulphuric acid, which produces a substance known as saltcake, which chemically is sodium sulphate. The process of making sulphuric acid in lead chambers for this procedure had been also been in use for some time. This results in a substance known as white ash. When this is refined, soda sodium carbonate , an alkaline substance is produced. By this method, alkali could be made artificially by fairly simple means for use in the production of soap. This was to prove revolutionary, not only for soap manufacture, but also as the basis for what was to become an entirely new industry, the chemical industry. Indeed the artificial production of alkali by the Leblanc process was to prove important for other industries, industries which were larger than the soap-manufacturing industry, those industries which were to play a major role on the development of the Industrial Revolution. The biggest of these was the textile industry where bleaching powder, which was synthesized from soda, solved a problem. The use of this substance replaced the labour-intensive and time-consuming need to bleach cloth by exposing it to the sun. Alkali was also a vital material in the paper and glass making industries. The necessary alkali for these industries was made mainly by the soap makers who produced more than they required for their own purposes and sold it on to them. As time passed, factories concentrating only on producing alkali by the Leblanc process were founded. These factories formed the basis for the chemical industry which developed in Runcorn and Widnes, elsewhere in the Mersey valley, and further afield. While the Leblanc process had beneficial effects in the production of chemicals for use in various industries and in the creation of profit for these industries, it also had considerable harmful effects. Its major disadvantage was environmental pollution. In addition to the production of smoke from the burning of coal, the procedure produced as by-products various evil-smelling sulphur-containing substances. And worst of all was the production of hydrochloric acid. This was produced as a gas which is heavier than air and which is lethal to all living things. It kills all plants with which it comes into contact and will kill animals if they inhale a sufficient quantity of it. In the early days of the Leblanc process there was no known use for hydrochloric acid and no convenient way to get rid of it. Many years later, it was to be rendered less harmful by passing it through the absorption towers devised by Gossage, and also many years later, a process was discovered to make chlorine from it. But in the earliest days the gas was just allowed escape with the smoke up relatively low chimneys. In time, very high chimneys were built to disperse the pollutants, in the hope that by the time the hydrochloric acid reached the ground, it would be sufficiently dilute to be relatively unharmful. In Runcorn, the first successful business to be established to make soap, and later alkali, was founded by an entrepreneurial businessman, John Johnson, in This business prospered and in another soap-making business, which was to become a major although a somewhat smaller concern, was established by another entrepreneur, Thomas Hazlehurst. Runcorn was ideally placed geographically to become a centre for soap making, and for using the Leblanc process for the manufacture of alkali. Its waterway links provided both a means for transporting the necessary raw materials to the factories and the finished products, soap and chemicals, away from the factories. This canal had connections inland with the Derbyshire limestone quarries. Along the nearby Weaver Navigation system came salt from the mid-Cheshire salt mines. Runcorn docks provided a connection with the Mersey river and estuary. From across the Mersey, coal could be transported from the Lancashire coalfields via the Sankey canal. The Mersey estuary gave access to the coastal ports of Great Britain and, beyond that, to the Irish Sea and to world markets. Through Runcorn docks came limestone from North Wales and, in the earlier days, kelp from Ireland and the Scottish islands. Later, sulphur for the manufacture of sulphuric acid arrived. This would be either in its elemental form from Sicily, or in the form of pyrites from mines in Ireland and further afield. When tallow was replaced by vegetable oils as the fat used for the soap-making process, palm oil and cocoanut oil were imported via Liverpool through Runcorn docks. At the time that the Runcorn firms started to make soap, it was subject to an excise duty of three pence for each pound of soap produced. The soap boiling pans were fitted with lids which were locked each night by the excise man.

Chapter 2 : History of chemistry - Wikipedia

Chemistry and the Chemical Industry in the 19th Century by Richard L. Hills, , available at Book Depository with free delivery worldwide.

