connection with the gases at the electrodes of the Wehnelt interrupter, and by Dr. Ernest Lecher, in connection with the effect of electrification of the field on the discharge. The electric conductivity of powders is treated by Franz Streinitz.

Speaking generally, the physical papers show a considerable amount of steady, plodding work in the elaboration of existing theories and the tabulation of statistical results rather than any very striking innovations in the direction of new theories.

Zoology.

The systematic position of the armoured dinosaurs from the upper Cretaceous of the Gosau district, originally described, on the evidence of extremely imperfect material, under the names of Struthiosaurus, Crataeomus and Anoplosaurus, has recently occupied the attention of Herr F. B. Nopessa, jun. (*Sitzungsberichte*, vol. cxi. p. 93, 1902). The author follows some previous observers in regarding the first and second of these presumed generic types as identical, as also in considering the third to be inseparable from the Huxleyan Acanthopholis. Consequently, the two genera Struthiosaurus and Acanthopholis have alone to be considered.

The suggestion of the late Prof. Marsh that these European forms are members of the same family (Ceratopsidæ) as the horned dinosaurs of the topmost Cretaceous of North America is discountenanced by Herr Nopessa. Rather, he thinks, they typify a family by themselves—the Acanthopholididæ—in many respects intermediate between the comparatively generalised Stegosauridæ and the highly specialised Ceratopsidæ. From the horned dinosaurs, the members of the intermediate family are readily distinguished by the absence of bony horn-cores on the skull and also of a frill-like neck-shield. They are further characterised by the non-fusion of the cervical vertebræ, the relatively large fore-limbs and the long and powerful tail. As regards the large size of the fore-limb, they are connected with the Stegosauridæ by the Wealden Polacanthus. Taken as a whole, their organisation tends to confirm the view that among the armoured dinosaurs the early bipedal, or partially bipedal, forms are the more primitive, and the quadrupedal types (Ceratopsidæ) the more specialised.

In the same communication, Herr Nopessa describes a chambered vertebra of one of the gigantic sauropodous dinosaurs from the Cretaceous of Neuquen, Patagonia. The reptile to which this vertebra belonged is regarded as generically distinct from Titanosaurus and Argyrosaurus, both of which have been recorded by Mr. Lydekker from the formation in question, but no further attempt is made to determine its systematic position. The sauropodous dinosaurs are now known in the southern hemisphere from both Madagascar and Patagonia.

Mollusca, both recent and fossil, have come in for a considerable share of attention in the issues of the *Sitzungsberichte* recently to hand. In vol. cx. p. 315, Herr R. Hoernes describes new cerithia, belonging to the group typified by *Clava bidentata*, from the Tertiary of Oisnitz, in Central Styria, with remarks on the distribution of that group in the Mediterranean and Sarmatian horizons. The paper is illustrated by a beautifully executed plate. In the succeeding volume (p. 5), Dr. C. Gorjanović-Kramberger treats of the Tertiary cockles of the genus Limnocardium in Croatia, more especially those pertaining to the subgenus Budmania. Some doubt has been thrown on the right of the latter group to distinction, but, from the hinge and other characters, the author justifies its separation from the more typical form. Finally, in the same volume (p. 123), Dr. R. Sturany discusses our present knowledge of the land molluscs of Asia Minor, describing a few new forms.

Botany.

An interesting paper by Prof. Haberlandt gives an account of cultural experiments made with isolated plant cells. These were taken from the mesophyll tissue of the leaf of *Lamium purpureum*, and when placed in culture solutions were kept living for several weeks. Considerable increase in size was observed in some cases, and an appreciable increase in the thickness of the walls occurred, especially where the walls were concave. In the solutions containing only inorganic salts, the chlorophyll corpuscles soon turned yellowish, but kept their green colour when sugar was supplied. It would appear that the plastids pass on all the products of their assimilation and require to be constantly nourished, to prevent decomposition of the chlorophyll. With regard to the renewed growth of the cells when isolated, Prof. Haberlandt regards this as the continuation of growth which is ordinarily arrested in the leaf to suit the requirements of the organism. Two peculiar effects of light are described by Dr. H. Molisch. A flagellate, *Chromophyton Rosanoffii*, shows a large chromatophore which takes up a position on the shaded side. If viewed from the direction in which light rays are impinging upon the organism, at certain angles the cells seem to sparkle. The effect is due to the light which is condensed by the cell on the chromatophore and thence reflected, and is similar to that described for the moss Schistostega. The second paper refers to the light which is emitted by the bacterium *Micrococcus phosphoreus* obtained during the decomposition of meat. The light is sufficiently strong to produce heliotropic curvature in many seedlings, and also in the sporangiophores of Phycomyces.

