the number of pupils under instruction showed the remarkable increase of 32,002, the totals for 1891 and 1892 being respectively 148,408 and 180,410. The number of examination papers worked was 203,347, and the number of individual examinees 108,858, so there was an average of nearly two papers for each student. The greatest number of papers, 29,051, was worked in mathematics. In physiography, 21,944 papers were written, and in theoretical inorganic chemistry, 21,578 papers. The lowest number of candidates were presented in mineralogy and nautical astronomy, the number of papers worked in these subjects being 119 and 141 respectively. With regard to the extent to which local authorities are devoting funds for the purposes of science, art, technical, and manual instruction, it is reported that "Of the forty-nine councils of counties in England (excepting Monmouth), forty-two are now giving the whole of the residue to technical education, while the remaining seven are giving a part of the amount; and of the sixty-one councils of county boroughs, fifty are devoting the whole of the residue to the same purpose, and ten are devoting a part of it, no decision having yet been arrived at in the case of Great Grimsby (which it may be mentioned was only constituted a county borough on April 1, 1891). Of the councils of the sixteen counties and county boroughs of Wales and Monmouth, to which the Welsh Intermediate Education Act, 1889, applies, fifteen are applying the whole of the residue to the purposes of intermediate and technical education, and one a part of it. Contributions are also made out of the rates under the Technical Instruction Act, 1889, in the case of seven counties and county boroughs in Wales and Monmouth. As regards Scotland, so far as returns have been received, the whole of the residue fund is being applied to technical education in the case of twenty counties (out of thirty-three) and sixteen burghs and police burghs (out of 187), while six counties and thirty-nine burghs and police burghs are giving part of it to the same purpose. Of the remainder, the majority of the local authorities are devoting the residue to the relief of rates, and a small proportion of them have under consideration the question of applying the money to technical education."

In conclusion, it is pointed out that "the opportunities afforded to people engaged in all branches of industry for acquiring a knowledge of much which is closely connected with their daily work, but which cannot be obtained in the factory or workshop, are constantly increasing. The municipal schools, which are steadily growing in number and efficiency in all parts of the country, must be of great service in this connection. Further, in proportion as local interest is developed, and employers show that they value sound scientific instruction and art teaching, the effectiveness of these schools will be promoted But whether the income of these schools be derived mainly from local or Imperial sources, it is essential that the course of instruction adopted shall be well adapted to the needs of the town or district. The more fully the educational welfare of the students takes the first place, and the mere earning of Government grants the second place in the new Municipal schools, the more certainly will they fulfil their object."

It is clear from this that the Department desires to stamp out the system whereby science classes are "farmed" by teachers. The acquisition of knowledge is rightly regarded as the proper goal, not the mere obtaining of a certificate. The technical instruction committees of some of the county councils would do well to bear this and the following admonition in mind: "Without a sound foundation of general education, the highest scientific training cannot be imparted; without a sufficient supply of teachers with adequate salaries, who are not overworked, and who not merely know their subject, but know how to teach it, a considerable part of the money expended on the encouragement of new forms of education must be wasted."

EUROPEAN LABORATORIES OF MARINE BIOLOGY.

MARINE laboratories are now recognised as essential to the progress of biology. The facilities they offer the collector and the investigator cannot be overrated, and it would be an excellent thing if institutions could be conducted on similar lines in every branch of science. Mr. Bashford Dean, in the *American Naturalist* of July, gives an illustrated description of marine laboratories in Europe, which is so interesting that a large portion of it is here reprinted. The description of the Marine Biological Station at Plymouth is omitted owing to the fact that a detailed account has already appeared in these columns (vol. xxxviii. p. 198, 1888). Mr. Dean prefaces his report as follows:—

"In every country the marine laboratory has become a need of the student of biology. During his winter studies in the university it serves to provide him with well-preserved material, often with living forms which he may himself prepare according to his wants; in summer it gives him opportunity to see and collect his study types, and utilise with profit and without physical discomfort abundant material relating to his studies. To the investigator the marine laboratory has become, in the broadest sense, a university. He may there meet the representative students of far and wide, fellow-workers, perhaps, in the very line of his own research, and must himself, unknowingly, teach and learn. He finds out gradually of recent work, of technical methods which often happen most pertinent to his present needs. He may carry on his work quietly and thoroughly; his works of reference are at hand; he has the most necessary comfort in working—the feeling of physical rest, untroubled by the rigid hours of demonstrations and lectures.

