V. A. Gookin S.J.

# American Association of Jesuit Scientists

## EASTERN STATES DIVISION

## PROCEEDINGS

*of the*

## SIXTH ANNUAL MEETING

HOLY CROSS COLLEGE
WORCESTER, MASS.
AUGUST 12 and 13
1927

## Program of the Sixth Annual Meeting

FRIDAY, AUGUST 12TH

10.00 A. M. GENERAL SESSION—Chemistry Amphitheatre.
Address of Welcome, Rev. Joseph N. Dinand, S.J.
Reading of Minutes.
Appointment of Committees.
Presidential Address, Rev. George F. Strohaver, S.J.

"COOPERATIVE RESEARCH"

New Business.
Adjournment.
2.30 P. M. Meeting of the Mathematics Section.
3.00 P. M. Meeting of the Biology and Chemistry Sections.
4.00 P. M. Meeting of the Physics Section.

SATURDAY, AUGUST 13TH

9.00 A. M. Meetings of the Various Sections.
1.30 P. M. GENERAL SESSION—Chemistry Amphitheatre.
Election of Officers.
Reports of Secretaries on Sectional Elections.
Reports of Committees.
Resolutions.
Adjournment.

# PROCEEDINGS

The sixth annual meeting of the American Association of Jesuit Scientists (Eastern States Division) was held at Holy Cross College, Worcester, Mass., August 12 and 13, 1927. The first general session was called to order at 10 a. m. on the 12th by the President of the Association. Rev. Joseph N. Dinand, S.J., President of Holy Cross College, extended a warm welcome to the members of the Association. The keynote of his address was that of encouragement. He gave a brief sketch of the good work of Jesuit scientists of former generations and emphasized the good that can be done in these days owing to the attraction that science has for the American mind. The minutes of the previous meeting were accepted as printed in the "Proceedings, 1926." Fr. Phillips called attention to the need for an abstract of each paper, as the titles of papers read should not be printed without an accompanying abstract. Then followed the appointment of the following committees:

Committee on Nominations: Fr. Coyle, Chairman
Fr. Shaffrey
Fr. Gipprich

Committee on Resolutions: Fr. Phillips, Chairman
Fr. D. P. Mahoney
Mr. Bihler

The President now placed before the house for consideration a suggestion made to him by several members of the Association, to have the Bulletin printed instead of mimeographed. Then followed the Presidential Address on—

### Cooperative Research

Actual cooperation in research between the universities and industries of this country has involved a great array of suggestions and plans, some of which have worked well while others have met with decided failure. In general, we may classify this active cooperation under three heads: Retainerships, Fellowships, and Scholarships.

That policy wherein a member of a university faculty is paid a retainer, or consultation fee, and is called upon for advice and assistance to the regular research personnel of an industry is, of course, ideal from the standpoint of both the university and the industry. This policy is steadily gaining in favor and gives promise of becoming the goal towards which our university men may direct their outside activities; the prerequisite, however, that the university man shall possess outstanding ability and be able to sense the practical significance of investigational steps restricts considerably this policy and confines the selection of such men to the upper division of our professorial group. The lower division of this professorial group—made up of instructors and teaching assistants—requires yet a few years' training and study. That practice where members of a university faculty are employed during the summer months in outside work falls under this particular classification.

The establishment of fellowships at universities under the direction of competent authorities offers another favorable plan for promoting research and maintaining promising young men in the proper atmosphere for study. This policy is steadily growing and contributing much both in the solution of many problems and in the building up of a larger and larger research clientele. Young men launched in this career, where practically their entire time is given over to research, should constitute excellent material from which our future university research professors can be selected. The position of research professor is altogether too rare in America. The complex problems before us today require the highest type of investigators. The university stands preeminent in affording the broadest scope for study in arts and sciences untrammeled by mundane restrictions. It therefore behooves universities to establish research professorships on their staffs at every opportunity.

The establishment of scholarships, as our third class, is very widely distributed throughout the country. These scholarships are largely based upon stipends of not much in excess of $750 a year and are largely held by undergraduates or graduates who are more or less occupied with regular college duties. Such scholarships, as founded at the universities by individuals or organizations, should be construed to a large extent as gratuities for needy and praiseworthy students and no attempt made on the part of the donors to secure therefrom scientific data of publishable value. At those universities where fellowships have been set up by industries, it would appear most appropriate that scholarships of lesser stipend might likewise be offered in order to stimulate advanced students and prepare certain promising candidates for the highly prized and more lucrative fellowships.

It will be seen from the above that the most direct method of building up a greater and greater cooperative spirit between the universities and the industries will proceed from that type of cooperation which we have just described as a fellowship. As a matter of general interest, we may cite here the general scheme for classification of fellowships, as drawn up by the Central Petroleum Committee of the

National Research Council in its distribution of funds and direction of research under the auspices of the American Petroleum Institute:

Research Associate—Stipend not below $3,000.
Research Fellow—Stipend $3,000 and downwards, not to include $2,000.
Junior Research Fellow—Stipend not in excess of $2,200.
Research Assistant—Stipend $600 up to $1,200.

The salaries attached to the representatives of any one class may overlap somewhat the other classes, but the general idea remains intact and we have a classification not inconsistent with professorial ranks. The research associate is the counterpart of the college professor. Several of the universities at which we have established these research associates have already given the rank of associate professor to the incumbent of this class and, furthermore, no university work is attached to the position. The research fellows are being appointed to assistant professorships and the research assistants to assistantships at our universities. There is no obligation on the part of the universities to accept these rulings of the Central Petroleum Committee, but, nevertheless, there has been an open-hearted and wholesome concurrence in favor of all possible means of giving proper recognition to these research appointments. We look upon the system as one of the most promising yet proposed between universities and industries. The results of the researches are to be published, and wherever discoveries should be secured by patent these patents are to be taken out and made available for the benefit of the public.

