constitutes by far the bulk of the work, being a tabulation of the numerical readings taken at successive dates throughout the year at the different stations.

There are two "Annexes." The first is a series of charts showing the disposition and extent of the various factories and works where hydraulic power is turned to account, and the second is a series of longitudinal sections, or profiles, of the watercourses of the Isère and the Arc.

All are admirably prepared, and give rise to the reflection that some things are done much better abroad than they are at home. Our own country stands out in "splendid isolation" in possessing no hydrological service and in making no official attempt whatever to catalogue, define, and conserve her natural resources of water power and supply, now running to waste or liable to misappropriation. In this attitude she finds no sympathy or support from her neighbour across the Channel, nor from the United States, nor Italy, nor Switzerland. Each of these countries has realised the advantages accruing to trade, agriculture, and the public welfare generally from a systematic development and control of La Houille Blanche.

POETRY AND SCIENCE.

THE Professor of Poetry at the University of Oxford, Dr. T. Herbert Warren, President of Magdalen College, gave a public lecture on March 2 on the subject of "Poetry and Science." He began by quoting his predecessor Matthew Arnold, who wrote on New Year's Day, 1882: "If I live to be eighty, I shall probably be the only person left in England who reads anything but newspapers and scientific publications."

Has Matthew Arnold's gloomy prophecy been fulfilled? Have newspapers and science killed real literature? In particular, are the interests of science hostile to the interests of literature?

Where science has dominated, has poetry languished? This is a very burning question, for science has certainly made great advances. It impresses the man in the street, chiefly by its usefulness. It is the poet and the poetic person who are impressed by the marvel, the magic, and the mystery of science. Matthew Arnold inherited the tradition of Wordsworth, who was a great poet of Nature, but not a poet of Natural Science. He strove hard to do justice to it, both in his prose prefaces and in his poetry, but with imperfect success. Wordsworth's poem "The Poet's Epitaph" contains a most beautiful and memorable description of the poet, but is scarcely fair to the man of science, who is generally a man also of natural affections. The man of science may be as fond of his mother as the poet, who is often one of the most selfish of beings, and if he would not "botanise upon his mother's grave" because he knows no botany might be quite capable of turning her into copy.

Further, the poet is not "contented to enjoy the things that others understand." He must synthesise in his own way. Wordsworth himself was for ever philosophising and moralising.

Keats, again, is often cited as complaining that Newton had destroyed the beauty of the rainbow by reducing it to prismatic colours, but Keats was perhaps not serious in this charge.

Goethe, on the other hand, did not object to Newton for reducing the rainbow to prismatic colours, but only for doing so wrongly.

Matthew Arnold "poked fun" at science as he did at religion, and was even less willing to treat it seriously than religion. He was often exceedingly amusing, and his famous description of a scientific education in "Friendship's Garland" was highly so.

Darwin, who began by being a great lover of poetry, thought that in later days he had lost the power through atrophy, but in point of fact the atrophy was by no means complete. He remained a most poetical writer. The closing paragraphs of the "Origin of Species" were worthy of Lucretius, which they strongly resembled.

History shows that poetry, philosophy, and science had all begun life together as children of one family. The early Greek poets, like the authors of the Books of Genesis and Job, dealt with the origin of things and the Story of Creation. The early thinkers who succeeded them expressed their thoughts in verse, and were often highly poetical. What could be more poetical than the "dark" science of Heraclitus? The same relation was maintained through Greek literature. The greatest astronomer of antiquity, the inventor of the Ptolemaic system, was the author of a beautiful epigram which was truly poetic. From Greece and Alexandria, science and poetry passed together to Rome, and might be found combined in Lucretius and Virgil. The greatest singers of antiquity were the most alive to science. Modern literature shows the same phenomenon in Dante and in Milton and in Tennyson. This is specially well brought out in a book by a living man of science, Sir Norman Lockyer's "Tennyson as a Student of Nature." On the last of the three poets Sir Oliver Lodge has also written briefly, but with rare force, in the recent volume "Tennyson and his Friends."