"The importance of the work of the marine laboratory has been keenly appreciated in foreign countries, and it is noteworthy how large a number of the original researches is at present conducted at, or upon material from, these distributing centres of biology. At the present day the entire coast line of Europe has become dotted with zoological stations great and small, grown out of the resources granted by societies, private individuals, or governments—perhaps by the combined efforts of all. It is a matter of great interest to note how thoroughly the marine laboratory system abroad had become a part of every grade of biological work. The student in a small university in the interior of France receives his first lessons from material sent regularly from Roscoff or Banyuls. He examines *living* sponges, hydroids, lucernarians, pennatulids, beroës, *Loxosoma*, *Comatula*, and *Amphioxus*. In Munich, hundreds of miles from the sea, is another example. Prof. Richard Hertwig, by the aid of material from Naples, demonstrates the larval character of ascidians, or the fertilisation of the egg of the sea urchin. Every group of European universities seems to have centralised its marine biological work in a convenient locality, and this branch of their needs is supported—and is well supported—even in countries whose financial resources are most limited. The importance of this work is felt to such a degree that it is not from reasons unselfish that universities have united in their support of a station like that of Naples. This has become literally an emporium cosmopolitan, bringing together side by side, perhaps not unnaturally, the best workers of many universities whose observations upon the best material, sharpened by discussion and criticism, are certainly tending to become the most accurate and the most fruitful in their direction and results.

"It is most singular that foreign countries are unquestioningly liberal in the support of *pure* biology, and in the work of marine stations the tendency is becoming less and less on the part of money-givers to ask how many fish will be hatched to become food material. Public interest has been gradually coming to be directed to the general laws and the problems of life and heredity. This has well been a hopeful sign, and the European biologists are not backward in emphasising the importance of their studies. Prof. de Lacaze-Duthiers does not hesitate even to propitiate the practical Cerberus, reminding him how often 'facts have been found at every step of science which were valueless at their discovery, but which, little by little, fell into line and led to applications of the highest importance—how the observation of the tarnishing of silver, or the twitching leg of the frog, was the origin of photography and telegraphy—how the purely abstract problem of spontaneous generation gave rise to the antiseptics of surgery.'"

Beginning with the marine laboratories of France, Mr. Dean says:—

"The extended sea coast has ever been of the greatest aid to the French student—along the entire northern coast the channel is not unlike the Bay of Fundy in the way it sweeps the waters out at the lunar tides. The rocks on the coast of Brittany, massive boulders, swept and rounded by the rushing waters, will, at these times become exposed to a depth as great as 40 feet. This is the harvest-time of the collector; he is enabled to secure the animals of the deep with his own hand, to take them carefully from the rocky crevices where they would ever have avoided the collecting dredge. From earliest times this

region has been the field of the naturalist. It was here that Cuvier, during the Reign of Terror, made his studies on marine invertebrates which were to precede his "Règne Animal." The extreme westernmost promontories of Brittany have, for the last half-century, been the summer homes of Quatrefages, Coste, Audouin, Milne-Edwards, and de Lacaze-Duthiers. Coste created a laboratory at Concarneau, but this has come to be devoted to practical fish culture, and is, at the present day, of little scientific interest. It is owing to the exertions of Prof. de Lacaze-Duthiers of the Sorbonne, that the two government stations of biology have since been founded. The first was established at Roscoff, in one of the most attractive and favourable collecting regions in Brittany, and has continued to grow in importance for the last twenty years. As this station, however, could be serviceable during summer only, it gave rise to a smaller dependency of the Sorbonne in the southernmost part of France, on the Mediterranean, at Banyuls, which had the additional advantage of a Mediterranean fauna.

"To these French stations should be added that of Prof. Giard, at Wimereaux near Boulogne, in the rich collecting funnel of the Straits of Dover; that of Prof. Sabatier at Cette, not far from Banyuls, a dependency of the University of Montpelier; that of Marseilles, and the Russian station at Ville-Franche, near the Italian frontier. An interesting station in addition, is that at Arcachon near Bordeaux, founded by a local scientific society, and having at its command the collecting resources of a small inland sea, famous for its oyster culture. Smaller stations are not wanting, as at the Sables d'Olonne.