When now we consider the fellowships carrying lesser stipends we come upon the great bulk of grants established by industries in our several universities. The fellowship holders are expected to spend all or nearly all of their time upon the problems at hand and in the course of a year or more the results of their work find expression through scientific journals. In the ever increasing number of industrial fellowships established at our universities we see the greatest hope for cooperative research. Young men will rejoice in the opportunity offered for several additional years of research under the guidance of erudite men and will reap therefrom worlds of benefit from an educational point of view, no matter whether immediate results may or may not be forthcoming.

The industries are intent upon maintaining a higher and higher degree of efficiency and they are thoroughly cognizant of the role which research must play in this program. It is not to be expected that all industries will establish fellowships providing for the entire livelihood of young men at our colleges and universities. Many will await the results of appointments already made, and especially will they follow closely upon this admirable plan on the part of Mr. John

D. Rockefeller, of the Standard Oil Company, and Mr. H. J. Halle, President of the Universal Oil Company, in their establishment of the $500,000 research program to cover the next five years of research on the fundamental problems of petroleum under the auspices of the American Petroleum Institute, as has just been discussed.

In the meantime the Division of Chemistry and Chemical Technology has undertaken to encourage every form of cooperation possible between the industries and the universities. To this end problems of industrial importance have been secured by the Division through its chairman, these problems have been given out to young university men wherever a particular research interest could be aroused. To some it may seem odd that our Division is emphasizing this particular mission when it is known that we are primarily committed to the establishment of fellowships.

From some quarters, indeed, we are well aware that university men look askance at this new venture, seemingly because they have been wont to await the establishment of a fellowship before instituting the research. The explanation is certainly simple enough. Industrial leaders know at least 300 university chemists of distinction and entertain no compunction whatsoever in placing fellowships under these men for the prosecution of researches. There are, however, many more problems for research than it is possible for these same distinguished chemists to undertake, even though they were each to be assigned one hundred fellowships.

Of the many colleges and universities in this country, possibly 500 may be considered as having facilities of some sort for some type of scientific study, but outside of possibly 150 academic centers for chemical research, the great majority of chemists in academic positions have little or no entrée to industrial plants and are far out of touch with the immediate trends necessary for industrial growth.

During the past fifty years we have witnessed a slow but steady development in American industries. Indeed, the strides made in the past five years actually surpass those of any preceding decade. The problems of our industries have become the problems of the greatest moment. Our preservation and future prowess are bound up in the solution of these problems. It is the call to research, and upon research alone our future as a nation must stand.

The problems that we have taken from the industries are to a large extent of industrial bent. It so happens that the greater number fall in the domain of organic chemistry; yet this is not surprising when we recognize that practically 75 percent of all chemical researches in America involve organic compounds. These problems, furthermore, may be considered as of seemingly less importance, yet, nevertheless, they serve admirably the purpose. For, whether the investigation savours either of fundamental or applied research, sooner or later the student comes upon the fundamental concepts that lie beneath, and to some phase of this revelation he is ready to devote his energies. Thus, our aim remains primarily the introduction of the study of fundamental problems. It should be born in mind that industrial laboratories are far better equipped for the applied researches than the university laboratories can ever hope to be.

In the main, we have approached more particularly the instructors and assistant professors of those universities and colleges somewhat removed from active chemical manufacturing centers. The spirit of enthusiasm that pervades this younger class is a decided asset in an attack upon the more or less resistive problems.

When once a problem is taken up by a university man a report from time to time on the progress of work is made to the Division. When, from these reports, the chairman of the Division is convinced that the investigator is making progress of such a nature and to such an extent that the particular industry concerned with the problem may be keenly interested in the research, then these reports are referred to this industry.

If the industry through its research department evinces no interest in the report, then the problem drops out, or, as is usually the case, it is presented to some other industry; but if no interest can be solicited from any industry, then the problem no longer claims our attention. It will be observed that we have here no expenditure of time or money on the part of the industry, save the supplying of various special chemicals sometimes needed for the research, and hence the industry stands to lose nothing. On the part of the university man the only possible loss is the time devoted to the undertaking, but this time is not supposed to cover a period of more than a month or six weeks, the work being done during one or two afternoons a week. This time could hardly be construed as an entire loss to anyone really and whole-heartedly intent upon finding a problem for research. It is, of course, a gamble on the part of the university man as far as time is concerned, but every research worker knows that real problems involve a bit of prospecting.

When, on the other hand, the particular industry concerned shows an interest in the reports from the investigator as submitted by the Division, and is desirous that the investigator proceed with the work he has begun, then it becomes the duty of the industry to pay a regular stipend directly to the investigator. This stipend is rated on the actual time per week given to the research and varies considerably among the industries.

In other words, we have in this plan virtually the genesis of a fellowship. Unrestricted publication is permitted the investigator. If a patent is to be taken out the particular industry must be given at least a shop right therein; the final status, however, rests upon the financial arrangements between the contracting parties. In many instances where the investigator proves his ability we shall now have every reason to expect that the industry, having learned of his ability in this particular direction, will more than likely embrace the opportunity of establishing a fellowship at the university where the investigator is resident. Naturally, the industry could not be expected to establish fellowships without some knowledge concerning the investigators, and thus we find a way of guiding the industries to men of creative minds. In the early stages of the work, before any progress has been noted, it is not necessary that the name of the investigator be made known to the industry nor the name of the industry to the investigator.