Its growth and development have taken place almost entirely in the past one hundred years. Nevertheless, it is well to remember that some of the foundation stones of the science were laid in the latter part of the eighteenth century. There was no such thing as a science of chemistry in the time of the ancient Greeks and Romans. Nor during the middle ages, nor previous to the year can there be said to have been any systematized chemical knowledge. In the middle of the eighteenth century the attempt was made to explain in a general way that most striking of all ordinary chemical changes, namely, fire or combustion. It was noticed that there are two classes of bodies, those that will burn and those that will not. The former were assumed to contain the element of fire, or phlogiston. In the process of burning the phlogiston was supposed to escape into the air; the ashes or products of combustion remained behind. The act of burning was looked upon as a decomposition. Combustible bodies were all supposed to be of a compound nature, consisting of phlogiston and the products of combustion. In the act of burning these two elements separated, the phlogiston going off into the air, the products of combustion remaining behind as the ashes. Last summer a bronze statue of Lavoisier was unveiled in Paris. A few years previous to this, in , Joseph Priestley, the English clergyman, had found that when the red calx of mercury is heated oxygen gas is obtained, and that substances burn very brilliantly in this gas. Lavoisier repeated the experiments of Priestley, saw, what the latter failed to see, that burning was the union of oxygen with the burning substance and that combustion was a chemical combination and not a decomposition. Thus began a new era for chemistry, a quantitative era. From now on the balance became the chief instrument of chemical investigation, Such In brief was the condition of chemistry one hundred years ago. The ideas of Lavoisier had, at the opening of the last century, come to be very generally accepted, but very little was known beyond these. Oxygen was the chief element and the oxides the chief compounds or, as Berzelius said: It was not even known at that time that substances do have a fixed composition; indeed, the fundamental laws of chemical action were still all undiscovered. Almost nothing was known of the composition of substances of vegetable or animal origin, that great and important class of bodies that we now know as organic substances. A century ago it was not known that alcohol contained oxygen; this fact was found out in the year There were no laws and principles. Inorganic chemistry was largely mineralogy, organic chemistry was chiefly botany. Limited as chemical knowledge was when the nineteenth century opened, there were, however, certain men at work, who had adopted the quantitative methods of Lavoisier, and who soon made important discoveries. First of all Proust, in , announced that every chemical compound has a fixed and definite composition, that when substances unite chemically they do so in definite ratios by weight. Berthollet maintained that compounds have a variable composition, and that if there are any that do appear to have a fixed composition it is an exception and not the rule. For eight years the controversy was carried on between these men. Proust finally came out victorious. More and more analyses of compounds were made until it was clearly established that every distinct substance has a fixed and unalterable composition. The second great law of combination was discovered in by John Dalton, and it is commonly called the law of multiple proportions. To explain these laws of combination, Dalton introduced the atomic theory into chemistry, and from now on the great problem was to determine the relative weights of the atoms. When the history of chemistry in the nineteenth century comes to be written, it will be largely the history of the atomic theory, and for more than sixty years- the two great problems to which the most eminent men gave their attention were the determination of the atomic weights and of the arrangement of the atoms in compounds. Side by side with this development of chemical theory has gone the discovery of new elements and compounds. Instead of the thirty elements or simple substances known at the beginning of the last century, we now have seventy-eight. Instead of a few scores of distinct compounds of definite composition, we now have thousands of these substances. To-day there are known 75, compounds of carbon alone. In the years and Bunsen and Kirchoff devised the spectroscope, and it has become, next to the balance, the most important instrument of chemical investigation. By means of it the elements rubidium, cesium, thallium, indium, gallium, scandium and helium have been discovered. Soon after the atomic weights had been determined satisfactorily, a very remarkable relationship was discovered by Lothar Meyer and Mendelejeff to exist between the atomic weights and the properties of the elements. It was found that when the elements were arranged in the order of increasing atomic weights, beginning with the lowest and going up regularly to the highest, there was a periodic variation in the properties of the elements. For example, it was noticed that the eighth element resembled the first, the ninth was analogous to the second, and so on. Mendelejeff expressed this fact in the following way: When the table of elements was first arranged it was incomplete, there were blank spaces. Mendelejeff predicted that elements would be found that would fill these spaces, and from the properties of the adjoining elements he foretold the properties of the unknown elements. In this way he predicted the properties of an element that would resemble boron, another that would be analogous to aluminium, and a third that would be closely related to silicon. These predictions have all been fulfilled. In Nilson discovered scandium. In Boisbaudran discovered gallium; it was the element resembling aluminium, and in Winkler discovered germanium; its properties were almost identical with those that had been predicted for the element resembling silicon. In the last few years it has been found that ordinary air contains some elements, the existence of which had not even been suspected. For nearly three quarters of a century it was supposed that we knew all about the composition of the air, but in Lord Rayleigh found that a globe filled with atmospheric nitrogen weighed more than the same globe filled with nitrogen made from chemical compounds containing nitrogen, and this observation followed up led to the discovery of argon, an inert gas, present to the extent of about one per cent in the air. Then efforts were made to find argon in mineral substances; certain minerals that were supposed to give off nitrogen on heating were heated in vacuous vessels and thus helium was discovered. Ramsey has found two other inert gases in air besides argon; he obtains them by the fractional evaporation of liquid air, and he has named them neon and kripton. Quite recently it has been claimed that the mineral pitch blende contains the elements radium, polonium and actinium, and that these elements emit rays that are capable of producing skiagraphic images on sensitive plates, and of discharging electrified bodies. Hand in hand with the development of scientific chemistry and the discovery of new compounds has gone the improvement of manufacturing processes and the methods of industrial chemistry. At the beginning of the last century potash was the chief alkali, and this was obtained from wood ashes. Leblanc invented a method of obtaining soda from salt, and for many years this was the only way of getting alkali on the large scale. Now this method has been almost entirely replaced by the Solvay or ammonia-soda process, and it is very probable that before many years this in turn will be replaced by the electrolytic process of obtaining alkali from salt solutions. There is a constant evolution of new methods in chemical industry, the older processes have to give way to more economic and perfect methods. For more than one hundred years, all the sulphuric acid that is used has been made in lead chambers, and one improvement after the other was added to this process until it was brought to a high state of perfection; but now, with the opening of the new century, the sulphuric acid manufacturers are pulling down their lead chambers. A new and better method of making the acid has been devised. Sulphur dioxide and air are led over finely divided platinum and the resulting sulphur trioxide is conducted into water. It has long been known that sulphuric acid can be made in this way on the small scale in the laboratory, but it is only recently that the principle has been adapted to the commercial preparation of the acid. The resulting sulphur trioxide is led into water and sulphuric acid of any degree of concentration obtained. Places like Niagara Falls that have abundant water power for the production of electric currents are rapidly becoming the seats of important chemical industries. The electric current is at present used chiefiy in two ways in inorganic chemistry. First it is used for the production of very high temperatures in the electric furnace. In simple form the electric furnace consists of a box of fire bricks in which the carbon poles of an electric arc light are placed, Under the infiuence of the high temperatures produced between the carbon pencils nearly all metal oxides are reduced by carbon, Aluminium oxide is reduced in this way at Niagara Falls, and aluminium bronze, an alloy of aluminium and copper, is made. Sand is reduced in the same way, and the element silicon unites with the excess of carbon and forms the compound carborundum, an exceedingly hard substance which is used so extensively as a substitute for emery. Artificial graphite and phosphorus are also made in the electric furnace and the carbides of a large number of metals have been prepared. Of these carbides calcium carbide has become of commercial importance, as it is used extensively for making acetylene. The other way in which the electric current Is utilized is for the electrolysis of liquids, either solutions of substances in water or fused substances. At Niagara metallic sodium is now made by the electrolysis of fused caustic soda. One of the uses of the metallic sodium is to prepare sodium peroxide, the new bleaching agent, for which purpose the metal is burnt in dry air. Caustic soda and chlorine are made by the electrolysis of salt solutions, and potassium chlorate by the electrolysis of potassium chloride solution. The electric current is also used in refining certain metals, for which purpose sheets of the crude metal are suspended at one pole in a bath of the metal salt and the pure metal deposited at the other pole. During the past century great progress has been made in the methods of extracting the metals from their ores. Not only has this been true of iron, but of all the useful metals. As an example, it is only necessary to call attention to the cyanide process of extracting gold and silver. Gold and silver ores which are so poor that it was unprofitable to work them in previous years are now successfully treated with a solution of potassium cyanide, which has the power, in the presence of air, of dissolving the noble metals. It is this method which has largely contributed to the increased production of gold in recent years. Side by side with this improvement of metallurgical processes has gone the utilization of by-products. Not only is blast-furnace slag used in making Portland cement, but other slags, such as those obtained in the basic steel process and which contain phosphoric acid, are used as fertilizers. The sulphur dioxide formed by roasting lead and zinc ores is no longer allowed to escape into the air, but is converted into sulphuric acid. But undoubtedly the most rapid strides in the development of chemistry have been made in the past century in that department known as organic chemistry. One hundred years ago our knowledge of the compounds occurring in the organs of plants and animals was very meager indeed. A few organic substances had been isolated, but their composition was very imperfectly known, as the methods of analysis were very crude. Liebig in improved the method of analyzing these compounds and thus laid the foundation of organic chemistry. A century ago it was generally believed that organic compounds could not possibly be made artificially by synthesi s in the laboratory, as was the case with mineral compounds. It was thought that a peculiar vital force in some way intervened in. But this idea soon had to be abandoned, for in Wohler succeeded in building up urea from simple inorganic substances, and thus the first synthesis of an organic substance was effected. This was soon followed by that of acetic acid by Kolbe, and then year after year an ever larger and larger number of substances was added to the list of synthetic compounds. It would take too long to enumerate all the compounds that have been made artificially in the laboratory. It is enough to say that the hydrocarbons of petroleum, common alcohol, wood alcohol, fusel oil, the ethers, the ethereal and essential oils, the fatty acids, glycerine, grape sugar and fruit sugar, coloring matters and dye stuffs like indigo and turkey red, aromatic substances like oil of bitter almonds, vanilline and cou- marine and many others, have been made, One hundred years ago it was generally believed to be impossible for two substances of entirely different properties to have the same composition. When Liebig in found that Wohler had analyzed silver cyanate, and stated the percentage composition, he saw that it was identical with the percentage composition of silver fulminate as found by himself. He at once wrote to Wohler and told him that he must have made a mistake. Silver cyanate and silver fulminate were very different substances, he said; they could not possibly have the same composition. Wohler repeated his analyses and found that they were correct. Liebi g again analyzed silver fulminate and found that his figures also were correct. Both substances had the same percentage composition.

