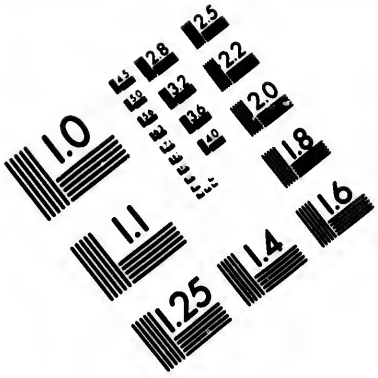

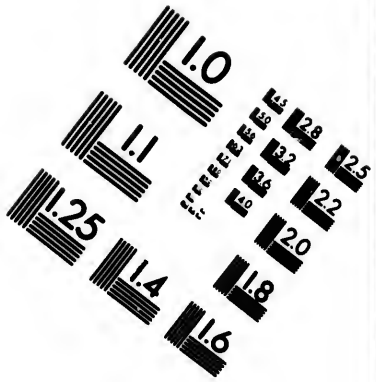

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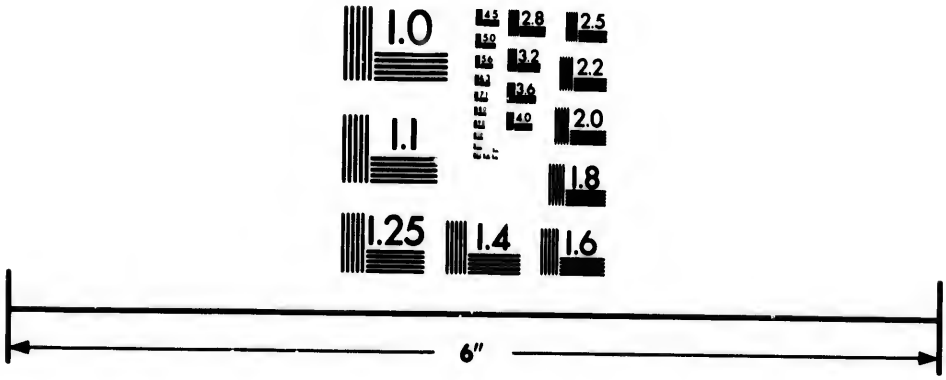

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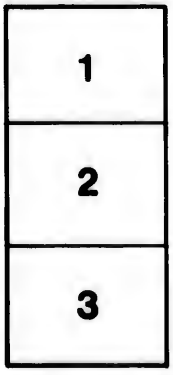

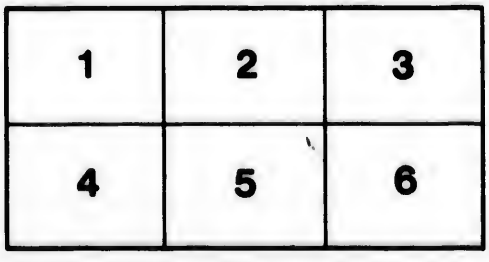

INTRODUCTION

TO AN

ESSAY ON SCIENCE.

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THE history of philosophy shews, that when the mind is gifted with knowledge, and energy in its pursuit, an observation, experiment, or idea, oftentimes reveals to it a further amount of knowledge, of which it had not previously any, or only a very vague, conception—oftentimes gives to it the first happy glimpse of a true definition, law, theory, science or method. We have instances of this in some of the noblest and most useful discoveries which have been made, and which at first by a mere chance were seen, and afterwards speculated on, verified or applied. Thus, a chance association disclosed to Archimedes in his bath a method for determining the specific gravities of bodies. Bacon speaks of his *Novum Organum*, as originating in a happy thought, and rather the product of time than of genius. Thus, the endeavour of Harvey to account for the use of the valves in veins,

led him to the discovery of the circulation of the blood. The apple which fell on Newton aroused his meditations on the subject of gravitation. A discussion on the nervous fluid, Locke tells us, gave rise to his Essay on the Human Understanding. A chance observation of Jenner led to vaccination, and of Galvani, opened the field of galvanism; and the unforeseen result of a lucky experiment, led Laennec to mediate auscultation. These may be taken as examples of the usual way by which gifted minds arrive at the laws of things observed, and by which, in many cases, they proceed from things known, to the determination of things previously ignored.

