

which aimed at producing upon readers the same effect which the voice of the master had produced upon hearers. For a time he was content thus to follow in the steps of Socrates, and of this period we have records in those dialogues which are commonly designated Socratic. But Plato had too decided a bent for metaphysics to linger long over propædæutic studies. Craving knowledge—not merely provisional and subjective knowledge of ethical concepts, such as that which had satisfied Socrates, but knowledge of the causes and laws of the universe, such as that which the physicists had sought—he asked himself what was necessary that the "right opinion" which Socrates had obtained by abstraction from particular instances might be converted into "knowledge" properly so called. In this way Plato was led to assume for every Socratic universal a corresponding unity, eternal, immutable, suprasensual, to be the cause of those particulars which are called by the common name. On this assumption the Socratic definition or statement of the "what" of the universal, being obtained by the inspection of particulars, in some sort represented the unity, form, or "idea" from which they derived their characteristics, and in so far as valuable; but, inasmuch as the inspection of the particulars was partial and imperfect, the Socratic definition was only a partial and imperfect representation of the eternal, immutable, suprasensual idea. How, then, was the imperfect representation of the idea to be converted into a perfect representation? To this question Plato's answer was vague and tentative. By constant revision of the provisional definitions which imperfectly represented the ideas he hoped to bring them into such shapes that they should culminate in the definition of the supreme principle, the Good, from which the ideas themselves derive their being. If in this way we could pass from unceremonious general notions, reflections of ideas, to the Good, so as to be able to say, not only that the Good causes the ideas to be what they are, but also that the Good causes the ideas to be what we conceive them, we might infer, he thought, that our definitions, hitherto provisional, are adequate representations of real existences. But the Platonism of this period had another ingredient. It has been seen that the Eleatic Zeno had rested his denial of plurality upon certain supposed difficulties of predication, and that they continued to perplex Antisthenes as well as perhaps Euclides and others of Plato's contemporaries. These difficulties must be disposed of if the new philosophy was to hold its ground; and accordingly, to the fundamental assertion of the existence of eternal immutable ideas, the objects of knowledge, Plato added two subordinate propositions, namely, (1) "the idea is immanent in the particular," and (2) "there is an idea wherever a plurality of particulars is called by the same name." Of these propositions the one was intended to explain the attribution of various and even inconsistent epithets to the same particular at the same time, whilst the other was necessary to make this explanation available in the case of common terms other than the Socratic universals. Such was the Platonism of the *Republic* and the *Phædo*, a provisional ontology, with a scheme of scientific research, which, as Plato honestly confessed, was no more than an unrealized aspiration. It was the non-Socratic element which made the weakness of this earlier theory of ideas. Plato soon saw that the hypothesis of the idea's immanence in particulars entailed the sacrifice of its unity, whilst as a theory of predication that hypothesis was insufficient, because applicable to particulars only, not to the ideas themselves. But with clearer views about relations and negations the paradox of Zeno ceased to perplex; and with the consequent withdrawal of the two supplementary articles the development of the fundamental assumption of ideas, eternal, immutable, suprasensual, might be attempted afresh. In the more definite theory which Plato now propounded the idea was no longer a Socratic universal, perfected and hypostatized, but rather the perfect type of a natural kind, to which type its imperfect members were related by imitation, whilst this relation was metaphysically explained by means of a "thoroughgoing idealism" (R. D. Archer-Hind). Thus, whereas in the earlier theory of ideas the ethical universals of Socrates had been held to have a first claim to hypostatization in the world of ideas, they are now peremptorily excluded, whilst the idealism which reconciles plurality and unity gives an entirely new significance to so much of the Socratic element as is still retained.

