

THE ANALYST

PROCEEDINGS OF THE SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

AN Ordinary Meeting of the Society was held on Wednesday, 1st April, 1925, at the Chemical Society's Rooms, Burlington House. The President, Mr. G. Rudd Thompson, F.I.C., was in the chair.

Certificates were read for the first time in favour of:—Messrs. Lewis Eynon, B.Sc. (Lond.), F.I.C., Jack Rowan Heather, Frederick George Hitchman, and William David Rogers, B.Sc. (Hons. Lond.), A.R.C.S., F.I.C.

Certificates were read for the second time in favour of:—Messrs. George William Fraser Holroyd, M.A. (Oxon.), F.I.C., Cecil Eric Keeley, Andrew Francis MacCulloch, M.A., B.Sc. (Edin.), A.I.C., Frank Vegetus North Mitchell, Charles Henry Thomson, and Walter Peter Whitley, B.A. (Oxon.).

The following were elected Members of the Society:—Messrs. Douglas James Talbot Bagnall, A.C.G.F.C., A.I.C., Reginald Henry Coysh, M.Sc., A.I.C., George Van Barneveld Gilmour, B.Sc., A.R.C.Sc.I., A.I.C., Percy May, D.Sc., F.I.C., John Parry, Wilfrid Smith, B.Sc., A.I.C., and Miss Winifred Wright, B.Sc., A.I.C.

The following papers were read:—"Quantitative Determination of Cotton, Linen and Wood Fibres in Paper Pulp," by W. Dickson, F.I.C. (under the Analytical Investigation Scheme); "Proposed Standards for Lemon Cheese," by G. D. Elsdon, B.Sc., F.I.C. (followed by a general discussion on the *Desirability of Standards for Food Products*); and A Demonstration of:—"Laboratory Filters made of Sintered Glass and their various Uses," by P. H. Prausnitz, Dr. Ing.

Obituary.

SIR EDWARD THORPE, C.B., F.R.S.

THOMAS EDWARD THORPE was born on December 8th, 1845, the son of a Manchester merchant; he died on February 23rd, 1925, at Salcombe in South Devon, where he had built a house and constructed a beautiful garden on the top of the steep hill overlooking the far reaches of the inlet of the sea. In the 80 years of his life he worked to within a few days of his death with a great breadth of outlook, contributing to the advancement of knowledge in many directions.

On leaving Owens College, Thorpe went to Heidelberg and Bonn, at the former place coming under the influence of Bunsen. His first appointment was as assistant to Roscoe, and their long friendship resulted in the record of the life of Roscoe which Thorpe has given us. Thorpe left Manchester to be Professor of Chemistry at the Andersonian Institution, Glasgow; thence in 1874 to the Chair of Chemistry in the Yorkshire College, Leeds (the laboratory of which he designed), and in 1885 to South Kensington. In 1894 he became Principal of the Government Laboratory, returning in 1910 to South Kensington to become Professor of Chemistry and Director of the Chemical Laboratories for two years, after which he retired to Devonshire. Thorpe married in 1870 the daughter of Dr. John Watts of Manchester, who survives him. He leaves no family.

It is not possible to do more than indicate briefly the wide field which the activities of Thorpe covered. In addition to his strenuous professorial work, he took part in several magnetic surveys, both in this country and abroad, and in four solar eclipse expeditions. The sea voyages connected with these may have led to that love for the sea which made him an expert and devoted yachtsman.

Honours came to him in many directions. In 1895 he was President of the Society of Chemical Industry, in 1899-1901 President of the Chemical Society, and so recently as 1921 of the British Association Meeting in Edinburgh. He received honorary degrees from various universities, and was a member of many foreign scientific bodies. He was the first Longstaff Medallist of the Chemical Society, and for his researches on fluorine compounds and his determination of the atomic weights of titanium and gold he received the Royal Medal of the Royal Society, of which body he acted as foreign secretary from 1899-1903.

The Bakerian lecture delivered by him before the Royal Society dealt with radium, the atomic weight of which he determined, and he was joint author of two other Bakerian lectures. He was made a Companion of the Bath in 1900, and was knighted in 1909.

Thorpe was abundant in literary labours. His delightful studies in historical chemistry will be prized for many generations, as for example the monographs on Priestley and Davy, the History of Chemistry, and the life of Roscoe. A review which he wrote for this Journal rather less than three years ago shows how wide and accurate was his knowledge of the historical progress of chemistry. But he

will be best remembered in this connection by his work in producing the Dictionary of Applied Chemistry, a book which has been found indispensable to all practising chemistry. To this he gave himself with characteristic vigour, especially during his retirement, and the proofs of the last volume of the edition now being issued were in his hands during the last few weeks of his life.

The contributions of Thorpe, either directly or indirectly, to analytical chemistry, the branch of the science with which this Journal is specially concerned, were considerable. In his early days as a Professor he had published two little handbooks on Qualitative and Quantitative Chemical Analysis; and throughout the period of his career at the Government Laboratory he revealed to those who had the privilege of working with him a keen interest in and an accurate knowledge of analytical method.

The design of the Government Laboratory at Clement's Inn will remain one of Thorpe's great achievements. Originally housed in attics and improvised rooms at Somerset House, where it had been established in 1842 to deal with a particular revenue question, it had outgrown its bounds by reason of the demands made upon it by many Government Departments, and Thorpe had the good fortune to transfer the laboratory in 1897 to a building which he had designed in every detail. The year after Thorpe had gone, his late Department, which he had done so much to establish as a necessary Crown activity, became the Department of the Government Chemist with Treasury direction to undertake chemical work for all other services of the Crown.

Thorpe was a member of the Royal Commission appointed in 1900 to enquire into the causes of the outbreak of arsenical poisoning, and acted as Chairman of a Committee of Chemists appointed by the Board of Inland Revenue to report upon the methods employed in the detection of small quantities of arsenic in materials used in brewing. Under his direction, the old Marsh-Berzelius method with zinc and acid as a source of hydrogen was much improved, and an electrolytic method was devised. Bloxam of King's College, in 1861, had described such a process, but it was not capable of general adoption, and no advance had been made with it. Thorpe's apparatus, except for slight modifications, is used to-day essentially in the form in which it was originally described by him.

Thorpe's position at the Government Laboratory, which since 1875 had been the authority for reference by the Courts in cases of disputed analyses under the Food and Drugs Acts, made it necessary for him to enquire closely into the methods of analysis employed. One of the matters which came up for review in this connection was the analysis of sour or decomposed milk, a subject of very great importance to public analysts whose figures might be challenged in the Courts. As a result of an investigation into the method, and of further extended experiments carried out, Thorpe communicated a paper to the Chemical Society in 1905, in which he described the methods adopted to obtain the figures for the original fresh milk from the analysis of the decomposed milk. This authoritative statement was welcomed by public analysts who found that Thorpe was always ready to discuss with them analytical processes.

A similar proceeding arose in connection with the Food and Drugs Act of 1899, which fixed a limit for the amount of butter fat in margarine. It was at Thorpe's suggestion that the Society of Public Analysts, of which he was an honorary member, appointed a committee to confer with him as to a suitable method for the estimation of the amount of butter fat. Thorpe had held for a short time an appointment as public analyst, and this experience no doubt became a point of contact with the work of this Society.

Among the important revenue questions which came before Thorpe, were two of special importance to analysts. One of them related to the determination of the original gravity of beers; in this work he collaborated with the late Dr. Horace Brown, F.R.S., and as a result of their report, the original tables based upon the work of Graham, Hofmann and Redwood sixty years before, were modified, and tables giving the new values were incorporated in the Finance Act of 1914. The other investigation related to the estimation of alcohol. Although it was the practice of analysts to determine the amount of alcohol with a pycnometer, using, in connection therewith, alcoholic tables of strength, the legal instrument for revenue purposes in this country had been, since 1816, Sikes' hydrometer. In order to make available the direct specific gravity method, Thorpe prepared for use a table of spirit densities based upon the work of Blagden and Gilpin, Drinkwater and Mendeléeff, at the same time revising the tables for use with Sikes' hydrometer. By an order in Council made under the powers of the Finance Act, 1907, it is now legal, for revenue purposes, to determine the strength of spirits by specific gravity, using in connection therewith these tables.

Thorpe was a member of numerous Departmental Committees, and his keen and energetic interest in the questions investigated by the Committees on "Preservatives and Colouring Matters in Food," on "Milk and Cream Regulations," on "Butter Regulations," and on "Industrial Alcohol," will be remembered by those who were associated with these enquiries. He was also Chief Analyst under the Fertilisers and Feeding Stuffs Act, and was chairman of the Committee which drew up for the Ministry of Agriculture the methods of analysis used under that Act.

One other of Thorpe's many activities may be mentioned. He was deeply interested in the use of lead in pottery glazes, and it was largely due to the investigations carried out under his directions, and to the evidence which he was able to give at the enquiry held into the matter, that steps were taken to limit the quantity of lead in soluble form in fritts and glazes.

This brief review leaves untouched a great deal of work in which Thorpe was actively engaged, although mention should be made of his work in connection with the International Committee on Atomic Weights, on which he served for many years. His great powers for work, his descriptive pen, his attractiveness as a lecturer, are well known. An illness which attacked him at Edinburgh on the eve of delivery of his Presidential address, in 1921, left its mark, but he carried on strenuously almost to the absolute close of his long life, talking as each day ended of the work with which the next day would be occupied.

He died in his own home at Salcombe—the port into which he had often sailed his yacht from quests in British and Continental waters—and thus belied the feeling which he once expressed that he would die on the sea he loved so much. The simple ceremony at the funeral at Salcombe, which the writer attended as representing the Government Chemist's Department and the Chemical Society, was in keeping with the man who disliked ceremony and who cared for life only for what could be accomplished in it.

GEO. STUBBS.

The Investigation of Ventilation Conditions.

By ROBERT C. FREDERICK.

(Read at the Meeting, March 4, 1925.)

THE factors relating to ventilation have been the subject of a vast amount of research, and it is only in recent years that the conditions and requirements of satisfactory ventilation have been fully understood. Before discussing the modern aspect it may be of interest to give some account of the views which have had currency.

From early times it has been recognised that a certain amount of air supply is essential for the maintenance of human life, and tragedy has followed swiftly when this fact has been forgotten or ignored. The infamous case of the Black Hole of Calcutta is common knowledge. There, in 1756, 146 people were confined in a building 18 feet square and with only two small windows to provide ventilation. Within an hour some were dead, and a little over nine hours later, when the prisoners were released, only 23 half-dead individuals staggered forth. In 1848 the S.S. *Londonderry*, on passage from Sligo to Liverpool, encountered heavy weather. The 150 steerage passengers were battened down in a cabin 18 feet long, 11 feet wide, and 7 feet high, and before an exit could be forced 72 were dead and others were dying. Again, after the battle of Solferino (1859) 300 men were confined in a small prison, and next day 260 lay dead.

CHEMICAL EXPLANATIONS.—Even a generation or two ago it was considered that air itself could contain a chemical causative agent of many diseases. Griscom,¹ writing in 1854, said: "It would appear that sulphuret of ammonia is the morbid agent exciting typhus fever, sulphuretted hydrogen being the pestilential virus producing yellow fever and the bilious remittents and agues of tropical climates." This ague, which we now know as malaria (Ital. *mala*, bad; *aria*, air), was considered to be due to a noxious vapour or miasma which was evolved when vegetable matter was in contact with water and the temperature was sufficiently high; this reaction was more pronounced at night.² Through the advance of scientific knowledge it is now known that malaria is caused by a parasite, part of the life cycle of which is spent in the anopheline mosquito, whose bite may convey the

infection to man. The mosquito breeds in marshes and swamps and is active only at night. It is not surprising, in view of these beliefs, that there was a general distrust of the "night air," and that windows and doors were commonly kept tightly closed after dark, with consequent lack of ventilation, though, no doubt, these precautions were not unrelated to the question of the security of the household from depredators. Yet the harmful effect of living in badly ventilated spaces was realised, though the explanation of this was founded on erroneous conceptions. A commission, which enquired into the relationship between disease and ventilation of the barracks in the Crimea, showed there was a much higher incidence and mortality among the men living in badly-ventilated quarters than among those in well ventilated ones.³

EFFECT OF RESPIRATION ON THE COMPOSITION OF AIR.—A man, at rest, breathes about 17 times a minute, and at each inspiration inhales some 500 c.c. of air. In this process the composition of the air is markedly altered, and the expired air contains, by volume, about 16.4 per cent. of oxygen instead of the original 20.9, and the carbon dioxide is increased from 0.03 to about 4.0 per cent.; the quantity of nitrogen and inert gases undergoes little change, but a large amount of water vapour is added. The composition of the air in a single expiration is subject to some variation. The alveolar air contains about 6.0 per cent. of carbon dioxide and correspondingly less oxygen; consequently the composition of the expired air is influenced by the depth of the expiration.

VARIATIONS OF HUMIDITY.—The amount of water vapour added to the air of a compartment by the occupants varies greatly according to the temperature, the work performed, and other factors. The degree of vitiation caused by this is much more than is commonly believed. For example, the relative humidity at 65° F. in an air-tight glass cabinet of 343 cb. ft. capacity, occupied only by the author, increased from 31 to 49 per cent. in half an hour. It has been stated⁴ that under the usual atmospheric conditions of temperature and humidity the amount of water given out, in respiration and sweat, by a man, at rest, in 24 hours, is 935 grms., an average of 39 grms. per hour. With three men at rest occupying the cabinet referred to above, in which the average temperature was 69° F., and the average relative humidity 62 per cent., it was found that 1300 grms. were added to the air in 2 hours, an average of 216.7 grms. of water per man per hour. The latter quantity is sufficient to cause saturation of 54.7 cubic metres (1932 cb. ft.) at 60° F. and 70 per cent. original relative humidity. In practice, however, it does not work out in this way. With twenty-one other men the author has occupied a steel compartment of about 8000 cb. ft. capacity for 12 hours. The initial and final temperatures were 46° F., and 52° F. respectively; the relative humidity actually fell from 82 to 79 per cent. Condensation of water vapour on the walls was marked, though the amount was insufficient to account for that added by the occupants. Again, in an air-tight glass chamber containing 337 cb. ft. of air at an average temperature of 64° F., and occupied by three men for 4 hours, the absolute humidity only increased 3.5 grms. per cubic metre, and no condensation could be detected. The disappearance of water vapour sufficient

in quantity to saturate the air of a space several times over will be the subject of further research; it is probable that a large amount is taken up by the clothing.

SIGNIFICANCE OF CARBON DIOXIDE.—The harmful effects of living in air vitiated by the products of respiration were formerly considered to be due to a poisonous action of the added carbon dioxide, the deficiency of oxygen, and the presence of some unidentified poison.

In the most overcrowded living spaces the carbon dioxide present as a result of respiratory addition never exceeds 0.9 per cent., and carbon dioxide even very much in excess of this figure is not poisonous and has no physiological significance. This is shown by the relatively enormous amounts breathed by people huddled in bed clothes and by workers in breweries and aerated water factories. Again, at each expiration in man there remains some 150 c.c. of air in the respiratory passages, and this with its high carbon dioxide content is the first to reach the alveoli in the following inspiration. In breathing air containing 0.5 per cent. of carbon dioxide the ventilation of the lungs is increased to such a small extent as to be quite unnoticeable.⁵ A concentration of 2.0 per cent. of carbon dioxide simply results in a 50 per cent. increase in the depth of breathing, such as occurs with moderate exercise.⁶ Living in such a concentration does not cause discomfort unless vigorous exercise is performed, and it is not until the amount increases to between 5 and 7 per cent. that breathing becomes laboured when the subject is at rest.⁷ Pettenkofer alone, among his contemporaries, realised that the carbon dioxide content was not the cause of the discomfort experienced when living in badly ventilated spaces.⁸

In calculating the amount of carbon dioxide added to the air of an apartment it is generally assumed that the output of an adult male at rest is 0.72 cb. ft. per hour, and that of a mixed community of men, women and children 0.6 cb. ft., women exhaling less than men, and children still less. I consider these figures too high. In a number of experiments it was found that the mean output per man at rest was 0.57 cb. ft. per hour. Macleod⁹ gives the output per man at rest as 0.327 grm. of carbon dioxide per hour per kilo. of body weight; calculating on an average weight of 68 kilos, this would give 0.4 cb. ft. per man per hour. When work is being performed there is a great increase in the amount of carbon dioxide exhaled. The ratio of carbon dioxide increase to oxygen decrease caused by respiration in a space occupied by average men I find to be 1:1.15.

