A. M. D. G.

American Association of Jesuit Scientists

Eastern States Division

PROCEEDINGS

of the

Thirteenth Annual Meeting

August 21, 22, 23, 1934

Georgetown University, Washington, D. C.

Published at

LOYOLA COLLEGE

BALTIMORE, MARYLAND

VOL. XII SEPTEMBER, 1934 NO. 1

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CONTENTS

Science Convention; Georgetown University, August 1934.

Bulletin of American Association of Jesuit Scientists

EASTERN STATES DIVISION

VOL. XII | SEPTEMBER, 1934 | No. 1

BOARD OF EDITORS

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PROGRAM OF GENERAL MEETING

Tuesday, August 21, 7:45 P. M. — **Senior Lecture-Hall**

Address of Welcome................Rev. W. Coleman Nevils, S.J.

Reading of Minutes

Appointment of Committees

Presidential Address......................Rev. T. H. Quigley, S.J.

Sadi Carnot and the Laws of Thermodynamics.

Adjournment

New Business

Thursday, August 23, 1:00 P. M. — **Senior Lecture Hall**

Reports of Secretaries

Reports of Committees

Discussion

Resolutions

Election of Officers

Adjournment

Program of Sectional Meetings

Wednesday, August 22, 9:00 A. M.—3:30 P. M.

Thursday, August 23, 9:00 A. M.

BIOLOGY SECTION

Chairman's Address........................Rev. Charles A. Berger, S.J.

The Genetics and Cytology of Oenothera.

Symposium on the Blood

Formed Elements of the Blood..........Mr. Harold A. Pfeiffer, S.J.

Haemolytic System and Erythrocytes....Mr. J. Franklin Ewing, S.J.

The Role of Platelets in Coagulation........Mr. Joseph Keegan, S.J.

The Role of the Blood in Immunity..Rev. Clarence E. Shaffrey, S.J.

Hemopoiesis..........................Mr. Francis X. Flood, S.J.

The Pathology of Red Cells...........Rev. Harold L. Freatman, S.J.

The Pathology of Blood Poisoning........Mr. Joseph P. Lynch, S.J.

CHEMISTRY SECTION

Chairman's Address.......................Rev. Francis W. Power, S.J.

Electrical Methods in Volumetric Analysis.

Determination of the Halogens in Micro Analysis
Rev. Richard B. Schmitt, S.J.

Certain By-Products of the Phenol Refinement of Oil
Rev. Lawrence C. Gorman, S.J.

Identification of Fatty Acids.........Rev. Joseph J. Sullivan, S.J.

Micro Determination of Oxygen...Mr. Gerald F. Hutchinson, S.J.

A Search for a New Electrode........Mr. Bernard A. Fiekers, S.J.

MATHEMATICS SECTION

Chairman's Address.....................Rev. Frederick W. Sohon, S.J.

The Changed Aspect of Mathematics.

Interpolation.........................Rev. Thomas D. Barry, S.J.

The Differentiation of the Definite Integral.Mr. Lincoln J. Walsh, S. J.

Isotropic Lines and Circular Points at Infinity.Mr. Leo J. Welch, S.J.

Complex Numbers...................Mr. William H. Schweder, S.J.

Geometry of the Complex Plane......Mr. James J. Hennessey, S.J.

Geometrical Duality..................Mr. Philip H. McGrath, S.J.

The Canonical Form of Incomplete Dyadics
Mr. J. Austin Devenny, S.J.

The Functions

Circular and Hyperbolic Functions......Mr. Peter J. McKone, S.J.

Elliptic Functions..................Rev. William J. Sheehan, S.J.

Hyper-elliptic Functions................Mr. Francis B. Dutram, S.J.

Automorphic Functions ....Rev. Joseph T. O' Callahan, S.J.

Program of Sectional Meetings

PHYSICS SECTION

Chairman's Address....................Rev. Emeran J. Kolkmeyer, S.J.

Physics a Prerequisite for a College Degree.

Laboratory Constants..................Rev. Henry M. Brock, S.J.

The Teaching of Wave Mechanics in the A.B. Course
Rev. John A. Tobin, S.J.

What Should be Said of the Ether in a General Physics Course?
Rev. J. Joseph Lynch, S.J.

Velocity of Light and the Doppler Effect..Rev. John S. O'Conor, S.J.

Joule and the Mechanical Equivalent of Heat
Mr. Lawrence M. Brock, S.J.

Lord Kelvin and the Absolute Scale of Temperature
Mr. Daniel Linehan, S.J.

Clapeyron and the Clapeyron-Clausius Equation
Rev. Joseph L. Murray, S.J.

Physics Exams.......................Rev. John P. Delaney, S.J.

Analysis of the Simple Pendulum........Mr. Lincoln J. Walsh, S.J.

Diffraction Pattern Photography......Mr. Edward L. McDevitt, S.J.

A Vacuum Tube Observation.........Mr. A. Robert Thoman, S.J.

The Radiation Theory of Radiant Energy, Mr. Carol H. Morgan, S.J.

FIRST GENERAL SESSION

The Thirteenth annual meeting of the American Association of Jesuit Scientists, Eastern States Division, was held at Georgetown University, Washington, D. C., on August 21, 22 and 23, 1934. The first general meeting was held on Tuesday, August 21st at 7:45 P. M. in the Senior Lecture-hall, the Rev. Thomas H. Quigley, S.J., presiding.

The Rev. W. Coleman Nevils, S.J., President of Georgetown University, delivered the address of welcome, in which he assured all the members of the Association of his desire to aid them in whatever way possible during their stay at Georgetown. Fr. Nevils also recalled that this year was the 400th anniversary of the founding of the Society of Jesus.

The minutes of the previous meeting were read and accepted as read. The chairman then named the following committees:

Committee on Resolutions:

Fr. Henry M. Brock
Fr. Richard B. Schmitt
Fr. Clarence E. Shaffrey

Committee on Nominations:

Fr. John S. O'Conor
Fr. Joseph J. Sullivan
Mr. Edward L. McDevitt

Fr. Schmitt then briefly recalled the work and abilities of Father Strohaver and the important role he played in the founding of the Association. In appreciation of this the motion was made by Fr. Schmitt that all the priests offer one Mass and the scholastics one Mass, communion and beads for Fr. Strohaver. The motion was seconded by Fr. Sullivan and unanimously carried.

It was suggested that the time of the final general meeting be changed from 1:00 P. M. as per program to 11 A. M., August 23, to permit of better train connections. Decision on this was postponed until the following day.

The announcement was made that on the following day a picture would be taken of all the members of the convention at one o'clock. The President, Rev. Thomas H. Quigley, then concluded the meeting with his Presidential address.

PRESIDENTIAL ADDRESS

Sadi Carnot and the Laws of Thermodynamics

A young French engineer, Sadi Carnot, in a remarkable memoire published in 1824 laid the foundations of Thermodynamics. His work was entitled: "Réflexions sur la puissance motrice du feu et sur les machines propres a développer cette puissance". This work, whose modest aim was to improve the yield from the recently discovered steam engines, was destined to have far-reaching consequences. For he built up a theory on two fundamental laws, laws to which there has never been known an exception in nature; and his theory is so rigerously deduced from these laws that it must endure as long as they do.

The first of these laws would be stated today as follows: "Whenever a quantity of energy of one form diminishes by any process, the same process involves an increase of energy in some other form; in fact the increase in the second form is exactly equal to the decrease in energy of the first form".*

The second of these laws would read: "Heat cannot on its own account pass from a cold body to one which is hotter".*

The first law prohibits the 'Perpetuum Mobile' of the first kind, that is, a machine which is capable of continuously driving some object without any energy being replaced; the second law prohibits the 'Perpetuum Mobile' of the second kind, that is, a machine which will run continuously by abstracting energy from its environment.

It was the genius of Carnot, his insight into nature, that enabled him to achieve that most difficult of objectives, to choose the essentials from the accidentals, and so to found his theory that it should, in its essentials, be quite independent of the theory on the nature of heat prevalent in his day.

Carnot recognized that, in order to perform work by means of heat engines, it is essential that we have two sources of heat at different temperatures. In his research into the conditions for obtaining a maximum yield from heat engines, Carnot's approach was both simple and daring. The maximum yield depends upon many factors, and to study these each in detail would seem an almost hopeless task. Carnot's method was more fruitful; he rested his case on the impossibility of realizing a 'Perpetuum Mobile' of either the first or second kind, and was ready to reject any conclusion which would involve their acceptance.

"The phenomena of producing movement by heat" he writes in his memoire "has not been considered from a point of view sufficiently general''. Carnot proposes to deal with the problem ''independently of any particular mechanism, of any particular agent". Thus his conclusions will be applicable to all machines "whatever be the working substance and whatever be the mode of working on it".

*Lehrbuch der Physik—Theodor Wulf, S.J.

Carnot well knew the daring of his mode of approach to the problem, for he writes: "One will perhaps object that the perpetual motion, shown to be impossible only for mechanical activity, would not prove to be unattainable when heat or electricity is used; but can the phenomena of heat or electricity be thought of as due to anything other than to some sort of movement of bodies, and as such, should it not be considered as subject to the general laws of mechanics?".

As was to be expected, Carnot made use of the theory of heat accepted in his day; but it was regarded as something accessory and not essential to his deductions. This theory held that heat was a material fluid; and this fluid, (called caloric) was considered to be invariable in amount in the universe. Bodies receiving caloric became warmer, bodies losing it grew colder.

It is worth while noting that of the two propositions which Carnot used in his theory, namely: (1) the impossibility of perpetual motion, (2) the indestructibility of caloric, the first (which we now admit without question) was vigorously attacked by some of Carnot's contemporaries whilst the second (now known to be erroneous) was readily accepted by them.**

As a starting point for his theory, Carnot makes use of the experimental fact that "the production of motion in a steam engine is always accompanied by a condition . . . . . . (which) is the re-establishment of equilibrium in the caloric, that is to say, its transfer from a body whose temperature is more or less high to another whose temperature is lower". For Carnot, who admitted the indestructibility of caloric, the production of work was not due to the consumption of heat but to the transfer of heat from a warm body to one colder, somewhat after the fashion in which work is done by the transfer of water from a higher to a lower level. But we must not lose sight of that which was of the essence of Carnot's basic principle, namely, that there can be no spontaneous transfer of heat from the colder to the warmer body, whilst the inverse process occurs spontaneously. The fundamental characteristic of the re-establishment of equilibrium in the caloric it is **irreversibility**.

In the development of his theory, Carnot introduces two concepts of far-reaching importance, namely: (1) the concept of a cycle of operations, (2) the concept of a reversible transformation.**

The advantage of dealing with a cycle of operations arises from the fact that, at the end of the cycle, the working substance is brought back to its original condition. We can, then, in our consideration of the relation between the heat supplied to the machine and the work performed by it, prescind entirely from the question of the changes in internal energy undergone by the working substance. This artifice makes it possible for us to avoid many delicate problems, not at all easy to solve to our satisfaction.

**Cf. L'entropie—Charles Brunold (Paris, 1930.)

The second notion introduced by Carnot is that of reversibility. A reversible transformation is, in the words of Clausius, "a limit that can never be reached completely, but which can be approached as closely as desired". Its utility arises from the fact that in many instances the physicist is concerned only with the initial and final states of a transformation, and not all with what has occurred in the interim. The physicist can, then, substitute for a transformation, which is, as a matter of fact, irreversible, another transformation which is theoretically reversible between the same two states. Such an artifice greatly simplifies the problem of the physicist, but it must not be forgotten that "a given system, under given conditions, necessarily changes in a given directon; taken literally, the words 'reversible change' is nonsense".***

Sadi Carnot, in his inquiry into the conditions for a maximum yield from heat engines, asks: "What is the meaning of the word 'maximum' in this connection? By what sign shall it be known whether or not the steam is employed to the greatest possible advantage in the production of motive power? Since every re-establishment of equilibrium in the caloric can be the cause of the production of motive power, then every re-establishment of equilibrium which occurse apart from the production of this power must be regarded as a true loss. A brief reflection will show that every change of temperature, which is not due to a change in the volume of the body, can be only an useless re-establishment of equilibrium in the caloric".

