per cent. of the whole, were killed by after-damp, the remainder being killed instantaneously by violence. In nearly every case of death from after-damp, the parts of the skin or mucous membrane through which the colour of the blood could be observed, had a red or pink colour, instead of being leaden-blue or pale, as is the case in death from any other cause. This reddening, as seen in the face, hands, &c., often gave the bodies an extraordinary appearance of life. There seemed to be only one cause which could account for the carmine red colour of the blood, namely, the presence of carbon monoxide. To make certain, Dr. Haldane examined the blood from two of the bodies on the spot, by means of a spectroscope, and he found that not only was carbon monoxide present, but that the hæmoglobin was nearly saturated with it. A quantitative determination proved that in both bodies the hæmoglobin was 79 per cent. saturated. This result is of special interest, as it shows, for the first time, the percentage saturation of the blood at the moment of death from carbon monoxide poisoning.

The recognition of carbon monoxide in the air of mines is, as Dr. Haldane points out, a matter of much practical importance, and many lives have been lost through ignorance of the fact that the lamps, to which miners trust for the recognition of other gases, give no *direct* indication of carbon monoxide. A simple test, which there is every reason to think might be successfully introduced, is suggested: it is to observe the symptoms of a mouse or other equally small warm-blooded animal, when exposed to the doubtful atmosphere. In small animals the rate at which the blood becomes saturated with carbon monoxide is far more rapid than in man; hence a small animal, such as a mouse, shows the effects of the gas far more rapidly than a man. Practically speaking, the condition of a mouse which has been for a very short time in a poisonous percentage of carbon monoxide, indicates what will be the condition of a man carrying it after a much more prolonged stay in the same atmosphere. With a man at rest it takes about twenty times as long for the man as for the mouse to be distinctly affected by the gas. Dr. Haldane's experiments show distinctly how valuable the indications given by a mouse, or other small animal, would be to men exposed to danger from after-damp. It is therefore suggested that a few white mice might easily be kept for this purpose in the engine-room at the top of the downcast shaft, and be taken down in small cages by the rescue party.

Another point to which attention may briefly be directed is the colour-test described by Dr. Haldane for use in post-mortem examinations as a criterion for carbon monoxide poisoning. A drop of the blood of the subject is diluted with about 100 times its volume of water, and is compared with a solution of normal blood, and with a similar solution saturated with coal-gas. According to the percentage saturation of the sample of blood under examination, the tint of the first solution will approach to that of the normal blood, or of the blood saturated with coal-gas (that is, with carbon monoxide), and a rough estimate may be made of the percentage saturations. The test is said to be more delicate than that with the spectroscope.

INDIVIDUALITY IN THE MINERAL KINGDOM.[1]

IT might be expected of a new Professor that in his inaugural address he should avail himself of the possibly unique opportunity of an audience, and should give some account of his science and of the manner in which he proposes to teach it. In that case he would doubtless claim for his own subject that it is the most fascinating and the most important of all branches of human knowledge; he would doubtless, also, proceed to prove, to his own satisfaction, that it should be a necessary feature in any system of education.

It is well known that every specialist has an exaggerated view of the importance of his own subject; a view which is no doubt largely due to his ignorance of all others. I am deeply conscious of sharing this failing, and therefore do not propose to give any laboured account of mineralogical science; instead of stating exactly what in my opinion should be taught in this university, I will rather state presently what I think should not be taught; instead of attempting to *prove* that mineralogy possesses a true educational value, I will assume that this may be accepted without further argument from the very fact that it is recognised by the University.

[1] An inaugural lecture delivered at the University Museum, Oxford, by Henry A. Miers, F.R.S., Waynflete Professor of Mineralogy.

Perhaps none of the sciences is more of a special subject than mineralogy, in this sense—that it is familiar to few besides those who have made it their particular study; for this reason I may be pardoned if I assume total ignorance on the part of my hearers, and begin by removing a confusion which may possibly exist in the minds of many.

Mineralogy is not crystallography. Mineralogy is the study of minerals in all their relations, and from every point of view; it is a branch of natural history; the study of one class of natural objects, namely, all the inorganic parts of the earth, which we are accustomed to class together as the Mineral Kingdom. Crystallography, on the other hand, is a distinct science, and is the study of matter in the crystalline state, not being by any means confined to minerals; it is, like physics, or chemistry, or geology, one of the sciences whose aid is invoked in the study of minerals.

