work done. Energy is expended upon the electrolyte to break it up, and the quantity thus chemically decomposed is an exact measure of the work done. Every electrolyte requires a certain voltage to overcome the affinity between its atoms, and then the mass decomposed per minute or per hour depends solely upon the current passing. The process is a cheap one and has become general. Three electrical HP. continuously applied deposit 10 lbs. of pure copper every hour from copper sulphates at the cost of one penny. All the copper used for telegraphy is thus obtained. Zinc in a very pure form is extracted electrolytically from chloride of zinc, produced from zinc blende, in large quantities. Caustic soda and chlorine are produced by similar means from common salt. The electroplating of gold, silver and nickel is a lucrative and extensive business, especially in Birmingham and Sheffield. Gold and silver are refined by this electrolysis in Russia, and nickel in the United States. Sea-water is decomposed in this way for disinfecting purposes by the Hermite process.

The passage of electricity through certain gases is accompanied by their dissociation and by the generation of intense heat. Hence the arc furnace. Aluminium is thus obtained from cryolite and bauxite at Foyers by utilising the energy of the Falls. Phosphorus is also separated from apatite, and other mineral phosphates. Calcium carbide, obtained in the same way, is becoming an important industry.

It is remarkable that our coalfields have not been utilised in this direction. Electrical energy can be generated on a coal-field, where coal of good calorific value is raised at a cost of 3*s.* per ton, cheaper than by a waterfall, even at Niagara.

Electro-metallurgy is now a very large business, but it is destined to increase still more, for the generation of electrical energy is becoming better understood and more cheaply effected.

THE TRANSMISSION OF POWER.

The energy wasted in waterfalls is enough to maintain in operation the industries of the whole world. Great cities as a rule are not located near great falls; nor has a beneficent Providence provided great cities with waterfalls as, according to the American humourist, He has with broad rivers. There is but one Niagara, and we are seeing how industries are rather going to the falls than the energy of the falls is being transmitted to the industrial centres. The arbitrament of money is limiting the distance to which energy can be profitably transmitted. The Cataracts of the Nile can be utilised in irrigating the waste lands of the upper regions of the river, but their energy cannot compete, at Alexandria, with that of coal transported in mass from England.

At Tivoli, fifteen miles across the Campagna, the energy of the falls are economically utilised to light Rome and to drive the tramways of that city. The electric railways at Portrush and Bessbrook, in Ireland, are worked by water-power, and Worcester, Keswick and Lynton use it in this country, but on a very small scale. It is not used more, for the simple reason that there are no more falls to use. Water-power is used very extensively in Switzerland, because it is so abundant there, and in our Colonies, especially in South Africa; but it is in the United States, especially in Utah and California, where the greatest works have been installed especially for the transmission of energy to mines.

In mines electricity is invaluable. It is used for moving trams and for working hoists. It lights up and ventilates the galleries, and by pumping keeps them free of water. It operates the drills, picks, stamps, crushers, compressors, and all kinds of machinery. The modern type of induction motor, having neither brushes nor sliding contacts, is free from sparks and safe from dust. Electrical energy is clean, safe, convenient, cheap, and it produces neither refuse nor side products. It is transmitted to considerable distances. In mountainous countries the economical distance is limited by the voltage which insulation can resist; 40,000 volts are being practically used between Provo Canyon and Mercur, in Utah, in transmitting 2000 horse-power thirty-two miles.

CONCLUSION.

I have touched lightly—I fear too lightly—upon some of the applications of electricity. I have confined myself, in a very general sense, to those with which I have been personally associated. I have shown how electricity began its beneficent career by protecting our lives and property from the disastrous effects of nature's dread artillery, how it facilitates intercommunication between mind and mind by economising time and annihilating space. It

> "Speeds the soft intercourse from soul to soul,
> And wafts a sigh from Indus to the Pole."

By its metallic nerves it brings into one fold not only the scattered families of one nation, but all countries and all languages, to the manifest promotion of peace and general good will. Not only does it show us how to utilise the waste energies of nature, but it enables us to direct them to the place where they are most wanted and to use them with the greatest economy. It opens to our view nature's secret storehouses, presenting us with new elements, new facts and new treasures. It economises labour and purifies material. It lightens our darkness in more senses than one, and by enabling us to see the unseen, it tends to aid the gentle healing art and to alleviate both suffering and pain. It aids us in the pursuit of truth, and it has exploded the doctrine that the pursuit of truth means the destruction of faith.

RECENT CORAL BORING OPERATIONS AT FUNAFUTI.