From which it appears, that in many cases it is not in our power to separate the origin of a science from its maturity; for in the attempt so to do, the science itself often vanishes, and we have left merely the thought or fact, which although the accidental incentive to investigation or discovery, or even fundamental in the science, was perhaps long before known alike to philosophers and to the multitude. And there seems as little reason in tracing, for example, the science of electricity to him who first noticed the attractive and repulsive actions between amber when rubbed and light bodies—whether he were a sage of Greece, or some fisherman on the shores of the Baltic—as there would be in tracing the science of universal gravitation to him who first observed the curve made by a projectile.

An accumulation of particular facts in the memory is one thing, and very different from a knowledge of their causes by a rigid induction: the former, by itself, cannot constitute science; the other supposes the former, and also it supposes science—for without knowledge, facts would accumulate to little purpose and fruition; and knowledge without facts would be vague. With both conjoined, we are enabled to copy nature by art, and to prove the coincidence of phenomena under one or other more or less general law.

Science, then, in the true acceptation of the term, requires for its rise and progress an understanding fitly trained in the investigation of the causes of particular phenomena, and consists of two parts inseparably united: (1), that which relates to practice; and, (2), that which relates to theory. The practical part is not only that from which the theory is derived, but also that to which it tends; as by arts and other inventions a theory is made useful, and its soundness determined. In other words, as the theoretical part arises out of the practical, so the mind must be initiated into the latter, and follow and solicit nature therein, before it can arrive at the other. And after such scholarship only, it is enabled, in many cases, to find out and to set in order a truly natural theory, which disclosing the secrets of Nature's operations on the one hand, points out on the other a more or less easy process of obtaining artificially, either a close imitation or

an original adaptation of natural contrivances. And as in the world without us, there is no object absolute, save God alone, but every thing which is, derives somewhat from other beings and things with which it is surrounded: so also in philosophy, each branch, though different in name, is in reality of one nature and family. And an adequate definition of any science must be in accordance with these principles. Thus, chemistry, for example:—(1st). Its practical part is to simplify compound, and to compound simple bodies; and to find out the qualities and differencing marks of bodies simple and of bodies compound. (2nd). Moreover, its object is to determine, as far as possible, those fundamental principles or laws which regulate every variety of natural separation and combination between bodies, and this constitutes the theory. (3rd). Still further, it receives support from other branches of philosophy—as heat, light, gravity, electricity, &c., and these are the sources of its strength and increase. (4th), and lastly. Its application to arts, as medicine, agriculture; and to manufactures, as to the making of sulphuric acid, steel, glass, sugar, &c., constitutes its final cause or use. And the like definition holds true, and may be given of every other science, by merely transposing the objects, laws, and ends of chemistry, for those objects, laws, and ends peculiar to the science to be defined.

Thus, the science of metaphysics: its practical

part is the consideration of objects abstracted from all particulars (time, place, quantity, &c.), as—God, space, eternity, matter, mind, motion, time, and the like; its theory, the consideration of their necessary laws. It abstracts therefore its objects from all things. Its further use is to enable us to conceive a law, theory, cause, &c., to account for particular phenomena, which we test by observation or experiment.*

Natural sciences are derived from natural philosophy, aptly termed the mother of them all; for it comprises the qualities and quantities, the motion and rest, the mechanism and uses of each and of every object, natural and artificial, of mind and of matter. And amid these particulars, it is for us to trace manifestations of order, principles of connexion—some design, which may lead us from less to more general and definitive marks and relations; to the classification of things similar, till by well-directed endeavours we are enabled to seize on those more silent and unobtrusive qualities which keep them in harmony as parts of a system together. And it is obvious, that from a few principles derived from qualities apparent or easily appreciated in

* "We have assigned to metaphysics the inquiry into formal and final causes. * * * That science is the worthiest which least chargeth man's understanding with multiplicity, and it is evident that that is metaphysics, as that which principally speculates those simple forms of things, which though they be few in number, yet in their commensurations and co-ordinations they make up all kinds of variety."—*Bacon Adv. of Learning.*

