THURSDAY, JANUARY 16, 1890.

THE NEW MUZZLING REGULATIONS.

AN essential fault of popular government is in danger of being exemplified just now by the possibility of the selfish interests of a few individuals attracting favourable attention, in utter opposition to the true interests of the nation at large.

A very reprehensible leading article which appeared in the *Standard* on the 4th inst., to which we shall presently refer in fuller detail, has started an agitation in the home counties, especially in Kent, in opposition to the valuable regulations recently issued by Mr. Chaplin against hydrophobia or rabies.

It is not uninstructive to review the way in which the issue of these regulations has been brought about, while it is a matter of painful interest to compare our position in England, as regards the prevalence of rabies, with that of some of the more advanced nations on the Continent.

Before M. Pasteur began his wonderful researches into rabies, the vast majority, even of the highly instructed public, regarded hydrophobia as a kind of Divine visitation, and rabies as a form of canine lunacy. Legislation, in the absence of that which has so frequently been called with a double meaning "a healthy despotism," necessarily lagged behind in the arrest of what everyone now knows to be a simple zymotic disease, which, enzootic in England, becomes, by steady increase during every few years of unchecked development, both epizootic and unfortunately epidemic.

The first advance towards rational prevention of the trouble was made in London in 1885–86 by the Chief Commissioner of Police, first by Sir E. Henderson, afterwards by Sir Charles Warren.

The result of their work is well known—namely, the temporary extirpation of rabies in London. In a country with more respect for scientific fact, such a benefit to the community would have been followed by the general establishment of preventive legislation throughout the centres of the disease, so as to arrest it completely; and this having been effected, the adoption of proper quarantine measures would alone of course have been required to free us for ever from the evil by preventing its re-introduction from abroad.

Partly owing to the fact that, until the most wise establishment by the present Government of a General Board of Agriculture, there was no special authority for moving in the matter, no such general action was taken. Lord Cranbrook, however, was earnestly convinced of the importance of the subject, and conferred a lasting benefit on all those interested in it by appointing that Select Committee of the House of Lords whose Report and evidence not only furnished a complete and exhaustive account of rabies, but also strongly emphasized the necessity of the adoption of thorough legislative measures, especially of muzzling, to prevent and eradicate the malady.

In the meanwhile, rabies in dogs, and of course concurrently its fatal attacks on men, steadily increased, until the spring of last year (1889) saw us threatened again in London with an epidemic like that of 1885.

All the large dog-owners and breeders who had experienced the manifest value of the regulations of 1885 called for the reinstitution of the muzzle, and at the present time the *Field*, *Fancier's Gazette*, &c., afford strong proof, in the earnestness of their expressions of satisfaction at the present muzzling order, of the folly of their contemporary who has endeavoured to oppose it.

Of course, as before, a few agitators, trading on the innate selfishness of some natures, and supported by the money of a small band of individuals whose names should be for ever preserved as having sought to work harm to their fellow-creatures, recommenced their irresponsible attacks on the authorities and others for this much-needed sanitary regulation, and it is a recrudescence of this selfish obstruction which the *Standard* has attempted for some (as yet unknown) reason to revive.

An amusing, if degrading feature of such opposition is the constant change of front which the inevitable progress of scientific truth forces upon these people, as their misstatements and ignorance become revealed to the public. At different stages of the agitation, their leaders, Miss Cobbe, "Ouida," and others, have stated with inexplicable self-contradiction, that no such disease as rabies existed, that it was wholly imaginary, that it was rare in England, that the police ran no risks in extirpating it, that the muzzle produced this (non-existent) disease, and so on to the end of the chapter. But while the logical difficulties in which these writers involve themselves must excite amusement, it is a matter of serious regret that they cannot be legally dealt with like other disseminators of false news, such for instance as those who in the wilderness of the "great gooseberry season" cry "'orrible murder" when homicide is *pro tem.* non-existent. The evil done by these latter is indeed small, compared with that of the far graver false statements which we have cited above.

In spite, however, of this flood of misrepresentations the muzzling regulations were enforced in London, and with notable benefit, and by the recent order they have been continued and extended by Mr. Chaplin, so as to cut right at the root of the evil, viz. in all the centres of the disease simultaneously.

It was with the consciousness that this measure would be required by the country of the President of the Board of Agriculture, that the anti-muzzlites made a last effort against it by holding a public meeting. The real nature of this agitation, which had been notorious from the commencement, was then made most amusingly conspicuous. We refer to the fact that this variety of obstruction is in truth only a branch of the anti-vivisectionist agitation, and worthy of such a parent stem. It seems that at the meeting an *amendment in strong support of muzzling* was carried by a majority of something like 80 per cent. The fact of the origin of the Association which had summoned the meeting having been alluded to, the Chairman, the Bishop of Ely, first (we are glad to see) repudiated the idea that he was an anti-vivisectionist, and then went on to say that the anti-vivisectionists had nothing to do with the anti-muzzling agitation. This repudiation on the Bishop's part was followed by the resignation of the originators of the movement, Miss Cobbe and others, demonstrating the truth of what we have just said and the inaccuracy of the Bishop's second statement.

The general facts bearing upon the origin and development of the agitation were fully exposed at the meeting, so that the strong expression of opinion in favour of the muzzling regulations (in conjunction with the disingenuousness of the argument of their opponents) is easily understood.

From a survey of the known behaviour of animals affected with rabies, and in accordance with the measures customarily adopted in dealing with infection among animals, where as in the present case it is not desirable to interfere with their free movement from place to place, Mr. Chaplin declared a number of counties as infected, taking areas around to provide sufficient margin against conveyance of contagion.

It is this wise and carefully-designed attempt to stamp out the disease, which the *Standard*, alone in the Press, has attacked in the most unmeasured language. Having no "case" from the scientific and medical stand-point, the editor through his leader-writers abuses his opponent's attorney (if Mr. Chaplin will forgive the simile). The Conservatives in Kent are positively called upon by the leading daily paper of their party to vote against their own Government, and why? Because they are asked to help stamp out rabies; and at what cost? it may be asked. None save that of the hire of a muzzle.

This is where the difficulty of our kind of Government arises. Because a solitary voice in the Press objects to a sanitary measure, which has nothing whatever to do with politics, ill-feeling is to be aroused among the voters. It is, however, satisfactory to add that possibly no such attempt on the part of any journal has ever met with such a chilling reception from the rest of its contemporaries—those who have not refrained from observations on the matter having only mentioned it to utterly condemn it.

A sanitary question, to our mind, becomes a question of moral right or wrong when the means proposed for its solution involve nothing beyond a little reasonable trouble, and it is this view of the matter which we fancy finally crystallizes out in the form of what is called public opinion. After the process of the actual experience of the last five years, public opinion is evidently set in the direction of preventing hydrophobia by muzzling. It is of course impossible that Mr. Chaplin should yield to this, the first abusive attack that has been made upon him in his official capacity, but certainly if anything should support him, it is the cognizance of the unworthiness of the opposition which the *Standard* has fomented against his action in the service of the community.

We should wish in conclusion to direct attention to certain obvious deductions which can justly be drawn from the history of this matter, and other events connected with the subject of rabies.

Both the prevention and the cure of this horrible zymotic malady are the outcome of close scientific experimental work. It was reserved for M. Pasteur to make clear and harmonize the various stages (always obscure and apparently contradictory at first) of our knowledge by the immense progress he inaugurated and carried out in the study of infection.

It is M. Pasteur who himself has pointed out better than anyone how the disease can be prevented from attacking man or animals, and he is the first who has shown in the slightest degree how it can be prevented from developing in the system after it has gained access to the body.

The nineteenth century, however, affords no shelter to the man of science to discover benefits for his fellow-men, for although the progress of knowledge has fortunately destroyed the Inquisition, yet society tolerates the existence of the anti-vivisectionist agitation, which not only scatters broadcast the foulest and falsest aspersions on such a man's life and character, but in its most recent development violently opposes the advance of hygiene.

POLYTECHNICS FOR LONDON.

WHETHER or not the London County Council comes to the wise decision to utilize the provisions of the new Technical Instruction Act, it is probable that for the most part Londoners will have to look for intermediate and higher technical instruction to other agencies than rate-aided schools, at all events in the immediate future. In these matters London is in an exceptional position as the capital of the Empire. In the first place, it is the natural home of the Normal Schools of Science and Art which form part of the machinery of the Science and Art Department. And, besides this, it is the centre of greatest activity of the organization of the City and Guilds Institute, whose three model Colleges are all situated within the metropolitan area.

The proportion, however, of the inhabitants of London whose education is affected by these higher institutions is necessarily small. The Government schools are imperial rather than local, and their situation is chosen regardless of the industrial needs of London. The Central Institution of the City and Guilds likewise belies its name by its situation at South Kensington. The other two schools of the City and Guilds, at Finsbury and Kennington, have a direct and most important relation to surrounding industries, and keep high the standard of what teaching in applied science and art ought to be. But teaching of this high order is very expensive, though the fees charged may be low, and of recent years a newer and more popular movement has sprung up, aiming at a lower standard of instruction carried on at less cost, and adapted, so far as practicable, to the benefit of the mass of working men.

The best type of such institutions in London is the so-called "Polytechnic" in Regent Street. The basis of the organization is the Young Men's Christian Institute started some years ago by Mr. Quintin Hogg. Round this nucleus he has gradually built up an institution in which evening classes, recreation, and gymnastics have all a part. Under his guidance the Institute has grown to great dimensions, and a number of very largely-attended classes of all kinds are now conducted in the building which for many years was occupied by the "Polytechnic" of the diving-bell and Prof. Pepper. Many of the classes are in general and commercial subjects, but there are science and art classes in connection with South Kensington, technological classes in connection with the City and Guilds Institute, and trade and practical classes in various industries and handicrafts. The greater part are held in the evening, but there are also day classes; and day schools for boys and girls are attached to the institution.

It will be seen that this experiment in technical education differs very materially in plan from that of such an institution as Finsbury College. The educational side of the Polytechnic does not form an organized school course so much as a set of classes among which a student may choose, and the standard aimed at is not so high. But there is this obvious advantage in taking the Polytechnic as a model for similar institutions that the instruction, so far as it goes, is far less costly than at Finsbury, being largely subsidized by science and art grants.

The example of the Polytechnic has been recently followed, with a certain amount of success, at the People's Palace in Mile End, where the Drapers' Company have devoted the funds which they have withdrawn from the City and Guilds Institute to building and endowing a school somewhat on the Polytechnic lines.

While these institutions have been developing, the Charity Commissioners have been engaged in pursuance of Mr. Bryce's Act of 1883 in framing a scheme for the application of the funds of the City parochial charities for the benefit of the working classes of greater London. The Commissioners came early to the determination to devote a large proportion of the proceeds of the charities to some educational purpose, and decided further that the main direction of the educational institutions thus established should be technical and industrial.

It is not our purpose to enter at all into the questions that have been raised as to the mode of division of the endowment between secular and ecclesiastical purposes, or the wisdom of tying up the greater part of the disposable funds in perpetuity. There are plenty of keen observers who will make their views felt on these questions; and indeed many champions of other schemes, such as the promotion of open spaces, are already in the field. But we must regard the main object to which the funds will be devoted as practically decided. The Charity Commissioners gave notice of it in their last Report, and little exception seemed then to be taken to the project. Since then large sums of money have been raised by local subscriptions on the faith of the proposal. It is too late now to advocate the application of the main part of the fund to any other object than education, and those who are agitating for such a change are, in our opinion, wasting their powder and shot.

But while the public is easily induced to join in a general outcry which, if it has any justification, certainly comes far too late, it is quite possible that, unless vigilant care is exercised, the final scheme may come into force without those alterations and improvements in detail which seem individually of small importance, but may make all the difference between a good and a bad scheme of technical education for London. The funds handled are far larger than those authorized to be raised for the whole of Wales under the new Intermediate Education Act. It behoves all friends of education to take care that these large endowments are used aright.

Let us glance, then, at the main outline of the scheme so far as it relates to technical education. The Commissioners were instructed under the Act to make provision for the "poorer classes." Consequently any technical schools established or aided under the scheme must aim directly at the benefit of the workman rather than that of the manager.

The Commissioners propose to devote large capital grants to the erection of technical and recreative institutes in various parts of London, somewhat on the model of the Regent Street Polytechnic, and to give a permanent endowment to these institutes, as well as to the Polytechnic and the People's Palace already in existence. Each institute is to be governed under a scheme, devised by the Charity Commission, and is to be subject to the general control of a Central Governing Body of Trustees.

The objects of the institutes are threefold. They are to be social centres, where concerts and entertainments may be given, and where outside clubs and working men's societies may have an opportunity of meeting; they are to include young men's and young women's institutes for social and recreative purposes, open to "young persons" between the ages of sixteen and twenty-five; and lastly, they are to provide for the educational wants of the working classes in the neighbourhood. Libraries, museums, swimming-baths, and gymnasia will form part of the equipment of most of these institutions.

It is with the educational work of these "Polytechnics" that we are here most directly concerned. But their educational and social sides must be very closely linked together, and the success of the classes will largely depend on the success of the institute as a whole. Entrance to the clubs may, under the scheme, be made contingent on entrance to the classes, as is now the case at the People's Palace, though such a course seems to us to be unwise. In any case we must not pass over the social side of the institutes without a word. The Young Men's Institute at the Polytechnic has been a great success, but it has been a growth of time, and it has grown round the nucleus of the Y.M.C.A. The social Institute at the People's Palace has sprung suddenly into existence, without the pre-existing nucleus; it is admitted to have been a failure, and is now suppressed. Can the lesson be mistaken? Doubtless the Charity Commissioners are alive to the difficulty. Their detailed regulations for the management of an institute, of which the draft has been published, are, in the main, carefully drawn. But those who hope that the scheme will result in the growth of a number of Palaces of Delight which will delight Mr. Walter Besant's heart will be doomed to disappointment. There will be no "People's Palaces"—only "*Young* People's Institutes." The present People's Palace will be constrained to confine its membership in future to persons between the ages of sixteen and twenty-five. Why this limitation? We see with pleasure that the Goldsmiths' Company, who are founding an institute at New Cross on somewhat the same model as those proposed by the scheme, have struck out the upper limit. There are far too many of these restrictions in the scheme. For example, smoking and dancing are (the latter with certain specified exceptions) forbidden. Surely details such as these can be left to the by-laws of the several institutes. Here, again, the Goldsmiths' Company have shown themselves in advance of the Charity Commission.

We have a similar criticism to make on the whole of the educational scheme. There is too little guidance in matters of principle, too much restriction in matters of detail.

Perhaps the most important thing to ensure is that the Central Governing Body shall be a strong body, exercising effective supervision over the teaching of the various institutes. Its official name ("Trustees of the City Parochial Charities") is unfortunate; it has too much of a flavour of Mr. Bumble's "porochial" office. It would require an Act of Parliament to change the name, so the best thing to do is to let it be forgotten. The Central Governing Body (for so let us call it) is to be representative of the Crown, the City Corporation, the County Council, the higher Colleges and University of London, the Ecclesiastical Commissioners (temporarily), and the Governing Bodies of the Bishopsgate and Cripplegate Foundations. No one can forecast the action of such a hybrid body until we know the actual men who are to be nominated. A very efficient educational body might be elected as proposed, and on the other hand it mightn't. It is to be hoped that one of the blots on the constitution of the Board—the absence of working-men representatives—will be partly corrected by the inclusion of some working-men leaders among the five Crown nominees. But it is impossible to resist the conviction that the suggested constitution—suitable enough to the time when the Act was passed and London had no organized system of local government—has far too little of the popular element, and that it would be far better to put the whole management of the scheme in the hands of the County Council, or a joint committee of the County Council and School Board.

Supposing that the Central Body is all that could be wished, the next thing to ensure is the satisfactory composition of the governing bodies of the various institutes, and their organic connection with the Central Body. It is essential that the schemes shall be so arranged that the educational programme of all the institutes shall pass through the hands of competent experts, and the educational work shall be adequately supervised, inspected, and revised, from time to time. The Charity Commissioners propose two methods of attaining this result. They give three nominations on each governing Board to the Central Governing Body, and these three members may be experts, though of this there is no guarantee. Further, the secretary of each institute is required to send to the secretary of the Central Governing Body a complete list of proposed classes a week before each term. This is presumably intended to give a power of suggestion, if not revision, to the Central Body, but what is the use of suggestions a week before term? What is wanted is a central committee of well-known experts to advise the Central Governing Body on educational matters. The committee should be small—say three scientific and three artistic representatives. They should be paid for their services, and should be in touch with the science and art divisions of every institute.

There is nothing in the scheme to prevent the appointment of such a Committee, though it would be well if some distinct suggestion of the kind were made. In any case it is a matter to be borne in mind and pressed when the time comes, for it may make all the difference in the world to the future of technical education in London. Let us be frank about the matter. How many men are likely in any given district to be on the governing body of the local institute who know the difference between good teaching and bad? And yet no scheme, however admirably drawn, will produce a good technical school, unless it is worked by such men. On the other hand, with a first-rate governing body we have little fear. Payment by results will lose most of its terrors if those in power know the difference between the incompetence which *cannot* earn grants, and the independence which prefers real teaching to cram. And we may add that it is only by associating with the governing body members engaged in local industries that the practical character of the trade classes can be assured.

So much for the machinery. We must next say a word about the character of the instruction to be aimed at in the institutions. It is to be mainly technical, and hence must be adapted to the special needs of each locality. It is by this time a truism to say that this adaptation will not be brought about by allowing a set of science and art teachers to take the line of least resistance through the South Kensington Directory to the goal of the maximum of grant. A lady is reported to have lately obtained a silver medal for agriculture at a London institution which the Charity Commissioners are proposing to endow. Is this adaptation to local needs and industries?

We wish sincerely that those responsible for the whole scheme had been able to arrange for exceptional treatment of the new institutes in the matter of the apportionment of the Government grant now paid on results. No better opportunity is likely to present itself for an experiment in basing grant on efficient inspection rather than on examination. But what chance is there of such a proposal when our Government departments responsible for public education are cut up into air-tight compartments without connection among themselves? The Charity Commission, the Education Department, and the Science and Art Department still form a great circumlocution office, and until this is altered abuses will continue, which it is nobody's business to remedy. Our great hope, therefore, depends on the choice of the principals, teachers, secretaries, inspectors, and governing bodies, who will make or mar the institutes through which, for many years, Londoners will derive their technical instruction. Let them be enlightened men, with broad views and sympathies, who know their business, or at least know their limitations, and all may be well. But if not, it were better that the whole scheme were put in the fire.