Since, however, the finest and most interesting examples of crystals have been found in the mineral kingdom, this study has been, by common consent, annexed by the mineralogist, and instruction in crystallography has been left entirely to him. The result has been in some ways disastrous; crystallography is in reality as essential to the student of chemistry or of physics as it is to the mineralogist, and yet remains in general a sealed book to them. They have been reluctant to go to the mineralogist for information, and consequently they have failed to make the acquaintance of crystallography. In this connection I may quote the forcible words of Mr. Lazarus Fletcher: "It seems obvious," he says in an address delivered a few years ago, "that in a satisfactory system of education every chemist should be taught how to measure and describe the crystalline characters of the products which it is his fate to call into existence. A knowledge of the elements of crystallography, including the mechanics of crystal-measurement, ought to be made a *sine quâ non* for a degree in chemistry at every university."

To this I would add that crystallography is not merely a matter of theoretical interest to the chemist, but is absolutely essential for the practical determination and description of any compound. It will scarcely be believed that there is only one teaching institution in the British Isles where crystallography forms a necessary part of the chemical student's course, namely the Central Technical College in London, where I was invited some years ago by Prof. Armstrong to found a class in the subject, and where excellent work is now being done by Mr. Pope. That it is found necessary to insist upon this study in a technical college of all places in the world is surely a remarkable confession that this, like every pure science, is far from being devoid of practical application.

If we turn now to mineralogy proper, the practical value of this science is obvious without any explanation.

In mining and metallurgy we have subjects of vast commercial importance in which a knowledge of scientific mineralogy is most desirable.

In particular it would be a great advantage to this country if all who are sent out to hold official positions in new or distant lands, could receive some previous instruction in the study of minerals which are of economic importance. We should not then hear of ruby companies formed through sheer ignorance to exploit what subsequently proved to be red garnets, neither would valuable ore deposits be overlooked for years simply because no one among the early settlers was familiar with the aspect of the common metallic minerals. I have no doubt that a course of lectures upon the detection of gold, silver, and precious stones, would prove attractive even in Oxford in these days of mining adventure and speculation, and I would not deny that they might be of some service to those whose future work lies in India or the colonies, or to those who travel in little-known regions. But I feel very strongly that our business here is with general education, and that the later the date in any educational system to which extreme specialisation or technical training can be postponed the better it will be for the student.

For this reason mining and metallurgy, which belong to technical education, have in my opinion no more place in such a university as this than any other branch of industrial or applied science. We do not seek here in the matter of practical engineering to compete with the great engineering workshops, or in the matter of clinical instruction with the great London hospitals; and in the same way, we should no more expect or desire to compete here with mining or metallurgical schools than to teach the jeweller's art.

A university can best serve the cause of technical education teaching precisely those features of any science which can not well be learnt in later life, and yet are the very foundation of practical knowledge; to the engineer his abstract mathematics and physics, to the medical man his physiology and comparative anatomy. Nothing can better illustrate the enormous value to the manufacturer, for example, of a sound training in pure science than the manner in which Germany has taken the lead in certain chemical industries owing to the excellent scientific instruction received at the universities by the men employed in those industries. Or, to take another instance, it has been confessed by the electrical engineers that the marvellous rapidity with which their industry has grown is largely due to the fact that the mathematical theory had been mainly elaborated before electrical science found its application; there can be no doubt that years of blundering were saved by this fact, for the form and structure of the mechanism required could be almost from the first worked out by well-established principles instead of blind trials.

In the same way I believe that the study of scientific mineralogy has a very considerable value, both educational and practical.

For the successful pursuit of this science a student must combine no inconsiderable knowledge of chemistry, physics and crystallography, and must therefore be to some extent familiar with certain branches of mathematics; if he is further to study the interesting problems of the origin, growth and changes of minerals, he must also be acquainted with the kindred science of geology. There is no fear lest a student of mineralogy should too early become a specialist; as a branch of natural history his science encourages habits of minute observation, as an experimental science it involves accurate physical and chemical work. I am speaking, it will be understood, of scientific mineralogy, the study of the nature and properties of minerals in themselves quite independently of their uses and applications; one who is a master of these matters will not be slow to find the applications.