some objects, Nature, when closely watched, by the small number of the laws which she employs to produce different actions, reveals to us the existence of the same qualities in other objects, whether these be in most respects similar, or more complicated or more removed from experiment, or in which the qualities themselves looked for are less easily traced; oftentimes secures to us the powerful assistance of analogy, in lieu of the infinite repetition of analysis, or, in cases where analysis would be impossible; opens to us (after having ascertained her laws) a further and satisfactory view of other objects, in which those qualities inhere; and enables us to see onward, as through a glass, the relations of other things, and to determine them with more or less exactness, although individually and experimentally unknown. And thus, by means of a few natural principles, we are admitted to the knowledge of an almost infinite variety of things: as when we affirm gravitation throughout the planetary system; affinity in all chemical combinations of dissimilar bodies; neutrality in the union of an equivalent of acid and of base; combustion in all changes which take place in the combination of oxygen with (the so-called) simple bodies; a nervous system in play, wherever there is muscular action in living animals. And besides these discoveries, we may notice those admirable endeavours of philosophers, who, being in advance of the age in which they lived, and of direct

experiment, have endeavoured to understand or to define phenomena: as the two discoveries of Bacon, in his elaborate essay on the form of heat. (1). The definition of latent, or combined heat; proved experimentally by Black, more than a century after. (2). That the effects of time on, and the decomposition of some bodies, are the results of combustion; and this, some years before air was known to be a ponderable body, and a century before oxygen was found out in a separate state, or was experimentally known to play any part in combustion. Also the conclusion of Copernicus, that if his system were true, the planet Venus would appear at times horned like the moon—a conclusion afterwards verified. The conclusion of Lavoisier, from general considerations, that earths are but metallic oxides, irreducible by the methods employed, some time before Davy reduced them by galvanism. The well-known query of Newton, who from the similarity of the action of light on inflammable bodies, and on the diamond and water, deemed it highly probably that combustible elements existed in these last—afterwards ascertained experimentally by the Florentine academicians, and by Cavendish. The very hypothetical query (the germ as it were of a great discovery) of Gilbert, and of Bacon after him, whether a body at a certain distance from the earth might not lose all attraction for it, and never return—afterwards demonstrated by

Newton. Thus even in physics, the greatest efforts of human knowledge leave experiments in the rear; so much are they in error who assert, that the whole of philosophy consists in the experiment.

These things establish, that man is enabled by some rule, after observations made, to speculate truly concerning their causes; and this end is achieved, by bringing his speculations to some test, besides their agreement with metaphysical truth, and with the established rules of propositions and demonstrations—a test which assures him whether the cause assigned is remote or proximate; whether it enters into the nature of the thing sought, or is merely instrumental in its display or change—a test, in fine, which enables him to a certain extent to separate those occasional causes which the nature inquired after may exist without, from those causes which, entering into that nature, proclaim, that wherever it is, they must be. Such a rule is the following:—that Nature is true to herself in all her laws; that the same natural actions are regulated by the same intrinsic causes, through all time and in every place; that the truths of science remain the same, whenever and wherever the facts on which they rest are found; the same in one country as in another, in one being as in another, in the heavens as in the earth—the same yesterday and for ever. With this rule, we apply to Nature, not only for observa-

tions, but also for answers to our suppositions, theories, &c., and we then assume laws when her actions and our own speculations coincide.

Further, as we live in a system in which all things are related and mutually sustained—in which no one thing or action exists alone and independently—the law has been derived: That any efficient supposes a co-efficient, and that any action supposes re-action in things;* a law which from its universality contains, as it were, all other less general laws, being applicable alike to the demonstration of opposing forces, and to the laws which regulate the combination of bodies; equally true of all things inanimate as well as animate; of the cohesion of the molecules of a body, and of this, whether in motion or at rest; of the planets, reciprocally attracted in their revolutions; of iron, with the load-stone; of an acid with an alkali; of air with a plant; of food with its so-called assimilating juices; of consciousness with its object. By which law we discard from philosophy both the distinction made by the ancients, and adopted by some among the moderns between active and passive natures; and also that perplexing and interminable variety, set down by logicians, of efficient causes; or reserving some of them, merely to assist us in our search after the true or necessary, that is, the proximate efficients—which, as

* Newton's Principia.

Bacon expresses it, "give the forms or laws of things, and in which the power of man resides."

By which law we may, for the sake of example, infer the narrowness and unsoundness of the more modern doctrine, which makes the relation of cause and effect to be a relation—or a sort of priority and sequence — between a remote occasional efficient and some assigned nature, popularly termed the effect; a partial and one-sided view of a synthetical arrangement of dissimilar and incongruous things: as over-feeding or starvation, the cause of death; as an object of sense, the cause of pleasure or pain; as fire, or a liquid and cold acid, the cause of the liquefaction of iron, or of the explosion of gunpowder; thus leaving us as much in the dark as we were before of the nature of death, pleasure, pain, iron, gunpowder, &c.; whereas the true causes of these things will also be found in the part or organ which dies, and in the state or constitution of the being pleased or pained, and in the nature of the iron, which has its own peculiar laws or causes, and by which alone, at a given temperature and pressure, it liquifies, and with a given acid it combines; and gunpowder, having another nature, other causes act in it, by virtue of which it is decomposed, and its elements explode. For in physics the inquiry is into those efficients which are concealed and active in the thing itself; efficients which, when discovered, disclose to us at once the nature of

that effect, in the production and continued existence of which they equally, simultaneously, and of necessity participate.