De Chaumont, in 1875, stated that when the normal amount of carbon dioxide in fresh air, which he considered to be 0.04 per cent., was increased by more than 0.02 per cent. from respiration this excess was perceptible to the senses by an associated disagreeable smell. It is remarkable how this statement received, and still receives, such general acceptance. The error was perpetuated in the fixation of the so-called sanitary limit for carbon dioxide, $0.04 + 0.02$, a total of 0.06 per cent., a figure which to this day appears to be regarded as standard by many analysts and sanitarians. Twenty-one years later this belief was elaborated by Russell¹⁰ in this curious statement:—"Experiment by means of the sense of smell has shown that air in a room seems fresh when the carbon dioxide does not

exceed 0.05999 per cent., a little unpleasant when the proportion is 0.08004 per cent., offensive and very close at 0.12335, and extremely close, when the smell can no longer differentiate, at 0.12818." It is difficult to know which to admire most, the delicacy of the investigator's olfactory sense or that of his analytical technique. In point of fact, the amount of carbon dioxide in fresh air averages 0.03 per cent., which would make the sanitary limit 0.05 per cent. Taking the permissible respiratory impurity as 0.02 per cent., and the carbon dioxide output as 0.6 cb. ft. per person per hour, De Chaumont calculated that 3000 cb. ft. per head per hour of fresh air must be supplied to prevent the sanitary limit being exceeded. Pettenkofer, whose perspicacity has already been noted, suggested, in 1858, a permissible maximum of 0.1 per cent. of total carbon dioxide.

The author has, in many years of ventilation investigation, worked to a permissible maximum of 0.12 per cent. of total carbon dioxide. It must be clearly understood that this figure has no chemical or physiological significance whatever, and that it is adopted for reasons different totally from those animating the school of de Chaumont; it functions simply as an index. A large proportion of disease dissemination is caused by air as the vehicle. The organisms are carried either by currents or by direct transfer in sputum or nasal spray. The probability of infection being contracted from a carrier by the other occupants of a space depends, among a number of other factors, upon whether the natural defences of the individual are sufficient to overcome the mass of infective material encountered; the larger the number of organisms which gain access to an individual the greater is the probability of their survival in a fresh host. It follows that the greater the degree of dilution of the air with the pure outside air, the less the probability of illness being communicated. This, then, is the function of the permissible limit of 0.12 per cent. of carbon dioxide; it ensures that the respiratory addition to the air space will be diluted to a certain minimum extent, and consequently that the risk of the spread of any infectious disease organisms present will be proportionately reduced. The figure is one which does not entail any unreasonable demands on ventilation practice.

DEFICIENCY OF OXYGEN AS EXPLANATION.—By the lay mind all the discomforts of inadequate ventilation are attributed to lack of oxygen. Actually the deficiency of oxygen under these circumstances is never more than 1.0 per cent., and this is without any effect whatever. The normal variation in the barometric pressure at sea-level is equivalent to a 10 per cent. difference in the partial pressure of oxygen in the atmosphere. Leonard Hill⁵ states that a person not exerting himself will fail to notice any effect until the oxygen has been reduced to about 11 per cent., and consciousness will not be lost until the percentage sinks below 7 per cent. The author has lived in an atmosphere containing 15.21 per cent. of oxygen and experienced no discomfort.

The belief in the existence of a poison in exhaled air was founded on experiments in which the condensed water vapour from human expirations was injected into animals with fatal results. The question has since been the subject of much

research, and the net result goes to show that there is no evidence that such a poison exists.

It is necessary to point out that while the carbon dioxide increment and the oxygen decrement which result from respiratory vitiation of air are of little importance, massive changes which certainly have a profound effect can occur through other causes. The author has shown¹¹ that storage of vegetable substances in an unventilated space may convert the air into a mixture of gases containing some 50 per cent. of carbon dioxide and hardly any oxygen, and that anyone entering such a space would be immediately killed. The research was made in order to elucidate the reason of a triple fatality, and the causative agent in this case was damp tobacco; hay, cabbage, potatoes, etc., react similarly. In a notice of this paper¹² the reviewer pointed out that there was a tradition amongst seafaring men of sailing ships that coffee beans wet with salt water in the holds cause sudden deaths amongst the crew. Douglas¹³ has reported a case during the war where three men lost their lives in clearing a cargo of grain in a ship which had been sunk and afterwards salvaged. In 1915 a cargo of oranges on another ship was responsible for the death of two men entering the hold. This, and another similar fatal accident in 1914, in which four men were killed on entering a silo containing immature Indian corn, are described by Brooke.¹⁴

For a particular purpose in carrying out some experiments the author had the floor of an air-tight cabinet painted over with boiled linseed oil and noticed that this caused a higher carbon dioxide content in the air. Subsequent research showed that exposure of the oil had this effect and, in addition, removed a large proportion of oxygen. A volume of oil in contact with 793 times its volume of air added 0.33 per cent. of carbon dioxide and reduced the oxygen to 11.72 per cent. in a week, and there was evidence that this change had been brought about some considerable time before the samples were actually analysed. It has been suggested that red lead paint has a high absorption capacity for oxygen, but red lead *per se* has no such effect; the reaction is due to the admixture of the oil constituent.

In a sample of air from a paint store the author found 2.05 per cent. of carbon dioxide and 15.86 per cent. of oxygen. The importance of recently painted surfaces in investigating ventilation conditions does not require elaboration. Large amounts of carbon dioxide in the air of breweries, aerated water factories, and bakehouses are to be expected. A fatality due to anoxæmia caused by the employment of a rusting composition in the hollow pier of a bridge is discussed by Wallace.¹⁵ The changes in the carbon dioxide and oxygen content of air brought about by combustion processes are an obvious factor to be considered. Except in the case of naked gas flames and tobacco smoking, it may be stated that, in general, the products of combustion do not enter a space, but find an exit in the connecting flues; a large volume of air is consumed, and its replacement from outside sources exerts a powerful beneficial ventilating influence. A naked gas flame can increase the carbon dioxide content of the air in a space very greatly; this carbon dioxide, however, is without the significance of that from respiration. A much more

important factor is the heat evolved; one cb. ft. of gas is said to raise the temperature of 31,290 cubic feet of air 1° F.¹⁶ In this paper it will not be possible to discuss the question of poisonous gases occurring in air.

EFFECTS OF TEMPERATURE AND HUMIDITY.—Hermans¹⁷ was the first to state definitely that the most important considerations in ventilation are not carbon dioxide, oxygen, or personal effluvia, but temperature and humidity. His teaching, for the most part, fell on deaf ears, and it was not until 1905, with the classic experiments of Flügge, Heymann, Paul, and Ercklentz,¹⁸ that his theories obtained general acceptance. In these experiments individuals experienced no discomfort and suffered no impairment of mental efficiency when confined in atmospheres containing 1.0 to 1.5 per cent. of carbon dioxide, and correspondingly less oxygen, provided the temperature and humidity were kept low. In other experiments, with carbon dioxide and oxygen in about the same amount as before, and with the temperature from 75 to 80° F., and relative humidity 88 per cent., discomfort was marked even when the subject, through a suitable attachment, breathed pure air from the outside. Their views were supported in reports to the Government in 1907 and 1909.^{19 20} In 1913 our knowledge was further extended with the publication of a monograph by Hill, Flack, McIntosh, Rowlands, and Walker.²¹

The importance of temperature and humidity is due to their influence on the body metabolism. The food consumed by the individual is continuously being converted into heat, and but for the natural heat-regulating mechanism, the body temperature, normally 98.4° F., would rise. The profound effect of even a degree rise in body temperature is common knowledge. To maintain a balance there must be a continuous process of heat loss. In cool temperatures this occurs principally by convection and, to a much less extent, by radiation. The cool air conveys away the body heat from the skin by convection, and loss by evaporation from the skin is at a minimum; from the respiratory membrane loss by evaporation is at a maximum by the breathing of cool air of low vapour tension.²² When the air of a space attains a temperature above 70° F. these processes are inadequate, and the body temperature would rise but for the secretion of perspiration which then occurs. As long as perspiration can evaporate freely the heat loss and production are maintained in equilibrium²³.

It follows, then, that when a person is living in a space in which the temperature and humidity are high, heat loss is retarded and, in consequence, discomfort is experienced; in extreme cases heat-stroke and death may supervene. The most essential requirement of satisfactory ventilation is, therefore, that conditions shall be maintained such as to permit of free heat loss from the individual. The heat-regulating mechanism is greatly assisted by any means which disperse the envelope of hot humid air surrounding the subject between the skin and the clothes. Movement of the air in a space by direct transfer and promotion of evaporation is the most potent factor in rendering this assistance, and its importance in ventilation cannot be over-emphasised. It has fallen to the author's lot, in the course of his investigations, to work in atmospheres foully vitiated by respiration,

vitiated, indeed, to such an extent that dilution of the respiratory impurity was absolutely *nil*; it is only under extreme conditions that the truly remarkable effect and relief afforded by pronounced air movement can be fully appreciated.

Satisfactory ventilation, therefore, demands that a sufficient quantity of pure air be supplied to dilute the respiratory impurity, that the air in the space be kept at a hygienic level of temperature and humidity, have a high cooling power, and be kept in appreciable movement. These conditions must be maintained without causing annoyance to the occupants.

Before discussing the methods to be adopted in investigating to what extent these requirements are being fulfilled it may be desirable to make some reference to what may be termed the psychological aspect. I am convinced that if the occupants of an apartment *think* the ventilation conditions are unsatisfactory, they will imagine they are exhibiting the symptoms these conditions bring in their train. As a result of persistent complaint by the operators, the author was requested to report on the ventilation conditions in the X-ray room of a large hospital. When the apparatus was in use the room was in total darkness except when momentarily illuminated by electric discharge flashes, and there was a pronounced and rather unpleasant smell of ozone. Under these circumstances it is not difficult to understand why the occupants thought the air *must* be very unhealthy. The amount of ozone was negligible, no noxious fumes were present, and the ventilation, in general, was quite satisfactory. After the matter had been explained complaints ceased.

EXAMINATION OF AIR.—From the foregoing discussion it will be seen that in investigating the ventilation conditions of a space it is necessary to make the following examination of the air:—1. Determination of carbon dioxide; 2. Determination of temperature and humidity; 3. Determination of cooling power.

Of these, the first is the most important, for, if the figure is low, it is probable, speaking generally, that the remaining determinations will also give satisfactory results. But they are really complementary, and should all be regarded as essential. Different parts of the space should be examined at about body level. A complete investigation can be made in a short time.

1. DETERMINATION OF CARBON DIOXIDE.—For carrying out this determination a method is available which is so advantageous from every point of view that no other need be considered. I refer to the Haldane Apparatus for Determination of Carbon Dioxide in Air. It is necessary to distinguish it clearly, as the admirable principles on which its use depends have been utilised by Haldane in the design of various other air and gas analysis apparatus. The apparatus is contained in a case measuring only about 8 by 13 by $3\frac{1}{2}$ inches and can be employed direct in the space under investigation or for examination of samples in the laboratory. The most convenient sample bottles have a capacity of 70 c.c., and are narrow-mouthed, and stoppered; they must be perfectly clean and dry. It is advisable, as soon as a new supply is obtained, to etch a distinguishing number on the stopper and bottle so that the correct stopper is always employed in each bottle. To ensure absolute tightness, the stopper

is smeared with a thin coat of vaseline. To prevent the stopper working loose, particularly when exposed to changes in temperature and pressure, it is essential to secure it by placing a rubber band over it and under the bottle; another smaller band, doubled over this and round the neck, maintains the first in position. In collecting a sample, one end of a rubber tube (about $2\frac{1}{2}$ ft. long and $\frac{3}{16}$ in. bore) is introduced into the bottle nearly to the bottom, and the other end is held in the mouth. A deep breath of air is then sucked through and the tube removed while the air is still being sucked up. The importance of not allowing any breath to pass backwards into the bottle and of keeping the bottle at arm's length need hardly be emphasised. The stopper is inserted, turned round, and secured with the rubber bands. The author has, elsewhere²⁴, described in detail the manipulation of the apparatus when used either direct in the space or with sample bottles. Since writing that account he has personally analysed some 5000 additional samples, but the directions given do not call for any important revision. One or two points, however, may be referred to with advantage. It is desirable to test, from time to time, whether the apparatus is air-tight; the best way of doing this is to note the reading after passing the air, which happens to be in the apparatus, backwards and forwards in six absorptions, then to repeat this with the residue, and see if the reading remains constant. If the apparatus is not quite tight, the trouble is usually due to the lubrication of the stopcocks. Resin cerate is the best lubricant, and a supply should be prepared by melting a quantity and allowing any hard impurity to settle; only the top portion of the solidified product is used. Too much attention cannot be given to the stopcocks to ensure freedom from gritty particles, pieces of fibre, etc. When using the apparatus direct in a space in which the temperature is high, inconveniently extensive movement of the potash levels may occur, but this can be avoided by shaking the water in the jacket immediately before closing the stopcocks after taking the sample into the apparatus. As has already been stated, the quantity of carbon dioxide should not exceed 0.12 per cent., and, of course, the less it is the better.

If, for any exceptional reason, a determination of the oxygen is also desirable, the Haldane General Air Analysis Apparatus should be employed. Full details for its manipulation have been given by the author elsewhere.²⁵ This apparatus may also be used for the determination of all combustible gases, and in this case the modified combustion chamber described by the author²⁶ will be found an advantage.

2. DETERMINATION OF TEMPERATURE AND HUMIDITY.—This is best carried out by means of a wet and dry bulb hygrometer of the Mason type. The common method of simply hanging up such an instrument on the wall of a space is useless; it is absolutely essential that the air surrounding the instrument should be in distinct movement. The test is conveniently made with a whirling hygrometer. The type recently introduced by Messrs. Casella has been found very satisfactory. In this, wet and dry bulb thermometers are mounted in an instrument very similar to the noise-producing device employed by certain football enthusiasts, and the method of using is also the same. The wet bulb is kept moist by an

absorbent fibre-covering dipping into distilled water contained in an attached reservoir. The thermometers are whirled round, and readings are quickly taken until constant. For investigations extending over a prolonged period, the recording thermo-hygrograph made by the same firm, the mechanism of which is actuated by a bi-metallic strip and the contraction and elongation of a bundle of human hair, will be found useful. It is necessary to standardise it from time to time with a whirling hygrometer. From the wet and dry bulb temperatures it is possible, by means of three tables, to calculate the Dew Point, the Absolute Humidity and the Relative Humidity (*i.e.* the percentage proportion of water, as vapour, in the air to that present when the air is saturated at the dry bulb temperature). The original tables were calculated by Glaisher many years ago, and the absolute humidity is given in grains per cb. ft. To conform to more modern usage, the author has calculated a condensed table to grms. per cubic metre, and with this has given the other tables necessary, and has described the method of calculation.²⁵ The normal variations in atmospheric pressure at sea-level in this country may be neglected in humidity calculations without serious error, but for greater differences Marvin's tables²⁷ should be consulted. In all cases where the relative humidity alone is to be determined, it may be obtained without calculation from the tables already mentioned. In the author's opinion the most satisfactory condition is when the dry bulb temperature is 64° F. and the wet bulb 57° F. This indicates a dew point of 51.2° F., and a relative humidity of 63.1 per cent. The relative humidity is a much more important consideration than the absolute humidity, for it is on the former that the power of the air for evaporating perspiration depends. Rubner found that at 73.4° F. a man at rest lost 75 grms. of water per hour when the relative humidity was 60 per cent., and only 19 grms. per hour when the relative humidity was 84 per cent. The wet bulb temperature in temperate climates should not exceed 70° F. There is a considerable margin between what is desirable and what can actually be endured without causing a rise in body temperature. Haldane states²⁸ that with the subject at rest and lightly clad the maximum tolerable wet bulb is 88° F. in still air, and 93° F. when the air is in movement; when work is being done these figures are 78° F. and 85° F. respectively. It would appear, however, as a result of recent research that light work can be done when the wet bulb registers 90° F., provided the air is in appreciable movement. So far consideration has only been given to the question of damp air, but air can also be too dry. The Chicago Commission on Ventilation, speaking of the very dry air supplied to the schools of that city, stated that the air tended to maintain a proper balance by absorbing moisture from the school structure and the bodies of the children and that this resulted in shrunken furniture, dust, dry throats, parched lips and a rapid rate of skin evaporation which rendered it necessary to maintain a high temperature for comfort. The author has found that with a relative humidity of 30 per cent. and the air in distinct movement a comparatively high temperature, say 75° F., gave an impression of being some 15 to 20 degrees cooler.