My predecessor in this chair always set before himself this high ideal, and during a period of forty years endeavoured to kindle among those who attended his lectures an interest in the more purely scientific aspects of mineralogy. As one of his pupils who, having conceived some degree of enthusiasm for the subject, was greatly encouraged by his inspiration, I am glad to have this opportunity of acknowledging my gratitude to Prof. Story-Maskelyne for directing the thoughts of his students in the ways of pure science; I believe it to be the proper course to pursue in the higher teaching at a university.

In this connection I should have been glad to devote the present address to the elucidation of a certain feature in mineralogy which has an educational interest; the fact, namely, that the order in which a subject can best be unfolded before a student's mind is very satisfactorily marked out by the historical development of the subject; that a profitable course of teaching is suggested by the history of a science; and that the order in which problems have presented themselves to successive generations is the order in which they may be most naturally presented to the individual.

It is a principle which comes out very forcibly in the case of mineralogy, and it may, for aught I know, be equally characteristic of other sciences.

First would come the examination of stones by all sorts of simple means; the study of the external characters by which they may be recognised; their colour and lustre; their hardness and weightiness; the methods of recognition employed by the miner; the system of study, in fact, which prevailed in the early part of the century, when the genius of Werner drew students from all parts of Europe to the Mining Academy of Freiberg; a system known as the natural history method. This is an exercise admirably adapted to train the faculty of inquisitive and careful observation in the schoolboy, and in my opinion should be unnecessary in the higher teaching of the science, although it does in an incongruous manner survive therein throughout the German and other universities.

Next, by a transition through the simpler chemical tests, the learner is led to the refined chemical analysis of minerals; a study to which far too little attention is paid at the present day, yet one from which the most fruitful results are to be expected.

Finally, as an inquiry suitable for the most advanced students, follows the investigation by exact methods of the internal structure and constitution of minerals; leading to such researches as are now being prosecuted in Oxford with remarkable success by Mr. Tutton.

Nothing can be more suggestive, from the educational point of view, than the curious history of mineralogy. An excellent account of the early phases is given in the "History and the Philosophy of the Inductive Sciences" of Whewell, who was, it will be remembered, Professor of Mineralogy at Cambridge before he became Professor of Moral Philosophy. But to dilate on these matters would be to do what I have already undertaken to avoid, to celebrate the educational virtues of my own science.

In choosing a subject to which I could more particularly devote an inaugural lecture, I have thought that one which is both interesting and suggestive, even from the scientific point of view, is to be found in the beauty of minerals. No one can glance through a collection of minerals, such as that which adorns this museum, without being impressed by their varied beauty of form and of colour; no one can read what has been written on the subject by Ruskin, without feeling that in their æsthetic aspect they possess a singular fascination. We are perhaps more familiar with them when they have been wrought into beautiful objects by the art of man; the beauty of marble and serpentine, of malachite and lapis lazuli, among decorative stones; that of sapphire and emerald and opal, among jewels; or of onyx and agate, among the less precious gem stones, is known to all. Yet their beauty is mainly that of the minerals themselves, and the hand of the artist does little more than make it visible. Few perhaps, save those who have had personal experience among minerals, are aware of their intrinsic beauty; let any visitor to a museum spend one half-hour among the mineral cabinets, and he will find his reward in the purely æsthetic pleasure to be derived from the contemplation of objects unrivalled in beauty of form and colour. The magnificent collection preserved in the British Museum is, of course, that from which the greatest pleasure can be derived; and in that collection there are no more interesting objects than the fine agates and chalcedonies brought together by Mr. Ruskin with the special purpose of illustrating their beauty of colour and structure. But even in a comparatively small collection like that of our university, there is much that will attract and gratify the eye.

Confronted by this wealth of beauty and interest, the reflective mind is led to propose to itself the question, What is the origin, and what is the object of all this beauty? what purpose does it serve in the economy of nature? In the beauty of the organic world it is possible to imagine both an origin and a purpose. The origin may conceivably be sought in utility. Even if it be denied that in the organic kingdom beautiful objects, whether plants, animals, or human beings, have become useful because they are beautiful, it may, at any rate, be suggested that they appear beautiful because they are useful. But in the mineral world it is altogether different; these wonderful spars and gems, with their infinite variety of form and colour, their intricate groupings of silky fibres and pearly flakes, may have been for ages hidden in dark recesses of the earth where they have led an unchanging existence; and when they are brought to the light of day for the use of mankind, we can admire their beauty, but we cannot see any purpose for which, or any process by which it has been acquired. It may be answered that herein is no cause for surprise; that there is no reason why inanimate objects should not be both beautiful and interesting in themselves apart from any teleological aspect; that, indeed, it is gratifying to find a branch of natural science into which utilitarian considerations do not enter. This may be so, but nevertheless the fact indicates a very remarkable distinction between minerals and other natural objects.

