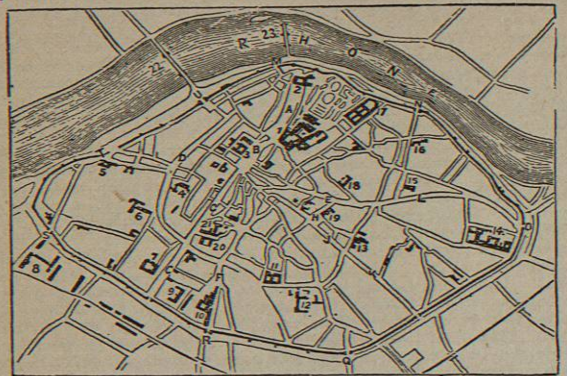
and, on the outside, by a line of pleasant boulevards planted with trees. A precipitous rock rises from the river's edge; and from its summit the cathedral of *Nôtre Dame des Doms*, a building of the 12th century, looks down on the city, but is almost thrown into insignificance by the Palace of the Popes, which rises by its side, and



Sketch Plan of Avignon

1. Palace of the Popes. 2. Former Palace of the Archbishops. 3. Town-House 4. Calvet Museum. 5. Convent of the Visitation. 6. Theological Seminary (St Charles). 7 Hospital (St Louis). 8. Cavalry Barracks. 9. Barracks. 10. Penitentiary. 11. Infantry Barracks. 12. St Joseph's College. 13. Convent of the Holy Sacrament. 14. Hotel-Dieu and General Charity. 15. Church of St Symphorien. 16. Church of the Sacred Heart. 17. Prisons. 18. Savings Bank and Loan Office. 19. Court-House. 20. Lyceum. 21. Lyceum. 22. Suspension Bridge. 23. Benezet Bridge. A, Place du Palais. B, Place de l'Hôtel de Ville. C, Rue de la République. D, Rue Calade. F, Place du Corps Saint. G, Rue des Lices. H, Place Pie. J, Vieux Septier. K, Rue du Saule. L, Rue Carréterie. M, Porte du Rhône. N, Porte de la Ligne. O, Porte St Lazarus. Q, Porte L'Imbert. R, Porte St Michael. S, Porte St Roche. T, Porte de l'Oulle.

stretches in sombre grandeur along the southern slope. This building, or congeries of buildings, was commenced by Benedict XII. in 1336, and continued by successive popes for sixty years. It covers an area of rather more than 1¼ acres. The paintings with which it was profusely adorned are in great measure destroyed, and even the grandeur of its dismantled interiors was for a long time broken in upon by the carpentry and plaster-work of French barracks. A restoration has, however, been for some time in progress; and the building will again be appropriated for ecclesiastical and civic purposes. The churches of St Agricol, St Didier, and St Pierre may be mentioned as of some importance; also the papal mint, now known as a music academy; the town-hall, built in 1862; the Calvet museum, rich in Roman remains; the Requien museum of natural history; and the Hôtel des Invalides. Of the church of the Cordeliers, in which Petrarch's Laura was buried, only a small part is standing, and the tomb itself has been entirely destroyed. The city is the seat of an archbishop, and has tribunals of primary jurisdiction and commerce, a royal college, a theological seminary, a society of arts, the Vaucluse academy, a public library, a theatre, &c. The chief object of industry is the preparation of silk and the manufacture of silk goods; there are also manufactures of paper, leather, hats, jewellery, iron-ware &c. Avignon is remarkably subject to violent winds, of which the most disastrous is the *mistral;* and, according to the proverb, *Avenio ventosa, sine vento venenosa, cum vento fastidiosa* (windy Avignon, liable to plague when it has not the wind, and plagued with the wind when it has it). The town was a place of some importance in the times of Roman supremacy, and seems to have had some special connection with the Greek colony at Massilia. It was incorporated with the Burgundian kingdom, and on its dissolution became a free republic, after the Italian type. As late, indeed, as 1790, it retained its consuls, though its republican constitution was really destroyed by Charles of Anjou. From 1309, when Clement V. took up his abode in the city, to 1377, when Gregory XI. returned to Rome, Avignon was the seat of the papal court, and it continued from 1378 to 1418 to be the seat of French anti-popes. In 1348 it was purchased by Pope Clement VI. from Joanna of Sicily for the sum of 80,000 florins, and it remained in possession of the popes till the French Revolution. Population in 1872, 38,196.