It is, perhaps, not to be wondered at, that the ancient, and especially the Grecian, philosophers, who were such masters of the more abstract sciences—logic, metaphysics, geometry—should have made but little progress in physics, in the practical part of which our senses are our chief guides, and in which any practical difficulty that can be solved, is to be solved by experiment. In the former, the practical part is not so much in the world without us, as in our own minds, and among our own ideas; the mind, having already abstracted in great measure what it requires from external nature, now closes the eye upon it. In physical sciences, man is the observer of what passes without, and he tries as much as possible to separate his ideas from the external objects under observation; considering, for instance, light, heat and sound, as bodies or qualities in contradistinction to the sensations which they produce; drawing conclusions as if light were not luminous, but a subtle matter; and heat, a peculiar motion among the minute parts of bodies; and sound, as if not audible, but a vibration. Men, imbued with a metaphysical spirit, would—while a true method of experimenting was unknown—from the force of habit, look for the same sort of evidence, and search for truth in the same channels to which they had

been accustomed, and strive at once to reach the most general principles; and the cause which Thales assigned for the attraction between amber and light bodies—that the essence of amber was by friction transfused and imparted—is characteristic. And to the question, Is physics, as a science, possible? most Grecian philosophers would, in all probability, have answered, that its possibility rested on the capabilities of the human mind to find out the real essences of things, that without these, as Nature does not and cannot perform any action, so also without a knowledge of them we should be in the dark respecting her operations; that we must know how she binds, before we after her can put together—and how she separates, before we can put asunder; that as any demonstration requires that each step thereof should be linked to one or other proposition, the truth of which is intuitively known and thus the necessary truth of the demonstration determined; so also it would be required in physics, to know at starting those laws or axioms which Nature had proposed to herself, and by which she has contrived, worked, differenced, united, harmonized, and established all things; that it is not a vague and indeterminate knowledge of the real existence of such essences, as the only possible conditions of the existence of things, but a direct and discriminating insight into the manner of their existence and instrumentality. That in this way alone we could

arrive at truth in physics, and define an object without us, with accuracy, as we do a complex conception, or demonstrate the precise constitution, for instance, of a stone or of water, of the brain or of bile; or the real difference between lightning and our culinary fires, or between venous and arterial blood; as we demonstrate the properties of a triangle, or difference a particular from a universal syllogism. And it in all probability would not easily have occurred to their understandings, to leave out these essences altogether; or, at any rate, to consider them as unknown quantities in their investigations; and, instead of beginning where Nature began, to take the opposite plan, and to begin where she, having completed, left off (if we may so speak), among things the most obvious and superficial. By not following this course, the ancients were at the onset thrown on unsurmountable difficulties, or lost in visionary speculations: the harmony of numbers, the theory of atoms, starry influences, critical days, substantial forms, circular motions, occult qualities, unintelligible definitions, the elements of things, &c.; and thus physics, contrary to its everlasting foundations, was severed from Nature, and ingeniously built-up on imaginations and matters of opinion, in which man is rather the interpreter of his own thoughts, than the patient dissector and narrator of things, and the faithful and undisguised expositor of those laws which regulate them.

It is to this labor lost that Bacon, we presume, alludes in his definitive sentence, that "the ancient Greeks were like children, ripe at talk, but unripe in works;" and says he "if our complaint appear unjust to any one, while so great a philosopher as Aristotle, assisted by so great a prince as Alexander, has compiled such an exact history of animals, and while others have written copious histories on plants, metals, fossils, &c., he does not appear sufficiently to understand our meaning. A natural history compiled for its own sake is one thing, and a natural history collected for informing the understanding, in order to the building up of natural philosophy, is another." For by this, in the main, is added to natural history all those benefits which it is capable of conferring on mankind: and as he who first described the silk-worm or the cotton-plant, water, the load-stone, nitre, lightning, intermittent fever, &c, unquestionably did little in comparison for mankind with him who to the first, added the manufacturing of silk or cotton as a garment; or to the second, the use of water in the turning of wheels, and its adaptation to mills and machinery; or to the third, the mariner's compass; or to the fourth, gunpowder and its use in the art of war, and in mining, and the use of nitre as a diuretic and in inflammations; or to the fifth, lightning conductors; or to the sixth, a specific, as bark, for the cure of the disease: so those who wrote on natural his-