What, again, is to be the scope of the instruction? Is it to be mainly confined to the level of "elementary" science and "second-grade" art? Or are there to be advanced classes in more specialized subjects? Provision is made for such classes in the scheme if they can be arranged without trenching on the endowment. The Commissioners are probably afraid of misapplying funds intended for the poor to the benefit of the middle classes. There is justice in their objection, but such instruction can never be made self-supporting, and it is most important that it should be included in the programme of the institutes, if only to keep the standard high throughout. Here is then an opportunity for the City and Guilds Institute. Let it relieve itself of the charge of its examinations, which may now be transferred on equitable terms to the Science and Art Department under the provisions of the Technical Instruction Act, and let it also transfer to the Government the Central Institution, the geographical situation of which marks it out plainly as an adjunct rather than a rival to the Normal School, and let it apply the energy thus liberated in establishing in every "Polytechnic" a higher department, providing for the more specialized wants of each locality. This will be a work which no body is so well fitted to undertake as the great Institute which has been a pioneer in higher technical instruction. Such, it appears to us, is the true solution of the question of the relations between the Charity Commissioners' scheme and the City and Guilds of London.

One word of caution in conclusion. The new institutes should be allowed to grow, and not be started on too ambitious a scale at first. Local wants change, and the institutes should develop in harmony with their changes. This is the lesson of the old Mechanics' Institutes and Athenæums. The lesson is repeated in the newer experiments of Mr. Hogg's Polytechnic, and the People's Palace. We do not want to begin with erecting huge shells of bricks and mortar, hoping that life will somehow come into them after a time. The life first, then the buildings, to grow as it expands and deepens—that surely is the law of nature. "Several architectural white elephants" is the dismal but suggestive forecast of a writer in the *Charity Organization Review*, on the supposition that this law is violated. If these warnings are neglected, the promoters of the movement will be merely courting failure, however good their intentions may be. And they will have failed because "they were not poets enough to understand that life develops from within."

ASSAYING.

Text-book of Assaying. By C. Beringer and J. J. Beringer. (London: Griffin and Co., 1889.)

THIS text-book marks an important departure in the literature of assaying. The authors abandon the dreary details of traditionary methods, and attempt with success to rationalize the art of the assayer, rather than to follow the usual course of reproducing "dry" assay methods and elaborate classifications of processes the interest of which is only historical. Assaying is here treated, in a broad sense, as the determination, by analytical methods, of components of ores and of intermediate or finished metallurgical products. Such compounds may be either of value in themselves, or important from being valuable or injurious in the operations of smelting, or in adapting the metals for use.

The methods of the authors, and the measure of success which they have attained, may be fairly judged by their treatment of copper, lead, and iron. Copper ores and furnace materials are still sold in the English market by the "Cornish" assay. This antiquated method of assaying has really no claim to retention, now that more trustworthy methods are well known, and the authors give it but little prominence. They, however, repeat the fallacious argument of its apologists by stating that "it gives the purchaser an idea of the quantity and quality of the metal that can be got by smelting." The Cornish assay does not deserve even this modified approval, as the results it affords neither represent the actual amount of copper contained in the ore, nor the proportion of metal which can be produced by smelting, and several expert assayers, working on portions of the same samples, will obtain results which vary in the most erratic way. Fortunately for those who may be guided by this text-book, its authors proceed to describe assaying processes which are really well calculated to give trustworthy indications as to the quantity and quality of metal obtainable from ores. These are to be found in well proved "wet" methods of determining actual copper contained in ores as well as the components that interfere with the extraction and the quality of the metal. In describing these methods, ample information is given for the guidance of the smelter under the varying conditions of the metal's occurrence. While passing shortly over the Cornish assay, the authors judiciously omit such clumsy "wet" methods of assay as the direct titration by cyanide of potassium, which is retained in some recent books of standing, although it has been abandoned by most skilful assayers. On the other hand, titration by cyanide of potassium after separation of the copper from interfering metals, and the assay by electrolysis, leave little to be desired in rapidity and accuracy, and to these due prominence is given. Failing reasonable manipulative skill, no assay can be accurate, and the expertness demanded by those who conduct the "dry" or Cornish assay is not more easily acquired than is the analytical skill needed for better "wet" methods. In an assay method giving accurately the amount of metal actually present in the ore, the metallurgist has a sure basis for calculation, the results of which can be brought under the control of his experience as to the losses of metal in operations on a large scale. The results of the Cornish assay, with all its inherent uncertainty, have equally to be judged in the light of the smelter's experience as to what the final "out-turn" will be. In lead, again, the dry assay is usually treated in books on assaying with much elaboration, which is no longer useful, if it ever was. It gives results that indicate neither the actual amount of metal contained in the ore, nor the amount which will be produced by smelting, and like the Cornish assay for copper is most unsatisfactory for guidance in smelting. The wet methods of lead assaying which are described are convenient and trustworthy, while the only practically useful methods of dry lead assay are given in sufficient detail. In the assay of iron ores we find dry methods entirely omitted. The wisdom of this cannot be doubted, for the want of exactitude which is characteristic of the dry assay of copper and lead is still more marked in the dry assay of iron. Processes of wet assay capable of giving prompt and strictly accurate results are available, and these are fully described.

The plan of subordinating or ignoring unsatisfactory methods of assay, while giving prominence to those which have proved to be trustworthy, runs through the treatment of methods of assaying the other metals, as well as estimating the components of ores which are not usually dealt with in books on assaying. Among the latter are silica, the earths, sulphur, arsenic, and phosphorus. These demand study by the metallurgist, to whom, under either the necessity of "fluxing" them away, or of minimizing their interference with the purity of the metals, their ready and accurate determination is a matter of the greatest importance. The details of assaying the precious metals, though hardly sufficient for adoption in the assay of bullion in a mint, are all that is needed in a works.

The authors have clearly not been content to merely record published processes, but in order to add to the completeness of their work have given unpublished results of the experience acquired by themselves and others. The writer notices their description of a process for the estimation of arsenic in minerals and metals, which was devised by himself for use in works under his control, that has not hitherto been published. It consists in the separation of arsenic from its associations, by distillation with ferric chloride mixed with calcium chloride, and subsequent titration of the distillate by iodine. The authors are mistaken in stating that there is a difficulty in obtaining ferric chloride free from arsenic. Even if there were difficulties, it is obvious that the process itself affords a ready means of eliminating arsenic from the ferric chloride mixture, before using it in the actual assay. In this and one or two other cases, there is a tendency to adopt the always undesirable method of "blank" experiments to correct error arising from the use of impure reagents, rather than whenever practicable to avoid the source of danger by the use of pure materials. These are, however, hardly noticeable blemishes in a really meritorious work, that may safely be depended upon by those using it either for systematic instruction or for reference. THOMAS GIBB.

BREWING MICROSCOPY.

The Microscope in the Brewery and Malt House. By Chas. Geo. Mathews, F.C.S., F.I.C., &c., and Francis Edw. Lott, F.I.C., A.R.S.M., &c. (London and Derby: Bemrose and Sons, 1889.)

THERE are certainly few industries the growth and development of which have been more influenced by the progress of pure scientific discovery than those of the brewer and distiller. These industries, formerly carried on upon purely empirical lines, handed down from father to son through countless generations, have in recent years, through the advances in chemical and biological science, been so transformed that their successful conduct at the present time requires a most thorough acquaintance with the leading principles of these sciences. As a consequence of this change, we find an increasing tendency for these industries to become concentrated in a smaller number of hands each producing on a larger and larger scale. The small brewer himself lacking the necessary scientific training, and not able to afford the requisite skilled assistance, gives way before the larger breweries employing a complete scientific staff and provided with the latest improvements.

The present work is, we understand, intended to bring before those connected with brewing a concise account of the assistance which may be derived in the conduct of their business from the use of the microscope. We are of opinion that the authors have been unfortunate already in the choice of their title, as one of the most conspicuous results of modern scientific research in this direction is that the use of the microscope alone is of comparatively little value in the study of micro-organisms in general, whether connected with fermentation or other processes. This inadequacy of microscopic study *per se* the authors in various parts of their work indeed frankly admit. Modern students of these low forms of life have, in fact, become more and more aware of the fallacious results yielded by mere microscopical observation when unaccompanied and uncontrolled by those processes of cultivation which have been developed during the past ten years. Even the work performed under the auspices of the masterly genius and supreme experimental skill of Pasteur has had to be revised and brought up to date by Hansen, with the aid of the more recent methods of research. Now, although the authors appear fully aware of the great change which has taken place since the earlier work of Pasteur, Reess, Fitz, and others, they have not sufficiently distinguished between observations which rest upon the surest foundation and fulfilling the most modern requirements, and those which, though possibly correct, require repetition and confirmation.

The absence of sharp differentiation in this matter cannot fail, we believe, to occasion much confusion in the mind of the ordinary practical student who depends upon text-books and manuals for his guidance and information, and it is, in our opinion, quite unnecessary that he should be burdened with the microscopic descriptions of the various forms of yeast given by the older observers, who were almost certainly dealing with impure cultures, but on the contrary he should rather devote his whole attention to the characters of such undoubtedly pure forms of yeast as have been obtained by the most recent methods. Moreover, unless the necessity of resorting to these cultivation experiments for obtaining accurate information is duly impressed upon the student, he will naturally be inclined to shirk these far more laborious and difficult observations, and place undue reliance upon microscopic features.

These remarks apply, perhaps, with even greater force to the manner in which the authors have dealt with the schizomycetes; in this part of the book we find much space devoted to microscopic descriptions of bacteria of uncertain purity, whilst there is little or nothing said about the methods by which these organisms can be really identified, and their characters defined. We also miss any adequate account of the staining-processes which are so invaluable in obtaining a correct idea of the microscopic forms and dimensions of bacteria. As an instance of the unsatisfactory present condition of brewing microscopy, we may quote the following sentence: "*Bact. lactis*, as seen in beers, is generally in the form of small rods, 2 to 3 μ in length, and sometimes in threads containing from 2 to 5 individuals; it is not certain, however, that this form is *B. lactis*." Thus, in respect of the bacterium which is perhaps of most consequence to the brewer, as being "the most commonly occurring disease-organism encountered in the brewing process" there is this absolute lack of all precise information.

What may be called the more purely scientific part of the work is succeeded by a chapter of "general remarks on the brewing process," which, embodying as it does some of the practical experience of the authors themselves, we would have gladly seen enlarged.

The book, which is printed on excellent paper and elegantly got up, is illustrated with a number of admirably executed plates, many of the best of which are original.

A full index and glossary are appended.

OUR BOOK SHELF.

Flower-Land: an Introduction to Botany. By Robert Fisher, M.A., Vicar of Sewerby, Yorks. (London: Bemrose and Sons, 1889.)

THIS is a capital first book of botany, intended for small children. The style, however, is really more elementary than the matter, and a child who has mastered this book will have made a very good start in the science. There is a good deal of information given about the internal structure and function, as well as the external form, of the organs of plants, and this information is given correctly, as well as clearly.

The book is illustrated by 177 woodcuts, most of which are well suited to their purpose. D. H. S.

Five Months' Fine Weather in Canada, Western U.S., and Mexico. By Mrs. E. H. Carbutt. (London: Sampson Low and Co., 1889.)

IN this book Mrs. Carbutt records her experiences during a remarkably pleasant journey made by herself and her husband in the New World. The scenes she describes have often been described before, but she writes so brightly about what she saw that even readers to whom she has nothing new to tell will find a good deal to interest them in her narrative. They will be particularly pleased with her account of "sunny Mexico, and its merry, courteous people."

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Duke of Argyll and the Neo-Darwinians.

IT has a curious and not uninstructive effect to see the pages of this journal invaded by the methods of discussion which are characteristic of political warfare. The letter of the Duke of Argyll, published in NATURE for December 26, 1889 (p. 173) is a clever debating speech. But it rather obscures than illuminates the questions really at issue. And, after the fashion of the political orator, it attributes to those who disagree with the writer motives which, in so far as they differ from reasoned conviction, are essentially insincere.

In politics, the personal rivalry which is bound up inextricably with the solution of great problems may make it a necessary part of the game to endeavour to belittle one's opponents. But in science it is not so. The newer problems which have been raised by Darwinism depend for their solution upon the discussion of evidence, and no competent biologists will, in the long run, be influenced in the opinions they form about them by anything else.

There is nothing in the Duke's letter which has not been worn threadbare by discussion. Still, there are, no doubt, many readers of NATURE who, while taking a general interest in the matter, have not followed all that has been written about it. I am disposed to think, therefore, that it may not be without its use to go over the ground which the letter covers.

First, as to acquired characters. Let us take a simple case. It is admitted that a blacksmith, by the constant use of his arms, may stimulate their abnormal muscular development; that is an acquired character. But a working man, whose arms are of perfectly average dimensions, may nevertheless have a son with arms which would seem to mark him out for the blacksmith's profession; that would be a congenital variation. Now we know that a congenital variation is likely to be inherited; that is a matter of observation. What is the case as to the acquired character? The answer must be, I take it, that there is no probability that the arms of a blacksmith's son will differ in any respect from those of the average inhabitant in the locality where he was born. The Duke of Argyll, however, suggests that there is "no necessary antagonism between congenital variation and the transmission of acquired characters." This is perfectly reasonable; theoretically, there is none. But this does not make the transmission of acquired characters less doubtful. The Duke has no doubt about it, however. "So far from its being unproved, it is consistent with all observation and all experience. It lies at the foundation of all organic development." Very possibly, but where is the observation and where is the experience? These are *the* biological *desiderata* of the day. Imagine the fate at the Duke's hands of any scientific writer who put forward statements such as these unsupported by a shred of a fact.

"This being so," however, the question then arises, Why do extreme Darwinians so fiercely oppose the idea of the transmission of acquired characters? Well, it is obvious that they do so because they think the evidence in its favour insufficient, and it is clearly the duty of a scientific man, whether an extreme Darwinian or not, to oppose the acceptance of that which experience does not support. But the Duke of Argyll attributes their opposition to two causes: first, jealousy of associating the names of Lamarck and Darwin; and, secondly, the dethronement of their idol Fortuity. The first of these reasons is almost too preposterous to discuss. No serious naturalist would speak with other than respect of Lamarck's position in scientific history; this cannot be effaced however much that of Darwin may be magnified. And no serious naturalist would adhere to any theory Darwin had propounded a moment longer than the evidence seemed to carry conviction. The charge in this particular matter is, however, the more grotesque, because, although Darwin did not esteem as of much value Lamarck's doctrine of development and progression, we know that his own mind became more and more fluid on the question of the "direct action of conditions." The idea is in fact so plausible that the difficulty is not in accepting it, but in shaking oneself free from it. What were probably the last words which Darwin wrote on the subject are contained in a letter to Prof. Semper, dated July 19, 1881. I quote a passage which appears to me to pretty accurately define the present position of the question:—

"No doubt I originally attributed too little weight to the direct action of conditions, but Hoffmann's paper has staggered me. Perhaps hundreds of generations of exposure are necessary. It is a most perplexing subject. I wish I was not so old, and had more strength, for I see lines of research to follow. Hoffmann even doubts whether plants vary more under cultivation than in their native home and under their natural conditions ("Life and Letters," vol. iii. p. 345).

Darwin's difficulty, in point of fact, was exactly that of everyone else. The evidence, instead of being "consistent with all observation and all experience," failed to be forthcoming.

The second reason is equally baseless. Fortuity is no idol of the neo-Darwinians; if it is an idol at all, it is an "idol of the market," imposed upon their understanding by the Duke. But at any rate he does not attribute any blame to Darwin. And as this is a rather important matter, on which I admit that persons who ought to know better have gone astray, I will quote a passage on the subject from Prof. Huxley's admirable biography (Proc. Roy. Soc., No. 269):—

"Those, again, who compare the operation of the natural causes which bring about variation and selection with what they are pleased to call 'chance,' can hardly have read the opening paragraph of the fifth chapter of the 'Origin' (ed. 1, p. 131): 'I have sometimes spoken as if the variations . . . . had been due to chance. This is of course a wholly incorrect expression, but it seems to acknowledge plainly our ignorance of the cause of each particular variation.'"

It is obvious that the use of accidental in the guarded sense in which it is employed by Darwin is widely different from fortuitous as employed by the Duke of Argyll. Darwin took variation as a fact of experience. Its causes and laws have still to be worked out. One of the latter, due to Quetelet, was explained by Prof. George Darwin in this journal (vol. viii., 1873, p. 505). He says: "One may assume, with come confidence, that under normal conditions, the variation of any organ in the same species may be symmetrically grouped about a centre of greatest density."

And this is quite in accord with the remark of Weismann that variability is not something independent of and in some way added to the organism, but is a mere expression for the fluctuations in its type. Variation is therefore not unlimited, and we must admit with Weismann that its limits are determined by "the underlying physical nature of the organism;" or as he again puts it, "under the most favourable circumstances a bird can never be transformed into a mammal." There is something more therefore than blind chance at work here.

But within the limits, it is a matter of experience that every possible variation may occur. If anyone will take the trouble to examine the leaves of the ribbon-grass so commonly cultivated in gardens, he will find it impossible to obtain any pair in which the green and white striping is exactly alike. If it were possible to raise to maturity all the progeny of some prolific organism, the same diversity (in different degree, of course) would manifest itself; but the whole group of variations in respect of any one organ would obey Quetelet's law. When we attempt to give some physical explanation of this fact, we know from the objective facts which have been made out about fertilization that, although the protoplasmic content of the fertilized ovum is, in a general sense, uniform, its actual structure and physiological components must be combined in as endless variety as the green and white stripes of the leaves of the ribbon-grass. If, with Prof. Lankester, we say that the combinations are kaleidoscopic, I do not see that we go beyond the facts. And it appears to me quite permissible to correlate the ascertained variable constitution of the ovum arising from this cause with the equally ascertained varying structure of the organism developed from it.