Let us pursue to its conclusion the inquiry which we have provoked, and see whither it leads us.

In the first place, I would point out that the distinction relates not only to the beauty, but to all the properties of minerals; we may equally inquire about them: What is their origin and what is their object? What purpose do they serve in the economy of nature? They have not been acquired by selection, they do not impart any advantage to the mineral itself.

The contrast between minerals on the one side, and animals and plants on the other, is very obvious. There is with the former no change or development, neither progress nor degeneration; no survival of the fittest, no variation of characters. They are perfect and complete, each in itself, immutable and immortal. No struggle for existence takes place in the mineral world as it does among the individuals of the animal and vegetable kingdoms.

It may be answered that this is natural, for such individuals do not exist in the mineral kingdom. In other objects which possess no individuality there is also no progress, and it is absurd to look for any development among ores, and stones, and rocks. That, however, is not so obvious.

Individuals exist in the mineral kingdom just as truly as they exist among animals and plants; each crystal is a distinct individual, capable of growth by itself, and independent of its fellows; each pursues its own existence; it is even in a sense capable of multiplication, for if a crystal growing from solution be broken in two, each half continues to grow as a distinct individual resembling in all respects the parent crystal.

Mutilate a growing crystal by breaking away one of its corners or edges, it will heal the fracture, restore the missing fragment, and become again a perfect crystal; thus asserting its individuality in an even more persistent manner than many a living organism. The experiment is one which may easily be performed with a crystal of alum.

Hence if a definition of life, or a distinction between organic and inorganic be based upon individuality, as it often has been, it will be exceedingly difficult to exclude crystals. This is precisely what many philosophical writers have found. One or two examples will suffice.

Schopenhauer, for instance, after stating that "in the inorganic kingdom of nature all individuality disappears," is obliged to confess that "the crystal alone is to be regarded as to a certain extent individual"; "in the forming of a crystal we see as it were a tendency towards an attempt at life." Having made this admission he goes on to say: "The crystal has only one manifestation of life, crystallisation, which afterwards has its fully adequate and exhaustive expression in the rigid form—the corpse of that momentary life." There is a constant tendency among philosophical writers to suggest that this individuality implies some relationship between life and crystallisation.

To take another illustration: St. George Mivart says that "in crystals and such forms as dolomite and spathic iron we have an adumbration of organic forms." There is a dubiously expressed feeling, even among writers upon evolution, that crystals may to some extent bridge over the great chasm between living and non-living objects.

Most striking and most surprising of the utterances upon this subject which I have encountered, considering its author, is a remark by Huxley in an article upon the origin of species, in which he says:—

"The inorganic world certainly has its metamorphoses and, very probably, a long Entwickelungsgeschichte out of a nebular blastema. Who knows how far that amount of likeness among sets of minerals in virtue of which they are now grouped into families and orders, may not be the expression of the common conditions to which that particular patch of nebulous fog which may have been constituted by their atoms, *and of which they may be in the strictest sense the descendants*, was subjected?"

What we are really led to see when we pursue further the comparison between minerals and organisms is not a resemblance, but an irreconcilable difference.

In the mineral world the forces of nature act upon the individual without producing any modification.

It is true that by chemical processes a crystal of olivine may have some of its constituents taken from it, and others added to it, whereby it becomes a totally different mineral, serpentine. Or by exposure to the air, a crystal of felspar is converted into crystals of a totally different mineral, china-clay; but until it is destroyed, there is no change or progress of the individual. Each remains, like Bishop Blougram, "calm and complete, determinately fixed, to-day, to-morrow and for ever." There is no response to external stimulus, no adaptation to environment.

The properties, the form, the beauty of living beings are due to continual interaction between external forces and the organism itself. In the organic world the teleological aspect, I imagine, can never be lost from sight; each individual works for its own salvation; unceasing change involves either unceasing progress or degradation. With the mineral this is not so. A crystal of natural quartz has doubtless been the same and has possessed the same properties for countless ages.

In an ever-changing world the crystal is a type of unchanging constancy—its properties remain as permanent as those of the very elements themselves.