THE subjoined extract from the *Sydney Daily Telegraph* of September 9, containing particulars as to the coral-boring operations at Funafuti, has been sent to us by a correspondent:—

News has just been received *via* New Zealand, through the U.S.S. Co.'s steamer *Poherua*, which coaled H.M.S. *Porpoise* at Funafuti, as to the progress of the two bores, one on land, and the other in the lagoon of that coral atoll. With regard to the lagoon bore, operations were commenced on August 15, Commander Sturdee having succeeded in mooring the war-ship so taut that it was possible to work the boring pipes without risk of their bending or breaking from the bows of the war-ship. Mr. G. H. Halligan, who is in immediate charge of the boring plant, reports that for the first twenty-four hours of boring a depth of 109 feet was attained, the total depth of the bore being 212 feet below the water level of the lagoon, the depth of water to the bottom of the lagoon being 103 feet. The *Poherua* left at the end of the first day's boring. As regards the nature of the material bored, Mr. Halligan states that the first 80 feet below the bottom of the lagoon were formed of sand, composed of joints of Halimeda (a seaweed which secretes a jointed stem of lime) and of fragments of shells. The remaining 29 feet were in similar material, but containing small fragments of coral getting larger at the deeper levels.

This is a record rate of boring, and considering the difficulty of holding the war-ship at her moorings absolutely steady, in spite of wind and tide, is a wonderful performance. The whole undertaking may be looked upon as a success from a scientific standpoint, even if no greater depth than 109 feet be ultimately reached. As, however, there was still nearly a week available for further boring, it is hoped that before the war-ship has to leave Funafuti, the bore may have been considerably deepened. This is probably the first bore that has ever been made in the bottom of the lagoon of a coral atoll.

The deepening of the old bore, discontinued last year at a depth of 698 feet, on the main island of Funafuti, has been proceeding slowly but steadily. The party were landed there by the London Missionary Society's steamer *John Williams*, on June 20 last. As was anticipated, little difficulty was experienced in re-driving the lining pipes into the old bore, and washing out the sand and rubble which had choked the bore-hole. Pipes were laid from the site of the old bore to some small water-holes from which a supply of fresh water was obtained for the boiler. By July 25, the re-lining and cleaning of the old bore having been successfully accomplished, boring was resumed, and up to the time when the steamer *Poherua* left, a depth of 840 feet had been reached. The bore last year terminated in soft dolomite limestone at 698 feet, but it has now been ascertained that below this is a hard rock, so hard that the portion of the bore-hole which penetrates it no longer needs to be lined with iron pipes, a condition which must facilitate the work of boring.

Mr. A. E. Finckh reports that this hard rock is largely composed of corals and shells. This depth of 840 feet is exactly the crucial depth which it was hoped the bore might reach, and if possible exceed, as at a corresponding depth on the ocean face of the reef there is a strongly marked shelf, as shown by the soundings by Captain A. Mostyn Field, of H.M.S. *Penguin*, and it is considered that this shelf, at the 140 fathoms level, marks the downward limit of the coral formation.

Exceptionally dry weather has been experienced, which has somewhat delayed the boring, on account of the temporary failure of the water-hole from which the water supplies were being drawn. Foreman Symons, however, who is in charge of the drill, had, by extending the line of suction pipes, been able to tap a second water-hole, from which water was being pumped to the boiler. Mr. Finckh's experiments on the rate of growth of the various reef-forming animals and plants were progressing satisfactorily. It was hoped that the bore would, in about eight weeks' time, reach the total depth of 1200 feet, which is the maximum depth contemplated. Further information may be expected shortly upon the return from Funafuti of H.M.S. *Porpoise*, which will convey all the core hitherto obtained from Funafuti, and tranship it to Sydney; and until the core has been subjected to thorough microscopic and chemical examination it would, of course, be premature to attempt to forecast the exact trend of the evidence. The results so far obtained are very satisfactory.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. Langley, F.R.S., has been elected a member of the Council of the Senate in the place of Principal Glazebrook, now of Liverpool University College.

Lord Wolsingham, the High Steward, has generously offered a second (bronze) medal for specially meritorious essays in biology which do not succeed in winning the Wolsingham gold medal.

At the matriculation on October 21 last, 897 students joined the University. These included 19 "advanced students" admitted to post-graduate research or other advanced work. The total entry for the year 1898 is thus brought up to 944, which is the highest since 1890.

An animated discussion on the proposed Sedgwick Memorial Museum took place in the Arts School on October 22. Two plans, a larger and a smaller, were before the Senate. The geological staff strongly pressed that the larger should be adopted, though it appeared that it would cost some 44,000*l*. Of this the Memorial Fund would contribute 27,000*l*.

Mr. R. S. Morrell, who was placed in the first class in both parts of the Natural Sciences Tripos in 1888-90, and Mr. J. S. Gardiner, who was similarly placed in 1893–95, have been elected to Fellowships at Gonville and Caius College.