The growth of the metaphysical system necessarily influenced Plato's ethical doctrines; but here his final position is less remote from that of Socrates. Content in the purely Socratic period to elaborate and to record ethical definitions such as Socrates himself might have propounded, as soon as the theory of ideas offered itself to Plato's imagination he looked to it for the foundation of ethics as of all other sciences. Though in the earlier ages both of the individual and of the state a sound utilitarian morality of the Socratic sort was useful, nay valuable, the morality of the future should, he thought, rest upon the knowledge of the Good. Such is the teaching of the *Republic*. But with the revision of the metaphysical system came a complete change in the view which Plato took of ethics and its prospects. Whilst in the previous period it had ranked as the first of sciences, it was now no longer a science; because, though Good absolute still occupied the first place, Good

relative and all its various forms—justice, temperance, courage, wisdom—not being ideas, were incapable of being "known." Hence it is that the ethical teaching of the later dialogues bears an intelligible, though perhaps unexpected, resemblance to the simple practical teaching of the unphilosophical Socrates.

Yet throughout these revolutions of doctrine Plato was ever true to the Socratic theory of education. His manner indeed changed; for, whereas in the earlier dialogues the characteristics of the master—

"The soft and intricate discourse,
The wit that makes us tolerant perforce,
The mystic legend, and the verse that drops
As snowflakes shower on wintry forest tops,
The questions working wedge-like to the proof,
The threads of prayer from old religion's woof,
The courteous skill of keen rebukes that chide
The learner's folly and the sophist's pride!"

are studiously and skillfully preserved, in the later dialogues Socrates first becomes metaphysical, then ceases to be protagonist, and at last disappears from the scene. But in the later dialogues, as in the earlier, Plato's aim is the aim which Socrates in his conversation never lost sight of, namely, the dialectical improvement of the learner.

Bibliography. Of the histories of Greek philosophy enumerated in the article *PLATONISM* the most important for the study of Socrates's life and work is Zeller's *Philosophie d. Griechen*. The part in question has been translated into English under the title of *Socrates and the Socratic Schools*, London, 1877. Schwieger's *Geschichte d. griechischen Philosophie* will also be found instructive. It is plainly impossible to supply here such a list of special treatises as is given by Ueberweg in his *Grundriss d. Geschichte d. Philosophie*, and still more so to provide a complete bibliography. But the following sources of information may be mentioned:—F. Schleiermacher, "Ueber d. Werth d. Sokrates als Philosophen," in *Abh. d. Berliner Akad. d. Wissensch.*, 1818, and *Werke*, iii., 2, 287-308, translated into English by C. Thirlwall, in the *Philosophical Museum*, Cambridge, 1838, ii. 538-555; L. F. Léaut, *Du Démon de Socrate*, Paris, 1836, 1856, reviewed by E. Littré in *Médecine et Médecins*, Paris, 1872; G. Grote, *History of Greece*, ch. lxxviii., and *Plato and the other Companions of Sokrates*, London, 1865; C. F. Hermann, *De Socratis accusatoribus*, Göttingen, 1854; W. H. Thompson, *The Phædrus of Plato*, London, 1868, Appendix I.; T. Wildauer, *D. Psychologie d. Willens bei Sokrates*, etc., Innsbruck, 1877. For the view taken in the present article with regard to the *daímōnyon*, see the writer's paper "On the *daímōnyon* of Socrates," in the *Journal of Philology*, v.; and comp. Chr. Meiners, *Vermischte philosophische Schriften*, Leipzig, 1776—"in moments of 'Schwärmerei' Socrates took for the voice of an attendant genius what was in reality an instantaneous presentiment in regard to the issue of a contemplated act." For a fuller statement of the writer's view of Plato's relations to Socrates, see a paper on *Plato's Republic*, vi. 509 D sq., in the *Journal of Philology*, x., and a series of papers on "Plato's later Theory of Ideas," in vols. x., xi., xiii., xiv. of the same periodical. Comp. SOCRATES and (by all means) EURIPIDES. (H. J. A.)

