S. J. B

A. M. D. G.

American Association of Jesuit Scientists

Eastern States Division

Founded 1922

PROCEEDINGS

of the

Eighteenth Annual Meeting

August 17 and 18, 1939

Fordham University, New York, N. Y.

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LOYOLA COLLEGE

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PRESIDENTIAL ADDRESS

Physics For Our College Course

REV. EMERMAN J. KOLKMEYER, S.J.

Last year the retiring President of our Association addressed us on Mathematics, the Queen of the Sciences. This year it seemed good to present some thoughts on the position of the science of Physics in our college course. We shall direct our thought to Our college course, and more specifically to our Arts course. But what I have to say will, from the very nature of things, have serious application in our Science Course.

The subject is timely. In the past few years, Superiors and deans and committees have been giving much attention to the arrangement of new schedules, cutting hours here and there to release the student from an excessive class room load, and to bring our courses into closer conformity with the requirements of the educational associations. One of the recommendations we hear is that in the Arts Course a single science be required for a degree but that no particular science be made obligatory. The thoughts we shall present will have no official weight or sanction, but it seemed good to bring before this body some clear and definite points about one subject in science and about its place in the training we hope to impart in the Arts Course.

All seem to agree that some science must be offered and a certain amount required. We need not go into the reasons for this. It may be that science now fills so great a part of the intellectual world that its place must be recognized, and that in mere living we are faced with the products of scientific discovery on every side; and the college has the obligation of fitting one for living in this world intellectually and physically. Certainly the accrediting associations demand some teaching of science, and just as certainly, we, in the Society, are bound by our own educational traditions to present some science to our students. It is more than mere tradition, though, because we make science something of a groundwork for our philosophy in that it gives us a more accurate picture of the external world than any we might gather from literature and the other subjects of the curriculum. We are not teaching science merely because it is the fashion to teach science. But is there a danger that we teach too much science or not the most effective science because we are permitting ourselves to follow a fashion?

We can not teach the whole realm of natural science. The parts of the old Natural Philosophy have developed so remarkably that they have grown into separate sciences, each with its own field and problems, each very important, some apparently almost vital to man in this age of science. What shall we choose? Shall we take astronomy or geology? They are cultural and intellectual, and we might use them as hooks on which to hang the scientific principles we want our student to carry away with him. We could give botany or ornithology and attain some very fine scientific results; in fact a graduate course in bird-calls was once given at one of our universities some twenty years ago, and undoubtedly was of some profit to the class.

Perhaps the choice should be left to the student, to his natural inclinations or his aptitudes. With or without previous training, with or without advice, let the student make his own choice. Everyone knows that this system fills the easy courses, the pleasant courses, the courses turning in the highest percentage of 'passes'. The educational value of a course is of secondary concern to so many young college minds.

In some institutions where the evils of this system have been recognized, the danger has been lessened by the introduction of an obligatory general science course, the science orientation course. It is a little astronomy, a little geology, some physics, a portion of chemistry, a dash of biology—highlights of them all with what coordination might be injected by the ingenious professor. The result is a small hill of facts and very little real science. Perhaps the student has found something to his liking, but he has not advanced in his education. To further the education of the college student that science must be chosen for him or by him which will promote the purposes of the college.

Many are the good and wholesome purposes proposed for the choice of a science in the prosecution of the purposes of the college. We have: the preparation for life or living, presentation of the great principles of nature, culture, the scientific method (whatever that has come to mean), acquisition of a technique, etc., etc. As a matter of cold fact these purposes could be fulfilled in the teaching of any of the sciences and a good job done by competent instructors. As a matter of still colder fact many of these science-purposes are ruled out. Our college courses are clearly not designed primarily for their usefulness or for their practical value. At least the subject need not be useful or practical in itself. Otherwise we should drop such subjects as Latin and Greek and history and poetry. Science subjects should not be chosen for their usefulness or practicality either. We do not demand that a well trained mind be expert in horticulture, in diagnosing the ailment of the canary, in wiring a radio receiver or in compounding the paint for the back fence.

But we do demand from the college man a certain culture and a certain mental alertness, the results of a college education. Culture and mental training should be found and can be found in all the prescribed non-science courses, except such, of course, as have been added to the schedule under some external pressure. By that I mean pressure from, let us say, professional schools in engineering, medicine, law, business, etc. Often these outside pressures force places on the schedule with small blessing from the college authorities. The forced subjects themselves foster a factual knowledge and a technique, only incidentally bearing mental training and culture.

Very well, then, the science which is taught must have both cultural and mental training purposes. Other reasons, as primary reasons, are ruled out. Physics will not be taught to make mechanics or engineers. Chemistry will not be taught to make analysts or petroleum chemists. Biology will not be taught to make botanists or even medical doctors. When they are put into the college they will be put there for the purpose of making men live more intelligent lives and of giving them culture of the well balanced man of his day: the educated man, trained to take the broader view of the things about him, to see the pebble but to see it as part of the universe and to see its special part in the universe.

What, then, makes a science cultural and gives it a special power in mental training? Most assuredly it can not be because it is a mass of facts. College is not for that and its science should not be. One does not train students to be encyclopedias. The well known John Kieran read himself into his store of facts and did not take it from his college. And again mental training and culture are not achieved in the teaching of a technique. However useful a scientific technique may be, its development is not in the province of the college. At times these techniques are very useful, they may in some instances be almost necessary, in fact necessary necessitate medii. But men have drowned because they did not know how to swim, and that has not persuaded the fathers of education to require seven semester hours of swimming for a degree in every accredited college.

Thus negatively. On the positive side we find two characteristics necessary: first, the field of the chosen science must be broad and of the widest applicability; second, the science must, almost of itself, teach the value of scientific conclusions, and the value of the results of scientific research. Still better if the subject not only lends itself readily to indications of the reliabiilty of scientific results but practically demands not only indications but measures of this reliability.

The reason for the need of the first characteristic is that such a subject gives the quality called the transfer of training, such a subject makes one better able to judge in other subjects, and does this more effectively. On this point let me quote from an address of Professor Otis F. Curtis of Cornell University as reported in SCIENCE of August 4 of this year. "It is true that educators in recent years have been emphasizing this lack of transfer of training but it seems that in many departments of education instead of teaching a few basic courses in such a manner as to favor transfer, they merely multiply courses."

Stress the word 'basic' in the quotation. It is not the specialized, restricted-field courses which will of themselves provide the transfer of training. A good teacher in any subject will try to effect this transfer of training, but that a subject should of itself be more suitable for promoting the transfer it must evidently be more basic, more fundamental. It will then naturally be more universally applicable.

The reason for the second of the demanded characteristics of the science subject—that it should lend itself more easily to the measurement of the reliabiilty of its conclusions—is the state of the public mind at the present time. Science has produced such wonderful advances and we are entirely surrounded by the marvelous applications of the discoveries of science that we need only say a thing or a thought is scientific to have it accepted almost without hesitation or doubt. It is advertising's lure; to which are attached hook, line and sinker. On the other hand we are faced with quite the reverse attitude of so many educated minds: the skepticism with which the laws of nature, as defined by scientific investigation, are received. Too often the so-called laws of nature were formulated loosely and without sufficient regard for the limits and the errors of the experimental work on which they rested. This is especially true in the less exact of the natural sciences. Too much credulity and too much reliance on insufficient evidence as we find it in the world require that the college teach a subject which forces the student to make judgments on the reliability of scientific evidence.

Dropping, therefore, all appeal to usefulness or cleverness or manual dexterity as non-essential in the choice of a college science subject, we must choose one that is broad, basic, fundamental and one that best teaches the student to measure the reliability of its content and of its advance. It seems that the science of Physics is the one science which in itself has these two characteristics. It is broad, not narrow. We define Physics as that natural science which treats of the more general laws of the related phenomena of matter and energy. It is here that one looks at the working and activities of nature, and not at the workings and activities of a part, large or small, of nature. All the other sciences confine themselves to narrower fields. Geology chooses only the activities of the earth, meteorology only those of the gases above the earth, astronomy only those of bodies beyond the earth, chemistry treats only of kinds of matter and substances identifying, separating, combining them according to their own specific affinities or activities.