Of the varied progeny, we know that some survive and others do not. And what Darwin has taught us is, that the reason of survival is the possession of favourable variations. The surviving race necessarily differs somewhat from its progenitors, and Darwin has further stated that it is probable that by the continued repetition of the process all the diversity of organic nature has been brought about.

The area of fortuity is narrowed down therefore, on this point of view, to the variable constitution of the individual ovum. And it is upon the recognition of this fact, for which there seems to be good scientific evidence, that the Duke of Argyll founds his charge that the neo-Darwinians make fortuity their idol. The reason appears to be that it comes into collision with teleological views. But such collisions are no new event in the history of the biological sciences. And teleology, like a wise damsel, has generally, though temporarily ruffled, managed to gather up her skirts with dignity and make the best of it. For some element of fortuity is inseparable from life as we see it. It is at the bottom one of the most pathetic things about it. Nowhere is this more vividly portrayed perhaps than by Addison in the "Vision of Mirzah." Yet I do not remember that anyone was ever so unwise as to taunt Addison with making fortuity his idol.

But, philosophically considered, what is gained by this tenacity about out-works? I reply, exactly as much as was gained by the tenacity of the Church in respect to the geocentric theory of the planetary system. Scientific men cannot be stopped in the application of their best ability to the investigation of Nature. If their conclusions are false, they will detect the falsity; if true, they will not be deterred from accepting them by some *a priori* conception of the order of the universe. It is not justifiable to say that this is due to any devotion to such an empty abstraction as fortuity. No scientific man is, I hope, so foolish as to suppose that, however completely mechanical may be his conception of Nature, he is in any way competent to account for its existence. The real problem of all is only pushed further back. And the Duke of Argyll's difficulty resolves itself into the old question, whether it is more orthodox to conceive of the universe as an automatically self-regulating machine, or as one which requires tinkering at every moment of its action.

It may be replied that this is all very well, but that it is not the way the neo-Darwinians state their case. I may be, therefore, excused for quoting some passages to the contrary from Weismann's "Studies in the Theory of Descent":—

"This conception represents very precisely the well-known decision of Kant: 'Since we cannot in any case know *a priori* to what extent the mechanism of Nature serves as a means to every final purpose in the latter, or how far the mechanical explanation possible to us reaches,' natural science must everywhere press the attempt at mechanical explanation as far as possible" (p. 638).

Further, he quotes from Karl Ernst von Baer:—

"The naturalist must always commence with details, and may then afterwards ask whether the totality of details leads him to a general and final basis of intentional design" (p. 639).

Again, he says:—

"We now believe that organic nature must be conceived as mechanical. But does it thereby follow that we must totally deny a final universal cause? Certainly not; it would be a great delusion if anyone were to believe that he had arrived at a comprehension of the universe by tracing the phenomena of Nature to mechanical principles" (p. 710).

In truth, this revolt of teleology against Darwinism is a little ungrateful. For, if Darwinism has done anything, it has carried on and indefinitely extended its work. In the last century, teleology was, it seems to me, a valuable motive-power in biological research. Such a book as Derham's "Physico-Theology" (1711) may be read with interest even now. I well remember that my first ideas of adaptive structures were obtained from the pages of Paley. Thirty years ago I do not know, except from them and the notes to Darwin's "Botanic Garden," where such information was to be otained. The basis of research was, however, too narrow to continue; it did not look beyond the welfare of the individual. The more subtle and recondite springs of adaptation opened up by the researches of Darwin, which look to the welfare of the race, were not within its purview. Consequently it dried up, and virtually expired with the Bridgewater Treatises.

To return, however, to the Duke of Argyll. "Neither mechanical aggregation, nor mechanical segregation, can possibly account for the building up of organic tissues." Who has said they did? The Duke has entirely misunderstood the matter. Prof. Lankester never suggested that it was possible to put so much protoplasm into a vessel, and shake out a cockatoo or a guinea-pig at choice. His image of the kaleidoscope had nothing to do with the building up of organisms, only with the varied combination of the elements known to take part in the formation of the fertilized ova from which organisms originate.

I am not sure that I perfectly comprehend what follows. Perhaps some further emendation than that already published is needed in one of the sentences. But it seems evident that the Duke is re-stating his old doctrine of "prophetic germs." He has already defined what he means by these (NATURE, vol. xxxviii. p. 564). "All organs," he says, "do actually pass through rudimentary stages in which actual use is impossible." Here, again, as in the case of the transmission of acquired characters, what one wants is not a reiteration of the assertion, but some definite observed evidence. For the production of this, if only in a single instance, Prof. Lankester pressed the Duke more than a year ago (NATURE, *l.c.* p. 588). None, however, has as yet been forthcoming; and it appears to me that it is not permissible to persist in statements for which he does not attempt to offer a shadow of proof.

The Duke exults in a very amazing fashion over what he strangely calls Prof. Lankester's admission that "natural selection cannot account for the pre-existence of the structures which are prescribed for its choice." I am afraid I have already trespassed on your space too much with quotations; but I have done so in order to show, in some measure at any rate, what is the consensus of opinions amongst students of Darwinism; and I must answer the Duke with one more from Prof. Huxley's admirable biography. It is true that the Royal Society publishes these things in the least attractive way possible; but this particular paper could hardly have escaped attention, as it won the notice and admiration of even a journal so little occupied with scientific discussion as *Truth*.

"There is another sense, however, in which it is equally true that selection originates nothing. 'Unless profitable variations . . . occur, natural selection can do nothing' ('Origin,' ed. 1, p. 82). 'Nothing can be effected unless favourable variations occur' (*l.c.*, p. 108). 'What applies to one animal will apply throughout time to all animals—that is, if they vary—for otherwise natural selection can do nothing. So it will be with plants' (*l.c.* p. 113). Strictly speaking, therefore, the origin of species in general lies in variation; while the origin of any particular species lies, firstly, in the occurrence, and, secondly, in the selection and preservation of a particular variation. Clearness on this head will relieve one from the necessity of attending to the fallacious assertion that natural selection is a *deus ex machinâ*, or occult agency."

And the Duke says he has been waiting for this for thirty years. One can only wonder what Darwinian literature has been the subject of his studies during that time.

W. T. THISELTON DYER.

Royal Gardens, Kew, January 6.

The Microseismic Vibration of the Earth's Crust.

IN Mr. White's article on British earthquakes (NATURE, Jan. 2, p. 202) he refers to me as having *discovered* the microseismic vibration of the earth's crust. My brother Horace and I were, we believe, the first to verify in England the observations of Bertelli, Rossi, d'Abbadie, and the other (principally Italian) pioneers in this interesting subject.

In our Reports to the British Association for 1881 and 1882 on "The Lunar Disturbance of Gravity," some account will be found of the earlier literature on the subject.

January 9. G. H. DARWIN.

Meteor.

ON Sunday, 12th inst., about 8.10 p.m., a bright meteor was seen here, coming into view near δ Aurigæ. It was of a reddish colour, moved slowly, leaving a short tail, and burst above ε Leonis, then with diminished light continued its course to the horizon. T. W. MORTON.

Beaumont College, Old Windsor, January 13.

MAGNETISM.[1]

I.

AS old as any part of electrical science is the knowledge that a needle or bar of steel which has been touched with a loadstone will point to the north. Long before the first experiments of Galvani and Volta the general properties of steel magnets had been observed—how like poles repelled each other, and unlike attracted each other; how the parts of a broken magnet were each complete magnets with a pair of poles. The general character of the earth's magnetism has long been known—that the earth behaves with regard to magnets as though it had two magnetic poles respectively near the rotative poles, and that these poles have a slow secular motion. For many years the earth's magnetism has been the subject of careful study by the most powerful minds. Gauss organized a staff of voluntary observers, and applied his unsurpassed powers of mathematical analysis to obtaining from their results all that could be learned.

The magnetism of iron ships is of so much importance in navigation that a good deal of the time of men of great power has been devoted to its study. It was *the* scientific study of Archibald Smith; and Airy and Thomson have added not a little to our practical knowledge of the disturbance of the compass by the iron of the ship. Sir W. Thomson, in addition to much valuable practical work on the compass, and experimental work on magnetism, has given the most complete and elegant mathematical theory of the subject. Of late years the development of the dynamo machine has directed attention to the magnetization of iron from a different point of view, and a very great deal has been done by many workers to ascertain the facts regarding the magnetic properties of iron. The upshot of these many years of study by practical men interested in the mariner's compass or in dynamo machines by theoretical men interested in looking into the nature of things, is, that although we know a great many facts about magnetism, and a great deal about the relation of these facts to each other, we are as ignorant as ever we were as to any reason why the earth is a magnet, as to why its magnetic poles are in slow motion in relation to its substance, or as to why iron, nickel, and cobalt are magnetic, and nothing else, so far as we know, is to any practical extent. In most branches of science the more facts we know the more fully we recognize a continuity in virtue of which we see the same property running through all the various forms of matter. It is not so in magnetism; here the more we know the more remarkably exceptional does the property appear, the less chance does there seem to be of resolving it into anything else. It seems to me that I cannot better occupy the present occasion than by recalling your attention to, and inviting discussion of, some of those salient properties of magnetism as exhibited by iron, nickel, and cobalt—properties most of them very familiar, but properties which any theory of magnetism must reckon with and explain. We shall not touch on the great subject of the earth as a magnet—though much has been recently done, particularly by Rücker and Thorpe—but deal simply with magnetism as a property of these three bodies, and consider its natural history, and how it varies with the varying condition of the material.

To fix our ideas, let us consider, then, a ring of uniform section of any convenient area and diameter. Let us suppose this ring to be wound with copper wire, the convolutions being insulated. Over the copper wire let us suppose that a second wire is wound, also insulated, the coils of each wire being arranged as are the coils of any ordinary modern transformer. Let us suppose that the ends of the inner coil, which we will call the secondary coil, are connected to a ballistic galvanometer; and that the ends of the outer coil, called the primary, are connected, through a key for reversing the current, with a battery. If the current in the primary coil is reversed, the galvanometer needle is observed to receive a sudden or impulsive deflection, indicating that for a short time an electromotive force has been acting on the secondary coil. If the resistance of the secondary circuit is varied, the sudden deflection of the galvanometer needle varies inversely as the resistance. With constant resistance of the secondary circuit the deflection varies as the number of convolutions in the secondary circuit. If the ring upon which the coils of copper wire are wound is made of wood or glass—or, indeed, of 99 out of every 100 substances which could be proposed—we should find that for a given current in the primary coil the deflection of the galvanometer in the secondary circuit is substantially the same. The ring may be of copper, of gold, of wood, or glass—it may be solid or it may be hollow—it makes no difference in the deflection of the galvanometer. We find, further, that with the vast majority of substances the deflection of the galvanometer in the secondary circuit is proportional to the current in the primary circuit. If, however, the ring be of soft iron, we find that the conditions are enormously different. In the first place, the deflections of the galvanometer are very many times as great as if the ring were made of glass, or copper, or wood. In the second place, the deflections on the galvanometer in the secondary circuit are not proportional to the current in the primary circuit; but as the current in the primary circuit is step by step increased we find that the galvanometer deflections increase somewhat, as is illustrated in the accompanying curve (Fig. 1), in which the abscissæ are proportional to the primary current, and the ordinates are proportional to the galvanometer deflections. You observe that as the primary current is increased the galvanometer deflection increases at first at a certain rate; as the primary current attains a certain value the rate at which the deflection increases therewith is rapidly increased, as shown in the upward turn of the curve. This rate of increase is maintained for a time, but only for a time. When the primary current attains a certain value the curve bends downward, indicating that the deflections of the galvanometer are now increasing less rapidly as the primary current is increased; if the primary current be still continually increased, the galvanometer deflections increase less and less rapidly.

Now what I want to particularly impress upon you is the enormous difference which exists between soft iron on the one hand, and ordinary substances on the other. On this diagram I have taken the galvanometer deflections to the same scale for iron, and for such substances as glass or wood. You see that the deflections in the case of glass or wood, to the same scale, are so small as to be absolutely inappreciable, whilst the deflection for iron at one point of the curve is something like 2000 times as

[1] Inaugural Address delivered before the Institution of Electrical Engineers, on Thursday, January 9, by J. Hopkinson, M.A., D.Sc., F.R.S., President.

great as for non-magnetic substances. This extraordinary property is possessed by only two other substances besides iron—cobalt and nickel. On the same figure are curves showing on the same scale what would be the deflections for cobalt and nickel, taken from Prof. Rowlands's paper. You observe that they show the same general characteristics as iron, but in a rather less degree. Still, it is obvious that these substances may be broadly classed with iron in contradistinction to the great mass of other bodies. On the other hand, diamagnetic bodies belong distinctly to the other class. If the deflection with a non-magnetic ring be unity, that with iron, as already stated, may be as much as 2000; that with bismuth, the most powerful diamagnetic known, is 0·999825—a quantity differing very little from unity. Note, then, the first fact which any theory of magnetism has to explain is: Iron, nickel, and cobalt, all enormously magnetic; other substances practically non-magnetic. A second fact is: With most bodies the action of the primary current on the secondary circuit is strictly proportional to the primary current; with magnetic bodies it is by no means so.

You will observe that the ordinates in these curves, which are proportional to the kicks or elongations of the galvanometer, are called induction, and that the abscissæ are called magnetizing force. Let us see a little more precisely what we mean by the terms, and what are the units of measurement taken. The elongation of the galvanometer measures an impulsive electromotive force—an electromotive force acting for a very short time. Charge a condenser to a known potential, and discharge it through the galvanometer: the needle of the galvanometer will swing aside through a number of divisions proportional to the quantity of electricity in the condenser—that is, to the capacity and the potential. From this we may calculate the quantity of electricity required to give a unit elongation. Multiply this by the actual resistance of the secondary circuit and we have the impulsive electromotive force in volts and seconds, which will, in the particular secondary circuit, give a unit elongation. We must multiply this by 10^8 to have it in absolute C.G.S. units. Now the induction is the impulsive electromotive force in absolute C.G.S. units divided by the number of secondary coils and by the area of section of the ring in square centimetres. The line integral of magnetizing force is the current in the primary in absolute C.G.S. units—that is, one-tenth of the current in amperes—multiplied by 4π. The magnetizing force is the line integral divided by the length of the line over which that line integral is distributed. This is, in truth, not exactly the same for all points of the section of the ring—an imperfection so far as it goes in the ring method of experiment. The absolute electro-magnetic C.G.S. units have been so chosen that if the ring be perfectly non-magnetic the induction is equal to the magnetizing force. We may refer later to the permeability, as Sir W. Thomson calls it; it is the ratio of the induction to the magnetizing force causing it, and is usually denoted by μ.

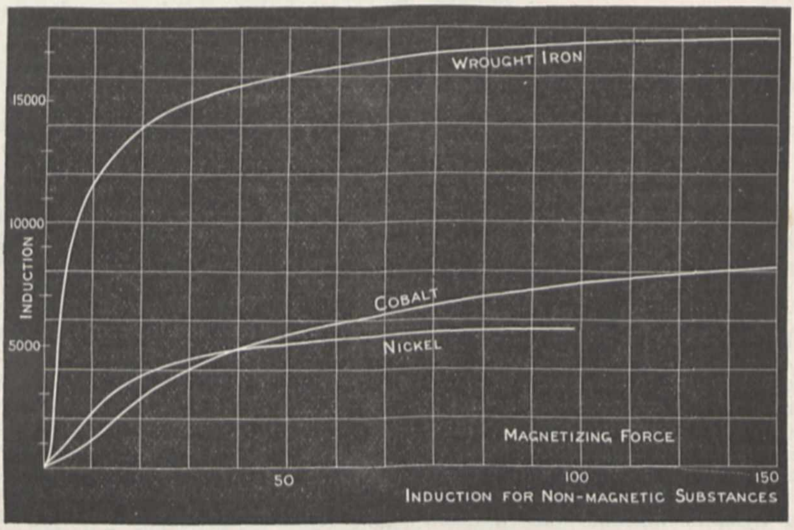

Fig. 1.

There is a further difference between the limited class of magnetic bodies and the great class which are non-magnetic. To show this, we may suppose our experiment with the ring to be varied in one or other of two or three different ways. To fix our ideas, let us suppose that the secondary coil is collected in one part of the ring, which, provided that the number of turns in the secondary is maintained the same, will make no difference in the result in the galvanometer. Let us suppose, further, that the ring is divided so that its parts may be plucked from together, and the secondary coil entirely withdrawn from the ring. If now the primary current have a certain value, and if the ring be plucked apart and the secondary coil withdrawn, we shall find that, whatever be the substance of which the ring is composed, the galvanometer deflection is one-half of what it would have been if the primary current had been reversed. I should perhaps say approximately one-half, as it is not quite strictly the case in some samples of steel, although, broadly speaking, it is one-half. This is natural enough, for the exciting cause is reduced from—let us call it a positive value, to nothing when the secondary coil is withdrawn; it is changed from a positive value to an equal and opposite negative value when the primary current is reversed. Now comes the third characteristic difference between the magnetic bodies and the non-magnetic. Suppose that, instead of plucking the ring apart when the current had a certain value, the current was raised to this value and then gradually diminished to nothing, and that then the ring was plucked apart and the secondary coil withdrawn. If the ring be non-magnetic, we find that there is no deflection of the galvanometer; but, on the other hand, if the ring be of iron, we find a very large deflection, amounting, it may be, to 80 or 90 per cent. of the deflection caused by the withdrawal of the coil when the current had its full value. Whatever be the property that the passing of the primary current has imparted to the iron, it is clear that the iron retains a large part of this property after the current has ceased. We may push the experiment a stage further. Suppose that the current in the primary is raised to a great value, and is then slowly diminished to a smaller value, and that the ring is opened and the secondary coil withdrawn. With most substances we find that the galvanometer deflection is precisely the same as if the current had been simply raised to its final value. It is not so with iron: the galvanometer deflection depends not alone upon the current at the moment of withdrawal, but on the current to which the ring has been previously subjected. We may then draw another curve (Fig. 2) representing the galvanometer deflections produced when the current has been raised to a high value and has been subsequently reduced to a value indicated by the abscissæ. This curve may be properly called a descending curve. In the case of ordinary bodies this curve is a straight line coincident with the straight line of the ascending curve, but for iron is a curve such as is represented in the drawing. You observe that this curve descends to nothing like zero when the current is reduced to zero; and that when the current is not only diminished to zero, but is reversed, the galvanometer deflection only becomes zero when the reversed current has a substantial value. This property possessed by magnetic bodies of retaining that which is impressed upon them by the primary current has been called by Prof. Ewing "hysteresis," or, as similar properties have been observed in quite other connections, "magnetic hysteresis." The name is a good one, and has been adopted. Broadly speaking, the induction as measured by the galvanometer deflection is independent of the time during which the successive currents have acted, and depends only upon their magnitude and order of succession. Some recent experiments of Prof. Ewing, however, seem to show a well-marked time effect. There are curious features in these experiments which require more elucidation.