SOCRATES, church historian. In the course of the last twenty-five years (425-450) of the reign of Theodosius II. (the first thoroughly Byzantine emperor) at least six church histories were written in Greek within the limits of the Eastern empire,—those, namely, of Philostorgius the Arian, of Philippus Sidetes, of Socrates, of Sozomen, of Theodoret, and of Hesychius. Of these the first, no longer extant except in fragments, seems to have been the most important. Those of Philip and of Hesychius (the former an untrustworthy and dreary performance) have also perished. The remaining three are now our main sources for church history from Constantine to Theodosius II. None of them has ventured upon a fresh treatment of the period dealt with by Eusebius; all three begin their narratives about the point where his closes. In the West the *Church History* of that author had already been continued by Rufinus and his *Chronicle* by Jerome, and the work of Rufinus was certainly known to the Byzantines; Nor did these write independently of each other, for SOZOMEN (*q.v.*) certainly had before him the work of Socrates, and THEODORET (*q.v.*) knew one or both of them. The three histories together became known in the West from the 6th century through the selection which Cassiodorus caused to be made from them, and it is to this selection (if we leave Rufinus and Jerome out of account) that the Middle Ages were mainly indebted for all they knew of the Arian controversies, and of the period generally between the councils of Nice and Ephesus.

The *Ἐκκλησιαστικὴ Ἱστορία* of Socrates, still complete, in several books, embracing the period from 306 to 439, was written about, or at all events not later than, 440. He was born and brought up at Constantinople; the date of his birth is uncertain, but it can hardly have been before 385. Of the facts of his life we know practically nothing, except that he was not a cleric but a "scholasticus" or advocate. Of the occasion, plan, and object of

his work he has himself informed us in the prologues to his first, second, fifth, and sixth books. It is dedicated to one Theodorus, who had urged him to write such a history. He had no thorough preparation for the task, and for the period down to the death of Constantius (361) was practically dependent on Rufinus. His work finished, he became a student of Athanasius and came to see how untrustworthy his guide had been. He accordingly rewrote his first two books, and it is only this revision that has reached us. The chief sources from which he drew were—(1) the *Church History*, the *Life of Constantine*, and the theological works of Eusebius; (2) the *Church History* of Rufinus; (3) the works of Athanasius; (4) the no longer extant *Συναγωγὴ τῶν Συνοδικῶν* of the Macedonian and semi-Arian Sabinius,—a collection with commentaries of acts of councils, brought down to the reign of Theodosius I. (this was a main source); (5) collections of letters by members of the Arian and orthodox parties; (6) the *Ancoratus* of Epiphanius; (7) works of Archelaus, Gregory of Laodicea, Evagrius, Palladius, orations of Nestorius, &c. Theological literature proper—as, for example, the writings of the Cappadocians—he quite neglected. On the other hand, he appears to have known some of Origen's work, and the *Apologia pro Origene* of Pamphilus. It is to Origen and Origen's immediate disciples that he refers when he speaks of "the old church writers," or of "the Christian philosophers"; the last designation, however, also includes the monks. Jeep alleges, but does not adduce any adequate proof, that Socrates made use of Philostorgius. As regards profane history his materials were exceedingly defective. Thus, for example, he confesses his reason for not relating the political history of Constantine to be that he has been unable to ascertain anything about it. Jeep has instituted an examination into the *fasti*, containing historical notes, made use of by our author with the following results. His chronological data with the facts he appends to them are of the highest value, especially in those cases where, as sometimes happens, data are preserved which are less precisely given in other *fasti* and chronicles. Somewhere about the year 395-400 his use of these precisely dated records of profane history comes to an end. From this point his information is purely ecclesiastical (dates of ordination and death of bishops and the like); that is to say, he makes use of church *fasti*. The secular *fasti* of Socrates come down precisely to the same point as those which lay in the first rank before Idatius.¹ His reckonings by Olympiads are generally wrong, the error arising not from any systematic source but merely from carelessness. It is not altogether impossible, however, after all that Socrates may have taken the historical data of his *fasti* at second hand from the profane historians. He certainly made use of Eutropius; but that he had any recourse to Eumapius and Olympiodorus is more doubtful, and indeed would be quite improbable if it could be proved that he had Philostorgius before him. There is no evidence of his having known the works of Dexippus and Zosimus. But he is greatly indebted to oral tradition and to the testimony of eye-witnesses, especially of members of the Novatian community in Constantinople; something also he has set down from personal knowledge. The contents of the closing books are for the most part derived from oral tradition, from the narratives of friends and countrymen, from what was still generally known and current in the capital about past events, and from the ephemeral literature of the day.