The crystal and the organism differ herein, that in studying the latter we have to take into account not only the unknown properties of the organism itself, but the nature of its environment and the character of the forces to which it is subjected; whereas in studying the mineral, we find that its properties express only the nature of the crystal in itself, and are therefore the same whatever may be the conditions of its growth and existence.

When we pass from the crystal even to other inanimate objects, this is no longer the case; the beauty, the form, the characters of any other natural objects are the result partly of their inherent properties and partly of the forces which act upon them. They have been, to some extent at least, moulded by their environment. The form of a mountain is due partly to the nature of the rock of which it consists, partly to the action of the wind, the water, and the weather to which it is exposed. The curve of a coast-line and the contour of its cliffs are to be attributed partly to the durability or the weakness of the chalk or the slate of which it is composed, but partly also to the sweep of the prevalent currents, the direction of the winds, and the rise and fall of the tide.

In no character is this more conspicuous than in symmetry of form and character.

The symmetry of living things is obviously due largely to their environment or to their movement. The symmetry of a tree depends upon the fact that the conditions under which a root grows are different from those which prevail where the branches spread; the symmetry of a fish is intimately connected with the fact that it swims in one direction; the bilateral symmetry of a man can be, I presume, referred to a similar cause. There is no inherent symmetry which is absolutely independent of external force. Vary the conditions, and the symmetry of the organism is varied in response. But in the mineral it is otherwise—the symmetry is essential and inherent; it belongs to the mineral quite independently of external forces. In the study of crystals we are in an altogether unique manner brought face to face with the nature of the thing in itself; surely an uniquely interesting subject for study.

But the contrast can be pursued still further.

The symmetry of crystals is expressed not only in their external form, but in all their properties internal as well as external. They have been the object of much attention on the part of careful experimentalists using the most refined methods of modern physics, and the result has been to establish this fact in the most unmistakable manner. Their symmetry is one not only of external form, but of internal structure. Further it is of a peculiar character, which entirely differentiates crystals from all other things animate or inanimate. It absolutely distinguishes the crystalline individual from the organism. No crystal has the symmetry of any organism, no organism has the symmetry of any crystal.

The latter has recently been the subject of much geometrical investigation, which is probably unknown to others than mineralogists, and a very interesting and suggestive discovery has been made by geometers working independently in Germany, France, Russia and England. The physical study of crystals, their action upon heat, light and electricity, has disclosed another remarkable feature characteristic of them. They are without exception homogeneous. At any point within a crystal its properties are absolutely the same as those at any other point within the same individual. This must be due to homogeneity of structure.

Just as a man walking in an orchard of identical trees planted in a regular geometrical manner, the Roman quincunx for example, would not be able to distinguish one part of the orchard from another by reason of its homogeneity, so we must imagine that Clerk Maxwell's demon, able to transport himself from one point to another within a crystal among the crowd of molecules, or particles, or whatever they may be of which it consists, would not be able to distinguish the one spot from the other.

The geometricians have therefore inquired in what manner such a homogeneous structure can be symmetrical.

In other words, if you take an infinite number of identical things, no matter what they be—molecules, portions of matter, systems of forces, or anything else—and range them side by side, either parallel to each other, or facing different ways, or turned inside out; provided only they are so arranged that the distribution at any one part of the mass is the same as at every other part, what will be their symmetry? This is a purely geometrical problem. The solution leads in the most remarkable way to precisely that sort of symmetry which is characteristic of crystals and of nothing else. Hence it follows that the symmetry of crystals results from their homogeneity, and is not an independent feature.

The result of our inquiry has been, therefore, not to suggest any fanciful resemblance between life and crystallisation, but to disclose a fundamental difference; not to bridge over the chasm between animate and inanimate objects, but to widen the gulf.

Crystals are symmetrical individuals by virtue of their homogeneity. Organisms cannot be homogeneous in the same sense, or they would possess the symmetry of crystals. One is led to conclude that the organic individual is never homogeneous, but consists of parts which are essentially different, just as the head is different from the body, the leaf from the stem, or the shell from the kernel.

This I imagine to be the result to which biologists have been led by quite independent reasoning; every organic individual, even the simplest possible individual, the cell, whether animal or vegetable, consists of parts which are different; a nucleus, for example, and something distinct from the nucleus.