Chapter 3 : An Outline of the Progress of Chemistry in the Nineteenth Century - Scientific American

The first part of this text examines the Henrys in Manchester and their role in the chemical industry in the 19th-century. The second half examines other aspects of the chemical industry, chemistry.

Histoire de la chimie. A History of the International Chemical Industry. Chemical Heritage Foundation, Philadelphia: University of Pennsylvania Press, Le nouvel esprit scientifique,. Growth and Decay of a Science. Johns Hopkins University Press, Deutscher Apotheker Verlag, From Vital Force to Structural Formulas. Beckman Center for the History of Chemistry, Benfey, Theodor O, ed. Classics in the Theory of Chemical Combination. Graham , W, Lepenies, P. Reidel, Sociology of the Science Yearbook, vol. Lavoisier and the Balance. Essays and Interpretation 33 Bensaude-Vincent, Bernadette, and I. A History of Chemistry. Cambridge, Mass; London England: Harvard University Press, Bensaude-Vincent, Bernadette, and F. Lavoisier in European Context. Negotiating a New language for Chemistry. The Enlightenment of Matter: The Definition of Chemistry from Agricola to Lavoisier. Marie Curie et son laboratoire: The Fontana History of Chemistry. Cambridge, New York, Melbourne: Cambridge University Press, Some Recent Trends in Historiography. Studies in the History of Chemical Philosophy.. Instruments and Experimentation in the History of Chemistry. The Discipline of Chemistry: Bud, Robert, and Gerrylynn K. Chemistry in Victorian Britain. Manchester University Press, Bud, Robert, and Deborah Warner, eds. Carneiro, Ana, and Natalie Pigeard. Jean-Baptiste Dumas, chimiste et homme politique. Guy le Prat, The Discovery of the Electron and the Chemists. A Contribution to Social Technology. From Animal Chemistry to Biochemistry. Bucks, Hulton Educational Publications, From Ionic Theory to the Greenhouse Effect. Science History Publications, Crosland, Maurice, The Society of Arcueil: The French Academy of Science, Cambridge, New York, Victoria: In the Shadow of Lavoisier: The Annales de chimie and the Establishment of a New Science. The Alden Press, Il y a deux cents Lavoisier. Philosophical Chemistry in the Scottish Enlightenment. Edinburgh University Press, A Reply to Perrin. Science, Administration, and Revolution. Oxford and Cambridge, Mass.: An Industrial Culture in Europe. Science History Publications, forthcoming, The Study of Chemical Composition: An Account of its Method and Historical Development. New York, Toronto, London: Historical Essays on the Interplay of Chemistry and Biology. Contrasts in Scientific Styles: Research Groups in the Chemical and Biological Sciences. American Philosophical Society, Science as Public Culture. Chemistry and Enlightenment in Britain, Essays on the Life and Work of Michael Faraday, Sabix, Ecole polytechnique, Graham , Loren R. A Scientific Correspondence during the Chemical Revolution. Berkeley Papers in History of Science, The Emergence of the German Chemical Profession The Chemical Industry during the Nineteenth Century. Chemical Warfare in the First World War. A Science of Impurity. Water Analysis in Nineteenth-century Britain. The Chemists and the Word: The Didactic Origins of Chemistry. Claude Bernard and Animal Chemistry. Eighteenth-Century Chemistry as an Investigative Enterprise. Between Biology and Medicine: The Formation of Intermediary Metabolism. Princeton University Press, The History of Chemistry. The Formation of the German Chemical Community, Berkeley, Los Angeles, and London: University of California Press, The Chemical Industry in Europe, Industriel Growth, Pollution and Professionalization:. The Developement of Modern Chemistry. New York, Evanston, and London: Librairie Polytechnique, Baudry et Cie, The Life and the Work of Pierre Duhem.. Science and Modernization in Imperial Germany. Chapel Hill and London: University of North Carolina Press,

Chapter 4 : Top Pharmaceuticals: Introduction: EMERGENCE OF PHARMACEUTICAL SCIENCE AND IN

The timeline of chemistry lists important works, discoveries, ideas, inventions, and experiments that significantly changed humanity's understanding of the modern science known as chemistry, defined as the scientific study of the composition of matter and of its interactions.