In this new plan of cooperative research we have a number of distinct purposes in view:

1. Bringing the immediate problems of the day to the attention of the chemists throughout the country: Disseminating research.

2. Supplying many chemists out of contact with different industries with just those problems particularly suited to their own fancies: Fitting the problem to the man.

3. Developing the knowledge and the competency of the young college scientist; a thing which the college is so prone to repress by burdening him with work more adequately and better accomplished by the average stenographer: Utilizing fertile minds for mental labor.

4. Preparing the way for more highly developed and experienced chemists in the future employ of the industries and the universities: Improving and broadening the chemical situation.

5. Making it possible for an industry to foster a large number of embryonic researches without actually increasing its regular research staff: Establishing university connections for an industry.

6. Opening the doors of the industries to suggestions from men of versatile minds and thus inspiring their own research staffs with new ideas: Revivifying industrial research men.

7. Introducing a scheme whereby any individual, whether he be connected with an industry or not, can have recourse to research men willing to tackle whatever problem may arise when promise of financial return is not out of range: Centralizing university laboratories for research suggestions.

When the research men of the universities and industries are thus brought into closer relationship, a great array of possibilities is bound to arise at every turn. Opportunity for summer work will be open to university men at many of the industrial laboratories, and later regular retainerships will accrue to the university men who have made their way.

The system as outlined above is already set into operation and results promise well for the enterprise. We realize, however, that no plan is perfect and that possibly there are many who may agree with some of the critics who pronounce the plan too much of a subsidy and a gamble.

Now, the subsidizing of young men to engage in fundamental research—if as such the plan is construed—is just what we have intended to accomplish—anything in fact to get the brilliant young men out of the doldrums of a listless existence. Indeed, after several years spent in the university many of the young men grasp the first opportunity and betake themselves to industrial laboratories. Here, however, the efforts of research are so sharply focused in closely circumscribed fields that free play of imagination ofttimes succumbs. What science needs is the conservation of this particular class of men of keen imagination and constructive ability in a locale primarily suited to free and independent thinking. They should be permitted to run rampant, as it were, and to vary their activities as their moods prescribe.

As the years go by, these same young men, through retainerships and consultation fees, may well be earning salaries that will enable them to remain in those highly honored academic positions in which the highest interest of science and the university is served. We are all subsidized by some organization, and the plan offered is merely one that young men may be subsidized by organizations of high financial standing.

In the criticism that the university man takes all the chances and that the odds are against him, we have again exactly the conditions we desire. The industries are not asking for the work. They are overwhelmed today with problems of their own making. Why should they fire into the air when no game is in sight? The problems that they give us carry much of future potential value, and when workers are found who can make headway in these studies then the industries are the first to sense the possibilities of carrying the results to their logical conclusions. The university man can have no influence upon the direction of industrial activity, but, if he hits upon some lead, then he may enter immediately into deliberations with industrial scientists and will have earned for himself the highest respect and confidence—a position that must redound to the good name of the university he represents.

Those who would have industries hand out fellowships on a silver platter to whomsoever cometh have little or no knowledge of the enormous expense incurred by our industrial research laboratories. The annual outlay of money for researches of various character in any one of our large industrial organizations would pay the annual running expenses of any one of our large universities. Is it possible for a young instructor to be given a fellowship by one of these universities merely for the asking, or even after years of research work?

Yet here the industry practically promises the equivalent of a fellowship on a few weeks' notice if the young man can demonstrate his ability to handle the problem. If this is gambling, then we pray that we may have more and more gambling.

In the afternoon the various sections held their separate meetings, the sessions of the Mathematics and Physics sections being held at different times to enable the members of the two sections to attend each other's meetings.

On Saturday morning, August 13, the sectional meetings were continued. At 11 A. M. the final general session was held in the Chemistry Amphitheatre. The report of the Treasurer followed the opening of the meeting by the President. The reports of the secretaries of the different sections showed that the following officers had been elected for the coming year:

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| Biology: | Chairman, Rev. John A. Frisch. |
| | Secretary, Mr. George J. Kirchgessner. |
| Chemistry: | Chairman, Rev. Richard B. Schmitt. |
| | Secretary, Mr. Edmund J. Wolff. |
| Mathematics: | Chairman, Rev. Edward C. Phillips. |
| | Secretary, Mr. Thomas D. Barry. |
| Physics: | Chairman, Rev. John A. Tobin. |
| | Secretary, Mr. John W. Tynan. |

The report of the Committee on Nominations followed. Fr. Coyle announced that the committee had decided to place the names of Fr. Phillips for President and Mr. Barry for Secretary. A motion was made, seconded, and carried that the nominations be closed.

Next followed the report of the Committee on Resolutions. Fr. Phillips read the following resolutions:

(1) Be it hereby resolved, That the President of the Association express to the Superiors of Holy Cross College the gratitude of all its members for the cordial welcome extended to them during this, the Sixth Annual Meeting of the Association, and in particular their deep appreciation of the encouraging words of Fr. Dinand in his address of welcome.

(2) Be it also resolved, That the sincere gratitude of the Association be extended to Father Brock for his unremitting editorial efforts for the success of the Bulletin, and to Father Mahoney and his assistants for the excellent physical production of the issues of the Bulletin.

On the motion of Fr. Coyle, the following resolution was added:

(3) Be it resolved, That the thanks of the Association be extended to the retiring President for his efficient conduct of our meetings and for his work in stimulating the interest of its members in the Association's activities.