We may even proceed a step further, for more is implied in this homogeneity than mere similarity of parts. It is also necessary that the parts should not change places. A gas may be homogeneous by virtue of the rapid and irregular movements of its particles; it may be the same at every point, because it is throughout devoid of any orderly arrangement. But this is not the sort of homogeneity which leads to crystalline symmetry. In the case of crystals there can be no taking the average of crowds of irregularly moving particles, such as forms the basis of the kinetic theory of gases; there can be no talk of a drifting of Lucretian atoms, although this was actually put forward as a theory of crystal structure some years ago.

Lord Kelvin's Boyle lecture on crystal tactics, which was delivered in this very room three years ago, dealt with these subjects, and it will be remembered that a crystal was in that lecture regarded as constructed of a number of bodies placed side by side in regular order, and all facing the same way. There can be no doubt that the ultimate particles of a crystal are really in motion, but their motions must be so circumscribed that none encroaches upon its neighbour, and the crystal may therefore be regarded as constructed of immovable units. In contrast with this, I imagine that any organism, even any organic cell, consists of parts which are not only different, but possess differential motions; this fact is indicated, I presume, by the life of any organism, and its growth by intussusception.

Our final conclusion is, therefore, that the symmetry of a mineral differs entirely from that of an organism, and is due to its homogenity and the fixity of its parts. We have been led to something resembling, in some degree, the Homœomeria of Anaxagoras.

It is remarkable that the earliest writer concerning minerals, whose works have survived, uses language which might almost be applied to the discoveries of yesterday; Theophrastus, in his treatise on stones, says that the crystal must be regarded as formed by the concretion of matter pure and equal in its constituent parts, ἐκ καθαρᾶς τινὸς συνεστάναι καὶ ὁμαλῆς ὕλης.

Among modern writers, Herbert Spencer has most explicitly stated that there is some such distinction between living and non-living things. He says: "Matter has two solid states, distinguished as colloid and crystalloid, of which the first is stable and the second unstable. Organic matter has the peculiarity that its molecules are aggregated into the colloid and not into the crystalloid arrangement." This almost amounts to saying that matter which lives cannot crystallise, and that crystallisable matter cannot live.

You will now see that the inquiry with which we began has led us far from our starting-point, and that, under the guise of some reflections upon the beauty of minerals, I have really been inflicting upon you a dissertation upon one of the most abstruse problems of mathematical crystallography—that concerning the ultimate structure of crystals.

You will also see that having proposed the question—What is the origin and purpose of mineral beauty?—I have not been so foolish as to attempt an answer, or to explain why minerals are beautiful, but have merely asserted that their beauty, like all their other properties, cannot have been acquired, and that in this they differ from living things.

My object in venturing on this difficult subject was two-fold. In the first place, I was anxious to show that mineralogy, taken even on its most abstract and most highly specialised side, overlaps other sciences, even biology, with which it might be expected to possess absolutely nothing in common. It brings us face to face with problems relating to the nature of life. Those who study the nature of living things cannot afford to ignore the nature of crystals, any more than those who study the nature of crystals can ignore that of living things.

If to the chemist and physicist some knowledge of crystallography is an absolute necessity, to the biologist it is at any rate a matter of interest.

Those who heard Lord Kelvin's Boyle lecture will have realised both the importance and the difficulty of these speculations relating to the ultimate structure of crystals; speculations which have attracted the keenest interest among many acute thinkers.

It is often forgotten that the earliest scientific work of the great Frenchman, whose name is associated with some of the most magnificent biological discoveries of the age, was in this direction. Pasteur was, at the very outset of his career, attracted by the relation between crystallisation and life. He imagined that in a peculiar mode of symmetry which he discovered in certain crystals, he had found an essential difference between living and non-living material, and that only such crystals as present this particular symmetry are the products of life. It has now been proved that such a symmetry is one which results from crystalline homogeneity, and is therefore proper to crystals; but the interesting fact remains that Pasteur entered upon his study of organisms by the way of crystallography, and that the one was inextricably bound up with the other.

Buckle saw in the history of mineralogy the strongest confirmation of his own views upon organic life. He regarded the early discoveries of the great French mineralogist Haüy, concerning the form and structure of crystals, as one of the most important contributions "to the magnificent idea that everything which occurs is regulated by law, and that confusion and disorder are impossible." Referring to the remarkable power possessed by crystals, in common with animals, of repairing their own injuries, he says: "However paradoxical such a noticn may be, it is certain that symmetry is to crystals what health is to animals. When therefore the minds of men became familiarised with the great truth that in the mineral kingdom there is, properly speaking, no irregularity, it became more easy for them to grasp the still higher truth that the same principle holds good of the animal kingdom."