It has been pointed out by Warburg, and subsequently by Ewing, that the area of curve 2 is a measure of the quantity of energy expended in changing the magnetism of the mass of iron from that produced by the current in one direction to that produced by the current in the opposite direction and back again. The energy expended with varying amplitude of magnetizing forces has been determined for iron, and also for large magnetizing forces for a considerable variety of samples of steel. Different sorts of iron and steel differ from each other very greatly in this respect. For example, the energy lost in a complete cycle of reversals in a sample of Whitworth's mild steel was about 10,000 ergs per cubic centimetre; in oil-hardened hard steel it was near 100,000; and in tungsten steel it was near 200,000—a range of variation of 20 to 1. It is, of course, of the greatest possible importance to keep this quantity low in the case of armatures of dynamos, and in that of the cores of transformers. If the armature of a dynamo machine be made of good iron, the loss from hysteresis may easily be less than 1 per cent; if, however, to take an extreme case, it were made of tungsten steel, it would readily amount to 20 per cent. In the case of transformers and alternate-current dynamo machines, where the number of reversals per second is great, the loss of power by hysteresis of the iron, and the consequent heating, become very important. The loss of power by hysteresis increases more rapidly than does the induction. Hence it is not well in such machines to work the iron to anything like the same intensity of induction as is desirable in ordinary continuous current machines. The quantity O A, when measured in proper units, as already explained—that is to say, the reversed magnetic force, which just suffices to reduce the induction as measured by the kick on the galvanometer to nothing after the material has been submitted to a very great magnetizing force—is called the "coercive force," giving a definite meaning to a term which has long been used in a somewhat indefinite sense. The quantity is really the important one in judging the magnetism of short permanent magnets. The residual magnetism, O B, is then practically of no interest at all; the magnetic moment depends almost entirely upon the coercive force. The range of magnitude is somewhat greater than in the case of the energy dissipated in a complete reversal. For very soft iron the coercive force is 1·6 C.G.S. units; for tungsten steel, the most suitable material for magnets, it is 51 in the same units. A very good guess may be made of the amount of coercive force in a sample of iron or steel by the form of the ascending curve, determined as I described at first. This is readily seen by inspection of Fig. 3, which shows the curves in the cases of wrought iron, and steel containing 0·9 per cent. of carbon. With the wrought iron a rapid ascent of the ascending curve is made, when the magnetizing force is small and the coercive force is small; in the case of the hard steel the ascent of the curve is made with a larger magnetizing current, and the coercive force is large. There is one curious feature shown in the curve for hard steel which may, so far as I know, be observed in all magnetizable substances: the ascending curve twice cuts the descending curve, as at M and N. This peculiarity was, so far as I know, first observed by Prof. G. Wiedemann.

I have already called emphatic attention to the fact that magnetic substances are enormously magnetic, and that non-magnetic substances are hardly at all magnetic:

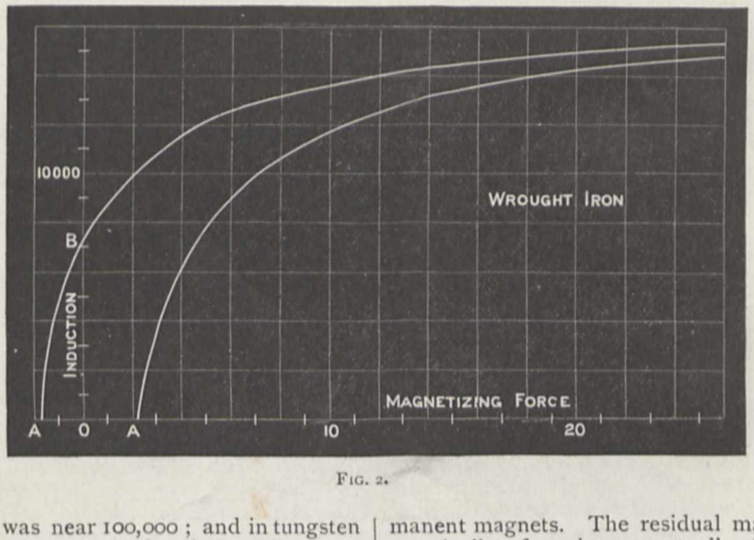

Fig. 2.

there is between the two classes no intermediate class. The magnetic property of iron is exceedingly easily destroyed. If iron be alloyed with 12 per cent. of manganese, the kick on the galvanometer which the material will give, if made into a ring, is only about 25 per cent. greater than is the case with the most completely non-magnetic material, instead of being some hundreds of times as great, as would be the case with iron. Further, with this manganese steel, the kick on the galvanometer is strictly proportional to the magnetizing current in the primary, and the material shows no sign of hysteresis. In short, all its properties would be fully accounted for if we supposed that manganese steel consisted of a perfectly non-magnetic material, with a small percentage of metallic iron mechanically admixed therewith. Thus the property of non-magnetizability of manganese steel is an excellent proof of the fact—which is also shown by the non-magnetic properties of most compounds of iron—that the property appertains to the molecule, and not to the atom; or, to put it in another way, suppose that we were to imagine manganese steel broken up into small particles, as these particles became smaller there would at length arrive a point at which the iron and the manganese would be entirely separated from each other: when this point is reached the particles of iron are non-magnetic. By the magnetic molecule of the substance we mean the smallest part which has all the magnetic properties of the mass. The magnetic molecule must be big enough to contain its proportion of manganese. In iron, then, we must have a collection of particles of such magnitude that it would be possible for the manganese to enter into each of them, to constitute an element of the magnet. Manganese is, so far as I know, a non-magnetic element. Smaller proportions of manganese reduce the magnetic property in a somewhat less degree, the reduction being greater as the quantity of manganese is greater. It appeared very possible that the non-magnetic property of manganese steel was due to the coercive force being very great—that, in fact, in all experiments we were still on that part of the magnetization curve below the rapid

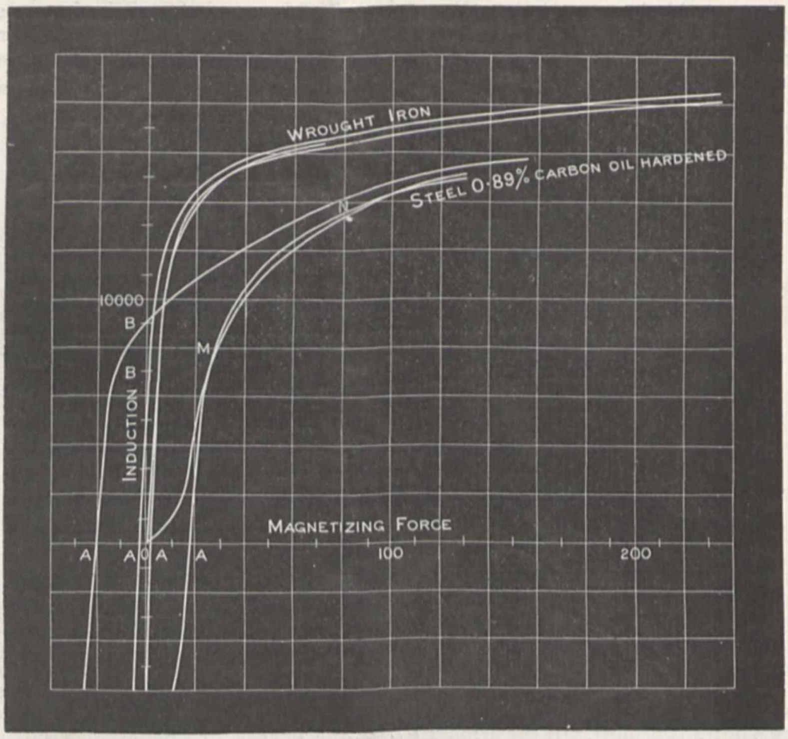

FIG. 3.

rise, and that if the steel were submitted to greater forces it would presently prove to be magnetic, like other kinds of steel. Prof. Ewing, however, has submitted manganese steel to very great forces indeed, and finds that its magnetism is always proportional to the magnetizing force.

No single body is known having the property of capacity for magnetism in a degree which is neither very great nor very small, but intermediate between the two extremes. We can, however, mix magnetic and non-magnetic substances to form bodies apparently intermediate. It is, therefore, interesting to consider what the properties might be of such a mixture. It depends quite as much on the way in which the magnetic part is arranged in the mass, as on its actual quantity. Suppose, for example, it is arranged as in Fig. 4—in threads or plates having a very long axis in the direction of the magnetizing force—we may at once determine the curve of magnetization of the mixture from that of the magnetic substance by dividing the induction for any given force in the ratio of the whole volume to the volume of magnetic substance. If, on the other hand, it is as in Fig. 5—with a very short axis in the direction of the force, and a long axis perpendicular thereto—we can equally construct the curve of magnetization. This is done in Fig. 6, which shows the curve when nine-tenths of the material is highly magnetic iron, arranged as in Fig. 5, whilst the other curve of the same figure is that when only one-tenth is magnetic, but arranged as in Fig. 4. You observe how very different is the character of the curve—a difference which is reduced by the much less proportion of magnetic material in the mixture in the one case than in the other. One peculiarity of these arrangements of the two materials in relation to each other is, that the resulting material is not isotropic; that is, its properties are not the same in all directions, but depend upon the direction of the magnetizing force in the material. Of course, this is not at all a probable arrangement, but it is instructive in showing the character of the result as depending upon the construction of the material. Let us, however, consider the simplest isotropic arrangement; let us suppose that one material is in the form of spheres bedded in a matrix of the other: if the spheres are placed at random this is clearly an isotropic arrangement. The result is very different according as the matrix or the spheres are of the magnetic material. Suppose that the volume of the spheres is one-half of the whole volume. In Fig. 7 we have approximately the curve for iron, for a mixture of equal quantities of iron and a non-magnetic material; the spheres being non-magnetic and the matrix iron, and for a mixture, the

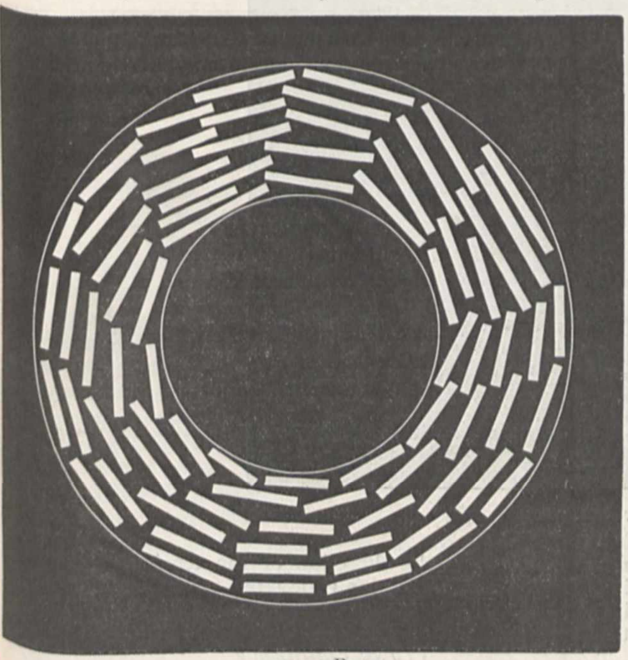

Fig. 4.

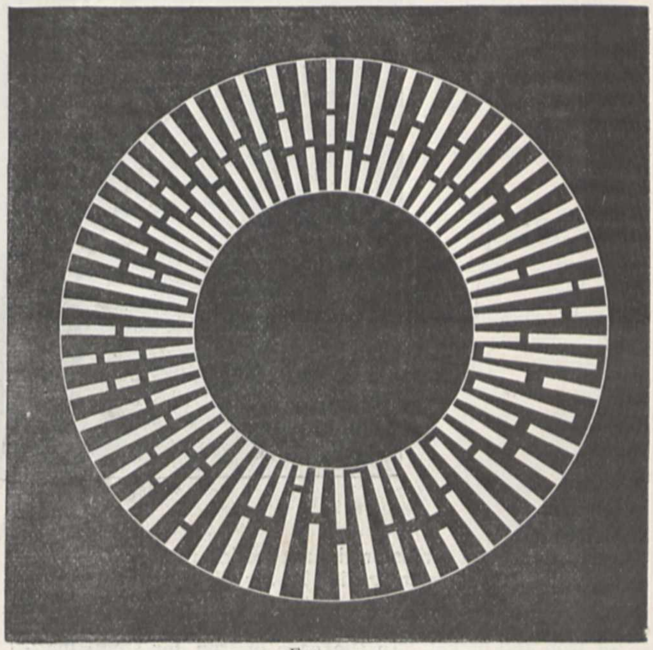

Fig. 5.

spheres being iron and the matrix non-magnetic. Observe the great difference. When the spheres are iron, the induction is near four times the force for all values of the force. When the matrix is iron, the induction is near two-fifths of the induction when the material is iron only.

In speaking of the properties of bodies which, like manganese steel, are slightly magnetic, it may be well here to enter a caution. But little that is instructive is to be learned by testing filings, or the like, with magnets, as these show but little difference between bodies which are slightly magnetic and those which are strongly

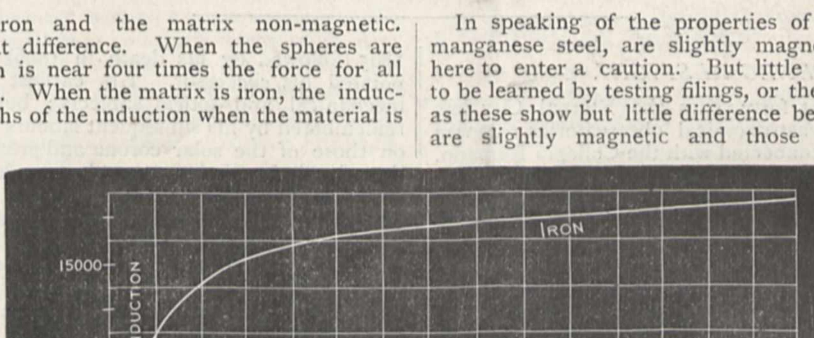

Fig. 6.

magnetic. Suppose the filings to be spheres; in the following table are given comparative values of the forces they would experience in terms of μ, if placed in a magnetic field of given value, μ having its ordinary signification—that is, being the ratio of the kick on the galvanometer when a ring is tried made of the material of the filing to the kick if the ring is made of a perfectly non-magnetic material:—

μ	Attraction.	
1	0	Non-magnetic body.
1·47	0·18	Manganese steel with 12 per cent.
3·6	1·2	Manganese steel with 9 per cent.
5	1·5	
10	2·1	
100	2·8	
1000	2·9	

Now bodies in which μ is so small as 3·6 belong distinctly to the non-magnetic class; but the test with the magnet would very markedly distinguish them from manganese steel with 12 per cent of manganese. The distinction, however, between $\mu = 3{\cdot}6$ and $\mu = 1000$ is comparatively small; whereas, under the conditions of experiment, μ is much more than 1000 for most bodies of which iron is the principal constituent.

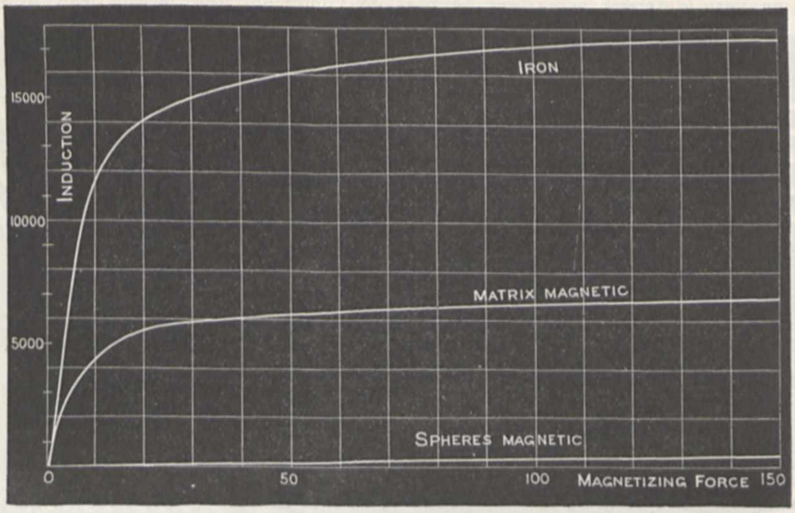

Fig. 7.

The effect of stress on the magnetic properties of iron and nickel have been studied by Sir W. Thomson. A fact interesting from a broad and general point of view is that the effects of stress are different in kind in the case of iron and nickel. In the case of iron, for small magnetizing forces in the direction of the tension, tension increases the magnetization; for large forces, diminishes it. In the case of nickel the effect is always to diminish the magnetization.

(*To be continued.*)

LORENZO RESPIGHI.

DURING the last forty years the Eternal City has possessed two astronomical observatories. It was at the old building, connected with the Collegio Romano, that Scheiner collected the principal materials for his famous work on the sun, called from its dedication to Prince Orsini, the Duke of Bracciano, "Rosa Ursina"; and though it is with some justice that Delambre speaks disparagingly of its contents as compared with its bulk, the observations of the solar spots show with what care they were made, and they afford the first indication of the now familiar fact that their rotation varies in duration in different heliographical latitudes, though Scheiner's idea seems to have been that it was not the same in the two solar hemispheres. But it was not until 1787 that the present observatory of the Collegio Romano was commenced, nor until 1804 that the general interest felt in the great eclipse of February 11 in that year induced Pope Pius VII. to provide G. Calandrelli with the means of furnishing it with suitable instruments. Another astronomical phenomenon, the appearance of the great comet of 1843, led his son Ignazio Calandrelli, to wish to form a new observatory on the Capitoline Hill; but it was not until five years later that Pius IX. was able, in 1848, to provide him with the means for carrying out this design. Meanwhile Calandrelli continued his observations at Bologna, ably assisted by the subject of our notice.

