instruction should commence with such simple exercises as drawing and describing different forms of leaves, and should gradually advance to the easier and more conspicuous flowers, and later to the more obscure and difficult forms of flowers, the fruits and seeds.

The zoölogical instruction in the lower schools should not attempt a systematic survey of the whole animal kingdom, but attention should be directed chiefly to the most familiar animals, and to those which the pupils can see alive. The common domesticated mammals should first be studied, and later the birds, the lower vertebrates, the insects, crustacea, and mollusks. While the range of zoölogical instruction must be limited as regards the number of forms studied, those few familiar forms should be so compared with each other as to give the pupils, very early, some conception of the main lines of biological study, — morphology, physiology, taxonomy.

Special prominence should be given to the study of plants and animals which are useful to man in any way; and the teacher may advantageously, from time to time, give familiar talks in regard to useful products of vegetable and animal origin, and the processes of their manufacture.

Attention should also be given to the more obvious characteristics of the kinds of minerals and rocks common in the region in which any school is situated, and to such geological phenomena as are comparatively simple and easily observed.

A most important feature of the scientific instruction in the lower grades should be to encourage the pupils to collect specimens of all sorts of natural objects, and to make those specimens the subject of object-lessons. The curiosity of the children will thereby be rationally cultivated and guided.

The subject of human physiology and hygiene is of so immense practical importance, and so few comparatively of the pupils ever enter the high school, that we regard as desirable some attempt to teach the rudiments of the subject in the grammar, and even in the primary schools.

They recommend the introduction of exceedingly rudimentary courses in physics and chemistry in the highest grades of the grammar school, and further, as perhaps the most desirable branches of science to be included in the classical courses in the high school, and to be required for admission to college, physical geography, phænogamic botany, and human physiology. The first is suggested as tending to keep alive in the student's mind a sympathetic acquaintance with nature in its broader aspects; the second, as affording unequalled opportunities for discipline in observation; the third, as affording knowledge of the greatest practical importance.

The rudiments of physics and chemistry, which they propose for the grammar schools, will enable physical geography and physiology to be intelligently studied in the early years of the high-school course.

For the scholars in the English course in the high school, there will naturally be more advanced and systematic instruction in chemistry, physics, and zoölogy, and also instruction in geology and astronomy; but the classical students may with propriety leave these studies until they reach them in the college course. The scientific instruction they will have received in the primary and grammar schools, and the study of the three branches above specified in their high-school course, will be sufficient to preserve that natural and wholesome sympathy with nature the loss of which is now the main obstacle to the successful study of natural science in the colleges.

THE COAL QUESTION IN ENGLAND.

MR. R. Price Williams, M.Inst.C.E., read a paper on the "Coal Question" at the meeting of the Royal Statistical Society on Feb. 19. The following is an abstract of the paper as given in *Engineering*: —

After paying a well-deserved tribute to the labors of the late Professor Jevons in connection with this subject, the author shows, by a series of tabular statements and diagrams, the rapid increase in the coal-production of England prior and subsequent to the date of the coal commission in 1871. The Northumberland and Durham coal-field, as is pointed out, still gives to Newcastle its pre-eminence as the chief source of the coal-supply, the output last year from Durham alone amounting to over 28,750,000 tons, or to more than one-sixth of the total production in the United Kingdom. Attention is drawn to the fact that during the last four or five years there has been a considerable decrease in the output from these northern coal-fields; and the maximum limit of the coal-production it is considered has been reached, and henceforward it will continue to decline. It is shown, that, at the average rate of increased production during the last twenty-two years, the 9,294,000,000 tons of available supply would be entirely exhausted in about ninety-four years.

The author devotes a considerable part of his paper to the South Wales coal-field, — a district he is well acquainted with, — and attention is directed to the remarkable development which has occurred during the last few years in the South Wales steam coal-trade, the 26,000,000 tons produced last year coming next in amount to that of Durham. This large quantity is shown (after allowance is made for waste in working) to represent about 5,381 acres of a four-foot-thick coal-seam practically worked out in the course of a single year. The total available supply in the South Wales coal-basin is estimated by the coal commissioners at 36,566,000,000 tons, or just one-third of the whole available supply in the United Kingdom, which, at the rapid rate of increased production which has obtained during the last quarter of a century, would, as the author shows, be entirely exhausted in the short space of seventy-nine years.