AVILA, a province of Spain, one of the modern divisions of the kingdom of Old Castile, situated between long. 4° 14′ and 5° 55′ W., and lat. 40° 48′ and 41° 18′ N. It is bounded on the N. by Valladolid, E. by Segovia and Madrid, S. by Toledo and Caceres, and W. by Salamanca. The area is 2570 square miles; population, 176,769. It naturally divides itself into two sections, differing completely in soil, climate, productions, and social economy. The northern portion is generally level; the soil is of indifferent quality, strong and marly in a few places, but rocky in all the valleys of the Sierra de Avila; and the climate alternates from severe cold in winter to extreme heat in summer. The population of this part is agricultural. The southern division is one mass of rugged granitic *sierras*, interspersed, however, with sheltered and well-watered valleys, abounding with rich vegetation. The winter here, especially in the elevated region of the Paramera and the waste lands of Avila, is long and severe, but the climate is not unhealthy. The inhabitants are occupied in the rearing of cattle. The principal mountain chains are the Guadarrama, separating this province from Madrid; the Sierras de Avila, a continuation of them westward; the Sierra de Gredos, running from the south of Piedrahita through Barco, Arenos and part of Cebreros; and the Paramera, stretching southwards from the city of Avila into Arenas and Cebreros. The various ridges which ramify from the latter are covered with wood, presenting a striking contrast to the bare peaks of the Sierra de Gredos, and the barren levels in which they rise on the north. The principal rivers are the Alberche and Tietar, belonging to the basin of the Tagus; and the Tormes, the Corneja, and the Adaja, belonging to that of the Douro. The mountains contain silver, copper, iron, lead, and coal, but their mineral wealth has been exaggerated, and the actual production is absolutely nil. Quarries of fine marble and jasper exist in the district of Arenas. The province has declined in wealth and population during the last two centuries, a result due less to the want of activity on the part of the inhabitants than to the oppressive manorial and feudal rights and the strict laws of entail and mortmain, which have acted as barriers to improvement. The principal production is the wool of the Merino sheep, which at one time yielded an immense revenue. Game is plentiful, and the rivers abound in fish, specially trout. Olives, chestnuts, and grapes are grown, and the culture of silk-worms is also carried on. There is little trade, and the manufactures are few, consisting chiefly of copper utensils, lime, soap, cloth, paper, combs, &c. The state of elementary education is comparatively good, and the ratio of crime is proportionately low (Madoz, *Diccionario de España*).

Avila (the ancient *Abula*), a city of Spain, the capital of the above province, is situated on the right bank of the Adaja, about 3000 feet above the sea-level, at the termination of the Guadarrama Mountains. "On all sides," says a recent traveller, "the town is surrounded by a tawny desert, over whose arid plains numbers of gray boulders are scattered like flocks of sheep." Its ancient wall is still in good preservation, crowned by a breastwork, with towers of great strength; but a large part of the town lies beyond the circuit. Avila is the seat of a bishop suffragan to Santiago, and has a Gothic cathedral, built by Garcia

de Estrella in 1107; a number of interesting churches, such as *Santo Tomas*, with the beautiful tomb of Prince Juan, *San Vincenti*, with its remarkable carving, and *Nuestra Seraf. Madre Santa Teresa*, built over the birthplace of the patroness of Spain (who here founded the convent of St Joseph); as well as several monasteries and schools, an infirmary, and a foundling hospital. It was formerly the seat of a university, which was founded in 1482, and changed into the college of St Thomas in 1807. The only manufacture of any importance is the spinning of the wool furnished by the native sheep. Population, 6892.

AVILA, Gil Gonzalez d', a Spanish biographer and antiquary, was born at Avila about the year 1577, and died there in 1658. He was made historiographer of Castile in 1612, and of the Indies in 1641. Of his numerous works, the most valuable are his *Teatro de las Grandezas de Madrid* (Madrid, 1623, *sqq.*), and his *Teatro Eclesiastico*, descriptive of the metropolitan churches and cathedrals of Castile, with lives of the prelates (Madrid, 1645–53, 4 vols. 4to).

AVILA Y ZUNIGA, Luis d', author of a Spanish history of the wars of Charles V. Nothing is known as to the place or date either of his birth or of his death. He was probably of low origin, but married a wealthy heiress of the house of Zuniga, whose name he added to his own. He rose rapidly in the favour of the Emperor Charles V., served in the army and as ambassador to Rome, and was present at the funeral of Charles in 1558. His work is entitled *Comentarios de la Guerra de Alemaña, hecha de Carlos V. en el año de* 1546 *y* 1547, and appears to have been printed in 1548. It became very popular, and was translated into English, French, Dutch, German, Italian, and Latin. As was to be expected from the position of the author, the book gave a rather one-sided account of Charles, and its misrepresentations have been severely criticised.

AVILÉS, San Nicolas de (the Latin *Flavionavia*), a town of Spain, in the province of Oviedo, about a league from the sea-coast, in lat. 43° 34′ N., long. 5° 58′ W. It has a considerable trade by means of its port, which affords good anchorage for all classes of vessels. There are here some copper works and coal mines, and the stone quarries are extensive and productive. Aviles has two parish churches, a theatre, and a public school. Population, 3297.

