by observing the times of descent of bodies falling down long inclined planes, that the postulated law was the true law. Even here, he was obliged to take for granted that the velocities acquired in descending from the same height along planes of every inclination are equal; and it was not until shortly before his death that he found the mathematical demonstration of this not very obvious principle.

The first law of motion—that which expresses the principle of inertia—is virtually contained in the idea of uniformly accelerated velocity. The recognition of the second—that of the independence of different motions—must be added to form the true theory of projectiles. This was done by Galileo. Up to his time it was universally held in the schools that the motion of a body must cease with the impulse communicated to it, but for the "reaction of the medium" which helps it forward. Galileo showed, on the contrary, that the nature of motion once impressed is to continue indefinitely in a uniform direction, and that the effect of the medium is a retarding, not an impelling one. Another commonly received axiom was that no body could be affected by more than one movement at one time, and it was thus supposed that a cannon ball, or other projectile, moves forward in a right line until its first impulse is exhausted, when it falls vertically to the ground. In the fourth of Galileo's dialogues on mechanics, he demonstrated that the path described by a projectile, being the result of the combination of a uniform transverse motion with a uniformly accelerated vertical motion, must, apart from the resistance of the air, be a parabola. The establishment of the principle of the composition of motions formed a conclusive answer to the most formidable of the arguments used against the rotation of the earth, and we find it accordingly triumphantly brought forward by Galileo in the second of his dialogues on the systems of the world. It was urged by anti-Copernicans that a body flung upwards or cast downwards would, if the earth were in motion, be left behind by the rapid translation of the point from which it started; Galileo, however, proved that the reception of a fresh impulse in no way interfered with the movement already impressed, and that the rotation of the earth was insensible, because shared equally by all bodies at its surface. His theory of the inclined plane, combined with his satisfactory definition of "momentum," led him towards the third law of motion. We find Newton's theorem, that "action and reaction are equal and opposite," stated with approximate precision in his treatise *Della Scienza Meccanica*, which contains the substance of lectures delivered during his professorship at Padua; and the same principle is involved in the axiom enunciated in the third of his mechanical dialogues, that "the propensity to fall of a body is equal to the least resistance which suffices to support it." The problems of percussion, however, did not receive a definitive solution until after his death.

His services were no less conspicuous in the statical than in the kinetical division of mechanics. He gave the first direct and entirely satisfactory demonstration of equilibrium on an inclined plane, reducing it to the lever by a sound and ingenious train of reasoning; while, by establishing the theory of "virtual velocities," he laid down the fundamental principle which, in the opinion of Lagrange, contains the general expression of the laws of equilibrium. He studied with attention the still obscure subject of molecular cohesion, and little has been added to what he ascertained on the question of transverse strains and the strength of beams, brought by him for the first time within the scope of mechanical theory. In his *Discorso intorno alle cose che stanno su l'acqua*, published in 1612, he used the principle of virtual velocities to demonstrate the more important theorems of hydrostatics, deducing from it the equilibrium of fluid in a siphon, and proved against the Aristotelians that the floating of solid bodies in a liquid depends not upon their form, but upon their specific gravities, relative to such liquid.

In order to form an adequate estimate of the stride made by Galileo in natural philosophy, it would be necessary to enumerate the confused and erroneous opinions prevailing on all such subjects in his time. His best eulogium, it has been truly said, consists in the fallacies which he exposed. The scholastic distinctions between corruptible and incorruptible substances, between absolute gravity and absolute levity, between natural and violent motions, if they did not wholly disappear from scientific phraseology, ceased thenceforward to hold the place of honour in the controversies of the learned. Discarding these obscure and misleading notions, Galileo taught that gravity and levity are relative terms, and that all bodies are heavy, even those which, like the air, are invisible; that motion is the result of force, instantaneous or continuous; that weight is a continuous force, attracting towards the centre of the earth; that, in a vacuum, all bodies would fall with equal velocities; that the "inertia of matter" implies the continuance of motion, as well as the permanence of rest; and that the substance of the heavenly bodies is equally "corruptible" with that of the earth. These simple elementary ideas were eminently capable of development and investigation, and were not only true, but the prelude to further truth; while those they superseded defied inquiry by their vagueness, and baffled it with their obscurity. Galileo was a man born in due time. He was superior to his contemporaries, but not isolated amongst them. He represented and intensified a growing tendency of the age in which he lived. It was beginning to be suspected that from Aristotle an appeal lay to nature, and some were found who no longer treated the *ipse dixit* of the Stagirite as the final authority in matters of science. A vigorous but ineffectual warfare had already been waged against the blind traditions of the schools by Ramus and Telesius, by Patricius and Campanella, and the revolution which Galileo completed had been prepared by his predecessors. Nevertheless, the task which he so effectually accomplished demanded the highest and rarest quality of genius. He struck out for himself the happy middle path between the *a priori* and the empirical systems, and exemplified with brilliant success the method by which experimental science has wrested from nature so many of her secrets. His mind was an eminently practical one. He concerned himself above all with what fell within the range of exact inquiry, and left to others the larger but less fruitful speculations which can never be brought to the direct test of experiment. Thus, while far-reaching but hasty generalizations have had their day and been forgotten, his work has proved permanent, because he made sure of its foundations. His keen intuition of truth, his vigour and yet sobriety of argument, his fertility of illustration and acuteness of sarcasm, made him irresistible to his antagonists; and the evanescent triumphs of successful controversy have been succeeded by the lasting applause of posterity.

The first complete edition of Galileo's writings was published at Florence (1842–1856), in 15 8vo vols., by the Società Editrice Fiorentina, under the able supervision of Signor Eugenio Albèri. Besides the works already enumerated, it contains the hitherto inedited *Sermones de Motu Gravium*, composed at Pisa between 1589 and 1591; his letters to his friends, with many of their replies, as well as several of the essays of his scientific opponents; his private comments on the *Orlando Furioso*, of which he was an enthusiastic admirer, and on the *Gerusalemme Liberata*, of which he was an equally persistent depreciator; some stanzas and sonnets of no great merit, together with the sketch of a comedy; finally, a reprint of Viviani's *Life*, with valuable notes and corrections. The original documents from the archives of the Inquisition, relating to the events of 1616 and 1633, recovered from Paris in 1846 by the efforts of Count Rossi, and now in the Vatican Library, were to a limited extent made public by Monsignor Marino-Marini in 1850, and more unreservedly by M. Henri de l'Épinois, in an essay entitled "Galilée, son Procès, sa Condemnation," published in 1867 in the *Revue des Questions Historiques*. He was followed by M. Karl von Gebler, who, in an able and exhaustive but somewhat prejudiced work, *Galileo Galilei und die Römische Curie* (Stuttgart, 1876), sought to impeach the authenticity of a document of prime importance in the trial of 1633. He has, however, been victoriously answered by Signor Domenico Berti, in *Il Processo originale di Galileo Galilei* (Rome, 1876), and by M. de l'Épinois, with *Les Pièces du Procès de Galilée* (Rome, Paris, 1877). The touching letters of Galileo's eldest daughter, Sister Maria Celeste, to her father were printed in 1864 by Professor Carlo Arduini, in a publication entitled *La Primogenita di Galileo Galilei*. See also M. Th. Henri Martin's excellent biography, *Galilée, les Droits de la Science et la Méthode des Sciences Physiques*, Paris, 1868; and the anonymous *Private Life of Galileo*, London, 1870. (A. M. C.)