As time has gone on, the scientific spirit has increasingly made itself felt in poetry, and may be seen in the works of F. W. H. Myers and his brother, in the late Duke of Argyll, in George Romanes, in Richard Watson Dixon, and still better in his friend and editor, Mr. Robert Bridges. And others of the earlier poets had also been acquainted with science, notably Gray and Shelley.

With regard to the greatest of all, if Bacon wrote Shakespeare it is odd that Bacon's science does not appear more often in the plays, but in any case it may be remembered that Bacon wrote poetry of his own and had a place in the "Golden Treasury."

Other lands and literatures too have had their scientific poets, the most famous being Goethe, of whom the best account is to be found in the popular lectures of a most poetical man of science, Helmholtz. I can speak at length only of one, the French poet of the last century, Sully Prudhomme, who combined science, philosophy, and poetry. The best account of him is to be found in the study by M. Zyromski. "Poetry," said Sully Prudhomme, "is not only the lyrical outburst of our sentiments. The great poetry has noble destinies, and will sing the conquests of science and the synthesis of thought."

The average man does not care for "great poetry," or only for that part of it which appeals directly to his own feelings. Just now, what Sully Prudhomme calls *lyrisme*, that is, personal poetry, holds the field, but that has not always been so, and will not always be so. Science has not destroyed poetry. Cambridge, the University of Science, has been the University of Poetry, and with the revival of Science at Oxford in the last century, beginning in Shelley's time, poetry revived too. The really great poet must respond to the main and moving interests and influences of his day. The old facts and factors, the old *motifs*, do not change. Rebekah at the Well, David's lament over Saul and Jonathan, Hector and Andromache, Catullus at his brother's grave, still move us. But while these remain, our outlook on the world does gradually change, as Sully Prudhomme foretold in his fine sonnet to "The Poets of

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the Future. Science will certainly go on, and scholarship and poetry will go on at its side and beneath its ægis. The "scientific use of the imagination" on which Tyndall, that most poetic man of science, discoursed so finely forty years ago will be balanced more and more by the imaginative use of science.

The famous epigram by Ptolemy, the author of the Ptolemaic system, with the Professor's version of it, may conclude the address:—

ΠΤΟΛΕΜΑΙΟΥ.

Οἶδ' ὅτι θνατὸς ἐγὼ καὶ ἐφάμερος· ἀλλ' ὅταν ἄστρων
μαστευω πυκινὰς ἀμφιδρόμους ἕλικας
οὐκέτ' ἐπιψαύω γαίης ποσίν, ἀλλὰ παρ' αὐτῷ
Ζανὶ θεοτρεφέος πίμπλαμαι ἀμβροσίης.

I know that I am mortal, and doomed to fleeting days,
But when I track the circling stars in myriad-orbèd maze,
I tread the earth no more, but sit beside the Lord of Heaven,
And taste the ambrosial food whereby the life of Gods is given.

CIVIL SERVICE ESTIMATES FOR SCIENCE AND EDUCATION.

THE Estimates for Civil Services for the year ending March 31, 1913, are being issued as a series of Parliamentary Papers. The following particulars referring to the money under this vote to be devoted to scientific work and to higher education are taken from the paper entitled "Class IV. Education, Science, and Art."

Under the heading "Scientific Investigation, &c.," we find that the amount of the grants in aid for 1912–13 is 125,523*l.*, which represents a net increase over the total for 1911–12 of 61,920*l.* This considerable advance is explained largely by the increase of 29,500*l.* in the grant to the National Library of Wales and of 31,000*l.* to the National Museum of Wales.

