ritic eruptions they had nothing to object; but the volcanic *facies* appeared to them a privilege restricted to recent geological times. To this the present writer might bear personal testimony, as he found his "way of Damas" only when he was fortunate enough to ramble over North Wales, and gather with his own hands pieces of vesicular lava embedded in the tuffs of the Snowdon, or boulders of true felsite, lying at the base of the Cambrian series at Llanberis.

Not only has Sir Archibald, in common with his countrymen, always escaped that kind of misconception, but he will have contributed more effectively than any other to place the matter in the true light. Thanks to the cliffs of Scotland, he has been able to trace the roots of old volcanoes, to show true volcanic bombs entombed in sediments, and to mark the site round which vast piles of lavas and tuffs, 5,000 or 6,000 feet in thickness, had been heaped up. Likewise, in his previous paper on Tertiary volcanoes, he had established by indisputable sketches that the granitic rocks of the islands of Mull and Skye were ejected during the earlier part of the Tertiary period, and that they belong to the central mass of intrusions, the lateral veins of which have taken the form of granophyres.

There is another kind of useful geological work which Sir Archibald has a right to be credited with: we allude to the restoration of the most friendly relations between the official survey and the Geological Society of London. For many years those relations had been maintained at a rather low temperature; both independent geologists and government surveyors showed, as it were, more inclination to mutual and severe criticism than to brotherly co-operation. This period of misunderstanding is now well over. Thanks to the present director, the Geological Society has more than once received the early flower of the capital results obtained by the survey, and the recent presidency of Sir Archibald has solemnly sanctioned the return of a harmony which will prove of great benefit to the advancement of geological science in England.

This is a very brief and imperfect account of the chief work accomplished by the field geologist, a work which would have been sufficient for the whole of a man's life. But we have now to consider in Sir Archibald the master who has been engaged in important educational duties. When he was appointed in 1871 to the chair of geology at Edinburgh he had the whole work of that department to organize, a task which may be wearisome, but which involves great benefit for a man of labor, as he must face every difficulty, and obtain day by day a clear and personal idea of all that is required for teaching. To that we are indebted for the undisputed superiority which Sir Archibald has displayed in his "Text-book," as well as in his other educational writings, such as the "Class Book," a very model of clearness, whereby it has been once more demonstrated that those only are qualified for writing elementary books who are in the fullest possession of the whole matter. Likewise he is the author of small books or "primers" on physical geology and geography, of which some hundreds of thousands of copies have been sold, and which have been translated into most European languages, as well as into some Asiatic tongues. This exceptional success will be easily understood if we remember that in Sir Archibald's works the traditional barrenness of geology is always smoothed and adorned by a deep and intense feeling for nature. Nobody has done more than he to associate geological science with the appreciation of scenery. In numberless writings he has undertaken to explain the origin of existing topographical features. Among others, reference may be made to the volume on "The Scenery of Scotland Viewed in Connection with its Physical Geology," first published in 1869, of which a new edition appeared in 1887; also to "Geographical Evolution," in the Proceedings of the Royal Geographical Society for 1879; and "On the Origin of the Scenery of the British Isles," published in *Nature* (vol. xxix., pp. 347, 396, 419, 442).

Nevertheless, whatever might have been the attainments of the geologist and of the teacher, they would not have been sufficient to secure universal recognition had not Sir Archibald been provided in addition with the best powers as a writer. From the beginning he was strongly convinced of the importance of cultivating the literary element in scientific exposition, not only in order to make science interesting and intelligible to those outside the circle of actual workers, as he did in writing "Geological Sketches at Home and Abroad," but because he did not admit the right of a man of science to appear before the public without putting on the "nuptial dress." Every one who knows Sir Archibald will readily admit that in doing so he is not impelled by a desire for personal display. He is essentially a man of thought as well as of action. "Res non verba" might well serve him as a motto, and whoever has seen his silent but piercing attention in listening to some scientific controversy would never be tempted to suspect him of a wish to search after resounding manifestations. But he has too much of the artist's temper to neglect correctness and elegance in the utterance of his thoughts. And since nothing in the world is less common than the union of scientific insight and acuteness with a vivid appreciation of nature and a delicate feeling for style, it is not strange that Sir Archibald's fame has passed far beyond the circle of professional men. The portrait will be duly completed when it is added that no one could have a better renown for frankness, fair dealing and perfect trustworthiness in every relation of life.