"The necessary condition, then, for a maximum yield is that there will not take place, in the body used to obtain the motive power of heat, any change of temperature which is not due to a change of volume. On the other hand, whenever this condition is fulfilled, the maximum yield will be obtained. We ought never lose sight of this principle in constructing a heat engine; it is most fundamental. If t cannot be rigorously observed, we should keep to it as far as possible. Every change of temperature, which is not due to a change of volume or to a chemical action, (assumed not to occur here), is of necessity due to the direct transfer of heat from a body more or less warm to a colder one. This transfer takes place chiefly at the points of contact of bodies of different temperatures; thus such a contact ought to be avoided whenever possible. It cannot, doubtless, be entirely avoided, but it is at least necessary that the bodies in contact should differ but little in temperature".

Thus Carnot outlines his objective, the goal attained theoretically in the well-known Carnot Engine. By a rigorous process of reasoning, he goes on to show that there can be no engine more efficient than this, and that the efficiency of this engine in no wise depends on the choice of working substance.

In the posthumous notes of Carnot (published in 1878), he shows quite clearly that, at least at the time of their writing, he knew of the

***P. Duhem—Les theories de la chaleur. (Revue des Deux Mondes, 1895.)

equivalence between heat and work. He even recognized the universality of the law of conservation of energy. Thus he writes: "It can be proposed, as a general thesis, that motive power is an invariable quantity in nature; that it is, strictly speaking, never created or destroyed. In reality, the form is changed . . . . . but it is never annihilated".

The last lines of Carnot's memoire show that Carnot was an excellent technician as well as an outstanding theorist: "One should not flatter himself that, in practice, he can ever derive the full benefit of all the motive of the combustibles. The attempts made to approach this result will be even more harmful than useful, if we lose sight of other important factors. The saving of combustibles is but one of the conditions that a heat engine should satisfy; in many instances, it is only secondary and should give way to considerations of safety, solidity and durability of the engine. . . . . . To know, in each instance, how to put the proper value on the considerations of suitability and economy under discussion, to know how to discern the more important from the less important, to weigh all circumstances to the end that by use of the easiest means we obtain the better results, such ought to be the chief qualification in the man who is called upon to direct, to co-ordinate, to make all serve for the desired end".

FINAL GENERAL SESSION

On Thursday, August 23, at 11 A. M. the final general session was held in the Senior class room.

The Secretaries of the sections reported the officers for the coming year.

Physics:

Chairman—Fr. E. J. Kolkmeyer
Secretary—Mr. E. L. McDevitt

Mathematics:

Chairman—Fr. F. W. Sohon
Secretary—Mr. L. C. McHugh

Chemistry:

Chairman—Fr. J. J. Sullivan
Secretary—Mr. G. F. Hutchinson

Biology:

Chairman—Fr. James L. Harley
Secretary—Mr. Joseph Keegan

Report of the Committee on Resolutions

The following resolutions are proposed for approval:

1. Be it resolved that the American Association of Jesuit Scientists (Eastern States Division) express its appreciation and gratitude to Rev. Father Rector, Father Minister and the Community of Georgetown University for their cordial reception and for the gracious hospitality shown to it during its convention. They have contributed greatly to the success and pleasure of the meeting.

2. Be it resolved that the Association give expression to its sorrow at the death of its former president and charter member, Father George Francis Strohaver and make known to Georgetown University its sincere sympathy at the loss of its dean and head of the Department of Chemistry. We may record the fact here that we have given testimony of our esteem for him and our deep appreciation of his devotion to our Association by the priests offering up one Mass and the Scholastics one Holy Communion for the repost of his soul. We request that a copy of this resolution be sent to his nearest relatives.

3. Be it resolved that a copy of these resolutions be presented to Rev. Father Rector of Georgetown University by the Secretary.

Committee on Resolutions

Rev. Henry W. Brock, S.J.
Rev. Richard B. Schmitt, S.J.
Rev. Clarence Shaffrey, S.J.

The following motions were made by Fr. Sohon and adopted by the house:

(1) That the motion requiring the appointment of a publicity agent be rescinded.

(2) That the President of the Association, as soon as the place of the coming meeting is determined, shall appoint a chairman of an arrangement committee, who with two others of his (i. e. the chairman's) own selection will arrange for the meeting, and give the Fr. Minister all possible assistance in providing for the wants of the members.

(3) That the members who desire to present papers at the coming meeting should send abstracts in advance to the arrangement committee which shall take care of the publicity.

Fr. Sohon then explained the purpose of the above resolutions.

Fr. Berger suggested that there be elected a permanent secretary of the Association, but this was not put in the form of a motion and was not adopted.

Fr. John P. Smith made the motion that the Association express its condolences to Rev. Fr. Provincial on the death of his brother. The motion was carried.

Fr. Joseph Kelley of Weston College then explained the work and purpose of the Science-Philosophy committee.

(1) That articles on scientific-philosophical questions be published in the Science Bulletin.

(2) That a dictionary of terms common to both be compiled.

Rev. Fr. Schmitt then described the benefits and advantages the members of the Association enjoy from the Science Bulletin. The case of the recovery from a severe case of cancer of the father of one of our scholastics, who read in the Bulletin an account of a new treatment, was told by Fr. Schmitt. Fr. Schmitt also requested more cooperation from the members in writing and sending in their papers to the Bulletin.

The report of the Committee on Nominations was then called for and Fr. O'Conor announced that the committee had placed in nomination for the office of president Fr. Power and Fr. Butler and for secretary Mr. Hogan and Mr. Quevedo. In the election that followed Fr. Power was elected President of the Association and Mr. Quevedo Secretary.

Fr. Power then thanked the outgoing officials for their work during the year and especially Fr. Schmitt, Editor-in-chief of the Bulletin.

Fr. Assmuth then made the motion that the meeting adjourn. The motion was carried.

PRESENT AT SCIENCE CONVENTION

1934

Fr. Assmuth, Joseph
Mr. Bello, Augustin M.
Fr. Berger, Charles A.
Fr. Bihler, Hugh J.
Fr. Brock, Henry M.
Mr. Brown, J. Robert
Fr. Burke-Gaffney, Walter
Fr. Butler, Thomas P.
Mr. Carey, Philip A.
Mr. Cohalen, Joseph F.
Fr. Coniff, Arthur A.
Mr. Carroll, John
Fr. Delaney, John P.
Mr. Dowling, William H.
Mr. Duross, Thomas A.
Mr. Ewing, Franklin J.
Mr. Fiekers, Bernard A.
Mr. Fitzgerald, Paul J.
Mr. Fitzpatrick, Fenton J.
Fr. Freatman, Harold L.
Mr. Garvin, Francis C.
Fr. Gisel, Eugene A.
Fr. Gorman, Lawrence C.
Fr. Harley, James L.
Mr. Hauber, Edward S.
Mr. Hennessey, James J.
Mr. Heyden, Francis J.
Fr. Hohman, Arthur J.
Mr. Hufnagel, Alvin A.
Mr. Hutchinson, Gerald F.
Mr. Kane, Matthew W.
Mr. Keegan, Joseph C.
Fr. Kelley, Joseph M.
Fr. Kelly, Joseph P.
Fr. Kolkmeyer, Emeran J.
Fr. Love, Thomas J.
Fr. Lynch, J. Joseph
Mr. Lynch, Joseph P.
Mr. Miller, Walter J.
Mr. Molloy, Joseph J.
Mr. Morgan, Charles H.
Fr. Muenzen, Joseph B.
Mr. Murray, Joseph W.
Mr. McCauley, Charles E.
Fr. McCauley, David V.
Mr. McCawley, Edward G.
Mr. McDevitt, Edward D.
Fr. McGown, George P.
Mr. McGrath, Philip H.
Mr. McHugh, Lawrence C.
Fr. McNally, Paul A.
Mr. McNeil, Arthur L.
Mr. Nugent, Paul V.
Mr. O'Brien, J. Kevin
Mr. O'Brien, John J.
Mr. O'Byrne, Francis M.
Fr. O'Conor, John S.
Mr. Pallace, James J.
Mr. Perez-Becerra, Ignatius
Mr. Perry, William G.
Mr. Pfeiffer, Harold A.
Fr. Power, Francis W.
Mr. Quevedo, Anthony J.
Fr. Quigley, Thomas H.
Mr. Reardon, Timothy P.
Fr. Schmitt, Richard B.
Mr. Schweder, William H.
Fr. Shaffrey, Clarence E.
Mr. Shea, Anthony F.
Fr. Smith, John P.
Mr. Smith, Thomas N.
Fr. Sohon, Frederick W.
Fr. Sullivan, Joseph J.
Mr. Thoman, A. Robert
Fr. Tobin, John A.
Mr. Walsh, Lincoln J.
Mr. Walter, William J.
Mr. Welch, Leo W.
Mr. Zegers, Richard T.
Mr. Zegers, Theodore A.

NEW MEMBERS

Mr. Lawrence Brock, Weston College.
Mr. Robert Brown, Gonzaga, Washington, D. C.
Mr. Philip Carey, Brooklyn, N. Y.
Mr. Joseph Cohalan, Woodstock College.
Mr. James J. Devlin, Weston College.
Mr. Joseph J. Donohue, Weston College.
Mr. Joseph C. Dooley, Boston College High.
Mr. J. Franklin Ewing, Woodstock College.
Mr. Eugene B. Gallagher, Canisius College.
Mr. Gerard A. Haggerty, Woodstock College.
Mr. Gerald Hennessy, Holy Cross College.
Fr. Sidney Judah, Weston College.
Mr. Joseph Martus, Holy Cross College.
Mr. Edward McCawley, Woodstock College.
Mr. Charles McCauley, Woodstock College.
Mr. Lawrence C. McHugh, Georgetown University.
Mr. Leo R. Muldoon, Boston College.
Mr. Joseph W. Murray, Woodstock College.
Mr. Paul V. Nugent, Woodstock College.
Mr. Francis M. O'Byrne, Woodstock College.
Mr. James J. Pallace, Fordham University.
Mr. Arthur F. Shea, Woodstock College.
Mr. Thomas N. Smith, Woodstock College.
Mr. Frank Wilkie, Boston College.
Mr. Richard T. Zegers, Woodstock College.
Mr. Theodore A. Zegers, Woodstock College.

Dedication

With humble recognition
of his untiring devotion
to the cause of science

This Number of the Bulletin
is Dedicated
To the Memory of

Rev. George Francis Strohaver, S.J.

Professor of Chemistry

President of the
American Association of Jesuit Scientists
1924 - 1926

Rev. George F. Strohaver, S.J.

Professor of Chemistry

REV. GEORGE FRANCIS STROHAVER, S. J.
1886 - 1934

"For if it shall please the great Lord,
He will fill him with the spirit of understanding;
And he will pour forth the words of his wisdom
As showers . . . .

Many shall praise his wisdom
And it shall never be forgotten.
The memory of him shall not depart away."
Eccl. 39, 8 . . .

Only occasionally in life do we associate with men who are so blessed with extraordinary gifts and accomplishments, that they can do *all* things well. Most of us have abilities that are normal; and we find our field of endeavor after reaching maturity and we make a supreme effort to make that one endeavor successful. We succeed more or less. It's really exceptional to find someone who is so endowed with physical and intellectual accomplishments that *all* endeavor is successfully and thoroughly executed. Such a man was Father George Strohaver. He was a scientist, a philosopher and an orator.