The grants in aid enumerated under the heading of the Royal Society, and voted for scientific investigations and scientific publications, for the expenses of the Magnetic Observatory at Eskdalemuir, and for salaries and other general expenses of the National Physical Laboratory, remain as in 1911–12; the grant in aid of the expenses of the aëronautical section of the National Physical Laboratory, however, has been increased from 4885*l.* to 5775*l.* The total grants in aid under all these headings reach 23,775*l.*

The grant to the Meteorological Office has been increased from 16,850*l.* to 17,000*l.*, and that of the Royal Geographical Society from 500*l.* to 1250*l.* The Edinburgh University will receive 1728*l.*, as compared with 1508*l.* in 1911–12, and the International Seismic Association 370*l.*, as compared with 210*l.*

The Estimate for Universities and Colleges, Great Britain, and Intermediate Education, Wales, amounts to 314,200*l.*, an increase of 10,400*l.* over that for 1911–12. The total for universities and colleges is 287,000*l.*, an increase of 10,500*l.*, which all goes to Scottish universities.

The vote for Science and Art in Ireland reaches 138,591*l.*, as compared with 117,883*l.* in 1911–12, 30,600*l.* of the increase being accounted for by larger annual grants to schools and classes of science, art, and technical instruction. The estimate of the amount required for grants under the Irish Universities Act, 1908, is 130,000*l.*, or a decrease of 56,256*l.* on 1911–12.

The estimate of the amount required to pay the salaries and expenses of the Board of Education and of the establishments connected therewith is 14,504,765*l.*, allocated, so far as the chief items are concerned, as follows:—administration, 202,333*l.*; inspection and examination, 249,633*l.*; elementary schools, 11,832,235*l.*; training of teachers, 603,000*l.*; secondary education, 756,000*l.*; technical institutions, evening schools, &c., 621,800*l.*; universities in respect of technological work, 42,000*l.*; Imperial College of Science and Technology, 20,000*l.*; Science Museum, 18,018*l.*; Geological Museum, 3694*l.*; Geological Survey of Great Britain, 17,644*l.*; and Committee on Solar Physics, 2171*l.*

THE GYROSTATIC COMPASS AND PRACTICAL APPLICATIONS OF GYROSTATS.[1]

THE problem of a *practical* gyrostatic compass has attracted the attention of many, but the credit of being the *first* to produce a practical working instrument belongs to Dr. Anschütz, who, with those associated with him, has devoted some twelve years of patient work and no inconsiderable sum of money in experiments. Since then some important work has been done by Hartmann and Braun in Germany, and Mr. Sperry in America, details of which are not available.

Few people have any idea of the difficulties attending the installation and correct adjustment of a magnetic compass on board a large steel ship, and more particularly on a battleship or cruiser, so as to work surrounded by huge masses of steel, and in order to withstand the terrific shocks caused by the firing of heavy guns, and the problem would to-day be impossible had it not been for the theoretical work of Sir George Airy, the applied genius of Lord Kelvin, and the present practical improvements introduced by the superintendent of compasses at the Admiralty.

A magnetic needle can only point in the direction of the lines of magnetic force at the place where it is set up, and it is well known that there are very few places on the globe where the magnetic needle points true north and south.

Dr. Anschütz attacked the problem of a gyrostatic compass with enthusiasm, and has continued to work at it in the face of many and great disappointments with a thoroughness and patience which is characteristic of his nationality. The construction of the compass meant new designs for everything in connection with its motors, &c. His first experiments were with gyrostats suspended with the gyro free to move about its three principal axes, or, as it is termed, having three degrees of freedom; but it is easy to show how impossible it is to construct such a gyro so as to be sensitive to small movements, and yet really accurate in practice.

To make use of the gravity effect of the earth, Dr. Anschütz mounts his gyrostat in the form of a pendulum; as the earth rotates the gyrostat tends to maintain its plane of rotation parallel to its original plane in space. The earth's gravity acts against this tendency, and a precession results, the only position of equilibrium occurring when the gyro axis has set itself parallel with the axis of rotation of the earth.

In the actual compass the friction of the universal joint carrying the pendulum arrangement must be very small for the gyro to take an ultimate position with accuracy—the length of the pendulum, and hence the effect of gravity, must be small, so as to keep the compass free from disturbances—and therefore the precession is very slow, and the compass would swing to and fro on either side of the meridian indefinitely; its mean position would, it is true, be the true north and south line, but valueless for practical use.

[1] From a Discourse delivered at the Royal Institution on Friday, February 23, 1912, by Mr. G. K. B. Elphinstone.

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