3. DETERMINATION OF COOLING POWER.—This determination is made by means of an instrument called by its inventor, Professor Leonard Hill, a Kata-thermometer.²⁹ In its latest form this consists of an alcohol thermometer with a cylindrical bulb about 1·7 cm. in diameter and 3·6 cm. long and a stem about 18 cm. in length with two graduations at 100 and 95° F. respectively. At the other end of the stem is a safety reservoir larger than those of ordinary thermometers. The purpose of this is to enable the thermometer to be heated well above the highest graduation without risk of breakage, and also to allow time for placing it in position and to attain a regular rate of cooling before the reading requires to be recorded. Both wet and dry Kata-thermometer readings are taken. To obtain the dry reading the instrument is placed in distilled water at about 170° F. (in working away from the laboratory a Dewar flask will be found convenient) until the liquid about half fills the reservoir and presents an unbroken column. It is then wiped quite dry and clamped in a burette stand well away from the body. It should be placed out of direct air currents, unless the occupants of the space are usually similarly situated, as the rate of cooling depends very greatly upon air movement around the instrument; with the tables provided the instrument can, indeed, be used to measure movements of the air much smaller than could be recorded by an air meter. The exact time taken by the liquid to recede from the 100 to the 95 mark is recorded in seconds by means of a stop-watch. This figure, divided into the particular factor engraved on each Kata-thermometer, gives the cooling power in millicalories per sq. cm. per second of a surface at 36·5° C. (97·7° F.). This figure is arbitrarily chosen as representing the skin temperature. The first reading should be ignored, and subsequently the mean of a number should be noted. To take the wet Kata-thermometer reading, the bulb is covered with a Lisle-thread finger stall and, after heating, the excess water is removed by drawing the covering up tightly and shaking the instrument when held in a vertical position. The remaining manipulation is exactly the same as for a dry reading. The dry Kata-thermometer gives the cooling power by radiation and convection, the wet by radiation, convection, and evaporation, and consequently the difference between the two is the cooling power by evaporation. Professor Leonard Hill states that the cooling power of air by the dry Kata-thermometer should not be less than 6, and that of the wet 18. In the author's opinion, however, these figures are perhaps idealistic, and 5 and 15, respectively, should be regarded as sufficiently satisfactory.

Air movement can be most conveniently studied by observing the behaviour of a column of smoke. In investigating ventilation conditions it is inadvisable, for obvious reasons, to add smoke produced by combustion to the air of the space under examination; the author has therefore designed an apparatus which, by simple pressure of a blowing bulb, delivers a column of artificial smoke. It is obtainable from Messrs. Casella & Co., Ltd.

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DISCUSSION.

Mr. W. J. A. BUTTERFIELD thought the resumé of the subject given in this paper extremely valuable. He believed, however, the author was not right in stating that the carbon dioxide in air was regarded up to 1908 as directly injurious, and not merely as an indicator of the degree of ventilation. For instance, in evidence given on 29th May, 1902, before the Select Committee on House of Commons Ventilation, Dr. J. S. Haldane stated (Question 820):—"The carbonic acid by itself is, of course, of no importance," and (Question 823), "but of course the carbon dioxide there is only treated as an index." These words suggest that earlier references could be traced to a fact which Dr. Haldane then spoke of as more or less common knowledge among ventilation experts.

In a paper read before the Society in 1909 (ANALYST, **34**, 257) the speaker quoted experience with 9000 samples of air taken by the bottle method referred to by the author as evidence of the satisfactoriness of that method of sampling, and his later experience with further samples had confirmed this evidence.

A form of hygrometer not mentioned by the author, which was much more convenient and less costly than the Assmann instrument, was that devised by C. V. Boys, formerly prescribed for use in connection with calorimetry in the official gas-testing stations in London.

Mr. R. C. FREDERICK, in replying, said how much he appreciated the generous reception which had been accorded to his paper. He had not seen the hygrometer designed by Professor Boys, and so could not form an opinion as to its suitability for investigation of ventilation conditions. He (the speaker) had recently designed one of a new type, but had not proceeded with it at the moment, as he found it would be relatively costly to manufacture. Mr. Butterfield had suggested that the conditions and requirements of satisfactory ventilation had been understood at an earlier date than that indicated in the paper, but he thought that enquiry would show that the facts were as stated.

The Carbon Error in the Quantitative Deposition of Nickel and Iron from Complex Oxalate Electrolytes.

BY P. K. FRÖLICH.

(*Read at the Meeting, March 4, 1925.*)

Nickel and iron, when deposited electrolytically from the complex oxalate electrolytes used in the quantitative determination of these metals, appear to be contaminated with organic matter, causing a yield greater than the theoretical.^{1,2,3,4,5} As the various investigators come to different conclusions regarding the cause and magnitude of the error thus introduced* (the so-called "carbon error"), it was thought advisable to undertake a systematic study of the problem.

I. DEPOSITION OF NICKEL.

Most experimenters agree that the organic contamination of nickel deposited from an oxalate electrolyte is too great for quantitative determination of the metal.^{2,6} Hence, in the separation of nickel from aluminium nickel and chromium, where an oxalate electrolyte is used, the analysis becomes complicated because it is necessary to re-dissolve and re-precipitate the nickel from a complex ammoniacal electrolyte in order to free the metal from the organic matter.⁶ To see if it might be possible to reduce the carbon error so as to warrant the direct determination of nickel from an oxalate electrolyte, the effect of different variables was studied. The temperature, anodic current density, cathodic current density, and length of time of electrolysis were varied. The results of these experiments are given in Table I.

EXPERIMENTAL.—Nickel sulphate of the highest purity was dissolved in distilled water to give a concentration of about 10 grms. of metal per litre of solution. Samples of 25 c.c. were pipetted out and made up to a volume of 250 c.c. with 10 grms. ammonium oxalate. The cathode consisted of platinum foil, 0.35 sq. dm.

* The literature on the subject is reviewed by the writer in a paper presented at the American Electrochemical Society's Detroit Meeting, October, 1924. (T.A.E.S., 46, 181, 1924).

in area. Platinum wire or foil was used as anode. The electrolyte was tested for exhaustion with dimethyl glyoxime. Unless otherwise stated, the deposition was quantitative. The excess weight of the deposit, given in the last column of the table, is calculated as per cent. of the actual metal content of the precipitated matter, which was determined by electro-deposition of the metal from a complex

TABLE I.

ELECTRO DEPOSITION OF NICKEL FROM COMPLEX OXALATE ELECTROLYTES.

Containing 0.2463 gm. Metal.

No.	Addition.	Cathodic C.D. amps./ sq.dm.	Anodic C.D. amps./ sq.dm.	Temp. °C.	Time Hours.	De- posited Grms.	Per cent. Excess Weight.	Notes.
35a		2.0	25	25	13	0.2485	0.90	Deposition not quantitative
35b		2.0	25	25	13	0.2490	1.10	
45		1.0	25	25	18	0.2498	1.42	
50		1.0	25	25	23½	0.2505	1.71	
57a		1.0	2.8	25	17	0.2489	1.06	
57b	10 c.c. 3% H ₂ O ₂	1.0	2.8	25	17	0.2503	1.62	
80	10 gm. NH ₄ Cl	1.0	2.8	25	21	0.2535	2.92	
36b		1.0	2.8	85-87	7	0.2478	0.61	
43b		1.0	2.8	85-87	7	0.2485	0.90	
54		1.0	2.8	85-87	8	0.2515	2.11	
36a		3.0	8.0	85-87	4	0.2521	2.35	
43a		3.0	48-50	85-87	4	0.2512	2.00	

ammoniacal electrolyte (standard method), the following being the result of three analyses:—0.2463 gm.; 0.2464; 0.2462. Av. 0.2463 gm. of nickel.

In order to avoid a lengthy discussion of details, it may be sufficient to refer to the table from which the wide variations in experimental conditions will be apparent. In no case is the excess weight of the deposit appreciably below one per cent., averaging about one and a half to two per cent. Although the length of time needed for quantitative deposition might be somewhat reduced by using ordinary analytical wire-gauze electrodes, instead of platinum foils, this would not, according to the writer's experience, change the degree of contamination to any considerable extent. Hence, the results show that under the conditions studied, it is not possible to bring the carbon error within the limits of the permissible analytical error.

Special mention may be made of the experiment (No. 57b), where hydrogen peroxide was added, in view of the beneficial results obtained by Madsen when applying this addition agent to commercial electrolytes.⁷ While in the latter case the peroxide is said to check the reactions leading to organic contamination of the deposit, it was found here that this agent worked in the opposite direction, *i.e.* an increase in excess weight of the deposit was observed as compared with a parallel blank run (No. 57a).

A diaphragm (porous cup) surrounding the anode did not prevent contamination of the deposit, as stated by Lambris.⁸ Furthermore, quantitative deposition was not obtained in this case as the nickel was precipitated as carbonate in the anode compartment.

The highest percentage of organic matter in the cathodic deposit was observed in the experiment (No. 80) where ammonium chloride had been added to the electrolyte. This result is interesting in comparison with the depressing effect exerted by ammonium chloride on the reactions leading to contamination of iron deposits (see the following section).

II. DEPOSITION OF IRON.

The method of electro-deposition from a complex oxalate electrolyte is far more important in the analysis of iron than it is in the case of nickel, because this is the only method known of quantitative determination of iron by electro-deposition while nickel may be deposited in an absolutely pure condition from a complex ammoniacal electrolyte. Fortunately the carbon error in the deposition of iron is less serious than in nickel deposition, though much controversy has arisen as to the real magnitude of the error introduced in the electro-analysis of this metal. No definite data on the subject are available in the literature. In view of an observation by Verver,⁵ however, most textbook authors recommend that the electrolysis be discontinued as soon as quantitative deposition has taken place, as prolonged electrolysis causes an increased accumulation of organic matter in the cathodically deposited iron.

EXPERIMENTAL.—Table II. gives the results of a series of experiments made under varying conditions, the details of experimental procedure being the same as before, except that 8 grms. of ammonium oxalate (instead of 10 grms) were added to each sample of the ferrous sulphate solution. The temperature was kept constant at 25° C. The true iron content of the stock solution used was 0.1947 grms. per 25 c.c. as determined by titration with permanganate. The character of the residue left upon dissolution of the iron in cuprammonium and ferric sulphate solutions is described in the last column of the table.

The results may be summarised as follows:

- (1) The degree of organic contamination
 - (a) Is constant in parallel runs (Nos. 77 and 81).
 - (b) Increases with the time of deposition (Nos. 79, 77, 81, 67).
 - (c) Increases with increasing anodic current density (Nos. 75 and 77).
 - (d) Increases with an addition of sodium chloride (Nos. 75 and 73, 69 and 70).
 - (e) Decreases with an addition of ammonium chloride (No. 84 to be compared with No. 69, and Nos. 74, 76 and 81 to be compared with No. 75).

(2) Iron deposited from an ordinary oxalate electrolyte is always more or less contaminated with organic matter, while the presence of 5 grms. ammonium chloride, at a current density of 1.0 amp./sq. dm. will prevent contamination even when the electrolysis is continued for 24 hours.

TABLE II.

ELECTRO DEPOSITION OF IRON FROM COMPLEX OXALATE ELECTROLYTES.

Containing 0.1947 gm. iron.

No.	Addition.	Cathodic C.D. amps./ sq.dm.	Anodic C.D. amps./ sq.dm.	Time Hours.	De- posited Grms.	Character of Residue.
67		1.0	12.5	33	0.1960	A greyish black residue left.
69		2.0	2.0	18	0.1952	As in No. 67
70	5 grms. NaCl	2.0	2.0	18	0.1956	A small residue detected by means of the microscope
73	5 grms. NaCl	1.0	1.0	24	0.1953	Negligible amount of organic matter
74	5 grms. NH ₄ Cl	1.0	1.0	24	0.1948	Visible under the microscope
75		1.0	1.0	25	0.1951	As in No. 67
76	10 grms. NH ₄ Cl	1.0	1.0	25	0.1948	None
77		1.0	12.5	24	0.1958	Rich in organic matter
78	5 grms. NH ₄ Cl	1.0	1.0	24	0.1947	None
79		1.0	12.5	12	0.1953	Smaller than in No. 77
81		1.0	12.5	24	0.1958	As in No. 77
82	5 grms. NH ₄ Cl	2.0	2.0	12	0.1948	Negligible residue
84	5 grms. NH ₄ Cl	2.0	2.0	24	0.1950	Small amount organic matter

In Table III. are given the results of a series of depositions made with extreme care and under strictly analytical conditions:—*Volume of electrolyte*: 180 c.c.; *Ammonium oxalate*: 8 grms.; *Electrodes*: Platinum wire-gauze, standard of analytical work; *Current*: 1.0 amp. (equivalent to 1.0 amp./sq. dm. cathodic C.D.); *Temperature*: 25° to 28° C.

TABLE III.

ELECTRO DEPOSITION OF IRON FROM COMPLEX OXALATE ELECTROLYTES.

Containing 0.2283 ± 0.0001 gm. Iron.

No.	Addition.	Time Hours.	Deposited Grms.	Excess Weight Grms.
87		12	0.2288	0.0005
88		12	0.2286	0.0003
89		12	0.2288	0.0005
90	10 grms. NH ₄ Cl	12	0.2284	0.0001
95		11	0.2288	0.0005
96	5 grms. NH ₄ Cl	11	0.2283	None
91		20	0.2291	0.0008
94		20	0.2296	0.0013
92	10 grms. NH ₄ Cl	20	0.2283	None
85		24	0.2293	0.0010
98		6	0.2280	Deposition not quantitative
97	5 grms. NH ₄ Cl	6	0.2279	" "

NOTE.—Organic matter was left upon dissolution of all the deposits except those formed in the presence of ammonium chloride.

The possible error introduced in pipetting out the samples from the stock solution was reduced to less than 0.0001 grm. calculated on the iron content. The true iron content was determined by titration with a permanganate solution which had been standardized on the purest sodium oxalate, prepared by the Bureau of Standards. The analyses, performed according to the directions given by F. P. Treadwell for the most accurate work of this kind,² gave the following results:—

Twenty-five c.c. of Ferrous Sulphate stock solution consumed: (I.) 41.70 c.c.,
(II.) 41.75 c.c. permanganate.

The blank titration required: 0.075 c.c. permanganate.*

Normality of permanganate solution: 0.9818 N.

Twenty-five c.c. of the stock solution contains: 0.2283 ± 0.0001 grm. iron.

These experiments confirm the previous conclusion that contamination of the deposited iron always occurs except when ammonium chloride is dissolved in the electrolyte.

The idea leading to the application of ammonium chloride as an addition agent to the oxalate electrolyte originated from an experimental study by the writer of the significance of colloidal reactions in the processes responsible for the contamination of iron and nickel deposits.¹⁰ In these experiments, where ammonium oxalate or some other organic material was added to a relatively concentrated solution of an inorganic iron salt, it was found that contamination did not take place so readily when ferrous chloride was substituted for ferrous ammonium sulphate in preparing the electrolyte. That the presence of chlorine ions alone is not responsible for the effect, however, is shown by the fact that an addition of sodium chloride to the oxalate electrolyte tends to increase the quantity of organic matter introduced into the deposit (Table II.). The effect of ammonium chloride is probably one of retardation rather than of prevention, since the experiments (Table II.) show that contamination may take place also in the presence of this agent.†

Preliminary experiments seemed to indicate that the use of ferrous chloride in preparing the electrolyte would be preferable to the sulphate. However, this was not further studied, as the iron generally will be present as, or converted into, its sulphate in the course of an analysis.

* The use of zinc as a reducing agent will explain this relatively high figure.

† The effect of ammonium chloride on the reactions leading to contamination of the metal cannot be fully explained until the exact nature of these reactions has been disclosed.

In the paper already referred to, the writer has advocated the idea of Lambris that the deposited metal (e.g. iron or nickel) acts as a catalyst of reactions involving decomposition of gaseous products formed by cathodic reduction. The presence of ammonium chloride counteracts the tendency of the ordinary oxalate electrolyte to increase in alkalinity as the electrolysis proceeds, and that the alkalinity is an important factor seems to be proved by the fact that the contamination of iron deposits does not take place until the latter stage of the electrolysis. Thus it may be that the effect of the ammonium chloride is one of preventing the formation of certain organic gas products which are formed by electrolytic reduction in the plain oxalate electrolyte and which are responsible for the contamination of the deposit. Recent experiments by Sontag¹¹ support this view.

Evidently we are here facing electrochemical phenomena which deserve further investigation.

The time factor is of great importance. The point where quantitative deposition has taken place is rather difficult to ascertain on account of the sensitiveness of the reaction for iron (potassium thiocyanate). It is true that, unlike nickel, iron is not contaminated at the beginning of the electrolysis. However, the writer has never been able to discontinue the electrolysis at a point where complete deposition of absolutely pure iron has taken place (as suggested by Verver, *loc. cit.*). The last traces of iron are deposited with great difficulty and only over a relatively long period of time. Table III. shows that 6 hours do not suffice for quantitative deposition, about 8 hours being the minimum, while 10 to 12 hours seem to be preferable. The application of elevated temperature (*e.g.* 50° C.) reduces the time somewhat. However, the writer has always found that as the temperature rises there is a tendency for iron to be deposited as a brownish film on the upper part of the wall and cover of the beaker. As this substance is insoluble in the electrolyte, a loss in iron results. Consequently, deposition at room temperature is to be preferred.