Is it not better and more logical to teach the general principles directly, drawing examples from all the fields, than to teach a science in which the field is circumscribed and in which the more general laws must be applied, and hence understood, in its exposition? Take an instance: in treating of the kinds of substances the chemist discusses gases for his class. He teaches the gas laws, the kinetic theory, diffusion, heat equivalents, specific heats, some thermodynamics—all this besides the purely chemical aspects of the matter in hand. Practically his main effort is in the exposition of the general laws of energy, and he is appplying Physics to his special field. Practically, he teaches more Physics than he does Chemistry in this part of his subject. He has to; his hearers have not had a course in Physics and the general laws are unintelligible to him unless they are explained here in the chemistry lecture. The gas laws are examples of energy laws, kinetic energies of motion both linear and rotational. Would it not be far better to teach these laws directly as general phenomena of nature, applied not only in gases but to all atoms and molecules, to the heavenly bodies, to every spinning and moving object, to the child's top and the man's automobile, the pitcher's curve and the golfer's slice, the pressure of the storm or the trajectory of the whirling rifle bullet?

Physics is certainly the more suitable for promoting the transfer of training because it is the more fundamental, more basic. What Philosophy is to all knowledge: a study of things in their last causes, Physics is to the natural sciences: an exposition of the more general laws of nature.

Historically, Physics is the parent of all the natural sciences; but may we be permitted to say that really all the other natural sciences rest on the solid support of Physics? It is true that the science are interdependent. Each science borrows from the other and none is segregated into a watertight compartment or held incommunicado from the rest. Each, in treating its own field will take from the others whatever might be of service to it. But necessarily the restricted-field science will depend for many of its principles, theories and often for its methods on the basic science or sciences. All the natural sciences, treating as they do of substances and bodies and energies, necessarily treat of the laws of matter and energy. If the subject matter of the science, its field, is narrow, it must of necessity restrict its discussions to the narrower applications of the general laws governing matter and energy; for the moment it can not be interested in the universal applicability of the general laws.

The validity of these general laws is ordinarily assumed in sciences other than Physics, and the dependence of the sciences of narrower field on the general laws of matter and energy is usually taken for granted. But we have branches of these sciences which look specifically to their dependence on Physics and by both name and content direct their attention to this dependence. We have geophysics, astrophysics, celestial mechanics, biophysics, physical chemistry. Only the other day the head of the Chemistry Department regretted the loss of a certain General Physics course at Canisius College because in that course 65% of his physical chemistry experiments had been directly explained and made the work of the student laboratory. His equipment would be boxed in compact form and more frequently than not merely indicated the value of an unexplained physical quantity. How that quantity was indicated the student need not have learned in order to perform his experiment in physical chemistry.

From the educational point of view it is obviously more logical to prefer the basic subject to the derived subject; the basic subject will give the broader knowledge and will act as the easy, proper approach to all subjects which study only a restricted part of the same matter. That is the method of exposition in individual subjects: general ideas which apply throughout the subject are given first and then the special applications are put under discussion. You will all remember that general ethics is given first and the principles there laid down are applied in the questions of the special ethics. It is the logical way of treating a subject. So too in the sciences: give first that which is general, basic, fundamental. Only after that give what is helpful, good or that for which there is time. If there is no more time, the fundamental principles at least have been presented; on them the individual may build by further reading or study in any of the fields in which his work or his interest may lead him. The solid ground work has been laid.

This is the position of Physics. It is the solid ground work on which the rest is built; and very often, let us confess, it is the true science, the only scientific part of some of the so-called scientific courses which actually are nothing more than application or technique. Let us remember too that the basic fundamental science is as important for the student going on to other scientific fields as it is for the student who has time for only a single course in science. It will make his path easier, it will light his way.

Several years ago, at its annual meeting, the American Association of Physics Teachers was startled by the paper of a medical doctor who had been asked to address the assembly. He was on the staff of a Philadelphia Medical School and in charge of the internes at the hospital. He made a demand for more time for Physics in the premedical courses in college. When asked what he would curtail in an already bulging schedule he made a still more startling statement: drop some of the Biology. "We," he said, "will give the medical training in medical school, but for heaven's sake give the boys more solid foundations in Physics, in the basic science." His suggestion was a minimum of two years of Physics as a premedical requirement.

The second characteristic of importance in the one year college science course is that it should, of itself, best teach the evaluation of scientific conclusions and the reliability of the results of scientific research. It should be the science which best lends itself to the demands for a measure of the reliability of one's work. One might say that this too could be taught in any subject. Perhaps. Usually it is not so taught; there is too much to be done and the subjects do not demand it. In the work in the Physics Laboratory this is nearly always forced on the student. Here the work is generally quantitative: measurements are made, and in the very nature of things, measurements will not repeat when they are carefully made with accurate instruments. The inevitable errors are forced into the line of vision, and obviously, things in the line of vision must be given some attention in the science laboratory. The variations will be studied, the errors examined; some will be found and rectified by a change of method or approach, others will be admitted and 'corrections' allowed for them, and still others will be found indeterminable. What of the conclusions derived from such data? Right there one is forced to evaluate results, form an idea of the precision of the work and then of the results, give some measure of the reliability of both the work and the conclusions. This is the most important thing to be gained by the student from laboratory work; unless of course, the particular laboratory is a preparation for some technical profession.

There are hundreds of things the science laboratory could inculcate: neatness, careful manipulation, accurate observation, watchfulness over the conditions under which the experiment is performed, and many others. A professor of Philosophy who once expected a life work in Chemistry told me that the finest thing he learned in the science course in college was the reasonableness of the necessity of neatness; and this he learned in Qualitative Chemistry. Evidently his particular professor or instructor was entirely responsible for this achievement. I do not know why he had not learned the same lesson the year before in General Chemistry, or in Biology, or in Physics. Do you? Is this the most important educational gain in a laboratory?

Sometimes it is said that the purpose of the student laboratory is to prove the laws of nature for the student. It isn't. No law of nature is proved by a single test. Except for technique what will a student learn by seeing a thing but once, or a whole series of things done but once? A change in color, the formation of a precipitate, the dissection of a muscle or a nerve or a whole nervous system, the appearance of cells or crystals or powdered rock under a microscope: if the purpose is to make the learning more vivid and thus to help the memory, well and good; if it is to train in handling instruments and experimental tools, also excellent; but neither of these is particularly good for the training in the general purposes of a college education. Such lessons add little to the mental training, to the general culture, and they fail to impress the student with the great need of the times in scientific work or reading: the need of some kind of measure of the reliability of the work and of the results.

More than in other subjects the class room or lecture hall work in Physics will teach some of this 'suspicion of data'; but it is in the Physics laboratory where the student sees that absolute facts are hidden by errors, where he must learn from the mixture of fact and concealing error how much of truth he can achieve.

With more of this type of training we should have fewer 'discoveries' of the too broad, all-inclusive, but unsubstantiated 'laws' of nature; we should be less frequently under the necessity of explaining that the laws discovered in the last century have not changed, that the truth was then as it is now, that these discredited laws never were laws but only unwarranted pronouncements made with too little regard for the limits and the errors necessarily present in every experiment.

These are the reasons why we should recommend Physics for the student who goes to college.

FIRST GENERAL SESSION

The 18th Annual Meeting of the American Association of Jesuit Scientists, Eastern States Division, was held at Fordham University, New York, N. Y., on August 17 and 18, 1939. The first general session was held at 3:00 P. M., in the Chemistry Lecture Hall, the Reverend Emeran J. Kolkmeyer presiding. The meeting opened with prayer followed by the welcoming address which was given by Rev. Charles J. Deane in the absence of the Reverend President of Fordham University. The reading of the minutes of the last meeting was omitted since they had already been published in the Bulletin. Fr. Kolkmeyer appointed the following committees:

Committee on Resolutions
Rev. J. J. Sullivan
Rev. T. J. Brown
Mr. J. F. Cohalan

Committee on Nominations
Rev. F. W. Power
Rev. G. A. O'Donnell
Rev. E. B. Berry

Fr. Kolkmeyer then delivered the presidential address. Under the head of new business Fr. Schmitt, the Reverend Editor of the Bulletin, read a letter from Fr. Fitzsimmons, Prefect General of Studies of the New York Province, asking the members of the Association to discuss the proposed revision of B.S courses in the colleges of the province. Outlines of the proposed schedules were handed to the members. The following morning, 10:30 A. M., the time of the concluding general meeting, was appointed for this discussion. The meeting adjourned and the members repaired to the various sectional meetings.