It is highly gratifying for England that the recognition of such achievements has not been left to future times, and that the present generation has not failed in the duty of rewarding so much continuous and fruitful labor. He was admitted to the Royal Society before reaching the age of thirty, a most unusual honor; he has been vice-president, and was recently elected foreign secretary of that society. Since 1890 an associate of the Berlin Academy; elected by the Royal Society of Sciences at Göttingen, after the death of Studer, the Nestor of Swiss geologists; enrolled among the members of the Imperial Leopold-Caroline German Academy, of the Imperial Society of Naturalists of Moscow, etc., he was chosen in 1891 as a correspondent by the French Academy of Sciences, and in the same year he was made a knight. An honorary LL.D. of the Universities of St. Andrews and Edinburgh, he has received the Murchison medal of the Geological Society of London, and twice the Mac-

Dougal Brisbane gold medal of the Royal Society of Edinburgh has been conferred on him, in recognition of the zeal and skill displayed in explaining the geological peculiarities of his mother-land. He is now at the summit of his career, and not so heavily laden with years but that we may express for him the wish *ad multos annos*. Let us hope that he will long remain at the head of the distinguished staff to which he has given so profitable an impulse, and continue to serve as a comforting example for those who refuse to acknowledge any other means of genuine success than constant labor and faithfulness to duty.

A. DE LAPPARENT.

HEAT AND CHEMICAL ENERGY.

By A. NAUMANN.

ON THE TRANSFORMATION OF HEAT INTO PERMANENT CHEMICAL ENERGY IN THE PRODUCTION OF WATER PRODUCER GAS AND CARBONIC ACID PRODUCER GAS.*

THREE methods are chiefly available for the transformation of coal into heating gas: the production of illuminating gas by destructive distillation of coal, that of water gas by the action of steam or the elements of water on heated fuel, and that of producer gas or carbonic oxide from coal supplied with air.

In the production of illuminating gas only a small fraction of the heat energy of the coal is transformed into gaseous fuel. The relatively high price of this gas prevents its application on a large scale as a heating gas; on a small scale it is employed for heating purposes and motive power in the absence of a cheaper gaseous fuel, and because it can be obtained in all large towns.

The formation of water gas is endothermic; heat is absorbed according to the thermochemical equation:

The somewhat complicated apparatus required for the production of water gas only allows of its preparation with advantage on a large scale, but in that case the advantage is so considerable that in the towns of North America water gas has been substituted, to a great extent and sometimes altogether, for illuminating gas for lighting purposes, its lighting power being obtained by so-called carbureting.†

The production of producer gas is comparatively simple and easily carried out. The formation of producer gas is exothermic; it liberates heat.

The amount of heat here indicated causes the theoretical temperature of producer gas at the moment of its formation to be 1,446° Cent., assuming that the specific heats of its constituents are the same at high as at ordinary temperatures. The heat of formation (29,690 calories) thus indicated is utilized if the gas be consumed on the spot as fast as it is produced, but is lost if the gas is conveyed to any distance or stored and allowed to cool to the ordinary temperature of the air, 15° Cent., the amount of heat then available being only that evolved by the combustion of the carbonic oxide in the gas—that is, 67,960 calories. Out of a total of 97,650 calories available, only 67,960 calories would be utilized in the latter case, corresponding to a waste of 30.4 per cent. of the theoretical quantity of heat available.

Two methods are within our reach for converting into permanent chemical energy the quantity of heat appearing in the form of high temperature in the producer and incorporating it in the gas.

Either so much water may be introduced into the producer with the air as to absorb from the heat generated (+29,690 calories) by being decomposed in contact with the fuel, thereby producing hydrogen and carbonic oxide, which mix with the ordinary producer gas generated at the same time, enriching it and forming a heating gas, which may be called water producer gas; or carbonic acid may be similarly introduced into the gas producer to form carbonic oxide, which mixes with the ordinary producer gas, generated at the same time, forming a heating gas which may be called carbonic acid producer gas.