CONCLUSIONS.

The results of the preceding experiments may be summarised thus:

(1) Though the different variables governing the process of electro-deposition of nickel have been varied within wide limits, it has not been possible to prevent contamination of the precipitated metal with organic matter.

(2) Unlike nickel, iron is not contaminated at the beginning of the deposition. Before the iron is completely removed from the electrolyte, however, organic matter starts to build up in the cathodic deposit.

(3) Ammonium chloride present in the electrolyte will prevent contamination of the deposited iron for a period more than sufficient for quantitative precipitation.

(4) The following method is recommended for the electrolytic determination of iron: 8 grms. of ammonium oxalate and 5 grms. of ammonium chloride are added to the electrolyte, which should contain about 0.25 grm. of iron as sulphate. The resulting solution is diluted to 150–200 c.c. with distilled water.

The electrolysis should be continued for about 12 hours (overnight) with a current of 1 ampere, using standard platinum wire-gauze electrodes.

In order to avoid oxidation the deposit should be washed with alcohol and ether before drying in oven at about 80 to 100° C. Blank experiments proved that no organic contamination was caused by the alcohol or ether.

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DISCUSSION.

Dr. B. S. EVANS said that in the current density seemed rather high to use with an unstirred solution. He asked what happened to the platinum anode, as in the presence of so much ammonium chloride one would rather expect it to be attacked. He was a little doubtful about the explanation offered of the action of the ammonium chloride, *i.e.* that it reduced alkalinity, as in this case one would have expected it to be as effective for nickel as for iron. He thought it significant that the metal which gave trouble in the matter of carbon contamination was the one which above all was noted for absorbing gases, and suggested that the carbonaceous matter was due to decomposition of gas (*e.g.* acetylene) which had been dissolved in the deposited nickel; the experiments carried out for the paper quoted (Frölich, *T.A.E.S.*, 46, 1924) lent countenance to this view.

Lemon Cheese.

By G. D. ELSDON, B.Sc., F.I.C.

(*Read at the Meeting, April 1, 1925.*)

It will probably be generally admitted that lemon cheese consisted originally of sugar, butter, eggs and lemons. The evidence to prove this is as nearly unanimous as such evidence can be. I have made extensive enquiry into the matter, and have come to this conclusion on the following grounds:—

1. Cookery books, although differing somewhat as to the proportions, are unanimous on the point that the constituents should be sugar, butter, eggs and lemons.

2. Many private and professional cooks of ability and experience have all, without exception, given it as their opinion that the bulk of the material should consist of these four ingredients, although one or two have suggested that a small amount of starch, in place of an equivalent quantity of sugar, is desirable in order to prevent "running" when the material is cooked. It should be added, however, that the old method is to put the lemon cheese in the pastry after it is cooked.

3. *The Opinions of the Manufacturers.*—Those manufacturers whom I have interviewed have unanimously agreed that lemon cheese consisted originally of the four substances already mentioned. One manufacturer in Salford has stated that he has given up the manufacture of lemon cheese as he could not compete with other firms whilst continuing to sell a genuine article, and that he refused to sell any other. The same experience has been related by a well-known manufacturer, and also by another firm in the North of England.

4. Retail shopkeepers in the Borough have been questioned as to their ideas on the subject, and the general opinion expressed by them is well summed up in the words of one of them who stated that she could only sell lemon cheese when it was labelled "Home Made." She further stated that she previously made a "Home Made" lemon cheese herself, for sale, which consisted only of the above four ingredients, and that she sold hundreds of pounds of it. She said that she considered that the product that she was then selling (labelled "Home Made," in spite of the fact that she buys it) was a genuine lemon cheese made as she used to make it, although of course, it was not.

There is, of course, at present no definite standard for lemon cheese, but it is in this respect in no different position from most other foods, as in practically all cases the magistrate before whom a case is heard has to fix his own standard on the evidence submitted to him. The trade in lemon cheese is now on a national scale, and has increased enormously in recent years; it is no longer a luxury, being used in large quantities as a substitute for jam; the trade is sufficiently extensive to require a keen supervision and also to provide an adequate defence in case of legal proceedings being taken.

5. The composition of the best commercial articles. One of these is labelled "This lemon cheese GUARANTEED to be made of Choicest Butter, Fresh Lemons, Fresh Eggs, and Pure Sugar only." This is most certainly suggestive as to the opinion of these makers of what lemon cheese should be. The same idea is indicated by labels on other products. Many samples which are by no means satisfactory are labelled in such a way that the purchaser is liable to be misled into thinking that eggs and butter are the principal ingredients. The fact that only quite small proportions of these substances are present does not affect the argument, as the purport of the labels and advertisements would appear to be a suggestion to the public that the articles are better than they really are.

From a careful consideration of various recipes which have been suggested, it would appear that the article domestically known as lemon cheese has a composition somewhat as follows:—

Sugar	55
Butter	14
Eggs	24
Lemon Juice and rind ..	7
	—
	100
	—

I have been able to see the original recipe of a high class manufacturer which, when worked out to percentages, gives the following composition:—

Sugar	54
Butter	11
Eggs	25
Lemon Juice and rind ..	10
	—
	100
	—

a composition which is quite near that suggested above and which was worked out quite independently.

There is good reason to believe that the lemon cheese originally manufactured on the commercial scale was substantially of this quality, but after such a substance had been in course of manufacture for some time and had been made a commercial success many competitors came into being, but, seeing that they made an inferior article, were able to sell at a lower price, thus being able to undercut the original manufacturers. These latter, in order to keep their trade, were forced to reduce the quality of their article. This process of cheapening, so commenced, has gone on and on during the last thirty years, until, at the present time, there are on the market doubtful concoctions containing no eggs, no butter, and little, if any, other fat, and having 30 to 50 per cent. of added water, the presence of which is masked by the addition of "British gum," and possibly gum tragacanth.

As proof of some of these points the following two recipes may be cited:—

Sugar	152 lbs.	160 lbs.
Tartaric acid	1 $\frac{3}{4}$ "	2 "
Glucose	20 "	140 "
Starches	36 "	—
Margarine	27 "	36 "
*Gum tragacanth solution	7 $\frac{1}{2}$ gallons	—
Water	12 "	160 "
Flavouring, etc.	1 lb.	1 "
Starch gum	—	30 "
Eggs	—	9 "
Product	=about 460 lbs., <i>i.e.</i> about 45 per cent. added water.	=539 lbs. (less evaporation in each case).

It is quite obvious that such products as these have little in common with the article known to the housewife as lemon cheese. Even if it be admitted that there is no rigid standard for lemon cheese, there must, of necessity, come a time when a product of any nature can no longer claim that title—the question to be decided is in regard to the point when this time arrives.

It is contended by some manufacturers that if such substances are sold at a fair price there is no objection to their being called "Lemon Cheese." This cannot be upheld, firstly because, if correct, the identical argument would hold in the case of margarine and butter and, secondly, because if such a principle is once admitted, there can be no guarantee that identical substances will not be sold at varying prices (*i.e.*, that the inferior article will not be sold at the fair price for the better), as, in many cases, different traders frequently disagree in price for the same article. One of the main points about the Food and Drugs Acts is that description and not price covers the sale; competition is allowed for by the possibility of selling the same article at different prices and not by the selling of different articles at the same price. The general public do not always consider that a lower price means an inferior article (and neither, in fact, does it); they put such variations in price down to keen competition, believing that traders will not be allowed to sell widely varying products under the same description.

* Prepared by soaking 1 lb. of gum tragacanth in about 3 $\frac{1}{2}$ gallons of water.

DISCUSSION.

Mr. RENDLE said that the cookery books were far from unanimous in their recipes for lemon cheese. He quoted pronounced variations from those given, and mentioned many proposed ingredients not referred to by the author, such as potatoes, cake crumbs, and almonds. He could produce cakes, made from the author's recipe, on the surface of which sugar had crystallised out. He gave widely divergent dictionary definitions of the terms "lemon cheese," "lemon curd," "cheese cakes," etc.

Mr. BLACK said that the "added water" in the manufacturer's recipe would evaporate on cooking until only the percentage in the author's recipe remained. No ingredient in lemon curd was absolutely required by an existing standard, not even eggs. If glucose, margarine and essential oils had been in use they would have appeared in the old cookery books. Modification should be permissible, provided wholesome ingredients were substituted, to place a cheaper article on the market. Manufacturers would not support fraudulent, misleading labels.

Mr. BOSELEY, referring to the recipes quoted, stated that with only 38 per cent. of sugars the sample would not keep. He asked if preservatives were employed, and, if so, which.

Mr. HINKS said that the last-named manufacturer's recipe was admittedly undesirable. Deterioration in quality could not be prevented without standardisation.

Mr. SALAMON said that a limit should be set to the ingenuity of manufacturers to make water "stand up." The public demand for a particular article need not preclude the exposition of a limit on valueless ingredients.

Mr. HAWKINS stated that the article sold should be what the purchaser thought he was buying, even though comparatively worthless. The presence of salicylic acid in lemon curd indicated bad keeping properties. As long as wholesome ingredients were introduced there need not be too great rigidity in fixing a standard.

Mr. BURFORD submitted that so long as the buyer received a non-injurious article it was a matter for the public rather than the chemist.

Mr. PARTRIDGE said the use of tartaric acid as a cheap substitute for citric acid was indefensible.

Mr. BOLTON traced the natural development of lemon cheese recipes. The danger of standardising food products, he said, was that they would tend to descend to the standard, as in the case of butter. A standard was only necessary when the public was defrauded.

The PRESIDENT thought the question could not be disposed of in a short discussion. The choice of lemon cheese as a typical food product was unfortunate. No distinction was made in the recipe between lemon juice and rind. As long as an article was non-injurious and the public was not defrauded there was no need for a standard. He referred to the analogous case of furniture polish, where beeswax and turpentine had given place to paraffin wax and turpentine substitutes without any loss in effectiveness.

Mr. ELSDON, replying, said that his recipes had been taken from modern cookery books published before, during and since the war. The article supplied to a customer should conform to his demand and with his expectations. Public analysts were presumably appointed with the idea of protecting the public from fraud as well as from injury to health. They should not be merely laboratory workers, but should be at the same time executive and administrative officers, this apparently being the considered opinion of the Society. The preservatives

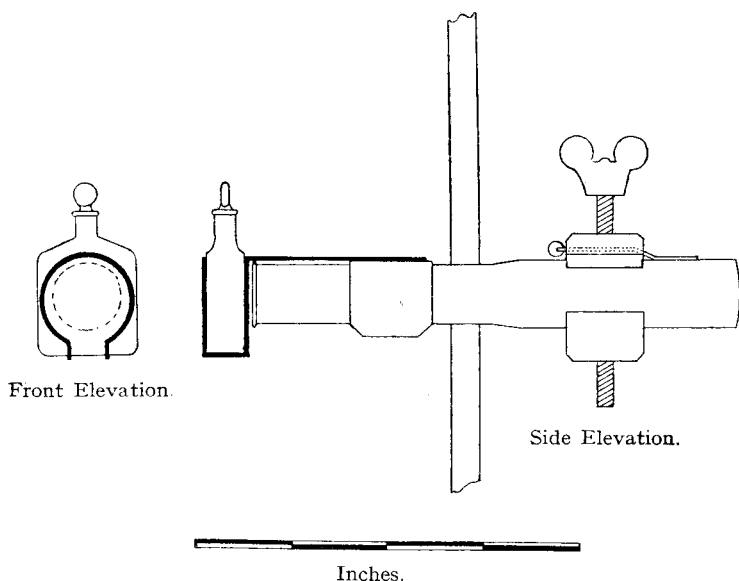
used in the manufacturers' recipes were boric acid and salicylic acid. The moisture content was less evaporation. Synthetic articles ought not to be sold as genuine articles. There was nothing to prevent the manufacturers raising the price of an inferior article. For years he had found very few butters containing excess of moisture. The distinction between lemon juice and rind was not important, as they were used as flavours. He disagreed with the President's views on furniture polish, as obviously if beeswax and turpentine were asked for, beeswax and turpentine should be supplied, whereas if furniture polish were asked for there was, so far as he knew, no generally accepted standard for this substance.

A Simple and Self-Contained Spectroscope Lighting Unit.

BY ROBERT C. FREDERICK AND E. R. WEBSTER.

(Shown at the Meeting, March 4, 1925.)

THE apparatus here described is designed for the spectroscopic examination of blood, with particular reference to investigations in suspected cases of carbon monoxide poisoning. In such tests it is essential that the absorption spectrum



of the sample, especially during the treatment with the reducing agent, should be made under continuous and simultaneous control by comparison with that of a normal blood under exactly similar conditions. The spectroscope must therefore

be one with a comparison spectrum, and this, again, calls for duplicate illumination. For this purpose only electric light can be considered satisfactory, but even when available from a main supply its employment presents considerable difficulty. In many instruments the light enters at two orifices, situated immediately at right-angles to each other and neither is more than a centimetre in diameter. The light from two ordinary lamps cannot readily be applied within such a small compass and, moreover, the glare in the observers' eyes interferes with his vision. The blood specimens must be contained in stoppered cells, and in the close proximity of lamps the expansion caused by the heat either blows out the stoppers or, as more frequently happens, fractures the cells.

These drawbacks are avoided by the use of the apparatus shown in the diagram, which is simple, self-contained, efficient, and inexpensive. The light is derived from a small pocket torch with dry battery. The torch is of a type which can be described as simulating the external appearance of a fountain pen of exaggerated diameter; the pocket clip is also the switch. With the clamp covering the clip the torch is firmly secured on a retort stand. The light is switched on and off simply by a fraction of a turn of the clamp screw actuating the switch; this does not alter the rigid hold on the torch. A frame to hold the cell in front of the light is made by bending a piece of brass wire of low flexibility into the shape shown in the smaller sketch; the two free ends are then bent back at right angles a distance slightly less than the thickness of the cell, and then upwards again to give a circular shape such as that made at the commencement. From here the two free ends are again bent back at right angles and taken in contact with each other a distance of about 2 inches. A spring clip is made by bending a piece of tin into the outline of the torch, and on to it the wire frame is soldered. With the frame clipped on to the torch, and the cell held in the wire spring, the apparatus is complete as shown in the larger sketch. One such apparatus provides the direct spectrum, and another, which can be clamped at any necessary angle, the comparison spectrum.

DISCUSSION.

Mr. W. PARTRIDGE mentioned the advisability of choosing a non-smoker as a subject for the spectroscopic test, as carbon monoxide was always present in the blood of a smoker.

Notes.

The Editor wishes to point out that the pages of the Journal are open for the inclusion of short notes dealing with analytical practice and kindred matters. Such notes are submitted to the Publication Committee in the usual manner.

DETERMINATION OF FAT IN CONDENSED MILK.

THE process described by Sutton (ANALYST, 1925, 17) for the determination of fat in condensed milk involves filtration and a cumbersome treatment of filter-paper. In 1907 I published (*Report of the Government Analyst, Transvaal*) a description of a method which avoids these inconveniences, and in which copper-protein, carrying the fat with it, is precipitated as in the process described by Sutton.

For the process 40 grms. of condensed milk (sweetened) are made up with water to 100 ml. Twenty ml. of the mixture are placed in a Leffmann and Beam bottle, and to it are added 5 ml. of Fehling's copper sulphate solution. The mixture is well shaken and centrifuged. The clear solution is separated from the precipitate (which contains all the fat) by means of a narrow-stem pipette. The precipitate is shaken with water, again centrifuged, and the clear liquid is removed. The washing of the precipitate is carried out twice. About 3 ml. of amyl alcohol are run on to the precipitate, and about 10 ml. of water are added. The mixture is then dealt with on the principle of the Gerber process. So much 90 per cent. sulphuric acid is added as will bring the fat layer into the graduated neck of the bottle. The mixture is warmed and centrifugalised: the fat reading is made at about 65° C. When the Leffmann and Beam bottle according to Richmond's specification is used each division (of which there are 80) corresponds with 0.206 per cent. of fat in the condensed milk (the specific gravity of the fat at 65° C. being taken as 0.895).

If it is desired to carry out the determination after the Röse and Gottlieb process, the precipitation, centrifuging and washing may conveniently be carried out in a Stokes, Gottlieb or similar tube, and the precipitate dealt with as described by Sutton (*loc. cit.*).

J. McCRAE.

GOVERNMENT CHEMICAL LABORATORIES,
JOHANNESBURG.

THE SAFEGUARDING OF SEALS.