On the evening of August 18 at 8 P. M., a special general meeting was held in the Physics Lecture Hall, Fr. John A. Tobin presiding. At this meeting Mr. Laurence C. Langguth of the New England Province read a paper on "Dr. Edwin H. Armstrong's New System of Radio Transmission and Reception Employing Frequency Modulation". This was followed by a special broadcast from Dr. Armstrong's transmitter at Alpine, N. J., using one of his receiving sets. This set was later donated to Fordham by Dr. Armstrong. Our congratulations and gratitude to Dr. Armstrong and Mr. Langguth. The meeting adjourned at 9 P. M.

FINAL GENERAL SESSION

The final general session was held in the Chemistry Hall at 10:30 A. M., August 18.

The secretaries of the various sections reported the results of the elections as follows:—

Biology
Chairman—Rev. James L. Harley
Secretary—Mr. Joseph E. Schuh

Chemistry
Chairman—Rev. Albert F. McGuinn

Mathematics
Chairman—Rev. Joseph T. O'Callahan
Secretary—Mr. John P. Murray

Physics
Chairman—Rev. Joseph M. Kelly
Secretary—Mr. Edward R. Powers

Fr. Brown read the following resolutions which were accepted after a motion by Father Power which was seconded by Father Schmitt.

RESOLUTIONS

August 18, 1939

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 Father Deane of Fordham University, for their cordial reception and for the gracious hospitality shown during its convention.

2) Be it resolved that we express our appreciation to the President of the Association for the laborious and toilsome efforts in making this meeting a success, and to Father Francis W. Power for his generosity in carrying the burden of financial affairs.

3) Be it resolved that a rising vote of thanks be given to Rev. Richard B. Schmitt, S.J., who, in spite of countless difficulties, has successfully completed his tenth year as the distinguished editor of the Bulletin of the American Association of Jesuit Scientists, Eastern States Division.

4) Be it resolved that a copy of the above resolutions be sent to all the above mentioned persons.

COMMITTEE ON RESOLUTIONS

REV. T. JOSEPH BROWN, S.J.
REV. JOSEPH J. SULLIVAN, S.J.
MR. JOSEPH F. COHALAN, S.J.

Fr. Power then presented an informal report of the finances of the Association. The balance on hand is $68.98. Fr. Power was then reappointed Treasurer.

At this time Fr. Kolkmeyer asked for a discussion of the proposed revision of the B. S. Schedules. A complete report of this discussion will be found in the private minutes of the Association.

The Committee on nominations reported the following nominees

President—Father John A. Tobin
Father Joseph T. O'Callahan

Secretary—Mr. John J. Blandin
Mr. Neuner

Father Tobin and Mr. Blandin were Elected. The meeting adjourned at 12:05 A. M.

EXECUTIVE MEETING

The Executive Committee met on Friday afternoon at 12:30. The candidates for membership in the Association were approved. Fr. Schmitt was reappointed Editor of the Bulletin. It was recommended that the time and the place of the next general meeting be announced in the issue of the Bulletin which appears around the Easter holidays. This recommendation met with the approval of the entire Committee. The Committee, suggested as a result of the discussion of the proposed revision of the B. S. Schedules, was appointed, as follows—

Fr. Tobin—ex-officio
Fr. John O'Conor—chairman—Math. and Physics
Fr. Francis Power—Chemistry
Fr. Clarence Shaffrey—Biology

It was recommended that the membership list be revised in accordance with the present personnel of the association. Fr. Schmitt requested that a biography of the late Father Langguth, of the Chemistry Department of Boston College be compiled for publication in the Bulletin.

MEMBERS ATTENDING THE CONVENTION

Father Assmuth
" Berger
" Berry
" Brown
" Coniff
" Connolly
" Delaney
" Didusch
" Dutram
" Harley
" Hauber
" Hohman
" Kelley
" Kolkmeyer
" Lynch
" Logue
" McAree
" McCoy
" McGrath
" McGuinn
" Murray
" O'Callahan
" E. O'Conor
" J. O'Connor
" O'Donnell
" Phillips
" Power
" Shaffrey

Father Schmitt
" Sohon
" Sullivan
" Tobin
" Walsh
" Welch

Mr. Acker
" Anable
" Bauer
" Blandin
" Benedetto
" Carroll
" Caulfield
" Cohalan
" Crowley
" Deeley
" Fay
" Fitzgerald
" Gerry
" Greene
" Kleff
" Langguth
" McCarthy
" Murray
" Powers
" Ring
" Schuh
" Winslow

NEW MEMBERS

Mr. Richard Anable, Canisius High School
Mr. John J. Blandin, Loyola College
Mr. John F. Caulfield, Boston College
Mr. Joseph P. Crowley, Cranwell Academy
Mr. John G. Fay, Loyola College
Mr. Stanislaus Gerry, Boston College
Mr. Merrill Greene, Boston College
Mr. George Lawlor, St. Louis University
Mr. Daniel McCoy, Loyola High School
Mr. John P. Murray, Boston College
Mr. Edward Powers, Georgetown University
Mr. Joseph E. Schuh, Fordham University
Mr. Francis A. Benedetto, Fordham University (New Orleans Prov.)

BIOLOGY

POLYPLOID NUCLEI IN RELATION TO CELL GROWTH

REV. CHARLES A. BERGER, S.J.

(This paper will be published in full.)

INITIATION AND PROPAGATION OF THE HEART BEAT

(Abstract)

REV. C. E. SHAFFREY, S.J.

The discussion pertains to one heart beat, the contraction of the auricles followed by that of the ventricles. The question is as to the nature of the stimulus, whether an inner one, arising in the heart musculature, or an external one, brought to the heart by nerves. Following Haller the idea of an internal stimulus was held from about 1797 down to about 1848 when Remak discovered ganglion cells within the heart. From that time the neurogenic theory was held for the next forty years, when Hiss, Jr., discovered the auriculo-ventricular bundle; this is a muscular bundle which establishes a muscular connection between the auricles and ventricles. The final ramifications of this bundle were found to be identical with the so-called Purkinjie fibres which had been discovered by that observer in the heart of the sheep and ox, but not in the heart of man. The discovery of this bundle in the human heart by His, and in that of other mammals by Kent in the same year, did much to establish the myogenic theory which holds that the stimulus is an internal one.

There are special tissues concerned with the initiation and propagation of the heart beat, namely, the sino-auricular node, the auriculo-ventricular node, and the bundle of His with its right and left branches in the respective ventricles.

The internal stimulus seems to be calcium ions acting on the sino-auricular node, producing a wave of contraction over the right auricule and left auricle, the waves converging to the auriculo-

ventricular node where it is transmitted to the main bundle of His and then to its right and left branches, causing the contraction of the ventricles.

When there is a defective conduction of the impulse due to injury or experimental ligation or clamping of the bundle, or destruction of one or other of the nodes of the system, there is produced the phenomenon known as heart block, the symptoms varying with the location of the injury on the conducting system.

POTASSIUM: ITS FUNCTION IN PLANT ABSORPTION

(Abstract)

REV. HAROLD L. FREATMAN, S.J.

Possibly potassium performs its essential function without change from the simple inorganic form in which it exists in the soil solution. Its chief role seems to be in photosynthesis and the translocation of carbohydrates because they depend on the presence of potassium. A deficiency of potassium is associated with lack of carbohydrate reserve. Experiments over many years and detailed in the literature bear out these conclusions.

Typical results in work with corn, peas, rape, buckwheat, sugar cane, tomatoes, apples, prunes, peaches, strawberries, potatoes and fungi were described and commented on in the course of the paper.