GALITCH, or HALICZ, a town of Russia, at the head of a district in the government of Kostroma, 80 miles N.E. of Kostroma, in 57° 15′ N. lat. and 42° 56′ E. long., on the low south-eastern shore of Galitch Lake. Among its public buildings are a hospital, a poorhouse opened in 1855, about 15 churches, and a convent of the third class. The chief occupation of the inhabitants is the manufacture of leather and gloves; and the fisheries of the lake yield about 30,000 rubles per annum, and give employment to about 400 fishermen, whose rights are secured by ancient charters. At the annual fair a considerable trade is done in woollen and cotton goods, earthenware, and miscellaneous articles. In 1860 the population was 6536; but in the *St Petersburg Calendar* for 1878 it is given at 5620.

GALL, FRANZ JOSEPH (1758–1828), anatomist, physiologist, and founder of phrenology, was born at Tiefenbrunn near Pforzheim, Baden, on the 9th of March 1758. After completing the usual literary course at Baden and Bruchsal, he began the study of medicine under Hermann at Strasburg, whence, attracted by the names of Van Swieten and Stoll, he removed to Vienna in 1781. Having received his diploma, he began to practise as a physician there in 1785; but his energies were mainly devoted to the scientific investigation of problems which, even from boyhood, had been occupying his attention. At a comparatively early period he had formed a generalization which he believed to be a sound one, that in the human subject at least a powerful memory is invariably associated with prominent eyes; and further observation had enabled him, as he thought, also to define the external characteristics indicative of special talents for painting, music, and the mechanical arts. Following out these researches, he gradually reached the strong personal conviction, not only that the talents and dispositions of men are dependent upon the functions of the brain, but also that they may be inferred with perfect exactitude and precision from the external appearances of the skull. Gall's first appearance as an author was made in 1791, when he published the first two chapters of a (never completed) work entitled *Philosophisch-medicinische Untersuchungen über Natur u. Kunst im kranken u. gesunden Zustande des Menschen*. The first public notice of his inquiries in cranioscopy, however, was in the form of a familiar letter addressed to a friend, which appeared in Wieland's *Deutscher Mercur* in 1798; but two years before this Gall had commenced giving private courses of phrenological lectures in Vienna, where his doctrines soon attracted general attention, and met with increasing success until, in 1802, they were interdicted by the Government on the ground that they were dangerous to religion. This step on the part of the authorities had the effect of greatly stimulating public curiosity and increasing Gall's celebrity. In March 1805 he finally left Vienna, in company with his friend and associate Spurzheim, and made a tour through Germany, in the course of which he lectured in Berlin, Dresden, Magdeburg, and several of the university towns. These expositions, which he knew how to make popular and attractive, were much resorted to by the public, and excited considerable controversy in the scientific world. He had almost reached the zenith of his fame when, in 1807, he repaired to Paris and established himself there as a medical practitioner, at the same time continuing his activity as a lecturer and writer. In 1808 appeared his *Introduction au cours de physiologie du cerveau*, which was followed in 1809 by the *Recherches sur le système nerveux en général, et sur celui du cerveau en particulier* (originally laid before the Institute of France in March 1808), and in 1810 by the first instalment of the *Anatomie et Physiologie du système nerveux en général, et du cerveau en particulier, avec des observations sur la possibilité de reconnaître plusiers dispositions intellectuelles et morales de l'homme et des animaux par la configuration de leurs têtes*. The *Recherches*, and the first two volumes of the *Anatomie*, bear the conjoint names of Gall and Spurzheim. The latter work was completed in 1819, and appeared in a second edition of six 8vo volumes shortly afterwards (1822–25). In 1811 he replied to a charge of Spinozism or atheism, which had been strongly urged against him in certain quarters, by a treatise entitled *Des dispositions innées de l'âme et de l'esprit*, which he afterwards incorporated with his greater work. In 1819 he became a naturalized French subject, but his efforts two years afterwards to obtain admission to the Academy of Sciences, although supported by Geoffroy St Hilaire, were unsuccessful. In 1823 he visited London with the intention of giving a series of phrenologieal lectures, but was disappointed of the reception he had anticipated, and speedily abandoned his plans. He continued to lecture and practise in Paris until the beginning of 1828, when he was disabled by an apoplectic seizure. His death took place at Montrouge near Paris, on the 22d of August 1828. The *Anatomie* has been translated into English by Lewis (Boston, U.S., 1835).

GALLAND, ANTOINE (1646–1715), Orientalist and archæologist, the first European translator of the *Arabian Nights*, was born in 1646 at Rollot, in the department of Somme. The completion of his school education at Noyon was followed by a brief apprenticeship to a trade, from which, however, he soon escaped, to pursue his linguistic studies at Paris. After having been employed for some time in making a catalogue of the Oriental manuscripts at the Sorbonne, he was, in 1670, attached to the French embassy at Constantinople; and in 1673 he also accompanied his chief (De Nointel) to Syria and the Levant, where he availed himself of the opportunity to copy a great number of inscriptions, and also to sketch, in some cases even to remove, historical monuments. After a brief visit to France, where his collection of antiquities attracted some attention, Galland returned to the Levant in 1676; and in 1679 he undertook a third voyage, being commissioned by the French East India Company to collect for the cabinet of Colbert; on the expiry of this commission he was instructed by the Government to continue his researches, and had the title of "antiquary to the king" conferred upon him. During his prolonged residences abroad he acquired a thorough knowledge of the Arabic, Turkish, and Persian languages and literatures, which, on his final return to France, enabled him to render valuable assistance to Thevenot, the keeper of the royal library, and to D'Herbelot. After their deaths he lived for some time at Caen under the roof of Foucault the intendant, himself no mean archæologist; and there he began the publication (1704–17) of *Les Mille et Une Nuits*, a translation which excited immense interest during the time of its appearance, and which is still the standard French translation (last edition 1872). In 1701 Galland had been admitted into the Academy of Inscriptions, and in 1709 he was appointed to the chair of Arabic in the Collége de France. He continued to discharge the duties of this post until his death, which took place February 17, 1715.

Besides a number of meritorious archæological works, especially in the department of numismatics, he also published a compilation from the Arabic, Persian, and Turkish, entitled *Paroles remarquables, bons mots et maximes des Orientaux* (1694), and a translation from an Arabic manuscript, *De l'origine et du progrès du Caffé* (1699). The former of these works appeared in an English translation in 1795. His *Contes et Fables Indiennes de Bidpaï et de Lokman* was published after his death (1724). Among his numerous unpublished manuscripts are said to be included a translation of the Koran and a Turkish dictionary.