ON Wednesday, October 26, Sir William Harcourt opened the new central block of Aberystwith University College, erected at a cost of about 20,000*l*., towards which sum he, when Chancellor of the Exchequer, gave a grant of 10,000*l*. Speaking subsequently at a luncheon, Sir William Harcourt referred to the unsatisfactory state of secondary or intermediate education in England, and said that what was required was a system of intermediate education similar to that which has been established in Wales, to connect the elementary schools with the universities.

SPEAKING at University College, Liverpool, on Friday last, Sir J. Gorst, Vice-President of the Committee of Council on Education, said that at the present time there was a strong desire on the part of all interested in education that a great step forward should be made in commercial and technical instruction. The necessity arose from industrial competition in foreign countries. Undoubtedly our higher and elementary education for industrial purposes was vastly inferior to that of many of our rivals, and no time was to be lost in setting to work to effect an improvement. To this forward step there were two essential conditions. In the first place, elementary education must be improved, for it was no use to attempt to organise a system of higher schools without having a sound elementary basis upon which to build. Moreover, it was essential that higher education should be perfectly organised, and that in each educational area there should be one clear and definite plan of education suitable to the particular conditions of the place.

THE report on the work of the Examinations Department of the City and Guilds of London Institute for the session 1897–98 has been published. From it we learn that the number of technical classes throughout the country registered by the Institute shows a marked increase, and the instruction is in closer touch with industrial requirements. The recognition by the Post Office of the Institute's certificate in telegraphy as qualifying the holder of it for increased remuneration has had the effect of nearly doubling the number of candidates for examination in that subject, and shows the influence, which employers generally might exercise, in encouraging attendance at technical classes, by giving some kind of reward to such of their employés as succeed in passing the Institute's examinations. County Councils have during the past year further availed themselves of the services of the Institute in connection with the technical classes under their control. Several important additions and alterations have been made in the programme of Technological Examinations.

THE Calendar of the University College of North Wales (which is a constituent College of the University of Wales) for the year 1898–99, has been published. The syllabus of classes shows that students are educated as well as instructed at the College, and the questions set in the science subjects in which candidates for entrance scholarships have been examined, give evidences that no credit is gained by perfunctory work or for information derived entirely from books. The College offers a course of training to those who intend to become teachers in secondary or intermediate schools, and in this, as in other subjects, the course involves practical as well as theoretical work. Among the subjects to be dealt with in the lectures are the psychology of the growing mind, and physiology and hygiene in their relation to school life. The agricultural department, and the College Farm, have recently been referred to (p. 611). After following a course of study at the College extending over three years, students may take the degree of Bachelor of Science of the University of Wales in the group "Agriculture and Rural Economy."

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 24.—M. Wolf in the chair.—On double integrals of the second species in the theory of algebraic surfaces, by M. Émile Picard.—Properties of calcium, by M. Moissan. The pure crystallised calcium whose properties are given in this paper, was prepared by the method already described in NATURE. The melting point, determined by a thermo-couple, was found to be 760° C. The metal can be cut, but it is much less malleable than sodium or potassium, as it can be broken, and shows a crystalline fracture. When totally free from nitride, its colour is brilliantly white, recalling that of silver. The density was found to be about 1·85; and it is hard enough to scratch lead, but not calcium carbonate. Neither chlorine, bromine, nor iodine attacks calcium in the cold, although the corresponding haloid salts are formed at higher temperatures. Calcium burns brilliantly in oxygen, the temperature resulting from the combustion being so high that a part of the quicklime produced is melted and volatilised. When burnt in air, the calcium combines with both constituents together, nitride and oxide being simultaneously formed. At a dull red heat the metal also combines with carbon with great energy, forming CaC_2. At high temperatures the reducing power of calcium is remarkable, oxygen being readily removed from sulphur dioxide, phosphoric anhydride, boron trioxide, silica, and the oxides of carbon.—On the decomposition by aluminium chloride, of a straight-chain saturated hydrocarbon, by MM. C. Friedel and A. Gorgeu. The reactions have been studied arising between aluminium chloride and the normal paraffins from methane to hexane. The latter, when heated to its boiling point with dry $AlCl_3$ gave rise to pentane and butane, the pentane predominating.—On a peculiar mode of formation of the pollen in *Magnolia*, by M. L. Guignard. As regards the mode of formation of the partitions in the pollen mother-cell, the *Magnolia* present a condition quite unknown in other plants. They are intermediate between Monocotyledons and Dicotyledons, resembling rather the former than the latter.—Extension of No. 162 of the "Disquisitiones Arithmeticae" of Gauss, by M. de Jonquières.—Remarks by M. Hatt on the new portion of the hydrographic map of the coasts of Corsica.—Observations of the new Brooks' comet (October 20, 1898), made at the Observatory of Paris, by M. G. Bigourdan.—On the intermediate integrals of equations of the second order, by