Bring fact-checked results to the top of your browser search. Chemistry and society For the first two-thirds of the 20th century, chemistry was seen by many as the science of the future. The potential of chemical products for enriching society appeared to be unlimited. Increasingly, however, and especially in the public mind, the negative aspects of chemistry have come to the fore. Disposal of chemical by-products at waste-disposal sites of limited capacity has resulted in environmental and health problems of enormous concern. The legitimate use of drugs for the medically supervised treatment of diseases has been tainted by the growing misuse of mood-altering drugs. The very word chemicals has come to be used all too frequently in a pejorative sense. There is, as a result, a danger that the pursuit and application of chemical knowledge may be seen as bearing risks that outweigh the benefits. The conversion of solar energy to more concentrated, useful forms, for example, will rely heavily on discoveries in chemistry. Long-term, environmentally acceptable solutions to pollution problems are not attainable without chemical knowledge. Progress in chemistry can no longer be measured only in terms of economics and utility. The discovery and manufacture of new chemical goods must continue to be economically feasible but must be environmentally acceptable as well. The impact of new substances on the environment can now be assessed before large-scale production begins, and environmental compatibility has become a valued property of new materials. For example, compounds consisting of carbon fully bonded to chlorine and fluorine, called chlorofluorocarbons or Freons , were believed to be ideal for their intended use when they were first discovered. They are nontoxic, nonflammable gases and volatile liquids that are very stable. These properties led to their widespread use as solvents, refrigerants, and propellants in aerosol containers. Time has shown, however, that these compounds decompose in the upper regions of the atmosphere and that the decomposition products act to destroy stratospheric ozone. Limits have now been placed on the use of chlorofluorocarbons, but it is impossible to recover the amounts already dispersed into the atmosphere. The chlorofluorocarbon problem illustrates how difficult it is to anticipate the overall impact that new materials can have on the environment. Chemists are working to develop methods of assessment , and prevailing chemical theory provides the working tools. Once a substance has been identified as hazardous to the existing ecological balance, it is the responsibility of chemists to locate that substance and neutralize it, limiting the damage it can do or removing it from the environment entirely. The last years of the 20th century will see many new, exciting discoveries in the processes and products of chemistry. Inevitably, the harmful effects of some substances will outweigh their benefits, and their use will have to be limited. Yet, the positive impact of chemistry on society as a whole seems beyond doubt. Usselman The history of chemistry Chemistry has justly been called the central science. Chemists study the various substances in the world, with a particular focus on the processes by which one substance is transformed into another. Today, chemistry is defined as the study of the composition and properties of elements and compounds, the structure of their molecules, and the chemical reactions that they undergo. Rather than starting with such modern concepts, though, a fuller appreciation of the subject requires an examination of the historical processes that led to these concepts. Philosophy of matter in antiquity Indeed, the philosophers of antiquity could have had no notion that all matter consists of the combinations of a few dozen elements as they are understood today. The earliest critical thinking on the nature of substances, as far as the historical record indicates, was by certain Greek philosophers beginning about bce. Leucippus and Democritus propounded a materialistic theory of invisibly tiny irreducible atoms from which the world was made. Thales of Miletus 6th century bce , philosopher, astronomer, and geometer, who was renowned as one of the Seven Wise Men of antiquity. He identified water as the original substance and basis of the universe. Consequently, there were many different kinds of earth, for instance, and nothing precluded one element from being transformed into another by appropriate adjustment of its qualities. Thus, Aristotle rejected the speculations of the ancient atomists and their irreducible fundamental particles. His views were highly regarded in late antiquity and remained influential throughout the Middle Ages. For thousands of years before Aristotle, metalsmiths, assayers, ceramists, and dyers had worked to perfect their crafts using empirically derived knowledge of chemical processes. By Hellenistic and Roman times, their skills were well advanced, and sophisticated ceramics, glasses, dyes, drugs, steels, bronze, brass, alloys of gold and silver, foodstuffs, and many other chemical products were traded. Hellenistic Alexandria in Egypt was a centre for these arts, and it was apparently there that a group of ideas emerged that later became known as alchemy. Alchemy Three different sets of ideas and skills fed into the origin of alchemy. First was the empirical sophistication of jewelers, gold- and silversmiths, and other artisans who had learned how to fashion precious and semiprecious materials. Among their skills were smelting , assaying , alloying , gilding , amalgamating , distilling , sublimating , painting , and lacquering. The second component was the early Greek theory of matter, especially Aristotelian philosophy, which suggested the possibility of unlimited transformability of one kind of matter into another. It is important to note, however, that Hellenistic Egypt is only one of several candidates for the homeland of alchemy; at about the same time, similar ideas were developing in Persia, China, and elsewhere. In general, alchemists sought to manipulate the properties of matter in order to prepare more valuable substances. Important materials in this craft included sulfur , mercury , and electrum a gold-silver alloy. There was a parallel religious dimension to all this as well. Finally, some alchemists spurned material manipulations entirely, devoting themselves to meditation with the goal of achieving spiritual purity and ultimate redemption. After the rise of Islam , Arabic-speaking scholars of the 9th century translated Greek scientific and philosophical works into their own language. Thereafter, philosophers in the Islamic world pursued chemical and alchemical ideas with enthusiasm and success. The sizable number of modern chemical words derived from Arabicâ€”alcohol, alkali, alchemy, zircon, elixir, natron, and othersâ€”suggests the importance of this period for the history of chemistry. One of the leading ideas of medieval Arabic alchemy was the theory that all metals were formed of sulfur and mercury in various proportions and that altering those proportions could transform the metal under studyâ€”even to produce silver or gold from lead or iron. Not every alchemist, however, believed in the possibility of such transmutations. Later, scholars in Christian western Europe learned of ancient Greek and early medieval Arabic philosophy by translating these books into Latin. Thus, the alchemical tradition, along with the rest of the Greco-Arabic philosophical and scientific corpus, passed to the West in the course of the 12th century. Alongside this learned literature, the empirical chemical arts continued to flourish and comprised a largely separate realm of expertise among artisans, engineers, and mechanics. Geber was the first to record methods for the preparation and use of sulfuric acid , nitric acid , and hydrochloric acid ; the earliest clear evidence for widespread familiarity with distilled alcohol also does not much predate his day. These substances could only have been produced by novel stills that were more robust and efficient than their predecessors, and the appearance of these remarkable new materials produced dramatic changes in the repertoire of chemists. The Renaissance saw even stronger interest in the science. The German-Swiss physician Paracelsus practiced alchemy, Kabbala , astrology, and magic, and in the first half of the 16th century he championed the role of mineral rather than herbal remedies. His emphasis on chemicals in pharmacy and medicine was influential on later figures, and lively controversies over the Paracelsian approach raged around the turn of the 17th century. Gradually the Hermetic influence declined in Europe, however, as certain celebrated feats of putative aurifaction were revealed as frauds. It would be a mistake to think that open-minded empirical investigation that is well integrated with theory which is how one might define science was absent from the history of alchemy. Indeed, as late as the end of the 17th century there was little to distinguish alchemy from chemistry, either substantively or semantically, since both words were applied to the same set of ideas. It was only in the early 18th century that chemists conferred different definitions on the two words, banishing alchemy to the ashbin of discredited occult pseudosciences. Phlogiston theory This shift was partly simple self-promotion by chemists in the new environment of the Enlightenment , whose vanguard glorified rationalism, experiment, and progress while demonizing the mystical. However, it was also becoming ever clearer that certain central ideas of alchemy especially metallic transmutation had never been demonstrated. One of the leaders in this regard was the German physician and chemist Georg Ernst Stahl , who vigorously attacked alchemy after dabbling in it himself and proposed an expansive new chemical theory. Stahl noted parallels between the burning of combustible materials and the calcination of metalsâ€"the conversion of a metal into its calx, or oxide. He suggested that both processes consisted of the loss of a material fluid, contained within all combustibles, called phlogiston. Phlogiston became the centrepiece of a broad-ranging theory that dominated 18th-century chemical thought. Phlogiston, in short, was thought to be a material substance that defined combustibility. When metallic iron becomes red rust, it loses its phlogiston, just as a burning log does. But iron calx can be converted back to the metal if it is strongly heated in the presence of a phlogiston-rich substance such as charcoal. The charcoal donates its phlogiston becoming ashes itself , while the calx turns into molten metallic iron. Thus, smelting reduction of metallic ores could also be understood in phlogistic terms. Later phlogistonists added respiration to the number of phenomena that the theory could elucidate. An animal breathes air, emitting phlogiston in an analogy to a slow fire, fueled by the phlogiston-rich food it consumes. Combustion, calcination, or respiration eventually cease in an enclosed space because air has a limited capacity to absorb the phlogiston emitted from the burning, calcining, or respiring entity. The phlogiston theory became popular both because of its great success in explaining phenomena and guiding further investigation and because of a certain Enlightenment predilection for materialistic physical theories the putative fluid of heat became known as caloric, and there were other suggested fluids of electricity , light , and so on. Enlightenment chemists established distinctive scientific communities and a well-defined discipline closely allied, to be sure, with medical and artisanal studies in the major countries of Europe. Still unsettled were some fundamental issues relating to chemical composition. To a phlogistonist, a metallic calx was elemental, and the associated metal was a compound of calx plus phlogiston. This puzzled some, though, since the metal gained rather than lost weight when it supposedly lost phlogiston to become a calx. The issues were sharpened in the s, when the virtuoso English chemist and Unitarian minister Joseph Priestley produced a new gas by heating certain minerals. A candle burned in this gas with extraordinary vigour, and in an enclosed space a mouse breathing it survived far longer than one could in ordinary air. Actually, gases then usually known as airs were a relatively novel object of chemical attention. In Scotland in , Joseph Black studied the gas given off in respiration and combustion, characterizing it chemically and following its participation in certain chemical reactions. Black, a physician, taught chemistry as a branch of medicine, as did most academic chemists of this era. His discovery that this gas was a normal component of common air at a fraction of a percent, to be sure was the first clear indication that atmospheric air was a mixture rather than a homogeneous element. In the following quarter century, many new gases were discovered and studied, by such workers as Priestley, the English physicist and chemist Henry Cavendish , and the Swedish pharmacist Carl Scheele. Lavoisier commanded both the wealth and the scientific brilliance to enable him to construct elaborate apparatuses to carry out his numerous ingenious experiments. Lavoisier first determined that certain metals and nonmetals absorb a gaseous substance from the air in undergoing calcination or combustion and, in the process, increase in weight. At this point October , Priestley communicated to Lavoisier his discovery of dephlogisticated air. Further experiments led Lavoisier to continuously modify his ideas, until it finally became clear to him that it was this new gas, and not fixed air, that was the active entity in combustion, calcination, and respiration. Moreover, he determined or so he thought, at least that this gas was contained in all acids. Rather than releasing anything, the combustible or metal absorbed more precisely, chemically combined with oxygen in the process that Lavoisier now called oxidation. He showed that atmospheric air was a mixture of two principal components, oxygen and a physiologically inert gas known to Priestley that he called azote or nitrogen. First, he carefully accounted for all the substances, including gases, entering into and emerging from the chemical reactions he studied by tracking their weights with the greatest possible precision.