GALLARATE, a flourishing town of Italy, the head of a circle in the province of Milan, situated on the railway 23 miles N.W. of Milan at the junction of the line running N. to Varese. It has a technical school, and carries on the manufacture of cotton and linen. In the Middle Ages it is mentioned as Galaratum and Glareatum, and especially in the 10th century it appears to have been a strongly fortified and important place. Population in 1871, 7576.

GALLAS, or more correctly GALLA, a powerful race of eastern Africa, scattered over the wide region which extends for about 1000 miles from the interior of Abyssinia to the neighbourhood of the river Sabacki, in 3° 12′ of S. latitude. Almost nothing has been definitely ascertained about the early homes and migrations of the race; but it appears to have occupied the southern portion of its present territory for nearly four centuries at least. According to Ludolf and Bruce, the Galla invaders first crossed the Abyssinian frontiers in the year 1537. The Gallas of Gójam (a district along the northern side of the river Abai) tell how their savage forefathers came from the south-east from a country on the other side of a bahr (lake or river), and the Yedju and Raia Galla also point towards the east and commemorate the passage of a bahr. Among the southern Gallas tradition appears to be mainly concerned with the expulsion of the race from the country now occupied by the Somali. It is usually maintained that the Gallas are ethnographically of Semitic affinity, and find their nearest kinsmen in the Somali, the Dankali, and the Abyssinians; but M. Lejean is of opinion that they rather belong to the Aryan race, and this is so far supported by their physiological characteristics. One thing is certain, that they have nothing in common with the negro type; the "musculation" of the arms, thighs, and calves is altogether different, and they have none of the fetor developed by the negro skin; their frame is large and powerful, their complexion a very dark brown, their brow broad and lofty, their eyes deep-sunk and lively, and their features not unfrequently of a regular and finely-shaped description. Of the Semitic affinity of the language their is no question, and according to the usual classification it belongs to the same Semitico-Hamitic group as the Somali, the Saho, and the Dankali.[1]

The Gallas are for the most part still in the nomadic and pastoral stage; though, as we advance northwards into Abyssinia, we find them more and more assimilated to the settled and agricultural inhabitants of that kingdom. Among the southern tribes it is said that about 7 or 8 head of cattle are kept for every man, woman, and child; and among the northern tribes, as neither man nor woman ever thinks of going any distance on foot, the number of horses is very large. The ordinary food consists of flesh, blood, milk, butter, and honey, the last being considered of so much importance by the southern Gallas that a rude system of bee-keeping is in vogue, and the husband who fails to furnish his wife with a sufficient supply of honey may be excluded from all conjugal rights. This last fact is one of those which indicate the comparatively high position occupied by the Galla women, who, moreover, have the right, but rarely granted in a savage state of society, of refusing an unacceptable offer of marriage. In the south monogamy is the rule, but in the north the number of a man's wives is limited only by his wishes and his wealth. Each tribe has its own heiitch or sultan, who enjoys the strange privilege of being the only merchant for his people, but in all public concerns must take the advice of the fathers of families assembled in council. The greater proportion of the tribes are still pagan, worshipping a supreme god Waka, and the subordinate god and goddess Oglia and Atilia, whose favour is secured by sacrifices of oxen and sheep. With a strange liberality of sentiment, they say that at a certain time of the year Waka leaves them and goes to attend to the wants of their enemies the Somali, whom also he has created. Some tribes, and notably the Wollo-Galla, have been converted to Mahometanism, and very bigoted adherents of the prophet they are. In the north a kind of superficial Christianization has taken place, to the extent at least that the people are familiar with the names of Maremma or Mary, Balawold or Jesus, Girgis or St George, &c.; but to all practical intents paganism is still in force. The serpent is a special object of worship, the northern Gallas believing that he is the author of the human race. A considerable number of the men find employment in the Abyssinian armies, and in comparison with their neighbours are brave and warlike. The total number of the Gallas was estimated by Krapf at from six to eight millions, and Plowden mentions individual tribes that could bring into the field 20,000 or 30,000 horse. Among the more important tribes in the south (the name in each instance being compounded with Galla) are the Ramatta, the Kukatta, the Baôle, the Aurova, the Wadjole, the Ilani, the Arrar, and the Kanigò Galla; the Borani, a very powerful tribe, may be considered to mark the division between north and south; and in the north we find the Amoro, the Jarso, the Toolama, the Wollo, the Ambassil, the Aijjo, and the Azobo Galla.

See Beke, "On the Origin of the Gallas," in *Trans. of Brit. Assoc.*, 1847; Krapf, *Travels . . . in Eastern Africa*, 1860; D'Abbadie, *Douze Ans en Haute-Éthiopie*, 1868; Brenner, "Forschungen in Ost-Afrika," in Petermann's *Mittheilungen*, 1868; Plowden, *Travels in Abyssinia and the Galla Country*, 1868; and a paper by Louis Lande in *Revue des Deux Mondes*, 1878.

[1] The similarity to the Semitic was pointed out by Benfey in *Gotting. Gelehrte Anzeigen*, 1846, in a review of Tutschek's lexicon and grammar (1844, 1845). Further details in regard to its vocabulary and structure will be found in Lottner's paper in the *Transactions of the Philological Society*, London, 1860–61, and in the *Novara Reise*, 1867. Krapf had published a grammar as early as 1840.

ALBERT GALLATIN.

ALBERT GALLATIN was born in Geneva, Switzerland, Jan. 29, 1761. His father, Jean Gallatin, was of an illustrious family and claimed descent from A. Atilius Callatinus, a Roman consul of the third century before Christ. This claim is not substantiated, as a period of fifteen hundred years lies between the Roman consul and the first authentic Gallatin who lived in Savoy in the thirteenth century. This Gallatin was at that time of aristocratic blood, with titles of nobility; so that the family must have been of considerable importance for at least a century before. In 1510 the family came to Geneva, identified themselves with John Calvin and a republican form of government, gave up their titles, and in large measure their fortunes, but they still held to the purity of their blood and were powerful factors in the social and political life of Switzerland. They were a numerous family and the little government did not afford employment for the talents of all of them, so they took service under different kings, won distinction, and lost their lives in gallant action; and became great civic potentates in foreign cities. Their personal friends were men whom accident or talent made famous, such as Voltaire and the Landgrave of Hesse.