The rapid development in the coal-production in the eastern division of this coal-field, which contains the famous steam coal-measures, is strikingly shown by the enormous growth of the coal-exports from Cardiff, more especially to foreign countries. In 1864 these only amounted to 1,500,000 tons, doubled in the next ten years, and again doubled in the following seven years; while in 1887 they amounted to 8,250,000 tons, or to more than a third of the entire coal-exports for the United Kingdom for that year.

Two-thirds of the South Wales coal-supply is obtained from Glamorganshire, more particularly from the eastern division, containing these valuable steam coal-seams. The author shows, that, if the production from this eastern portion of the coal-basin continues to increase at the average rate it has done during the last twenty-four years, the whole available supply, which the coal commissioners estimated at 12,963,000,000 tons, will be entirely worked out in the course of the next sixty years; and the portion containing the lower or steam coal-seams, in the short space of forty-two years.

The coal exported from Cardiff, consisting chiefly of this high class of coal, the author points out, represents, after making allowance for waste in working, about seven acres of the famous four-foot steam coal-seam entirely worked out during each working day of the year.

The coal-productions from all the other principal coal-fields are separately dealt with; and the dates at which, at the average increased rate of output during the last twenty-four years, they will become exhausted, are given in the following summary: —

	Years.
Northumberland and Durham	94
South Wales	79
South Wales (eastern division)	46
Lancashire and Cheshire	74
Yorkshire, Derbyshire, and Nottingham	90
Warwickshire	53
Denbighshire and Flintshire	250
Scotland	92
United Kingdom	102

Under the head of coal-consumption, particulars are given of the chief uses to which the coal is applied, from which it appears that the coal consumed in the manufacture of pig iron, and in the manufacture of merchant iron and steel of various kinds, amounted at the time of the coal commission to nearly one-third of the coal produced in the United Kingdom. The large economies since effected by the Bessemer, Siemens, and other processes, are shown, however, to have reduced the consumption in 1887 to little more than 16 per cent of the coal-production. Attention is drawn to the large economies effected and to be effected by the use of compound

engines for steam navigation and locomotive purposes. The amount of coal used by ocean-going steamers during 1887 amounted to nearly 7,000,000 tons, and that consumed by the much larger number of steamers engaged in the coasting trade is estimated to have equalled that amount. The coal consumed by the locomotives on the railways in England in the same year is shown to have exceeded 6,000,000 tons.

Particular attention is drawn to the very rapid growth of the export of coal, which has increased from 4,333,333⅓ tons in 1854, to over 27,000,000 in 1888. The author considers it is but the measure of increased commercial prosperity, and that to impose any tax upon such exports would be like killing the goose that lays the golden eggs.

The author, in his concluding remarks, observes, that, if the growth of the trade and prosperity of England is to continue as it has done in the past, its coal-production, which is at once the cause and effect of this growth, must necessarily keep pace with it; and it is pointed out that unless large economies, which can and ought to be effected in its consumption, are realized, all the largest and best sources of the coal-supply will be exhausted in the very short periods mentioned in this paper. The hope is expressed, that, by drawing attention to this most vital subject, further strenuous efforts may be made to husband English coal resources in every possible way, and to put a stop to the great waste in working the mines, and in the consumption of coal generally.

MINING INDUSTRIES IN SIAM.

SIAM is rich in minerals. Gold, iron, tin, and copper are found in many parts of the country; but the want of roads, and consequent difficulty of getting these metals to market, prevent their being worked, except for the limited wants of the natives.

The English consul at Bangkok, Mr. Child, says, in his last report, an abstract of which appears in the *Journal of the Society of Arts* for Feb. 22, that the eastern part of Siam is very rich in iron, antimony, and argentiferous copper and tin. It is from the provinces of Petchaboon and Löm that the cutlasses, spears, and knives are furnished to all the provinces of the north and east. Silver is not found in Siam.

As regards gold, this metal is found in many places, but the mines at Bang Tapan on the west coast are said to contain the purest gold in the country. They have been worked by the natives by simply turning over the ground, the gold being found in the shape of nuggets. When nuggets over a certain size were found, the miners were obliged to hand them over to the government, but they were paid for the same according to a tariff fixed by the authorities.

A syndicate of foreigners has been formed, with a concession from the king, for working these mines, and has now a number of workmen employed, the prospects for rich developments being good.