In the following tables for each of these two heating gases the composition, heat of combustion, rise of temperature of the flame, and heat given up by the products of combustion for a reduction of 1° in temperature are compared with the corresponding amounts for producer gas. I may here mention that the method of procedure for determining these values is tedious and troublesome, and I therefore limit myself to tabulating the results.

The composition of water producer gas from fluid water at 15° and gaseous water at 15° is calculated from the following thermochemical equations II. and III., and that of carbonic acid producer gas from equations I. and IV.

water gas

water gas

In the following tables are given separately, first, the volumes of the gases formed and mixed in the producer and of the water gas which together form water producer gas; and, secondly, the volumes of the chem-

* "Berichte der Deutschen Chemischen Gesellschaft," No. 25, 1892. Engineering.

† Hence my opinion as regards water gas expressed more than ten years ago in the last sentence of my paper, "The Question of Heating, with special reference to the Production of Water Gas and Heating by Water Gas" (Giessen, J. Ricker's Library, 1881, page 96), has been proved to be correct; and where the theory indicates such favorable prospects its practical application should follow.

ical constituents of those gases; for carbonic acid producer gas the volumes of the producer gas and the carbonic oxide formed by the reduction of the carbonic acid introduced into the producer are first given, and afterward the volumes of the chemical constituents of those gases.

I.—Composition of producer gas from pure carbon:
Carbonic oxide..... 34.3 per cent. by volume.
Nitrogen..... 65.7 " "

100.0

II.—Composition of water producer gas:

	From liquid H ₂ O at 15°.	From gaseous H ₂ O at 15°.
	Percentage by volume.	
1. { Producer gas ...	65.55	57.9
{ Water gas.....	34.45	42.1
	100.00	100.0

Equivalent to:

2. { Hydrogen.....	17.2	21.1
{ Carbonic oxide..	39.7	40.9
{ Nitrogen.....	43.1	38.0
	100.0	100.0

III.—Composition of carbonic acid producer gas:

	Percentage by volume.
1. { Producer gas.....	65.3
{ Carbonic oxide made from carbonic acid and carbon.....	34.7
	100.0

Equivalent to:

2. { Carbonic oxide.....	57.1
{ Nitrogen.....	42.9
	100.0

A glance at the above volume percentage composition of the three heating gases shows at once the superiority of water producer gas and of carbonic acid producer gas over ordinary producer gas. This superiority is shown still more clearly by a comparison of the following values: 1. The heat of combustion of a liter of each gas calculated from the above composition and the known heat of combustion of their constituents. 2. The rise of temperature of the flame calculated from the temperature of combustion and specific heat and quantity of gases existing after combustion. 3. The heat given off by the products of combustion of a liter of gas by reducing the temperature 1°.

For comparison these values are also calculated and given for water gas, it being assumed that combustion in all cases is effected with only the quantity of air theoretically necessary.

Heating Gas.	Heat of Combustion of 1 Liter of Gas, the Water Produced being Assumed to be Gaseous at 15° C.	Rise of Temperature of Flame.	Heat Units given up by the Products of Combustion from 1 Liter of the Gas in Cooling 1°.
	Calories	Degrees	Calories
1. Producer gas.....	1044	1904	0.5487
2. Carbonic acid producer gas.....	1739	2449	0.7101
3. Water producer gas from liquid water at 15°.....	1652	2356	0.7016
4. Water producer gas from gaseous water at 15°.....	1790	2431	0.7363
5. Water gas.....	2812	2830	0.9934

The above changes of sensible heat into permanent chemical energy, which have been theoretically and experimentally determined, have also been applied in practice.

The so-called Dowson gas* is technically water producer gas, where for its production air and steam are introduced together into the hot fuel. The values for the steam only vary slightly from those given above for water steam at 15°, as the difference between the heat of evaporation of water at 15° and at higher temperatures is but slight. Such water producer gas had, according to Dowson's† own data, the following composition, I.; another, according to a paper of Schilling,‡ has the composition II.