Albert's father, Jean Gallatin, married Sophie Albertine Rolaz du Rosey, of Rolle, and died in 1765, when Albert was but four years of age. His mother followed in 1770, thus leaving the boy an orphan at the early age of nine, with an invalid sister five years older. At the time of his father's death one of his mother's intimate friends, Catherine Pictet, seeing the young widow overwhelmed with the care of her husband's business and of her sick daughter, took Albert into her own household. After his mother's death, he became virtually her own child, beside being the heir of his grandfather, Abraham Gallatin, and the favorite of a wealthy uncle, Alphonse Rolez, of Rolle. He had a right to expect a fortune from these three people and was popular and beloved by all his friends and relatives; his education was carefully supervised by his foster mother, Mlle. Pictet. At sixteen years of age he was sent to boarding school and afterwards to an academy, graduating in 1779. No expense was spared in his education. His small property was so frugally managed that by the time he reached his majority his father's debts had all been paid from the income. About this time both his uncle and grandfather died insolvent, and Albert's patrimony was so small that he

was thrown almost entirely on his own resources. Yet, from the distinction of his family, and the mental acquisitions he had gained in college, he was on the road to success and could easily have gained fame and fortune in the city of his birth. At the age of eighteen he was clear-minded, sober and practical. The first year after graduation he returned to Mlle. Pictet and occupied himself as tutor to her young nephew, Isaac Pictet. He often visited his grandmother, who urged him to enter the service of the Landgrave of Hesse, but a military life had but little attraction for him. During this year he visited Voltaire; and widened his acquaintance among the many learned and distinguished men who made Geneva their home. He breathed this balmy atmosphere of learning and was filled with ambitious dreams and at the same time with a noble discouragement. It seemed to the youth that where there was so much intellectual and moral worth in the market, distinction would be difficult to obtain. This, together with his loss of fortune and a quarrel with his grandmother on account of his refusal to "serve under a tyrant," as he termed the Landgrave of Hesse, made him resolve on a course of action, which lost a gladiator for the little arena of Geneva and gained Albert Gallatin for the larger political field which the young and growing government of the United States afforded.

He made silent preparations for his departure, and carrying with him such small resources as he could command, accompanied by his college friend Henri Serre, he departed from Geneva in the spring of 1780, leaving behind him the city of his ancestry, his influential friends, congenial society and prestige, and emigrated to America. He was but nineteen years of age when he thus took his fortunes in his own hands and cut himself off from the assistance of his grandmother and Mlle. Pictet. He regretted this step near the close of his life in spite of his wonderful successes, and said that he had advised only one man to emigrate, Jean Badollet, who afterwards joined him in America, and that he was sorry for having done so. He was proud, shy and reticent. He was moved by political ideals and filled with a spirit of adventure and leadership. For many years these traits of Albert Gallatin's character controlled his actions. They explain the apparent perversity with which he abandoned his friends and prospects. He departed secretly from fear that he would be restrained, should his plans become known. This was a weak and unworthy excuse, as he afterwards acknowledged, for although his friends opposed him they would gladly have furnished him with the necessary equipment for his journey to the New World, if he had only declared to them his intention to go. The two young men started with the small sum of 166 louis d'or. The cost of their passage reduced the little amount to about $400, all of which belonged to Gallatin. The friends in Geneva strove in every way to smooth the path to success for these young men, and wrote letters of introduction for them to influential people in America, but Gallatin disliked large cities, where his learning would have given him an immediate foothold, and disdaining all these helps struck out into the wooded wilderness of Maine. He had courage, endurance, hope and discipline of a high order, else he would have fallen back on the "cushion of circumstance," which was always held invitingly before him. He never used his letters of introduction. Mlle. Pictet wrote him long letters telling how she mourned his loss, but he was unwilling to tell her of his hardships and did not write to her for a whole year.

In 1781, after untold privations in the woods, and a failure in trade, he obtained a French class in Harvard College. But New England asceticism and the rigor of the climate were unfriendly to the Gallic youth. His life in Boston was unproductive and unsatisfactory, and he finally cut himself loose from it and plunged into the freer air of Pennsylvania and Virginia. Here he found his natural element. He engaged in land speculation and local politics, married a Miss Sophia Allegre and settled down in a country where it needed energy to live. Here he would have developed naturally into a provincial potentate and wealthy land owner on a large plantation, had his young wife not died a few months after marriage. To this sad event is probably due his subsequent career. He was driven into the excitement of politics by his grief and loneliness. Soon his rare origin and attainments brought him forward rapidly in a pioneer settlement. The times needed such men. Independence had been wrested from England, but the government had not yet been established. The constitution was before the States for adoption. Gallatin belonged to the anti-Federalist, the minority party, and was thus one of the men who helped draft some of the amendments to the constitution. He could not speak English plainly, and was hampered in debate, but the clear force of his reasoning, united with his grasp of the situation, at once brought him to the front in the legislature of Pennsylvania, and carried him to Congress. The impression he made on public men is to be explained only by his intellect and integrity, because he was not a man to whom many people ever became warmly attached. He was tall and strong, with a severe cast of countenance and cold manner, and disdained to conciliate any one. He soon became the leader of the Republican party in Pennsylvania. He came into collision with Alexander Hamilton at this time on account of the excise on spirits. This measure was the simplest way to meet the existing necessity for money in order to carry on the government. The tax was unpopular, as any tax was bound to be with a people who had just successfully resisted taxation, but Hamilton forced the excise, and subsequent events proved his wisdom in having done so. Gallatin was one of the most powerful opponents of Hamilton's scheme, and, thus, while fighting on purely legal grounds, identified himself with a lawless element and was thus practically at war both with the Federalists and with his own constituents. His own force and integrity kept him erect and compelled the respectful attention of both parties throughout this trying period, when he stood the severest test to which a man in public life can be subjected. He received a singular proof of this confidence in him by being chosen to represent Pennsylvania in Congress by a vote of both parties. The Federalists being in a powerful majority annulled his election on the ground of his being the leader of the insurrectionists and retired him to private life. At the rise of the "whiskey rebellion" by the anti-Federalists he risked his life to face a mob of his own constituents and denounced them in unqualified terms, and by his prompt action turned this movement into a ridiculous affair. He had made a mistake in his estimate of the character of the population and hastened to oppose the rebellion. In history there will always be some doubts expressed as to Gallatin's part in the whole proceeding, and in the opinion of most people he must be held responsible for the first resistance to the government. But at the time he came out of the encounter with a spotless reputation,—the only western anti-Federalist who did so. Shortly afterwards he was again elected to the House of Representatives. His previous mistake in gauging his constituency seems to have been the only time in a long public career when he was not endowed with a keen faculty for feeling the public pulse. This quality was felt by all public men who came in contact with him, and had instant effect when he returned to Congress. He became the leader of the Republican party at once and held his place easily during the six years he remained in the House. There was no one else who compared with him in intellectual ability, foresight, judgment, moderation or convincing speech, though many surpassed him in eloquence. He was always dignified and calm, never descending to personalities, but carrying his point by sheer force of reason. For opponents he had John Marshall, Griswold, Bayard, Harper, Dana and other distinguished men. He had besides to contend against an imperfect knowledge of English and bad pronunciation. His ultimatums were the result of hard study. He informed himself of the minutest details and depended upon his grasp of a subject more than his command of words. In his own party, as possible rivals for the foremost place, there were only Madison and Livingston; both great men, but not possessed of the qualities necessary for parliamentary leadership. He was never a radical Republican, but maintained an equilibrium between two parties on an individual platform. He often expressed

views at variance with those of his party, so he affiliated with all men, on some points maintaining only his opposition to strong governments, when he identified himself with the Republicans.

He filled the position in Congress of financier for his party and succeeded in modifying the radical measures of Hamilton and improving the financial schemes of the government. His leadership laid him open to all the bitter personal attacks of the time, but he was never betrayed into retorts of the same kind, so that the assaults of his opponents lost their point. His was always the important speech of the opposition. His only mistakes were when he gave up his individual judgment in loyalty to his party. When the Republicans began to be deserted by their leaders in Pennsylvania, still steady, he stood alone, and then when quarrels split the opposition he carried the Republicans into power. When the country was in peril from the growing power, it was Gallatin and Jefferson who averted the calamity. The year 1801 was carried through without disaster, because these two men were at the helm. The "war party" was crushed.