tory, for its own sake, did little in comparison with those who elevated it from a merely formal existence, and brought it to action and usefulness, and bound it to natural philosophy by the same ties that we are bound to health, enterprize and command.

This great change, which constitutes so remarkable an epoch in the history of the human mind, may be traced to causes and effects which had for a long while previously been in active operation; the chiefest of which, without doubt, was, the spread of Christianity in Western Europe—which applying another sort of evidence, and deciding at once, and by a revelation, on those great questions, which had till then engaged the attention and ingenuity of philosophers of all sects, and in all ages—the existence of God, the nature and immortality of the soul, the purest morality, the highest felicity. By answering these, on an authority which is infallible, and with a clearness and precision which brought them home to every one, and this not only on subjects which could be explored by human reason, as the necessary existence of God, and the sure immortality of the soul, thinking or unthinking; but also on those altogether out of the reach of unassisted human reason: as the providence and the mercy of God; the constant activity, the happiness or misery of the soul through immortality; added to this, a morality and felicity marked out for man here, in connexion with

those future prospects to be realized hereafter. This spoiled metaphysics of its chief charm, as a separate philosophy; and Christianity, created and enriched by revelation, took its place in the minds of men: an infinite boon conferred on mankind; and, in a worldly sense, a great gain to the illiterate believer, thus without previous training or preparation of the understanding, enlightened from above, and no loss in this life to the unbeliever who preferred the darkness of the old way; but the philosopher saw, that for reputation and usefulness, he must cast about for new paths—that it was absurd to set up a candle where men had the sun to guide them. How, then, was the restless and inquisitive spirit of man now to be satisfied, now that the objects of its greatest concernment here and hereafter to know, had received an illumination which set human reasoning and question at rest for ever?

Physics, indeed, in respect of its objects, was evident to the senses from the creation of the world, and doubtless admired. Man must, in many cases, have applied it with success. In a less remote antiquity it was dwelt on with delight, and considered worthy the devotion of the most exalted understandings. In the Egyptian temples, we are told, were placed the images even of brutes, that had by their instinct afforded lessons on inventions to mankind. The successful professors of medicine, and of other arts, were in many instances numbered among the gods. To

Archimedes (as is well known), for his skill in science, was intrusted the defence of Syracuse. To Aristotle, that he might compose a natural history of animals, was given power over all men who could assist him in Greece and Asia Minor. Hence, even in ancient times, it was not for the want of hope of physics, as a subject of great extent, and pregnant with usefulness, that men remained at a stand-still or advanced singly, or by chance, from first to last. It must, then, have been, either because their minds were pre-occupied by other, and still more fascinating investigations, or for the want of a method, which, as in all things, so in this chiefly, is required.

After the revival of learning in Europe, when the health of the body-politic gave occasion to the developement of a sound appetite for the increase of knowledge, towards the close of the sixteenth century, natural philosophy was pursued with extraordinary success by Gallileo, Des Cartes, Bacon, Kepler, &c. But ever and anon the want of a true method became apparent: imaginary speculations often took their place, side by side, as equally true and important with Nature's laws. Kepler, as if in mockery of his famous discoveries, revived the antiquated notion that the earth was animated, and that the tides were the effects of its respiration. Des Cartes sought for the cause of the blood's motion in the works of Aristotle. When Bacon, a severe observer of Nature, perceiving the

extreme insufficiency and inapplicability of the logic in use, and assisted by the few discoveries at his time known, and the few experiments which had been turned to useful purposes, opposed himself singly to destroy the rooted conceits of philosophers, which for nearly two thousand years had derived support from the decisions of Aristotle; and moreover published, and dedicated to mankind, his new method. This work, confessedly unfinished in its minor parts, had an immediate success; it was lauded by kings, and rivetted the attention of historians and philosophers; its natural simplicity and truth forced the logic of Aristotle to give way, and the title which he had so long held, of Nature's Secretary, was, by common consent, transferred to Bacon.