Constituents.	I. In volumes per cent.	II.
Hydrogen.....	18.73	17
Carbonic oxide.....	25.07	23
Methane.....	0.31	2
Ethylene.....	0.31	—
Carbonic acid.....	0.57	6
Nitrogen.....	48.98	52
Oxygen.....	0.03	—
	100.00	100.0

The discrepancies in the composition of theoretical water gas and of that used in practice are explained by the consideration that the latter contains carbonic acid, which if completely reduced would give double its volume of carbonic oxide, and that pure carbon is assumed to be used in the formation of theoretical water producer gas in the above calculations.

In Dowson's arrangement the excess heat of production of the producer gas is actually transformed into the chemical energy of water gas, produced by the simultaneous introduction of air and steam into the producer, and their decomposition by the coal, which,

* "Journal für Gasbeleuchtung," 1881, page 674, German patent No. 27,165; see Wagner Fischer, "Jahresber. Chem. Tech.," 1887, pages 189 to 193. In 1885 Dowson gas had already been frequently used in England for heating, melting and motive power. But water gas can also be used, at least in those cases in which it can be burnt on leaving the producer. See T. A. Jahn's separate print, "Two Furnaces Worked by Illuminating Gas, etc.," Prag, October, 1881, published by the author. Later still, J. Quaglie referred in his paper, "Water Gas as the Fuel of the Future," Wiesbaden, 1880, page 23, to the use of water producer gas, but has more recently shown it to be impracticable on account of the amount of nitrogen. In the Frankfurt Electro-Technical Exhibition, 1890, a water gas producer was set up to drive a gas motor of 60 horse power in the machine hall, which was coupled with a dynamo used for charging the secondary battery in the theater.

† Wagner Fischer, "Annual Chem. Tech.," 1887, page 171.

‡ R. Biedermann, "Chem. Tech. Annual," 1889-90, pages 12 and 206.

being added to the producer gas, forms water producer gas.

In the new form Siemens furnace* the same *modus operandi* is partially carried out; steam is also blown into the producer, and besides this a portion of the products of combustion is led into the producer at a high temperature. As these products of combustion contain steam as well as carbonic acid, both water gas and also carbonic acid producer gas are formed. The sensible heat is here converted into chemical energy by the conversion of steam into water gas ($H_2O + C = H_2 + CO$), and the CO_2 into CO ($CO_2 + C = 2CO$), the result being an increase of the hydrogen and carbonic oxide in the gas made. To produce water gas from steam and hot carbon without any extraneous heat, the steam would have to be introduced at the temperature of $3,230^\circ$. To produce carbonic oxide from carbonic acid and heated carbon without any extraneous heat, the carbonic acid would have to be introduced at a temperature of $4,008^\circ$. However, the nitrogen contained in the hot products of combustion carries with it a considerable amount of heat, which is available for the above-named processes of conversion. But the introduction of relatively large volumes of nitrogen contained in the products of combustion into the gas producer, and thus going into the heating gas produced, prevents the total utilization of the products of combustion in this manner. Therefore in the new form Siemens furnace not more than half the products of combustion are returned to the gas producer. The theoretical limit of this amount depends upon the temperature of the returned products of combustion, also on their composition, as per table below, assuming that only the theoretical amount of air required for perfect combustion is used and taken with reference to the calorific and other values given above for one liter of producer gas, water producer gas, carbonic acid producer gas, and, for comparison, also water gas.

Weights of products of combustion in grammes in one liter of theoretical heating gas:

Heating Gas.	Products of Combustion in Grammes.		
	CO_2 .	N.	H_2O .
1. Producer gas.....	0.6762	1.6474	
2. Water producer gas from gaseous water at 15°	0.806	1.965	0.171
3. Carbonic acid producer gas.....	1.125	1.909	
4. Water gas.....	1.064	3.207	0.504

According to scientific observation these are the highest results which can be attained theoretically for converting sensible heat into chemical energy for water producer gas and carbonic acid producer gas. A comparison of these with the results already obtained in practice would be a guide as to how far the heat in various fuels can be utilized to the best advantage, and so avoid errors in treating fuel.

BACILLI IN BUTTER.

By GRACE C. FRANKLAND.