AVLONA, or Valona (the ancient Αὐλών), a town and seaport of Albania, in the eyalet of Yanina. It stands on an eminence near the Gulf of Avlona, an inlet of the Adriatic, almost surrounded by mountains. The port, which is protected by the island of Sasseno, the ancient Saso, is the best on the Albanian coast. It is visited weekly by Austrian steamers, and carries on considerable intercourse with Brindisi, &c. The town is about a mile and a half from the sea, and has rather a pleasant appearance with its minarets and its palace, surrounded with gardens and olive-groves. The Christian population, of which a considerable proportion are Italians, is largely engaged in commerce; while the Turks manufacture woollen stuffs and arms. The material imported into England for tanning, under the name of *Valonia*, is the pericarp of an acorn produced in the district. Avlona played an important part in the wars between the Normans and the Byzantine empire. In 1464 it was taken by the Ottomans; and after being in Venetian possession in 1690, was restored to them in 1691. In 1851 it suffered severely from an earthquake.

AVOIRDUPOIS, or Averdupois, the name of a system of weights, commonly supposed to be derived from the French, *avoir du pois*, to have weight. The suggested derivation from *averer*, to verify, seems, however, more probable, *averdupois* being the earlier form of the word. Avoirdupois weight is used for all commodities except the precious metals, gems, and medicines. The pound avoirdupois, which is equal to 7000 grains troy, or 453·54 grammes, is divided into 16 ounces, and the ounce into 16 drams. See Weights and Measures.

AVOLA, a city on the coast of Sicily, in the province of Syracuse, with 11,912 inhabitants. It manufactures straw-mats, and has trade in wine, grain, oil, honey, &c.: and there are sugar plantations.

AVON, the name of several rivers in England, Scotland, and France. The word is Celtic, appearing in Welsh as *afon*, in Manx as *aon*, and in Gaelic as *abhuinn* (pronounced *avain*), and is radically identical with the Sanskrit *ap*, water, and the Latin *aqua* and *amnis*. The root appears more or less disguised in a vast number of river names all over the Celtic area in Europe. Thus, besides such forms as *Evan, Aune, Anne, Ive, Auney, Inney*, &c., in the British Islands, we have *Aff* and *Aven* in Brittany, *Avenza* and *Avens* in Italy, *Avia* in Portugal, and *Avono* in Spain; while the terminal syllable of a large proportion of the French rivers, such as the *Sequana*, the *Matrona*, the *Garumna*, and so on, seems originally to have been the same word. The names Punj*ab*, Do*ab*, &c., show the root in a clearer shape. (See Taylor's *Words and Places.*) Of the principal English rivers of this name in its full form three belong to the basin of the Severn. The Upper or Shakespearean Avon, rising in Northamptonshire, near the battlefield of Naseby, flows through Warwickshire, Worcester, and Gloucester, past Rugby, Warwick, Stratford, and Evesham, and joins the larger river at Tewkesbury; while the Lower Avon has its sources on the borders of Wiltshire, and enters the estuary of the Severn at King's Roads, after passing Malmesbury, Bath, and Bristol. (See Ireland's *Upper Avon;* Lewis's *Book of English Rivers*, 1855.) The Middle or Little Avon has its whole course in Gloucestershire, and reaches the Severn a short distance below the town of Berkeley. Another river of this name rises in Wilts, and flows past Salisbury to the British Channel. In Scotland one is a tributary of the Clyde, another belongs to the basin of the Forth, and a third joins its waters with the Annan, while an *Aven* is a confluent of the Spey. In France there are two "Avons" in the system of the Loire, and two in that of the Seine.

AVRANCHES (ancient *Abrincatæ*, or *Ingena*), a town of France, in the department of Manche. It was an important military station of the Romans, and has in more modern times sustained several sieges, the most noticeable of which was the result of its opposition to Henry IV. It stands on a wooded hill, commanding a fine view of the bay and rock of St Michel, about three miles distant. At the foot of the hill flows the river Sée, which at high tide is navigable from the sea. The principal trade is in corn, cider, and salt; and candles, lace, nails, parchment, leather, &c., are manufactured. Avranches was formerly a bishop's see; and its cathedral, destroyed as insecure in the time of the first French Revolution, was the finest in Normandy. Its site is now occupied by an open *place*, called after the celebrated Huet, bishop of Avranches; and one stone remains with an inscription marking it out as the spot where Henry II. received absolution for the murder of À Becket. Saint-Saturnin's church dates from the 13th century, and has a remarkable gateway. The ancient episcopal palace is now used as a museum of antiquities; and an extensive public library is kept in the "mairie." A new cathedral is in course of erection. The agreeable situation and climate of this town make it a favourite residence of English families. Population in 1872, 8137.