Lorenzo Respighi was born at Cortemaggiore, in the province of Placentia, in 1824. His first studies were made at Parma, from which town he proceeded to the University of Bologna, where he obtained high honours in the departments of mathematics and philosophy in 1847. Nominated Professor of Optics and Astronomy in 1851, he subsequently succeeded Calandrelli as Director of the Observatory. On the retirement of the latter in 1865 (followed by his death in 1866) Respighi was appointed his successor. His earliest papers were on mechanical and optical subjects; but he will be best remembered by his subsequent labours on stellar spectra, on those of the solar corona and protuberances, and on the scintillation of the stars. In 1871 he went on an expedition to Poodocottah, in Hindustan, to observe the total eclipse of December 12 in that year; an account of the observations will be found in the eclipse (41st) volume of the Memoirs of the Royal Astronomical Society, of which Respighi was elected an Associate in 1872. He formed from his observations between 1875 and 1881 a catalogue of 2534 stars in the northern hemisphere from the first to the sixth magnitude, which was published in successive numbers of the Memoirs of the Lincean Academy.

His death took place after a long illness, aggravated by the recent epidemic, on December 10 last, and the Campidoglio Observatory has thus been deprived of its second director, who has so ably and energetically conducted its operations during nearly the last quarter of a century.

W. T. LYNN.

NOTES.

ON Saturday evening, at the Royal Institution, Prof. Max Müller delivered an address to inaugurate the establishment of a school for modern Oriental studies by the Imperial Institute in union with University College and King's College, London. The Prince of Wales presided, and among those present were many eminent persons, including some distinguished Orientals Prof. Müller presented with admirable force and clearness the need for a great English school for Oriental studies, and had much to tell his hearers as to work done in this direction in other countries. His account of the new Berlin seminary of

Oriental languages was particularly interesting. This institution has the following staff of professors and teachers:—One professor of Chinese; two teachers of Chinese, both natives—one for teaching North Chinese, the other South Chinese; one professor of Japanese, assisted by a native teacher; one professor of Arabic, assisted by two native teachers—one for Arabic as spoken in Egypt, the other for Arabic as spoken in Syria; one native teacher of Hindustani and Persian; one native teacher of Turkish; one teacher of Suaheli, an important language spoken on the East Coast of Africa, assisted by a native. Besides these special lectures, those given by the most eminent professors of Sanskrit, Arabic, Persian, and Chinese in the Universities of Berlin are open to the students of the Oriental seminary. The number of students amounts at present to 115. Of these, 56 are said to belong to the faculty of law, which must be taken to include all who aspire to any employment in the consular and colonial services. Fifteen belong to the faculties of philosophy, medicine, and physical science; four to the faculty of theology, who are probably intended for missionary work. Twenty-three are mentioned as engaged in mercantile pursuits, three are technical students, five officers in the army, and nine are returned as studying modern Greek and Spanish, languages not generally counted as Oriental, though, no doubt, of great usefulness in the East and in America. Prof. Müller succeeded in conveying a remarkably vivid impression of the fact that England, looking at the subject simply from the point of view of her own material interests, cannot afford to neglect the studies to which so much attention is devoted elsewhere. "England," he said, "cannot live an isolated life. She must be able to breathe, to grow, to expand, if she is to live at all. Her productive power is far too much for herself, too much even for Europe. She must have a wider field for her unceasing activity, and that field is the East, with its many races, its many markets, its many languages. To allow herself to be forestalled or to be ousted by more eloquent and persuasive competitors from those vast fields of commerce would be simple suicide. Our school, in claiming national support, appeals first of all to the instinct of self-preservation. It says to every manufacturing town in England, help us, and, in doing so, help thyself. Whenever the safety and honour of England are at stake we know what enormous sums Parliament is willing to vote for army and navy, for fortresses and harbours—sums larger than any other Parliament would venture to name. We want very little for our School of Oriental Languages, but we want at least as much as other countries devote to the same object. We want it for the very existence of England; for the vital condition of her existence is her commerce, and the best markets for that commerce lie in the East."

ON Saturday, February 22, the Physikalisch-ökonomische Gesellschaft of Königsberg is to hold its centenary celebration. The proceedings will consist of a Festsitzung at 11 a.m., a visit to the Provinzial-Museum at 1, and a Festessen at 8 p.m.

SEVERAL courses of afternoon lectures which promise to be exceptionally interesting will be delivered during the present season at the Royal Institution. On January 21 Mr. G. J. Romanes, F.R.S., will begin a series of ten lectures, forming the third part of his course on "Before and After Darwin." This series will relate to the post-Darwinian period, and will include a discussion of Weismann's theory of heredity. Prof. Flower, F.R.S., will begin on January 25 a course of three lectures on the natural history of the horse, and of its extinct and existing allies. A course of four lectures on the early developments of the forms of instrumental music will be begun by Mr. F. Niecks on March 6.

THE annual general meeting of the Institution of Mechanical Engineers will be held at 25 Great George Street, Westminster, on January 29, 30, and 31. The chair will be taken each evening by the President at 7.30 p.m. The following are the papers: on the compounding of locomotives burning petroleum refuse in Russia, by Thomas Urquhart; on the burning of colonial coal in the locomotives of the Cape Government railways, by Michael Stephens; on the mechanical appliances employed in the manufacture and storage of oxygen, by Kenneth S. Murray.

THE annual general meeting of the Anthropological Institute of Great Britain and Ireland will take place on Tuesday, the 28th inst., at 8.30 p.m., Dr. John Beddoe, F.R.S., President, in the chair. The following will be the order of business:—Confirmation of the minutes, appointment of scrutineers of the ballot, Treasurer's financial statement, Report of Council for 1889, the Presidential Address, report of scrutineers, and election of Council for 1890.

DURING the last few years anthropological studies have excited a good deal of popular interest, and lately it occurred to the Council of the Anthropological Institute that it might be worth while for them to arrange for the preparation of a series of lectures presenting clearly the results of recent anthropological research. Accordingly a course on the following branches of the subject has been planned: physical anthropology; the geological history of man; prehistoric and non-historic dwellings, tombs, and ornaments; the development of the arts of life; social institutions; anthropometry. The Assistant-Secretary of the Institute is prepared to arrange for the delivery of these lectures at places within convenient distance of London.

THE first volume of Prof. Thorpe's "Dictionary of Applied Chemistry" (Longmans) will be published in a few days. The work will consist of three volumes, and will treat specially of chemistry in its relations to the arts and manufactures. It will be uniform with the new edition of Watts's "Dictionary of Chemistry," edited by Muir and Morley.

M. GRANEL has been appointed Professor of Botany to the Faculty of Medicine at Montpellier.

ON Monday the Khedive opened the new Museum at Ghizeh, whither the archæological treasures hitherto preserved at Boulak have been transferred.

THE "tercentenary of the invention of the compound microscope" will be celebrated by a Universal Exhibition of Botany and Microscopy, to be held at Antwerp during the present year, under the auspices of M. Ch. de Bosschere, President, M. Ch. Van Geert, Secretary, and Dr. H. Van Heurck, Vice-President. It is proposed to organize an historical exhibition of microscopes, and an exhibition of the instruments of all makers, and of accessory apparatus and photomicrography. At the conferences the following subjects will be discussed and illustrated:—The history of the microscope; the use of the microscope; the projecting microscope and photomicrography; the microscopical structure of plants; the microscopical structure of man and of animals; microbes; the adulteration of food-substances, &c. Communications are to be addressed to M. Ch. de Bosschere, Lierre, Belgium.

WE regret to have to record the death of Mr. Daniel Adamson, well known from his connection with the iron and steel industries. He died on Monday at the age of 71. Mr. Adamson was President of the Iron and Steel Institute in 1887, and was a member of other mechanical and scientific associations.

DR. F. HAUCK, the eminent algologist, died at Trieste on December 21, 1889, at the early age of forty-four. He was the author of the volume on marine Algæ in the new edition of Rabenhorst's "Cryptogamic Flora of Germany."

THE December number of the *American Geologist* contains an interesting paper, by William Upham, on the late Prof. Henry Carvill Lewis, who, it will be remembered, died at Manchester on July 21, 1888, a day or two after his arrival in this country from America. He became ill during the voyage, and it seems that the immediate cause was the contamination of the water supply of Philadelphia, where he had been living, and where about a thousand cases of typhoid fever appeared at nearly the same time. Prof. Lewis was only in his thirty-fifth year. An excellent portrait of him accompanies Mr. Upham's paper.

AT the meeting of the University Experimental Science Association, Dublin, on December 13, Mr. J. Joly read a paper on a resonance method of measuring the constant of gravitation. A simple pendulum of small mass is hung in a tall glass tube, rendered vacuous. In close proximity two massive pendulums, one at either side, are maintained in a state of vibration for any desired period of time. The times of vibration of all these pendulums are alike. The observations consist in observing the amplitude, or the increase of amplitude, of the central pendulum, after a known number of vibrations executed by the exterior pendulums. Several modifications, carrying out the same principle, were suggested. It is proposed to test the method in the vaults of the physical laboratory.

THE Central Meteorological Observatory of Mexico, which is situated at 7489 feet above the sea, has published a summary of meteorological results for each month of twelve years ending 1888 (excepting January and February 1877). The coldest month is January, the mean temperature of which is 54°, and the warmest month is April, the mean temperature of which is 64°. The absolute maximum in the shade was 89°, and the minimum 28°·9. The wettest month is August, in which the mean rainfall is 5·4 inches, and the driest month is February, with an average of 0·4 inch. The greatest fall at one time was 2·5 inches. The prevalent direction of the wind is north-west.

THE *Essex County Chronicle* of January 10 says that on Tuesday, the 7th inst., two slight shocks of earthquake were noticed at Chelmsford. The first occurred at 12.30, when a low rumbling sound like thunder in the distance was heard, accompanied by a vibration of the ground and a rattling of the windows. The shock was observed in several parts of the town. The more pronounced shock was, however, at 1.25 p.m., when the rumbling, moaning sound was intensified, there being a heavy throbbing in the air like the pulsation of an engine. At many houses there was a violent shaking of the windows, and two cases are reported of things trembling on the tables. Some men working for Mr. Norrington heard the sound, took it to be the rumble of a heavy waggon, and went out to see it. Nothing was in sight. Several people recognized the shock as being similar to the forerunner of the 1884 earthquake, and rushed out of their houses. Mr. Arthur E. Brown, writing to us from Brentwood, says that the shocks were noticed there. They were attributed by the people in his house to the firing of guns at Woolwich. They rattled the doors violently.

A CORRESPONDENT writes that during the thunderstorm which prevailed over the greater part of Scotland early on Monday morning, January 6, a slight shock of earthquake was felt in a district of Perthshire. "This," he says, "is somewhat similar to what took place at Argyll on the evening of July 15 last year, and might lead one to suppose that atmospheric influence has something to do with the production of seismic disturbances."

AT a meeting of the Royal Botanic Society on Saturday, attention was called to a specimen of the double cocoanut, or *cocoa de mer*, now known to come from the Seychelles. For some hundreds of years these nuts have been occasionally found washed up by the sea, and their extraordinary appearance, large size, and mysterious origin have given rise to many stories of miraculous virtue in the cure of diseases. Some are even said to have been sold for their weight in gold. This specimen belonged to General Gordon, and was given by him to General Gerald Graham, by whom it has been presented to the Society.

THE Transactions of the Congrès pour l'Utilisation des Eaux fluviales, held last summer in Paris, have just been issued. The volume contains a great number of engravings.

A BOOK on the Congo State, by E. Dupont, the Director of the Natural History Museum of Brussels, has just been published. He presents the scientific results of his travels, devoting especial attention to geological questions.

MESSRS. GEORGE PHILIP AND SON have published the second issue of their valuable "Educational Annual." The work has been enlarged, revised, and to some extent rearranged; and it ought to be of great service to all who are for any reason especially interested in educational institutions.

MESSRS. PERKEN, SON, AND RAYMENT have produced a projecting optical lantern, which is likely to be of considerable service. When enlargements are required, a condenser of 10-inch diameter is available; but when a magic-lantern entertainment is to be provided, a condenser of 4-inch diameter can be substituted. The apparatus consists of a mahogany-body lantern with a long bellows-camera adjusted by the patent quick-action rack and pinion, and lighted by the refulgent three-wick lamp.

ON January 21, and the three following evenings, Dr. E. Symes Thomson will deliver, at Gresham College, a course of lectures on influenza or epidemic catarrh. In the first lecture he will present a historical sketch of the subject. The remaining lectures will be on influenza as it affects the lower animals, the causes and consequences of influenza, and diagnosis and management.

THE additions to the Zoological Society's Gardens during the past week include four Leopard Tortoises (*Testudo pardalis*), three Well-marked Tortoises (*Homopus signatus*), a Rufous Snake (*Ablabes rufulus*), six Gray's Frogs (*Rana grayi*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; two Spur-winged Geese (*Plectropterus gambensis*) from West Africa, presented by Mr. C. B. Mitford; six Red-bellied Waxbills (*Estrelda rubriventris*), five Crimson-eared Waxbills (*Estrelda phœnicotis*), seven Grenadier Waxbills (*Uræginthus grantinus*, 6 ♂ 1 ♀), three Paradise Whydah Birds (*Vidua paradisea*), three —— Weaver Birds (*Euplectes* ——) from Benguela, West Africa, presented by Mr. T. W. Bacon; a Bluish Finch (*Spermophila cœrulescens* ♂) from Brazil, presented by Mrs. Mayne; a Green Turtle (*Chelone viridis*) from the West Indies, presented by Mrs. Harris; a Chattering Lory (*Lorius garrulus*) from Moluccas, presented by Captain Bason, P. and O. s.s. *Bombay*; three Yellow-winged Sugar Birds (*Cœrea cyanea*), two Yellow-fronted Tanagers (*Euphonia flavifrons*) from South America, deposited; four Tufted Umbres (*Scopus umbretta*) from Africa, a Geoffroy's Terrapin (*Hydraspis hilarii*) from the Argentine Republic, purchased; a Koala (*Phascolarctus cinereus* ♀) from Australia, two Indian Cobras (*Naia tripudians*), an Indian Python (*Python molurus*) from India, received in exchange.

OUR ASTRONOMICAL COLUMN.

OBJECTS FOR THE SPECTROSCOPE.

Sidereal Time at Greenwich at 10 p.m., January 16 = 5h. 45m. 8s.

Name.	Mag.	Colour.	R.A. 1890.	Decl. 1890.
			h. m. s.	° ′
(1) G.C. 1185	—	—	5 30 7	− 5 20
(2) 119 Tauri	4	Reddish-yellow.	5 25 46	+18 31
(3) σ Orionis	4	Whitish-yellow.	5 33 12	− 2 40
(4) γ Orionis	2	White.	5 19 12	+ 6 15
(5) 64 Schj.	8	Very red.	5 38 29	+24 22
(6) R Ceti	Var	Yellowish-red.	2 20 24	− 0 40
(7) U Ceti	Var.	Reddish.	2 28 26	−13 37

Remarks.

(1) This is described in Herschel's general catalogue as "a remarkable object, very large, round, with tail, much brighter in the middle." The spectrum has not yet been recorded, but it promises to be one of great interest, as the nebula is apparently one of the cometic ones. The meteoritic hypothesis suggests that these are produced by a condensed swarm moving at a high velocity through a sheet of meteorites at rest, or a swarm almost at rest surrounded by a moving sheet. In the former case the collision region would be behind the swarm, and would be spread out like a comet's tail, the angle of the fan and length of "tail" depending upon the velocity of the moving swarm. Observations for variations of spectrum between nucleus and tail will also be valuable.

(2) This is a typical example of stars of Group II. Observations similar to those suggested for 20 Leporis, U.A., last week, are required.

(3) Konkoly classes this with stars of the solar type. The usual differential observations, as to whether the star belongs to Group III. or to Group V., are required.

(4) In Gothard's list of star spectra this is described as Group IV. The usual observations are suggested.

(5) Dunér describes the spectrum of this star as Group VI., but his description is not complete. The characters of the different bands, especially of Band 6, require further observation. It may be remarked in connection with these stars of small magnitude, that the observations are by no means so difficult as in the case of small stars with spectra consisting of fine lines. The bands are broad and generally dark, so that the continuous spectrum is broken up into zones.

(6) This variable has a period of 167 days, and ranges in magnitude from about 8 at maximum to 13 at minimum. The spectrum is of the Group II. type, and, as in other variables of the same group, bright lines may appear at maximum. Dunér states that the bands are very wide and dark, but he does not state what bands are present. Maximum on January 18.

(7) The spectrum of this variable has not yet been recorded, but the colour indicates that it is probably either Group II. or Group VI. The period is 228 days, and the range from 7 at maximum to 10 at minimum. The maximum will occur on January 18. A. FOWLER.

THE TEMPERATURE OF THE MOON.—Prof. Langley, by means of the bolometer, made some measurements of the heat from different parts of the eclipsed moon on the night of September 23, 1885 (*Phil. Mag.*, January, 1890). These measurements were made in connection with a much more extended study on the temperature of our satellite. The following particulars are given:—The diameter of the lunar image was 28·3 millimetres, and of this only a limited portion (0·08 of the whole) fell upon the bolometer. As the penumbra came on, the diminution of heat was marked, being measured by the bolometer even before the eye had detected any appearance of shadow. The heat continued to diminish rapidly with the progress of the immersion in the penumbra. At one hour before the middle of the total eclipse, the deflection in the umbra was 3·8 divisions. Fifty minutes after the middle of the eclipse, it had diminished to approximately 1·3 divisions, this being less than 1 per cent. of the heat from a similar portion of the uneclipsed moon. The rise of the temperature after the passage of the umbra was apparently nearly as rapid as the previous fall. The most important conclusion drawn by Prof. Langley from his researches is that the mean temperature of the sunlit lunar soil is most probably not greatly above zero Centigrade.