He was born in Baltimore, Maryland, September 2nd, 1886, the son of John and Anna Strohaver, of German-Irish extraction. He attended the parochial school of St. Gregory's parish and was taught by the Sisters of Mercy. Even in his early youth, he distinguished himself in his studies, particularly in mathematics and christian doctrine. At the age of fifteen, he entered Loyola High School, and each year he showed that his intellectual ability was above the average. In the college department of Loyola, he again was the leader of his class and his main interests were in the art of expression, namely oratory, debating and acting. He had a leading part in every play that was presented at Loyola during his college career. He enacted roles in Shakespearean drama and other lighter productions. Then too, he showed a special aptitude for chemistry and always took highest honors in this branch of science.

On September 8th, 1907, he entered the Society of Jesus at St. Andrew-on-Hudson, Poughkeepsie, New York. He gave himself wholeheartedly to the study of the Ignatian rule of life, namely to conquer self and give forth his efforts for the greater glory of God. With this principle always in mind, he launched forth on his glorious career that ended so abruptly. He spent four years at the Noviciate, and then sojourned to Woodstock College, where he spent three years studying philosophy and science. After these seven years of intensive application, he was well prepared for the five years of regency.

His first assignment, as a professor of chemistry, was at Fordham University, New York City, in the year 1914. He taught inorganic and analytical chemistry. His labors at Fordham included the directorship of dramatics; and his productions were master-pieces of technique and dramatic art.

In September 1917, he was assigned to teach organic chemistry at Canisius College, Buffalo, New York. He was there only a year and four months, when the Reverend Father Provincial sent him to Boston College to finish his regency at the new college at Chestnut Hill. His scholastic teaching period being completed, he returned to Woodstock College for his theological studies; and was ordained to the priesthood on June 29, 1921. His former pastor, Bishop O. B. Corrigan, was the officiating prelate in Dahlgren Chapel of Georgetown University, Washington, D. C. He remained at Woodstock until he finished four years of theology and again he showed his superior qualities in his public appearances expounding the doctrines of divine truths. His last year of spiritual formation was at St. Andrew-on-Hudson, where he made his tertianship.

Having now finished seventeen years in the Society, he was ready to do his most efficient and most successful work. His first appointment as a fully formed Jesuit, was to Fordham University as Head of the Department of Chemistry; and in the Spring of 1925, he was made Dean of the Undergraduate School. In both of these assignments he showed his splendid faculty of organization, which was one of his great assets in his varied career. However, as a chemist, he showed his greatest efficiency at Holy Cross College, Worcester, Mass. During the seven years of Father Strohaver's directorship of the Department of Chemistry, he rebuilt the old laboratories and constructed several new ones. He also established many new courses in chemistry and fully organized these courses in such a way that the faculty now grants degrees of Bachelor of Science and Master of Science; the latter being post-graduate work under the guidance of a competent faculty. While here, he founded and directed "THE HORMONE", a chemical journal from the Chemists' Club of Holy Cross College. This magazine had a nation-wide circulation and received the highest commendations from colleges and universities throughout the country. He was a charter member and president of the Worcester Chemists' Club. One of his co-workers, a Professor of Chemistry, who labored with him for seven years, well said: "Father Strohaver left a record at Holy Cross College which will remain for many years a monument to his genius and industry." As a preacher and orator he was eagerly listened to by many thousands in the city of Worcester and its environs, and they always remember his ringing appeal and clear exposition of the Divine Truths. With all his genius in oratory, science and philosophy, he had a keen wit and humor, clever and unique but never offending; he combined the genial humor of Dickens with the piercing wit of Dean Swift.

Father Strohaver was a charter member of the American Association of Jesuit Scientists (Eastern States Division) and was the president of this organization from 1924 to 1926. We recall too, that he formulated the schedule of studies for the Science Courses in our colleges and universities; and this schedule is still followed at the present time.

The sudden death of Father George Coyle in 1932, left the Chemistry Department of Georgetown University, Washington, D. C., without a director; and so in July of that year, Father Strohaver was appointed Dean of the Department of Chemistry in that institution. Here again he was confronted with the problem of planning and designing the new chemical laboratories in the White-Gravenor Building. The new laboratories were splendidly executed and he left another monument to his untiring efforts and exceptional ability as an organizer and a chemist. His efficiency was recognized, and besides his duties as Head of the Chemistry Department, he was made Dean of the School of Arts and Sciences in June 1933. Now he had an opportunity to extend his power of organization in a larger field of education; and again his indefatigable labors resulted in a splendid system of order and detail that was superb. Furthermore, it was here in the Capitol City where he displayed his greatest power as preacher and orator. From the first month of his arrival in Washington, until a few days before his untimely death, he was in constant demand to speak to eager audiences. During the Lenten Season of 1933, he gave three courses of sermons: on Sunday mornings, he preached at St. Matthew's Church, Washington; on Sunday, evenings, at the Cathedral in Richmond; and on Wednesday evenings, at St. Philip and James Church in Baltimore. In June and July of the same year, he gave a series of six addresses over a nation-wide broadcast, sponsored by the National Council of Catholic Men and the Radio Corporation of America. After each radio broadcast, he received hundreds of letters of commendation and expression of the spiritual help given to souls in their struggle of the battle of life. The spiritual encouragement and the increase of devotion to Christ in the Holy Eucharish which he gave to his thousands of listeners, is known only to God Himself. He also gave retreats at Manresa-on-the-Severn, many conferences and addresses in educational institutions to lay-people and religious. He held the attention of all his listeners by his diction, his logic and presentation of his arguments. Three weeks before his death, he spoke at a meeting in Washington, at which Protestant clergymen, lawyers, doctors and business men were present. After his formal address, these men, who were the intellectual leaders of the city, stormed him with questions for more than two hours on the teachings of the Catholic Church, the attitude of the Church on birth-control, divorce, philosophy and theology. At the conclusion of the meeting he received a long ovation. On the last Sunday in April, he spoke very forcibly to his fellow-members in the Loyola College Alumni Association on the topic of "Modern Philosophy." His last public appearance was the following Sunday, May 6th; he preached at the annual demonstration of the Sodality Union at the National Shrine of the Immaculate Conception. Even though these addresses and sermons were numerous and arduous, nevertheless, he gave himself without stint to his duties as Dean of the College. In the beginning of this short sketch, we remarked that he did *all* things well; surely we have given adequate proof of this patent fact.

Father Strohaver became ill on May 7th and was taken to the College Infirmary on May 9th. A few days later, he apparently recovered from what seemed to be cardiac rheumatism. However, he suffered a relapse and on Monday May 14th was taken to Georgetown Hospital. The following day the blood tests showed a streptococcus infection had developed in the blood stream. A blood transfusion was given, but proved unsuccessful. He was fortified by all the rights of the Church and in the presence of Father Rector and several of his fellow Jesuit priests he passed away on Friday, May 18th. The Mass of Requiem was in Dahlgren Chapel of Georgetown University, the place where he was ordained to the priesthood in 1921. After Holy Mass, he was laid to rest in Georgetown Cemetery in the presence of the entire student-body, members of the Clergy, representatives of various religious orders, many Jesuits and innumerable friends from far and near.

It may be said with literal truth, and not in the spirit of mere eulogy, that Father Strohaver's untimely death was a great loss not only to the Province, but to the Church in the Eastern States; and we may add that our Province is richer, more than words can express, for the years he spent with us. To those who had the privilege of knowing him intimately, his life, his labors and his ideals will always be an inspiration.

"These shall resist the empire of decay
When time is o'er, and worlds have passed away;
Cold in the dust the perished heart may lie:
But that which warmed it once, can never die."

Richard B. Schmitt, S.J.

REV. GEORGE FRANCIS STROHAVER, S.J.

Scientist, Philosopher and Orator

Born: September 2, 1886, at Baltimore, Md.

Early Education: St. Gregory's School, Baltimore, Md.

1901-1907 Undergraduate Studies at Loyola College, Baltimore, Md.

Sept. 8, 1907 Entered the Society of Jesus.

1907-1911 Novitiate and Classical Studies, St. Andrew-on-Hudson, Poughkeepsie, N. Y.

1911-1914 Philosophical Studies, Woodstock, Md.

1914-1917 Professor of Chemistry, Fordham University, New York City.

1917-1918 Professor of Chemistry, Canisius College, Buffalo, N. Y.

1918-1919 Professor of Chemistry, Boston College, Boston, Mass.

1919-1923 Theological Studies, Woodstock, Md.
Ordained to the Priesthood, June 29, 1921.

1923-1924 Tertianship at St. Andrew-on-Hudson, Poughkeepsie, N. Y.

1924-1925 Professor of Chemistry and Dean, Fordham University, New York City.

1925-1932 Professor of Chemistry, Holy Cross College, Worcester, Mass.

1932-1934 Professor of Chemistry and Dean, Georgetown University, Washington, D. C.

May 18, 1934 Died at Georgetown Hospital, Washington, D. C.

PUBLICATIONS: Organizer and Faculty Director of "THE HORMONE", a Chemical Messenger from the Chemists' Club, Holy Cross College, Worcester, Mass. (1927-1932)

LABORATORY MANUAL FOR GENERAL CHEMISTRY. (1932)

Revision of: "COYLE'S BASIC ANALYSIS." (1933)

"LOVE'S VEILED VICTORY AND LOVE'S LAWS." (1933)

(Addresses delivered over a nation-wide broadcast sponsored by the National Council of Catholic Men and the National Broadcasting Co.)

BIOLOGY

FORMED ELEMENTS OF THE BLOOD

Harold A. Pfeiffer, S.J.

The formed elements of the blood include:—

1. The red corpuscles, or erythrocytes.
2. White blood cells, or leucocytes.
3. The blood platelets.

The erythrocytes are non-nucleated, circular disks having a shallow central depression on each surface. Seen on the flat, the corpuscle has a circular outline, the central depression appearing as a lighter or darker area depending on the focusing. Seen on edge, the shape resembles that of a dumb-bell. Singly, their color is greenish-yellow, en masse they give the red color characteristic of blood. Their average diameter is about 7.5mu, their greatest thickness is about 2.5mu. The larger are known as meglalocytes, the smaller microcytes. The corpuscles have a tendency to adhere to each other by their concave surfaces, forming rows or rouleaux like piled-up coins. Histologically, the erythrocytes appear entirely homogeneous in the fresh condition, or when subjected to ordinary technique. The corpuscles are very elastic and distensible, as may be seen when they are passing through narrow capillaries or around the bend of a branching blood vessel. In man there are about 5,000,000 erythrocytes in a cubic millimeter of blood, in woman about 4,500,000. The red blood cells of mammals are non-nucleated, highly specialized corpuscles which are used up rapidly by their intense physiological activities. The estimated duration of life of an adult erythrocyte is from three to six weeks. The red corpuscles are mainly destroyed by fragmentation in the blood stream, so-called blood-dust representing in part such debris.