THE method of sealing samples put forward by Evans (ANALYST, 1925, 130) appears, at first sight, to be simplicity itself, but when carefully examined, it shows defects, which would in all probability have results much more serious than those it is supposed to remedy. The two persons most seriously affected by the method are the inspector and the "referee" analyst. Dealing first with the inspector (presuming that all inspectors are infallible), the method is excellent from his point of view; unfortunately inspectors are not infallible. Firstly he has to carry about with him twelve different bottles of ink and twelve different pens, and he has to remember which pen belongs to each ink, otherwise he will inevitably get some of the wrong secret substance into the other inks; secondly, if he has to mark all three portions of the sample with the same ink, he has twelve different ways of doing it, and he must enter in his book the exact ink used for each sample; if he has to mark each portion of the sample with a different ink,

there are something approaching 400 million different ways of doing it, and the possibility of error is enormous in either case.

The provision that the "referee" analyst is to receive the "key" substance privately is also a serious matter. As one who has a considerable number of such samples, taken in many districts, to analyse during the year, I am afraid that this provision is quite unworkable; in many cases the third portion of the sample is not received by the "referee" analyst until a day or two before the summons is to be heard, and it would usually be quite impossible for him to write either to the analyst or to the inspector of the Local Authority concerned and receive an answer and test the seal before the summons is heard. The system of sealing which has been used for many years in the County Borough of Wallasey appears to be very much simpler and less open to the possibility of error than that put forward. In this case the inspector is provided with several seals, each of which bears a secret mark on its face, this mark is not obvious on the seal to a casual examination, but when the seal is carefully examined, as all seals should be, by the "referee" analyst, it is obvious to him, and he is therefore in a position to state definitely that the seal of the sample, examined by him, has not been tampered with and is the same as the seal on the sample, examined by the official analyst; as the inspector takes out with him only one seal, the possibility of error on his part is nil.

This system has stood the test of time, and the possibility of forgery is also reduced to a minimum, as a possible forger would have to have the whole range of seals, as he could never be sure that any particular seal was going to be used; the cost of providing the whole range of seals would be so high that the forger would not be repaid for his trouble.

T. R. HODGSON.

Notes from the Reports of Public Analysts.

The Editor would be glad to receive the Annual or other Reports of Public Analysts containing matter of interest to the Society. Notes made from such Reports would be submitted to the Publication Committee.

HAMMERSMITH BOROUGH COUNCIL.

ANNUAL REPORT OF THE PUBLIC ANALYST FOR 1924.

OF the 614 samples submitted during the year 1924, 600 were purchased under the Sale of Food and Drugs Acts, and 12 under the Public Health (Milk and Cream Regulations). Of the Food and Drugs samples 508 were reported as genuine, 34 as adulterated, and 58 were of inferior quality.

MILK.—During the year 438 samples were examined, of which 362 were reported as genuine, 58 as inferior, and 18 as adulterated.

MEAT AND FISH PREPARATIONS.—Six of the 20 samples examined contained boron preservative, the amount ranging from 1·8 to 16·1 grains per lb.

PRESERVED VEGETABLES.—Seven of 10 samples of peas contained copper salts in quantities ranging from 0·6 grain to 2·5 grains per lb., expressed as crystallised copper sulphate.

DRUGS.—Of the 18 drugs examined 2 did not comply with the B.P. requirements. Both of these were samples of borax, one of which contained 200 parts and the other 65 parts of arsenious oxide per million.

P. A. ELLIS RICHARDS.

Legal Notes.

Under this heading will be published notes on cases in which points of special legal or chemical interest arise. The Editor would be glad to receive particulars of such cases.

MINERAL MATTER IN CHOCOLATE EGGS.

AN application was made by the Liverpool Corporation to the Liverpool magistrates, on April 3, for the destruction of over 9000 chocolate Easter eggs, which had been found, on analysis, to be unfit for human consumption.

Mr. D. P. Oliver, for the Corporation, said that last July a Liverpool firm had ordered from a firm of cocoa manufacturers in Deptford 23 cwt. of "waste" chocolate in slabs. The greater portion of this had been made into Easter eggs, which had been supplied to various Liverpool retailers. One of these firms had informed an inspector of the Corporation that there was some doubt about some of the eggs, and samples were accordingly submitted to the City Analyst. The analysis showed that they contained 3.5 per cent. of silicious matter, mainly particles of quartz, a few minute fragments of glass, traces of lead, zinc, copper, and a considerable quantity of a woody material of the nature of sawdust. A sample of the original slab chocolate, of which about 3 cwt. remained, was found to contain 3.8 per cent. of silicious matter, mainly quartz, 1.4 grains of lead, and 0.8 grain of zinc per lb., with many minute fragments of metal, some of which were iron and some lead.

The whole of these chocolate eggs had been recalled by their manufacturers, and were in the possession of the Medical Officer.

None of the firms mentioned offered any evidence, and an order for the destruction of the eggs was made.

MISBRANDING OF EMMENAGOGUE PILLS.*

ON February 24, 1924, the United States Attorney for Texas, filed, in the District Court of the United States, a libel praying the seizure and condemnation of 97 boxes of emmenagogue pills which had been shipped from the State of Missouri into the State of Texas, and charging misbranding in violation of the U.S.A. Food and Drugs Acts.

Analyses by the Bureau of Chemistry, U.S. Dept. of Agriculture, of samples of the various articles contained in these packages had given the following results:

La Derma Vagiseptic discs contained salt, alum, starch, milk sugar and talc.

Bick's Nerve Tonic consisted of two products—brown tablets containing phosphorus and compounds of zinc and iron, coated with sugar and calcium carbonate, and yellow pellets containing compounds of iron, strychnine and phosphorus, coated with sugar and calcium carbonate.

Arthur's Sextone Tablets contained iron oxide, calcium carbonate, a compound of zinc, and extract of plant drugs, coated with sugar.

Arthur's Emmenagogue Pills, *Leslie's Emmenagogue Pills*, and *Thomas's Emmenagogue Pills* contained iron sulphate, aloes, and extract of plant drugs, coated with sugar and calcium carbonate, coloured pink.

* U.S. Dept. Agriculture, Service and Regulatory Announcements, Jan. 31, 1925. Supplement No. 12559.

Bick's Sextone Pills consisted of two products—chocolate-coloured pills containing a small amount of extract of plant drugs, 50 per cent. of sugar, 25 per cent. of calcium carbonate, 7 per cent. of iron oxide, and 7 per cent. of talc; and orange-coloured tablets containing 31 per cent. of metallic iron, 11 per cent. of calcium carbonate, extract of nuxvomica and sugar.

Bick's Daisy 99 consisted essentially of extracts of plant drugs, including cascara sagrada and buchu, sodium acetate, alcohol and water.

Bick's Sarsaparilla Compound contained less than 1 per cent. of sodium salicylate, 0·7 per cent. of potassium iodide, extracts of plant drugs, including sarsaparilla and a laxative drug, sugar, alcohol, and water.

Misbranding of the articles was alleged for the reason that the statements appearing in the labelling were false and fraudulent, in that the said products contained no ingredient or combination of ingredients capable of producing the said therapeutic effects.

No claimant having appeared for the property, judgment of condemnation and forfeiture was entered, and it was ordered by the Court that the products be destroyed by the United States Marshal.

Medical Research Council.

INVESTIGATION OF THE SALMONELLA GROUP, WITH SPECIAL REFERENCE TO FOOD POISONING.*

OUTBREAKS of food poisoning and food infection are almost invariably due to infection with a bacillus belonging to the Salmonella group. Practically all the strains investigated fell into one or other of the following types:—Enteritidis type (*B. enteritidis* Gaertner); Derby type; Schottmüller type (*B. paratyphosus* B.); Stanley type; Aertrycke or Mutton type (*B. aertrycke*, probably including the Binnes type strains of Schütze); Newport type; Reading type; Suipestifer or Hog Cholera type (including *B. suipestifer*, *B. paratyphosus* C., *B. Glässer*, and *B. Voldagsen*); Abortus Equi type (*B. abortivo equinus* or *abortus equi*); and *B. paratyphosus* A.

PART I. SEROLOGICAL STUDIES.—To establish the serological identity of two strains, A and B, it is essential to prove:

1. That A supplied in adequate doses is capable of entirely exhausting B serum of agglutinins for B;
2. That B supplied in adequate doses is capable of entirely exhausting A serum of agglutinins for A.

Such proof of identity is essentially qualitative and does not guarantee identical quantitative behaviour. The results of the absorption test are only conclusive when the qualities of the type strains and sera actually employed are known. For this reason the method of working from single colonies was largely used in this research, and the same bacillary agglutination and absorption emulsions were used through each series of experiments. (Details of the technique are given.)

It was observed that agglutination in the Salmonella group was liable to assume two distinct forms—luxuriant flocculation and a fine granulation similar to

* By W. G. Savage, M.D., and P. Bruce White, B.Sc., Pp. 149. Obtainable at Adastral House, Kingsway, W.C.2. Price 3s. 6d. net.

that seen in the case of *B. dysenteriae*. The typical Salmonella exhibits two series of antigenic elements: those which are unstable at a temperature much above 60° C. and completely destroyed after heating at 100° C. for 1 to 2 hours, and those which persist unaltered for several hours at 100° C. The former yield with their corresponding agglutinins flocculent agglutination; the latter granulate with the homologous agglutinins.

A description is given of the specific and non-specific phases of Salmonella strains and of the stability of these phases, together with an account of cross absorption experiments with these strains and the corresponding sera.

In experiments on the heat-stable Salmonella antigens in toxic canned food, it has been found that repeated injection of animals with saline extracts of the suspected foods will, in certain instances, stimulate the appearance of low-titre agglutinins for Salmonella bacilli. These are almost always purely granulating in action.

As in the case of *B. dysenteriae*, older laboratory cultivations of the Salmonella series may change from their original form of smooth colonies to a granular or "rough" form, and this change appears to be permanent and irreversible. The development of new granulating antigen, peculiar to roughness, tends to be associated with reduction in the quantity and quality of the original antigenic constituents, both flocculating and granulating.

The general conclusion drawn from the seriological work is that the absorption behaviour of the different types affords a practical basis of classification.

PART II. THE CLASSIFICATION AND DISTRIBUTION OF THE SALMONELLA GROUP.—Features common to the types mentioned above are:—They are short sporeless bacilli with rounded ends, possessing flagella and exhibiting motility; gram-negative and staining readily with ordinary dyes; bile tolerance. Culturally they grow as a semi-translucent growth upon agar; grow well in gelatin without liquifying it; grow in milk, with preliminary acid production and subsequent (often delayed) production of marked alkalinity, except in the case of Glässer and Voldagsen types. The milk is never clotted; indol is not produced; lactose, sucrose and salicin are not fermented. In considering inter-classification the most important characters are the biological and serological data, and whilst the serological tests, in particular, have shown that some types are much more nearly related than others, it is not yet possible to adopt an adequately expressive form of grouping. The following summary indicates the distribution and disease-producing rôle of the group:—

B. enteritidis produces in man—gastro-enteritis of food poisoning type; occasionally sporadic cases of illness; in animals, disease of cows, calves and of rats. *Derby type*: in man, food-poisoning; in animals (pigs), exact disease-producing role unknown. *B. paratyphosus* B: in man, paratyphoid fever, probably never food poisoning; in animals, not found. *B. aertrycke*: in man, food poisoning (possibly sporadic cases of illness); in animals, a widespread cause of enteritis in mice, guinea-pigs, and other rodents; occasionally found in pigs; a cause of enteritis in parrots and other birds, and calves; does not occur in rats. *Stanley type*: in man, food poisoning; in animals, not yet isolated. *Newport type*: in man, food poisoning and possibly sporadic cases of illness; in animals: dog suffering from enteritis, otherwise unknown. *B. abortus equi*: in man, not found; in animals, abortion of horses. *B. suispestifer*: in man, paratyphoid fever (C type) and very exceptionally food poisoning; in animals, secondary invader in pigs in hog cholera, and occasionally a cause of disease in pigs.

PART III. STUDIES UPON THE METHODS OF ACTION OF THE SALMONELLA GROUP.—Salmonella food poisoning is, in the majority of cases (probably about

three quarters) due to *B. aertrycke*. Next in importance as a causal agent is *B. enteritidis*, possibly causing particularly severe outbreaks, and very likely more prevalent in other countries. The *Newport* type is responsible for a certain number of outbreaks, and the *Stanley* and *Derby* types more rarely. The importance of *B. suispestifer* in this connection is insignificant, and *B. paratyphosus* B. and *B. abortus equi* may probably be altogether discounted. The attack falls mainly on the alimentary tract; general infection is rare, and when it does occur, usually fatal. These food poison bacilli have low invasive powers. In outbreaks apparently associated with dead bacilli (e.g. from toxic canned foods) members of the *Salmonella* group are almost certainly implicated. The sera of sufferers seldom show any appreciable development of agglutinins for *Salmonella* bacilli, and no pathogenic bacilli can be isolated from the food or fæces.

D. G. H.

The Presence of Expert Witnesses in Court.

It is customary for expert witnesses, either in civil or criminal cases, to be allowed to remain in court throughout the proceedings, although sometimes they are excluded, like ordinary witnesses. The assumption on which permission for an expert witness to remain is based is that his evidence, usually regarded as a matter of opinion, will not be affected by the evidence of facts given by the other witnesses. This applies more particularly to the chemist than to the medical man, who not infrequently is asked to express an opinion on evidence which he has only just heard.

Referring to this subject in a letter to the *Lancet* (March 28th, p. 685), Sir William Willcox points out that in toxicological cases it is essential for an expert witness to hear the medical evidence, since he may be asked whether the symptoms described are consistent with poisoning by a particular substance. In fact, opposing counsel have, on occasions, observed that they would object to the toxicological evidence if the witness had not heard all the evidence relating to the symptoms. The final decision whether or not any witness shall remain in Court rests with the Judge, but, if the point is raised, previous rulings are taken into consideration.

An outline of some of these rulings, summarised by a legal authority, is given in the letter, from which the following condensed particulars may be cited:

“There is no Statutory regulation on the subject, but it is the usual practice for witnesses who are called to give expert evidence and not to speak to facts to be allowed to remain, even although other witnesses are excluded. If a witness does remain, notwithstanding an order of exclusion, his evidence is not rendered inadmissible, but is the subject of comment.

“The question whether expert witnesses may be allowed to remain in court to hear the evidence is now decided by the kind of questions which may be put to the expert witness, and which assume that he has heard the evidence in the case. In the *MacNaghten* case (1843) (in which medical men conversant with insanity, who had never seen the prisoner previously, were asked to express an opinion as to his state of mind from the evidence) the Judges to whom the case was referred reported on this point as follows: ‘We think the medical man under the circumstances supposed cannot in strictness be asked his opinion in the terms stated, because each of those questions involves the determination of the truth of the facts deposed to which it is for the jury to decide, and the questions are not mere questions upon a matter of science, in which case such evidence is admissible,

but where the facts are admitted or not disputed, and the question becomes substantially one of science only, it may be convenient to allow the question to be put in that general form, although the same cannot be insisted on as a matter of right.'

"In the case of *Rex v. Wright* (1821) a medical witness was allowed to discuss the facts of the case, and to express an opinion that the prisoner's mind was disordered. This was quoted in the case of *Rex v. Searle* (1831), in which a medical witness who had heard all the evidence was allowed to express his opinion as to the sanity of the prisoner.

"In *Russell on Crimes* (8th Edn., p. 2142) there is a note to the effect that: 'It is now the ordinary course to permit not only attorneys, but also professional or scientific persons to remain in Court, the rule being considered as not applying to witnesses of these descriptions.'

"There may well be matters to which neither side attaches importance, which the expert, on hearing them, may deem of great importance. Consequently, I think that, always subject to the discretion of the Judge, but recollecting the established practice, a medical man or other expert should remain in Court, and the value of his assistance in a technical matter to the jury and Court would be much depreciated if he were excluded therefrom."

EDITOR.

ABSTRACTS OF PAPERS PUBLISHED IN OTHER JOURNALS.

Food and Drugs Analysis.

Separation of Egg-yolk into Fractions by Solvents. M. A. Rakusin and G. Pekarskaja. (*Zeitsch. Unters. Nahr. Genussm.*, 1925, 49, 39-41.)—A partial separation of the constituents of egg yolk may be effected by extraction with a series of solvents. The yolks are dried in an air oven at 60-70° C., then powdered and first extracted with petroleum spirit, which removes all the egg oil (sp. gr. at 19° C.=0.9403 [α]_D=0.0). This is followed by an alcohol extraction, which removes an optically inactive substance containing carbohydrates. The next treatment is with water, after removing the alcohol by warm air; this yields a non-carbohydrate nitrogenous substance giving the biuret reaction and containing tryptophane. The residue is then extracted with 1 per cent. acetic acid, and lastly with 1 per cent. sodium hydroxide solution; the former gives a non-sugar substance showing Adamkiewicz's reaction but not the other protein tests, and the latter extract gives reactions for sugars and the biuret, Millon's and the other protein reactions, except Ostromyslenski's test for amino-bodies. H.E.C.