The theological position of Socrates, so far as he can be said to have had one, is at once disclosed in his unlimited admiration for Origen. All the enemies of the great Alexandrian he regards merely as empty and vain obscurantists; for the orthodoxy of his

¹ See Holder-Egger, *Neues Archiv f. Deutsche Gesch.*, ii. 61.

hero he appeals to Athanasius. Closely connected with his high regard for Origen are his appreciation of science generally and the moderation of his judgment on all dogmatic questions. According to him, *ἐλαφρὰ παιδεία* is quite indispensable within the church; many Greek philosophers were not far from the knowledge of God, as is proved by their triumphant arguments against atheists and gainsayers of divine providence. The apostles did not set themselves against the study of Greek literature and science; Paul had even made a thorough study of them himself. The Scriptures, it is true, contain all that appertains to faith and life, but give no clue to the art of confuting gainsayers. Greek science, therefore, must not be banished from the church, and the tendency within the church so to deal with it is wrong. This point of view was the common one of the majority of educated Christians at that period, and is not to be regarded as exceptionally liberal. The same holds true of the position of Socrates in regard to dogmatic questions. On the one hand, indeed, orthodoxy and heresy are symbolized to his mind by the wheat and the tares respectively; he clings to the naive opinion of Catholicism, that contemporary orthodoxy has prevailed within the church from the first; he recognizes the true faith only in the mystery of the Trinity; he judges heretics who have been already condemned as interlopers, as impudent innovators, actuated by bad and self-seeking motives; he apologizes for having so much as treated of Arianism at all in his history of the church; he believes in the inspiration of the ecclesiastical councils as much as in that of the Scriptures themselves. But, on the other hand, he takes absolutely no interest in dogmatical subtleties and clerical disputes; he regards them as the source of great evils, and expresses his craving for peace: "one ought to adore the ineffable mystery in silence." This attitude, which was that of most educated Byzantine laymen, has in particular cases made it possible for him to arrive at very free judgments. Even granting that some feeble remains of antique reserve may have contributed to this, and even although some of it is certainly to be set down to his disposition and temperament, still it was his religious passivity that here determined the character of Socrates and made him a typical example of the later Byzantine Christianity. If Socrates had lived about the year 325, he certainly would not have ranked himself on the side of Athanasius, but would have joined the party of mediation. But—the *ὁμοειδὸς* has been laid down, and must be recognized as correctly expressing the mystery; only one ought to rest satisfied with that word and with the repudiation of Arianism. Anything more, every new distinction, is mischievous. The controversy in its details is a *πυκτομαχία* to him, full of misunderstandings. Sometimes he gives prominence, and correctly, to the fact that the disputants partially failed to understand one another, because they had separate interests at heart,—those on the one side desiring above everything to guard against polytheism, those on the other being most afraid of Sabellianism. He did not fail, however, to recognize also that the controversies frequently had their root in mere emulation, slander, and sophistry. Not unfrequently he passes very sharp judgments on whole groups of bishops. In the preface to his fifth book he excuses his trenching on the region of political history on the ground of his desire to spare his readers the disgust which perusal of the endless disputes of the bishops could not fail to excite, and in that to his sixth book he prides himself on never having flattered even the orthodox bishops. This attitude of his has given him a certain measure of impartiality. Constantius, and even Julian—not Valens, it is true—are estimated very fairly. The Arian Goths who died for their religion are recognized as genuine martyrs. His characterizations of Cyril and Nestorius, and his narrative and criticism of the beginnings of the Christological controversy, are models of candour and historical conscientiousness. In frequent instances, moreover, he acknowledges his own incompetency to give an opinion and hands the question over to the clergy. For the clergy as a whole, in spite of his criticism of individuals, he has the very highest respect, as also for the monks, without himself making any inordinate religious professions. In a special excursus of considerable length he has paid a tribute of the highest order to monachism, and in his characterization of Theodosius II. also (where he has made use of the brightest colours) he does not fail to point out that in piety the emperor could almost compete with the monks. But, apart from these two chapters (iv. 28, vii. 22), it is but seldom that one could learn from the pages of Socrates that there was such a thing as monasticism in those days. To his mind the convent is not far removed from the church, and as a layman he is not at all inclined to accept the principles of monachism as applying to himself or to square his views of history in accordance with them. He has even gone so far as formally to express his sympathy with Paphnutius, the champion of the right of bishops to marry.