And this leads me to the second reason which I had for selecting my subject, namely, the excellent illustration which it affords of the manner in which each branch of human thought not only overlaps every other, but requires its support.

If philosophic writers can illustrate their views by misleading statements, it is because their illustrations are drawn from subjects with which they have little personal acquaintance, and because they have not consulted those who have made a special study of such subjects. It seems to me that here in Oxford, above all places, more might be done in the matter of mutual assistance, and I am thinking not so much of the aid which might be given by science to philosophy, as of the benefits which philosophy might confer upon science.

I have chosen for my text an instance in which philosophic writers have confused two very different things—the individuality of organisms, and the individuality of crystals, owing to their imperfect acquaintance with the latter. It would have been much easier and far more amusing to select instances in which the scientific specialist has fallen into worse confusion owing to his want of philosophic training.

In Oxford, with our magnificent school of Literæ Humaniores, it seems disastrous that the science student should not receive some of the crumbs that fall from her bounteous table—some encouragement to that philosophic habit of thought in which he acquires far too little training. I can only speak as a specialist, but with the knowledge of what my own subject has suffered through this need, and with the suspicion that this is equally the case with others. It is not for me to suggest how such an object could best be attained; but even if questions were asked in the final school of natural science which would encourage attendance at certain lectures on philosophy, I believe that science students would gain much thereby. It would, no doubt, be equally profitable for the philosophic student to gain some insight into the matters and methods of modern science.

I will conclude by quoting what Goethe has said about crystallography. "It is," he says, "not productive; it exists for itself alone, and leads to no results. The mind derives from it within limits a certain pleasure of satisfaction; its details are so manifold that it may be said to be in exhaustible." "For this reason," he adds, "it has powerfully attracted the acutest intellects, and has kept firm hold upon them."

As regards the want of practical application in this science, the words of Goethe are no longer true. Elsewhere he says: "There is a flavour of the monk or the old bachelor about crystallography, and therefore it is self-sufficient. Practical application in life it has none; its rarest objects—the crystallised precious stones—have to be cut and polished before we can adorn our ladies with them." But you will remember that crystallography means now much more than the study of external form; what is done by the lapidary is really much what is done by the scientific investigator—the result in both cases is to reveal the inherent but hidden beauty of the crystal.

It is, however, very true that there is a self-sufficiency about the science, and for a reason which I have already indicated: crystals can be considered as things which exist for themselves, since their nature is independent of their surroundings.

The philosophic contemplation of these beautiful and unchanging objects among the fleeting scenes of a restless world, does bring with it a philosophic content. Nowhere is the evidence of the permanent order that prevails in nature written in more lustrous and indelible characters than in the mineral kingdom.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE University of Utrecht has just celebrated its 260th anniversary by a series of brilliant *fêtes*.

MR. JOHN R. FELLOWS, of New York City, has given 5000 dols. to Notre Dame University to found scholarships.

THE University of Virginia, which suffered serious damage by fire last autumn, is being rebuilt on the plans of its founder, Thomas Jefferson, friends having subscribed a fund of 250,000 dols. for that purpose.

DR. FRANK P. GRAVES, of Brooklyn, has been unanimously elected president of the State University of Wyoming, located at Laramie. President Graves was born in 1869, and is probably the youngest college president in America.

THE *Electrical Review* states that the Baden Chamber has voted £30,000 to the Technical High School at Karlsruhe, to build a new electro-technical institute. The whole cost of the building projected, exclusive of the cost of the land, is estimated to be about £25,000. The building is to be commenced immediately, and it is expected to be ready for occupation in two years.

THE following are among recent announcements:—Dr. Paul Eisler to be professor of anatomy in the University of Halle; Dr. L. Joubin to be professor of zoology in the Faculty of Science at Rennes; Dr. H. Prous to be professor of zoology in the Faculty of Science in Lille; Dr. J. A. Wislicenus to be professor at the School of Forestry at Tarandt; Dr. G. Frege to be professor of mathematics at the University of Jena; Dr. H. Klinger to be professor of pharmaceutical chemistry in the University of Königsberg, and Dr. Scholl to be assistant professor of chemistry at Karlsruhe.