The white blood cells contain no haemoglobin and differ from the red corpuscles in many other important respects. They possess a nucleus and they have the power of active ameboid movement by means of which they are able to pass through the walls of the blood vessels. They are much less numerous than the red cells, there being about 8,000 to the cubic millimeter of blood. The leucocytes never function in the blood itself, but outside the blood stream in the connective tissue. There are three classes of leucocytes:—a) the lymphocytes; b) the monocytes; c) the granulocytes. The lymphocytes vary in size from 7-10mu, the majority being about the size of a red blood corpuscle. They have a large spherical nucleus with stained, densely packed chromatin enclosed in a narrow shell of homogeneous cytoplasm staining with a basic dye. In the larger lymphocytes the nucleus may be ovoid and slightly indented and the cytoplasm more abundant. There are comparatively few granules found in the cytoplasm of the lymphocytes. Lymphocytes are comparatively undifferentiated cells and reproduce by mitosis. Such division does not take place in the blood stream itself as a rule. The lymphocytes constitute from 20-25% of the white blood cells. The monocytes, or mononuclear leucocytes, are large cells varying in size from 14-20mu. The nucleus is ovoid, kidney, or horse-shoe shaped, very rarely spherical, and usually eccentrically placed. In comparison with that of the lymphocyte the nucleus has a pale staining and finer nuclear network. The cytoplasm is abundant and has a somewhat reticulated or vacuolated appearance. Outside a few azurophilic granules the cytoplasm is not granular. The monocytes are characterized by their remarkable phagocytic activity. Granulocytes, or granular leucocytes, are characterized by the presence of numerous granules which may be seen in the living cell and which are easily demonstrated by common histological methods. In many cells these granules are fine and only slightly refractile, in some the cytoplasm is filled with coarse and highly refractile granules. They possess a many-lobed nucleus. The lobes of chromatin are as a rule connected by delicate chromatin strands, hence the name of polymorphonuclear leucocytes. According to the nature of their granulation, these leucocytes are divided into three groups, the neutrophile, eosinophile and basophile leucocytes.

1. The neutrophile polymorphonuclear leucocytes vary in size from 8-10mu, and are the most numerous of the white blood cells, constituting from 60-70% of their entire number. The polymorphous nucleus shows a variety of forms, usually consisting of from three to five sausage-shaped masses of chromatin connected by fine threads and arranged in the form of an S or a horse-shoe. The neutrophile leucocytes are cells of intense physiological activities. They are capable of rapid amoeboid movement and actively phagocytose bacteria and other small particles. They constitute the microphages of the body. The neutrophile granulocyte is a highly specialized cell, incapable normally of cell division and like the erythrocyte has to be replaced by new cells arising in the blood forming organs.

2. The eosinophile leucocytes are somewhat larger than the neutrophiles, and are characterized by an abundance of coarse, refractile granules of a uniform size, which stain intensely with eosin or other acid dyes. The nucleus is polymorphous, but the lobes are fewer, most commonly two in number. The function of the eosinophile is obscure. They show amoeboid movement but phagocytosis has not been observed. Normally they constitute about two to four per cent of the white blood cells.

3. The basophile leucocytes are present in blood in an almost negligible quantity, constituting less than half to one per cent of the white blood cells. In size they vary from 8-10mu. The nucleus is voluminous and usually irregularly polymorphous. The cytoplasm contains a variable amount of

coarse granules, which vary in size and stain deeply with basophilic dyes. Their function is also obscure.

The blood platelets or thrombocytes, the third of the formed elements of blood, are minute, colorless bodies from 2-4mu in diameter. In fresh blood their shape is round or ovoid, in fixed preparations they appear stellate. Their number has beben variously estimated, the average being from 200,000 to 300,000 per cubic milimeter. In the blood stream they are separate, but show a marked tendency to agglutinate directly the blood is drawn. Structurally they consist of a central granular mass which stains deeply with basic dyes, and a peripheral hyaline zone. No nucleus is evidenced. It is probable that they merely play a mechanical role in the process of coagulation, merely accelerating the formation of fibrin due to their great viscosity and tendency to agglutinate with each other.

ROLE OF PLATELETS IN COAGULATION

(Abstract)

Joseph G. Keegan, S.J.

1. Description of Platelets

They are demonstrable in preparations with Wright's stain but whether they are actual formed elements of the blood, whether they are cellular fragments or nucleated cells, whether upon disintegration they yield cephalin or some other product, are all matters requiring more accurate determination. They certainly manifest an activity in clot formation and in the reduction of the clot.

2. The observable phenomena in coagulation

A. In the injured blood vessel

The platelets aggregate at the site of a lesion and constitute a center of fibrin precipitation. A thrombus is formed to prevent blood loss through hemorrhage and to initiate the formation of scar tissue.

B. In collected blood

The deposition of fibrin in a hydrosol-hydrogel transition.

3. The known factors involved

A. Fibrinogen is a protein of the globulin group, probably produced in the liver and capable of being precipitated out of solution to form the essential acicular constituents of the clot. Laboratory preparations of fibrinogen solutions have yielded valuable information as to the mode of behaviour.

B. Thrombin, called fibrin ferment (lacking, however, several characteristics of the true chemical ferment) activates fibrinogen. It too has been prepared in potent form by laboratory methods.

C. Calcium salts are also essential to the process but appears to be concerned not with the end process of fibrin formation but rather with the activation of thrombin from its inactive form, prothrombin. The calcium must be present in a dissolved form and as an ionized salt.

D. Tissue extracts are also involved but at the present time it is hardly accurate to regard them strictly as known factors. The non-committal term, thromboplastic substances best designates the character of these so-called tissue extracts.

4. The Problem

Concerning these factors the investigators are for the most part in agreement. Coagulation is due finally to the interaction of thrombin and fibrinogen. Fibrinogen is present as such in the circulating plasm. Thrombin as such is not present but is produced by some single or multiple precursor after the blood is shed. For the production of thrombin the presence of calcium salts is requisite. However, these factors alone do not supply a comprehensive explanation of the entire process and consequently various theories have been proposed in order to fill in the lacunae in the factual framework. The origin of thrombin, the role of the calcium salts and the precise nature and influence of thromboplastic substances furnish centers of controversy and the theories differ largely in the manner they attempt to solve these issues.

5. Summary of the Main Theories

Morawitz—emphasizes platelet disintegration and endeavors to build up a theory on the factual data without postulating other factors.

Woolridge—ignores the influence of Ca salts and holds that thrombokinase and thrombogen interact directly to form fibrin. But in general his explanation can be interpreted in terms of that of Morawitz.

Nolf—regards thrombin as a coagulation product which is capable of further saturation to be converted into fibrin. He makes no mention of the platelets.

Bordet—calls the active substance in the tissues cytozyme (favors the view that it is a lipoid) and the prothrombin in the blood he calls serozyme. The two interact to form thrombin.

Howell—prothrombin can be changed to thrombin by the action of calcium alone, but in the circulating blood an inhibitory substance (antiprothrombin) prevents this reaction. The tissue extract which is a cephalin or cephalin compound, neutralizes antiprothrombin so that prothrombin can be activated by calcium. The tissue extract is derived in large part from the platelets.

Consequently, it is not accurate to assign any definite role to the platelets, but their unusual behaviour at the instant of clotting favors the view that the full explanation of the coagulation process will recognize the importance of the platelets.

HAEMOLYTIC SYSTEMS AND ERYTHROCYTES

(Abstract)

J. FRANKLIN EWING, S.J.

Haemolysis is the discharge of haemoglobin from erythrocytes. This is brought about by changes in tonicity of surrounding medium and by addition of lysins, e.g., saponin. Natural lysins are protein substances in sera of blood of different animals. For example eel's serum in small amount will produce haemoglobinuria or death in rabbit, depending on size of animal. Practical results of study of haemolysis are a greater understanding of blood transfusions and of immunization, as well as more speculative results in the field of protoplasm study.

Latest figures on erythrocytes of mammals, especially man, as given by Ponder (1934). Count in man—male, 5.47 million per mm^3, female, 4.75 million; diurnal variations not proven, nor age changes after two weeks after birth; after exercise and under low barometric pressure higher count. Dimensions—mean diameter, 8.6mu ± 3mu, shrinkage after drying 8-16%, variable on same slide, hence use of dried films for measurement misleading; mean thickness—greatest, 2.40mu, least 1.02mu; area—163mu^2, volume 88mu^3 ± 7mu^3. Shape—compromise between sphere and disc. Structure—a viscous (about olive oil) "cytoplasm" with investing pellicle; no stroma, this from work of micrurgists, microscopists, chemists. Permeability of membrane—with O_2 tension 1/3 atmosphere, pigment half sat. in 0.01 sec. CO more rapid. Facts lead to suppose membrane a mosaic of lipoids and proteins, various portions permeable or impermeable to substance in question.

Haemolytic theories discussed. Latest depend on base-binding power of haemoglobin, or on loss of osmotically active substances from cell.

CHEMISTRY

ELECTRICAL METHODS IN VOLUMETRIC ANALYSIS

(Abstract)

Rev. Francis W. Power, S.J.

The paper dealt with the application of electrical methods of determining the end point of the reaction between dilute sulphuric acid and barium chloride (or acetate). The application was particularly for the micro determination of sulphur by Pregl's method.

Both potentiometric titration and conductance titration have been extensively used for various volumetric problems. The former may be used in the form of the hydrogen or quinhydrone electrode combined with the calomel electrode; or antimony may be used instead of the hydrogen electrode. Bimetallic pairs, one of them sometimes polarized, are often used, especially the combination gold-tungsten. The output may be put directly on to a potentiometer, or it may be impressed on the grid of a vacuum tube and the resulting changes in plate current followed with a microammeter provided with a suitable shunt. In no case tried, however, in these experiments was there a sharp enough break in the titration curve to enable one to determine the end-point with sufficient accuracy.

If the dilute sulphuric acid be placed in a small conductance cell with the addition of about 33% of its volume of alcohol, the change in conductance as the titrating solution is added (barium acetate in this case) will give a fairly accurate indication of the end-point. However, it is never quite accurate enough for purposes of micro analysis; the end-point found by projecting the two branches of the conductance curve occurs a little too soon, and that found from the actual electrical minimum occurs a little too late.

In view of the other and simpler methods of handling the sulphuric acid from a micro sulphur determination, these electrical methods are not as yet recommended as substitutes.

It was suggested that the old barium chromate method for determining sulphates volumetrically be investigated with micro quantities to see if it is capable of the requisite accuracy for this determination.

THE MICRO DETERMINATION OF HALOGENS IN ORGANIC COMPOUNDS

(Abstract)

REV. RICHARD B. SCHMITT, S.J.

HISTORY:

Drs. Pregl and Hans Lieb, 1914. Combustion and absorption method.

Dr. Dieterle, 1921; and Drs. Nomura and Murai, 1924. A mixture of concentrated sulphuric acid and potassium dichromate together with silver nitrate for the oxidation of the organic material before proceeding to the determination of the halide.

Drs. Willard and Thompson, 1930. Oxidation of the sample by means of fuming sulphuric acid to which potassium persulphate was added. Then the halogen was distilled into alkaline arsenite and precipitated as silver halide.

Drs. Zacherl and Krainick, 1932. They modified the method of Nomura and Murai by employing a mixture of concentrated sulphuric acid, silver dichromate and potassium dichromate as the oxidizing agent and collected the halogen in a mixture of 0.01 N caustic soda with acid free hydrogen peroxide, in which it was determined by titration of the excess alkali.

PREGL METHOD:

Apparatus: Oxygen tank, bubble counters, drying tube, combustion-tube and burners, beads (glass or porcelain) or spiral, platinum boat, platinum contacts, receiving-tube and filter-tube.

Chemicals (halogen free): Distilled water, concentrated nitric acid, sodium carbonate, sodium bisulphite, perhydrol, silver nitrate, acidulated water and alcohol.

Procedure: According to Pregl.

Results: Tribromphenol:

5.040 mgm - 8.545 mgm AgBr	72.15% Br
Theory	72.27% Br

Trichlordinitrobenzene:

6.558 mgm - 10.41 mgm AgCl	39.27% Cl
Theory	39.19% Cl

Time of analysis: About four hours.

PARR BOMB METHOD:

Apparatus: Parr Bomb, test-tube and filter tube.