Determination of Benzoic Acid in Egg-yolk. T. Grethe. (*Zeitsch. Unters. Nahr. Genussm.*, 1925, 49, 51-52.)—Ten grms. of the yolk are triturated in a small mortar with 4 c.c. of hydrochloric acid, then 30 grms. of calcined gypsum are ground in, and the mixture dried over sulphuric acid overnight. The dry

powder is extracted in a Soxhlet with ether for 2 hours, 2 grms. of dry sodium hydroxide being previously placed in the flask. The ether is distilled off, the residue, which must be alkaline in reaction, is dissolved in warm water, and from this the fat is removed by shaking out with ether in the ordinary way. The alkaline solution is now acidified, and the benzoic acid is extracted with ether, the ethereal solution being washed with water. The ether is distilled at a very low temperature, and the residue of benzoic acid is titrated with standard alkali.

H. E. C.

The Coagulation of Albumin. M. A. Rakusin and A. Rosenfeld. (*Zeitsch. Unters. Nahr. Genussm.*, 1925, 49, 38-39.)—By heating coagulated egg albumin with five times its weight of water at 101° C. under pressure for 72 hours a partial polymerisation takes place, yielding a solution containing about 1 per cent. of albumin which has an $[\alpha]_D = -39.65$. This substance gives all the well known protein reactions of albumin—biuret, xanthoprotein, Millon's, Liebermann's, Adamkiewicz's, Ostromyslenski's, Molisch's, and Pettenkofer's reactions—but it does not coagulate. Ordinary albumin begins to coagulate at 63°. H. E. C.

Detection of Benzoyl Peroxide in Flour and Dough and their Products and in so-called "Improvers." S. Rothenfusser. (*Chem. Zeit.*, 1925, 49, 285-287.)—The proportion of benzoyl peroxide permitted in flour in Germany, namely 0.005 per cent., is not detectable by the official method, according to which an alcoholic extract of such flour liberates iodine when treated with acidified potassium iodide and starch solution. The detection may be effected, however, by means of a reagent prepared by grinding 1 gm. of *p*-diamino-diphenylamine sulphate in a mortar with 96 per cent. alcohol, rinsing out into a flask, making up to about 100 c.c. with the alcohol, and heating under a reflux condenser for about 30 minutes on a water-bath. On cooling, the alcoholic solution deposits fine crystals, but these are not removed, the liquid being shaken before use. This reagent gives a greenish-blue coloration with benzoyl peroxide.

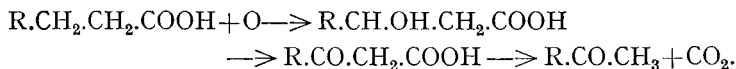
In the case of a flour, use is conveniently made of a cylinder about 11 cm. in height and 0.8 cm. bore and provided with three marks. The first of these indicates the space occupied by about 0.7 gm. of an average flour when the cylinder is gently tapped on a bench. Petroleum spirit is then added to the second mark, and the cylinder, closed with a cork or the thumb, shaken vigorously for a few seconds, and allowed to drain; more of the petroleum is added to bring the level again to the second mark, about 2.5 c.c. being added in all. After the contents have been gently mixed, from 1 to 1.5 c.c. of the shaken reagent is added (to the third mark) and mixed. If the flour contains 0.01 per cent. of benzoyl peroxide, the petroleum spirit and the alcohol layers are coloured greenish-blue immediately, whilst with smaller proportions the colour may appear only after the lapse of some minutes; with more of the peroxide, the flour itself becomes coloured, any granules of the peroxide being easily visible. If a doughy material is to be tested, a small portion is treated with a few c.c. of petroleum spirit until it crumbles, and 1 to 1.5 c.c. of the reagent then added.

T. H. P.

Preparation of Fehling's Solution for the Volumetric Determination of Reducing Sugars. J. H. Lane and L. Eynon. (*J. Soc. Chem. Ind.*, 1925, 44, 150-152T.)—Seven samples of copper sulphate showed variations in the proportion of contained copper from 98.4 to 99.7 per cent. of that required by the formula, and in the volumetric determination of reducing sugars this is sufficient to be of importance, introducing errors up to 0.7 per cent. of the sugar determined. Elimination of included water from copper sulphate crystals is a tedious operation, and it is preferable to test each stock of copper sulphate by preparing Fehling's solution from it, and titrating this against standard invert sugar solution. When a solution containing 0.5 gm. of invert sugar per 100 c.c., and 25 c.c. of Fehling's solution are used, and with the method previously described (*J. Soc. Chem. Ind.*, 1923, 42, 32T., and *ANALYST*, 1923, 48, 220) 24.8 c.c. of sugar solution should be required, corresponding to a factor of 1240 mgrms., and the adjustment of the copper solution may be made accordingly. D. G. H.

The Fatty Acid Constituents of some Natural Fats. II. Palm Kernel Oil. E. F. Armstrong, J. Allan and C. W. Moore. (*J. Soc. Chem. Ind.*, 1925, 44, 143-144T.)—Following the procedure detailed in Part I. (*J. Soc. Chem. Ind.*, 1925, 44, 63T., *ANALYST*, 1925, 191), the fatty acids prepared from the oil of West African palm kernels were examined and the ethyl esters found to have a saponification equivalent (mol. wt.) of 246.5, and iodine value 14.8. Nine fractions were finally obtained after distillation of the esters under reduced pressure. The "liquid" acids appeared to consist entirely of oleic and linolic acids, and, on esterification, yielded two fractions. The deduced percentage composition of the fatty acids from this palm kernel oil was:—Caprylic acid, 3; capric, 3; lauric, 52; myristic, 15; palmitic, 7.5; stearic (?), 2.5; oleic, 16; and linolic acid, 1. D. G. H.

The Rancidity of Fats. H. E. Fierz-David. (*Zeitsch. angew. Chem.*, 1925, 6; *J. Soc. Dyers and Col.*, 1925, 115.)—It has been found that ordinary mould fungi, such as *Penicillium glaucum* and *Aspergillus niger*, are capable of hydrolysing fats, the resulting fatty acids being further converted into the same ketones as are obtained by treating them, according to the method of Dakin (*Amer. Chem. J.*, 44, 41), with hydrogen peroxide and ammonia. The latter process is one of oxidation and takes effect according to the following scheme:—



Thus every fatty acid yielded a characteristic ketone identified by conversion into a semi-carbazone. The rancidity of fats is due, in the absence of bacteria, either to the action of air or to light and moisture, on the unsaturated fatty acids (including possibly also ricinoleic acid), which yield aldehydes and acids, but fats containing saturated fatty acids are oxidised in the presence of moulds to the methylalkyl ketones which are obtainable by Dakin's process. P. H. P.

Detection of Rancidity in Fats and Oils. T. von Fellenberg. (*Mitt. Lebensmittelunters. Hyg.*, 1924, **15**, 198-208; *J. Soc. Chem. Ind.*, 1925, **44**, B179.)—The reagent, which should be stored in the dark and not used for 24 hours after making up, consists of 5 grms. of magenta in 800 c.c. of water, 12 grms. of crystallised sodium sulphite, and 100 c.c. of 0.1 *N* hydrochloric acid, in 1 litre. One c.c. of oil or fat in 1 c.c. of petroleum spirit is shaken with 1 to 2 c.c. of the reagent for half a minute, and if, after 10 minutes, no more colour is present than in a solution of 10 to 20 mgrms. of acetaldehyde per litre, flavour and analytical data must be considered. Coloration of the aqueous layer indicates more advanced rancidity than that of the oily layer only. D. G. H.

Biochemical, Bacteriological, etc.

New Histological Reaction for Proteins. M. Romieu. (*Compt. Rend.*, 1925, **180**, 875-877.)—Although there are many reactions for proteins, there is none suitable for application to histological structures; the new reaction depends upon the red-violet colour produced by syrupy phosphoric acid at about 52° C. It is thought probable that the colour is really due to tryptophane. When applied to a section of tissue this reagent colours protoplasm or epithelium a delicate rose tint, similar to that of eosin. Collagen and gelatin are not coloured, but haemoglobin gives a dull brown. The fragments of tissue should be hardened in alcohol or embedded in collodion, then covered with a drop of syrupy phosphoric acid, and warmed in the paraffin stove for a few minutes. The tissue is thereby rendered transparent as by glycerin and can be examined as usual. The colour is permanent for some hours, then gradually turns brown. H. E. C.

Influence of Pasteurisation on the Digestibility of the Proteins and Mineral Constituents of Milk. E. F. Terroine and H. Spindler. (*Compt. Rend.*, 1925, **180**, 868-870.)—The digestibility of the proteins and mineral constituents of milk before and after pasteurising at different temperatures has been investigated by feeding experiments on young pigs. Milk in the raw state and after pasteurising at 63° C. for 25 minutes, or 95° C. for 1 to 2 minutes, or at 75° C. followed by prompt cooling showed the same condition of digestibility both for protein and ash. It is concluded that pasteurisation has no deleterious effect on milk from the point of view of absorption. H. E. C.

Reproductive Potency of Dry Milk as affected by Oxidation. G. C. Supplee and O. D. Dow. (*J. Biol. Chem.*, 1925, **63**, 103-114.)—The results are recorded by charts of a preliminary investigation wherein it is shown that oxidation changes which may take place under conditions prevailing in milk powder, stored in air over long periods, prevent reproduction. Milk powder containing 12 per cent. of fat, packed and kept in an atmosphere of air in hermetically sealed containers for nearly 2 years, does not permit reproduction in white rats when given in quantities varying from 11.7 to 35 per cent. of the ration, but the same powder

stored in deoxygenated air for the same period allowed normal reproduction and the rearing of young when given in quantities varying from 23·3 to 35 per cent. of the ration. Reproduction was possible on lower quantities, but rearing of the young was not successful. An atmosphere of carbon dioxide acted similarly to the atmosphere of air. It cannot be stated whether the negative results thus obtained were due to the carbon dioxide or to an oxygen impurity. Milk powder of the same brand, made under the same conditions at the same time of year as that for the storage experiments but held in an atmosphere of air for 7 months, allowed reproduction and successful rearing of the young when given as 41·7 per cent. of the ration. Reproduction on smaller quantities was possible, but rearing was not successful. Successful reproduction and rearing of the young resulted when the butter fat, as supplied by the Just process dry milk, comprised from 2·8 to 5 per cent. of the ration, providing the milk powder had not been subjected to excessive oxidation after manufacture.

P. H. P.

Mineral Deficiencies of Milk as shown by Growth and Fertility of White Rats. A. L. Daniels and M. K. Hutton. (*J. Biol. Chem.*, 1925, 63, 143-156.)—That rats fed exclusively on cow's milk seldom reproduce, and that only a very small percentage of the young born survive appears to be due to the fact that milk is low in certain inorganic substances necessary for the production of a new generation. Experiments carried out over a number of years are described, and tables and charts show the results. The addition of from 7 to 10 grms. of soya bean powder to 1 litre of milk was effective in correcting this deficiency. Even the ash of the soya bean was effective, and an analysis showed that the ash contained aluminium and silicon. The addition to milk of those unusual mineral substances present in milk in low concentration, *i.e.* manganese, fluorine and aluminium, together with sodium silicate, have resulted in the production of five generations of normal young. These four, used alone or in combinations of two and three, were less effective in correcting the nutritive deficiencies of milk than was the mixture of four salts. The addition of aluminium, manganese, fluorine and silicon to a purified ration made to simulate milk, in the same concentration in which they were used in milk, was without effect on the reproductive processes. It is suggested that failure may have been due to a lack of vitamin X in this mixture, or to too little of the added salts. The addition of iron salts and iodine to milk did not give good results.

P. H. P.

Colorimetric Determination of Tryptophane by the Vanillin and Hydrochloric Acid Reaction. Quantitative Separation from Indole and Skatole. I. Kraus. (*J. Biol. Chem.*, 1925, 63, 157-178.)—The vanillin reaction, specific for tryptophane, is more sensitive with tryptophane itself than any method previously cited. By it, tryptophane has been detected in zein and gelatin which have been considered tryptophane-free. Indole and skatole have been quantitatively separated from tryptophane by means of toluene. Homer's barium hydroxide treatment of tryptophane has been shown by the vanillin reaction to

introduce a loss of about 20 per cent.; by direct application of the phenol reagent without toluene extraction a loss of 7 per cent. is introduced. In the barium hydroxide hydrolysis of proteins different decomposition products appear than with tryptophane; the mercury precipitation of tryptophane carries these down. Tyrosine comes down, unless its concentration is low, when it is separated from tryptophane by Folin's method by mercury precipitation in sulphuric acid concentration above 3.5 per cent. Tryptophane, when incubated with the diamino acid fraction and U.S.P. pancreatin or glucosamine with hydrochloric acid and U.S.P. pancreatin, has not been recovered quantitatively. The other simple amino-acids do not prevent recovery of tryptophane. It has not been recovered quantitatively from proteins when hydrolysed by acids, barium hydroxide or U.S.P. pancreatin. Experimental details and results are given. P. H. P.

A Protein in the Edible Portion of Orange. A. H. Smith. (*J. Biol. Chem.*, 1925, 63, 71-73.)—Previous investigations do not give data concerning the nitrogenous constituents, especially the presence and character of protein, in orange juice. The author describes the search for protein in orange juice and some details of its characterisation. In the orange juice as separated from the fruit, containing the orange-red bottom layer, but not the fibrous shreds, there is, at most, 0.2 per cent. of protein, all of which is located in the highly pigmented material contained in the chromatophores of the pulp vesicles. Of the total nitrogen of this material, about 10 per cent. is extracted by strong alcohol and is presumably part of the pigment. Experiments described indicate that the protein found in the pulp of the orange is distinguished from any of the conventional classes of proteins by its unusual solubilities. It is insoluble in water, neutral salt solution, or weak acids, but is soluble in weak alkali. It is not precipitated from its solution by 95 per cent. alcohol, nor is it coagulable by heat at neutral, acid, or alkaline reactions. A polysaccharide, resembling pectin, accompanies the protein fraction throughout the course of the extraction. Since the precipitation-point of this protein is P_{H} 4.7 and the P_{H} of orange juice is 4.3, it follows that under ordinary conditions the protein is insoluble within the fruit. Although closely associated with the pigment, the protein is not apparently in chemical combination with it. P. H. P.

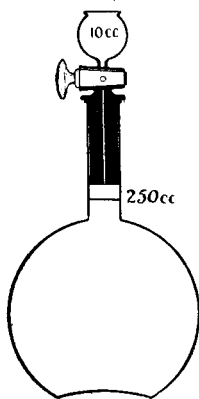
Toxicological, Forensic, etc.

Extraction of Alkaloids from Viscera. R. Fabre. (*Compt. Rend.*, 1925, 180, 966-967.)—The lengthy, though reliable, Stas-Otto extraction may be replaced by proteolysis by pancreatin. The finely divided viscera are pulped with five times their weight of water, boiled for a few minutes, then cooled to 50-55°, and about 2 per cent. of their weight of pancreatin is added and allowed to act at 50-55° for 10-12 hours. The mixture is then boiled, cooled and separated either by filtration or by centrifuging, and the alkaloid or other substance is extracted from the clear solution by shaking out with an immiscible solvent. It is, of course,

necessary to be certain that the substance sought for is not affected by pancreatic digestion; strychnine, narcotine, veronal, sulphonal, atropine, cocaine, and morphine are among the substances which can be extracted in this way. H. E. C.

Water Analysis.

Determination of Dissolved Oxygen. J. N. Friend. (*Chem. News*, 1925, 130, 163.)—The flask shown in the diagram has been devised to overcome certain difficulties in using Winkler's method.



The flask is filled to the mark with the water, and 1 c.c. of a solution containing 33 grms. of sodium hydroxide and 10 grms. of potassium iodide per 100 c.c. is added. About 2 c.c. of a manganous chloride solution (40 grms. per 100 c.c.) are now added, sufficient to raise the level of the liquid above the lower end of the stopper and to fill the capillary tube in the stopper when this is pushed home. After the reaction is over in the flask, about 5 c.c. of hydrochloric acid are put into the funnel, the tap opened, and the stopper gradually withdrawn to a sufficient extent to admit the acid without any air. The stopper may now be replaced by a rubber one, and the flask is then shaken and allowed to stand for five minutes, after which the solution is transferred to another

flask for the thiosulphate titration. By this means two difficulties are overcome:—(1) Closing the apparatus after introduction of the water and the reacting chemicals without including a bubble of air; (2) opening the apparatus and adding the acid necessary to stop further oxidation, without admitting air.