FOR the evening exhibitions in science and technology offered for competition by the Technical Education Board of the London County Council in April last, and the awards of which have recently been published, 285 candidates entered as compared with 256 last year. There is a similar increase in the number of awards, there being eighty-eight as compared with seventy-seven last session. The examiners' report: "The most noticeable feature was that the performance of candidates who selected such practical subjects as building construction, machine construction, plumbing, metal plate work, &c., was greatly superior, as a rule, to that of candidates who selected branches of pure or experimental science such as mathematics, physics, chemistry, &c." The second conspicuous fact brought to light is the complete want of ability on the part of most of the industrial candidates to deal with the simplest applications of arithmetic to their own trades. This is an old complaint of teachers of technical subjects, and the pity is that it seems as just now as ever. The children from elementary schools leave off their tuition with no knowledge of the principles of arithmetic, though some of them are experts in working ordinary "rules" as they learn to call them. The majority of the successful candidates consist of men engaged in engineering, building, carpentering and plumbing trades. It is to be hoped that one result of their work during the coming session will be to introduce them to those general principles of science on a knowledge of which a successful career in their various avocations most certainly depends.

A BRIEF history of the City and Guilds of London Institute has been received. A glance through the pamphlet should be enough to make members of the Corporation and Livery Companies of London proud of the part they have played in the advancement of technical education in this country since 1876, when, at a meeting of representatives of Livery Companies, it was resolved: "That it is desirable that the attention of the Livery Companies be directed to the promotion of education not only in the metropolis but throughout the country, and especially to technical education, with the view of educating young artisans and others in the scientific and artistic branches of their trades." It was this resolution which led to the foundation of the Institute in 1878. A few years later the Central Technical College—than which there is no more efficient institution for teaching the relations of science to industrial processes—was established. Other Colleges connected with the Institute are the Technical College, Finsbury, the South London Technical Art School, and the Leather Trades School. A very important part of the Institute's work consists of the technological examinations. These examinations have become a powerful agency in encouraging the establishment of technical schools and classes throughout the country, in assisting County Councils and other bodies in the organisation of their local schools and classes, and in securing the useful expenditure of the grants placed at their disposal under the Local Taxation Act, 1890. In 1881 the number of students in attendance at these classes was only 2500, but last year it reached 24,920. The Institute also takes part in establishing and assisting experimental classes in manual training, wood-work and metal-work, cookery, laundry-work, and housewifery, for boys and girls in elementary schools. For this provision and organisation of technical education in the metropolis and in the provinces, the total amount subscribed by the Livery Companies during the past eighteen years is, in round figures, £480,000, of which £150,000 has been expended on buildings and equipment, and the remainder on maintenance, scholarships, prizes, and grants-in-aid. The splendid work done by the various branches of the Institute more than justifies this expenditure.

ON Friday last the Prince of Wales was installed as Chancellor of the National University of Wales; and a large and brilliant company assembled at Aberystwith to witness this crowning of the movement for which educational pioneers in Wales have worked so zealously. After the installation, honorary degrees were conferred upon the Princess of Wales, Mr. Gladstone, Lord Herschell, and Lord Spencer. The three colleges comprised in the new University—Aberystwith, Cardiff, and Bangor—have all been founded within the last five-and-twenty years, and sums amounting to nearly £200,000 have been subscribed to support them. The Welsh people have from very early times shown a desire for knowledge, and now they have a truly national University they will doubtless take still greater pride in developing their heritage. The Vice-Chancellor, Principal J. Viriamu Jones, F.R.S., told the history of the foundation of the University to the Welsh National Society of Liverpool in November last, and a copy of his address, which is published at the offices of the *Western Mail*, Cardiff, was received a few days ago. The need for the University definitely emerged from a proposal adopted by the Cymmrodorion Section of the National Eisteddfod in 1887, that teachers in elementary schools should be trained at the University Colleges. The need was again felt when the Welsh Intermediate Education Bill became law in 1889, for a question which had to be considered in connection with the Bill was the nature and constitution of the authority to which the work of inspecting and examining the intermediate schools should be committed. For these reasons, and because educational pioneers in Wales felt that the existence of a national University was essential to the vitality of the colleges, the foundation of such a University was urged nine years ago, and now what was then ideal has become a fact. Some remarks by Principal Jones on the functions of a teaching University such as that of Wales are not without interest to those who cherish the hope that a teaching University of London may eventually be established. He says:—"It is certainly part of the ideal of any university institution that its professors should be leaders in the departments of scholarship or science which they profess, and that, as such, they should help to frame the courses of study leading to graduation.