THE VIRUS

(Abstract)

REV. JOSEPH P. LYNCH, S.J.

As used in this paper "virus" means "filtrable virus", that is, an infectious agent which is so small that it will pass through the pores of a Berkefeld or Chamberland filter and consequently invisible to the microscope.

Viruses are numerous. Of man's 742 infectious diseases 31 are ascribed to viruses. These vary in virulence from 100% fatal rabies down to the harmless wart. Every Class among the vertebrates has one or more examples of virus disease. Among the invertebrates also are found many, especially in the insects. The plant kingdom

too has its generous share. Even the lowly bacteria have virus diseases that kill them off. These latter are called bacteriophages.

Viruses seem all to be large protein molecules with estimated molecular weights running from about 8 million to 63 millions. They are thought to be rod-like particles with diameters from about 11 millimicrons to 25 millimicrons and lengths from 430 milimicrons to 725 millimicrons.

The true nature of viruses is not known. Even the question as to whether or not they are living organisms is still in dispute. The evidence for the various stands on this latter question was presented and discussed. Particularly stressed were the opinions of Cowdry, Green, Gowen, Price, Northrup, Stanley and Lauffer. In this discussion was treated also the possibility of viruses being a) escaped genes, b) invisible bacteria, c) chromosomes nucleoproteins, d) degenerated parasitic cells, e) enzymes,—and also whether they are tactoids or only liquid crystals. The greater probability lies with the opinion that viruses are autocatalytic enzymes.

THE MORPHOLOGY OF GIANT NUCLEI IN THE SALIVARY GLANDS OF DROSOPHILA MELANOGASTER

(Abstract)

PHILIP B. CARROLL, S.J.

The larval salivary gland nuclei of **Drosophila melanogaster** are exceptionally large—about 25 microns in diameter. In the smear technique, the nucleus is ruptured and is seen to be composed of the following:

1) Six chromosomal strands which represent the diploid complement. Eight chromosomes do not appear as in normal diploid somatic tissue first, because salivary gland chromosomes undergo somatic synapsis during which homologues become completely fused and second, because the apex of the V-shaped chromosomes is embedded in the chromocenter with the result that the two arms are seen as individual chromosomes. The chromosomes are about 50 times as long as ordinary metaphase chromosomes and 1000 times their voiume. Each one has its own peculiar pattern of light and dark bands.

2) A chromatic body, termed the chromocenter, situated near the periphery of the nucleus, to which all the chromosomes are attached at their spindle-fiber regions.

3) A centrally nucleolus.

In this paper the above features were described. It also included a discussion of the theories concerning the detailed structure of the chromosomal bands.

WATER: STRUCTURAL PART OF THE BODY

(Abstract)

JAMES J. DEELEY, S.J.

Many theories and hypotheses have been formulated to enhance the understanding of the complicated process of imbibition by protoplasmic material. Every one of these theories, such as the polarity of water, the electrical charge of the colloid molecule, the Helmholz Double Layer Theory, the influence of salt and ionic concentration tend to point to the electrical nature of the phenomenon. Since all these forces are a result of the configuration of the bio-molecule, this configuration ultimately plays a large part in the phenomenon. The properties of hysteresis, swelling, syneresis and elasticity are difficult of explanation, when we consider the numerous factors that affect the imbibing powers of protoplasm. In most active structures the capacity to imbibe and bind water is finely regulated and this regulation seems to be under chemical, hormonal and nervous control. While some of the individual events in the process of imbibition and binding of water may be explained in such physical terms as those of a so-called osmosis, the fundamental cause seems to be the labile configuration peculiar to bio-molecules.

ANTHROPOLOGY, BASED ON FACTS

(Abstract)

STANISLAUS T. GERRY, S.J.

Anthropology is the science which principally concerns itself with the end of the prehistoric period, when contact with history is being made, but before literary history, unassisted by the spade can really carry on the story. The science has frequently been condemned in rash and sweeping statements as entirely conjectural and unsupported by facts. In refutation, the general methods of the prehistorian or anthropologist were discussed, wherein four distinct lines of procedure were considered, viz,. 1) Stratigraphy, 2) Typology, 3) Associated Finds, and 4) The State of Preservation of the Artifacts of Ancient Man. Thus the soundness of principles was revealed in discovering, correlating, comparing and recording the cultural remains of prehistoric man. There followed a brief and final word on the tracing and recording of a culture.

CHEMISTRY

AN IMPROVED METHOD FOR MOLECULAR WEIGHT DETERMINATIONS OF ORGANIC COMPOUNDS

(Abstract)

REV. RICHARD B. SCHMITT, S.J.

There are two methods for molecular weight determinations in common use in research laboratories: the vapor pressure method and the elevation of the boiling-point method. The vapor pressure method is restricted, because the molecules of organic compounds are frequently decomposed at high temperatures and so results are vitiated.

The elevation of the boiling-point method, however, in many instances avoids this difficulty. This principle has been successfully used in microchemistry by Pregl, Romer, Swietoslawski, Rieche, Suchard, Bobranski and others.

By investigation we find that at present European laboratories found this method must useful for a wide field of organic compounds.

We improved the apparatus as designed by Sucharda and Bobranski. About 15 mgs of materials are used, a macro balance can be used, and a determination can be made in less than an hour. The design of the apparatus, the method of procedure and typical examples of molecular weight determinations are given.

MODERN VIEWS ON ACIDS, BASES AND SALTS

(Abstract)

REV. JOSEPH J. SULLIVAN, S.J.

Brönsted and Lowry proposed a new view-point on acid-base phenomena in 1923. This view-point is only now being accepted by present-day educators in chemistry. In substance, it makes the proton (H^+) the unit of transfer in all acid-base reactions. With this simplification of our concepts, we are able to side-step many obscurities in the textbooks of to-day.

Just as the electron is the unit of transfer in oxidation-reduction processes, so the proton is the unit of transfer in acid-base reactivity. The following equation defines both an acid and a base:

$$\underset{\text{Acid}}{A} \rightleftarrows \underset{\text{Base}}{B} + \underset{\text{Proton}}{H^+}$$

An acid, therefore, is a supplier of protons; a base is an acceptor of protons.

This mechanism presupposes the modern findings regarding electrolytes as proposed in the Debye-Hückel theory:

1) Complete ionization of strong electrolytes,
2) solvation of ions,
3) effect of dielectric constant of solvent.

This theoretical picture seems to be here to stay. It behooves us, as educators, to present it to our students.

MATHEMATICS

SQUARING FOUR POINTS

A School Exercise and a Mathematical Recreation *

REV. EDWARD C. PHILLIPS, S.J.

Part I.

NOTE. The following geometrical problem was proposed by a prospective teacher of Mathematics in the secondary school field; he had received it from someone else, but the solution, if ever published, was not available. If any reader of the BULLETIN *has come across the problem in any of the manuals or exercise books with which he is familiar I would be grateful for a reference to the same.*

On examining the problem it appeared to me to be well adapted to find a place on the Program of some of the Mathematical Clubs which are rather common now in the High Schools and Freshman classes of our American Colleges. Having had this audience in view in developing the problem, I have given to its treatment a style which is somewhat more pedagogical than is customary in the pages of the BULLETIN. *For the same reason there have been interjected questions, hints, collateral remarks and indications of subsidiary problems; and some of the proofs have been purposely left incomplete: all with the hope of challenging and stimulating the initiative of the tyro 'research students' who usually form the majority of the membership of such Clubs.*

THE PROBLEM AND ITS SOURCE

THE PROBLEM is this: GIVEN four arbitrarily designated points in a plane, TO CONSTRUCT the square or squares whose sides, extended if necessary, pass one by one through the four points.

The proposer of the problem on being asked what, if any, elements of the solution had been found, replied that he had a partial solution leading to the construction of a rectangle with sides approximately equal, but that the means of determining a rectangle absolutely square had not yet been found.

The proposed constructions were as follow:

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*Paper read at the Eighteenth Annual Meeting of Association, August 18, 1939.