AXHOLM, or Axelholm, an island in the N.W. part of Lincolnshire, England, formed by the rivers Trent, Idle, and Don. It consists mainly of a plateau of slight elevation and comprises the parishes of Althorpe, Belton, Epworth, Haxey, Luddington, Owston, and Crowle; the total area being about 47,000 acres. At a very early period it would appear to have been covered with forest; but this having been in great measure destroyed, it sank into a comparative swamp. In 1627 King Charles I., who was lord of the island, entered into a contract with Cornelius Vermuyden, a Dutchman, for reclaiming the meres and marshes, and rendering them fit for tillage. This undertaking led to the introduction of a large number of Flemish workmen, who settled in the district, and, in spite of the violent measures adopted by the English peasantry to expel them, retained their ground in sufficient numbers to affect the physical appearance and the accent of the inhabitants to this day. Elaborate volumes have been published on the island by Peck (1815), Stonehouse, and Read. (See paper, by E. Peacock, in *Anthropological Review*, 1870.)

AXIOM, from the Greek ἀξίωμα, is a word of great import both in general philosophy and in special science; it also has passed into the language of common life, being applied to any assertion of the truth of which the speaker happens to have a strong conviction, or which is put forward as beyond question. The scientific use of the word is most familiar in mathematics, where it is customary to lay down, under the name of axioms, a number of propositions of which no proof is given or considered necessary, though the reason for such procedure may not be the same in every case, and in the same case may be variously understood by different minds. Thus scientific axioms, mathematical or other, are sometimes held to carry with them an inherent authority or to be self-evident, wherein it is, strictly speaking, implied that they cannot be made the subject of formal proof; sometimes they are held to admit of proof, but not within the particular science in which they are advanced as principles; while, again, sometimes the name of axiom is given to propositions that admit of proof within the science, but so evidently that they may be straightway assumed. Axioms that are genuine principles, though raised above discussion within the science, are not therefore raised above discussion altogether. From the time of Aristotle it has been claimed for general or first philosophy to deal with the principles of special science, and hence have arisen the questions concerning the nature and origin of axioms so much debated among the philosophic schools. Besides, the general philosopher himself, having to treat of human knowledge and its conditions as his particular subject-matter, is called to determine the principles of certitude, which, as there can be none higher, must have in a peculiar sense that character of ultimate authority (however explicable) that is ascribed to axioms; and by this name, accordingly, such highest principles of knowledge have long been called. In the case of a word so variously employed there is, perhaps, no better way of understanding its proper signification than by considering it first in the historical light—not to say that there hangs about the origin and early use of the name an obscurity which it is of importance to dispell.

The earliest use of the word in a logical sense appears in the works of Aristotle, though, as will presently be shown, it had probably acquired such a meaning before his time, and only received from him a more exact determination. In his theory of demonstration, set forth in the *Posterior Analytics*, he gives the name of axiom to that immediate principle of syllogistic reasoning which a learner must bring with him (i. 2, 6); again, axioms are said to be the common principles from which all demonstration takes place—common to all demonstrative sciences, but varying in expression according to the subject-matter of each (i. 10, 4). The principle of all other axioms—the surest of all principles—is that called later the principle of Contradiction, indemonstrable itself, and thus fitted to be the ground of all demonstration (*Metaph.*, iii. 2, iv. 3). Aristotle's followers, and, later on, the commentators, with glosses of their own, repeat his statements. Thus, according to Themistius (*ad Post. Anal.*), two species of axioms were distinguished by Theophrastus—one species holding of all things absolutely, as the principle (later known by the name) of Excluded Middle, the other of all things of the same kind, as that the remainders of equals are equal. These, adds Themistius himself, are, as it were, connate and common to all, and hence their name Axiom; "for what is put over either all things absolutely or things of one sort universally, we consider to have precedence with respect to them." The same view of the origin of the name reappears in Boethius's Latin substitutes for it—*dignitas* and *maxima* (*propositio*), the latter preserved in the word Maxim, which is often used interchangeably with Axiom. In Aristotle, however, there is no suggestion of such a meaning. As the verb ἀξιοῦν changes its original meaning of *deem worthy* into *think fit*, *think* simply, and also *claim* or *require*, it might as well be maintained that ἀξίωμα—which Aristotle himself employs in its original ethical sense of *worth*, also in the secondary senses of *opinion* or *dictum* (*Metaph.*, iii. 4), and of simple *proposition* (*Topics*, viii. 1)—was conferred upon the highest principles of reasoning and science because the teacher might require them to be granted by the learner. In point of fact, later writers, like Proclus and others quoted by him, did attach to Axiom this particular meaning, bringing it into relation with Postulate (αἴτημα), as defined by Aristotle in the *Posterior Analytics*, or as understood by Euclid in his *Elements*. It may here be added that the word was used regularly in the sense of bare *proposition* by the Stoics (Diog. Laert., vii. 65, though Simplicius curiously asserts the contrary, *ad Epict. Ench.*, c. 58), herein followed in later times by the Ramist logicians, and also, in effect, by Bacon.