As a source for the period within which he wrote, the work of Socrates is of the greatest value, but as "history" it disappoints even the most modest expectations. Eusebius, after all, had some conception of what is meant by "church history," but Socrates has none. "As long as there is peace there is no material for a history of the church"; but, on the other hand, neither do heresies by rights

come into the story. What, then, is left for it? A collection of anecdotes and a series of episodes. In point of fact this is the view actually taken by Socrates. His utter want of care and consistency appears most clearly in his vacillation as to the relations between ecclesiastical and political history. At one time he brings in politics, at another he excuses himself from doing so. He has not failed to observe that church and state act and react upon each other; but he has no notion how the relation ought to be conceived. Nevertheless his whole narrative follows the thread of political—that is to say, of imperial—history. This indeed is characteristic of his Byzantine Christian point of view; church history becomes metamorphosed into a history of the emperors and of the state, because a special church history is at bottom impossible. But even so one hardly hears anything about state or court except great enterprises and anecdotes. Political insight is wholly wanting to Socrates; all the orthodox emperors blaze forth in a uniform light of dazzling splendour; even the miserable Arcadius is praised, and Theodosius II. figures as a saint whose exemplary piety turned the capital into a church. If in addition to all this we bear in mind that in his later books the historian's horizon is confined to the city and patriarchate of Constantinople, that he was exceedingly ill informed on all that related to Rome and the West, that in order to fill out his pages he has introduced narratives of the most unimportant description, that in not a few instances he has evinced his credulity (although when compared with the majority of his contemporaries he is still entitled to be called critical), it becomes sufficiently clear that his *History*, viewed as a whole and as a literary production, can at best take only a secondary place. One great excellence, however, cannot be denied him, his honest and sincere desire to be impartial. He tried also, as far as he could, to distinguish between the certain, the probable, the doubtful, and the untrue. He made no pretence to be a searcher of hearts and frequently declines to analyse motives. He has made frank confession of his nescience, and in certain passages his critical judgment and sober sense and circumspection are quite striking. He writes a plain and unadorned style and shuns superfluous words. Occasionally even there are touches of good humour and of trenchant satire,—always the sign of an honest writer. In short, the rule to be applied in the criticism of Socrates is that his learning and knowledge can be trusted only a little but his goodwill and straightforwardness a great deal. Considering the circumstances under which he wrote and the miseries of the time, it can only be matter for congratulation that such a man should have become our informant and that his work has been preserved to us.

Finally, it is to be noted that Socrates was either himself originally a Novatianist who had afterwards joined the Catholic Church, or that whether through his ancestors or by education he had stood in most intimate relations with the Novatianist Church. In his *History* he betrays great sympathy with that body, has gone with exactness into its history in Constantinople and Phrygia, and is indebted for much of the material of his work to Novatianist tradition and to his intercourse with prominent members of the sect. Both directly and indirectly he has declared that Novatianists and Catholics are brothers, that as such they ought to seek the closest relations with one another, and that the former ought to enjoy all the privileges of the latter. His efforts, however, had only this result, that he himself afterwards fell under suspicion of Novatianism. For bibliography, see SOZOMEN. (A. HA.)