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The Spanish chemical industry in the 21st century Sales of the worldwide chemical industry in were more than â‚¬ trillion, almost â‚¬1 trillion more than in

In lieu of an abstract, here is a brief excerpt of the content: The Henrys of Manchester and Other Studies. In view of the price, I wonder if this volume of collected papers really serves any worthwhile purpose. Wilfred Farrar is sorely missed: His pioneering work on the Henry family of Manchester with his wife, Kathleen, and E. Scott deserves to be preserved in a permanent form. Is this the way to go about it, though? The book contains papers on numerous topics, ranging from sanitary science to the chemical elements, early synthetic dyes, and the German university system. Surely it would have been far better to have collected papers on a common theme. Travis , and the development of chemical education, to name just three. By comparison, to use authors as the guiding principle, as Variorum has done, seems an easy option of limited value. He intended to publish the work on the Henrys as a book, but no publisher would accept it. So the Farrars and Scott were forced to publish their material bit by bit in Ambix. They were excellent papers, but there is considerable overlap among them, and there are changes in emphasis as the papers were published. Nonetheless, the book exists, so what does it contain? Over half the book is devoted to the papers on the Henry family. In the days before modern antiulcer and antacid treatments there was obviously a great deal of money to be made from such remedies, which are still popular today. It is a fascinating account of provincial science around as experienced by knowledgeable bystanders. Of the remaining papers, the ones on Richard Laming and the [End Page] coal gas industry, Richard Angus Smith and water pollution, and Andrew Ure and the philosophy of manufactures will be of the most interest to readers of Technology and Culture. The latter two appeared in Notes and Records of the Royal Society, which is hardly a mainstream journal for the history of technology, and American readers, in particular, may be unfamiliar with his work in these areas. This volume will be useful for teaching collections in libraries that do not subscribe to Ambix and Notes and Records, individuals who need to refer frequently to the papers on the Henrys, and the many friends and admirers of Wilfred Farrar. Morris is senior curator of experimental chemistry at the Science Museum, London.

Chapter 6 : Timeline of chemistry - Wikipedia

The chemical industry had a central position in the changing industrial world of the late 19th century. This industry did not hatch fully grown; it was based on nearly a century's worth of scientific advances in the universitiesâ€”particularly German universities.