When Jefferson came into power, Gallatin, and Madison with him, formed a triumvirate which ruled the United States for twelve years. Gallatin took the treasury portfolio at a time when Hamilton's brilliant policy needed modification. Debt was accumulating, and expenditures were greater than the country could bear. It took a wise mind and a firm hand to pilot the finances of the country into a safe port. Revenue must be increased, internal taxes must be reduced. The navy, however, demanded a greater sum for maintenance. Gallatin strove for freedom from debt and opposed war with the Barbary States. After six years' work with the debt nearly out of sight, foreign wars broke out and crippled Glalatin's plans. He fought the sympathy with Napoleon and urged peace with England at any cost. At this time, this opposer of strong governments became the champion of some of the most oppressive laws which have ever been framed, and failed in his efforts. He was not sustained by Jefferson, and though retaining his place in the cabinet under Madison, he had new difficulties to encounter. A strong faction had grown up against him in Congress, headed by Senator Smith, of Maryland. Every measure of Gallatin's was frustrated. The bank was defeated, the foreign policy overthrown and the legislative power of the government weakened. Bonaparte did the rest, and thus the war of 1812 with England was precipitated. At Gallatin's instance Robert Smith, brother of Senator Smith, was dismissed from the cabinet, and Gallatin was master of the situation. Then, for the only time in his life, this staunch Swiss weakened, and made such reports of the finances of the country as strengthened the war party. His object has been variously accounted for, but the fact remains that these false reports did incalculable harm and finished the work which ended in a three years' war with England. But he took the finances up with a strong hand after the beginning of the war, resigned from the treasury, and heading a commission, bombarded English diplomats and compelled peace. At the close of the war he went to Paris as American Minister to France, a position which he held for seven years. After having been one of the greatest financiers the country has seen, he became a diplomat second only to Franklin. In Paris he was surrounded by the most distinguished society of Europe, and did much to effect the stability of American commerce. In 1823 he returned to the United States, and after returning from a mission to England, on which he had been sent by John Quincy Adams, he retired to private life.

This versatile man then turned his attention to Indian ethnology, he being the first student of the subject who ever contributed any scientific knowledge to it. When more than eighty years old he appeared as an opposer of the annexation of Texas and of the war with Mexico.

Gallatin was an idealist in Civil Service. His thought was that employes of the government should be trained to the work and then have permanent positions, taking no part in politics. It was the opposite of the Jackson policy, which afterward carried everything before it. Jefferson was infected by the spoils system and failed to support Gallatin. Another idea of his was good management of the navy and in this also he was defeated. He held his place in the cabinet against all opposition of Jefferson to his policy and plans and bore the attacks of Duane and Leit without aid from his chief. Yet that Jefferson was able to defend him, was proved by his treatment of Burr and Randolph. Gallatin believed in simplicity of government, no debt, no taxes—and saw his plans again defeated by war. But, though all his theories failed, one after another his methods prevailed, and carried the party through a perilous period.

In religion Gallatin was a Calvinist of a severe type. He was austere, having no Gallic lightness of character.

He married a Sarah Nichelson for a second wife and left three children. In his home life he was tender and loving but never indulgent. He had the characteristics of the Scotch and of the Puritans. He was reticent, cool and tenacious, with severe morals. He stood unmoved amid storms of invectives.

Though he was not so great a man as Hamilton, he had sterling qualities which were needed by the times. He evinced cool judgement, rather than brilliancy, for the conduct of affairs.

He died in 1849, busy with private and public affairs to the last day of his life.

AUTHORITIES.—*The Life of Albert Gallatin*, by H. Adams; *Writings of Albert Gallatin*, by H. Adams; *Albert Gallatin*, by H. C. Lodge.

GALLE, or POINT DE GALLE, a town and port in the southern province of Ceylon, on the south-western coast, about 72 miles S. of Colombo, with which it is connected by a good carriage road. It was made a municipality in 1865, and divided into the five districts of the Fort, Callowelle, Galopiadde, Hirimbure, and Cumbalwalla. The fort, which is more than a mile in circumference, commands the whole harbour, but is commanded by a range of hills. Within its enclosure are not only several Government buildings, but an old church erected by the Dutch East India Company, a mosque, a Wesleyan chapel, a hospital, and a considerable number of houses occupied by Europeans. The old Dutch building known as the queen's house or governor's residence, which dated from the year 1687, was in such a dilapidated state that it was sold by Governor Gregory in 1873. Elsewhere there are few buildings of individual note, but the general style of domestic architecture is pleasant and comfortable, though not pretentious. One of the most delightful features of the place is the profusion of trees, even within the town, and along the edge of the shore—suriyas, palms, cocoa-nut trees and bread-fruit trees. The ramparts towards the sea furnish fine promenades. In the harbour deep water is found close to the shore, and the outer roads are spacious; but the south-west monsoon renders entrance difficult, and not unfrequently drives vessels from their moorings. Galle is an important point on the lines of communication between Calcutta and Australia, and between Suez and Singapore. The Peninsular and Oriental Steam Navigation Company, the *Messageries Maritimes*, and the British India Steam Navigation Company have agencies at the port. The trade is mainly in the productions of the surrounding country, of which in 1873 there was shipped 11,477 cwts. of cocoa-nut oil, 10,083 cwts. of cinnamon, 23,377 cwts. of plumbago, and 22,932 cwts. of coir. Cotton goods are the principal import, 143,410 pieces being the amount for 1873. The inhabitants of Galle are of very mingled origin, comprising not only Singhalese European residents and Eurasian half-castes, who are locally denominated "Burghers," as being mainly the descendants of the old Dutch settlers, but also "Moors" or "Moormen" (that is, Arabians or semi-Arabians), Hindus, Parsees, people from the Coromandel coast, and Maldivians. The Moors are largely engaged as lapidaries and workers in tortoise-shell; and the urgency of the itinerant vendors is one of the inevitable plagues of the European visitor to the town. According to the returns of 1871, the total population of the municipality was 47,059, distributed in 8979 families, occupying 7496 houses, and consisting of 24,294 males and 22,765 females.

Galle, according to Sir J. E. Tennent, is the Tarshish of Solomon; but of this opinion there is no proof, even if it were certain that the Jewish fleets visited the island of Ceylon at all. The place is mentioned by none of the Greek or Latin geographers, unless the identification with Ptolemy's Avium Promontorium or Cape of Birds be a correct one. It is hardly mentioned in the native chronicles before 1267, and Ibn Batuta, in the middle of the 14th century, distinctly states that Kali,—that is, Galle,—was a *small* town. It was not till the period of Portuguese occupation that it rose to importance. When the Dutch succeeded the Portuguese they greatly strengthened the fortifications, which had been vigorously defended against their admiral, Koster; and under their rule the place had the rank of a commandancy. In the marriage treaty of the infanta of Portugal with Charles II. of England it was agreed that if the Portuguese recovered Ceylon they were to hand over Galle to the English; but as the Portuguese did not recover Ceylon the town was left to fall into English hands at the conquest of the island in 1796. The name Galle is derived from the Singhalese *galla*, equivalent to rock; but the Portuguese and Dutch settlers, being better fighters than philologists, connected it with the Latin *gallus* a cock, and the image of a cock was carved as a symbol of the town in the front of the old Government house.