SODIUM AND SODA. Sodium is one of the two principal alkali metals, regarding the general properties of which the reader is referred to CHEMISTRY (vol. v. p. 524) and the introductory portion of POTASSIUM (vol. xix. p. 588). In combination sodium is a generally diffused and most abundant element. The salt dissolved in sea water consists chiefly of chloride of sodium (NaCl), and according to Dittmar's calculation (see SEA WATER) the oceans of the world contain of sodium calculated as chloride not less than $36,000 \times 10^{12}$ (i.e., 36,000 million million) tons, whilst of potassium calculated as sulphate the amount in sea water is 1141×10^{12} (1141 million million) tons. From sea water have been deposited the enormous beds of rock salt found in many parts of the world (see SALT). Sodium carbonates are also widely dispersed in nature, forming constituents of many mineral waters, and occurring as principal saline components in natron or trona lakes, as efflorescences in Lower Egypt, Persia, and China, and as urao in Mexico, Colombia, and Venezuela. The solid crusts found at the bottom of the salt lakes of the Araxes plain in Armenia contain about 16 per cent. of carbonate and 80 of sulphate of soda. In New Granada there occurs a double salt, $\text{Na}_2\text{CO}_3 + \text{CaCO}_3 + 5\text{H}_2\text{O}$, known as gay-lussite. In Wyoming, California, and Nevada enormous deposits of

carbonates, mixed in some cases with sulphate and with chloride, occur. About Szegedin in Hungary and all over the vast puszta (steppes) between the Theiss and the Danube, and from the Theiss up to and beyond Debreczin, the soil contains sodium carbonate, which frequently assumes the form of crude alkaline crusts, called "szekso," and of small saline ponds. A purified specimen of such Debreczin soda was found to contain as much as 90 per cent. of real carbonate (NaCO_3) and 4 of common salt. Natural sulphate occurs in an anhydrous condition as thenardite (Na_2SO_4) at Tarapaca, Peru, and in the rock-salt deposits at Espartinas near Aranjuez, Spain. Hydrated sulphates occur at several localities in the province of Madrid and in other provinces of Spain, and at Mühligen in Aargau, and copious deposits of glauberite, the double sulphate of sodium and calcium, are met with in the salt-mines of Villarrubia in Spain, at Stassfurt, and in the province of Tarapaca, Peru, &c. A native nitrate of soda is obtained in great abundance in the district of Atacama and the province of Tarapaca, and is imported into Europe in enormous quantities as cubical nitre for the preparation of saltpetre (see NITROGEN, vol. xvii. p. 518). Cryolite, a fluoride of aluminium and sodium, $\text{AlF}_3 + 3\text{NaF}$, is extensively mined in Greenland for industrial purposes. These form the principal natural sources of sodium compounds,—the chloride as rock salt and in sea water being of such predominating importance as quite to outweigh all the others. But it is questionable whether taken altogether the mass of sodium they represent is as much as that disseminated throughout the rocky crust in the form of soda felspar (i.e., as silicate of soda) and in other soda-containing rocks. From this source all soils contain small proportions of sodium in soluble forms, hence the ashes of plants, although they preferably imbibe potassium salts, contain traces and sometimes notable quantities of sodium salts. Sodium salts also form essential ingredients in all animal juices.

Considered industrially, by far the most important bodies are the carbonates, the sulphates, and caustic soda (sodium hydrate), the manufacture of which forms the basis of the soda industry. Immense quantities of these bodies are used in the manufacture of soap and glass, and under the name of "washing soda" or "soda crystals" the consumption of the hydrated carbonate for domestic washing is also very great. There are indeed few chemical industries in which soda in one form or another does not play an important part, and the combinations of economic value into which it enters are numberless. It will be convenient to treat of the manufacture as a whole by itself, after speaking of sodium and its salts in their chemical relations.

Sodium, in German *Natrium* (symbol, Na; atomic weight, 23.053; O = 16), is a univalent metal. It occurs nowhere in nature in an uncombined condition, and was first isolated in 1807 by Sir Humphrey Davy through the medium of voltaic electricity. It is prepared by distillation of an intimate mixture of carbonate of soda with charcoal. The process is quite analogous to that followed in making metallic potassium (POTASSIUM, vol. xix. p. 590), but much easier of execution, and free from certain dangers which attend the preparation of the other. The distillation is conducted in cylindrical iron retorts protected against the fire by means of fireclay tubes fitting closely round them. In the charge is included a certain proportion of chalk, which, giving off carbonic acid, aids in driving over the metallic vapour and protects the distillate against oxidation. The metal cast into the form of cakes or ingots is protected from the air by a coating of paraffin and secured in closely fitting soldered-up tinned-iron boxes. Metallic sodium is very similar in properties and appearance to potassium. The principal points of difference are its pure white colour