That Aristotle did not originate the use of the term axiom in the sense of scientific first principle, is the natural conclusion to be drawn from the reference he makes to "what are called axioms in mathematics" (*Metaph.*, iv. 3). Sir William Hamilton (Note A, Reid's *Works*, p. 765) would have it that the reference is to mathematical works of his own now lost, but there is no real ground for such a supposition. True though it be, as Hamilton urges, that the so-called axioms standing at the head of Euclid's *Elements* acquired the name through the influence of the Aristotelian philosophy, evidence is not wanting that by the time of Aristotle, a generation or more before Euclid, it was already the habit of geometricians to give definite expression to certain fixed principles as the basis of their science. Aristotle himself is the authority for this assertion, when, in his treatise *De Cœlo*, iii. 4, he speaks of the advantage of having definite principles of demonstration, and these as few as possible, such as are postulated by mathematicians (καθάπερ ἀξιοῦσι καὶ οἱ ἐν τοῖς μαθήμασιν), who always have their principles limited in kind or number. The passage is decisive on the point of general mathematical usage, and so distinctly suggests the very word axiom in the sense of a principle assumed or postulated, that Aristotle's repeated instance of what he himself calls by the name—If equals be taken from equals, the remainders are equal—can hardly be regarded otherwise than as a citation from recognised mathematical treatises. The conclusion, if warranted, is of no small interest, in view of the famous list of principles set out by Euclid, which has come to be regarded in modern times as the typical specimen of axiomatic foundation for a science.

Euclid, giving systematic form to the elements of geometrical science in the generation after the death of Aristotle,

propounded, at the beginning of his treatise, under the name of ὅροι, the definitions with which modern readers are familiar; under the name of αἰτήματα, the three principles of construction now called postulates, together with the three theoretic principles, specially geometrical, now printed as the tenth, eleventh, and twelfth axioms; finally, under the name of κοιναὶ ἔννοιαί, or common notions, the series of general assertions concerning equality and inequality, having an application to discrete as well as continuous quantity, now printed as the first nine axioms. Now, throughout the *Elements*, there are numerous indications that Euclid could not have been acquainted with the logical doctrines of Aristotle: a most important one has been signalised in the article ANALYSIS, and, in general, it may suffice to point out that Euclid, who is said to have flourished at Alexandria from 323 (the year of Aristotle's death) to 283 B.C., lived too early to be affected by Aristotle's work—all the more that he was, by philosophical profession, a Platonist. Yet, although Euclid's disposition of geometrical principles at the beginning of his *Elements* is itself one among the signs of his ignorance of Aristotle's logic, it would seem that he had in view a distinction between his postulates and common notions not unlike the Aristotelian distinction between αἰτήματα and ἀξιώματα. All the postulates of Euclid (including the last three so-called axioms) may be brought under Aristotle's description of αἰτήματα—principles concerning which the learner has, to begin with, neither belief nor disbelief, *Post. Anal.*, i. 10, 6); being (as De Morgan interprets Euclid's meaning) such as the "reader must grant or seek another system, whatever be his opinion as to the propriety of the assumption." Still closer to the Aristotelian conception of axioms come Euclid's common notions, as principles "which there is no question every one will grant" (De Morgan). From this point of view, the composition of Euclid's two lists, as they originally stood, becomes intelligible: be this, however, as it may, there is evidence that his enumeration and division of principles were very early subjected to criticism by his followers with more or less reference to Aristotle's doctrine. Apollonius (250–220 B.C.) is mentioned by Proclus (*Com. in Eucl.*, iii.) as having sought to give demonstrations of the common notions under the name of axioms. Further, according to Proclus, Geminus made the distinction between postulates and axioms which has become the familiar one, that they are indemonstrable principles of construction and demonstration respectively. Proclus himself (412–485 A.D.) practically comes to rest in this distinction, and accordingly extrudes from the list of postulates all but the three received in modern times. The list of axioms he reduces to five, striking out as derivative the two that assert inequality (4th and 5th), also the two that assert equality between the doubles and halves of the same respectively (6th and 7th). Euclid's postulate regarding the equality of right angles and the other assumed in the doctrine of parallel lines, now printed as the 11th and 12th axioms, he holds to be demonstrable: the 10th axiom (regarded as an axiom, not a postulate, by some ancient authorities, and so cited by Proclus himself)—Two straight lines cannot enclose a space—he refuses to print with the others, as being a special principle of geometry. Thus he restricts the name axiom to such principles of demonstration as are common to the science of quantity generally. These, he then declares, are principles immediate and self-manifest—untaught anticipations whose truth is darkened rather than cleared by attempts to demonstrate them.