Call the four points A, B, C, D. Draw the sides AB, BC, CD and DA of the quadrilateral having the four points as vertices.

On each of these sides as diameter construct a circle.

On one of these circles choose any point P near to but distinct from one of the vertices, say D. Draw a line from P through the adjacent vertex D and extend it till it meets the adjacent circle in Q; from Q draw a line through A and meeting the next circle in R;

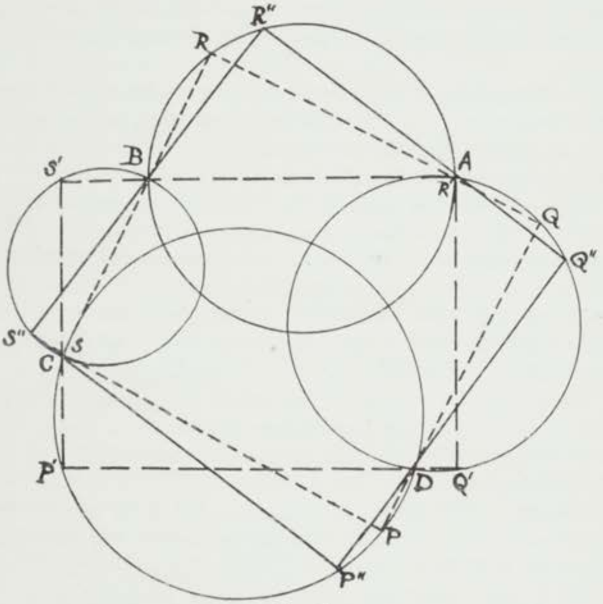

Fig. 1

from R draw the line through B and meeting the fourth circle in S; from S draw the line through C which will meet the first circle again in the original point P. (?). The quadrilateral PQRS is a **rectangle** passing through the four points.

Proof. That it passes through the four points is evident since by construction each side goes through one of the four points in succession.

Moreover, by construction, each of the angles at P(?), Q, R and S is inscribed in a semicircle and is therefore a right angle. Therefore the four angles of the quadrilateral are right angles and the figure is a rectangle. Q.E.D.

Now choose another point P′ on the same circle near the other vertex (C) and construct the rectangle starting at this point P′.

Usually (?) the ratio of the side passing through A to the side passing through B will be too small, i. e., less than unity which is required for a square, in one of the rectangles and too large in the other rectangle. Determine these ratios (by measuring the respective sides): let them be equal to 1—a and 1+b. Divide the arc PP′ in the ratio a:b and let the point of division be P″. Starting at P″ construct a rectangle in the manner described above.

This third rectangle will doubtless (?) be very approximately a square.

Critique of this Method

This solution by trial and error, as admitted by its author, is of course unsatisfactory—even if we admit all the underlying suppositions.

In the first place, it does not prove or make evident the possibility of constructing a square for any and every set of four points. And if it is always theoretically possible to have a square passing through any four points, we could never tell when we have a square: for the criterion here involved is the physical measuring of the sides to determine their ratio, and such a criterion is only approximate no matter what refinements we use in our instruments and methods of measuring.

I said "even if" the underlying suppositions are true. Question marks (?) were inserted in the text of the above construction, to call attention to points of doubt.

First. Will the figure close in at the initial point P on the circle? Might not the fourth line SC intersect the first line PD not on the circle but within or outside the circle? In that case the whole construction would fail.

Answer. The figure does necessarily close in at P and form a rectangle. The proof of this should not be too difficult for the student to establish.

Second doubt. Will the ratio of sides through A to the corresponding sides through B always be respectively less and greater than unity? The answer to this is not clear. The ratio might be greater than unity in both cases; or less than unity in both cases: or they might be (as closely as our measurements can go) equal to each other. How would we then choose the point P″?

Third doubt. And if the two ratios are found to be respectively less and greater than unity, will the new point of division P″ necessarily give us a better rectangle, one more nearly square, than either of the previous ones?

The answer to this is very probably in the affirmative; but it can scarcely be said to be evident.

The problem therefore still remains to be solved.

Making a New Start

Since no intuitive solution presented itself, it was decided to seek the solution by means of Analytical Geometry. And first of all, it is evident that we can construct on any four points in a plane an infinite number of **rectangles.** For through any one of the four points we can draw a straight line in **any direction** we choose, and we can then complete the rectangle by drawing through another of the points a parallel line and through the remaining two points perpendiculars to the first line. The indicated constructions are always possible according to the ordinary postulates of Euclid. However among the infinite number of such possible rectangles through the four points there may be a limited number of what Mathematicians call **degenerate cases**, i. e. cases in which the two lines of either one or of both pairs of parallels coincide. Barring these exceptional cases, of which we will speak later on, we ask: Is it always possible to construct not only a rectangle but also a true square? And if so, how is it to be determined?

We should note here that given four points, they can be **paired off** in three different ways. By a pair of points we mean the two points which are to lie on one pair of opposite or parallel, sides of the square; the other pair of points lying, of course, on the remaining pair of opposite sides. For call the points A, B, C, D: then the three sets of pairs are (1) AB and CD; (2) AC and BD; (3) AD and BC. In what follows we will, unless otherwise noted, consider the points paired off in the "natural" way, i. e., AC; BD, which follows the location of the points in the order A, B, C, D, on the four **successive** sides of the square.

The Equations of the Four Sides

With these explanations given we proceed to the analytical solution. We recall that the equation (in rectangular coordinates) of any straight line through a designated point, (x_1, y_1) is of the form $y-y_1=m(x-x_1)$; where m is the slope of the line, that is the tangent of the angle which the line makes with the X-axis and that the slopes of any two perpendicular lines bear to each other the relationship of negative reciprocals; hence a line through any point (a, b) and perpendicular to the line given above has for its equation:

$$y-b=(-1/m)\ (x-a) \text{ or } (x-a)=-m(y-b).$$

(x—a), which can be expressed also in the form $(x-a)=-m(y-b)$. If, then, (x_1, y_1), (x_2, y_2), etc., are the coordinates of the four points in question, we can write the equations of **any** set of lines passing one by one through the four points in the order A-B-C-D and forming a **rectangle**, as follows:

(1) For line l_1 passing through	A:	$y-y_1=m(x-x_1)$
l_3,	C:	$y-y_3=m(x-x_3)$
l_2,	B:	$x-x_2=-m(y-y_2)$
l_4,	D:	$x-x_4=-m(y-y_4)$

Necessary Conditions for a Square

In order to have these equations represent lines **forming a square**, we must assign such a value or values to the slope m as will make the perpendicular distance between the two parallels l_1 and l_3, the same as that between the other pair of parallels l_2 and l_4. To assist us in finding these values of m we introduce the following lemma:

Lemma

The segment (marked S″U′ in the adjoined figure) cut off on the X-axis between one pair of sides of a rectangle bears to the segment S′R′ cut off on the Y-axis between the other pair of sides, the same ratio as the corresponding sides SU and SR of the rectangle bear to each other.

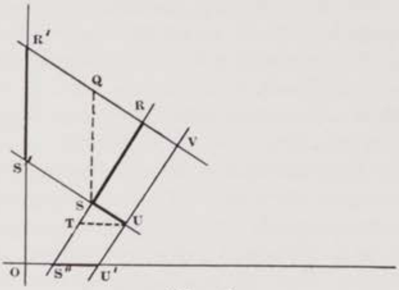

Fig. 2

The proof of this Lemma, which we leave to the student to develop, can be easily established by means of the similar triangle TSU and SQR made by drawing TU parallel to the X-axis and SR parallel to the Y-axis. To determine the algebraic value of these segments we proceed as follows:

The **intercepts** OS′ and OR′ of the lines l_1 and l_3 obtained by putting $x=O$ in their respective equations, are

$$OS' = y_1 - mx_1 \text{ and } OR' = y_3 - mx_3.$$

And the intercepts of the other pair of lines, l_2 and l_4, are correspondingly

$$OS'' = x_2 + my_2 \text{ and } OU' = x_4 + my_4.$$

The **segments** cut off by the respective pairs of parallel lines will be the differences of the pairs of their intercepts; hence we have

$$OR' - OS' = SR = (y_3 - y_1) - m(x_3 - x_1)$$
$$OU' - OS'' = S''U' = (x_4 - x_2) + m(y_4 - y_2)$$

Algebraic Statement of the Requisite Conditions

From the LEMMA stated above, we see that the necessary and sufficient condition which assures the rectangle being a square is **that these two segments be equal in length**, though they may be either equal or opposite as to algebraic sign or direction of measurement. Hence for a square, the absolute, or numerical, value of S″U′ must be equal to that of S′R′. There are two convenient ways of expressing this condition:

First. We may equate the **squares** of the two functions, since by this means any difference of algebraic signs of the functions disappears.