THE fact that milk affords a particularly suitable medium for the growth and multiplication of most micro-organisms has rightly led to its being regarded as a dangerous vehicle for the propagation of disease. On the Continent the practice of boiling all milk before use, and so destroying any pathogenic microbes which may be present, is almost universal, and recently a number of special pieces of apparatus have been devised for household use, insuring the efficient so-called "pasteurization" of milk. In England, however, we but rarely boil our milk, in spite of outbreaks of diphtheria and typhoid fever having been not infrequently traced to a particular milk supply. In a paper by Cnopf on the bacterial contents of milk it is stated that on one occasion out of every thirteen samples of milk supplied to Paris one was found to contain tubercle bacilli, while it is well known that the germs of typhoid, cholera, diphtheria, anthrax, etc., thrive readily in this medium. But although milk has been made the subject of much careful experimental investigation, comparatively little is known of the microbial condition of butter. Heim has shown that cholera bacilli purposely rubbed into butter could be demonstrated after thirty-two days, while typhoid bacilli similarly introduced were found after three weeks, and tubercle bacilli after the lapse of a month, although Gasperini discovered the latter in butter even after 120 days. Quite recently Lafar has published a paper, "Bacteriologische Studien über Butter," in the *Archiv für Hygiene*, in which he has recorded his investigations on the micro-organisms found in Munich butter. These experiments are instructive as exhibiting the fitness of butter to support a large number of bacteria, and thus furnish an interesting supplement to what is already known concerning the longevity of pathogenic microbes in this medium. The samples examined were prepared from fresh cream and were investigated as soon as possible after the butter was made. It was found that the number of microbes differed according as the portion for experiment was taken from the outside or from the interior of the piece of butter. Thus in one instance while one grm. from the center of the pat contained 2,465,555, on the outside in the same quantity as many as 47,250,000 micro-organisms were found. Taking the average of a number of examinations, it was estimated that the interior of a lump of butter possessed from 10 to 20 millions of bacteria in a single grm. Lafar is inclined to regard this as an under rather than an over statement of the number, inasmuch as there are always probably present a certain proportion of microbes which will not develop at the ordinary temperature, or on the gelatine-peptone medium usually employed. He graphically puts it that in some cases it is conceivable that the number of organisms swallowed with a moderately sized slice of bread and butter may exceed that of the whole population of Europe! Lafar found that butter kept in a refrigerator with a temperature of between 0° to $+1^\circ$ C. at first (after five days) showed a marked reduction in the number of bacteria, but that no further diminution took place, although the sample was kept

for a month at this temperature. Samples kept at from 12° to 15° C. exhibited a marked increase in the number of micro-organisms, a rise from 6 to 35 millions being observed in the course of 9 days, while when placed in the incubator (35° C.) after 4 days the bacteria had fallen from 25 to 10 millions, and after 34 days only 5 per cent. of the original number present were discoverable. Experiments were also made to ascertain what was the bacterial effect of adding salt to butter kept in a refrigerator. It was found that although the numbers were thereby considerably reduced, yet, even when as much as 10 per cent. of salt was added, the complete destruction of the bacteria was not accomplished. On examining, however, gelatine plates prepared from these samples, it was ascertained that the organisms present consisted almost entirely of a pure cultivation of one particular microbe, which was apparently entirely unaffected by the addition of salt, and had grown and multiplied to the exclusion of nearly all the other bacteria originally present. When samples similarly salted were placed in the incubator (35° C.) the result was rather different, for while there was more apparent connection between the proportion of salt added and the diminution in the number of bacteria, more varieties of micro-organisms were found on the gelatine plates. But in this case, also, the germicidal effect produced was not proportional to the increase in the amount of salt. Samples of artificial butter were also examined, and were invariably found to be much poorer in bacteria than ordinary butter. Thus, while the smallest number found in one grm. was 747,059, in real butter considerably over two million microbes was the minimum. Two varieties of bacilli have been isolated and described, which were found very constantly present in butter throughout these investigations. They are beautifully illustrated and shown in colored plates as individual organisms and colonies at the end of the paper. Lafar purposes continuing his investigations, and it is to be hoped that the examination of butter for pathogenic micro-organisms, about which so little is known, will form an important feature in any further researches he may undertake.—*Nature*.

GLYCERIN.*

By J. LEWKOWITSCH, Ph.D.