The question as to the axiomatic principles, whether of knowledge in general or of special science, remained where it had thus been left by the ancients till modern times, when new advances began to be made in positive scientific inquiry and a new philosophy took the place of the peripatetic system, as it had been continued through the Middle Ages. It was characteristic alike of the philosophic and of the various scientific movements begun by Descartes to be guided by a consideration of mathematical method—that method which had led in ancient times to special conclusions of exceptional certainty, and which showed itself, as soon as it was seriously taken up again, more fruitful than ever in new results. To establish philosophical and all special truth after the model of mathematics became the direct object of the new school of thought and inquiry, and the first step thither consisted in positing principles of immediate certainty whence deduction might proceed. Descartes accordingly devised his criterion of perfect clearness and distinctness of thought for the determination of ultimate objective truth, and his followers, if not himself, adopted the ancient word axiom for the principles which, with the help of the criterion, they proceeded freely to excogitate. About the same time the authority of all general principles began to be considered more explicitly in the light of their origin. Not that ever such consideration had been wholly overlooked, for, on the contrary, Aristotle, in pronouncing the principles of demonstration to be themselves indemonstrable, had suggested, however obscurely, a theory of their development, and his followers, having obscure sayings to interpret, had been left free to take different sides on the question; but, as undoubtedly the philosophic investigation of knowledge has in the modern period become more and more an inquiry into its genesis, it was inevitable that principles claiming to be axiomatic should have their pretensions scanned from this point of view with closer vision than ever before. Locke it was who, when the Cartesian movement was well advanced, more especially gave this direction to modern philosophic thought, turning attention in particular upon the character of axioms; nor was his original impulse weakened—rather it was greatly strengthened—by his followers' substitution of positive psychological research for his method of general criticism. The expressly critical inquiry undertaken by Kant, at however different a level, had a like bearing on the question as to the nature of axiomatic principles; and thus it has come to pass that the chief philosophic interest now attached to them turns upon the point whether or not they have their origin in experience.

It is maintained, on the one hand, that axioms, like other general propositions, result from an elaboration of particular experiences, and that, if they possess an exceptional certainty, the ground of this is to be sought in the character of the experiences, as that they are exceptionally simple, frequent, and uniform. On the other hand, it is held that the special certainty, amounting, as it does, to positive necessity, is what no experience, under any circumstances, can explain, but is conditioned by the nature of human reason. More it is hardly possible to assert generally concerning the position of the rival schools of thought, for on each side the representative thinkers differ greatly in the details of their explanation, and there is, moreover, on both sides much difference of opinion as to the scope of the question. Thus Kant would limit the application of the name axiom to principles of mathematical science, denying that in philosophy (whether metaphysical or natural), which works with discursive concepts, not with intuitions, there can be any principles immediately certain; and, as a matter of fact, it is to mathematical principles only that the name is universally accorded in the language of special science—not generally, in spite of Newton's lead, to the laws of motion, and hardly ever to scientific principles of more special range like the atomic theory. Other thinkers, however, notably Leibnitz, lay stress on the ultimate principles of all thinking as the only true axioms, and would contend for the possibility of reducing to these (with the help of definitions) the special principles of mathematics, commonly allowed to pass and do duty as axiomatic. Still others apply the name equally and in the same sense to the general principles of thought and to some principles of special science. In view of such differences of opinion as to the actual matter in question, it is not to be expected that there should be agreement as to the marks characteristic of axioms, nor surprising that agreement, where it appears to exist, should often be only verbal. The character of necessity, for example, so much relied upon for excluding the possibility of an experiential origin, may either, as by Kant, be carefully limited to that which can be claimed for propositions that are at the same time synthetic, or may be vaguely taken (as too frequently by Leibnitz) to cover necessity of mere logical implication—the necessity of analytic, including identical, propositions—which Kant allowed to be quite consistent with origin in experience. The question being so perplexed, no other course seems open than to try to determine the nature of axioms mainly upon such instances as are, at least practically, admitted by all, and these are mathematical principles.