Chemicals (halogen free): Sodium peroxide, sugar, potassium nitrate, distilled water, concentrated nitric acid, silver nitrate (hydrazine sulphate), acidulated water and alcohol.

Procedure: According to Elek.

Results:	Ortho-chlor benzoic acid:		
	5.505 mgm - 5.105 AgCl		22.65% Cl
	Theory		22.66% Cl
	Chloro-m- cresol:		
	5.465 mgm - 5.465 AgCl		24.74% Cl
	Theory		24.88% Cl
	Bromocamphor:		
	3.510 mgm - 2.848 AgBr		34.53% Br
	Theory		34.60% Br

Time of analysis: One hour and a half.

VOLUMETRIC METHOD: To be published.

SUMMARY

A new method for the rapid and accurate micro determination of halogens on organic compounds has been developed. It is based upon the oxidation of the compound with sodium peroxide in a modification of the Parr sulphur bomb. From the variety of the substance analyzed, the method would appear to be applicable to all kinds of halogenated organic compounds.

IDENTIFICATION OF ORGANIC ACIDS

(Abstract)

Rev. Joseph J. Sullivan, S.J.

Before 1916, the accepted method of identifying organic acids was to prepare derivatives such as the acid amide, the anilide or the toluide, in many instances obtaining a compound which had a melting point above laboratory temperatures. In most instances, however, such derivatives were either oils or solids difficult to crystallize.

In an endeavor to find a reagent which would give derivatives of fatty acids with moderately high melting points, Reid of Johns Hopkins tried p-nitro benzyl chloride with some success. Later, he experimented with phenacyl bromide and then with p-bromo-phenacyl bromide with better results. In 1930, at the University of Maryland, Drake and his students tried p-phenyl phenacyl bromide and obtained esters both of the fatty acids and of the dibasic acids of the malonic series which gave satisfactory melting points. In 1933, Kelly at Holy Cross decided to try the effect of substituting bromine in the para position on the second phenyl group of the above to form the compound p (p-brom phenyl)-phenacyl bromide. He and his students prepared this reagent and the esters of this reagent for the first ten members of the fatty acid series. In all instances with the exception of the ester of butyric acid, the melting points of the compounds formed were considerably higher than those of the un-substituted p-phenyl phenacyl esters. Since the fatty acids were not re-purified in the Holy Cross laboratory, it would seem likely that the discrepancy in the case of the butyric acid is due to impurities in the acid. All the acids used, however, and the other materials used in the synthesis of the reagent were Eastman "highest purity" chemicals. This work is to be continued.

THE QUINHYDRONE ELECTRODE

(Abstract)

Bernard A. Fiekers, S.J.

(An abstract of the paper read at the chemistry section of the convention of the Am. Assoc. Jes. Scientists, Eastern Div., 8/22/34)

An attempt to extend the advantages of the quinhydrone electrode to the alkaline range of the pH scale was unsuccessful. Quinhydrone derivatives were used. They included the quinhydrones of:

Bromohydroquinone with benzoquinone,
Chlorohydroquinone with benzoquinone,
Dichlorohydroquinone with benzoquinone,
Toluhydroquinone with benzoquinone,
Hydroquinone with 1, 2, napthaquinone,
Hydroquinone with sodium-beta-napthaquinone-4-sulfonate,
Bromohydroquinone with sodium-beta-napthaquinone-4-sulfonate,
Chlorohydrequinone with 1, 2, napthaquinone.

THE DETERMINATION OF OXYGEN IN ORGANIC COMPOUNDS BY MICRO COMBUSTION METHODS

Gerald F. Hutchinson, S.J.

Introduction

Since the year nineteen hundred and ten, when Pregl introduced his method of micro analysis, micro and semi micro work have advanced with rapid strides into a position of remarkable popularity throughout the world. The method has been applied to practically all known quantitative analyses, and in most cases has met with complete success. The direct determination of oxygen in organic compounds has been a vexacious problem for some time, and only recently has a method been proposed which gives satisfactory results upon universal application. This is the method of ter Muelen which has been revised by Russell and Fulton at Brown University.[1] It is not surprising, therefore, that a search of the literature fails to yield any attempt to apply micro methods to direct oxygen determination. To find whether such an application can be made this work was undertaken.

Theory

The chemical reactions which take place are the same as those found in the macro method. The main point of theory is therefore, exactly the same, and consists in the control of the following reactions,

$$1\text{— } CO + 3H_2 = CH_4 + H_2O$$
$$2\text{— } 2CO + 2H_2 = CO_2 + CH_4$$
$$3\text{— } CO_2 + 4H_2 = CH_4 + 2H_2O$$

Since these reactions are reversible they go to some definite equilibrium, depending on the temperature, and during a definite period of time, depending on the catalyst. It is of prime importance that the optimun temperature be found and employed. Reid, in his text book on the subject[2], says that reaction one above begins between 180 and 200°C, and proceeds smoothly between 230 and 250°C. Reaction two begins at 230-300°C and proceeds without complication up to 400°C. Muelen claims that the optimum range for these reactions is 350-420°C. Russell and Fulton have found that their improvements have reduced the range to 300-350°C. The last authors cited also claim that all three reactions proceed to practical completion under the conditions of experiment, and all the oxygen is found in the first calcium chloride tube as water. The data to be presented should be interesting in view of these temperature ranges.

In the work that follows, what pertains to micro work will be taken as rigidly as possible from the directions of Pregl[3], and what is peculiar to the direct determination of oxygen will be taken with the same rigor from Russell and Fulton. Obviously the one precludes an absolute following of the other, but to these two sources the author is indebted for pointing two paths which he has tried to fuse into one.

Apparatus

Broadly the apparatus consists of three parts, the combustion tube heated in a carbon-hydrogen furnace, the purification train and the absorbtion train. The combustion tube and the absorbtion train are the parts demanded for micro carbon hydrogen, and which are listed in Eimer and Amend's catalog. The purification train was home made. Connections between the tubes were made by ordinary rubber tubing, since no pressure tubing, of sufficiently small bore, was available. To make up for this deficiency the ends of the tubes were brought together inside the rubber.

The purification train consisted of two calcium chloride tubes, a catalyst and a flow meter. The latter was discarded in the course of the work. All the purifying tubes were of the same size, 10 cm. long and 10 mm. outside diameter, and were made of pyrex glass fitted with rubber stoppers. The flow meter was of the usual construction, containing mineral oil and was calibrated for 40, 60 and 125 cc. per minute. One calcium chloride tube was placed after the catalyst and another after the flow meter. When the flow meter was discarded it was replaced by a soda lime tube.

A micro balance was used for all the weighings of the absorbtion tubes and the samples. To further protect the balance, a large square case with glass sides and top was placed over the balance case proper. On a few occasions only was it possible to obtain the sensitivity promised, namely ten pointer divisions equal to one tenth of a milligram. Usually the sensitivity was taken after the first weighing and this used for all subsequent weighings. It was found to be in the neighborhood of seven most of the time. The lighting system for the pointer scale was unique. A glass vessel, resembling a fish pond, was placed on supports on top of the outer case. Four 25 watt bulbs were suspended from a pipe into the vessel, the sockets being protected from the water by means of sealing wax. An outlet in the side of the vessel permitted the continual flow of water while the balance was in use. By this means a constant temperature was maintained, and since the temperature of the water was kept near the temperature of the room, this arrangement helped to maintain the whole apparatus at constant temperature. The light was abundant for the purpose and there were no disturbing influences from the heat generated. A set of Bureau of Standards calibrated weights was used throughout, those of denomination less than a gram being aluminum, and those of denomination greater than a gram brass. However, since all weighings were made by difference, and in most cases the difference was measured on the rider scale, this is unimportant.

A micro desiccator was made, but soon found unnecessary for the compounds employed, and then discarded. A two inch heavy walled capillary was drawn on a foot length of Carius tubing. By means of pressure tubing a calcium chloride tube was attached to the capillary end, and the large end attached to suction in such a way that the tube could be tightly stoppered. The substance to be dried was placed in a macro combustion boat and this placed in the desiccator. Dry air was sucked over the sample for the space of about an hour at a temperature just under one hundred degrees centigrade. The tube was then completely evacuated and allowed to stand till ready for use. It was found that drying in an oven was quite as efficient for the compounds used. The amount of substance used was so small that cooling was almost instantaneous, and no substance of great hygroscopic properties was used.

Preparation of Materials

The catalyst, thorium promoted nickel, the cracking surface, platinized quartz were prepared according to the method of Russell and Fulton, as described in the article already quoted. The catalyst for the purifying train, paladized asbestos, was prepared according to J. N. Friend.[4] The other chemicals used were those specified for micro work unless otherwise stated.

Experimental Work

The apparatus was set up as described and as shown in the accompanying diagram. At all times when not in use the absorbtion tubes were kept in the balance case. Holders were made for them by cutting out the center of the small end of large corks and lining the gauge with tin foil. On standing in these the static charge, if induced, was quickly dissipated, and by leaving the door of the balance case slightly open the temperature was rapidly equalized. The author noted that when the tubes were taken from the combustion train the hydrogen diffused out and was replaced by air, thus giving a variable weight for about an hour. To eliminate this source of error, the whole train, as taken from the combustion tube, was attached through calcium chloride and soda lime tubes to a pump, and air gently blown through for the space of two minutes. Definite weighings could then be obtained in ten minutes.

The three tubes were carefully weighed to the sixth decimal place and immediately joined by the rubber tubing and connected to the combustion train. A blank was run for one half hour. At the end they were carefully wiped with a clean towel, the hydrogen replaced by air, carried to the balance case and in due time reweighed. The boat containing the sample was then transferred to the combustion tube, and this section kept cold while any air which might have entered with the boat was blown out by a rapid stream of hydrogen. It was left in this manner while the absorbtion train was being assembled and joined to the combustion tube. When all was ready the speed of the hydrogen was adjusted to about 60 cc. per minute. The section of the furnace containing the boat was heated a short distance from the boat proper to somewhat above the melting point of the substance, gradually moved toward the boat and finally flush with the section containing the cracking surface and the catalyst. When all the substance was driven into the cracking surface the first section was again moved back, raised to full heat and again moved forward. This operation took about twenty minutes. Ten minutes more were allowed for blowing out the train. The rest of the procedure was the same as that after the blanks. Including the weighings each determination could be made in about half an hour.

Blanks

Although every effort was made to completely exclude all moisture and air from the apparatus, a zero blank could not be attained with regularity, and in practically all cases the correction had to be made. The nickel catalyst may not have been completely reduced at the start of the work, and this would account for the gradual decrease in the blank as the work progressed. Again the pallidized asbestos may have done its work but poorly. Yet considerable evidence of moisture was found in this tube at the conclusion of the work. It was suspected that some moisture was coming over the flow meter, and this was taken from the line and replaced by a soda lime tube, but the blank continued. Any of these reasons may explain the blank in the first calcium chloride tube, but the reason for the continued increase of weight in the guard tube over the loss in the soda lime tube remains a complete mystery to the author. These increases will be noted in the data presented.

Compounds Used

The benzoic acid used was the Bureau of Standards sample, No. 39d.

The succinic acid was previously purified until it gave a constant and sharp melting point, 189°C.

Cane sugar was tried but gave consistently high results.

Data

A	B	C	D	E	F	G
6.118	0.650	0.350	3.056	49.94	54.23	260-280
5.037	1.273	0.483	2.512	49.80		260-280
7.083	0.542	0.308	3.720	52.52		300-310
6.901	0.036	0.376	3.368	48.94		280-300
6.487	0.043	0.332	3.518	54.36	54.23	360.
5.592	0.000	0.332	3.096	54.37		360
7.285	0.056	0.241	1.904	26.14	26.23	360
5.808	0.056	0.241	1.520	26.30	26.23	360

The significance of the above data is as follows:

Column A represents the weight of the sample taken.