The quartz-mines of Muang Krabin, although productive, were declared unprofitable to the government. Experienced engineers from Australia, mining machinery of recent invention, immense upright pumps and other hydraulic machinery, and a narrow-gauge railroad with rolling stock for the conveyance of the product, had been procured for the working of the mine; but, the organizer of the great scheme having been decapitated for alleged treason, the whole of the plant is lying idle.

The royal metal of Siam is mostly manufactured into vases, teapots, betel-boxes, and other articles, which it is the custom of the kings of Siam to present to subjects upon their elevation to high rank in the peerage of the kingdom. They are looked upon in a sense as insignia of their exalted rank, the shape and style of the set denoting the standing of the beneficiary.

It is impossible to procure statistics concerning the output of the mines. Iron of good quality is found in the eastern provinces, but it is worked in a very crude and primitive manner. Founderies are unknown. A hole or pit having been dug close to the mountain, the miner collects and piles up his ore, which he smelts with charcoal. The molten metal is deposited in a cavity prepared for its reception, and when cold the product is carried home. There a fire is prepared, which is kept alive by a bellows made of two trunks of hollow trees buried in the ground, and having two long sticks as handles. A child works the bellows, while husband and wife or son hammer the iron into shape.

The knife, cutlass, spear, or agricultural implement produced by this combined labor finds a ready sale throughout the north of Siam, and, although the workmanship is poor, it suits the requirements of that section. The locality of the mines preclude shipments to Bangkok, as it would have to be conveyed to the river on elephants, — a method of conveyance too expensive for the commodity.

Tin is found in profusion in the Malayan peninsula, and is worked by Chinamen. It is generally exported direct to Singapore from the locality in which it is mined. Tin is also found in eastern Siam to a limited extent, but none of it finds its way to the capital.

Copper is found in certain localities, especially in the eastern provinces, — Champasak, Petchaboon, and Löm. In the former province, on the Makong River, there is a place where the natives procure the finest metal, of which they make a coin that passes current in that locality. It is about two inches in length, a quarter of an inch in breadth, and shaped like a canoe. The province adjoining that has an iron coin of the same shape, but larger in size. Virgin copper is held in great esteem by many for certain qualities it is supposed to possess when employed as an agent in transmuting metals. Without it as a basis, the native alchemists claim that gold cannot be obtained.

Coal is found on the coast and in the interior, but cannot be utilized. Limestone is brought to Bangkok from the interior. The lime is mixed with turmeric, and is used to a large extent by the Siamese in combination with the betel-nut and *seri* (pepper-leaf).

Precious stones come principally from the province of Chantibun; rubies, sapphires, topaz, asterias, and other stones being found in that district. The diamond is unknown as a native stone. The sapphire mines to the south of Chantibun, to which thousands of Burmese flocked a few years ago, have been exhausted.

BOOK-REVIEWS.

Popular Lectures and Addresses. By SIR WILLIAM THOMSON. In 3 vols. Vol. I. Constitution of Matter. London and New York, Macmillan. 12°. $2.

THE author of this work possesses in an eminent degree the ability of putting into untechnical language those essentials of knowledge which are most interesting and attractive, and at the same time most useful, to the general reader. Among the contents of this volume may be mentioned "Capillary Attraction," which was originally delivered as a lecture before the Royal Institution in 1886; to which are added three appendixes treating of certain curious motions observable on the surfaces of wines and other alcoholic liquors, gravity and cohesion, and the equilibrium of vapor at a curved surface of liquid.

Shortly after the delivery of this lecture, it was suggested to Mr. Thomson that it might be advisable to make it more conveniently accessible to the general public than it could be in the "Transactions of the Royal Institution;" and it was accordingly arranged to bring out, as one of the Nature Series, a small volume containing the lecture mentioned, together with several other papers pertinent to the subject. While the volume was in course of preparation, it was decided to increase the size of it, adding several other lectures and addresses to the contents, and make it the first of a series of three volumes, constituting a reprint, in a revised form, of all Sir William's popular lectures and addresses. The result is the volume before us, the first volume of the series.

Besides the lecture already spoken of, a chapter each is devoted to the following subjects: "Electrical Units of Measurement," "The Sorting Demon of Maxwell," "Elasticity viewed as possibly a Mode of Motion," "The Size of Atoms," "Steps towards a Kinetic Theory of Matter," "The Six Gateways of Knowledge," "The Wave Theory of Light," "The Age of the Sun's Heat," and "Electrical Measurement." These were originally delivered as lectures and addresses before the Royal Institution, the Institution of Civil Engineers, the British Association, and the Franklin In-