its specific gravity (0.9735 at 13° 5 C.), and its fusing point (95° 6 C.). In thin layers its vapour is colourless, but dense fumes have a purple tint. It decomposes water violently, but the hydrogen evolved does not take fire, although the reaction is more dangerous than the corresponding phenomena developed by potassium, because it leads frequently to most violent explosions. Yet the process serves in practice for the preparation of pure soda hydrate. In this operation a piece of sodium is placed in a silver basin standing in a shallow cold-water bath. Drop by drop water is added—the metal between the additions being allowed to expend its energy—till the desired quantity of hydrate is formed. The process, in short, is so conducted that, except at first, the metal never touches water in any other form than that of a strong soda lye. Sodium is largely made for use as an agent in the manufacture of aluminium and magnesium, and as a reagent in laboratory operations. The metal does not affect carbonic oxide at any temperature; it acts on hydrogen as potassium does; but the compound is less stable. On ammonia gas it acts, as in the parallel case of potassium, with the formation of NH_2Na , only the reaction is less energetic. Sodium has less powerful affinity to oxygen than potassium; in dry air or oxygen it burns into the dioxide Na_2O_2 —a product obtainable also by heating the nitrate or nitrite. A white solid soluble in cold water, forming a hydrate, $\text{Na}_2\text{O}_2 + 8\text{H}_2\text{O}$, is obtainable in crystals, the solution of which is strongly alkaline. With acids it yields sodium salts and peroxide of hydrogen. Sodium tetroxide (Na_2O_4) is not known to exist.

Caustic Soda (NaHO) is prepared from carbonate by means of caustic lime, just as caustic potash is made from its carbonate (see POTASSIUM). The analogy between the two caustic alkalis is so perfect that we need only summarize the points of difference between them. Compared with caustic potash, caustic soda is less easily soluble in water, less caustic, less energetically basilous, less prone when fused in air to pass into peroxide, hence less destructive to platinum, iron, nickel, and silver vessels.

Sodium Chloride (NaCl) occurs in nature in a nearly pure state. Absolutely pure salt is made from commercial salt by precipitating from a solution the lime and magnesia by pure carbonate of soda, filtering, neutralizing with pure hydrochloric acid, concentrating by evaporation, and then precipitating the pure salt by a stream of hydrochloric acid gas. The crystalline precipitate is collected over glass wool, washed with pure fuming hydrochloric acid, and dried by heating in a platinum basin. It forms non-hygroscopic crystals, free from combined water, having a specific gravity at 16° C. of 2.162 (Stolba), and according to Carnelley fusing at 776° C. The solubility of pure salt in water is almost independent of temperature; 100 parts of water dissolve—

at 0°	14°	60°	100°	109° 7 (boiling)
35.52	35.87	37.25	39.61	40.53

parts of NaCl.

Regarding its commercial relations, &c., see SALT.

Chlorate of Soda (NaClO_3) is a salt of some industrial importance, from its use in the manufacture of aniline black. It may be made from the potash salt (a) by decomposing this with hydrofluosilicic acid (which precipitates the potassium as fluosilicate and yields a solution of chloric acid), and neutralizing the chloric acid solution with soda, or (b) by double decomposition with bitartrate of soda $\text{NaHC}_4\text{H}_4\text{O}_6$ —the cream of tartar ($\text{KHC}_4\text{H}_4\text{O}_6$) separating out almost completely, whilst the chlorate of soda remains in solution. According to Weldon, it is best manufactured from caustic soda by the direct action of chlorine, the two salts NaCl and NaClO_3 being separated by crystallization. Chlorate of soda forms cubes which often exhibit tetrahedral faces; 100 parts of water dis-

solve at 0° 81.9, at 20° 99, and at 100° C. 233 parts of the salt. Hence it is much more soluble than the potash salt, on which account it is preferred for aniline black printing.