" B " the blank applied to the first calcium chloride tube.

" C " the blank for the guard tube, i. e. the gain in this tube over the loss of the soda lime tube.

" D " the total amount of oxygen collected, from the first calcium chloride tube and from the soda lime tube.

" E " the % oxygen calculated from the data.

" F " the theoretical % oxygen.

" G " the temperature of the experiment, i. e. the cracking surface and the catalyst.

The first set of data is for succinic acid, the second for benzoic acid. All weights are in milligrams.

Discussion of Results

The first point of interest to note is the relationship between the temperature and the percentage found. The optimum temperature as found by these experiments is 360°C., which confirms the work of Russell and Fulton on a macro scale, but is higher than that of the other authors cited in this paper. Russell and Fulton also state that under the conditions of the experiment all the oxygen will be found as water in the first calcium chloride tube. This could not be duplicated on the micro scale. The answer may readily be found in the activity of the catalyst. The divergence of results at the various temperatures is undoubtedly due to the incomplete reduction of carbon monoxide to methane. An attempt was made at the beginning of the work to test for carbon monoxide in the exit gas, but the author was unable to obtain any reaction of this gas which hydrogen would not also perform. Such a reaction would be of invaluable assistance in this work.

The catalyst and the cracking surface were heated in the same compartment and therefore to the same degree. In previous work the cracking surface was employed at red heat.

To the author the case of the blanks was quite interesting. The explanation may be found in a too rapid flow of hydrogen, or in some reactions between the exit gas and the soda lime. The subject demands further investigation.

Conclusions

1—Micro methods have been applied to direct determination of oxygen in organic compounds, and with the compounds used and under the conditions of the experiments, have been found successful.

2—The case of the blanks is far from satisfactory, and due to the uncertainty connected with them no general conclusion can be drawn.

3—For the compounds used the micro desiccatory was found unnecessary. The flow meter was discarded, perhaps with a sacrifice of accuracy.

4—The work is to be continued in the Holy Cross Laboratories.

(For diagram of apparatus: cf. Mr. Gerald F. Hutchinson, S.J.)

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MATHEMATICS

THE CHANGED ASPECT OF MATHEMATICS

(Abstract)

REV. FREDERICK W. SOHON, S.J.

The paper shows how the unfolding of the notion of a *group* has brought to our attention a multitude of new concepts and fundamental general principles vastly more significant than the particular developments of, say, quaternions, vectors, tensors and matrices. As a consequence, the new mathematics cannot be defined as a science that deals exclusively with quantity. Moreover, with the new generalized mathematics as a background, the new methods permeate problem after problem of the older mathematics.

INTERPOLATION

(Abstract)

REV. THOMAS D. BARRY, S.J.

The paper showed the method of forming tables of differences, and gave the three principle formulae for interpolation, with examples. The method of interpolation where rates are printed instead of differences was explained. Simple and double interpolation were also touched on.

THE DIFFERENTIATION OF THE DEFINITE INTEGRAL

(Abstract)

LINCOLN J. WALSH, S.J.

The paper treated of two special cases for obtaining the derivative of a function defined in terms of the Definite Integral. The first case dealt with the differentiation of the Definite Integral with respect to its upper or its lower limit. The second case treated of the differentiation of a function, which is defined as a Definite Integral containing a parameter.

COMPLEX NUMBERS

(Abstract)

William H. Schweder, S.J.

After a short history of the subject, the representation of complex numbers by means of the Argand diagram was discussed. Addition and subtraction were then shown to be much the same as the addition and subtraction of vectors. For multiplication, division, finding powers and extracting roots, the polar form of the complex number was found more advantageous.

MAPPING IN THE COMPLEX PLANE

(Abstract)

James J. Hennessey, S.J.

The paper concerned itself with the geometrical representation of complex variables in two planes. These planes have a relationship one to the other so that the curves in one plane map into corresponding curves in the other plane. This mapping was illustrated by several simple curves of various functions.

GEOMETRICAL DUALITY

(Abstract)

Philip H. McGrath, S.J.

The general notion of duality, as found in projective geometry, and the principles of duality as applied to a plane and space were given. Then several applications including the quadrangle and quadrilateral, cube and octahedron were examined. It was then shown why the duality did not hold in Cartesian geometry, and the importance of duality in higher geometry was mentioned.

THE CANONICAL FORM OF INCOMPLETE DYADICS

(Abstract)

John J. A. Devenny, S.J.

In discussing the Hamilton-Cayley Equation, we may assume that the roots of the auxiliary cubic do or do not vanish. If they do not, we obtain the seven complete dyadics, which may be found in Gibbs-Wilson, Chapter V. If they do, we obtain the following nine incomplete dyadics:

1. null
2. linear self-perpendicular
3. linear non-self-perpendicular
4, 5. planar self-perpendicular
6, 7, 8, 9. planar non-self-perpendicular

In the paper the canonical forms, and the geometric and analytic properties of the above dyadics are listed.

CIRCULAR AND HYPERBOLIC FUNCTIONS

(Abstract)

Peter J. McKone, S.J.

By a similar treatment of the circle and the rectangular hyperbola, each with a semiaxis one, we obtain the circular functions and the hyperbolic functions, and these functions correspond fully to one another.

ELLIPTIC INTEGRALS

(Abstract)

Rev. William D. Sheehan, S.J.

This paper aimed at being a simple, clear and brief exposition of the origin and use of elliptic integrals. In this exposition there were four steps.

1) It was shown how the elliptic integral first arose out of the attempt at rectifying an ellipse.
2) It was shown how the attempt to determine the time of oscillation of a simple pendulum gives rise to a similar integral.
3) The reduction of certain complicated-looking integrals to elliptic integrals was next treated.
4) A few words were finally said on the evaluation of these integrals by series and on the use of tables of elliptic integrals.

METEOROLOGY

INFORMAL MEETING OF FAR EAST OBSERVATORY DIRECTORS

On Sunday, April 15th, Father Gherzi, Meteorological and Seismological Director of the Zikawei Observatory, and Mr. C. W. Jeffries, Director of the Hong Kong Observatory, accompanied by Mrs. Jeffries, arrived in Manila on the "President Hoover." They were met at the pier by Fathers Selga, Depperman and Repetti.

Mr. Jeffries came directly to the Observatory and made a complete inspection under the guidance of Father Repetti, special attention being given to the seismological division. In the afternoon Father Repetti accompanied Mr. Jeffries to the magnetic observatory at Antipolo.

On Monday morning Father Selga accompanied Mr. and Mrs. Jeffries to Baguio whence they returned on Tuesday evening.

Father Gherzi devoted the entire day of Monday to a conference with Father Depperman on Meteorology. On Tuesday morning Fathers Gherzi and Repetti discussed seismological problems and methods. In the afternoon Mr. Heyden accompanied Father Gherzi to the Naval Transmitting Station at Cavite.

All of Wednesday morning was devoted to a conference by Fathers Selga and Gherzi and Mr. Jeffries and in the afternoon Mr. Jeffries departed for Hong Kong on the "President Hoover".

On Thursday Father Gherzi visited the Naval Radio Receiving Station at Los Banos and the seismic observatory at Ambulong on Lake Taal. On Saturday afternoon he went to the magnetic observatory at Antipolo. He took advantage of this visit to Manila to arrange with Dr. Faustino of the Bureau of Science for an exchange of shells and corals for the new Jesuit museum at the Aurora University in Shanghai.

Father Gherzi sailed for Shanghai on the "President Grant" on Wednesday, April 25th.

From the South China Post, Hong Kong, April 23rd, 1934.

WEATHER EXPERTS CONFERENCE

Co-operation By Far East Observatories

Local Signal Code.

Hope for improvements in the joint service of the Hong Kong, Manila and Shanghai Observatories to the public in the future was voiced by C. W. Jeffries, Director of the Royal Observatory, Kowloon, on his return to the Colony after visiting Manila for conference with Father Gherzi, of the Shanghai Observatory, and Father Selga, Director of the Central Observatory of the Weather Bureau, Manila, on matters bearing upon the work of the three observatories.

Mr. Jeffries left Hong Kong on April 13th and arrived in Manila two days later.

On the voyage and during his stay, Mr. Jeffries told a S.C.M. Post representative he had many opportunities of discussing with the other two directors matters affecting their respective observatories. Before leaving on Wednesday last Mr. Jeffries sat in conclave with the two Fathers for the greater part of the morning and the result of their deliberations was an undertaking to cooperate in every way in order that each Observatory should be able to produce the most accurate maps and give the best weather service in its power.

Local Signal Code

Sympathetic consideration was given to the recommendation of the International Meteorological Organization to adopt two new signals to replace the traditional "drum" and "ball", but neither Father Selga nor Mr. Jeffries felt that local traditions should be hastily disturbed. If any adaptation of the local signal code is made it will be made in Manila and Hongkong simultaneously. In the meantime the Shanghai authorities will institute a code which is to contain nothing inconsistent with that which Manila and Hongkong may eventually adopt.

In the course of the past twenty-five years, there have been many visits to Hongkong by the different members of the institutions at Manila and Shanghai, and the greatest cordiality has existed in the relations between Mr. Jeffries' two predecessors and himself, and the successive heads and assistants of the sister institutions. More frequent visits by the officers of this department might be deemed an advantage, but the local personnel is comparatively limited and opportunities are not so easily found. Although something of a business man's holiday, Mr. Jeffries said he enjoyed his trip very much, and appreciated the opportunity of meeting together the distinguished meteorologists whom he had previously met separately.

Visit to Baguio

It was difficult said Mr. Jeffries to adequately express his appreciation of the courtesy and hospitality of Fr. Selga. In company with his Assistant Director, Fr. Depperman, and the superintendent of magnetical and seismological work, Fr. Repetti, he met Mr. and Mrs. Jeffries on arrival, and practically gave them the whole of his time during their stay. In his company he visited the Mirador Observatory at Baguio, and on the journey to and fro, and at other times, he found him a most entertaining companion, and a mine of information on all things concerning the Philippine Islands. The order of Jesuits has been established in the Philippines for an extremely lengthy period, and their archives probably contain the complete history of the Archipelago since the earliest Spanish occupation. From personal experience Mr. Jeffries said he imagines that it would be difficult to find more charming and instructive mentors in any matter concerning the Philippine Islands.

Baguio was a most entrancing spot; the railway journey of five hours through flat country was distinctly monotonous, but the drive of two hours by motor coach and the thrill of ascending the Zigzag was not easily forgotten. It was quite an ordinary thing to fly from Manila to Baguio these days, the journey taking about one hour.

Rev. William C. Repetti, S.J.

PHYSICS

A PREREQUISITE FOR THE COLLEGE DEGREE

REV. EMERAN J. KOLKMEYER, S.J.

The occasion for this paper was a change in the college schedule proposed here last spring: a change in the catalogue rule* reading:

> ''In all cases it is plainly understood that whatever a student's major may be, he is always obliged to follow the prescribed courses of Philosophy and Physics in junior and senior' . . . .'

The specific change was to be made in two steps: this year the junior was to be permitted to elect between physics and biology for his science, and next year, or later, when the consultors of the province should pass it, to drop chemistry also from the column of obligatory subjects and shift it into the elective column. The change has already been made in some other colleges of this province.

The problem to be solved was, it seems, the nesessary reduction of a schedule too heavy for the average student to carry. The argument advanced for the change was that 'only one course in science is required in other colleges for the A.B. degree, without any prescription for any particular science,'; although I may be permitted to point out that the action or policy of these other colleges was admitted to have no weight whatsoever in regard to the other subject mentioned in the same rule, viz., philosophy.