AT the outset, I wish to disclaim any intention on my part of bringing anything new before you. But having been asked to say something about glycerin—with the manufacture of which I am connected—I thought I might perhaps supplement the remarks made last year by Mr. Siebold and several other gentlemen in the discussion following Mr. Siebold's paper.

This will be done mostly from the manufacturer's point of view, as manufacturing processes cannot be supposed to be generally known, and it is not at all unlikely that erroneous opinions may be current among those not conversant with practical processes used in chemical works.

During the last year it has been repeatedly stated that some samples of glycerin destined for pharmaceutical purposes contained arsenic, a fact which was not unknown to manufacturers, but on which for very obvious reasons they did not care to enlighten the consumers. The arsenic in the glycerin owes its existence only to the arsenic contained in the reagents used in the manufacturing process. It has been pointed out by several gentlemen in last year's discussion, that glycerin purified by distillation would not be contaminated by this poisonous substance; although it is but fair to say that Mr. Allen had some doubts about it, still, in the concluding remarks it was distinctly stated that arsenic could be removed by distillation.

This is not so, as the simple fact will show that now all glycerin for pharmaceutical purposes is distilled, nay, even double distilled, glycerin. The times when glycerin was being prepared by other processes of refining have gone by, and a glycerin which had not been purified by steam distillation would be unsalable for pharmaceutical purposes.

But to remove every doubt I prepared the substance formed when arsenious acid is dissolved in glycerin, a substance which has been described by Schiff, and later on by Jackson, who apparently overlooked the earlier publication of Schiff. This substance is the arsenious ether of glycerin, $AsO_3(C_3H_5)_3$. On being heated to 250° C., it decomposes, while arseniureted hydrogen and other volatile arsenious compounds distill over. At the same temperature glycerin distills also over, and it is quite evident, therefore, that any arsenic contained in glycerin will distill along with it. The experiments which I carried out could not show any other result.

Arsenic contained in glycerin cannot be removed by distillation, and to my knowledge there is no process known for completely freeing glycerin from arsenic on a practical scale.

Pure glycerin, free from arsenic, can therefore be obtained from such sources only where reagents not contaminated with arsenic are being used. As it has been suggested last year that glycerin emanating from certain processes ought to be rigorously excluded by the Pharmacopœia, I may be allowed here to very briefly review from our point of view the processes used for manufacturing glycerin. The raw materials are exclusively fats and oils which yield on saponification or hydrolysis the glycerin as a by-product.

Glycerin free from arsenic will be obtained in those processes where the fats are hydrolyzed by means of water, whether it be used in the liquid state, under high pressure, or as superheated steam. The lime saponification, which is yet largely practiced, especially in smaller works, will, as a rule, also yield an arsenic-free glycerin. On the contrary, all glycerin coming from works where the sulphuric acid saponification is practiced will contain arsenic, as the glycerin will extract all the arsenic from the sulphuric acid. There is, however, no doubt that even such glycerin would be pure, as far as arsenic is concerned, if sulphuric acid free from arsenic were used, as it may be prepared from the sulphur obtained by Chance's process.

There is consequently no doubt that there are sources from which one may easily obtain a pure glycerin. With a view to ascertain whether there are in commerce samples of glycerin absolutely free from arsenic—for in many works several processes are simul-

taneously used, and the glycerin will be mixed in the end—I examined ten samples of glycerin coming from ten different works. As I wished to detect smallest traces, I used silver nitrate instead of mercuric bichloride. Three of the samples would have to be rejected, four samples contained very small traces, which might be disregarded, while three only were absolutely free from arsenic.

There is still another process for saponifying fats, and consequently manufacturing glycerin, practiced on a very large scale indeed—that which yields the soap lye glycerin. At last year's conference the glycerin derived from that source was very badly treated, and it was demanded that soap lye glycerin ought to be entirely excluded from pharmacy. Unnecessary precaution!—up to now, at least; for no chemically pure glycerin has been prepared hitherto from soap lees, owing to the difficulties incident to the purification of it.

Being wishful to prove here that soap lye glycerin has a far worse reputation than it—or, or let me say some of it—deserves, I undertook during the last few weeks to prepare chemically pure glycerin from soap lees, not in the laboratory, but on a large scale in the works. I had to use such glycerin as I just had at hand, and as this contained, owing to the impure reagents, some arsenic, I had on starting to expect a glycerin containing traces of arsenic; but this is, from reasons pointed out above, only of secondary importance, as, on repeating the manufacture of it, I shall have to start with purer reagents, and the real difficulties are lying in quite another direction.