The President called on Fr. Brock for suggestions as to ways and means to improve the Bulletin. After Fr. Brock, Fathers Kolkmeyer, Schmitt, Coyle, Strohaver, and Ahern spoke on the subject. As the result of the discussion the following motion was presented by Fr. Phillips: "That we accept the recommendations of the President to the effect that the matter of the Bulletin be divided into six sections, namely, Editorial, News, Biology, Chemistry, Mathematics, and Physics, and that the sectional subeditors be personally responsible for the collection and preparation of the matter of their respective sections, subject to the editorial supervision of the Editor-in-Chief." The motion was seconded by Fr. McCullough and carried.

Mr. Berger spoke advocating that the Bulletin be printed. This matter had also been touched upon in the preceding discussion. No change was made with regard to the printing of the Bulletin. Mr. Quigley offered to undertake the mimeographing of the Bulletin during the coming year. It was suggested that the Bulletin be mailed in heavier envelopes.

A motion was made, seconded, and carried to adjourn.

The following members of the Association were present at the meeting:

Ahern, Rev. Michael J.
Barry, Thomas D.
Berger, Charles A.
Bihler, Hugh J.
Blatchford, John A.
Brock, Rev. Henry M.
Brown, Rev. T. Joseph.
Butler, Rev. Thomas P.
Busam, Rev. Joseph F.
Coyle, Rev. George L.
Crawford, Rev. William R.
Crotty, Edward M.
Crowley, John J.
Fey, Leo F.
Freatman, Harold L.
Gipprich, Rev. John L.
Gookin, Vincent A.
Gorman, Lawrence C.
Harley, James L.
Hearn, Joseph R.
Hohman, Rev. Arthur J.
d'Invilliers, Joseph A.
Kirchgessner, George J.
Kolkmeyer, Rev. E. J.
Logue, Rev. William G.
Long, John J.
MacCormack, Anthony J.
McCullough, Rev. Henry B.
McLaughlin, Thomas L.
MacLeod, Henry C.
Mahoney, Rev. Daniel P.
Murphy, John J.
Nuttall, Edmund J.
O'Mahony, Timothy J.
Phillips, Rev. Edward C.
Power, Francis W.
Quigley, Thomas H.
Schmitt, Rev. Richard B.
Shaffrey, Rev. Clarence E.
Smith, Rev. John P.
Strohaver, Rev. George F.
Sullivan, Rev. Joseph J.
Tobin, Rev. John P.
Wolff, Edmund J.

Rev. Francis J. Dore, of Boston College, also attended the meeting.

# Papers Read in the Various Sectional Meetings

## BIOLOGY

### Chairman's Address

### Bacteriology of Scarlet Fever

REV. CLARENCE E. SHAFFREY, S.J.

The etiology of scarlet fever remained unknown until recently. Much was done by the research workers and more than one felt he had found the germ, in one case a diphtheroid bacillus, in another a coccus, etc. The hemolytic streptococcus was known to be present in most cases but was regarded as a secondary invader until the decisive of work of Dick and Dick, George F. Dick, M.D., and his wife, Gladys Henry Dick, of Chicago. Animal experimentation had given negative results because of the immunity of the common animals, as mice, guinea pigs, and rabbits, to the toxin. Human experimentation was necessary, and this the Dicks did on a number of volunteers, with the result that they have demonstrated a hemolytic streptococcus to be the infecting germ. By repeated experiments they have shown that not only have they isolated the germ but have succeeded in rendering individuals immune to the disease after their susceptibility has been demonstrated by the Dick test which is made just as the Shick test for diphtheria. As a result of the Dicks' work a serum has been prepared which is effective as a prophylactic when used in adequate doses in saving life and in reducing the severity and the frequency of the disease, until now this disease, which has always been such a scourge to children, can be treated and controlled as readily as diphtheria has been for many years by its antitoxin.

### The Mechanism of the Assimilation of Carbon Dioxide and Water in Plants

REV. FRANCIS A. TONDORF, S.J.

(Read by title)

The mechanism whereby green plants assimilate carbon is an unsolved problem in botany today. Plants absorb carbon dioxide and water from the air and soil, from these inorganic substances are built up most complex organic substances; v. g., sugars with higher energy contents than the derivatives. The sun supplies the necessary energy. By what conditioning process this transformation is effected is a dispute with plant physiologists and chemists. The former insist that living protoplasm of the assimilating cell concurs, the chemists feel that the problem has its solution in chemistry or, better said, photochemistry. The physiologists admit the production of sugars from carbon dioxide and water without the intervention of the living cell, but contend that this production in vitro does not argue a like production in the plant. They add that all laboratory production of sugars is accompanied with the intermediate production of formaldehyde, no such production showing in leaves. For the production of sugars in plants, light and green pigment are indispensable; the purely chemical production is effected without either visible radiation or chlorophyll. The status of the problem as defined by physiologists: First, what are stages of synthesis? First stage, purely physical; to wit, the diffusion of carbon dioxide from air into assimilating cell. Second stage, meeting of carbon dioxide with water from soil and either within or at surface of the chlorophyll-containing granules the transformation.