Other arguments too have been heard from time to time stressing the need of reducing the status of the physics course: in order to provide room at least for work in biology as a subject of general cultural interest and a necessary preparation for the work in psychology; to provide room also for chemistry with its broad covering of all the materials in modern life and to prepare the student for his cosmology, particularly for the discussion on the constitution of matter. Then too, on the word of at least one dean, difficulties of schedule, faculty, class room have had their influence in the same direction, while on the word of several deans, it is to be noted that physics is too hard for many students, they spend too much time on it, and they should be permitted to elect the easier subjects of chemistry or biology.

Without intending to criticise anyone whose function and duty it is to permit, sanction or make changes in the schedule of studies, we propose here merely to make a timely examination of the problem. For it is the province of the physics teacher to study and to know the importance of his subject better than any one else, and to present that knowledge where it may be useful.

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*Catalogue Georgetown University—the College. 1933-34, page 39, under the heading REQUIREMENTS FOR THE A.B. AND B.S. DEGREES.

The point we would make, succinctly stated, is this: When there is room for a single, one-year course in a natural science in a non-scientific college course (A.B., Ph.B., B.S.S., etc.), that science should be physics. Practically the question reduces itself at present to a choice between physics as an obligatory subject and the privilege of electing either chemistry or physics or biology.

No good logician, and certainly no good scientist, will spurn the argument from experience, and we shall appeal first of all to the formulated experience of three hundred years of teaching as embodied in the Ratio Studiorum of the Society. Let us note several of the studied prescriptions found therein:

> The professor of physics is listed as one of the professors of philosophy, just as is the professor of ethics, cosmology or psychology.
>
> He is to be a Jesuit.
>
> The matter he is to teach is set forth in Rule 30 of the rules for the professors of philosophy; it says: "After some general notions on the properties of bodies comes the explanation of dynamics, mechanics, hydrostatics, hydraulics, air in motion, pneumatics and the points refering to them; the elements of astronomy; the treatises on light, heat, electricity, magnetism, and if desirable, on meteors."
>
> His rule No. 31 makes the only mention of chemistry and it says, best quoted in Latin, "Chemiam, ubi unus est tantum physicae professor, brevius pertractet".
>
> His rule No. 37 is the only one to hint at biology in the ratio. It reads "Historiae naturalis, ubi Superiori videbitur opportunum, elementa tradere poterit."

There is no question of the exalted position of the subject of physics in the tradition of the society, nor for that matter, of the more lowly place given to the other sciences.

But are not the times so changed, and the sciences so modified in their value that we must depart from the old order and establish a new and more satisfactory one? The times have changed, and the sciences have grown enormously in importance, but today more than ever it is the subject of physics that should be given the student who can take but a single one-year natural science course in his stay at college. For physics is the broadest and the most fundamental of the sciences.

Physics may be defined as the science of the continuous properties of matter, or, better I think, as the science relating to the more general laws of matter and energy. The parent of practically all the physical sciences (this very name tells their origin) physics grew and developed and propagated itself into many sciences. These have now also grown and developed and themselves propagated the characteristics of the parent. In all of these so called new sciences we find hardly anything but the special applications of the fundamental laws proposed, expounded and explained in what is at present admitted to be the domain of pure physics.

In fact we find these sciences forever actually harking back to the solid principles they took from their parent science, and, in the deeper searches into the portion of nature singled out by the special sciences, so evident has this general return become that in modern literature and in modern text books such terms as astrophysics, physical chemistry, geophysics, biophysics have become commonplaces. One might even go so far as to agree with the statement that the real science in the progeny of physics now insists on being recognized even in name as the legitimate child of the father of all the natural sciences: physics.

Now it is not the specialized subjects and the particular applications of the laws of nature that we hope to teach in the courses leading to the non-scientific degrees. It is the purpose of the Arts course to develop the whole man and in last years of his college to fit his mind to accept the findings of specialists, judge the value of their discoveries and to weigh their conclusions in the light of his knowledge of general and fundamental principles. There is no change ever intended in the old rule No. 34 of the professor of physics which reads: "The professor is to expose theories, systems and hypotheses so as to make it clear what degree of certitude or probability belongs to each."

And how much more often does not science, logic and truth suffer from the loose application of fundamental principles than from the supposed recognition of a fact; from the explanation more often than from the description of a phenomenon?

But rather than go directly into the advantages of physics to the Arts or non-scientific student, let us compare it with the two other possible substitutes: chemistry and biology. For these the schools are now provided with the faculty, laboratory and physical equipment. They are acceptable to the accrediting associations.

Biology. Let us say at the outset that biology would be our second choice for a science if two sciences were to be taken in the course. This science, treating of living things, in contrast to the non-living objects of the other natural sciences would seem to be in a class by itself in that it is independent of physics. It has two very strong points in its favor as the choice for a single one-year course in natural science. It treats of living things and that is very important for us as living beings. It treats in some detail a few of the subjects the student should have learned for his psychology.

But biology does not treat of life; philosophy does that. And because it is a factual course, interested in the classification of living things according to structure, development and organization, there is much memory work. Too much memory work. In our system the memory should have been trained before this stage. The intellect should now come in for practise in precise thought and no one will deny that there is more hard accurate thinking required of the student in a one-year physics course than in a one-year course in biology. No student ever denied that. Biology gives a good training in sharp observation and the production of good scientific reports; but the laboratory in physics does not lag behind here, and besides gives the student a healthy exposure to the inevitable experimental error so likely to vitiate results in scientific research.

Despite the questions of life, sense knowledge, evolution, etc., which require some biological knowledge for their discussion in philosophy (psychology), it still seems that a course in physics is to be preferred to a course in biology as a preparation for philosophy. It is so much more easy to read up the necessary biology than the necessary physics. The following question was put to our professor of psychology (Fr. Lucey, S.J.): If either physics or biology is to be given in the college course, which is more necessary as a preparation for philosophy? He answered "Physics" and allowed himself to be quoted. In fact he claims he gives all the biology necessary for his course in his lectures, in notes, or in assigned reading. Two other professors of the same subject in the province do the same thing. On the other hand he says it would be impossible for either the professor to give or for the student to find for himself the physics required for the understanding of certain parts of philosophy.

Chemistry. When it comes to a choice between the one-year courses of chemistry or physics for the A.B. there is no question whatever. Chemistry is a specialized branch of physics.

The little round solid homogeneous atom has been blown to bits by the physicist, and now the chemist explains his ionization, affinity, periodicity of properties, crystal structure, etc., on the new complex little universe of nucleus, and electrons, protons, nuclear and planetary electrons, positrons and neutrons. He has learned that the reason his most delicate methods failed to explain why all atomic weights were not integers is because his methods were incapable of detecting the difference between isotopes. The test tube and the balance must give way to the potentiometer, the spectroscope, to X-ray analysis and to the mass spectograph. Theoretical chemistry—the science of chemistry—is more and more a restricted use of the methods of physics.

The modern one-year course in chemistry is being called pandemic chemistry: chemistry for all the people. The originator of this type of teaching a single one-year course, Professor John Arrend Timm of Yale, states in his preface to the first edition of his text:

> "It is inevitable that much of physics must be included in a text of this type. For this the author offers no apologies for he is convinced that as time goes on the early training of both physicists and chemists will be practically identical and that in order to understand modern chemistry some knowledge of physics is essential to the elementary student. This knowledge can not be assumed in the case of students of the type for which this text is primarily designed."

And then he proceeds to give so much space to physics, pure physics, that one wonders at the title to the book: An Introduction to Chemistry, until one remembers that the only introduction to the specialized field of chemistry is physics.

It is interesting to note the percentage of problems Richardson, in his General Chemistry, takes from the physics texts: Every one of the 17 problems in at the end of chapter VIII could be transferred without change to a physics text.

If then only one of the natural sciences is to be taught how can that science be chemistry, a specialized field wherein some of the fundamental physics would have to be taught anyhow, and the rest of the scientific fundamentals left entirely untaught in the college course?

And when it comes to a preparation for philosophy one must almost close one's eyes to the notions of the old chemistry with its chemical changes and its affinities and seek nearly all the new information on the constitution of matter from the new physics. The new chemist, talking on the constitution of matter is talking pure physics.

LABORATORY CONSTANTS

(Abstract)

REV. HENRY M. BROCK, S.J.

In this paper a brief discussion was given of certain fundamental constants whose values are not only of general interest in connection with the work of the Physics Laboratory but are also sometimes useful in the solution of problems and in correcting and checking experimental results. Those considered were the position and elevation of the laboratory, the acceleration of gravity and the magnetic elements. It was pointed out how their values may be obtained most conveniently.

1) Geographical position: There are various ways of finding the latitude and longitude of the laboratory or of some point on the campus. Where no great accuracy is desired the simplest way is to scale off the values on the U. S. topographical map of the district. These maps are published by the U. S. Coast and Geodetic Survey and may be obtained from Washington for ten cents a sheet. They are also usually carried in stock by several stationary and book sellers in the larger cities. Of course the values obtained will be affected not only by the error of estimation but also by the errors of the map. This fact and the size of the map itself will in general permit one to obtain only the position of the college as a whole and not of any particular point. A direct astronomical determination may also be made. Georgetown and Woodstock are our only colleges in the East with observatories where accurate observations have been made. When instruments of precision are not available a sextant or surveyor's transit may be used according to methods given in standard Manuals e. g. Hosmer's "Practical Astronomy". However, an ordinary transit reads only to minutes of arc which in the case of latitude corresponds to about a mile. The mean of a number of observations will give a closer result. The geodetic method is very satisfactory and is capable of considerable accuracy. A conspicuous point such as a cross or pinnacle on a tower is selected and the distance from it to some point whose coordinates are

known is measured by triangulation. The azimuth of the line is also found from a known azimuth. The difference between the coordinates of the two points is then computed by standard formulae.

2) Elevation: This is the height above mean sea level of the floor of the laboratory or of some point on the campus. A rough value may be obtained by estimation from the contour lines on the topographical map but it is much better to measure it directly according to methods given in books on Surveying e. g. "Elementary and Higher Surveying" by Breed and Hosmer. A Wye or Dumpy Level and a leveling rod are used. If a Level is not available a transit may be used although its spirit level is less sensitive. The nearest bench mark whose elevation is accurately given must first be located. The Geodetic Survey has established a large number of precision marks throughout the country, usually along some railroad. Their location in any district may be obtained from the publications of the Survey or by writing directly to the Washington office. It may happen that the nearest mark is at an inconvenient distance. In this case a nearer state or city mark may be found. If nothing else is available the nearest railroad may be able to furnish the elevation of some convenient point along its line.

3) The acceleration of Gravity ("g"): It is not possible to determine this constant with satisfactory accuracy with the apparatus available in the ordinary laboratory. The Geodetic Survey has made many precise determinations throughout the country. It is only necessary to write to the Washington office giving the location and elevation of the college. They will furnish the most probable value interpolated from that of the nearest station.

4) Magnetic declination.

5) Magnetic inclination or dip.

6) Horizontal Component of the earth's magnetic field.

These magnetic elements are considerably affected by the steel construction, conduits and electrical circuits of our laboratories. They may change from room to room so that they are of little practical use in the laboratory. Moreover the declination is changing continually. The best that can be done is to have on record the general values for the district. These may be obtained with fair accuracy from the magnetic maps of the Geodetic Survey but again it is just as convenient to write to Washington for information. They would know of any local anomalies. The annual change in the declination must also be obtained. This may amount to four or five minutes a year. The declination, since it gives the deviation of the compass from true north, is the most important magetic constant. It is useful in surveying. For most purposes it may be obtained with sufficient accuracy with a surveyor's transit by observations on Polaris or the sun for the meridian. The dip can be determined with a dipping needle or with an earth inductor and ballistic galvanometer. The horizontal intensity can be measured with a magnetometer. To have any general value all such measurements must be made in a place free from magnetic disturbances.