The poisonous effects so well known in the case of leaves of *Primula obconica* are further elucidated by the investigations of Dr. A. Nestler. Besides various cultivated forms of *Primula obconica*, three species, *Primula sinensis*, *Primula Sieboldii* and *Primula cortusoides*, all belonging to the group *sinensis*, were found to produce similar effects, giving rise to throbbing and inflammation. The source of irritation was traced to the secretions of glandular hairs. These readily crystallise out, and by sublimation were obtained pure. The writer recommends the outward application of strong alcohol as a palliative.

THE FUTURE OF COAL GAS.[1]

WHEN, in the early years of last century, coal gas became a commercial reality, the one end and aim of the manufacturer was to produce his gas, and such details as purity, illuminating and calorific value never troubled his mind. As time passed on, however, and competing companies vied with each other in their endeavours to secure customers, advantages had to be offered to coax consumers from the enemy's camp, and those who remember the battle of the two then existing City companies with another proposed rival in 1847–48–49, and the way in which the gas consumers in the City were at that time pestered and pamphleted by the supporters of the rival schemes, will realise that even in those days gas management was not a bed of roses. The outcome of the rivalry was the introduction in the early 'fifties of a standard of illuminating value, and a string of Parliamentary requirements which have ever since safeguarded the consumer and harried the gas manufacturer.

In 1850 a Bill was passed which enacted that a consumption of 5 cubic feet of gas per hour should be equal to the light of twelve wax candles of the size known as sixes, the burner employed being a brass Argand burner with fifteen holes. In 1860 another Act changed the illuminating power to twelve sperm candles, which meant an increase of some 16⅔ per cent. in the illuminating value of the gas, owing to the fact that the wax candles originally used were only equal in illuminating power to 10.3 sperm candles, as at present employed for testing purposes. In 1868 the illuminating power was again raised to fourteen candles, whilst, in 1876, the present sixteen-candle standard was reached.

The amount of light emitted, however, by the gas was still insufficient to satisfy the desires of the consumers, who, utterly ignoring the fact that the illumination to be derived from coal gas was quite as much dependent on the burners employed as it was upon the standard illuminating value, vented their dissatisfaction at the light emitted by small flat-flame burners by clamouring for a higher quality of gas; and even thirty years ago the great aim of the gas-consuming public was to obtain the highest candle power that could be squeezed out of the gas company, in order that they might gain something like decent illumination from the flat-flame burners then almost exclusively used, and which were, as a rule, so small as to destroy entirely the value of the gas. It was at this period that the anomaly became common of seeing a town supplied with gas of more than twenty-candle illuminating value swathed in semi-darkness, whilst another, using the much-abused thirteen- or fourteen-candle gas, supplied at a good pressure and burnt in decent-sized burners, was well illuminated.

It was at this time, also, that some of our most able chemists ranged themselves on the side of the votaries of

[1] Abstract of Cantor lectures delivered at the Society of Arts by Prof. V. B. Lewes.

high illuminating power, and even such practically minded men as the late Sir Edward Frankland clamoured for the introduction of high illuminating power gas, such as is produced from cannel, in place of sixteen-candle coal gas, the general line of argument being well shown by portions of Sir Edward Frankland's introduction to the section of his published researches dealing with applied chemistry, in which such paragraphs as the following occur :—

"Coal gas is not suitable for use in dwelling houses by reason of its very low illuminating power—100 cubic feet of coal gas containing only 4 cubic feet of illuminating gas; the rest is mere rubbish, which heats and pollutes the air in which the gas is consumed. . . . It cannot be too widely known that coal gas, although it costs less per 1000 cubic feet, is, light for light, much dearer than cannel gas." [1]

Even now, when altered circumstances make a high-power gas an anything but desirable and economical supply, there are not wanting advocates who, undaunted, or perhaps ignorant of the practical side of the question, still try to bolster up the old idea.