GALLIC ACID, trioxybenzoic acid, or dioxysalicylic acid, $C_7H_6O_5 + H_2O$ or $C_6H_2(OH)_3.CO(OH) + H_2O$, the *acidum gallicum* of pharmacy, is a substance discovered by Scheele, which exists as such in the leaves of the bearberry, in pomegranate root-bark, and in tea, in gall-nuts to the extent of about 3 per cent., and in other vegetable productions. It may be prepared by keeping moist and exposed to the air for from four to six weeks, at a temperature of 20° to 25° C., a paste of powdered gall-nuts and water, and removing from time to time the mould which forms on its surface; the paste is then boiled with water for twenty minutes to obtain a solution of the gallic acid; this is filtered through calico, and the deposit of acid it affords on cooling is drained by pressure between folds of bibulous paper, and purified by dissolving in boiling water, by recrystallization at about 27° C., and washing of the crystals with ice-cold water. The production of the acid appears to be due to the presence in the galls of a ferment. This is not contained in Chinese gall-nuts, which consequently require the addition of yeast or of common galls to determine the decomposition of their tannin necessary for the formation of gallic acid (see C. H. Viedt, *Dingler's Polyt. Journ.*, ccxvi., 1875, p. 454). Powdered gall-nuts, containing 43 per cent. of tannic acid, were found by M. Sacc to yield 50·4 per cent. of pure dry gallic acid (*Compt. Rend.*, lxxii., 1871, p. 766). Gallic acid is most readily obtained by boiling with weak solution of acids the tannin procured from oak-galls by means of alcohol and ether. The changes which take place in this, as in the first described mode of preparation, apparently consist in the splitting up of tannin, or gallo-tannic acid, which, according to some experiments, is a glucoside of tannic acid, of the formula $C_{34}H_{32}O_{22}$, to give with two molecules of water two molecules of digallic or tannic acid, $C_{14}H_{10}O_9$, and glucose, $C_6H_{12}O_6$. The former body, which may be represented as an etheric anhydride of gallic acid, $C_6H_2(OH)_2.CO(OH).O.CO.(OH)_3C_6H_2$, by the assimilation of a molecule of water is then converted into two molecules of gallic acid (see Armstrong, *Organic Chemistry*, p. 304, 1874). Gallic acid may be produced by heating an aqueous solution of diiodosalicylic acid with excess of alkaline carbonate, by acting on dibromosalicylic acid with moist silver oxide, and by other chemical methods. It crystallizes in white or pale fawn-coloured acicular prisms or silky needles, and is soluble in alcohol and ether, and in 100 parts of cold, and 3 of boiling water, is without odour, and has an astringent, acidulous taste, and an acid reaction. Dried at 100° C. it loses 9·5 per cent. of its weight of water; at about 200° C. it melts; and at 210 to 215° it is resolved into carbon dioxide and pyrogallol, $C_6H_3(OH)_3$. With ferric salts its solution gives a deep blue colour, and with ferrous salts, after exposure to the air, an insoluble, blue-black, ferroso-ferric gallate. Bases of the alkali metals give with it four series of salts; these are stable except in alkaline solutions, in which they absorb oxygen and turn brown. Solution of acid calcium carbonate becomes with gallic acid, on exposure to the air, of a dark blue colour. Unlike tannic acid, gallic acid does not precipitate albumen or salts of the alkaloids, or, except when mixed with gum, gelatin. Salts of gold and silver are reduced by it, slowly in cold, instantaneously in warm solutions, hence its employment in photography. With phosphorus oxychloride at 120° C. gallic acid yields tannic acid, and with concentrated sulphuric acid at 100°, *rufigallic acid*, $C_{14}H_8O_8$. Phosphorus perchloride, and also, after several hours, solution of arsenic acid near the boiling point (J. Löwe, quoted *Chem. News*, xix., 1869, p. 41), convert it into *ellagic acid*, $C_{14}H_8O_9 + H_2O$, a substance which occurs in gall-nuts, in the external membrane of the episperm of the walnut (T. L. Phipson, *Chem. News*, xx. p. 116), and probably many plants, and composes the "bezoar stones" found in the intestines of Persian wild goats. Gallic acid may be estimated, after removal of tannic acid by gelatin, by means of permanganate of potassium, with which it evolves carbon dioxide, and (F. Jean, *Compt. Rend.*, lxxxii., 1876, pp. 982–4), by means of iodine in the presence of an alkaline carbonate.

Gallic acid has been advantageously employed as an internal medicinal agent in scarlatinal albuminuria, in which its effect appears to be due to an astringent and tonic action on the inflamed capillaries of the kidneys;[1] in other forms of albuminuria;[2] in cases of chyluria, in which, as not causing nausea and headache, it is preferable to tannic acid;[3] and in pyrosis, diarrhœa, some forms of dysentery, and tabes and rickets, and atonic states of the alimentary canal and of the body generally. In checking the night-sweats of phthisis it has been found of especial service.[4] As a hæmostatic, when administered internally, it has proved of value in hæmatemesis, epistaxis, fungus hæmatodes,[5] menorrhagia,[6] and more particularly in hæmaturia. Gallic acid has been highly recommended in hæmoptysis,[7] in which, however, ergot, from its not occasioning griping and constipation, or interfering with a liberal use of milk, has been found a better remedy.[8] It may be given in considerable quantities without any evil consequences. The effects of too large a dose are to render

[1] *Braithwaite's Retrospect*, lxxiii., 1876, 114.
[2] *Lancet*, 1878, ii. 580; *Med. Times*, 1853, ii. 55, and 1854, i. 594; according to Parkes (*ib.*, 1854, ii. pp. 28, 29), ferric chloride is superior to it as a means of reducing the albumen in nephritis.
[3] Bence Jones, *Med. Times*, 1852, ii. 653, and 1853, ii. 494.
[4] *Ib.*, 1854, i. 594; and *Brit. and For. Med.-Chir. Rev.*, 1872, i. 194.
[5] *Med. Times*, 1858, ii. 373.
[6] *Ib.*, 1862, i. 49; and *Lancet*, 1860, ii. 254.
[7] Williams, *Ranking's Ab tracts*, 1862, i 73; and Waters, *ib.*, 1871, i. 56
[8] Williamson, *Lancet*, 1876. i 696.

the pulse hard and wiry, and to produce pallor, a whizzing sound in the ears, dizziness, and faintness. Its administration in a case of Bright's disease described by Dr Bence Jones was followed by epilepsy (see *Med. Times*, 1853, ii. 495). As a topical styptic application, gallic is inferior to tannic acid.[1] With glycerin it is combined to form the pharmaceutical preparation *glycerinum acidi gallici*.