It indicates that early humans had an elementary knowledge of chemistry. History of ferrous metallurgy and History of metallurgy in the Indian subcontinent The earliest recorded metal employed by humans seems to be gold which can be found free or "native". Small amounts of natural gold have been found in Spanish caves used during the late Paleolithic period, c. However, for millennia fire was seen simply as a mystical force that could transform one substance into another burning wood, or boiling water while producing heat and light. Fire affected many aspects of early societies. These ranged from the simplest facets of everyday life, such as cooking and habitat lighting, to more advanced technologies, such as pottery, bricks, and melting of metals to make tools. It was fire that led to the discovery of glass and the purification of metals which in turn gave way to the rise of metallurgy. Bronze Age Certain metals can be recovered from their ores by simply heating the rocks in a fire: However, as often happens with the study of prehistoric times, the ultimate beginnings cannot be clearly defined and new discoveries are ongoing. Mining areas of the ancient Middle East. Yellow area stands for arsenic bronze , while grey area stands for tin bronze. These first metals were single ones or as found. By combining copper and tin, a superior metal could be made, an alloy called bronze , a major technological shift which began the Bronze Age about BC. The Bronze Age was period in human cultural development when the most advanced metalworking at least in systematic and widespread use included techniques for smelting copper and tin from naturally occurring outcroppings of copper ores, and then smelting those ores to cast bronze. These naturally occurring ores typically included arsenic as a common impurity. After the Bronze Age, the history of metallurgy was marked by armies seeking better weaponry. Countries in Eurasia prospered when they made the superior alloys, which, in turn, made better armor and better weapons. Iron Age The extraction of iron from its ore into a workable metal is much more difficult than copper or tin. While iron is not better suited for tools than bronze until steel was discovered , iron ore is much more abundant and common than either copper or tin. So iron was much more often available locally without have to trade for it. The secret of extracting and working iron was a key factor in the success of the Philistines. Historical developments in ferrous metallurgy can be found in a wide variety of past cultures and civilizations. This includes the ancient and medieval kingdoms and empires of the Middle East and Near East, ancient Iran , ancient Egypt , ancient Nubia , and Anatolia Turkey , Ancient Nok , Carthage , the Greeks and Romans of ancient Europe, medieval Europe, ancient and medieval China, ancient and medieval India, ancient and medieval Japan, amongst others. Many applications, practices, and devices associated or involved in metallurgy were established in ancient China, such as the innovation of the blast furnace , cast iron , hydraulic -powered trip hammers , and double acting piston bellows. Atomism Democritus , Greek philosopher of atomistic school. Philosophical attempts to rationalize why different substances have different properties color, density, smell , exist in different states gaseous, liquid, and solid , and react in a different manner when exposed to environments, for example to water or fire or temperature changes, led ancient philosophers to postulate the first theories on nature and chemistry. The history of such philosophical theories that relate to chemistry can probably be traced back to every single ancient civilization. The common aspect in all these theories was the attempt to identify a small number of primary classical element that make up all the various substances in nature. The early theory of atomism can be traced back to ancient Greece and ancient India. Leucippus also declared that atoms were the most indivisible part of matter. This coincided with a similar declaration by Indian philosopher Kanada in his Vaisheshika sutras around the same time period. What Kanada declared by sutra, Democritus declared by philosophical musing. Both suffered from a lack of empirical data. Without scientific proof, the existence of atoms was easy to deny. Aristotle opposed the existence of atoms in BC. Earlier, in BC, a Greek text attributed to Polybus argues that the human body is composed of four humours. Around BC, Epicurus postulated a universe of indestructible atoms in which man himself is responsible for achieving a balanced life. In the work, Lucretius presents the principles of atomism ; the nature of the mind and soul ; explanations of sensation and thought; the development of the world and its phenomena; and explains a variety of celestial and terrestrial phenomena. Much of the early development of purification methods is described by Pliny the Elder in his Naturalis Historia. He made attempts to explain those methods, as well as making acute observations of the state of many minerals. Medieval alchemy[edit] See also: Minima naturalia , a medieval Aristotelian concept analogous to atomism Seventeenth-century alchemical emblem showing the four Classical elements in the corners of the image, alongside the tria prima on the central triangle. They were seen by early alchemists as idealized expressions of irreducibile components of the universe [18] and are of larger consideration within philosophical alchemy. The three metallic principles: Paracelsus saw these principles as fundamental and justified them by recourse to the description of how wood burns in fire. Mercury included the cohesive principle, so that when it left in smoke the wood fell apart. Smoke described the volatility the mercurial principle , the heat-giving flames described flammability sulphur , and the remnant ash described solidity salt. Alchemy and chemistry share an interest in the composition and properties of matter, and prior to the eighteenth century were not separated into distinct disciplines. The term chymistry has been used to describe the blend of alchemy and chemistry that existed before this time. The bain-marie, or water bath is named for Mary the Jewess. Her work also gives the first descriptions of the tribikos and kerotakis. During the Renaissance, exoteric alchemy remained popular in the form of Paracelsian iatrochemistry , while spiritual alchemy flourished, realigned to its Platonic , Hermetic, and Gnostic roots. Early modern alchemists who are renowned for their scientific contributions include Jan Baptist van Helmont , Robert Boyle , and Isaac Newton. There was no systematic naming scheme for new compounds, and the language was esoteric and vague to the point that the terminologies meant different things to different people. The language of alchemy soon developed an arcane and secretive technical vocabulary designed to conceal information from the uninitiated. Less than a century earlier, Dante Alighieri also demonstrated an awareness of this fraudulence, causing him to consign all alchemists to the Inferno in his writings. A law was passed in England in which made the "multiplication of metals" punishable by death. Despite these and other apparently extreme measures, alchemy did not die. Indeed, many alchemists included in their methods irrelevant information such as the timing of the tides or the phases of the moon. The esoteric nature and codified vocabulary of alchemy appeared to be more useful in concealing the fact that they could not be sure of very much at all. As early as the 14th century, cracks seemed to grow in the facade of alchemy; and people became sceptical. Alchemy in the Islamic world[edit] Main article: Alchemy and chemistry in medieval Islam In the Islamic World , the Muslims were translating the works of the ancient Greeks and Egyptians into Arabic and were experimenting with scientific ideas. Paracelsus â€” , for example, rejected the 4-elemental theory and with only a vague understanding of his chemicals and medicines, formed a hybrid of alchemy and science in what was to be called iatrochemistry. Paracelsus was not perfect in making his experiments truly scientific. For example, as an extension of his theory that new compounds could be made by combining mercury with sulfur, he once made what he thought was "oil of sulfur". This was actually dimethyl ether , which had neither mercury nor sulfur. Early chemistry[edit] Agricola, author of De re metallica See also: Timeline of chemistry and Corpuscularianism Practical attempts to improve the refining of ores and their extraction to smelt metals was an important source of information for early chemists in the 16th century, among them Georg Agricola â€” , who published his great work De re metallica in His work describes the highly developed and complex processes of mining metal ores, metal extraction and metallurgy of the time. His approach removed the mysticism associated with the subject, creating the practical base upon which others could build. The work describes the many kinds of furnace used to smelt ore, and stimulated interest in minerals and their composition. It is no coincidence that he gives numerous references to the earlier author, Pliny the Elder and his Naturalis Historia. Agricola has been described as the "father of metallurgy". In Jean

Beguin published the Tyrocinium Chymicum , an early chemistry textbook, and in it draws the first-ever chemical equation. The book contains the results of numerous experiments and establishes an early version of the law of conservation of mass. Working during the time just after Paracelsus and iatrochemistry , Jan Baptist van Helmont suggested that there are insubstantial substances other than air and coined a name for them - " gas ", from the Greek word chaos. In addition to introducing the word "gas" into the vocabulary of scientists, van Helmont conducted several experiments involving gases. Jan Baptist van Helmont is also remembered today largely for his ideas on spontaneous generation and his 5-year tree experiment , as well as being considered the founder of pneumatic chemistry. Robert Boyle[edit] Robert Boyle , one of the co-founders of modern chemistry through his use of proper experimentation, which further separated chemistry from alchemy Title page from The sceptical chymist, , Chemical Heritage Foundation Anglo-Irish chemist Robert Boyle â€" is considered to have refined the modern scientific method for alchemy and to have separated chemistry further from alchemy. In the work, Boyle presents his hypothesis that every phenomenon was the result of collisions of particles in motion. Boyle appealed to chemists to experiment and asserted that experiments denied the limiting of chemical elements to only the classic four: He also pleaded that chemistry should cease to be subservient to medicine or to alchemy, and rise to the status of a science. Importantly, he advocated a rigorous approach to scientific experiment: The work contains some of the earliest modern ideas of atoms , molecules , and chemical reaction , and marks the beginning of the history of modern chemistry. Boyle also tried to purify chemicals to obtain reproducible reactions. Boyle was an atomist, but favoured the word corpuscle over atoms. He commented that the finest division of matter where the properties are retained is at the level of corpuscles. He also performed numerous investigations with an air pump , and noted that the mercury fell as air was pumped out. He also observed that pumping the air out of a container would extinguish a flame and kill small animals placed inside. Boyle helped to lay the foundations for the Chemical Revolution with his mechanical corpuscular philosophy. Development and dismantling of phlogiston[edit] Joseph Priestley , co-discoverer of the element oxygen, which he called "dephlogisticated air" In , German chemist Georg Stahl coined the name " phlogiston " for the substance believed to be released in the process of burning. Around , Swedish chemist Georg Brandt analyzed a dark blue pigment found in copper ore. Brandt demonstrated that the pigment contained a new element, later named cobalt. Cronstedt is one of the founders of modern mineralogy. In , Scottish chemist Joseph Black isolated carbon dioxide , which he called "fixed air". Cavendish discovered hydrogen as a colorless, odourless gas that burns and can form an explosive mixture with air, and published a paper on the production of water by burning inflammable air that is, hydrogen in dephlogisticated air now known to be oxygen , the latter a constituent of atmospheric air phlogiston theory. In , Swedish chemist Carl Wilhelm Scheele discovered oxygen , which he called "fire air", but did not immediately publish his achievement. Scheele and Torbern Bergman suggested that it might be possible to obtain a new metal by reducing this acid.