"At Roscoff the laboratory building looks directly out upon the channel. In its main room on the ground floor, work-places are partitioned off for a dozen investigators; this on the one hand leads to a large glass-walled aquarium-room, while on the other opens directly to adjoining buildings which include lodging quarters, a well-furnished library, and a laboratory for elementary students. Surrounding the building is an attractive garden, which gives one anything but a just idea of the barrenness of the soil of Brittany. From the sea-wall of the laboratory one looks out over the rocks that are becoming exposed by the receding tide. A strong enclosure of masonry serves as a *vivier* to be used for experiments as well as to retain water for supplying the laboratory. The students are, in the main, those of the Sorbonne, and are under the direction of Dr. Prouho, their *maitre de conférences*. They are given every opportunity to take part in the collecting excursions, frequently made in the laboratory's small sailing vessels, among the rocky islands of the neighbouring coast. Strangers, too, are not infrequent and are generously granted every privilege of the French student. Liberality is one of the characteristic features of Roscoff. The stranger who writes to Prof. de Lacaze-Duthiers is accorded a work-place which entitles him gratuitously to every privilege of the laboratory—his microscope, his reagents, even his lodging-room should a place be vacant. It seems, in fact, to be a point of pride with Prof. Lacaze that the stranger shall be welcomed to Roscoff, and upon entering the laboratory for the first time, feel as much at home as if he had been there a week. He finds his table in order, his misroscope awaiting him, and the material for which he had written displayed in stately array in the glass jars and dishes of his work-place. So, too, he may have been assigned one of the large aquaria in the glass aquarium-room—massive stone-base stands, aërated by a constant jet of sea water. He finds a surprising wealth of material at Roscoff, and his wants are plentifully and promptly supplied.

"At Banyuls, the second station of the Sorbonne, the buildings are less imposing than those of Roscoff. It is a plain, three-storey building facing the north, at the edge of the promontory which shelters the harbour of Banyuls. The vivier is in front of the station, behind is a reservoir cut in the solid rock—receiving the water of the Mediterranean, and distributing it throughout the building. On the first floor is a large aquarium-room lighted by electricity, well supplied with tanks, and decorated with statuary given by the Administration of the Beaux-Arts. The bust of Arago occupies an important place, as the laboratory has been named in his honour. The wealth of living forms in the aquaria shows at once by variety of bright colours the richness of southern fauna. Sea lillies are in profusion, and are gathered at the very steps of the laboratory. The work-rooms of the students are on the second floor, equipped in a manner similar to those of Roscoff. The director of this station is Dr. Frédéric Guitel. It is usual during the holidays at fall or winter, for the entire classes of the Sorbonne to spend several days in collecting trips in the neighbourhood. The region, with its little port, is famous for its fisheries, and one in especial is that of the Angler, *Lophius*.

"The station on the Straits of Dover, at Wimereaux, has earned a European reputation in the work of Prof. Giard. It is but a small frame building, scarcely large enough to include the advanced students selected from the Sorbonne. The laboratory is, in a way, a rival of Roscoff, and it is noteworthy that its workers seem to make a point of studying the laboratory methods of the German universities.

"The marine laboratory of Arcachon, one of the oldest of France, was built in 1867 by the local scientific society, and was carried on independently until the time of the losses of the Franco-Prussian War. Its management was then fused with that of the faculty of medicine of Bordeaux, with whose assistance, aided by that of a small subsidy from the government, the work of the institution is carried on. Arcachon, in itself, is a most interesting locality near Bordeaux. It has become a summering-place, noted for its pine-lands and the broad, sandy *plage*, picturesque in summer with swarms of quaintly-dressed children, the local head-dress of the peasant mingling with the latest toilets from Paris. Here and there is to be seen that accompaniment of every French watering-place, the goat boy in smock and berret, fluting to his dozen charges who walk in a stately way before him. The Bay of Arcachon is a small, tranquil, inland sea, long known for its rich fauna. In large part it is laid out in oyster parks which constitute to no small degree the source of wealth of the entire region. Shallow and warm waters seem to give the marine life the best conditions for growth and development. The laboratory is placed just at the margin of the water. It includes a dozen or more work-places for investigators, well supplied with aquaria, a library on the second floor, a small museum containing collections of local fauna, including the numerous relics of Cetaceans that have found their way into this inland sea. A small aquarium-room, opened to the public, is well provided with local forms of fishes, and like that of Naples, is eagerly visited. Those who are entitled freely to the use of the work-places are instructors in French colleges, members of the Society, and all the advanced students from the colleges of the State. For other students work-place is given upon the payment of a fee whose amount is regulated each year by the trustees. As at Roscoff, material is plentifully supplied.