It was in the latter part of the 'eighties that the lot of the worried manager was made even harder by the rise in price taking place in cannel coal, on which, up to that time, he had entirely relied in admixture with ordinary gas coal to give those higher grades of illumination demanded by the fashion of the time, and which, although it ruined his coke, yet proved an efficient and trustworthy servant.

This increase in price became so serious that in 1889 the Gas Light and Coke Company commenced experiments which led to the introduction of carburetted water gas in place of cannel as an enricher, this process proving itself a most valuable addition to the manufacture of coal gas, and rapidly gaining favour and popularity, not only as giving an easy means of raising the candle power of poor coal gas, but also as a stand-by in case of any sudden calls upon the production power of the works.

About this same period also, another method of enrichment was introduced, which consisted of adding to gas which did not fulfil the Parliamentary requirements the vapours of such highly volatile hydrocarbons as petroleum spirit and benzol, which, on account of their high illuminating value, gave the necessary increase in the candle power by the addition of an amount of vapour not likely afterwards to recondense from the gas.

Whilst these changes were taking place in gas manufacture, rivals which seemed to threaten its very existence had forced their way to the front, and with the electric light largely used by the rich, and petroleum reduced to a price at which even the poorest could afford its use as an illuminant, the field of utility seemed to be rapidly disappearing from beneath the feet of the gas industry. However, when things were looking their blackest, there slowly struggled into prominence and commercial success a factor which at once restored gas to its position of primary importance.

It was in 1885 that the researches of Dr. Auer von Welsbach culminated in the production of the incandescent mantle, which, frail and unsatisfactory in its earlier forms, was gradually so improved in composition and manufacture that by 1892 it became a brilliant commercial success, and placed in the hands of the gas industry a weapon which rendered its position unassailable in competition with electricity.

Looked at from a common-sense point of view, the incandescent mantle will be seen to be merely a method of enrichment. Instead of increasing the illuminating power of a flame by crowding into the gas more and more hydrocarbons, which during combustion are capable of separating carbon particles, the incandescence of which would increase the amount of light emitted by the flame, and *pro rata* the amount of heating and vitiation, with the mantle you charge the flame with incombustible particles of far greater light emissivity than the carbon possesses, and they do their work without that increase in the temperature and fouling of the atmosphere inseparable from the other processes. It is the introduction of the incandescent mantle and the improvements which are possible in its construction which really give the possibilities to the gas of the future.

Taking the enriched gas as supplied during the 'nineties, the light which can be obtained from it is entirely dependent upon the burner in which it is consumed. This may be stated as follows :—

Light emitted per cubic foot of sixteen-candle gas consumed.

Burner.	Candle units.
Incandescent—high pressure	30 to 35
,, Kern	20 to 25
,, ordinary	14 to 19
Regenerative	7 to 10
Standard Argand	3·20
Ordinary Argand	2·90
Union jet flat flame No. 7	2·44
,, 6	2·15
,, 5	1·87
,, 4	1·74
,, 3	1·63
,, 2	1·22
,, 1	0·85
,, 0	0·59

In considering the value given to the gas by these burners, it is seen that, according to the method by which it is burnt, the consumer may obtain anything from thirty-five candles down to less than one candle per cubic foot of gas. It must also be borne in mind that the burners employed in these tests were all good, well-made burners, giving the best duty that can be obtained from them, whilst an examination of burners used in consumers' houses shows that in most cases any antiquated and corroded burner is considered good enough at which to burn the gas, and the very people who are loudest in their complaints as to the quality of the gas are those who most disregard the method of its consumption.

England is far behind Germany in the use of incandescent lighting, and an inquiry made into the uses to which the coal gas supply of a large town was put gave the following result :—

	Per cent.
Incandescent lighting—private...	12·00
,, public	6·25
Cooking	22·65
Gas engines	6·60
Used in other ways	52·50
	100·00

So that 47.5 per cent. is used for purposes in which illuminating power is of no use and calorific effect is the one important factor.