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This theory provided the scientific basis for the dramatic expansion of the German chemical industry in the last third of the 19th century. Today, the large majority of known organic compounds are aromatic, and all of them contain at least one hexagonal benzene ring of the sort that KekulÃ© advocated.

Those pursuing their interests into specific areas of chemistry communicate with others who share the same interests. Over time a group of chemists with specialized research interests become the founding members of an area of specialization. The areas of specialization that emerged early in the history of chemistry, such as organic, inorganic, physical , analytical , and industrial chemistry, along with biochemistry , remain of greatest general interest. There has been, however, much growth in the areas of polymer, environmental, and medicinal chemistry during the 20th century. Moreover, new specialities continue to appear, as, for example, pesticide, forensic , and computer chemistry. University College Cork, Ireland Analytical chemistry Most of the materials that occur on Earth, such as wood , coal , minerals , or air , are mixtures of many different and distinct chemical substances. Each pure chemical substance e. The detection of iron in a mixture of metals, or in a compound such as magnetite, is a branch of analytical chemistry called qualitative analysis. Measurement of the actual amount of a certain substance in a compound or mixture is termed quantitative analysis. Quantitative analytic measurement has determined, for instance, that iron makes up Over the years, chemists have discovered chemical reactions that indicate the presence of such elemental substances by the production of easily visible and identifiable products. Iron can be detected by chemical means if it is present in a sample to an amount of 1 part per million or greater. Some very simple qualitative tests reveal the presence of specific chemical elements in even smaller amounts. The yellow colour imparted to a flame by sodium is visible if the sample being ignited has as little as one-billionth of a gram of sodium. Such analytic tests have allowed chemists to identify the types and amounts of impurities in various substances and to determine the properties of very pure materials. Substances used in common laboratory experiments generally have impurity levels of less than 0. For special applications, one can purchase chemicals that have impurities totaling less than 0. The identification of pure substances and the analysis of chemical mixtures enable all other chemical disciplines to flourish. The importance of analytical chemistry has never been greater than it is today. The demand in modern societies for a variety of safe foods, affordable consumer goods, abundant energy, and labour-saving technologies places a great burden on the environment. All chemical manufacturing produces waste products in addition to the desired substances, and waste disposal has not always been carried out carefully. Disruption of the environment has occurred since the dawn of civilization, and pollution problems have increased with the growth of global population. The techniques of analytical chemistry are relied on heavily to maintain a benign environment. The undesirable substances in water, air, soil, and food must be identified, their point of origin fixed, and safe, economical methods for their removal or neutralization developed. Once the amount of a pollutant deemed to be hazardous has been assessed, it becomes important to detect harmful substances at concentrations well below the danger level. Analytical chemists seek to develop increasingly accurate and sensitive techniques and instruments. Sophisticated analytic instruments, often coupled with computers, have improved the accuracy with which chemists can identify substances and have lowered detection limits. An analytic technique in general use is gas chromatography , which separates the different components of a gaseous mixture by passing the mixture through a long, narrow column of absorbent but porous material. The different gases interact differently with this absorbent material and pass through the column at different rates. As the separate gases flow out of the column, they can be passed into another analytic instrument called a mass spectrometer , which separates substances according to the mass of their constituent ions. A combined gas chromatographâ€"mass spectrometer can rapidly identify the individual components of a chemical mixture whose concentrations may be no greater than a few parts per billion. Similar or even greater sensitivities can be obtained under favourable conditions using techniques such as atomic absorption, polarography, and neutron activation. The rate of instrumental innovation is such that analytic instruments often become obsolete within 10 years of their introduction. Newer instruments are more accurate and faster and are employed widely in the areas of environmental and medicinal chemistry. Inorganic chemistry Modern chemistry, which dates more or less from the acceptance of the law of conservation of mass in the late 18th century, focused initially on those substances that were not associated with living organisms. Study of such substances, which normally have little or no carbon, constitutes the discipline of inorganic chemistry. Early work sought to identify the simple substancesâ€”namely, the elementsâ€”that are the constituents of all more complex substances. Some elements, such as gold and carbon, have been known since antiquity, and many others were discovered and studied throughout the 19th and early 20th centuries. Today, more than are known. The study of such simple inorganic compounds as sodium chloride common salt has led to some of the fundamental concepts of modern chemistry, the law of definite proportions providing one notable example. This law states that for most pure chemical substances the constituent elements are always present in fixed proportions by mass e. The crystalline form of salt, known as halite , consists of intermingled sodium and chlorine atoms, one sodium atom for each one of chlorine. Such a compound, formed solely by the combination of two elements, is known as a binary compound. Binary compounds are very common in inorganic chemistry, and they exhibit little structural variety. For this reason, the number of inorganic compounds is limited in spite of the large number of elements that may react with each other. If three or more elements are combined in a substance, the structural possibilities become greater. After a period of quiescence in the early part of the 20th century, inorganic chemistry has again become an exciting area of research. Compounds of boron and hydrogen , known as boranes , have unique structural features that forced a change in thinking about the architecture of inorganic molecules. Some inorganic substances have structural features long believed to occur only in carbon compounds, and a few inorganic polymers have even been produced. Ceramics are materials composed of inorganic elements combined with oxygen. For centuries ceramic objects have been made by strongly heating a vessel formed from a paste of powdered minerals. Although ceramics are quite hard and stable at very high temperatures, they are usually brittle. Currently, new ceramics strong enough to be used as turbine blades in jet engines are being manufactured. There is hope that ceramics will one day replace steel in components of internal-combustion engines. In a ceramic containing yttrium , barium , copper , and oxygen , with the approximate formula YBa2Cu3O7, was found to be a superconductor at a temperature of about K. A superconductor offers no resistance to the passage of an electrical current, and this new type of ceramic could very well find wide use in electrical and magnetic applications. A superconducting ceramic is so simple to make that it can be prepared in a high school laboratory. Its discovery illustrates the unpredictability of chemistry, for fundamental discoveries can still be made with simple equipment and inexpensive materials. Many of the most interesting developments in inorganic chemistry bridge the gap with other disciplines. Organometallic chemistry investigates compounds that contain inorganic elements combined with carbon-rich units. Many organometallic compounds play an important role in industrial chemistry as catalysts , which are substances that are able to accelerate the rate of a reaction even when present in only very small amounts. Some success has been achieved in the use of such catalysts for converting natural gas to related but more useful chemical substances. Chemists also have created large inorganic molecules that contain a core of metal atoms, such as platinum, surrounded by a shell of different chemical units. Some of these compounds, referred to as metal clusters, have characteristics of metals, while others react in ways similar to biologic systems. Trace amounts of metals in biologic systems are essential for processes such as respiration, nerve function, and cell metabolism. Processes of this kind form the object of study of bioinorganic chemistry. Although organic molecules were once thought to be the distinguishing chemical feature of living creatures, it is now known that inorganic chemistry plays a vital role as well. Organic chemistry Organic compounds are based on the chemistry of carbon. Carbon is unique in the variety and extent of structures that can result from the three-dimensional connections of its atoms. The process of photosynthesis converts carbon dioxide and water to oxygen and compounds known as carbohydrates. Both cellulose , the substance that gives structural rigidity to plants, and starch , the energy storage product of plants, are polymeric carbohydrates. Simple carbohydrates produced by photosynthesis form the raw material for the myriad organic compounds found in the plant and animal kingdoms. When combined with variable amounts of hydrogen, oxygen, nitrogen , sulfur , phosphorus, and other elements, the structural possibilities of carbon compounds become limitless, and their number far exceeds the total of all nonorganic compounds. A major focus of organic chemistry is the isolation, purification, and structural study of these naturally occurring substances. Many natural products are simple molecules. Other natural products, such as penicillin, vitamin B12, proteins, and nucleic acids, are exceedingly complex. The isolation of pure natural products from their host organism is made difficult by the low concentrations in which they may be present. Once they are isolated in pure form, however, modern instrumental techniques can reveal structural details for amounts weighing as little as one-millionth of a gram. The correlation of the physical and chemical properties of compounds with their structural features is the domain of physical organic chemistry. Once the properties endowed upon a substance by specific structural units termed functional groups are known, it becomes possible to design novel molecules that may exhibit desired properties. The preparation, under controlled laboratory conditions, of specific compounds is known as synthetic chemistry. Some products are easier to synthesize than to collect and purify from their natural sources. Tons of vitamin C , for example, are synthesized annually. Many synthetic substances have novel properties that make them especially useful. Plastics are a prime example, as are many drugs and agricultural chemicals. A continuing challenge for synthetic chemists is the structural complexity of most organic substances. To synthesize a desired substance, the atoms must be pieced together in the correct order and with the proper three-dimensional relationships. Just as a given pile of lumber and bricks can be assembled in many ways to build houses of several different designs, so too can a fixed number of atoms be connected together in various ways to give different molecules. Only one structural arrangement out of the many possibilities will be identical with a naturally occurring molecule. The antibiotic erythromycin, for example, contains 37 carbon, 67 hydrogen, and 13 oxygen atoms, along with one nitrogen atom. Even when joined together in the proper order, these atoms can give rise to , different structures, only one of which has the characteristics of natural erythromycin. The great abundance of organic compounds, their fundamental role in the chemistry of life, and their structural diversity have made their study especially challenging and exciting. Organic chemistry is the largest area of specialization among the various fields of chemistry. Biochemistry As understanding of inanimate chemistry grew during the 19th century, attempts to interpret the physiological processes of living organisms in terms of molecular structure and reactivity gave rise to the discipline of biochemistry. Biochemists employ the techniques and theories of chemistry to probe the molecular basis of life. An organism is investigated on the premise that its physiological processes are the consequence of many thousands of chemical reactions occurring in a highly integrated manner. Biochemists have established, among other things, the principles that underlie energy transfer in cells, the chemical structure of cell membranes, the coding and transmission of hereditary information, muscular and nerve function, and biosynthetic pathways. In fact, related biomolecules have been found to fulfill similar roles in organisms as different as bacteria and human beings. The study of biomolecules, however, presents many difficulties.