GALLIENUS, P. Licinius (218–268), Roman emperor, son of the emperor Valerian, was born about 218. From 253 to 260 he reigned conjointly with his father, and gave proof of both bravery and ability, especially in the defeat near Milan of 300,000 Alemanni, with a force of only 10,000 Romans. When, however, his father was defeated and taken prisoner by Sapor, king of Persia, in 260, Gallienus made no effort to obtain his release, or to withstand the incursions of the invaders who threatened the empire from all sides. He occupied part of his time in dabbling in literature, science, and various trifling arts, but gave himself up chiefly to excess and debauchery. His generals rebelled against him in almost every province of the empire, and this period of Roman history came to be called the reign of the thirty tyrants, although in reality the usurpers numbered only nineteen. Gallienus was killed at Milan in 268 while besieging Aureolus, who had been proclaimed emperor by the Illyrian legions.

GALLINULE. See Moorhen.

GALLIO, Junius Annæus, proconsul or "deputy" of Achaia at the time of the apostle Paul's first visit to Corinth (53 A.D.), was the son of M. Annæus Seneca, a Roman eques and rhetorician, and was born at Cordova about the beginning of the Christian era. His mother's name was Helvia; and L. Annæus Seneca, the philosopher, and L. Annæus Mela, the geographer, were his full brothers, his own proper name being Marcus Annæus Novatus. After he had received a careful education from his father at Cordova, he went to Rome, where he attracted the notice of L. Junius Gallio, a rhetorician of some repute, who ultimately adopted him, thus conferring the name by which he is usually known. The terms on which he lived with his kindred and with the world are well illustrated in the epithet "dulcis" applied to him by Statius (*Silv.*, ii. 7, 32), and by Seneca (*Nat. Qu.*, 4 pref.—"nemo mortalium uni tam dulcis est quam hic omnibus"). It is probable that Gallio shared the misfortunes of his brother when the latter, having incurred the enmity of Messalina, was banished to Corsica; and that both returned together to Rome when Agrippina had selected Seneca to be tutor to Nero. Towards the close of the reign of Claudius, Gallio received the proconsulship of the newly constituted senatorial province of Achaia (Acts xviii. 12), but seems to have been compelled by ill health to resign the post within a few years (Pliny, *H. N.*, xxxi. 33; Seneca, *Ep.* civ.). In the fifth year of Nero we hear of him as having been again in Rome (Dio Cassius, lxi. 20, 21), and on the same authority we learn that he finally became one of the last victims of that emperor (lxii. 25). The statement of Jerome in the chronicle of Eusebius, that Junius Gallio "frater Senecæ, egregius declamator, propria se manu interfecit," appears to be founded on a confusion of names. Seneca's works, *De Ira* and *De Vita Beata*, are dedicated to Gallio, who himself appears to have written some treatises in natural history (Sen., *N. Q.*, v. 11). Compare Tacitus, *Ann.*, xv. 73; xvi. 17; Dio Cassius, lx. 35.

GALLIPOLI, the ancient Καλλίπολις, a seaport town of Turkey in Europe, in the province of Rumili and vilayet of Edirneh, at the north-east extremity of the Straits of Dardanelles, on a narrow peninsula 130 miles S.W. of Constantinople, and 90 miles due S. of Adrianople, in 40° 24′ N. lat. and 26° 40′ 30″ E. long. Nearly opposite is Lapsaki on the Asiatic side of the channel, which is here about 2 miles wide. The town of Gallipoli presents a miserable aspect; the streets are narrow, the houses mostly of wood and ill built, though there are a few better structures near the harbour, and the Anglo-French occupation of 1853–6 led to some improvements. The only noteworthy buildings are the large, crowded, and well-furnished bazaars, with leaden domes. There are several mosques, none of them remarkable, and many interesting Roman and Byzantine remains, especially a magazine of the emperor Justinian, a square castle and tower attributed to Bajazet I., and some tumuli on the south, said to be the tombs of the Thracian kings. The lighthouse, built on a cliff, has a fine appearance as seen from the Dardanelles. Gallipoli is the residence of a captain-pasha and the seat of a Greek bishop. It has two good harbours, and is the principal station for the Turkish fleet. From its position as the key of the Dardanelles, it was occupied by the allied French and English armies in 1854. Then the isthmus a few miles to the north of the town, between it and Boulair, was fortified with strong earthworks by English and French engineers mainly on the lines of the old works constructed in 1357, when the Turks first crossed over into Europe, nearly 100 years before they gained possession of Constantinople. These fortifications were renewed and enlarged in January 1878, on the Russians threatening to take possession of Constantinople. The peninsula thus isolated by the fortified positions has the Gulf of Saros on the N.W., and extends some 50 miles to the S.W. The guns of Gallipoli command the Dardanelles just before the strait joins the Sea of Marmora. The town itself is not very strongly fortified, the principal fortifications being further down the Dardanelles, where the passage is narrower. The district of Gallipoli is exceedingly fertile and well adapted for agriculture; a great variety of crops are raised, but, previous to the war of 1877–8, nearly all progress was stopped on account of the maladministration of the Turkish authorities. Nevertheless considerable quantities of the various cereals were exported, besides wine, oil, skins, cotton, sheep, &c., much of the trade being transit. The principal imports are manufactured goods, coal, sugar, coffee, rice, soap, iron. The line of railway between Adrianople and the Egean Sea has been prejudicial to the transit trade of Gallipoli, and several attempts have been made to obtain concessions for the construction of a railway that would connect this part with the Turkish railway system. There is little industry in Gallipoli, though previous to the war attempts had been made to extend and improve the manufacture of silk thread and silk goods, and some little business was done in the construction of coasting vessels. Steamers to and from Constantinople call regularly at Gallipoli. Widely different estimates have been given of the population of the town: it is probably somewhere about 25,000 or 30,000.

GALLIPOLI, an important seaport town of Italy, in the province of Lecce, and about 25 miles N.E. of the city of that name, beautifully situated on a rocky islet on the east shore of the Gulf of Taranto, and connected by a long stone bridge of twelve arches with the suburb of Lizza on the mainland. The town is well built and fortified, and has a castle erected by Charles I. of Anjou, a large cathedral, a gymnasium, and an episcopal seminary. It is chiefly noted for its extensive cisterns cut in the solid rock for containing the olive oil collected from all parts of Puglia; but it has besides a productive tunny fishery, and manufactures muslins, cotton stockings, and woollen goods. The harbour has been improved since 1855 by a new mole, but the entrance is still somewhat dangerous. In 1873 there entered 350 vessels with a total tonnage of 66,652 tons, 281 being Italian and 29 British. The principal exports are oil (of which 9628 tons were shipped in 1875), wine, oats, and cotton seed; and the imports, fish from Norway, manufactured goods from France, petroleum from the United States, staves from Austria, and wheat and barley from Greece and Turkey. The population of the town in 1871 was 7578, and of the commune 9951. Gallipoli preserves the name and almost certainly occupies the site of the ancient Callipolis, the "Beautiful City," founded, according to Dionysius, by a Spartan named Leucippus and a number of the citizens of Tarentum.