ON THE ORBIT OF STRUVE 228.—The *Monthly Notices* of the Royal Astronomical Society, December 1889, contains a note, communicated by Mr. J. E. Gore, on this binary star. Recent measures show that, since Struve discovered the star in 1829, it has described about 120° of its apparent orbit. The following provisional elements have been computed:—

Elements of Σ 228.

$P = 88{\cdot}73$ years.	$\Omega = 84^\circ\ 49'$
$T = 1906{\cdot}03$	$\lambda = 51\ \ 36$
$e = 0{\cdot}5311$	$a = 0''{\cdot}98$
$i = 70^\circ\ 59'$	$\mu = +4^\circ{\cdot}057$

According to this orbit, the distance between the components will gradually increase during the next few years up to a maximum of about 0″·55, and then diminish again as the companion approaches the periastron. The minimum distance will not be reached until the position angle is 180° (after the periastron passage), when the components will probably be separated by less than 0″·2. The binary lies a little preceding 62 Andromedæ, the position for 1890·0 being approximately—

R.A. 2h. 6m. 59s., Decl. + 46° 58′·4.

The magnitudes of the components are about 6·7 and 7·6.

ORBIT OF SWIFT'S COMET (V. 1880).—The orbit of this comet has been computed, by Gibbs's vector method, by Messrs. W. Beebe and A. W. Phillips (*Astr. Journ.*, Nos. 207, 208). This method is found to possess advantages over those of Gauss and Oppolzer. Below are given elements which have been computed from eight observations ranging from October 25, 1880, to January 7, 1881, and compared with these are the elements computed from three observations by Gibbs's method. Both are referred to the ecliptic and mean equinox of 1880·0:—

Eight observations.	Three observations.
$i = 5^\circ\ 23'\ 3''{\cdot}8$	$i = 5^\circ\ 22'\ 2''{\cdot}03$
$\pi - \Omega = 106\ 13\ 4{\cdot}1$	$\pi - \Omega = 106\ 13\ 19{\cdot}17$
$\Omega = 296\ 42\ 55{\cdot}1$	$\Omega = 296\ 52\ 2{\cdot}09$
$\log e = 9{\cdot}8163726$	$\log e = 9{\cdot}8146985$
$\log a = 0{\cdot}4905937$	$\log a = 0{\cdot}4873065$
T = 1880 Nov. 7·786610	T = 1880 Nov. 7·782810
Periodic time = 1988·33 days.	Periodic time = 1965·88 days.

ON THE VARIABILITY OF R VULPECULÆ.—Schönfeld, from a discussion of the observations from 1859 to 1874, found that a uniform period left systematic deviations outstanding which exceeded seven or eight times the uncertainty of the single maxima, but that a quadratic term, corresponding to a shortening of 0·12 days from epoch to epoch, brought them within the range of the probable errors. The divergence from observation, however, soon began, and rapidly widened, until in 1885 it amounted to 106·5 days. Mr. Chandler (*Astr. Journ.*, No. 208) gives a table showing the maxima and minima observed since 1807, with the deviations from the elements of his catalogue. It is seen that, whereas the difference between the observed and the calculated maxima and minima, using Schönfeld's elements, are very considerable, the elements given by the author differed from those observed only in a very slight degree.

ON THE ROTATION OF MERCURY.—Nearly a century has elapsed since Schröter published his first observation of the physical aspect of Mercury, and assigned to the planet a period of rotation; but it has been left to that perspicacious observer, Signor Schiaparelli, to demonstrate the fact by a series of remarkable observations given by him in *Astronomische Nachrichten*, No. 2944. The observations extend from 1882 to the end of last year. As many as 150 drawings have been made of the markings upon the planet with respect to the best positions for observation. It is noted that one of the finest drawings was made on August 11, 1882, when Mercury was only 3° 2′ from the sun's limb. The markings that are visible on Mercury when observed at the same hour on consecutive days are identical in their aspect, and this being so, three hypotheses have been propounded (*Astr. Nach.*, 2479) regarding the rotation of the planet, viz.:—

That (1) the time of rotation is about 24 hours.

(2) The planet makes two or more rotations in the same interval.

(3) The time of rotation is so slow as to be inappreciable when observing the markings during a few days.

Schröter decided in favour of the first hypothesis, and Bessel, from a discussion of this observer's data, determined the time of rotation to be 24h. 0m. 52·97s. Schiaparelli's observations support the last of these hypotheses, and are opposed to the rotation period determined by Schröter.

Following a series of dark markings, shown in the figure which accompanies the article, it was found that—

Mercury revolves round the sun in the same manner that the moon revolves round the earth, always presenting to it the same hemisphere; hence, since the planet's periodic time is 87·9693 days, this must be the time of rotation on its axis.

The dark markings observed appear extremely faint, and are not easily recognized. On good occasions the colour may be seen to be reddish-brown, and always differs from the general colour of the planet's disk, which is a bright rose changing to copper.

This most interesting and important communication from Milan Observatory must be read in detail in order that it may be appreciated.

ON CERTAIN APPROXIMATE FORMULÆ FOR CALCULATING THE TRAJECTORIES OF SHOT.

In the postscript to a paper by Mr. W. D. Niven, "On the Calculation of the Trajectories of Shot," which is published in the Proceedings of the Royal Society, vol. xxvi. pp. 268–287, I have given, without demonstration, some convenient and not inelegant formulæ applicable to a limited arc of a trajectory when the resistance is supposed to vary as the nth power of the velocity.

In these formulæ, the angle between the chord of the arc and the tangent at any point is supposed to be always small. The index n is not restricted to integral values, but may take any value whatever.

As the proof of these formulæ is not altogether obvious, and a similar method of treatment may be found useful in other problems, I think it may not be unacceptable to your readers if I show here how the formulæ may be demonstrated.

Analysis.

Investigation of formulæ applicable to a small arc of a trajectory, when the resistance varies as the nth power of the velocity.

Let x and y denote the horizontal and vertical co-ordinates at time t, u the horizontal velocity, and ϕ the angle which the direction of motion makes with the horizon at the same time.

Hence the velocity at time t is $u \sec\phi$, and we may denote the resistance by $ku^n(\sec\phi)^n$, where k is constant throughout the small arc in question.

Also let p and q denote the values of u at the beginning and end of the arc, α and β the corresponding values of ϕ, g the force of gravity, T the time taken to describe the arc, X and Y the corresponding total horizontal and vertical motion.

Making ϕ the independent variable, the fundamental formulæ are—

$$(1)\quad \frac{du}{d\phi} = \frac{ku^{n+1}}{g}(\sec\phi)^{n+1};$$

$$(2)\quad \frac{dx}{d\phi} = -\frac{u^2}{g}(\sec\phi)^2;$$

$$(3)\quad \frac{dy}{d\phi} = -\frac{u^2}{g}(\sec\phi)^2\tan\phi;$$

$$(4)\quad \frac{dt}{d\phi} = -\frac{u}{g}(\sec\phi)^2.$$

From the first of these equations—

$$\frac{1}{u^{n+1}}\frac{du}{d\phi} = \frac{k}{g}(\sec\phi)^{n+1};$$

and therefore, by integration between the limits $\phi = \alpha$ and $\phi = \beta$,

$$\frac{1}{q^n} - \frac{1}{p^n} = \frac{kn}{g}\int_\beta^\alpha(\sec\phi)^{n+1}d\phi.$$

Also, we have—

$$X = \frac{1}{g}\int_\beta^\alpha u^2(\sec\phi)^2 d\phi;$$

$$Y = \frac{1}{g}\int_\beta^\alpha u^2(\sec\phi)^2\tan\phi\, d\phi;$$

and

$$T = \frac{1}{g}\int_\beta^\alpha u(\sec\phi)^2 d\phi;$$

and we wish to compare the two former of these definite integrals with the following known one, viz. :—

$$\frac{1}{q^{n-2}} - \frac{1}{p^{n-2}} = (n-2)\int_\beta^\alpha\frac{1}{u^{n-1}}\frac{du}{d\phi}d\phi = \frac{k(n-2)}{g}\int_\beta^\alpha u^2(\sec\phi)^{n+1}d\phi;$$

and the last with—

$$\frac{1}{q^{n-1}} - \frac{1}{p^{n-1}} = (n-1)\int_\beta^\alpha\frac{1}{u^n}\frac{du}{d\phi}d\phi = \frac{k(n-1)}{g}\int_\beta^\alpha u(\sec\phi)^{n+1}d\phi.$$

This may be done by means of the following lemma, which follows immediately from Taylor's theorem :—

Lemma.

If F(ϕ) be any function either of ϕ only, or of ϕ and u, where u is a function of ϕ given by the above differential equation (1), and if α and β be the limiting values of ϕ in the integral and $\gamma = \frac{1}{2}(\alpha + \beta)$, then, putting for a moment $\phi = \gamma + \omega$,

$$\int_\beta^\alpha F(\phi)d\phi = \int_{-\frac{1}{2}(\alpha-\beta)}^{\frac{1}{2}(\alpha-\beta)} F(\gamma+\omega)d\omega = \int_{-\frac{1}{2}(\alpha-\beta)}^{\frac{1}{2}(\alpha-\beta)}\left\{F(\gamma) + F'(\gamma)\omega + F''(\gamma)\frac{\omega^2}{2} + F'''(\gamma)\frac{\omega^3}{6} + F''''(\gamma)\frac{\omega^4}{24} + \&c.\right\}d\omega$$

$$= (\alpha-\beta)\left\{F(\gamma) + \frac{1}{24}(\alpha-\beta)^2F''(\gamma) + \frac{1}{1920}(\alpha-\beta)^4F''''(\gamma) + \&c.\right\}$$

where $F'(\phi) = \frac{dF(\phi)}{d\phi}$, $F''(\phi) = \frac{d^2F(\phi)}{d\phi^2}$, &c., and F($\gamma$), F'($\gamma$), F''($\gamma$), &c., are what F($\phi$), F'($\phi$), F''($\phi$), &c., become when γ is substituted for ϕ, and the corresponding value of u (u_0 suppose) is put for u.

In what follows, the last of the terms above written, which is of the 5th order in $(\alpha - \beta)$, is neglected, together with all terms of the same order of small quantities.

All the definite integrals with which we are here concerned are included in the two forms

$$\int_\beta^\alpha u^l(\sec\phi)^m d\phi, \text{ and } \int_\beta^\alpha u^l(\sec\phi)^m\tan\phi\, d\phi.$$

In the first place, we will apply the above formula to the case in which F(ϕ) is a function of ϕ only, viz. when $F(\phi) = (\sec\phi)^{n+1}$.

Hence

$$F'(\phi) = (n+1)(\sec\phi)^{n+1}\tan\phi;$$

$$F''(\phi) = (n+1)[(n+1)(\sec\phi)^{n+1}(\tan\phi)^2 + (\sec\phi)^{n+3}]$$

$$= (n+1)[\overline{n+2}(\sec\phi)^{n+3} - \overline{n+1}(\sec\phi)^{n+1}];$$

and therefore,

$$\int_\beta^\alpha(\sec\phi)^{n+1}d\phi = (\alpha-\beta)(\sec\gamma)^{n+1}\left\{1 + \frac{n+1}{24}(\alpha-\beta)^2[\overline{n+2}(\sec\gamma)^2 - \overline{n+1}]\right\}, \text{ to the 4th order inclusive.}$$

Hence

$$\frac{1}{q^n} - \frac{1}{p^n} = \frac{kn}{g}(\alpha-\beta)(\sec\gamma)^{n+1}\left\{1 + \frac{n+1}{24}(\alpha-\beta)^2[\overline{n+2}(\sec\gamma)^2 - \overline{n+1}]\right\},$$

which gives q when p is known.

In the next place, let $F(\phi) = u^l(\sec\phi)^m$.

Hence

$$F'(\phi) = \frac{dF\phi}{d\phi} = lu^{l-1}\frac{du}{d\phi}(\sec\phi)^m + mu^l(\sec\phi)^m\tan\phi$$

$$= F(\phi)\left[\frac{l}{u}\frac{du}{d\phi} + m\tan\phi\right],$$

or

$$F'(\phi) = F(\phi)\left[\frac{kl}{g}u^n(\sec\phi)^{n+1} + m\tan\phi\right];$$

and $F''(\phi) = F'(\phi)\left[\frac{kl}{g}u^n(\sec\phi)^{n+1} + m\tan\phi\right] + F(\phi)\left[\frac{kln}{g}u^{n-1}\frac{du}{d\phi}(\sec\phi)^{n+1} + \frac{kl}{g}(n+1)u^n(\sec\phi)^{n+1}\tan\phi + m(\sec\phi)^2\right]$,

or

$$F''(\phi) = F(\phi)\left[\frac{k^2l^2}{g^2}u^{2n}(\sec\phi)^{2n+2} + 2\frac{klm}{g}u^n(\sec\phi)^{n+1}\tan\phi + m^2(\sec\phi)^2 - m^2\right]$$
$$+ F(\phi)\left[\frac{k^2ln}{g^2}u^{2n}(\sec\phi)^{2n+2} + \frac{kl}{g}(n+1)u^n(\sec\phi)^{n+1}\tan\phi + m(\sec\phi)^2\right]$$
$$= F(\phi)\left\{\frac{k^2l}{g^2}(l+n)u^{2n}(\sec\phi)^{2n+2} + \frac{kl}{g}(2m+n+1)u^n(\sec\phi)^{n+1}\tan\phi + m(m+1)(\sec\phi)^2 - m^2\right\}.$$

Since

$$\frac{du}{d\phi} = \frac{k}{g}u^{n+1}(\sec\phi)^{n+1},$$

this last expression may be put under the form—

$$F''(\phi) = F(\phi)\left\{l(l+n)\left(\frac{du}{ud\phi}\right)^2 + l(2m+n+1)\left(\frac{du}{ud\phi}\right)\tan\phi + m(m+1)(\sec\phi)^2 - m^2\right\}.$$

Hence, by the above lemma,

$$\int_\beta^\alpha u^l\sec\phi^m d\phi = (\alpha-\beta)F(\gamma)\left\{1 + \tfrac{1}{24}(\alpha-\beta)^2\left[l(l+n)\left(\frac{du}{ud\phi}\right)_0^2 + l(2m+n+1)\left(\frac{du}{ud\phi}\right)_0\tan\gamma + m(m+1)(\sec\gamma)^2 - m^2\right]\right\}$$
$$= (\alpha-\beta)\,u_0^l(\sec\gamma)^m\left\{1 + \tfrac{1}{24}(\alpha-\beta)^2(\text{as before})\right\}$$

where $\left(\frac{du}{ud\phi}\right)_0$ denotes what $\frac{du}{ud\phi}$ becomes when $\omega = 0$, or when γ is substituted for ϕ, and u_0 for u, that is—

$$\left(\frac{du}{ud\phi}\right)_0 = \frac{k}{g}u_0^n(\sec\gamma)^{n+1}.$$

The factor u_0^l may be eliminated from this expression, and the expression itself simplified, by means of the formula—

$$\frac{1}{q^{n-l}} - \frac{1}{p^{n-l}} = (n-l)\int_\beta^\alpha\frac{1}{u^{n-l+1}}\frac{du}{d\phi}d\phi = \frac{k(n-l)}{g}\int_\beta^\alpha u^l(\sec\phi)^{n+1}d\phi,$$

for, putting $m = n+1$ in the above expression, we have—

$$\int_\beta^\alpha u^l(\sec\phi)^{n+1}d\phi = (\alpha-\beta)u_0^l(\sec\gamma)^{n+1}\left\{1 + \tfrac{1}{24}(\alpha-\beta)^2\left[l(l+n)\left(\frac{du}{ud\phi}\right)_0^2 + 3l(n+1)\left(\frac{du}{ud\phi}\right)_0\tan\gamma + \overline{n+1}\;\overline{n+2}\,(\sec\gamma)^2 - (n+1)^2\right]\right\}.$$

Hence

$$\int_\beta^\alpha u^l(\sec\phi)^m d\phi \div \int_\beta^\alpha u^l(\sec\phi)^{n+1}d\phi,\ \text{ or }\ \int_\beta^\alpha u^l(\sec\phi)^m d\phi \div \frac{g}{k(n-l)}\left(\frac{1}{q^{n-l}} - \frac{1}{p^{n-l}}\right)$$
$$= (\sec\gamma)^{m-n-1}\left\{1 + \tfrac{1}{24}(\alpha-\beta)^2\left[2l(m-n-1)\left(\frac{du}{ud\phi}\right)_0\tan\gamma + \overline{m-n-1}\;\overline{m+n+2}\,(\sec\gamma)^2 - \overline{m-n-1}\;\overline{m+n+1}\right]\right\}.$$

It will be noticed that the term involving $\left(\frac{du}{ud\phi}\right)_0^2$ has disappeared by this division.