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Chapter 8 : SOAP AND THE EARLY CHEMICAL INDUSTRY

Chemistry, the science that deals with the properties, composition, and structure of substances (defined as elements and compounds), the transformations they undergo, and the energy that is released or absorbed during these processes.

Merck, for example, began as a small apothecary shop in Darmstadt, Germany, in , only beginning wholesale production of drugs in the s. Other firms whose names carry recognition today began with the production of organic chemicals especially dyestuffs before moving into pharmaceuticals. A merging of these two types of firms into an identifiable pharmaceutical industry took place in conjunction with the emergence of pharmaceutical chemistry and pharmacology as scientific fields at the end of the 19th century. Oriented to identifying and preparing synthetic drugs and studying their impacts on pathological conditions, both disciplines were intimately linked with the rise of the industry. Pharmaceutical firms, first in Germany in the s and more recently in the U. The resulting exchange of research methods and findings drove a focus on dyes, immune antibodies, and other physiologically active agents that would react with disease-causing organisms. Postulated by Paul Ehrlich in following more than a decade of research, the concept that synthetic chemicals could selectively kill or immobilize parasites, bacteria, and other invasive disease-causing microbes would eventually drive a massive industrial research program that continues to the present. Already in the early 19th-century, chemists were able to extract and concentrate traditional plant-based remedies, giving rise to treatments such as morphine and quinine. By the start of the 20th century, applying similar methods to animal systems resulted in the isolation of epinephrine adrenaline as the first hormone that could be used as a medicine. Meanwhile, synthetic organic chemistry evolved as an industrial discipline, especially in the area of creating dyestuffs derived from coal tar. It was only a short step from staining cells to make them more visible under microscopes to dyeing cells to kill them. Chemists soon modified the raw dyestuffs and their by-products to make them more effective as medicines. Early products of research continue to have application today; for example, N-acetyl-p-aminophenol, the active ingredient in Tylenol and Panadol, is a fast-acting metabolite of the analgesics acetanilide and phenacetin created in German laboratories in the s. In , a chemist at Bayer, Felix Hoffmann, first synthesized aspirin, another staple of our medicine cabinets. The end of the 19th century also saw the development of several important vaccines, including those for tetanus and diphtheria. A theory relating chemical structure to pharmaceutical activity emerged from the interplay of experimental results from animal and human tests using vaccines, antitoxins, and antibodies with chemical knowledge about dyes and their molecular structures. This structure-activity theory inspired Ehrlich to pursue a long and systematic course of research that resulted in the antisyphilitic Salvarsan, often considered the first systematically invented therapy. It was founded in as the Division of Pharmaceutical Chemistry one year after ACS instituted a divisional structure. Chemists in the U. Those activities were largely monopolized by German chemists working in conjunction with the major German chemical companies. World War I blockades forced U. In , the ACS division renamed itself the Division of Medicinal Products to reflect the wartime change in focus from analysis to synthesis. Edging ever closer to research functions, in the division took on its present name. Dyes were among the first substances investigated for pharmaceutical activity. A Merck delivery truck in front of company headquarters in New York City, circa While largely unregulated by government bodies prior to the 20th century, the pharmaceutical industry faced challenges in differentiating its products from patent drugmakers whose secret recipes, in fact, were not patented. The development of diphtheria antitoxin in the s and subsequent cases of inactive or contaminated doses led the health ministries in Germany and France to test and oversee biologicals; likewise, the U. Hygienic Laboratory was authorized to license manufacturers under the Biologics Control Act. Nevertheless, at the start of the s, most medicines were sold without a prescription and nearly half were compounded locally by pharmacists. In many cases, physicians dispensed medicines directly to patients; companies often supplied physicians with their favorite formulations. While the medical profession was well-established in Europe and America, the pharmaceutical industry was only beginning to develop medicines to treat pain, infectious diseases, heart conditions, and other ailments. Direct application of chemical research to medicine appeared promising, but only a few substances--newly isolated vitamins and insulin--were more effective than treatments available at the turn of the century.

Chapter 9 : Chemistry and the Chemical Industry in the 19th Century : Richard L. Hills :

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