Two intermediate stages are here involved. One a purely chemical action taking place in the dark, the second a photochemical reaction in the presence of light. The rate of carbon assimilation has a temperature coefficient of two. This is the coefficient of the dark reaction. Some interpret the chemical stage as an enzyme action. There seems some evidence that chlorophyll is concerned in the photochemical stage and the enzyme, if one, in the dark stage. The process of the photosynthesis assumes an intermediate product, formaldehyde. The conversion of the radiant energy into chemical in the assimilating plant is held too intimately bound up with the problem of the green pigment. Pigments responsible for coloring of plants are four. Two green, two yellow; green chlorophyll a and b, yellow, xanthophyll and carotin. Greens and yellows closely related, chemically and physically. Greens absorb energy for photosynthesis. This energy is utilized in the photochemical reduction, but how is not clear. Some hold that it is referred to carbon dioxide, which is then reduced to formaldehyde. As chlorophylls are fluorescent, it is held by some that in the light they undergo change, resulting in formation of isomer of higher energy content, which thereupon changes back to first form with evolution of absorbed energy as phosphorescent light, which is absorbed by carbon dioxide. Some hold that the rays reradiated from green pigment are of infra-red type and that these are absorbed by carbon dioxide. These are physical functions of chlorophylls. The chemical. Some have thought of chlorophylls uniting with carbon dioxide. Others of a derivative of chlorophyll, the product of the action of light reacting with the derivative of carbonic acid. In accounting for the two chlorophylls, the more likely opinion is that the mixture of the two greens absorb more light than an equal quantity of one. In accounting for the function of yellows, some hold that the absorption by these is complimentary to that of greens. Some hold the function purely chemical, not physical; that is, they protect the chlorophylls against oxidation. *Adhuc sub judice lis.*

### The Shore of Keyser Island at Ebb Tide

MR. G. J. KIRCHGESSNER, S.J.

The paper recounts a few facts, observed and read, concerning some of the marine animals that live on or near the shore of Keyser Island.

The habits and appearance of the fiddler crab, the spider crabs, and the hermit crabs are touched on. The experience of finding and hatching a batch of horseshoe crab's eggs is described. Some of the habits of razor-shelled clam are mentioned. And note is made of the progress in the migration of the long-necked clam and the periwinkle down the Atlantic coast.

### What Are the Facts of the Evolution Question?

MR. CHARLES A. BERGER, S.J.

Evolution in some form or other is accepted by practically all the eminent biologists of the present. Hence the question merits our serious consideration. The object of this paper was in no way an argument for evolution, but was an argument for the serious study of the evolution question, which study we are neglecting. Outside of a few books which belong rather to Christian apologetics than to scientific literature, the only place where a Catholic opinion on evolution is hazarded is in our philosophical theses. Here, once the doctrine of the soul has been covered, the treatment of most of the other points is in many cases obsolete and superficial. The blame for this condition was not put upon the philosophers except in some cases for their disparagement of science, but was rather laid to the discredit of the biologists themselves, who appear to have been giving the subject no study whatever.

As an example of the charge of superficiality, the way in which the argument from rudimentary organs is swept away with a sweeping generalization was quoted, and the following example given to show the inadequacy of the solution. In the chick embryo the excretory system passes through three stages, each a separate organ and termed, respectively, the pronephros, mesonephros, and metanephros. The pronephros forms first and is the most anterior of the three. The mesonephros forms next and functions during the greater part of embryonic life. The metanephros, last to form and most posterior in position, begins to function shortly before the egg hatches and continues through adult life. The first of these organs is an evident rudiment. In general, an excretory system consists of a number of small tubes, called nephric tubules. The free end of each is surrounded with a glomerulus of small blood vessels, from which the waste matter is taken into the tubule and passed out through a duct. In lower forms the free end of the nephric tubule is a funnel-shaped ciliated opening called a nephrostome, and the fluid is taken in by the action of the cilia from the body cavity direct (condition in earthworm). In the kidneys of higher forms the free end of the nephric tubule is closed and surrounded by a capsule containing the glomerulus of blood capillaries called a Malpighian Corpuscle. Both of these forms are found in the three stages of the chick excretory system. The pronephros has nephrostomes, the metanephros has Malpighian corpuscles, and the mesonephros has both nephrostomes and Malpighian corpuscles. The pronephric tubules begin to form on the second day and are usually completely lost on the fourth day of incubation, having degenerated without ever becoming a fully formed organ. The pronephric duct is always formed and sometimes a lumen is formed in the tubule, but it is never continuous with the duct, consequently if the tubules were able to collect waste matter they would not be able to excrete it.

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## CHEMISTRY

### Chairman's Address

### Chemistry of Sugar Manufacture

REV. R. B. SCHMITT, S.J.

(Abstract)

In this paper a brief outline was given of the theory of sugar chemistry. Sucrose with all its physical and chemical properties; decomposition of sucrose on boiling, by the action of acids, oxidizing agents, and by fermentation.

In the second part there was given a brief synopsis of the process of sugar manufacture, which included the extraction of the juice by the milling process; the composition and value of bagasse as fuel; the method of clarification and the treatment of the clarified juice; also the concentration of the juice in the evaporators by the quadruple effect; and finally the graining in the vacuum pans.

Then followed an enumeration and explanation of the various quantitative laboratory experiments which are necessary in the manufacture of sugar. These included: determination of sucrose in mill-juice; determination of glucose by the Munson and Walker method; determi-

nation of sucrose in commercial sugar; determination of sucrose in bagasse, in syrup, and molasses; determination of moisture and ash.

Finally, there was a description of some special quantitative experiments, as the determination of potash and phosphoric acid in cane-juice; determination of available calcium oxide in lime; and the analysis of boiler-feed water by the $\alpha$-naphthol color test.

(Slides were used throughout.)

### Organic Laboratory Technique

MR. F. W. POWER, S.J.

A few points it would be well to call to the students' attention during a course in Organic Lab.

1. Care in setting up apparatus, neat layout, clean desk, avoid strain on the part of clamps by releasing each one for a moment, readjusting if necessary before putting the layout into operation.

2. Care in sources of heat. Danger of naked flame near a distillation or exposure of inflammable liquid (cf. the accident at Hopkins this spring). This applies to electrical apparatus, even hot plates, and sparks from motor (cf. the Colgate fire). Selection of proper flame and proper part of the flame. Air bath recommended.