"The zoological station at Cette is a direct annex of the University of Montpelier. The present temporary building is to be replaced by one of stone, which will enable Prof. Sabatier to add in no little way to the working facilities of his students. The region, in every essential regard, is similar to that of Banyuls.

"The station at Marseilles is devoted in great part to questions relating to the Mediterranean fisheries, and owes, in a measure, its financial support to this practical work.

"The station at Ville-Franche is essentially Russian. An account of this with figures has recently been published (Russian text) in Cracow. The station itself is well known through the work of Dr. Bolles Lee, and it is here that Prof. Carl Vogt has been a constant visitor."

After a description of the Plymouth laboratory, Mr. Dean mentions those of Liverpool and St. Andrews, north-east of Edinburgh concerning which he remarks: "The work of these stations is only in part purely biological; the practical matters of fisheries must be considered to insure financial support. In addition to these there are several stations, notably one south-east of Edinburgh, and another, recently equipped, on the Isle of Man.

"At St. Andrews, Prof. MacIntosh has studied the questions relating to the hatching and development of the North Sea fishes. Its situation upon the promontory leading into the Firth of Forth seems to have been especially favourable for the study of the North Sea fauna—the locality, moreover, is far enough northward to include a number of boreal forms. The importance of St. Andrews is at length better recognised, and a substantial grant from the Government will enable a large and permanent marine station to be here constructed. The facilities for work have, up to the present time, been somewhat primitive—a simple wooden building, single-storied, has been partitioned off into small rooms, a general laboratory, with work-places for half a dozen investigators, a director's room, aquarium, and a

small outlying engine house with storage tanks. The laboratory owns a small sail-boat to assist in the work of collecting."

Passing to Holland, we read—"Holland, in the summer of 1890, opened its zoological station in the Helder, a locality which, for this purpose, had long been looked upon with the greatest favour. There is here an old town at the mouth of the Zuyder Zee, the naval stronghold of Holland, a station favourable for biological work on account of the rapid running current which renews the waters of the Zee. The station was founded by the support of the Zoological Society of the Netherlands, whose valuable work by the contributions of Hubrecht, Hoek, and Horst has long been known in connection with the development of the oyster industry of Holland. The work of the society had formerly been carried on by means of a portable zoological station which the investigators caused to be transplanted to different points along the East Schelde, favourable on account of their nearness to the supplies of spawning oysters. The present station at the Helder is situated directly adjoining the great Dyke, a small stone building of two storeys, surrounded by a small park. In itself the laboratory is a model one—the rooms are carefully finished and every arrangement has been made to secure working conveniences. A large vestibule leads directly into two laboratory rooms, and by a hallway communicates with the large, well-lighted library, and the rooms of the director. The aquarium-room has, for convenience, been placed in a small adjacent building. The director of this station is Prof. Hoek, and the president of the society is Prof. Hubrecht."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Stanford University of California (the *Times* says) is rapidly becoming the wealthiest institution of the kind in the world. Yet there are several American Universities and colleges which enjoy enormous wealth. For example, Columbia University has an invested capital of £2,600,000; Harvard, £2,200,000; Yale, £2,000,000; the California, £1,400,000; and the Johns Hopkins, £600,000. The endowment fund of the Stanford University cannot at present be stated, partly because the benefaction exists in the shape of property which is rapidly increasing in value. But estimates which appear to be well founded have been made at San Francisco showing that at no distant date the University will be worth £40,000,000, yielding an annual income of £2,200,000.