Arsenic, although the most objectionable impurity, is, however, not the only one which may be found in "chemically pure" glycerin. As the British Pharmacopœia treats glycerin somewhat cursorily, I may be allowed to point out here one or two tests which will perhaps be found useful.

The glycerin may contain organic impurities, either fatty acids, etc., or so-called polyglycerols, under which name I may summarize all those substances having a higher boiling point than glycerin itself. The way to test for the latter is to gently evaporate a known quantity of glycerin in a platinum dish at a temperature of 160° C. The residue left, from which the ash subsequently found on incineration has to be deducted, will give a fair indication as to the care with which the glycerin has been distilled.

The following table gives the residues for eight "chemically pure" glycerins, arranged according to the quantity of organic residue, to which I have added the analysis of the soap lye glycerin:

	Organic residue. Per cent.	Ash. Per cent.
1.....	0.0243	0.00603
2.....	0.0327	0.0050
3 (a).....	0.0328	0.0140
(b).....	0.0267	0.0102
4.....	0.0360	0.0138
5.....	0.0371	0.0081
6.....	0.0443	0.0066
7.....	0.0738	0.014
8.....	0.0751	0.0154
9.....	0.0931	0.0305

No. 3 represents the figures found for two batches of the soap lye glycerin, which I have shown.

Fatty acids, as butyric acid, etc., and other organic impurities will be easily detected by testing with ammoniacal silver nitrate at ordinary temperature, which is recommended by the German Pharmacopœia.

It is required of a good glycerin that it should not reduce the silver within fifteen minutes. This test is far more delicate than that in which silver nitrate alone is used, as the manufacturers of cosmetics do, who reject any glycerin which reduces silver nitrate in less than twenty-four hours. I think that the test with ammoniacal silver nitrate is a little too rigorous, as ammoniacal silver nitrate is easily reduced by glycerin at an elevated temperature; in fact, of all the glycerin samples I examined, there were only two (Continental ones) which fairly responded to this test, while all others would have to be rejected. Testing with nitrate of silver alone would perhaps be sufficient to show whether there are any silver nitrate-reducing substances in the glycerin.

Under No. 68 of the blue list an answer is requested to the question how to estimate glycerol in pharmaceutical preparations. I am afraid there is no satisfactory answer to that question, as we are not yet in possession of sufficient quantitative material. Lately, two methods have been proposed for the estimation of glycerol, which seem specially suitable in a great many cases, unhappily not in all. The first method, based on oxidation of glycerol to oxalic acid, can only be of use where no other organic substance is present which might yield oxalic acid. The glycerol in glycerinum aluminis might be thus estimated. The second method—boiling of glycerol with acetic anhydride and sodium acetate—requires highly concentrated solutions, and would, of course, be completely useless when other substances are present which combine with acetic anhydride, as would be the case with, e. g., glycerinum acidi carbolici, or glycerinum acidi gallici and glycerinum acidi tannici. For such preparations it would be required to have a method for completely transforming the glycerol into a weighable substance, e. g., a tribromine derivative.

PHYSICAL PHENOMENA AT LOW TEMPERATURES.

PICTET has experimented on the chemical and physical phenomena observable at very low temperatures. He finds that by means of powerful compressors and aspirators, a mixture of sulphur dioxide and carbon dioxide will give a temperature of -110° , nitrogen monoxide and ethylene about -150° , and air a minimum temperature of -210° to -213° . These low temperatures were measured with a dry hydrogen thermometer, or by alcohol or ether thermometers, verified by the hydrogen thermometer. The author observes that the very long radiant waves emitted at these very low temperatures pass readily through almost all bodies. Thus a vessel at -110° for example will cool with practically the same rapidity whether the layer of cotton enveloping it be 50^{cm} or 10^{cm} or only 2^{cm} in thickness. Moreover, he finds that when chloroform is immersed in nitrogen monoxide at -120° , a ther-

* English patent No. 4,644, of 1889.

* British Pharmaceutical Conference, Leeds.