R. F. I.

Action of Water upon Copper Pipes. J. C. Thresh. (*Lancet*, 1925, 208, 675–677.)—Minute quantities of copper are widely distributed in food and in the human body, and the evidence leads to the conclusion that an amount of copper in water not exceeding 0.1 grain per gallon is not objectionable. The action of water on copper is similar to that on lead, but the solubility of copper oxide is much less than that of lead oxide; filtration removes nearly all the metal from water. The following table shows the action of certain waters on copper pipes determined by the author's well-known method for lead (*ANALYST*, 1921, 46, 270). The action of hot water is much greater than that of cold water, and the presence of an electric current greatly accelerates the cupro-solvent action. Almost all waters take up copper, but in too small amounts to endanger health.

	Copper parts per 100,000.		Copper parts per 100,000.
River water, moderate temporary hardness.		Moorland water (<i>continued</i>).	
London	0·04	Hardness 2·75° ..	0·15
Surrey	0·025	„ 1° ..	0·65
Hampshire	0·035	„ (very acid)	
An unfiltered river water ..	0·06	„ acid neutralised	
Deep well waters.		with chalk	0·01
Chalk	0·000	„ 2·3° ..	0·05
Limestone	0·05	„ 4° ..	0·00
New red sandstone ..	0·01	„ 0·5° ..	0·10
Alkaline water.		„ 4° ..	0·045
Thanet sand	0·04	„ 5° ..	0·06
Ditto	0·025	Spring waters.	
Greensand water.		Hardness 21° ..	0·05
Hardness 4°	0·01	„ 3° ..	0·075
Moorland water.		„ 15° ..	0·06
Hardness 4°	0·033 to 0·065	Very pure distilled water.	
„ 3°	0·01	Hardness 0° ..	0·14–0·20
„ 1°	0·057 to 0·075	+4 mgrm. MgCl ₂	
„ 1°	0·15	Hardness 4° ..	0·02
		+4 mgrm. NaCl	
		Hardness 0° ..	0·01

H. E. C.

Organic Analysis.

Determination of Carbon in Organic Substances. A. Desgrez and R. Vivario. (*Compt. Rend.*, 1925, 180, 886–890.)—The wet combustion process has been examined and found to be satisfactory for the determination of carbon in biological fluids, urine, blood plasma, etc. Potassium ferrocyanide and borax efficiently remove all volatile chlorine products, and the oxidation is complete in the presence of the short length of heated copper oxide. The apparatus comprises an aspirator, a 300 c.c. combustion flask fitted with a tap funnel and a reflux condenser from the top of which a tube passes to three U-tubes containing sulphuric acid and pumice, granules of potassium ferrocyanide, and small lumps of fused borax, respectively; then follows a short length of combustion tube containing copper oxide heated to redness, and lastly the usual drying and absorption tubes. The substance to be analysed is placed in the flask with 10 grms. of potassium dichromate, 10 c.c. of water are added, and then, slowly, 125 c.c. of sulphuric acid. The flask is kept gently heated until all evolution of gas ceases, a slow current of air (free from carbon dioxide) being aspirated through the apparatus throughout the experiment.

H. E. C.

New Azo-Reaction. F. M. Rowe. (*Chem. Trade J.*, 1925, 10, 391.)—If a solution of 4-nitrobenzene-2-naphthol-1-diazosulphonate in one molecular proportion of sodium hydroxide be acidified, Para Red can be obtained, but not when an excess of sodium hydroxide is used. In this case, an intense crimson

colour is developed which disappears gradually and on subsequent acidification little or no Para Red is obtained, but a compound $C_{16}H_{12}O_7N_3SNa$ can be isolated in a yield of $91\frac{1}{2}$ per cent. Many other diazosulphonates were prepared and tested for this reaction, other diazotisable amino compounds being used in place of *p*-nitraniline. The only compounds not containing a nitro group which gave rise to this new reaction were *p*-aminoazo compounds. R. F. I.

Gravimetric Determination of Picric Acid in a Mixture of Picric Acid and Trinitrometacresol. L. Desvergnés. (*Ann. Chim. anal.*, 1925, 7, 65-67).

—The mixture is dissolved in a warm saturated solution of picric acid in alcohol, and the picric acid which crystallises out on cooling, is weighed. The following identification tests should first be applied:—(1) By warming with a 5 per cent. sodium carbonate solution a clear solution should be obtained. (2) The alkaline solution heated to $80^\circ C.$ should give a dark red colour. (3) If treated with alkaline hypobromite and bromate and acidified, the mixture should absorb no bromine. The saturated alcoholic solution of picric acid is prepared by heating 100 grms. of pure picric acid in 1 litre of 96 per cent. alcohol till dissolved, and filtering the solution after standing for 3 days at $15^\circ C.$ The filtrate contains 6.8 to 6.9 grms. of picric acid per 100 c.c., but the exact figure must be determined by evaporation of 50 c.c. *in vacuo*. Twenty-five grms. of the mixture to be examined (powdered and dried *in vacuo*) are heated with 390 c.c. of the picric acid solution (measured at $15^\circ C.$) under a reflux condenser till solution is complete, and then left for 5 days at $15^\circ C.$ The solution is then filtered through a double tared filter on a Buchner funnel, and the crystallised picric acid is dried *in vacuo* and weighed. R. F. I.

Detection and Determination of small Amounts of α -Naphthol in β -Naphthol. T. Callan. (*J. Soc. Chem. Ind.*, 1925, 44, 125-127.)—An investigation into the sensitiveness of some of the published methods for the detection and determination of α -naphthol in β -naphthol showed that the following 3 tests readily detect as little as 0.2 per cent. of α -naphthol. *Volcy-Boucher test* (*Ann. Chim. anal.*, 1908, 13, 335).—Half a gm. of the material is dissolved in the smallest possible amount of 45 per cent. alcohol, 2 c.c. of 10 per cent. copper sulphate solution added, and, after shaking, 4 c.c. of a freshly prepared 10 per cent. solution of potassium iodide, when a violet-red precipitate is given by α -naphthol, and a yellow precipitate by β -naphthol. The *Artzberger test* (*Pharm. Post*, 35, 753; *Pharm. J.*, 1903, 70, 89).—Three-tenths of a gm. of material are dissolved in 2 to 3 c.c. of alcohol, 10 to 15 c.c. of water added, and, after occasional shaking for 5 to 10 minutes, the solution is filtered, and 10 to 12 drops of 10 per cent. potassium hydroxide solution, 1-4 drops of a solution of 1 gm. of iodine and 2 grms. of potassium iodide in 60 c.c. of water added, when a violet coloration is given by α -naphthol, and a yellow solution by β -naphthol. *The modified B.P. test*.—One tenth of a gm. of the sample is dissolved in 10 c.c. of boiling distilled water, the solution cooled, the crystals of naphthol filtered off, and 0.5 c.c. of a 1 in 30 ferric chloride solution added, drop by drop, to the filtrate, and the colour

noted after 15 minutes; α -naphthol imparts a violet tinge. The *Liebmann* method (*J. Soc. Chem. Ind.*, 1897, 294) and *Prochazka's* method (*J. Soc. Chem. Ind.*, 1897, 894, and *J. Ind. Eng. Chem.*, 1923, 15, 944), which give quantitative results, depend on the fact that both α - and β -naphthol couple with diazotized p -nitroaniline, to give p -nitroazo derivatives soluble in the case of α -naphthol in sodium hydroxide solution to a deep blue colour, whilst in the case of the β -naphthol the reddish compound is practically insoluble. These methods are capable of determining 0.1 per cent. of α -naphthol. Since α -naphthol is more soluble in cold water than β -naphthol, the sensitiveness of the reaction in tests requiring an aqueous extract is increased.

D. G. H.

Determination of Paraffin Wax in Rubber Goods. J. Lagerqirst. (*J. Soc. Chem. Ind.*, 1925, 44, 157-162T.)—The various methods for the determination of paraffin wax are reviewed, and divided into those published previous to 1916, and those published or adopted since that date. Particular attention is paid to the new German method, which is found to give results which are high, particularly when the proportion of paraffin is low, although with softer waxes and with rubber compounds containing vaseline, it is more satisfactory. As a result of experience the following procedure is recommended: The acetone extract from 5 grms. of rubber sample is dissolved in 40 c.c. of absolute alcohol, with the use of a flask with a reflux condenser, and any undissolved sulphur removed by filtering, the flask and filter being washed with 10 to 20 c.c. of boiling absolute alcohol. If, after cooling for 1 hour in a mixture of ice and salt at 4 to 5° C. no flocculent precipitate appears, and there are no indications of mineral oil, the absence of paraffin may be assumed. If present, the precipitate is filtered through a cooled funnel, washed with 50 to 60 c.c. of 90 per cent. (vol.) alcohol, dissolved in warm benzene, and transferred to a weighed flask. The benzene is distilled, and the residue dried and weighed. The filtrate is evaporated to dryness, the residue dissolved in 10 c.c. of carbon tetrachloride, transferred to a separating funnel, and the flask washed out with 10 to 15 c.c. of carbon tetrachloride, followed by 20 to 25 c.c. of concentrated sulphuric acid, both of which are poured into the funnel, and, after vigorous shaking, the acid is allowed to settle and is drawn off. The solution is shaken with further portions of acid until the acid remains colourless, and subsequently water and about 100 c.c. of ether are added. Washing with water is continued until the water is no longer acid, and, after the water has separated from the ether, the ethereal solution is decanted into a weighed flask, the solvent distilled, and the residue dried and weighed. Any sulphur in either residue must be determined (by oxidation with nitric acid and precipitation as barium sulphate) and deducted.

D. G. H.

Inorganic Analysis.

Buffer Mixtures Prepared without the Use of Standardised Acid or Base. I. M. Kolthoff. (*J. Biol. Chem.*, 1925, 63, 135-141.)—A new set of buffer mixtures that can be prepared with solutions of weighed crystalline substances is

described. The standard substances must obey the condition that they can easily be obtained pure. This is the case with succinic acid, acid potassium phosphate and borax. The mixtures of 0.05 molar succinic acid solution and 0.05 molar borax cover a range of P_H from 3.0 to 5.8; those of 0.1 molar primary potassium phosphate and 0.05 molar borax, from P_H 5.8 to 9.2. For physiological work this range of P_H (from 3.0 to 9.2) will usually suffice. Two graphs, one for succinic acid and borax mixtures and one for KH_2PO_4 and borax mixtures are given, in which the P_H values obtained are plotted as ordinates against the composition of the mixtures as abscissæ. Tables also shew the composition of the mixtures. The buffer action of these mixtures is discussed. P. H. P.

Electrolytic Determination of Cadmium. E. Büttgenbach. (*Zeitsch. anal. Chem.*, 1925, 65, 452-455.)—The following procedure is recommended in preference to the usual deposition from cyanide solution:—The solution, containing 0.2 gm. of cadmium as sulphate in a bulk of about 150 c.c., is treated with 2 c.c. of strong sulphuric acid, then with 10 to 15 per cent. of sodium hydroxide solution until slightly turbid. After addition of a solution of 6 grms. of potassium hydrogen sulphate the liquid is electrolysed at ordinary temperature at 3.8 volt pressure, the anode disc rotating at 300 R.P.M. The metal is deposited in 40 minutes (hydrogen sulphide test). It is washed as usual without interruption of the current. If more cadmium is present, the addition of the bisulphate and the time of deposition must be increased proportionately. W. R. S.

Determination of Bismuth and its Separation from Lead by Pyrogallol. F. Feigl and H. Ordelt. (*Zeitsch. anal. Chem.*, 1925, 65, 448-451.)—Solutions of bismuth salts are precipitated quantitatively by pyrogallol if the acidity does not exceed 0.1 *N*. The yellow crystalline precipitate has the composition $BiO_3C_6H_3$ (Bi 62.84 per cent.). The acid solution is neutralised with ammonia until a slight permanent turbidity is produced; this is removed with a drop of dilute nitric acid; a strong solution of pyrogallol is added, and the liquid heated to boiling. The precipitate is collected and washed with dilute nitric acid and water on a Gooch or porous crucible, and dried at 110° C. to constant weight. In the presence of lead, the filtrate from the bismuth precipitate is saturated with hydrogen sulphide, and the lead determined as usual. The results shown are very close. W. R. S.

Separation of Calcium and Magnesium. G. Luff. (*Zeitsch. anal. Chem.*, 1925, 65, 439-448.)—The separation of calcium as oxalate may be accomplished by a single precipitation from a hot, faintly ammoniacal (1 c.c. excess) solution containing 10 grms. of ammonium chloride in a total volume of 200 c.c., to which ammonium oxalate solution is added, drop by drop, an excess being carefully avoided. The solution, before filtration, is kept one hour on the waterbath. W. R. S.

Determination of Germanium. E. B. Johnson and L. M. Dennis. (*J. Amer. Chem. Soc.*, 1925, 47, 790-793.)—The precipitation of germanium as disulphide is complete under the conditions usually employed, but the use of nitric

acid to convert the disulphide into dioxide may be replaced advantageously by that of hydrogen peroxide. The oxidation should be effected in a platinum vessel, since high results are obtained when glass is used; the hydrogen peroxide must leave no appreciable residue when evaporated. The disulphide precipitate is dissolved by addition to the filter of several small portions of redistilled ammonia solution, the solution being received in a small weighed platinum dish and oxidised cold by 20 c.c. of perhydrol diluted to 3 per cent. strength. The solution is evaporated to dryness at about 105° C., and the residue moistened with concentrated sulphuric acid and gently heated until the acid and ammonium sulphate are driven off. The residual germanium dioxide is ignited until constant in weight.

T. H. P.

Determination of Chloride, Bromide, or Thiocyanate in Presence of Cyanide. E. Schulek. (*Zeitsch. anal. Chem.*, 1925, **65**, 433-435.)—Formaldehyde in excess reacts quantitatively with cyanide, yielding glycolate and hexamethylenetetramine; the reaction may be utilised in the volumetric determination of chloride, bromide, or thiocyanate in presence of cyanide. From 0.1 to 0.3 gm. of the salt mixture is dissolved in 50 c.c. of water in a flask; 5 c.c. of 20 per cent. formaldehyde solution are added. The flask is well shaken, the solution acidified with 5 c.c. of 30 per cent. nitric acid, and treated with excess of 0.05 *N* silver nitrate solution. The excess is measured by Volhard's method with 0.05 *N* thiocyanate solution, ferric nitrate being the indicator. The process is also valuable for the qualitative detection of the above ions in presence of cyanide.

W. R. S.

Organic Reactions at the Surface of Titania. Adsorption of certain Gases by Titania. F. Bischof and H. Adkins. (*J. Amer. Chem. Soc.*, 1925, **47**, 807-826.)—Sabatier and Mailhe's statement that acetic and propionic acids are reduced by formic acid in presence of titania to the corresponding aldehydes (*Compt. Rend.*, 1912, **154**, 561) is found to be erroneous. Various preparations of titania, made in different ways, differ markedly in their catalytic effects on formic and acetic acids, ethyl acetate, ethyl and *n*-butyl alcohols, and ethyl ether. Only some of these preparations are reproducible as far as their relative catalytic activity is concerned, and the surface conditions determining such activity depend, not only on the size and shape of the radicle attached to the titanium when the compound passes into the solid state, but also on the mechanism of the hydrolysis and dehydration by which the catalysts are obtained. Measurement of the adsorption of carbon dioxide, ethylene, ethane, and hydrogen shows that, although the different samples of titania differ greatly in both absolute and relative catalytic activities, no such differences occur in the adsorption of the gases produced in the reactions catalysed.

T. H. P.

Separation of Thorium from Zirconium and the Tervalent Rare Earths. L. Fernandes. (*Gazz. Chim. Ital.*, 1925, **55**, 3-6.)—The following method of separation, based on the varying solubilities of the double thallosulphates,

gives satisfactory results. The mixed hydroxides, precipitated by means of ammonia, are washed repeatedly with boiling water and dissolved in cold dilute sulphuric acid. The filtered liquid is treated with excess of thallium sulphate, which precipitates almost the whole of the cerium earths. These are removed by filtration, and the filtrate is heated on a water-bath until more than one-third of the solvent is expelled, the last traces of trivalent earths being thus precipitated. When the filtered liquid is cooled, the first fraction, containing the thorium absolutely pure, separates. The liquid is evaporated again until almost concentrated sulphuric acid is obtained, the various thorium fractions separating being removed. The solution is finally heated to boiling to precipitate the last traces of thorium as the normal sulphate, which is removed by filtration through asbestos or a porous crucible. When the filtrate is cooled, the zirconium compounds separate.