That propositions with an exceptional character of certainty are assumed in mathematical science is notorious; that such propositions must be assumed as principles of the science, if it is to be at once general and demonstrative, is now conceded even by extreme experientialists; while it is, farther, universally held that it is the exceptional character of the subject-matter of mathematics that renders possible such determinate assumption. What the actual principles to be assumed are, has, indeed, always been more or less disputed; but this is a point of secondary importance, since it is possible from different sets of assumption to arrive at results practically the same. The particular list of propositions passing current in modern times as Euclid's axioms, like his original list of common notions, is open to objection, not so much for mixing up assertions not equally underivative (as the ancient critics remarked), but for including two—the 8th and 9th—which are unlike all the others in being mere definitions (viz., of equals and of whole or part). Being intended as a body of principles of geometry in particular within the general science of mathematics, the modern list is not open to exception in that it adds to the propositions of general mathematical import, forming Euclid's original list, others specially geometrical, provided the additions made are sufficient for the purpose. It does, in any case, contain what may be taken as good representative instances of mathematical axioms both general and special; for example, the 1st, Things equal to the same are equal to one another, applicable to all quantity; and the 10th, Two straight lines cannot enclose a space, specially geometrical. (The latter has been regarded by some writers as either a mere definition of straight lines, or as contained by direct implication in the definition; but incorrectly. If it is held to be a definition, nothing is too complex to be so called, and the very meaning of a definition as a principle of science is abandoned; while, if it is held to be a logical implication of the definition, the whole science of geometry may as well be pronounced a congeries of analytic propositions. When straight line is strictly defined, the assertion is clearly seen to be synthetic.) Now of such propositions as the two just quoted it is commonly said that they are self-evident, that they are seen to be true as soon as stated, that their opposites are inconceivable; and the expressions are not too strong as descriptive of the peculiar certainty pertaining to them. Nothing, however, is thereby settled as to the ground of the certainty, which is the real point in dispute between the experiential and rational schools, as these have become determinately opposed since the time and mainly through the influence of Kant. Such axioms, according to Kant, being necessary as well as synthetic, cannot be got from experience, but depend on the nature of the knowing faculty; being immediately synthetic, they are not thought discursively but apprehended by way of direct intuition. According to the experientialists, as represented by J. S. Mill, they are, for all their certainty, inductive generalisations from particular experiences; only the experiences are peculiar (as already said) in being extremely simple and uniform, while the experience of space—Mill does not urge the like point as regards number—is farther to be distinguished from common physical experience in that it supplies matter for induction no less in the imaginative (representative) than in the presentative form. Mill thus agrees with Kant on a vital point in holding the axioms to be synthetic propositions, but takes little or no account of that which, in Kant's eyes, is their distinctive characteristic—their validity as universal truths in the guise of direct intuitions or singular acts of perception, presentative or representative. The synthesis of subject and predicate, thus universally valid though immediately effected, Kant explains by supposing the singular presentation or representation to be wholly determined from within through the mind's spontaneous act, instead of being received as sensible experience from without; to speak more precisely, he refers the apprehension of quantity, whether continuous or discrete, to "productive imagination," and regards it always as a pure mental construction. Mill, who supposes all experience alike to be passively received, or, at all events, makes no distinction in point of original apprehension between quantity and physical qualities, fails to explain what must be allowed as the specific character of mathematical axioms. Our conviction of their truth cannot be said to depend upon the amount of supporting experience, for increased experience (which is all that Mill secures and secures only for figured magnitude, without psychological reason given) does not make it stronger; and, if they are conceded on being merely stated, which, unless they are held to be analytic propositions, amounts to their being granted upon direct inspection of a particular case, it can be only because the case, so decisive, is made and not found—is constituted or constructed by ourselves, as Kant maintains, with the guarantee for uniformity and adequacy which direct construction alone gives. Still it does not therefore follow that the construction whereby synthesis of subject and predicate is directly made is of the nature described by Kant—due to the activity of the pure *ego*, opposed to the very notion of sensible experience, and absolutely *a priori*. As we have a natural psychological experience of sensations passively received through bodily organs, we also have what is not less a natural psychological experience of motor activity exerted through the muscular system. Only by muscular movements, of which we are conscious in the act of performing them, have we perception of objects as extended and figured, and in itself the activity of the describing and circumscribing movements is as much matter of experience as is the accompanying content of passive sensation. At the same time, the conditions of the active exertion and of the passive affection are profoundly different. While, in objective perception, within the same or similar movements, the content of passive sensation may indefinitely vary beyond any control of ours, it is at all times in our power to describe forms by actual movement with or without a content of sensation, still more by represented or imagined movement. Our knowledge of the physical qualities of objects thus becomes a reproduction of our manifold sensible experience, as this in its variety can alone be reproduced, by way of general concepts; our knowledge of their mathematical attributes is, first

and last, an act of conscious production or construction. It is manifestly so, as movement actual or imaginary, in the case of magnitude or continuous quantity; nor is it otherwise in the case of number or discrete quantity, when the units are objects (points or anything else) standing apart from each other in space. When the units are not objects presented to the senses or represented as coexistent in space, but are mere subjective occurrences succeeding each other in time, the numerical synthesis, doubtless, proceeds differently, but it is still an act of construction, dependent on the power we have of voluntarily determining the flow of subjective consciousness. Thus acting constructively in our experience both of number and form, we, in a manner, *make* the ultimate relations of both to be what for us they must be in all circumstances, and such relations when expressed are truly axiomatic in every sense that has been ascribed to the name.