Now make $m = 2$, and this formula becomes—

$$\int_\beta^\alpha u^l(\sec\phi)^2 d\phi = \frac{g}{k(n-l)}\left(\frac{1}{q^{n-l}} - \frac{1}{p^{n-l}}\right)(\cos\gamma)^{n-1}\left\{1 - \tfrac{1}{24}(\alpha-\beta)^2\left[2l(n-1)\left(\frac{du}{ud\phi}\right)_0\tan\gamma + \overline{n-1}\;\overline{n+4}\,(\sec\gamma)^2 - \overline{n-1}\;\overline{n+3}\right]\right\}.$$

Divide throughout by g, and put $l = 2$, then, from before,

$$X = \frac{1}{k(n-2)}\left(\frac{1}{q^{n-2}} - \frac{1}{p^{n-2}}\right)(\cos\gamma)^{n-1}\left\{1 - \frac{n-1}{24}(\alpha-\beta)^2\left[4\left(\frac{du}{ud\phi}\right)_0\tan\gamma + (n+4)(\sec\gamma)^2 - \overline{n+3}\right]\right\}.$$

Similarly, divide throughout by g, and put $l = 1$, then—

$$T = \frac{1}{k(n-1)}\left(\frac{1}{q^{n-1}} - \frac{1}{p^{n-1}}\right)(\cos\gamma)^{n-1}\left\{1 - \frac{n-1}{24}(\alpha-\beta)^2\left[2\left(\frac{du}{ud\phi}\right)_0\tan\gamma + (n+4)(\sec\gamma)^2 - \overline{n+3}\right]\right\}.$$

Lastly, let

$$F(\phi) = u^l(\sec\phi)^m\tan\phi = f(\phi)\tan\phi \text{ suppose,}$$

so that

$$f(\phi) = u^l(\sec\phi)^m;$$

then

$$F'(\phi) = f'(\phi)\tan\phi + f(\phi)(\sec\phi)^2,$$

and

$$F''(\phi) = f''(\phi)\tan\phi + 2f'(\phi)(\sec\phi)^2 + 2f(\phi)(\sec\phi)^2\tan\phi.$$

Hence

$$\int_\beta^\alpha F(\phi)d\phi = (\alpha-\beta)\{F(\gamma) + \tfrac{1}{24}(\alpha-\beta)^2F''(\gamma)\}\text{ approximately,}$$
$$= (\alpha-\beta)\left\{f(\gamma)\tan\gamma + \tfrac{1}{24}(\alpha-\beta)^2[f''(\gamma)\tan\gamma + 2f'(\gamma)(\sec\gamma)^2 + 2f(\gamma)(\sec\gamma)^2\tan\gamma]\right\};$$

also

$$\int_\beta^\alpha f(\phi)d\phi = (\alpha-\beta)\{f(\gamma) + \tfrac{1}{24}(\alpha-\beta)^2f''(\gamma)\}\text{ approximately;}$$

and therefore

$$\int_\beta^\alpha F(\phi)d\phi \div \int_\beta^\alpha f(\phi)d\phi = \tan\gamma + \tfrac{1}{12}(\alpha-\beta)^2\left[\frac{f'(\gamma)}{f(\gamma)}(\sec\gamma)^2 + (\sec\gamma)^2\tan\gamma\right];$$

in which the term involving $f''(\gamma)$ has disappeared.

Now, since $f(\phi) = u^l(\sec\phi)^m$, we have, as before

$$f'(\phi) = f(\phi)\left[l\left(\frac{du}{ud\phi}\right) + m\tan\phi\right];$$

and therefore—

$$\frac{f'(\gamma)}{f(\gamma)} = l\left(\frac{du}{ud\phi}\right)_0 + m\tan\gamma.$$

Hence—

$$\int_\beta^\alpha F(\phi)d\phi \div \int_\beta^\alpha f(\phi)d\phi = \tan\gamma + \tfrac{1}{12}(\alpha-\beta)^2(\sec\gamma)^2\left[l\left(\frac{du}{ud\phi}\right)_0 + \overline{m+1}\tan\gamma\right];$$

and in the particular case where $l = 2$, and $m = 2$, we have—

$$\frac{Y}{X} = \tan\gamma + \tfrac{1}{12}(\alpha-\beta)^2(\sec\gamma)^2\left[2\left(\frac{du}{ud\phi}\right)_0 + 3\tan\gamma\right]$$

$$= \tan\left\{\gamma + \tfrac{1}{12}(\alpha-\beta)^2\left[2\left(\frac{du}{ud\phi}\right)_0 + 3\tan\gamma\right]\right\}.$$

Hence the angle which the chord of the arc makes with the axis of x is—

$$\gamma + \tfrac{1}{12}(\alpha-\beta)^2\left[2\left(\frac{du}{ud\phi}\right)_0 + 3\tan\gamma\right] = \bar{\gamma}, \text{ suppose.}$$

Multiplying by the value of X found above, we have—

$$Y = \frac{1}{k(n-2)}\left(\frac{1}{q^{n-2}} - \frac{1}{p^{n-2}}\right)(\cos\gamma)^{n-1}\left\{\tan\gamma - \tfrac{1}{24}(\alpha-\beta)^2\left\{\left(\frac{du}{ud\phi}\right)_0\left[4\overline{n-1}(\tan\gamma)^2 - 4(\sec\gamma)^2\right] + \tan\gamma\left[\overline{n-1}\,\overline{n+4}(\sec\gamma)^2 - 6(\sec\gamma)^2 - \overline{n-1}\,\overline{n+3}\right]\right\}\right\};$$

or

$$Y = \frac{1}{k(n-2)}\left(\frac{1}{q^{n-2}} - \frac{1}{p^{n-2}}\right)(\cos\gamma)^{n-1}\left\{\tan\gamma - \tfrac{1}{24}(\alpha-\beta)^2\left\{\left(\frac{du}{ud\phi}\right)_0\left[4\overline{n-2}(\sec\gamma)^2 - 4\overline{n-1}\right] + \tan\gamma\left[\overline{n-2}\,\overline{n+5}(\sec\gamma)^2 - \overline{n-1}\,\overline{n+3}\right]\right\}\right\}.$$

Considering $\frac{1}{q^{n-2}} - \frac{1}{p^{n-2}}$, $\frac{1}{q^{n-1}} - \frac{1}{p^{n-1}}$, and $\alpha - \beta$ to be small quantities of the first order, the above expressions for $\frac{1}{q^n} - \frac{1}{p^n}$, X, Y, and T are true to the fourth order.

The quantity $\left(\frac{du}{ud\phi}\right)_0$ which occurs as a factor in some of the terms of the third order may be put under a very convenient form in the following manner.

We have, by Taylor's theorem,

$$u = (u_0) + \left(\frac{du}{d\phi}\right)_0\omega + \left(\frac{d^2u}{d\phi^2}\right)_0\frac{\omega^2}{2} + \&c.$$

In this make $\omega = \frac{1}{2}(\alpha-\beta)$ and $-\frac{1}{2}(\alpha-\beta)$ successively; therefore

$$p = u_0 + \tfrac{1}{2}(\alpha-\beta)\left(\frac{du}{d\phi}\right)_0 + \tfrac{1}{8}(\alpha-\beta)^2\left(\frac{d^2u}{d\phi^2}\right)_0 + \&c.,$$

and

$$q = u_0 - \tfrac{1}{2}(\alpha-\beta)\left(\frac{du}{d\phi}\right)_0 + \tfrac{1}{8}(\alpha-\beta)^2\left(\frac{d^2u}{d\phi^2}\right)_0 - \&c.$$

Hence we have to the first order of small quantities—

$$\frac{p-q}{\alpha-\beta} = \left(\frac{du}{d\phi}\right)_0,$$

and

$$\tfrac{1}{2}(p+q) = u_0;$$

and therefore

$$\left(\frac{du}{ud\phi}\right)_0 = \frac{2(p-q)}{(p+q)(\alpha-\beta)} \text{ to the first order.}$$

Making this substitution for $\left(\frac{du}{ud\phi}\right)_0$ the expressions for X, Y, and T become—

$$X = \frac{1}{k(n-2)}\left(\frac{1}{q^{n-2}} - \frac{1}{p^{n-2}}\right)(\cos\gamma)^{n-1}\left\{1 - \frac{n-1}{3}\cdot\frac{p-q}{p+q}(\alpha-\beta)\tan\gamma - \frac{n-1}{24}(\alpha-\beta)^2\left[n+4(\sec\gamma)^2 - \overline{n+3}\right]\right\};$$

$$Y = \frac{1}{k(n-2)}\left(\frac{1}{q^{n-2}} - \frac{1}{p^{n-2}}\right)(\cos\gamma)^{n-1}\left\{\tan\gamma - \tfrac{1}{3}\cdot\frac{p-q}{p+q}(\alpha-\beta)\left[\overline{n-2}(\sec\gamma)^2 - \overline{n-1}\right] - \tfrac{1}{24}(\alpha-\beta)^2\tan\gamma\left[\overline{n-2}\,\overline{n+5}(\sec\gamma)^2 - \overline{n-1}\,\overline{n+3}\right]\right\};$$

$$T = \frac{1}{k(n-1)}\left(\frac{1}{q^{n-1}} - \frac{1}{p^{n-1}}\right)(\cos\gamma)^{n-1}\left\{1 - \frac{n-1}{6}\frac{p-q}{p+q}(\alpha-\beta)\tan\gamma - \frac{n-1}{24}(\alpha-\beta)^2\left[\overline{n+4}(\sec\gamma)^2 - \overline{n+3}\right]\right\};$$

and these values are still true to the fourth order, considering $\frac{p-q}{p+q}$ and $\alpha-\beta$ to be small quantities of the first order as before.

The angle which the chord of the arc makes with the axis of x becomes, in like manner—

$$\bar{\gamma} = \gamma + \tfrac{1}{3}\frac{p-q}{p+q}(\alpha-\beta) + \tfrac{1}{4}(\alpha-\beta)^2\tan\gamma,$$

which is true to the third order.

The above expressions for X and Y may be transformed by introducing this angle $\bar{\gamma}$ into them instead of γ, thus—

$$(\cos\bar{\gamma})^{n-1} = (\cos\gamma)^{n-1} - (n-1)(\cos\gamma)^{n-2}\sin\gamma\left[\tfrac{1}{3}\frac{p-q}{p+q}(\alpha-\beta) + \tfrac{1}{4}(\alpha-\beta)^2\tan\gamma\right]$$

$$= (\cos\gamma)^{n-1}\left\{1 - \frac{n-1}{3}\frac{p-q}{p+q}(\alpha-\beta)\tan\gamma - \frac{n-1}{4}(\alpha-\beta)^2(\tan\gamma)^2\right\}.$$

Hence we find—

$$X = \frac{1}{k(n-2)}\left(\frac{1}{q^{n-2}} - \frac{1}{p^{n-2}}\right)(\cos\bar{\gamma})^{n-1}\left\{1 - \frac{n-1}{24}(\alpha-\beta)^2[\overline{n-2}(\sec\gamma)^2 - \overline{n-3}]\right\},$$

and

$$Y = X\tan\bar{\gamma} = \frac{1}{k(n-2)}\left(\frac{1}{q^{n-2}} - \frac{1}{p^{n-2}}\right)(\cos\bar{\gamma})^{n-2}\sin\bar{\gamma}\left\{1 - \frac{n-1}{24}(\alpha-\beta)^2[\overline{n-2}(\sec\gamma)^2 - \overline{n-3}]\right\};$$

or

$$X = \frac{1}{k(n-2}\left(\frac{1}{q^{n-2}} - \frac{1}{p^{n-2}}\right)(\cos\bar{\gamma})^{n-1}Q;$$

$$Y = \frac{1}{k(n-2)}\left(\frac{1}{q^{n-2}} - \frac{1}{p^{n-2}}\right)(\cos\bar{\gamma})^{n-2}\sin\bar{\gamma}\,Q;$$

Q being $= 1 - \frac{n-1}{24}(\alpha-\beta)^2[\overline{n-2}(\sec\gamma)^2 - \overline{n-3}]$.

Similarly, if

$$\bar{\gamma}' = \gamma + \tfrac{1}{6}\frac{p-q}{p+q}(\alpha-\beta) + \tfrac{1}{4}(\alpha-\beta)^2\tan\gamma,$$

we have

$$(\cos\bar{\gamma}')^{n-1} = (\cos\gamma)^{n-1} - (n-1)(\cos\gamma)^{n-2}\sin\gamma\left[\tfrac{1}{6}\frac{p-q}{p+q}(\alpha-\beta) + \tfrac{1}{4}(\alpha-\beta)^2\tan\gamma\right];$$

$$= (\cos\gamma)^{n-1}\left\{1 - \frac{n-1}{6}\frac{p-q}{p+q}(\alpha-\beta)\tan\gamma - \frac{n-1}{4}(\alpha-\beta)^2(\tan\gamma)^2\right\};$$

and therefore

$$T = \frac{1}{k(n-1)}\left(\frac{1}{q^{n-1}} - \frac{1}{p^{n-1}}\right)(\cos\bar{\gamma}')^{n-1}\left\{1 - \frac{n-1}{24}(\alpha-\beta)^2\left[\overline{n-2}(\sec\gamma)^2 - \overline{n-3}\right]\right\}$$

$$= \frac{1}{k(n-1)}\left(\frac{1}{q^{n-1}} - \frac{1}{p^{n-1}}\right)(\cos\bar{\gamma}')^{n-1}Q,$$

where Q has the same value as before.

Hence the values of X, Y, and T are as stated in my postscript to Mr. Niven's paper.

Although the method of finding the expressions for X and T given above, is perhaps the plainest and most straightforward that can be taken, the following leads to simpler operations.

Let $f(\phi) = u^l(\sec\phi)^{n+1}$.

Then $\int f(\phi)d\phi = \int u^l(\sec\phi)^{n+1}d\phi = \frac{g}{k}\int u^{l-n-1}\frac{du}{d\phi}d\phi$ by equation (1)

$$= \frac{g}{k(l-n)}u^{l-n} + \text{const.}$$

Hence

$$\int_\beta^\alpha f(\phi)d\phi = \frac{g}{k(l-n)}(p^{l-n} - q^{l-n})$$

Now let

$$F(\phi) = f(\phi)(\sec\phi)^m = u^l(\sec\phi)^{m+n+1},$$

then

$$F'(\phi) = f'(\phi)(\sec\phi)^m + mf(\phi)(\sec\phi)^m\tan\phi,$$

and

$$F''(\phi) = f''(\phi)(\sec\phi)^m + 2mf'(\phi)(\sec\phi)^m\tan\phi + mf(\phi)[m(\sec\phi)^m(\tan\phi)^2 + (\sec\phi)^{m+2}]$$

$$= f''(\phi)(\sec\phi)^m + 2mf'(\phi)(\sec\phi)^m\tan\phi + mf(\phi)[\overline{m+1}(\sec\phi)^{m+2} - m(\sec\phi)^m].$$

Hence, by the lemma,

$$\int_\beta^\alpha F(\phi)d\phi = (\alpha-\beta)\{F(\gamma) + \tfrac{1}{24}(\alpha-\beta)^2F''(\gamma)\}$$

$$= (\alpha-\beta)\left\{f(\gamma)(\sec\gamma)^m + \tfrac{1}{24}(\alpha-\beta)^2(\sec\gamma)^m[f''(\gamma) + 2mf'(\gamma)\tan\gamma + mf(\gamma)[\overline{m+1}(\sec\gamma)^2 - m]]\right\}$$

$$= (\alpha-\beta)(\sec\gamma)^m\left\{f(\gamma) + \tfrac{1}{24}(\alpha-\beta)^2[f''(\gamma) + 2mf'(\gamma)\tan\gamma + mf(\gamma)[\overline{m+1}(\sec\gamma)^2 - m]]\right\}.$$

But from above

$$\frac{g}{k(l-n)}(p^{l-n} - q^{l-n}) = \int_\beta^\alpha f(\phi)d\phi,$$

$$= (\alpha-\beta)\{f(\gamma) + \tfrac{1}{24}(\alpha-\beta)^2f''(\gamma)\}.$$

Hence, by division,

$$\int^\alpha F(\phi)d\phi \div \frac{g}{k(l-n)}(p^{l-n} - q^{l-n}) = (\sec\gamma)^m\left\{1 + \tfrac{1}{24}(\alpha-\beta)^2\left[2m\frac{f'\gamma}{f\gamma}\tan\gamma + m(\overline{m+1}(\sec\gamma)^2 - m)\right]\right\},$$

It will be noticed that in this division the quantity $f'''(\gamma)$ has disappeared.

Now, from above,

$$f(\phi) = u^l(\sec\phi)^{n+1},$$

and therefore

$$\frac{f'(\phi)}{f(\phi)} = l\frac{du}{ud\phi} + (n+1)\tan\phi,$$

and

$$\frac{f'(\gamma)}{f(\gamma)} = l\left(\frac{du}{ud\phi}\right)_0 + (n+1)\tan\gamma.$$

Hence

$$\int_\beta^\alpha F(\phi)d\phi \div \frac{g}{k(l-n)}(p^{l-n} - q^{l-n}) = (\sec\gamma)^m\left\{1 + \tfrac{1}{24}(\alpha-\beta)^2\left[2lm\left(\frac{du}{ud\phi}\right)_0\tan\gamma + 2m\overline{n+1}(\tan\gamma)^2 + m\left(\overline{m+1}(\sec\gamma)^2 - m\right)\right]\right\}$$

$$= (\sec\gamma)^m\left\{1 + \tfrac{1}{24}(\alpha-\beta)^2\left[2lm\left(\frac{du}{ud\phi}\right)_0\tan\gamma + m(m+2n+3)(\sec\gamma)^2 - m(m+2n+2)\right]\right\}$$

Now make $m + n + 1 = 2$,

or $m = -(n-1)$, and we have

$$\int_\beta^\alpha u^l(\sec\phi)^2 \div \frac{g}{k(l-n)}(p^{l-n} - q^{l-n}) = (\cos\gamma)^{n-1}\left\{1 - \tfrac{1}{24}(\alpha-\beta)^2\left[2l(n-1)\left(\frac{du}{ud\phi}\right)_0\tan\gamma + (n-1)(n+4)(\sec\gamma)^2 - (n-1)(n+3)\right]\right\}.$$

In this make $l = 2$, and $l = 1$, successively, and we obtain the same expressions for X and T as before.

The case thus treated is not one of mere curiosity, but is practically important. From theoretical considerations, Newton concluded that the resistance of the air to the motion of projectiles is proportional to the square of the velocity, and very little progress has been made in the theory of the subject since his time. Experiments have shown that the relation between the velocity of a projectile and the resistance offered by the air to its motion is far from being so simple as that given by the theory. The most extensive and accurate series of such experiments which we have are those made by Mr. Bashforth by means of his chronograph, which measures with the greatest precision the times taken by the same projectile in passing over several successive arcs in the course of its flight. In a summary of his results for ogival-headed shot, struck with a radius of $1\frac{1}{2}$ diameters, given in NATURE (vol. xxxiii. pp. 605, 606), Mr. Bashforth concludes that the resistance may be approximately represented by supposing it to vary as one power of the velocity when that velocity lies between certain limits, as another power when the velocity lies between certain other limits, and so on.