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No. 8 (1893).—Polarisation of undiffracted infra-red radiation by metal wire gratings, by H. E. J. G. du Bois and H. Rubens. Polarised light passing without diffraction through silver wire gratings experiences in general a rotation of its plane of polarisation. The transmitting power of the gratings for light polarised in a plane perpendicular to the length of the wires was found to be greater than that for light polarised in a plane parallel to them. The present, experiments were conducted with finer gratings than before the smallest interval attained being 0·001 cm. and the measurements were taken in the infra-red region. The intensity of radiation transmitted was measured by the bolometer. It was found that as long as the wave length does not exceed a certain value, the grating transmits a larger fraction of the radiation when the electric vector is parallel to the wires; this value appears to be independent of the width of interval, but characteristic of the metal; for greater wave-lengths the transmittance is greater when the magnetic vector lies in the direction of the wires.—The superior limit of wave-lengths which may occur in the thermal radiation of solids; a conclusion from the second law of thermodynamics, by Willy Wien. Assuming the second law, and the existence of none but Maxwell's ponderomotor forces in the pressure exerted by a gas, the author shows that thermal radiation does not imply waves of all lengths, but that the curve of energy, when traced along the spectrum, falls continuously to infinitesimal values on the less refrangible side, and practically disappears in the region of Hertz's finite waves.—Electric oscillations of molecular structures, by H. Ebert. It is shown that the mechanism of luminescence may be fully explained by Maxwell's theory, regarding the luminous molecules as analogous to Hertz oscillators of very small dimensions.—A photometer, by E. W. Lehmann. This is constructed on the principle of Joly's photometer; it consists of two totally reflecting prisms placed side by side in a box. In each prism one of the adjoining faces is ground, and the two ground faces are turned in opposite directions so as to be illuminated by the two sources to be compared. The plain faces are turned towards the observer, with their edges touching. The observer looks at them through a tube containing a telescope; the box to which the tube is attached can be swung round through 180°, so as to exchange the ground faces. The sensitiveness is such that forty successive readings with amyl acetate burners at 120 cm. gave results not differing by more than 0·4 per cent.

Bulletin de l'Académie de Belgique, No. 6 (1893).—We notice the following among the scientific papers: Megamicros, or the sensible effects of a proportional reduction of the dimensions of the universe, by J. Delbœuf. According to Laplace, if the dimensions of all the bodies in the universe, their mutual distances and velocities were to increase or diminish in a constant proportion, these bodies would describe the same curves as they do now. The appearances presented to observers would be the same, and independent of the dimensions assumed. Hence the only facts we are able to appreciate are ratios. In opposition to this theorem, M. Delbœuf shows that if a system consisting of the sun and the earth were to be diminished in linear dimensions to one-half, all densities remaining the same at homologous points, and the orbital velocity of the earth were reduced to one-half its value, there would be certain changes in the relations of an observer to his surroundings which could not escape notice. The velocity of sound propagation will be the same as before, but the distance traversed during a certain number of vibrations will appear larger. If a metric system were to be determined on the reduced planet in a manner analogous to ours, the hectare will be a quarter, the litre one-eighth, and the kilogramme—owing to the reduction of gravitation—one-sixteenth of the corresponding actual measures. Hence the work done in lifting a kilogramme through one metre will be $\frac{1}{16}$ of an actual kilogramme-metre. Muscular power, on the other hand, being proportional to the volume or mass of muscle, will be only reduced to one-eighth, and the observer will be able to lift four times the previous maximum weight. All work necessary for life will proceed at four times the usual rate, and hence life itself will be more rapid. These considerations pursued by the author into the regions of building, thermometry, animal heat, respiration and circulation, go to show that real space is different from geometric space, and that the dimensions of the universe are absolute.—Note on the variations of temperatures of transformation below and above the critical temperature, by P. de Heen. The superior limit of pressure of superheated steam before the passage into the liquid state is the simple prolongation of the curve expressing the variation of the tension of saturated vapour.—On the production of ammonia in the soil by microbes, by Émile Marchal. Nitrification takes place in three principal stages, which may be described as ammonisation, nitrosation, and nitratation, resulting in the production of ammonia, nitrites, and nitrates respectively from the organic nitrogen. Ammonisation takes place essentially under the influence of microbes living in the upper layers of the soil. In arable land, the action of bacteria is predominant. The *Bacillus mycoides*, the most energetic of these, exerts a double activity in the production of ammonia, being ammonising in the presence of nitrogenous organic matter, denitrifying when embedded in easily reducible substances such as nitrates.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 1.—"On the Flow in Electric Circuits of Measurable Inductance and Capacity; and on the Dissipation of Energy in such Circuits." By Alfred W. Porter, B.Sc., Demonstrator of Physics in University College, London. Communicated by Prof. G. Carey Foster, F.R.S.

The arrangement of the apparatus in the experiments described was as follows:—

L is a coil possessing self-inductance; S, a condenser; R, an