Beyond the mathematical principles which may be thus accounted for, there are, as was before remarked, no other principles of special science to which the name of axiom is uniformly applied. It may now be understood why the name should be withheld from such a fundamental generalisation as the atomic theory in chemistry, even when we have become so familiar with the facts as to seem to see clearly that the various kinds of matter must combine with each other regularly in definite proportions: the proposition answers to no intuition or direct apprehension. At most could it be called axiomatic in the sense, of course applicable to mathematical principles also, that it is assumed as true in the body of science compacted by means of it. The laws of motion, however, formulated by Newton as principles of general physics, not only were called by him axiomatic in this latter sense, but have been given out by others since his time as propositions intuitively certain; and, though it cannot seriously be pretended that there is the same case for ascribing to them the character of *a priori* truths, there must be some reason why the name of axiom in the full sense has been claimed for them alone by the side of the mathematical principles. The *a priori* character, it is clear, can only in a peculiar sense be claimed for truths which all the genius of the ancients failed to grasp, and which were established in far later times as inductions from actual experiments; Newton, certainly, in calling them axioms, by no means claimed for them aught but an experiential origin. On the other hand, it must be conceded that motion as an experience has in it a character of simplicity, like that belonging to number and form, consisting mainly in a clear apprehension of the circumstances under which the phenomenon varies, while, again, such apprehension is conditioned by the psychological nature of the experience, namely, that it is one depending on activity of our own which we can control, and does not come to us as bare passive affection which we must take as we find it. We do in truth make or constitute motion, as we construct number and space; moving, as we please, without external occasion, and, when apprehending objective movements, following these with conscious motions of our members. Notwithstanding, our proper motions far less adequately correspond to the reality of external motions than do our subjective constructions of space and number answer to the reality of things figured and numbered. With limited store of nervous energy and muscles of confined sweep, we cannot execute at all such continued unvarying movements as occur, at least approximately, in nature; we cannot, by any such combinations of movements as we are able to make, determine beforehand the result of such complex motions as nature in endless variety exhibits; nor, again, can we with any accuracy appreciate the relation between action and reaction by opposing our muscular organs to one another. We must wait long upon experience that comes to us, or rather, in face of the objective complexity presented by nature, sally forth to make varied experiments with moving things, and thereupon generalise, before anything can be determined positively respecting motion. This is precisely what inquirers, until about the time of Galileo, were by no means content to do, and they had accordingly laws of motion which were, indeed, devised *a priori*, but which were not objectively true. Since the time of Galileo true, or at least effective, laws of motion have been established inductively, like all other physical laws; only it is more easy than in the case of the others, which are less simple, to come near to an adequate subjective construction of them, and hence the claim sometimes set up for them to be in fact *a vriori* and in the full sense axiomatic.

It remains to inquire in what sense the general principles of all knowledge or principles of certitude may be called, as they often are called, axioms. The laws of Contradiction and of Excluded Middle, noted though not named by Aristotle, together with that formulated as the law of Identity, presupposed as they are in all consistent thinking, have, with a character of widest generality, also a character of extreme simplicity, and may fitly be denominated axioms in the sense of immediate principles. They stand, however, as pure logical principles, apart from all others, being wholly formal, without a shade of material content. There can be no question, therefore, of their certainty being guaranteed by a direct intuition, valid for all cases because fully representative of all; as little does there appear valid ground for calling them, in the proper sense, inductive generalisations from experience. They may rather be held to admit only of the kind of proof that Aristotle calls dialectical: whoever denies them will find that he cannot argue at all or be argued with; he cuts himself off from all part in rational discourse, and is no better, as Aristotle forcibly expresses it, than a plant. The like position of being postulated as the condition of making progress belongs to the very different principle or principles (which may, however, be called logical, in the wider sense) implied in the establishment of truth of fact, more particularly the inductive investigation of nature. Whether expressed in the form of a principle of Sufficient Reason, as by Leibnitz, or, as is now more common, in the form of a principle of Uniformity of Nature, with or without a pendant principle of Causality for the special class of uniformities of succession, some assumption is indispensable for knitting together into general truths the discrete and particular elements of experience. Such postulates must be declared to have an experiential origin rather than to be *a priori* principles, but experience may more truly be said to suggest them than to be their ground or foundation, since they are themselves the ground, express or implied, of all ordered experience. Their case is perhaps best met by pronouncing them hypothetical principles, and as there are no axioms—not even those of mathematics—that are thought of without reference to their proved efficiency as principles leading to definite conclusions, they may be called axiomatic on account of their extreme generality, however little they possess the character of immediacy.

The name axiom, at the end of the inquiry, is thus left undeniably equivocal, and it clearly behoves those who employ it, whether in philosophy or science, always to make plain in what sense it is meant to be taken. Before closing, it is, perhaps, necessary to add why, in dealing with the question of origin, no account has been taken of the doctrine of evolution which has become so prominent in the latest scientific and philosophical speculation. From the point of view of the present article, that doctrine has only an indirect bearing on the inquiry. If the conditions of experience as they are found in the