Thus, if v denote the velocity expressed in feet per second,

d the diameter of the shot in inches,

and w its weight in pounds,

and if $\frac{d^2}{w} = c$,

then, when v lies between 430 f.s. and 850 f.s.,

the resistance is nearly $= 61{\cdot}3\,c\left(\frac{v}{1000}\right)^2$;

when v lies between 850 f.s. and 1040 f.s.,

the resistance is nearly $= 74{\cdot}4\,c\left(\frac{v}{1000}\right)^3$;

when v lies between 1040 f.s. and 1100 f.s.,

the resistance is nearly $= 79{\cdot}2\,c\left(\frac{v}{1000}\right)^6$;

when v lies between 1100 f.s. and 1300 f.s.,

the resistance is nearly $= 108{\cdot}8\,c\left(\frac{v}{1000}\right)^3$;

and lastly, when v lies between 1300 f.s. and 2700 f.s.,

the resistance is nearly $= 141{\cdot}5\,c\left(\frac{v}{1000}\right)^2$.

Hence the resistance varies nearly as the square of the velocity both when the velocity is less than 850 f.s., and when it is greater than 1300 f.s., but the coefficient increases from 61·3 in the former case, to 141·5 in the latter. Also, the resistance varies nearly as the cube of the velocity, both when v lies between 850 f.s. and 1040 f.s., and also when it lies between 1100 f.s. and 1300 f.s., but the coefficient increases from 74·4 in the former to 108·8 in the latter case. Again, for velocities which are nearly equal to that of sound in air, the proportionate increase of the resistance is much greater than that of the velocity.

Mr. Bashforth remarks that the points of transition from one law of resistance to another, as stated above, are somewhat arbitrary, but that, if they were changed a little in either direction, the practical error would not be large.

Of course, if we had at our disposal much more numerous and still more accurate observations, it would be possible to represent the experimental results with any degree of exactness that might be desired, by subdividing the observations into a larger number of groups, so that the limiting velocities in any one group should be closer together, and that the change of the index of the power of the velocity in passing from one group to the next should be less abrupt.

J. C. ADAMS.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, December 19, 1889.—Dr. W. J. Russell, F.R.S., in the chair.—The following papers were read:—Frangulin, by Prof. T. E. Thorpe, F.R.S., and Mr. H. H. Robinson. The authors prepared the glucoside frangulin from the bark of the alder buckthorn (*Rhamnus frangula*), and find its formula to be $C_{22}H_{22}O_9$. On hydrolysis it yields a yellow product, $C_{15}H_{10}O_5$, which agrees in its properties with emodin, and a sugar which has the power of reducing Fehling's solution, and is not identical with dextrose.—Arabinon, the saccharon of arabinose, by Mr. C. O'Sullivan, F.R.S. The substance having an optical activity "well above $[\alpha]_j = 140$," obtained by the author by the hydrolysis of arabic acid, and described under the name of α-arabinose (Chem. Soc. Trans., 1884, 55), yields arabinose on hydrolysis, and appears to bear to this carbohydrate a relation similar to that which saccharon (cane sugar) bears to dextrose: the author therefore terms it arabinon. It has the formula $C_{10}H_{18}O_9$, and on hydrolysis gives a yield of arabinose agreeing very closely with that required by the equation $C_{10}H_{18}O_9 + H_2O = 2C_5H_{10}O_5$. As yet it has not been obtained in a crystalline state; it has a specific rotatory power of $[\alpha]_D = 198^\circ{\cdot}8$, and 100 parts have the same cupric reducing power as 58·8 parts of dextrose.—On the identity of cerebrose and galactose, by Mr. H. T. Brown, F.R.S., and Dr. G. H. Morris. The authors give the results of an examination of a specimen of cerebrose, prepared from phrenosin, which was placed in their hands early in 1888 by Dr. Thudichum, who first isolated and crystallized this substance. They show that its specific rotatory power, cupric reducing power, and molecular weight as determined by Raoult's method, are identical with those of galactose, thus confirming the recent work of Thierfelder, *Zeit. Physiol. Chem.*, 14, 209) who has proved the sugar produced by the action of acid on cerebrin to be identical with galactose. In the discussion which followed the reading of the paper, Dr. Thudichum said that phrenosin, $C_{41}H_{79}NO_8$, consisted of the sugar now shown to be identical with galactose, $C_6H_{12}O_6$, of neurostearic acid, $C_{18}H_{36}O_2$, an isomeride of stearic acid, fusing at 84°, and of sphingosine, an alkaloid of the formula $C_{17}H_{35}NO_2$. Some human brains contained as much as 4 per cent. of phrenosin in addition to other glucosides. The crystallized sugar (galactose) from phrenosin was always accompanied by an almost equal weight of uncrystallizable sugar, of which the nature was not yet ascertained.—The action of chloroform and alcoholic potash on hydrazines, Part 3, by Dr. S. Ruhemann. The products formed by the action of chloroform and alcoholic potash on hydrazines are to be regarded as derivatives of tetrazine, $N \begin{matrix} \diagup CH.NH \diagdown \\ \diagdown NH.CH \diagup \end{matrix} N$; and in the present communication the author describes the di-paratolyl,-orthotolyl, and -pseudocumyl derivatives of this base (cf. Chem. Soc. Trans., 1889, 242).

Royal Microscopical Society, December 11, 1889.—The Rev. Dr. Dallinger, F.R.S., Vice-President, in the chair.—Mr. E. M. Nelson read a short paper descriptive of a new semi-apochromatic objective which he exhibited.—Mr. C. Rousselet exhibited a small tank for Rotifers which could be readily moved about in such a way as to render an examination of the contents very easy, so that any desired specimens could be easily picked out. The lens used was a Zeiss's No. 6 Steinheil, the focussing being done by rackwork.—Mr. Crisp called attention to a number of stereoscopic photomicrographs of embryos, by Prof. Fol. They afforded a conclusive answer to the question brought forward at their meeting as to whether stereoscopic photomicrographic slides had been produced before that time.—Mr. Crisp read some extracts from a paper by Mr. Gill, which he was sorry to say was only handed in at the conclusion of their last meeting, as otherwise it could have been read then, and would have added to the interest of the specimens exhibited at the *conversazione*, which seemed almost conclusively to prove that the "markings" on certain diatoms were apertures.—Mr. A. W. Bennett gave a *résumé* of his paper on the freshwater Algæ and Schizophyceæ of Hampshire and Devon. It was the result of collections made, during his summer holidays, in the New Forest and on Dartmoor, many of the species being not only interesting, but also new to science.—Mr. Crisp reminded the Fellows present that at the last meeting mention was made of a new objective with an aperture of 1·60, the price of which was said to be £400. Some doubt was expressed at the time as to whether the account was true, but since then they had received several communications about it. A letter from Prof. Abbe, describing the principles of its construction, was read. Letters were also read from Dr. van Heurck, describing the performance of the lens, and inclosing a series of remarkable photomicrographs of diatoms taken with it, with magnifying powers of 10,000 and 15,000 diameters.

PARIS.

Academy of Sciences, January 6.—M. Hermite in the chair.—State of the Academy on January 1. Full lists are given of the Members of the various Sections. Amongst the foreign Associates and Correspondents occur the following English and American names:—*Associates:* Sir Richard Owen, Sir George Biddell Airy, and Sir William Thomson. *Correspondents: Geometry*—James Joseph Sylvester and George Salmon; *Astronomy*—John Russell Hind, J. C. Adams, Arthur Cayley, Joseph Norman Lockyer, William Huggins, Simon Newcomb, Asaph Hall, Benjamin Apthorp Gould, and Samuel Langley; *Geography and Navigation*—Rear-Admiral George Henry Richards; *General Physics*—George Gabriel Stokes; *Chemistry*—Edward Frankland and Alexander William Williamson; *Mineralogy*—James Hall and Joseph Prestwich; *Botany*—Joseph Dalton Hooker and Maxwell Tylden Masters; *Rural Economy*—John Bennet Lawes and Joseph Henry Gilbert; *Anatomy and Zoology*—James Dwight Dana, Thomas Henry Huxley, and Alexander Agassiz; *Medicine and Surgery*—Sir James Paget.—M. Duchartre was elected Vice-President for the year 1890.—Analogy of diamantiferous matrix in South Africa to meteorites, by M. Daubrée. It is argued that the South African diamonds were not formed *in situ*, but were erupted from great depths together with the fragmentary materials in which they are embedded. The presence of the diamond in the normal state and as carbonado, as well as transformed from graphite in various types of meteorites, is now placed beyond reasonable doubt. Attention is here called to the analogous conditions of association under which this crystal occurs in South Africa and in meteorites. M. Daubrée incidentally infers that the diamond is not, as is generally supposed, of vegetable origin, but is of inorganic nature, as is also the graphite occurring in analogous beds.—On some new fluorescent materials, by M. Lecoq de Boisbaudran. The author describes some new fluorescent appearances which he has obtained by employing samaria and the earths $Z\alpha$ and $Z\beta$ as agents, and calcined silica and zircon as solid solvents. Mr. Crookes's failure to obtain any fluorescences from samaria with SiO_2 and ZrO_2, he considers was probably due to their having been calcined at too low a temperature.—Observations of Borrelly's comet made at the Observatory of Algiers, by MM. Trépied, Ramraud, and Renaux. The observations are for the period December 23–30, when the nebulosity was somewhat elongated, and about 2′ in extent.—Observations of Brooks's comet (July 6, 1889) made at the Observatory of Nice with the 0·38m. equatorial, by M. D. Eginitis.—On the elliptic functions, by M. Paul Appell. It is shown that the representation of the elliptic functions by the quotient of Θ functions may be justified *a priori* by considerations which seem capable of being extended to the functions of two variables with four groups of periods.—On the rational integrals of equations of the first order, by M. P. Painlevé. Given a differential equation of any order, it is shown that the polynomes may always be found which verify the equation by determining a higher limit of their degree.—On the absolute value of the magnetic elements on January 1, 1890, by M. Th. Moureaux. These values are deduced from the mean of the horary observations taken at the Parc Saint-Maur on December 31, 1889, and January 1, 1890, and at Perpignan from the twenty-four horary observations taken on January 1.—On the refracting powers of the simple salts in solution, by M. E. Doumer. Owing to Mr. B. Walter's recent note in *Wiedemann's Annalen* (1889, No. 9, p. 107), M. Doumer here publishes somewhat prematurely the researches on this subject, which he has carried on for over five years, and during which he has dealt with 90 salts. He concludes that all salts formed by the same acid have the same molecular refracting power when they are constructed on the same type; that the refracting powers of salts belonging to different types are approximately multiples of the same number; lastly, that the molecular refracting powers of all salts are functions of the number of valencies of the metallic element entering into their construction.—Papers were read by M. Georges Vogt, on the composition of the rocks employed in China for the manufacture of porcelain; by M. Charles Combes, on matezite and matezo-dambose; by M. E. Guinochet, on the carballylates; by M. A. Lacroix, on the mineral-bearing cipoline marbles and the wernerite rocks of Ariège; and by M. Thoulet, on the sub-lacustrine relief, geology, and temperature of Lake Longemer (Vosges).

BERLIN.

Physiological Society, December 13, 1889.—Prof. du Bois-Reymond, President, in the chair.—Prof. Moebius spoke on a "drumming" fish (*Balistes aculeatus*) from Mauritius. During a recent visit to this island he observed a bright blue-coloured fish in the shallow waters of the harbour; when caught and held in the hand this fish emitted from its interior a most striking noise, like that of a drum. A careful examination of the animal failed to reveal any obvious movements, with the exception of one part of the skin, lying just behind the gill-slit, which was in continuous vibration. Nothwithstanding prolonged endeavours he had not been able to secure a second living example of this fish, and had hence been able to carry out his investigations on the cause of the drumming noise only on dead specimens. The portion of the skin (membrana supra-axillaris) which vibrates stretches from the clavicle to the branchial arch: it is provided with four large bony plates, and lies over the swim-bladder, which in this fish for the most part projects out of the trunk-muscles. Behind the clavicle lies a curiously-shaped long bone, which is attached to the clavicle at one point in such a way as to form a lever with two arms. The long arm of this bony lever (os post-claviculare) is embedded in the ventral trunk-muscles, and is capable of easy movement to and fro. The short arm slides during this movement over the rough inner side of the clavicle, and gives rise to a crackling noise, and this noise is then intensified by the swim-bladder, which lies in close proximity to the short arm of the lever, and acts as a resonator. When the trunk-muscles contract the body cavity is diminished in size, the air in the swim-bladder is driven forward, and the bladder then communicates the vibrations of the bony lever to the membrana supra-axillaris, and the latter communicates them to the air. The speaker was of opinion that the above was the explanation of the "drumming" of this fish; he was, at all events, unable to find any other organ in it which could account for the noise. This noise is not known to be emitted by other species of Balistes, although it is known to occur in other groups.—Prof. Fritsch spoke on the anatomy of *Torpedo marmorata*. In opposition to the revolutionary views of many recent investigators, who deny the nervous nature of the ganglion-cells, he laid great stress upon the extremely close relationship which exists between the ganglia and end-organs, and is so strikingly shown in Torpedo. A thick nerve-fibre runs from each ganglion-cell to the electrical-organ, divides into twelve to twenty-three fibrils before it reaches the organ, and each of these fibrils is connected up with some one special plate of the organ. Now, since each plate, which is of hexagonal shape, owing to the close juxtaposition of the columns, receives one nerve-fibre at each of its angles, it hence follows that the number of the plates must be, on the average, three times as great as the number of the ganglia. The fibres of one ganglion supply eighteen plates, the latter (being hexagonal) require six times eighteen fibres for their supply, and since on an average eighteen fibres run out from each ganglion, it requires six ganglia to supply eighteen plates with nerves. The speaker had counted the plates of an electrical-organ in Torpedo, and obtained a number corresponding closely with an older enumeration of Valentin's made on a Torpedo of the same size; the number of plates he found to be 179,625. He had further counted the ganglion-cells which supply the plates with nerves and found them to number 53,739; this corresponds closely with the enumeration of Boll, who counted 53,760. The counting of ganglion-cells is subject to much uncertainty, chiefly owing to the fact that in sections of the central nervous system many cells are cut through, and are thus liable to be counted twice: hence the speaker had enumerated, most readily by means of photographs, the axis-cylinders of the nerves which supply the electric-organ; he found them to number 58,318, corresponding to the same number of ganglion-cells. The last number is nearly one-third the number of plates in the electrical-organ, and corresponds closely to the number which should be found if the older view is the correct one, that the ganglion-cells are the centres for the nervous end-organs.

DIARY OF SOCIETIES.

London.

THURSDAY, January 16.

Royal Society, at 4.30.—On the Chief Line in the Spectrum of the Nebulæ: Prof. J. N. Lockyer, F.R.S.—Observations on the Excretion and Uses of Bile: A. W. Mayo Robson.—On the Theory of Free Stream Lines: J. H. Michell.

Linnean Society, at 8.—Life-History of a Remarkable Uredine on Jasminum grandiflora: A. Barclay.—Certain Protective Provisions in some Larval British Teleosteans: E. Prince.

Chemical Society, at 8.—On a New Method of estimating the Oxygen dissolved in Water: Dr. J. C. Thresh.

Zoological Society, at 4.

FRIDAY, January 17.

Society of Arts, at 8.

Physical Society, at 5.—On a Carbon Deposit in a Blake Telephone Transmitter: F. B. Hawes.—On Electric Splashes: Prof. S. P. Thompson.—On Galvanometers: Prof. W. E. Ayrton, F.R.S., T. Mather, and W. E. Sumpner.

SUNDAY, January 19.

Sunday Lecture Society, at 4.—How I crossed Africa from the Indian Ocean to the Atlantic (with Oxyhydrogen Lantern Illustrations): Commander V. L. Cameron, R.N.

MONDAY, January 20.

Royal Geographical Society, at 8.30.—Mr. J. R. W. Pigott's Journey to the Upper Tana in 1889: E. G. Ravenstein.—The Mouths of the Zambezi: Daniel J. Rankin.

Society of Arts, at 8.—The Electromagnet; Dr. Silvanus P. Thompson.

Aristotelian Society, at 8.—The Universals: M. H. Dziewicki.

Victoria Institute, at 8.—Ancient Eastern Laws in Regard to Land: Rev. J. Neil.

TUESDAY, January 21.

Society of Arts, at 5.—Tea, Coffee, and Cocoa Industries of Ceylon: John Loudoun Shand.

Institution of Civil Engineers, at 8.—Recent Dock Extensions at Liverpool: George Fosbery Lyster. (Discussion.)

Royal Statistical Society, at 7.45.

Royal Institution, at 3.—The Post-Darwinian Period: Prof. G. J. Romanes, F.R.S.

University College Biological Society, at 5.15.—Vegetarianism: W. North.

WEDNESDAY, January 22.

Society of Arts, at 8.—Vision-testing for Practical Purposes: R. Brudenell Carter.

Geological Society, at 8.—On the Crystalline Schists and their Relation to the Mesozoic Rocks in the Lepontine Alps: Prof. T. G. Bonney, F.R.S.—The Variolitic Rocks of Mont Genèvre: Grenville A. J. Cole and J. W. Gregory.

THURSDAY, January 23.

Royal Society, at 4.30.

Institution of Electrical Engineers, at 8.

Royal Institution, at 3.—Sculpture in Relation to the Age: Edwin Roscoe Mullins.

FRIDAY, January 24.

Institution of Civil Engineers, at 7.30.—The Up-keep of Metalled Roads in Ceylon: Thos. H. Chapman.

Royal Institution, at 9.—The Scientific Work of Joule: Prof. Dewar F.R.S.

SATURDAY, January 25.

Royal Botanic Society, at 3.45.

Royal Institution, at 3.—The Natural History of the Horse, and of its Extinct and Existing Allies: Prof. Flower, F.R.S.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

A Search for Knowledge, and other Papers: A. N. Pearson (Melbourne).—The Magic Lantern (Perkin).—The Fauna of British India, including Ceylon and Burma; Birds, vol. i.: E. W. Oates (Taylor and Francis).—A Text-book of Animal Physiology: Dr. W. Mills (Appleton).—Our Earth and its Story, vol. iii.: edited by Dr. R. Brown (Cassell).—Geological and Natural History Survey of Canada; Annual Report, vol. iii., Parts 1 and 2, Maps, &c., to accompany ditto (Montreal).—Stanley's Explorations in Africa; a new Map (Philip).—The Scenery of the Heavens: J. E. Gore (Roper and Drowley).—Graphical Statics: L. Cremona; translated by T. H. Beare (Oxford, Clarendon Press).—Annuaire de l'Académie Royale de Belgique, 1890 (Bruxelles).

CONTENTS.