THE TEACHING OF WAVE MECHANICS IN THE A. B. COURSE

(Abstract)

Rev. John A. Tobin, S.J.

The paper reported the work done in teaching Modern Physics to members of the A.B. course who have completed one year of Philosophy. As they had completed their study of Cosmology the students are prepared to accept theories that seem to be at variance with their senses. The problem is to explain these theories to students who have no great mathematical training.

As an example the "Wave Theory of Matter" was explained. A century ago there were six distinct branches of Physics. After 1900 we had two branches, Molecular and Atomic Physics for particles, and the Electromagnetic Theory for waves. Matter was corpuscular and light was a wave. On account of the great symmetry in nature it was only natural to suggest that both matter and light have the dual nature of a corpuscle and a wave. In 1924 Louis de Broglie worked out this Wave Theory of Matter.

From other lectures the following was presupposed. a) The determination of the value of e by Millikan. b) The prod''ct of a charge by the potential is work. (W = QV) c) The Kinetic Energy is equal to the work. $\left(Q\,V = \frac{m\,\bar{v}^2}{2}\right)$ d) Thompson's value of the specific charge. $\left(\frac{q}{m}\right)$. Also from the photoelectric effect the velocity of ejection is only a function of the frequency. The energy is found E = h n.

From the Compton Effect the MASS and the MOMENTUM of the Photon is determined. $m = \frac{h\,n}{c^2}$

$$m\,\bar{v} = \frac{h\,n}{c}$$

DeBroglie suggested all this could be applied to the small particle called the electron.

$$c = n\,\lambda$$

$$m\,v = \frac{h}{\lambda}$$

$$\lambda = \frac{h}{m\,v} \text{ and u (vel. of material wave)} = \frac{h\,n}{m\,v} = \frac{m\,c^2}{m\,v} = \frac{c^2}{v}$$

But the velocity of the material wave is found to be greater than the velocity of light. To avoid this difficulty they used the new mathematics of group velocities. If we have a large number of waves in different phase they partly destroy each other and partly reinforce each other as in the phenomenon of beats in sound. These beats travel at the same velocity as the waves, or with a smaller or greater velocity, depending on the velocity of the waves that reinforce each other. The Photon then is a beat of light or energy center that travels with the velocity of light. The electron is an energy center or beat that travels with the velocity of the electron waves. When Davisson and Germer discovered the diffraction of electrons they used this theory to explain the waves from what we think are corpuscles.

VELOCITY OF LIGHT AND THE DOPPLER EFFECT

(Abstract)

REV. JOHN S. O'CONOR, S.J.

From a consideration of the limiting case of a vibrating source in motion, it was shown that from Doppler's principle such a body must cease to radiate before it can move with a velocity equal to or exceeding that of the wave velocity of the medium in which it is moving.

Reasoning from the Third Law of Thermodynamics, the conclusion follows that it is impossible for any body to move with a velocity equal to or exceeding the value of c,- the velocity of light. This conclusion while in agreement with the implications of the special Relativity Theory, seems to have been arrived at independently of any postulates of the same.

JOULE AND THE MECHANICAL EQUIVALENT OF HEAT

LAURENCE M. BROCK, S.J.

Until about a century ago Heat was supposed to be a substance devoid of weight or mass, called "Caloric" which when added to a body caused it to become hotter and when withdrawn left the body colder. Probably the first to undermine this theory was Count Rumford, an Englishman, employed by the Austrian government to make heavy caliber guns. It was about the year—1798—when Rumford observed that in the process of boring guns the rise in temperature was so great, that he found it difficulty to justify the postulates of the Caloric Theory, that the heat was due to the Calories set free by the abrasion.

His interest being aroused Count Rumford set himself the task of verifying, and if possible of refuting the prevalent theory of heat. After exhaustive tests of one kind and another, he convinced himself and many others that the Caloric theory could not be justified. His most spectacular proof was founded in the fact that as the drilling continued and more Caloric was taken from the cannon, it actually became hotter instead of colder as the Caloric theory required—furthermore the amount of heat developed seemed to depend upon the amount of work done in the turning of the drill.

Despite these pioneering experiments many were not convinced that the theory had been refuted, since they still claimed that an explanation could be had in the abrasions. Sir Humphrey Davy in 1812 now came forward with the first conclusive proof against the Caloric theory. Taking two blocks of ice Davy carefully flattened their sides and placed them in a vacuum receiver. Here shielded from any extraneous heat he could move them to and fro by means of two rods also insulated from external heat by two stuffing boxes.

Sir Humphry Davy now rubbed the two blocks of ice together and water collected in the bottom of the receiver. If the motion ceased, no more water was formed. According to the Caloric theory the Equation should be—

Ice + Caloric = Water.

In Davy's experiment no Caloric was supplied to the ice yet water was formed. It was impossible to explain the effect by the "ebrasion idea" used to account for the effects observed by Rumford, since the water collected in a pool in the bottom of the receiver. So Davy substituted for the former equation—

Ice + Motion = Water,

or in modern parlance Davy's equation would read—

Ice + Energy = Water.

These epocal experiments of Rumford and Davy completely overthrew the Caloric Theory and the Scientific world awaited the proof that heat was a form of energy. To establish this new theory it was necessary to prove that a relation existed between the units of heat and energy.

The experiments by which this fact was established were of fundamental importance, for not only did they verify the theory that a given quantity of heat had an exact Mechanical Equivalent—and so verifying the energy theory of heat, but also the established principle of the Conservation of Energy.

Foremost of these men of science was the French Physicist and Engineer "Hirn" in the year 1857. His experiments were numberless both in converting heat into work and work into heat. His work is especially praiseworthy because of the fact that he established the following two principles:—

1) When work is converted into heat, the heat generated bears a definite relation to the work done in producing this heat. 2) That this relation is constant by whatever process the conversion takes place. Hirn's experimental methods were somewhat crude, and his results were not of a high order of accuracy, but to him belong the honor of showing that heat was truly a form of energy.

So the final task was to devise some form of apparatus simple in construction yet sufficiently accurate to measure all kinds of energy. It is easily seen that the final task was by far the most difficult when we consider the numberless forms of energy. However it became clear that some means had to be devised preferably where only one kind of energy was used and another kind appeared. Thus we come to the epocal work of Dr. Joule of Manchester, England, whose experiments are classical in their fame. Being the first to measure accurately the Mechanical Equivalent of Heat, so to him belongs the honor of determining that value for which so many strove and in recognition of his scholarship we have the unit of work called the "joule."

I feel that an explanation of Dr. Joule's first experiments and his apparatus must be of interest to all present, so a brief outline will follow. Through almost a half century of research between the years 1840-1888 Dr. Joule set himself the task of determining this Mechanical Equivalent of Heat, yet it seems that it was not until close to 1878 that he crowned his labors with success.

In his first experiments he used a special calorimeter in which he rotated a paddle with eight sets of vanes attached to a central spindle. The calorimeter itself had four sets of fixed vanes through which the moving vanes passed. Rotation of the paddle was produced by means of two cords wound round a wooden cylinder at the top of the central spindle. The other ends of the cord were attached to two large weights suspended from drums whose axles were mounted on frictionless roller bearings.

The experiment consisted in allowing both weights to fall through a measured distance and immediately noting the change in temperature in the calorimeter. Thus the mechanical energy of the falling bodies was imparted as heat to the water which had been violently churned by the rotating paddles. Dr. Joule computed the amount of energy which had been supplied from the weight of the falling bodies and the distance through which they fell. The heat units or calories were easily reckoned by the change in temperature and the weight of the water. He likewise took into consideration the thermal capacity of the Calorimeter. In order to obtain the equivalent of a considerable fall the weights were raised and allowed to fall many times during an experiment. In the raising of the weights the upper cylinder was loosened so that no extra energy might be imparted to the water. Special precautions were taken to guard against any heat lost from the calorimeter while corrections were made for those that he could not completely eliminate.

Some ten years later Dr. Joule made even more accurate determinations at the request of the British Association. He used slightly improved apparatus. The principal difference being in the elimination of various disadvantages of his former apparatus. No doubt the paramount point of interest in the new apparatus being the addition of a large flywheel above the calorimeter and in place of the weights he had this flywheel rotated at a constant speed. He easily computed the work done in this manner. So accurate were his results that to this day they have been but slightly changed. Dr. Joule computed the Mechanical Equivalent of Heat as:— 4.177×10^7 ergs per calorie at 15° in the c.g.s. system. So today this result is known as the Mechanical Equivalent of Heat.

Rowland in America—1879—carried on Joule's experiments only using an engine to rotate the flywheel and with vastly improved apparatus he obtained slightly better results:—$J = 4.188 \times 10^7$ ergs per calorie at 15°.

Since then the Mechanical Equivalent of Heat has been measured in many ways, perhaps a dozen or more. In particular it is very easy to use electrical methods since the ratio of mechanical energy to electrical can very easily be determined and electrical energy can be converted into thermal energy with great accuracy.

KELVIN'S THERMODYNAMIC SCALE OF TEMPERATURE

(Abstract)

DANIEL LINEHAN, S.J.

In measuring temperatures by the expansion of some substance whether it is a liquid, gas or solid, the magnitude of the degree will depend very much upon the nature of the substance employed in each case. Since the ultimate aim of science is to obtain measurements in fundamental units, this dependence upon variables greatly hinders the attainment of this goal.

Lord Kelvin discovered that Carnot's principles and the thermodynamic laws could easily be applied to determine temperature measurements. With the determination of the adiabatics and isothermals of a certain substance, he causes the ratio temperatures and heat absorbed and rejected to accomplish his aim. Fundamentally, it is the energy required to convert heat into work that he makes his norm, and since this is unchangeable, it makes his scale absolute in the true sense of the word.

OBJECTIVE TESTS IN PHYSICS

(Abstract)

REV. JOHN P. DELANEY, S.J.

The searching thoroughness of the new type of objective examinations has gained for the new method wide favor among educators and examining boards. The writer has used the new method both in Physics and in Evidence tests, and the results have been gratifying.

The objective test is more difficult of formulation, but the time given to preparation of the exam is more than compensated for in the time saved in correcting papers. The results of the exam are generally more positive and they give a longer and more satisfactory gradation curve than the classical type of exam.

Independently of the intrinsic value of the new type of objective test, it seems that teachers are under obligation at least to acquaint their students with the new method. Many students will have to face the method in such critical instances as the aptitude tests for medical schools, in Civil Service Exams, in exams for West Point and Annapolis, and in tests for teachers positions and for admission to post-graduate work. Such has been the case in Buffalo.

The new method under its various forms is discussed in various pedagogical texts, and its application to Physics, with specimen exams, can be found in contributions to The American Physics Teacher, especially for February '33.

A comprehensive study of the objective method may be found in the Review of Educational Research, February '33.

DIFFRACTION FRINGE PHOTOGRAPHY

(Abstract)

Edward L. McDevitt, S.J.

Rather good results in photographing diffraction fringes can be obtained with the following apparatus. A 20 ft. light-tight tube 8 in. in diameter has a holder for photographic plates at one end and a point source of light at the other. An opaque object such as a razor-blade or a coin is mounted in the center of the tube directly in front of the light source. The light passing around the object forms a shadow picture and a set of diffraction fringes. With a 200 watt projector lamp focused on an opening .34mm in diameter as the light source, and using the Eastman Process plate, an exposure of 45 seconds will give a well defined set of lines, provided the object is rather small. In photographing the fringes caused by light passing through a slit about 1 mm. wide, an exposure of at least an hour is required.

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