Second. We may equate one of the functions to the other **function affected by the plus and minus sign** ($\pm$).

Each method has its advantages and we will use both.

By the first means, the condition takes the form

$$(2) \quad [y_3 - y_1 - m(x_3 - x_1)]^2 = [x_4 - x_2 + m(y_4 - y_2)]^2$$

Once the four points have been given and paired off in a definite fashion, the only variable or arbitrary constant remaining in this equation is the slope m; hence this equation places on m, i. e., on the direction of the sides of the rectangle, a condition the fulfillment of which assures the equality of the sides, or the squareness of the rectangle. As the equation is a quadratic in m, it will have, in general, for its roots two real and distinct values of m, i. e., among the infinity of rectangles whose sides pass through the two given pairs of points there will be, in general, two and only two which are squares and the above equation enables us to pick these two out of the totality of rectangles. We might indicate to the student that this equation has therefore the same, or even a greater efficacy than the proverbial magnet that would help us to pick a needle out of a haystack.

Solving equation (2) for m, we obtain the following expression for its values:

$$(3) \quad m = \frac{(x_3 - x_1)(y_3 - y_1) + (x_4 - x_2)(y_4 - y_2) \pm [(y_3 - y_1)(y_4 - y_2) + (x_3 - x_1)(x_4 - x_2)]}{(x_3 - x_1)^2 - (y_4 - y_2)^2}$$

By the second and simpler means we obtain the following form of the condition:

$$(4) \quad (y_3 - y_1) - m\,(x_3 - x_1) = \pm\,[(x_4 - x_2) + m\,(y_4 - y_2)].$$

And solving this for m, we have:

$$(5) \quad m = \frac{(y_3 - y_1) \pm (x_4 - x_2)}{(x_3 - x_1) \mp (y_4 - y_2)}$$

in which the double signs in numerator and denominator must be taken in the order indicated; i. e., for one value of m we take the plus sign in the numerator with the minus sign in the denominator, and vice versa for the other value of m.

Since the two equations (3) and (5) express the same geometric condition they must be equivalent to each other; the verification of this fact may be left to the student as an exercise in algebra. He might be assisted by suggesting that he first factor the denominator of equation (3) and then see whether either, or both, of its factors is also a factor of the numerator, proper regard being had to the sign in the numerator.

Analysis of the Equations of Condition

We limited certain of our previous statements by the phrase "in general" which suggests that there may be exceptions, and hence we are led to propose to ourselves the following questions.

Query a).—Are there cases admitting of more than two solutions?

Query b).—Are there cases admitting of less than two solutions?

Query c).—Are there cases admitting of no real (algebraic) solutions?

Query d.)—Has every real algebraic solution a corresponding geometric sodution, i, e., can we construct a real square for every value of m determined by equations (3) and (5)?

We will answer Query c) first. Since the radical which ordinarily appears in the solution of a quadratic equation has disappeared in our equation (3), its disappearance being due to the fact that the function under the radical sign turned out to be a perfect square, the equation can never have imaginary roots, and hence whatever roots it, or equation (5), has are real roots.

Unlimited or Indeterminate Solutions

Q. a). Can there be more than two solutions? We would be inclined to give at first glance a negative answer. However we must remember that a fractional function, such as we have here for the values of m, can become **indeterminate:** this happens when the numerator and denominator of the fraction become simultaneously either zero or infinite. As we suppose all our four points to be in the finite part of the plane, none of the coordinates can be infinite and hence equations (3) and (5) will become indeterminate whenever and only when both numerator and denominator are simultaneously zero. The expression for the slope in these cases becomes the fraction O/O, which has no definite numerical value and hence the slope may be given any value we choose. This indeterminateness may be expressed in another way which will probably be more readily understood by the student: Since m is the tangent of an angle, its value is the ratio of the sine and cosine of that angle, and if we substitute this ratio in place of m in equation (5) and then clear the equation of fractions it will have the following form:

(6) $$[(x_3-x_1) \mp (y_4-y_2)] \sin \Theta = [(y_3-y_1) \pm (x_4-x_2)] \cos \Theta.$$

Now if in this equation we suppose the coefficients of both sin Θ and cos Θ to become zero, the equation is satisfied no matter what value we give to sin Θ or cos Θ, that is to the slope m.

Corresponding Geometric Conditions

But how can the coefficients become zero? In other words, since their values depend upon the relative position of the four points, we desire to know what configurations of points make both the numerator and denominator of eq. (5), or both of the coefficients in eq. (6) become zero.

Taking the upper signs we have two equations to be satisfied simultaneously, namely

(7) $(y_3-y_1) + (x_4-x_2)=0$ and $(x_3-x_1) - (y_4-y_2)=0$.

We can put these in the following slightly more convenient form:

(8) $y_3-y_1=-(x_4-x_2)$

$x_3-x_1=+(y_4-y_2)$

Dividing the first and second member of the first equation by the corresponding members of the second equation we have:

(9) $$\frac{y_3-y_1}{x_3-x_1} = -\frac{x_4-x_2}{y_4-y_2}.$$

Now the first member of this equation is the slope of the line AC passing through the first pair of points, (x_1, y_1) and (x_3, y_3); whilst the second member is the negative reciprocal of the slope of the line passing through the other pair of points (x_2, y_2) and (x_4, y_4). But this relationship, as we noted above, is that which is characteristic of two mutually perpendicular lines, and hence we see that when the equation determining the values of m becomes indeterminate **the two pairs of points lie on two perpendicular lines.**

However this is only one condition placed upon the four points, whilst for indeterminateness of equation (5) two conditions must be satisfied, i. e., **the two independent equations** of No. (7) or its equivalent No. (8); hence we must look for a second condition placed upon the four points. If we square both sides of the two equations of No. (8), and add these, member by member, we get:

(10) $(x_3-x_1)^2 + (y_3-y_1)^2 = (x_4-x_2)^2 + (y_4-y_2)^2$

from which we see that **the length of the segment AC must also be equal to the length of the segment BD***. Hence we conclude that

The necessary and sufficient conditions that every rectangle passing through the paired points AC, BD be a square is that the two segments AC; BD be equal to each other in length and perpendicular in direction.

We now come to our second question, or

Query b). Are there cases admitting of less than two solutions? (In consequence of our answer already given to Query c), this question may be expressed in the form: Are there cases in which there is only one solution?)

The answer is, Yes: and can be established very conveniently by using the longer and apparently complicated form of our main equation, namely Equation (3). In this equation, the part which in the ordinary case gives us two different solutions is that affected by the double sign, $\pm$. Now if this part happens to be zero there is only a single value for m; i. e., only one solution. Hence by equating this part of the equation separately to zero we have the condition for a single solution; namely

*Note. The student should be required to show that if we take the lower signs in Equation (5) or (6) we arrive at the very same Equations (9) and (10) which therefore express fully the conditions imposed on the four points.

(11) $(y_3 - y_1)(y_4 - y_2) + (x_3 - x_1)(x_4 - x_2) = 0.$

If we bring the x's to the right hand side of the equation and divide both sides by $(x_3 - x_1)(y_4 - y_2)$, we obtain the following relation of the coordinates:

(12) $$\frac{y_3 - y_1}{x_3 - x_1} = -\frac{x_4 - x_2}{y_4 - y_2}$$

which is identical with equation (9) and indicates, as shown above, that the lines through the two pairs of points are mutually perpendicular. This relationship, then, of the four points is **the necessary and sufficient condition that there should be a single definite solution** of equation (3) and likewise of its equivalent equation (5).