T. H. P.

Separation and Determination of the Alkali Metals by the Use of Perchloric Acid. I. Solubilities of the Perchlorates of the Alkali Metals in Mixed Organic Solvents. G. F. Smith. (*J. Amer. Chem. Soc.*, 1925, 47, 762-769; cf. *ANALYST*, 1923, 48, 627.)—The author has determined the solubility at 25° C. of anhydrous sodium, potassium, rubidium, caesium, and ammonium perchlorates, and of monohydrated sodium and trihydrated lithium perchlorates in mixtures of methyl, ethyl, and *n*-butyl alcohols in various proportions with ethyl acetate. The data given indicate the use of mixed solvents to be of advantage in the separation of the alkali metals by means of their perchlorates. In mixtures of two alcohols, the solubilities of the perchlorates are normal, but in mixtures of ethyl acetate with alcohols the solubilities are abnormally high owing to interaction between the two solvents. The composition of the solvent best fitted to any particular separation may be determined from the numerical results furnished; in general, mixtures of absolute (or 93 per cent.) ethyl alcohol and ethyl acetate give the best results, and mixtures of *n*-butyl alcohol and ethyl acetate exhibit the lowest solubilities for these perchlorates and could probably be used in all proportions. The addition of perchloric acid (for its common -ion effect) to mixed solvents with ethyl acetate as major component is of no value. T. H. P.

Separation and Determination of the Alkali Metals by the Use of Perchloric Acid. II. Precise Determination of the Insoluble Alkali Metal Perchlorates. G. F. Smith and J. F. Ross. (*J. Amer. Chem. Soc.*, 1925, 47, 774-781.)—If dried at 150° C., potassium perchlorate, crystallised from its aqueous solution, may contain about 0.3 per cent. of occluded moisture, which is eliminated only at about 350° C. Of caesium, rubidium, and potassium perchlorates, the first occludes the least, and the last the most, perchloric acid; this occlusion is not dependent on the nature of the organic solvent used. Since strong perchloric acid readily dissolves sodium perchlorate, this salt may occur in appreciable proportion in the crystallised potassium salt. The results described in this and the preceding paper lead to the following procedure for the separation of the alkali perchlorates:—The mixed alkali metal chlorides, free from ammonium chloride,

are dissolved in water and treated with two or three times the equivalent weight of pure perchloric acid (not less than 1 c.c. of 60–70 per cent. acid), and the solution thus obtained evaporated to dryness on the hot plate in a 150 c.c. Pyrex beaker, any condensed acid on the walls of the beaker being removed by brushing with the flame. The beaker is then cooled somewhat, and the contents dissolved by addition of a minimum of hot water (2 or 3 c.c. usually suffice), and the liquid again evaporated to dryness on the hot plate. From 10 to 20 c.c. of the mixed organic solvent chosen (see preceding Abstract) are added, and the solution digested near the boiling point for two to three minutes. The liquid is cooled, and the supernatant solution decanted through a platinum-sponge filtering crucible or a Gooch asbestos crucible, and the residue first washed thrice by decantation to remove most of the soluble perchlorate and then dissolved in the minimum of hot water, and the solution again evaporated. The dried salts are extracted, as before, with 10 c.c. of solvent, digested, cooled, and filtered into the original crucible. The precipitate is transferred to the crucible by means of a wash-bottle containing the same solvent, and the contents of the crucible washed with ten to fifteen portions of 0.5–1 c.c. each. The filtrate, which should amount to 35 to 45 c.c., is concentrated on the hot plate preparatory to further analysis. The precipitating beaker is returned to the hot plate until dry, and any remaining particles of perchlorate then brushed into the crucible, which is dried for a few minutes at 110° C. and finally for 15 minutes in a muffle at 350° C. When no sodium or lithium perchlorate is present, the second precipitation and extraction may be omitted.

T. H. P.

Separation of Selenium and Tellurium by Sulphur Dioxide in Hydrochloric Acid Solution. V. Lenher and C. H. Kao. (*J. Amer. Chem. Soc.*, 1925, 47, 769–772.)—In this separation the amount and the concentration of the hydrochloric acid present are of great importance, selenium monochloride not being formed in the cold when concentrated hydrochloric acid is used with a large excess of sulphur dioxide. The procedure recommended is as follows:—A quantity of the mixed oxides of the two elements containing not more than 0.25 grm. of either selenium or tellurium is dissolved in 100 c.c. of cold concentrated hydrochloric acid, and 50 c.c. of concentrated hydrochloric acid saturated at ordinary temperature with sulphur dioxide are then added, with constant stirring. When the red selenium formed subsides, the solution is filtered through an asbestos filter into a filtering flask, and the precipitate washed thoroughly with cold, concentrated hydrochloric acid, then with cold water until all chlorine is removed, afterwards with alcohol, and finally with ether. The selenium is dried for 3 to 4 hours at 30–40° C., and for 1 to 2 hours at 120° to 130° C., and weighed. The filtrate is concentrated to 50 c.c. on a steam-bath below 100° C. to remove excess of acid, and the tellurium afterwards precipitated by the Lenher and Homberger method:—Fifteen c.c. of saturated sulphur dioxide solution are added, and then 10 c.c. of 15 per cent. hydrazine hydrochloride solution, this being followed by 25 c.c. of saturated sulphur dioxide solution. The liquid is boiled, and the precipitated tellurium washed on a Gooch crucible with hot water until all chlorine

is removed, and then rapidly with alcohol; the crucible and its contents are dried at 105° C. Under these conditions the tellurium does not oxidise, and the results obtained are more accurate than those given by any other method. T. H. P.

Physical Methods, Apparatus, etc.

The Adsorption of Indicator (Cresol Red) by Serum in the Spectrophotometric Determination of the P_{H} . E. F. Hirsch. (*J. Biol. Chem.*, 1925, **63**, 55-59.)—In order to determine whether the spectrophotometric method could be used in measuring the P_{H} of sera or plasmas, cresol red was chosen as indicator, because the usual variations in the reaction of the blood are within the middle and lower portions of the P_{H} range (6.4 to 9.4) of the indicator. The amount of cresol red necessary for correct transmission values with the spectrophotometric determination of the H-ion concentration of sera varies for different species, and even with sera of individuals from the same species. The amount in rabbit serum is approximately the same as that necessary in the ordinary buffer solutions, but with human serum it is more, and with sheep serum the quantity is considerably greater. A table shews the results. A certain amount of the indicator seems to be bound by some of the serum constituents. When this affinity has been satisfied, or an equilibrium established, there is needed a definite amount unbound which undergoes the tautomeric changes incident to P_{H} variations. These differences in the quantity of indicator bound by sera may be associated with species specificity. P. H. P.

Fluorescence as a criterion of purity in organic compounds. E. Bayle and R. Fabre. (*J. Pharm. Chim.*, 1925, **8**, 248-253.)—Fluorescence is measured by the curve of spectral distribution of the intensity of the emissions, by plotting the different radiations of equal intensity as functions of the length of the waves. If the ordinate corresponding to the maximum degree of sensitiveness of the eye for the wave length a is taken as 5.550 Angström units, definite bell-shaped curves are obtained. If the intensity of the light of fluorescence is compared with that of white light for each radiation, a curve is obtained, and if the ordinates of this curve are multiplied by the corresponding ordinates for the visibility curve, then the distribution of the intensity of the light in the fluorescent spectrum is defined. This may be of importance in ascertaining the purity of many crystalline bodies, and the method has been applied, in particular, to hydrastine which is very fluorescent, but of which the derivatives, with the exception of opianic acid, are non-fluorescent. Incidentally, the strength of unstable solutions may also thus be ascertained (*cf.* ANALYST, 1924, **49**, 454). D. G. H.

Reviews.

NEW REDUCTION METHODS IN VOLUMETRIC ANALYSIS. E. KNECHT and E. HIBBERT. Pp. x + 134. London: Longmans, Green & Co. Price 8s. 6d. net.

The second edition of Knecht and Hibbert's book is very welcome. The extraordinary reducing power of titanous chloride has made it very desirable that its numerous applications to analytical processes should be collected together in an easily accessible form. This the authors have succeeded in doing.

The subject matter has been rearranged, and every endeavour has been made to bring it up to date by including work from foreign papers and introducing a number of new estimations, among which may be mentioned those of vanadium and phenylhydrazine. The range of determinations covered is very large, as can be judged by the following selection: Copper, chromium (separately and together), perchlorates, nitro compounds, various dye stuffs and sugars. A glance at the index shows what a large number of determinations, otherwise doubtful or impossible, can be made by means of titanous chloride, and in the text one finds actual figures obtained from analyses of samples of known purity, and hence it is easy to judge the degree of accuracy to be expected. Finally, attention may be drawn to the excellent list of original papers and to the subject and author indexes.

The book is a very useful addition to the literature of analytical chemistry, and should prove of great value.

HAROLD TOMS.

CHARTS OF THE CHEMICAL REACTIONS OF THE COMMON ELEMENTS. By JOHN A. TIMM, Ph.D. Pp. ix.+81. New York: John Wiley & Sons, Inc.; London: Chapman & Hall. Price 10s. net.

In this book are arranged, in alphabetical order, charts indicating the main reactions of the common elements. Each chart is followed by a list of these reactions expressed in equation form. The object of this volume, so we read in the preface, is to enable a teacher to set his students periodic and rapid reviews of his course. Possibly the book is useful for this purpose and it may be that students working for the London Matriculation will find these charts and lists of equations helpful.

HAROLD TOMS.

BITUMINOUS SUBSTANCES. By P. E. SPIELMAN, Ph.D., F.I.C. Pp. xv.+206. London: E. Benn, Ltd. 1925. Price 15s. net.

In writing this book Dr. Spielman has set himself the task of bringing together in one volume an account of the chemical and physical investigations carried out on bitumens during the last 15 years. The use of bitumen as asphalt in road-making has increased enormously during this period but, though the amount of scientific work has not been small, the problem of the composition of the different known varieties is still far from being solved. Dr. Spielman's book, therefore, in giving a full account of the present position of scientific knowledge, serves as a milestone in the progress of the chemistry of bituminous materials.

The book commences with an interesting chapter on the first references in early history to the use of bitumen. The second and third chapters review the present knowledge of the origin of the different varieties of bitumen and of their composition and give an account of their physical and chemical properties. The effect of heat on constitution and properties is discussed at length, but so far the extent of the changes which are described appears not to have been determined, except in a very few instances.

The physical and chemical tests on bitumens are fully described in Chapter V., and should be read in conjunction with the Appendix giving the standard tests devised by the Institution of Petroleum Technologists, 1924. Many of the tests are empirical ones, and the correlation of the results with one another is carefully described and discussed.

The Appendix, apart from the above standard tests, consists of a discussion of the nomenclature which has been applied to bituminous substances by the various workers in the field. This chapter is particularly interesting in that it illuminates the views of the various authorities. In this respect it should be read carefully along with the view expressed in the chapter on composition and origin.

The book is well written, and the bibliography is full and well arranged. The subject-matter should prove of great interest to all enquirers on this subject, and be of considerable assistance to all scientific workers in this field.

The publishers are to be complimented on having produced a compact volume, well printed in very clear type, at a reasonable cost. J. G. KING.

SYNTHETIC ORGANIC COMPOUNDS. By S. P. SCHOTZ, D.Sc. Pp. 412. London: Ernest Benn, Ltd. 1925. Price 45s. net.

This is a very interesting book and it should prove of much value to the average student of organic chemistry. It will give him an idea how organic substances are prepared in industry, and it will also make him realise the differences between laboratory and factory work. The book is obviously not written for the industrial chemist, since it is quite impossible for one author to deal with such a variety of subjects as perfumes, synthetic tannins, artificial silk, explosives, etc. Industrial chemists will therefore be disappointed, as was the reviewer, when he read the article on synthetic tannins. Incidentally, it might be mentioned that it was not Stiasny (1912), but Baeyer, who discovered, in 1872, that formaldehyde condenses with phenols to give a product which precipitates gelatin, and it was this discovery which led Stiasny to patent his syntans.

The book is well, if not luxuriously, printed. Much cost could have been saved, however, if more space had been economised in the printing of the book. One wonders if the graphical formulæ for phenyl salicylate (p. 134), phenyl carbonate (p. 136), phthalic anhydride (p. 209), Baekland's formulæ for resin (pp. 383, 384) are really required? The omission of such extravagances would surely have reduced the cost of the book. After all, 45s. is a high price to be paid for a book which can only be of passing interest. M. NIERENSTEIN.

COLLOID CHEMISTRY. By JEROME ALEXANDER, M.Sc. 2nd Edition. Pp. 208+viii. London: Chapman & Hall. 1925. Price 9s. 6d. net.

Mr. Jerome Alexander's treatise on Colloid Chemistry serves two useful purposes. In the first place it puts forth in a clear and interesting manner for the general reader how the work of the chemist in his laboratory forms the foundations of the great industries of civilisation; and in the second place it points out to the chemist himself how the results of laboratory experiments can be applied and adapted in wider and wider spheres. The full title of Mr. Alexander's book, set out on the title page, is "Colloid Chemistry, an Introduction and some Applications." The abbreviated title on the cover suggests a text book merely, and is a little misleading, for although this new edition may serve as a text book, there is no doubt that its chief merit, as in the former edition, lies in the masterly review of the manifold applications of colloid chemistry to civilisation. Mr. Alexander has a judicial mind. He asks, "What is colloid chemistry?" and then he picks out the salient points from the mass of evidence before him, and, while ignoring nothing of importance, answers the question in fifty-four pages. The second chapter, in which he makes sure that his readers get an understanding of the mental tools which they will be called upon to use, is especially to be commended. These tools, as in every other branch of exact science, are the special methods of analysis and measurement that are required by the nature of the subject. Without an understanding of them, progress on the theoretical side is impossible.

In any matter of colloidal theory "where doctors disagree," all sides are given a fair hearing, and though there is never any doubt as to Mr. Alexander's intellectual preference, he never descends to being partisan.

The remaining 140 pages are devoted to the applications of colloid chemistry, and the subjects range over medicine, physiology, food, clothing, dyes, explosives, coal and steel.

Mr. Alexander is editing a monograph on the theory and practice of colloid chemistry. The tantalising glimpses at the subject in this little volume provoke an eager longing for the appearance of the big one. D. JORDAN LLOYD.

CHEMISTRY IN THE SERVICE OF MAN. By ALEXANDER FINDLAY, M.A., D.Sc., F.I.C. 3rd Edition. Pp. 300. London: Longmans, Green & Co. Price 6s. net.

During recent years there has been a considerable output, by men of science, of books in which the bearing of science on everyday life has been set forth in such a manner that it can be appreciated by the intelligent lay reader. The fact that such books pass into second and even later editions is evidence that the public is quite willing to take an interest in science, provided its ideas come to it expressed in a language it can understand.

Professor Alexander Findlay's *Chemistry in the Service of Man* has now deservedly reached a third edition. Three new chapters have been added on "Radioactivity and Atomic Structure," "The Rare Gases of the Atmosphere,"

and "The Metals and their Alloys." An understanding of modern theories of radioactivity and atomic structure has now become a necessity for the chemist, and the story of the discovery of the isotopes of the elements is an interesting instance of how an apparent difficulty in harmonising the theoretical requirements of integral atomic weights with the fractional values obtained by accurate analysis led to one of the greatest advances in knowledge, since the original discovery of the chemical equivalence of the elements. The story of the discovery of the rare gases of the atmosphere, again, is an instance of the value of the correct interpretation of accurate analytical results in leading to new knowledge and discoveries. The chapter on the metals will be enlightening to many people now that the expression "non-ferrous metals" has become a political catch-word.

Of the book, as a whole, it may be said that it gives an able exposition of its subject. Professor Findlay's style is particularly easy to read. The unlaboured presentment which he achieves is only possible where the writer has a firm grip on his subject.

It is a pity that the publishers have found it necessary in this new edition to alter the type. The combination of smaller fount and coarser paper, while leaving the bulk of the volume almost unaltered, imposes a considerably increased strain on the eye.

D. JORDAN LLOYD.

A GERMAN-ENGLISH DICTIONARY FOR CHEMISTS. By AUSTIN M. PATTERSON, Ph.D. Pp. 343. New York: John Wiley & Sons; London: Chapman & Hall. 1924. Price 12s. 6d. net.

The first edition of this excellent little dictionary was published in 1917, and it has now been reprinted for the fifth time, bringing the total issue up to twenty-one thousand. The present issue, however, is not merely a reprint of the first, for it contains 26 pages of addenda, also arranged alphabetically, giving a large number of less common words or of those used in a specialised sense. This addition adds greatly to the value of the book. Not only are purely chemical terms given, in this or the older portion, but there are also numerous technical words used in anatomy, botany, medicine and various crafts, such as ceramics, dyeing and printing, and a useful feature, not to be found in the large general dictionaries, is the inclusion of the various abbreviations used in German chemical and technical journals.

In warmly recommending this dictionary to chemists the reviewer can speak from experience, for he has had the first issue in constant use for some years, and has seldom found it wanting, even when the word sought has been an obsolete or unusual one.

EDITOR.