3. Distillation—try to include an experiment showing the efficacy of a rectifying column; e. g., try a mixture of toluene and carbon tetrachloride, collecting at 5 degree intervals, and check composition of distillate by s.g. determinations. Apply this to alcohol-water mixture.

4. Determination of melting points—choice of apparatus open to discussion, best for precision work is an oil or glycerine bath heated by immersion heater and provided with motor-stirrer. Not much good for high temperatures. Best simple baths are the Thiele and the hand-stirred small bath in a flask. Use $H_2SO_4$ up to about 150°, then for higher temp. use "Nujol." Glycerine good for lower temp. also, Crisco for medium to high temp.

5. Liquid extractions, study each case of furry interface to see how it can be broken up, acids, salts, alkali, etc. Use many small quantities of the extracting liquid rather than a few large quantities. Show this by extracting with water a solution of acetic acid. For lubricating stopcocks where ether is the extracting fluid, use cholesterol.

6. Filtration by suction, for pressing out a cake of crystals or other substance that has been filtered on a Buchner funnel, tie a piece of rubber dam over the top of the funnel and apply the suction, and the rubber will be forced down tightly over the cake, thus pressing it

thoroughly and uniformly. For microfiltration, use burette funnel with loose glass plug in stem, over which a very small disk of filter paper can be placed.

These suggestions for the most part are based on those of Dr. Hans Thatcher Clark of the Eastman Lab. given at the A. C. S. meeting at Richmond. Each one will have his own tricks of the trade to add to these few; the idea being to try to get the student to adopt as many as possible in his own practice and to try to devise some of his own. The student must be strongly assured that if he goes into scientific work later on, involving any sort of laboratory work, his superiors will compare him favorably or unfavorably with his colleagues by noting with what neatness, ingenuity, and dexterity he carries out his ordinary laboratory duties. After an experienced man has watched the workers in a laboratory for a few days, he has had plenty of time to find out who the chemists are and who the quacks.

### A Problem in Vapor Pressures

REV. J. J. SULLIVAN, S.J.

Immiscible substances were considered, like water and turpentine, and water and nitrobenzene. Since there is no diluting effect (worth considering), neither substance lowers the vapor pressure of the other. Each exerts its own vapor pressure independently, and the effect is additive. The following questions were asked: What will be the boiling point of such a couple? What proportion of each will be in the distillate? The answers were derived in two ways, algebraically and graphically.

### Odor and Molecular Structure

REV. G. F. STROHAVER, S.J.

This paper showed that, since odor was due to chemical changes which occur both in the animate and in the mineral world, chemists have been able to manufacture synthetic perfumes, which have numerous advantages over natural products, especially in regard to purity, constancy of constitution, and ease and cheapness of manufacture. Odor appears to depend on psychological and esthetic factors, physiological effects, physical factors (such as vapor pressure, solubility and partition coefficients, dilution and ionization), and chemical factors. The connection between odor and molecular structure was shown by citing the example of the alcohols, phenols, and ethers.

### Motion Pictures in Scientific Research

REV. M. J. AHERN, S.J.

(An extended abstract of this paper, with additions, appears in the Bulletin.)

## Chemotherapy

REV. G. L. COYLE, S.J.

After laying down some general principles of Chemotherapy and explaining the difficulties met with in finding remedies for disease which would act on specific organs without harm to the bodily economy, some recent work in Chemotherapy was mentioned. Dr. Johnson, of Yale, has found that the tuberculosis germ has a protective coating of fat, and effort is now being made to hook up a germicide with a solvent to penetrate the coating and destroy the germ. Some work along similar lines has been done at Georgetown during the past two years in the endeavor to link some of the phenol derivatives with dye bases which will penetrate the cells and kill the germs. Three compounds have been made which are germicidal, but their toxicity must be tested during the coming year before any publicity can be given to the work. Another piece of work has been the effort to prolong the heart action of adrenalin. (Case of woman pronounced dead by five doctors, yet now living through injection of adrenalin in heart fibers; stillborn children revived.) We have learned the causes of the rapid and evanescent effect of adrenalin and are now at work on forming a compound which will combine the benign effects of adrenalin and at the same time protract its effects, by substituting the slower-acting group of ephedrine—derived from Huang oil—for one of the side strains of adrenalin. This we hope to finish this year and hope it will be of benefit to suffering humanity.

## Chemical Aspects of Color

MR. HUGH J. BIHLER, S.J.

It was shown that the investigation of the relation between chemical constitution and color began shortly after Perkin's discovery of mauve. The early theories advanced by Armstrong, Witt, and Nietzki, together with the pioneer observations of Graebe and Liebermann, all were based on eye-observation. But with the introduction of the spectroscope into the field, it soon became evident that it was unsatisfactory and dangerous to trust to eye-observations alone.

Therefore it was deemed advisable, because more logical, to shift the investigation from the effect of selective absorption, which is the objective reality of the physiological sensation of color, to the study of the absorption bands themselves (i. e., absorption bands of colored substances).

Two criteria for the evaluation of the truth of any theory on color were proposed. First, the theory must ascertain the cause of the absorption bands and, secondly, account for the fact that these bands are in the visible part of the spectrum.

In the light of the above criteria, Lewis' theory seems most probable—but only probable, as it rests on the electromagnetic theory, which is only probable. Lewis accounts for the absorption bands by the explanation that when the frequency of light is near the characteristic frequency of the particle (the electron, which is held in loose constraint), the latter is set to vibrating, and through frictional processes the energy of the light is absorbed. The absorption bands are but the registration of this fact.

He fulfils the second requirement, viz., of accounting for these absorption bands in the visible spectrum, by the observation that if the characteristic frequency of the loosely held electron is lowered so that it is near the frequency of light, in the visible range of the spectrum, different colors result.