To the student this result will doubtless appear paradoxical; for we found the same condition when we sought the relationship of the points which would involve an infinite number of solutions. The paradox is removed by calling attention to the further fact that whilst the verification of equation (9) or (12) is a **necessary condition** common to both cases, it is a **sufficient condition** only for the case of a single solution. That is, when we simply make the two segments AC and BD perpendicular, we assure the presence of a single solution, or to speak more accurately, of a singular solution; when we go further than this and make the two perpendicular segments also equal in length we pass from the singular solution, which is exceptional, to the case of an infinite number of solutions, which is more exceptional still but includes, as a **particular** solution of the set, the singular solution of the previous case corresponding to Query b).

Geometrical Construction of the Squares

A more complete explanation of the exceptional cases will appear from the examination of our fourth question.

Query d). Has every real algebraic solution (ordinary or exceptional) a real geometric meaning?

Our answer is again in the affirmative; and to justify it we must now give an account of the various geometrical constructions involved in the analytical treatment given above.

We suppose therefore that we start with a piece of blank paper: some one marks four dots on the paper in whatever, arbitrary, positions may please him. To get our analytical statement of the problem, we must have the coordinates of the four points. Hence, choose any set of rectangular cartesian coordinate axes i. e., draw on the sheet of paper any two perpendicular lines, calling one the X-axis and the other the Y-axis.

Now measure, with a conveniently divided straight edge or ruler, the distance of the four dots (points) from these two axes, thus obtaining the numerical values of the eight coordinates, x_1, x_2 . . . ; y_1, y_2, etc. Substitute these with their proper algebraic signs in place of the x's and y's in either equation (3) or (5), and calculate the resulting values of m, calling them m_1 and m_2. They will be in the form of two numerical fractions which we may call p/q and r/s; and will represent the slopes of the two lines passing through A or C, each of these latter lines being one side of the two squares on the four given, ordered points AC; BD.

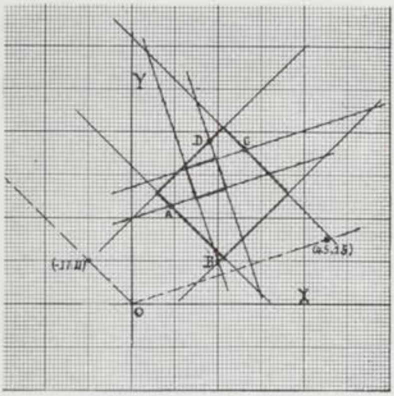

Fig. 3

A = (9,23) B = (20,10)
C = (26,36) D = (18,38)

$$m = \frac{13 \pm (-2)}{17 \mp 28} \qquad m = 11/-11 \qquad m = 15/45$$

(q, p) = (−11,11) (s, r) = (45,15)

To construct these lines, we first plot the two points (q,p) and (s,r)—and **note well** that the **denominators** of our two values of m **are the** x's, and **numerators are the y's** of the two points. Through the origin and the point (q,p) draw a straight line: this gives the initial **direction** for the first square which is constructed by drawing parallels to this direction through A and C, and perpendiculars through B and D. Do likewise starting with the point (s,r), and we have constructed the second square. Q.E.F.

Supposing that the two values of m are definite and different (corresponding to the **ordinary** case) the two squares will be definite and different; hence we have justified our statement that in the ordinary case the real algebraic solution has a corresponding real geometric meaning; i. e., two corresponding real squares.

Freedom in Choice of the Coordinate System

It is useful to remark here that as these squares are fully determined by the four points themselves, they are therefore quite independent of the particular set of coordinate axes chosen. Had we chosen some other axes, the **individual** values of the x's, y's, and m's would have been different but their functional relationship would have remained the same, and the squares themselves would necessarily be the same. The coordinate system is merely a means or a vehicle for bringing us from the four points to the four sides of the squares, analogous to the starting point and end of a journey which we may have to make. We might make the journey by train or boat or airplane. Similarly we are free to use any coordinate system we prefer; hence we can choose with advantage whatever particular set of axes will simplify the measurements, calculations and constructions indicated above. Thus, e. g., we may take for the X-axis a line through the points A and C, and for the Y-axis the perpendicular to this through the point A. The coordinates of A are then (O,O) and and those of C are (x_3, O), so that x_1, and y_1 and y_3 are all zero, which simplifies the measurements and calculations: it also simplifies the constructions since A, now being the origin, the line through the origin and the point (q,p) or (s,r) is not merely parallel to a side of the square, but is itself the side.

The Geometric Meaning of the Singular Solutions

We have thus shown that for the ordinary case, in which Equations (3) and (5) give two real, distinct values for m, we have two real corresponding geometric squares: but what about the case of a singular solution? We saw that for the singular case the two segments AC and BD are perpendicular. Using now the coordinate system just described, the slope of the segment AC is zero, since AC is part of the X-axis: hence the segment BD must be perpendicular to the X-axis, i. e., parallel to the Y-axis. From this it follows that $x_4 - x_2 = O$. Putting these values, namely, $x_1 = O$, $y_1 = O$, $y_3 = O$, $x_4 - x_2 = O$, in equation (3) or (5) we find that the single value of the slope m is zero. Hence when we draw a line through A (at the origin) with slope zero, it coincides with the line AC i. e., the two sides of the square coincide; likewise the perpendicular lines through B and D coincide, since the segment BD is parallel to the Y-axis. From all this we infer that for the singular case, with a single value of m, there is a corresponding real geometric construction, namely two perpendicular lines each traced over twice; but this is a degenerate square which consists of the common intersection of these two perpendicular line-doublets. It is a square of zero dimensions.

The Geometric Meaning of the Indeterminate Solutions

Finally for the indeterminate case, there is not only one or two real squares, but an infinite number of them, including as a limiting construction the degenerate case just described above. The following considerations may help the student to form a somewhat clearer idea of what this endless collection of squares is like.

If we call α the angle which the first side of any square included in the indeterminate case makes with the line AC, then the length of the side of the square will be equal to AC $\sin\alpha$; if we choose as an initial side a line at right angles to the segment AC, $\sin\alpha$ is unity and the distance between the parallel sides of the square, i. e., the length of the side, will be AC; if we vary the direction continuously decreasing the angle α, the distance between the two parallel sides will also decrease, in the same ratio as the sine of α; hence as α approaches zero so also will the length of the side of the corresponding square approach zero; and when α reaches its limit, i. e., when the first side of the square coincides with AC, the length of the side of the square also reaches its limit and is zero.

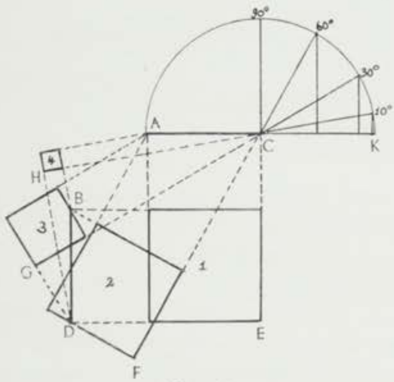

Fig. 4

"Round and Square Points"

The mathematician can, therefore, consider the existence (as entia rationis) of "square points"; or indeed of points of any shape. Thus by making a circle or a triangle, etc., shrink in size continuously according to some definite law of change, whilst retaining its shape, until the radius or the length of the sides become zero, he will have a "round point", or a "triangular point", etc. The mathematician however does not in such cases consider the point alone, as an isolated geometric entity; he must include in his consideration its definite relationship with the figure of which it is a limiting case. In fact he looks upon a square not simply as the boundary of the finite enclosed portion of a plane called a square in our elementary textbooks, but rather as the total configuration of four straight lines of unlimited length, lying in a plane and having those definite positional relationships which give to the finite, enclosed figure the character of squareness; the square from this point of view is the configuration made up of two pairs of parallel straight lines, the distance between the members of one pair being equal to the distance between the members of the other pair, each pair also being at right angles to the other pair. And this relationship still holds when the distance between the parallel members approaches and becomes zero.