GALLIUM, so called in honour of France (Gallia), symbol Ga, atomic weight 69·9, a metal discovered, August 27, 1875, by M. Lecoq de Boisbaudran, in the spectroscopic examination of zinc-blende from Pierrefitte in the valley of Argeles, Hautes Pyrénées, and since found to exist in blende from several other localities, notably in that of the mines of Lüdrich and Apfel at Bensberg, on the Rhine, which contains nearly 16 milligrammes per kilogramme. Its density and approximate atomic weight, and other of its characters, were predicted by Mendeljeff, in accordance with his law that the properties of the elementary bodies, as also the constitution and properties of their combinations, are periodic functions of their atomic weights (see article Chemistry, vol. v. p. 543, col. 2). Gallium may be prepared by a process the chief features of which are the treatment of the ore, which contains the metal in only very minute quantity, with zinc; the removal, from a hydrochloric acid solution of the gelatinous precipitate thereby produced, of various foreign metals by means of hydrogen sulphide; the fractionation of the residual liquid with sodium carbonate, gallium being thrown down before zinc by that reagent; the formation of a sulphate from the resultant precipitate; and, lastly, the electrolysis of a potash solution of the purified oxide obtained therefrom, the metal appearing on the negative platinum electrode. Solid gallium is greyish-white, of octahedral crystallization, and remarkably hard and resistant even at a temperature little below its melting point, and is but slightly malleable and flexible, though thin plates of it will bear bending several times without breaking. It melts when held in the fingers, its point of fusion being 30°·15 C. (86°·27 Fahr.). The liquid metal is of a silvery white colour, and adheres to glass, forming a mirror resembling that of mercury. It exhibits in a remarkable degree the phenomenon of superfusion, but when some degrees below its melting point crystallizes immediately if a small fragment of the solid metal attached to a platinum wire be inserted into it. At 24°·5 C. (76°·1 Fahr.) the specific gravity of the solid metal is 5·956, and of the liquid 6·069; the specific heat of the former between 12° and 23° C. is 0·079, giving atomic heat 5·52, and that of the latter between 119° and 106° C. is 0·0802 (Berthelot, *Compt. Rend.*, lxxxvi. 786–7). At a red heat in air gallium is not perceptibly volatilized. It is little affected by cold nitric acid, but dissolves readily in hydrochloric acid; with potash solution it liberates hydrogen. It furnishes a deliquescent and very soluble chloride, $GaCl_3$ or Ga_2Cl_6, a corresponding bromide and iodide, and an ammonio-gallic alum. Its oxide is more soluble in ammonia than is alumina. In basicity it holds a place intermediate between aluminium and indium. It is precipitated by alkaline carbonates and barium carbonate, but not by hydrogen sulphide and ammonium sulphide in the absence of zinc. Gallium affords two brilliant lines in the violet part of the spectrum.

See L. de Boisbaudran, in *Chemical News*, 1877, i. pp. 148, 157, 167; also L. de Boisbaudran and E. Jungfleisch, *Compt. Rend.*, lxxxvi., pp. 475–478 and 577–579, and *Journ. Pharm. Chim.*, ser. 4, xxvii. pp. 338–340—quoted in *Phil. Mag.*, 1878, p. 319, and *Journ. Chem. Soc.*, "Abstracts," 1878, pp. 556 and 837.

GALLOWAY, Thomas (1796–1851), a Scottish mathematician, was born at Symington, in the upper ward of Lanarkshire, 26th February 1796. After receiving such education as the schools of his own and adjoining parishes could give, he entered in 1812 the university of Edinburgh, where he distinguished himself specially in mathematics. In 1823 he was appointed one of the teachers of mathematics at the military college of Sandhurst, and on the death of Sir John Leslie in 1832 he was an unsuccessful candidate for the vacant chair of natural philosophy in Edinburgh. In the following year he was appointed actuary to the Amicable Life Assurance Office, the oldest institution of that kind in London, and in this situation he remained till his death, November 1, 1851. Galloway was a voluminous though, for the most part, an anonymous writer, and took a leading part in the proceedings of the principal scientific societies of London. He contributed largely to the seventh edition of the *Encyclopædia Britannica*, and also wrote several scientific papers for the *Edinburgh* and *Foreign Quarterly Reviews*. His *Encyclopædia* article "Probability" was published separately.

GALLS. In animals galls occur mostly on or under the skin of living mammals and birds, and are produced by Acaridea, and by dipterous insects of the genus *Œstrus*. Signor Moriggia[1] has described and figured a horny excrescence, nearly 8 inches in length, from the back of the human hand, which was caused by *Acarus domesticus*. What are commonly known as galls are vegetable deformities or excrescences, due to parenchymatous hypertrophy, and, according to the definition of Lacaze-Duthiers, comprise "all abnormal vegetable productions developed on plants by the action of animals, more particularly by insects, whatever may be their form, bulk, or situation." For the larvæ of their makers the galls provide shelter and sustenance. The exciting cause of the hypertrophy, in the case of the typical galls, appears to be a minute quantity of some irritating fluid, or virus, secreted by the female insect, and deposited with her egg in the puncture made by her ovipositor in the cortical or foliaceous parts of plants. This virus causes the rapid enlargement and subdivision of the cells affected by it, so as to form the tissues of the gall. Oval or larval irritation also, without doubt, plays an important part in the formation of many galls. Though, as Lacaze-Duthiers remarks, a certain relation is necessary between the "stimulus" and the "supporter of the stimulus," as evidenced by the limitation in the majority of cases of each species of gall-insect to some one vegetable structure, still it must be the quality of the irritant of the tissues, rather than the specific peculiarities or the part of the plant affected, that principally determines the nature of the gall. Thus the characteristics of the currant-gall of *Spathegaster baccarum*, L., which occurs alike on the leaves and on the flower-stalks of the oak, are obviously due to the act of oviposition, and not to the functions of the parts producing it; the bright red galls of the saw-fly *Nematus gallicola* are found on four different species of willow, *Salix fragilis*, *S. alba*, *S. cæprea*, and *S. cinerea*;[2] and the galls of a Cynipid, *Biorhiza aptera*, usually developed on the rootlets of the oak, have been procured also from the deodar.[3] Often the gall bears no visible resemblance to the structures out of which it is developed; commonly, however, outside the larval chamber, or gall proper, and giving to the gall its distinctive form, are to be detected certain more or less modified special organs of the plant. The gall of *Cecidomyia strobilina*, formed from willow-buds, is mainly a rosette of leaves the stalks of which have had their growth arrested. The small, smooth, seed-shaped gall of the

[1] On the therapeutics of gallic acid see further R. Neale, "Clinical notes upon the use of gallic acid in various diseases," *Medical Times*, 1855, i. 458 *sq.*; and W. Bayes, "On Gallic Acid," *Association Medical Journal*, 1854, p. 506.

[1] Quoted in *Zoological Record*, iv., 1867, p. 192.
[2] P. Cameron, *Scottish Naturalist*, ii. pp. 11–15.
[3] *Entomologist*, vii. p. 47.