Another point in favor of Lewis' theory is the fact that it relieves us of the necessity of postulating different causes of color for organic and inorganic substances, since in either case the cause is the same, viz., the approximate synchronization of the frequency of an electron that is held loosely, with that of light in the visible range of the spectrum.

The paper closed with a brief critique of the various other modern theories of the cause of color. Some were shown to be particular instances of the main postulates of Lewis' theory. All were inadequate and lacked universality in their application.

### Teaching Freshman Chemistry

Mr. Lawrence C. Gorman, S.J.

Purpose of paper: To start a discussion on best methods for teaching freshman chemistry.

Problem: Given any class in chemistry, what is the best method of teaching chemistry to that class?

In order to furnish a peg on which to hang the discussion, an outline of the method of teaching chemistry used last year at Georgetown was given under three headings:

1. Method of conducting lectures.
2. Method of conducting laboratory.
3. Method of conducting examinations.

1. Method of conducting lectures:

(a) General idea of the chapter is given, showing relation to what has gone before.

(b) A bracket analysis of the lecture written point by point on the board, so that at the end of lecture complete outline of lecture is on blackboard.

(c) Students were required to take down these outlines, and hand in completed notes every Monday.

(d) Lecture experiments were performed whenever of help.

Advantages of the above method: Even if a student did not do any studying he would have met every essential idea at least five different times:

(a) When he heard it in lecture.

(b) When he saw it written on the blackboard.

(c) When he copied it down in his notes.

(d) When he rewrote a copy to be turned in for correction.

(e) When he heard a repetition of it in class.

If after meeting an idea five different times a student is unable to assimilate it, there is always the possibility of his doing a little private study!

2. Method of conducting the laboratory: A definite experiment or set of experiments was assigned for each laboratory period and all marking was done on the basis of the assigned matter being completed.

3. Method of conducting tests and examinations: Fifty-minute written tests. A question would be dictated and four minutes given for an answer. Then the second question would be dictated and four minutes given for an answer, and so for ten questions. About seven or eight minutes would be left at the end of the test, during which time corrections or additions could be made. For the Midyear and Final, a group of fifty questions was assigned and the students told that the examinations would be taken from the questions on the list. A set of questions of this type seems to have the psychological effect of inducing many indifferent students to study, simply because the matter has been reduced from a rather vague and indefinite nightmare to fifty definite and specific questions.

Results of the above plan of teaching Freshman Chemistry: Out of a class of 275 with which we started the year, about 35 dropped or changed their course, and about 30 more failed out at the end of the year, leaving over 200 who successfully passed their freshman year in chemistry.

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## MATHEMATICS

### Chairman's Address

### Some Advantages of Imaginary and Complex Numbers

REV. E. C. PHILLIPS, S.J.

(Abstract)

The speaker described briefly the gradual enlargement of our number system from its simplest stage, in which it included only positive integers, by the successive addition of *new kinds of numbers* such as rational fractions, negative numbers, surds, and the so-called

imaginary unit or square root of minus one. It was shown how these additions to the number system were made necessary by the fact that various arithmetical problems having definite physical meaning and hence demanding definite arithmetical expression could not be mathematically solved or properly stated except by thus enlarging the number domain. It was also shown that the addition of such new kinds of numbers was justified by the fact that these numbers enable us more adequately to express various classes of objective physical realities and also obey all the fundamental laws of arithmetic. It was then shown in particular that the "imaginary numbers" have definite physical and geometrical meaning, and hence are not imaginary in the strict sense of the word. Reference was made to the earliest successful attempt to establish the reality and reasonableness of imaginary numbers; this was contained in a small but highly useful work of Jean Robert Argand, a Swiss accountant residing in Paris, in the year 1806. His work was entitled "Essai sur une manière de representer les quantités imaginaires dans les constructions géometriques." For many years this little work was neglected or forgotten by the mathematical public, but its importance is now well recognized. A valuable English translation of this document with some additional explanations and historical notes was edited by Professor A. S. Hardy and published by Van Nostrand under the title "Imaginary Quantities: Their Geometrical Interpretation" (New York, 1881).

The geometrical meaning and methods of representation of imaginary and complex numbers were then explained in some detail and a few of the simpler applications to the solution of trigonometrical problems were set forth.

The nature of complex numbers and their applications to problems of electrical engineering are well explained in the May, 1926, Bulletin of the School of Mines and Metallurgy of the University of Missouri, in an article by Professor L. E. Woodman, entitled "An Introduction to the Study of Complex Numbers." Those specially interested could probably secure a copy of the article by writing to Professor Woodman, University of Missouri, Rolla, Mo.

### Some Seventeenth Century Geometry

MR. THOMAS D. BARRY, S.J.

This paper gave a few methods of geometrical construction as practiced in the seventeenth century, especially referring to the construction of the ellipse. Especial reference was made to "Exercitationes Mathematicae," by Francis a Schooten, published by John Elzevir in 1662.

### Harmonic Curves

MR. JOHN A. BLATCHFORD, S.J.

### Status of Mathematics in Secondary Schools

MR. T. J. O'MAHONY, S.J.

This paper was a brief discussion of two modern tendencies, unification of subject matter, with the "Function concept" as a correlating norm, and the advancing of subject matter forward in the experience of the pupil. The former tendency was found satisfactory, the latter a dangerous innovation.

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## PHYSICS

### Chairman's Address

### Recent Advances in Physics

REV. JOHN L. GIPPRICH, S.J.