It is also seen that 18.25 per cent. of the total gas made is used for incandescent lighting, and this represents about 23 per cent. of the gas used for illuminating purposes, as against 90 per cent. used in this way in Germany.

This 23 per cent. thus used gives for a consumption of five cubic feet not less than seventy candles, whilst the average light obtained by the combustion of the remaining 77 per cent. is 8.5 candles.

It is quite clear that under such conditions as these the supply of gas of a high candle power is simply waste of money, and it is manifestly unfair that the consumer of average intelligence, who is willing to utilise the benefits given by the incandescent mantle, should have to pay for a quality of gas only rendered necessary by the inertia of those who decline to march with the times.

Coal gas is daily being used more and more as a fuel, and although the slight diminution of calorific value which must of necessity accompany a lowered illuminating value is a slight drawback, yet in practice any desired temperature can be attained by a slightly larger consumption. Also a cheapening of the gas would induce many to adopt it as a fuel, this in turn tending to level up the load in production, and so to render more economies possible.

Everything clearly points in one direction, and that is, that the future of coal gas is entirely dependent upon a plentiful supply of low-grade gas—low grade from the point of view that it should only have an illuminating value of ten to twelve candles, that its heating value shall be as high as can be practically attained and that its price shall be as low as is consistent with the interests of the consumers as well as of the shareholders in the gas industry.

Already the stream has set in in this direction, and the

[1] Frankland's "Experimental Researches in Pure, Applied and Physical Chemistry," 1877, p. 488.

lowering of the Parliamentary standard of sixteen to fourteen candle power in the case of the South Metropolitan, Commercial and West Ham Companies will soon be followed by many companies now saddled with a higher standard than fourteen candles seeking relief. That relief cannot in fairness be refused, whilst experience of the benefits conferred by the reduction will soon lead to the further step that will place gas manufacture in this country on the same advanced footing that it has already gained in the most progressive cities in Germany.

In making low-grade gas of this character, several processes may be employed, but probably the most economical is to utilise water gas as an aid to the distillation of the coal in the retorts, the proportion of water gas so used being kept down to a point at which the carbon monoxide in the finished gas shall not exceed 16 per cent.

The cheapening in mantles which is now taking place, together with improvements in their manufacture which will give an increased length of life and light, promises a great extension in the use of gas for this purpose.

Another direction in which the future of coal gas will benefit largely, by a cheapening in price owing to economies in manufacture and distribution, will be for use as a fuel. Already the ever-increasing demand made upon the metropolitan companies during the day marks the advance of the utilisation of coal gas for cooking, heating and power, so that whilst the increase in the amount of gas used at night is only rising by some 3 per cent. annually, the day consumption shows an increase of 16 per cent. Directly it becomes possible to reduce the price of gas to about 2*s*. a thousand, advance on these lines will become extremely rapid, and the gas companies are naturally doing everything in their power to foster this development. It is, however, necessary, in order further to popularise gas as a fuel, that everything that can be done should be done to remove any prejudices that exist against heating by gas.

There are many excellent gas stoves on the market, well designed, and giving high heating duty for the gas consumed, but there are also many that, both in their performance and their effect upon the atmosphere, are radically bad. Now that the gas companies have so largely taken over the sale and pushing of gas-heating apparatus, it is a duty they owe to themselves and to their customers to take care that only stoves of scientific construction and good efficiency should be supplied. Many of the worst stoves are the most ornate, and for that reason find their way into many homes, as they, in the first place, appeal to the eye of the housewife, and afterwards to the nose and health of the household, the result being that a good customer is converted into an enemy of gaseous fuel. No gas fires should be sold or let on hire that do not do a large proportion of the heating by radiation, and a gas company that sells a flueless gas stove, save for hall or passage heating, should be prosecuted.