Sulphate (Na_2SO_4) is the most largely produced of all soda salts in manufacturing operations, although it is regarded principally as an intermediate product. The anhydrous salt readily combines with water into a crystalline soluble compound, $\text{Na}_2\text{SO}_4 + 10\text{H}_2\text{O}$, known as Glauber's salt. This forms large transparent monoclinic crystals, and is characteristically prone to form supersaturated solutions. 100 parts of water dissolve—

at 0°	11° 67	25° 05	32° 73	33° 88
12.17	26.38	99.48	322.1	312.1

parts of $\text{Na}_2\text{SO}_4 + 10\text{H}_2\text{O}$,
5.02 10.12 28.11 50.65 50.4 parts of Na_2SO_4 .

As the temperature rises beyond about 33°, the solubility decreases (Gay-Lussac). Glauber's salt, when exposed to dry air, especially in summer heat, gradually falls into a powder of anhydrous sulphate. It is much less volatile than the chloride. The thiosulphate, $\text{Na}_2\text{S}_2\text{O}_3$ (commercial hyposulphite of soda), and soda salts of other lower sulphur acids, are reserved for SULPHUR.

Of all sodium compounds, except common salt, the carbonates are by far the most important, both industrially and chemically. These comprise the following.

Normal Carbonate, Na_2CO_3 .—The anhydrous salt usually presents itself in the form of a white opaque porous solid, specific gravity 2.65 (Karsten). According to Carnelley, it fuses at 818° C. (dull red heat) into a colourless liquid. On fusing it loses some of its carbonic acid, and at a bright red heat it volatilizes appreciably. The porous salt absorbs water from the air; when moistened with water it gives off heat and unites into crystalline hydrates, of which the important compound is

Decahydrate, $\text{Na}_2\text{CO}_3 + 10\text{H}_2\text{O}$.—This salt, known as soda crystals or washing soda, forms large transparent monoclinic rhomboidal prisms or double pyramids. The salt dissolves readily in water, forming strongly alkaline solutions, which emulsionize fats, though less readily than is done by caustic lyes. 100 parts of water dissolve—

at 0°	15°	20°	30°	38°	104°
21.33	63.20	92.82	273.6	1142.2	539.6

of crystals,
6.97 16.20 21.71 37.24 51.67 46.47 of Na_2CO_3 .

(Löwel). According to this observer, the dissolved salt from 38° C. upwards assumes the form of lower hydrates, hence the diminution in solubility at higher temperatures. A saturated solution, when evaporated down by heat, deposits a granular salt of the composition $\text{Na}_2\text{CO}_3(\text{H}_2\text{O}$ or $2\text{H}_2\text{O})$. The decahydrate, when exposed to dry air even at ordinary temperatures, loses water, with the formation of monohydrate, $\text{Na}_2\text{CO}_3\text{H}_2\text{O}$. It also readily takes up carbonic acid with the formation of

Bicarbonate, NaHCO_3 .—Its formation may be thus formulated— $\text{Na}_2\text{CO}_3 + 10\text{H}_2\text{O} + \text{CO}_2 = 2\text{NaHCO}_3 + 9\text{H}_2\text{O}$. The bicarbonate remains as a crystalline mass, while the liberated water runs off with more or less of dissolved carbonate and the saline impurities which may be present. Bicarbonate forms small four-sided monoclinic plates with a feebly alkaline taste and reaction. 100 parts of water dissolve—

at 0°	20°	40°	60°
6.90	9.60	12.70	16.40

of NaHCO_3 .

(Dibbits). From about 70° C. upwards the solution gives off carbonic acid with formation of *Sesquicarbonate*,— $2\text{Na}_2\text{O} + 3\text{CO}_2 + 4\text{H}_2\text{O} = \text{Na}_2\text{CO}_3.2\text{NaHCO}_3 + 3\text{H}_2\text{O}$. This salt, found in nature as trona or urao, forms in its pure state crystals which do not lose water in the air. At 20° C. 100 parts of water dissolve 18.3 parts of the salt calculated as anhydride, $2\text{Na}_2\text{O}.3\text{CO}_2$. Both bicarbonate and sesquicarbonate when heated dry break up readily (below redness) into normal carbonate, water, and carbonic acid.