A general review was given of the more important contributions to the science of Physics during the past quarter century or more. The opening of a new era was attributed to the discovery of the X-ray by Roentgen. This was followed by the discovery of radioactivity, in which matter leaving a body is converted into radiant energy. This theory is used by astronomers in explaining the radiation of the sun and stars. The introduction of the corpuscular theory of the propagation of light with its usefulness in explaining many of the phenomena of light was dwelt upon, and a comparison was made between the explanations of these phenomena by the old and new theories.

### The Photoelectric Effect and Some of Its Applications

REV. HENRY M. BROCK, S.J.

Light is capable of varying the resistance of certain substances such as selenium, and also of causing the emission of electrons from various metals. This latter phenomenon is called the photoelectric effect. Some forty years ago Hertz had noticed that a spark starts more readily between the terminals of an induction coil if they are illuminated by light rich in violet and ultra-violet. It was also found that a polished zinc plate rapidly lost a negative but not a positive charge. This was due to an emission of electrons and it was possible under certain conditions to produce an electric current. Hallwachs, Elster, and Geitel, and more recently Millikan, have studied the effect in detail. A number of substances show the effect. There is a definite wave length at which the electron emission begins. For many metals it lies in the ultra-violet. However, the alkali metals respond also to ordinary light.

The electron emission is governed by two laws; first the number of electrons emitted per second by the metal is proportional to the intensity of the incident light and, secondly, the energy of any electron leaving the metal is independent of the light intensity. No satisfactory explanation of the second law has yet been given on the basis of the classical wave theory of radiation. In 1905 Einstein applied Planck's quantum theory to account for it. According to this theory energy is emitted and absorbed in small bundles or quanta equal to the product of a constant h and the frequency of the radiation $v$. The electron absorbs a whole quantum of energy or none at all. When an electron receives a quantum "h$v$" a portion w is expended in extracting it from the metal. The remainder it carries with it in the form of kinetic energy $\frac{1}{2}mv^2$. The latter is equal to the product of the charge e on the electron and the potential V just necessary to stop it. We have, therefore, Einstein's photoelectric equation $eV = hv - w$. It has been tested by Millikan for the alkali metals using a large range of frequencies and found to hold true within the limits of experimental error.

An inverse photoelectric effect, i. e., the production of light radiation by driving electrons against a metal with low potential, has also been detected. Thus Franck and Hertz used mercury vapor in a glass bulb containing a filament and a platinum gauze. The latter was made positive and attracted electrons from the filament when it was heated. These electrons passing through the vapor gave rise to the characteristic spectral lines. Other substances show similar effects.

The photoelectric effect has been applied in various ways to study variations in light intensity and also in connection with some amplifying device to produce various mechanical and electrical effects by means of light. A few of these applications may be mentioned. Stebbins, who employed a selenium cell to study the light curve of Algol, repeated his observations in 1919-1920 with a photoelectric cell and obtained more accurate results. Kuntz and Stebbins also used the cell during the eclipses of 1918 and 1925 to measure the intensity of the corona. Shelford and Gail have used it to study the penetration of light into sea water, and Bouty also used it to measure coefficients of absorption, the electron current depending upon the diminution of light after passing through various absorbing media. He also used it to study the details of spectral photographs. In the transmission of photographs by wire or radio the photoelectric cell plays an important part. A fine pencil of light passes through successive portions of a negative and then upon the metal of the cell. The bright and dark portions vary the light intensity and the corresponding varying electron current operates a relay at the receiving station, which causes a pen to make a copy of the picture. The photoelectric cell is also used in television, of which a demonstration has recently been given. It is used in the photometer to determine equality of illumination and has also been employed in a color-matching machine.

## Efficiency of the Woodstock Motor-Generator Sets

Mr. F. W. Power, S.J.

A report was presented of certain measurements of the efficiency of the two Westinghouse motor-generator sets which supply the D.C. house current for Woodstock College. The A.C. input (220 v. 3-phase) was determined by timing the company's meter over an interval of several minutes; the D.C. output was determined from the switchboard meters of the house. This efficiency was determined several times for each set at different loads at times when the load was steady enough to give readings of at least moderate accuracy. The A.C. power required to operate the sets when no output was being delivered to the house was 1.66 kw. for the 15 kw. set and 3.54 kw. for the 25 kw. set. The maximum efficiency of the small set was 83 per cent, reached at about 13 kw.; that of the large set 76 per cent, reached at about 19 kw. The absolute efficiencies at half-load were 68 per cent for the small set and 73 per cent for the large set. Two plots were presented, 1, of input against output; and 2, of efficiency against load; the nearly straight lines of plot 1 were later found to follow closely the empirical equations:

(large set) $y = .00652x^{1.967} + x + 3.54$

(small set) $y = .00673x^{2.025} + x + 1.66$

where x=D.C. output in kw. and y=A.C. input in kw. In the following table are given some of the figures taken from the smoothed curves of the observed values:

| Large Set | | | Small Set | | |
|---|---|---|---|---|---|
| Output, kw. | Input, kw. | Efficiency | Output, kw. | Input, kw. | Efficiency |
| 0 | 3.54 | .. | 0 | 1.66 | .. |
| 4 | 7.70 | 54% | 2 | 3.72 | 54% |
| 8 | 12.25 | 67 | 4 | 5.76 | 68 |
| 12 | 16.82 | 73 | 6 | 7.95 | 76 |
| 16 | 21.43 | 75 | 8 | 10.15 | 80 |
| 20 | 26.24 | 76 | 10 | 12.35 | 82 |
| 25 | 32.20 | 76 | 12 | 14.70 | 82 |
| | | | 14 | 17.05 | 83 |
| | | | 16 | 19.55 | 83 |
| | | | 18 | 22.20 | 82 |

Bus-bar voltage in all cases, 117 volts.

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