A cubic foot of coal gas on its complete combustion yields 0.52 cubic foot of carbon dioxide and 1.30 cubic feet of water vapour, and if you do not mind breathing hot polluted air highly charged with water vapour, and getting chilled with cold walls, a Bunsen burner stood on the floor is the most effective method of getting the whole of the heat of combustion into the air of the room, and no flueless stove can do more than this. In order to get something to sell, stoves are constructed in which some of the water is condensed, and the public are gravely informed that this removes all deleterious products. But it is impossible to get away from the fact that if healthful heating is to be obtained, it is the solid objects and walls of the room that must be heated, and not the air, and that although some of the heat is lost thereby, a flue to take off all products is an absolute essential.

The gas companies have it in their power to govern the gas-stove trade, and unless they choose to take the initiative, it will retard the popularity of heating by gas to a most serious degree. With all stoves in which solid bodies like asbestos are heated by atmospheric burners, a trace of carbon monoxide is always produced, and if there is not a proper flue passing well into the chimney, a headache is added to the other discomforts.

Improvements in gas motors and gas engines are steadily going on, and as soon as the price of coal gas can be reduced sufficiently to attract this class of custom, a wide field will be opened up for it.

The development of large gas engines during the last few years gives promise of an entire revolution in our methods of procuring power, and it is highly probable that within a very few years the gas engine will make great inroads upon the generation of power by steam. Already gas engines up to 1500 horse-power have been constructed, whilst engines of more than double that power are under construction.

In England, Messrs. Crossley Brothers and other well-known makers are producing a very large number of such engines for driving dynamos, whilst it is stated that on the Continent Messrs. Korting Brothers have made, or have under construction, thirty-two gas engines, with a total of 44,500 horse-power, averaging 1390 horse-power each engine, and the John Cockerill Company and several German companies follow not far behind.

With such a development of gas for motor purposes, it is manifestly the policy of the gas companies to make a determined bid for so wide a field of output, and if they can supply a clean heating gas with 460 to 500 B.T.U.'s heating power, it is clear that the convenience of doing away with separate generating plant would cause a large proportion of this business to fall to their share, if the price of the coal gas could be made to compete with a fuel gas, that is to say, if nearly the same number of thermal units could be obtained by its use at the same cost.

Gas fittings should be entirely taken over by the gas companies, which should supply incandescent fittings and mantles and keep them in order at a small yearly rental; and where swinging brackets and other causes demand flat-flame burners, the companies should fit nipples with broad slits regulated to burn at the lowest possible pressure.

Everything at the present time points to the gas of the future being a twelve-candle-power gas, with a calorific value of not less than 460 B.T.U.'s net and a selling price of not more than 2*s*. a thousand, the economies necessary to reach this lower price being brought about by making the gas in the holder at 9*d*. to 9½*d*. a thousand and distributing it at a considerably increased pressure, the pressure being regulated down to 1½ inches at the entrance to the consumer's meter.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. C. B. N. Cama, St. John's College, has been elected to the Isaac Newton studentship in optics and physical astronomy.

The Smith's prizemen are Mr. H. Knapman, Emmanuel, second wrangler 1901, and Mr. A. P. Thompson, Pembroke, fifth wrangler 1901. Mr. W. H. Jackson, Clare, bracketed third wrangler 1901, receives honourable mention.

The following have been appointed as representatives of the University to the joint committee of the Royal Society for the purpose of securing an appropriate memorial of the late Sir G. G. Stokes:—The Chancellor, the Vice-Chancellor, Profs. Jebb, Forsyth, Darwin, Ball, Thomson and Mr. W. Burnside.

THE Sedgwick Memorial Museum syndicate, in an amended report, estimates that the cost to the University of the new building, over and above the amount contributed from the memorial fund, will be not less than 18,480*l*.

IT is stated that Mr. David Davies, of Llandinam, grandson of the late millionaire, has presented the University College of Wales, Aberystwyth, with a sum of 20,000*l*.

THE New York correspondent of the *Daily Mail* announces, on the authority of the *New York Journal*, that Mr. Carnegie has arranged to present 200,000*l*. to Princeton University as a thank-offering for his recovery from his recent illness.

LORD AVEBURY will take the chair on March 17 at a conference on higher education at the Institution of Mechanical Engineers, Storey's Gate, Westminster. Representatives of the county and county borough councils and