A Mathematico-philosophical Digression

And here perhaps we may be allowed a mathematico-philosophical digression. What is the ontological nature of the objective concept of "a square point", described in the preceding paragraph? It clearly cannot have a physical existence independent of the lines that constitute the configuration, and is therefore at most an ens ratonis: but, moreover, the fundamentum of this ens rationis, namely the four lines having a definite spacial relationship, is itself an ens rationis since all geometric lines are entia rationis, though they have a real fundamentum a parte rei. The "square point" would therefore seems to be **an ens rationis of the second degree**, or perhaps even of the third. Will the logician and the ontologist concede to this ultra tenuous abstraction the title and privileges of citizenship in the all-including realm of **being?** If so, I would propose for their consideration, and that of the student of Theology, the following **reconciliation of contradictories.**

About any finite square we can circumscribe a circle on which the four corners of the square will lie, the sides forming chords of the circle. Having done this, let the configuration shrink continuously in size: no matter how small the figure becomes, it remains a square inscribed in a circle, though the straight lines being infinite in length remain unaltered except in position. When the square reaches its limit as a "square point", the circle simultaneously becomes a "round point" and both completely coincide with each other, and behold we have "a square circle"! the classical example of a contradiction in terms. And yet, by the processes, geometrical and logical indicated above the contradictories have been reconciled and fused harmoniously into one entity. If this can be imagined in the infinitely small, why cannot an analogous (very analogous, I admit), reconciliation be imagined in the infinitely great? And if we do not hesitate to accept, at least as reasonable, the story that St. Patrick helped his neophytes to accept the doctrine of the Blessed Trinity through the tenuous analogy of the three-leafed shamrock, may we not be allowed to offer to the mathematically minded the vanishing of the equilateral triangle inscribed in a circle—a figure which from early centuries has been an accepted symbol of the Trinity—as a closer analogy of this mystery of mysteries. The three sides are in all things equal—in the finite configuration they merely intersect. the circle, but in the limit spoken above they become identified with it: and yet because of the mutual relationships which the vanishing sides receive from the lines forming them, they still retain real distinction between themselves: Three beings distinguished in and by their constitutive relationships but in all else identified with and in a single entity.

The Complete Solution

It is well to recall here that all we have said above about, ordinary, singular and indeterminate solutions applies to one definite manner of pairing off the four points. Generally when we have a singular or indeterminate solution for the four points paired off in the order AC;BD there will be an ordinary solution with two and only two determinate values of m for each of the other two arrangement of points, namely AB;CD and AD;BC. For convenience we place here the corresponding equations for m, obtained by pairing off the points in the two new orders, AB;CD and AD;BC. It will not be necessary to derive the equations anew from the start: all we have to do is take Equation (3) or (5)—and we choose equation (5) as the more convenient for our purpose—and first interchange the coordinates of the point C with those of the point B, getting equation (5b) and then interchange the coordinates of C with those of D, getting equation (5d). Our complete set of equations for all the possible ways of pairing the four points, is, then, as follows:

(5c) $$m = \frac{(y_3 - y_1) \pm (x_4 - x_2)}{(x_3 - x_1) \mp (y_4 - y_2)}$$ for the pairs AC ; BD

(5b) $$m = \frac{(y_2 - y_1) \pm (x_4 - x_3)}{(x_2 - x_1) \mp (y_4 - y_3)}$$ for the pairs AB ; CD

(5d) $$m = \frac{(y_4 - y_1) \pm (x_3 - x_2)}{(x_4 - x_1) \mp (y_3 - y_2)}$$ for the pairs AD ; BC

Generally these three equations will give us six different values of m, determining the directions of the six lines through the point A from which we build up the six squares through, or on, the four points.

(Part II will appear in the next issue of the Bulletin)

SOME RECENT WORK IN NUMBER THEORY

(Abstract)

R. Eric O'Connor, S.J.

This paper gives a brief account of attempts to answer the question:—How densely are the primes distributed among the positive integers? Write $\Pi(x)$ for the number of primes (i. e., 2, 3, 5, 7, 11, . . .) less than or equal to the positive real number x. Euclid showed that "the number of primes is infinite" i. e., that $\Pi(x)$ increases beyond all bounds with x. Long searches for an approximation to $\Pi(x)$ culminated in the proof, independently by Hadamard

and de la Vallée Poussin in 1896, that the ratio of $\Pi(x)$ to $x/\log x$ has limit unity as $x \to \infty$. A better approximation is given by the integral $\int_2^x \frac{du}{\log u}$. That the difference of this integral from $\Pi(x)$ is less in absolute value than $A\,x\,\exp(-a\sqrt{\log x})$, where A and a are positive constants, was shown in 1899 by de la Vallée Poussin and since then this measure of possible error has been successively lessened. The investigation is far from complete and is strangely tied up with the theory of functions of a complex variable.

INFLUENCE OF FOURIER THEOREM ON MATHEMATICAL ANALYSIS

(Abstract)

JOHN F. CAULFIELD, S.J.

In the development of the analysis of a variable function before Fourier's time, no type of function had been found that could represent mathematically the periodicity that so often occurred in Nature, e. g., in wave propagation, heat conduction, etc. Fourier took up the possibility of representing the phenomena exactly by means of a series of sine and cosine terms. He was able to show that the series satisfied under certain conditions. In giving rigor to these conditions, subsequent mathematicians made a considerable advance in the knowledge of a variable function, e. g., the nature and the proof for convergence, the nature of limits, of continuity and discontinuity, etc. This paper stressed the contribution of Fourier as a shrewd guess that stood up under vigorous tests and aided greatly in advancing mathematical knowledge. The expansion of the function into its series form was indicated, and the ordinary conditions for its convergence were specified—taking the cases of continuous function—and the first type of a discontinuous function.

THE LAGRANGIAN INDETERMINATE MULTIPLIER

(Abstract)

JAMES W. RING, S.J.

This paper described the method of Lagrange for handling problems on equilibrium. An analytical treatment was presented intro-

ducing the indeterminate multiplier 'x' which quickly enabled the statical equations of equilibrium to be set down. It was further shown how this method could also discover the geometrical forces of a system. Finally a problem was introduced and solved to illustratte the elimination of the 'k' undetermined multipliers.

OTHER BASES THAN BASE TEN

(Abstract)

John P. Murray, S.J.

The number ten plays an important part in our system of numbers. In fact, ten is the base of our number system. The question arises: Why should the number ten be preferred? Could some other base be used? We may conjecture that ten is used as a base because the ten fingers on man's hands suggested ten as a convenient unit. Any natural number could have been chosen as the base of our number system, and it is possible that some other base might prove to be advantageous once we were conversant with it.

Suppose that we have a group of objects, the number of which we represent, using base ten, by seventeen. If we wish to express this quantity, using six as a base, we have 2—6+5 objects and therefore the representation of the number of objects is "25". In base six, 10 means 1 x six+O. We indicate seventeen objects by the operation 2. 10+5 which is the sequence 25. The following symbols designate in bases six and twelve the number of objects in a group.

Number of objects	In base six	In base twelve
5	5	5
6	10	6
10	14	t
11	15	e
12	20	10
13	21	11

The representation of fractions is simpler in base twelve than in base ten.

Base ten	Base twelve
$\frac{1}{3} = .3333$	$\frac{1}{3} =$ 4 twelfths $= \frac{4}{10} = .4$
$\frac{1}{4} = .25$	$\frac{1}{4} =$ 3 twelfths $= \frac{3}{10} = .3$
$\frac{1}{6} = .1666$	$\frac{1}{6} =$ 2 twelfths $= \frac{2}{10} = .2$

PHYSICS

INTEGRATION OF B.S. AND GRADUATE COURSES IN PHYSICS

(Abstract)

REV. JOHN A. TOBIN, S.J.

Careful observation is the raw material of accurate thought. If the data are wrong, no amount of logical reasoning will help the result. This paper gives the data about the B. S. in Physics course for the last ten years. The purpose of the course, the selection of studies to obtain this purpose, the results from this course, and errors discovered and corrected, were explained. Briefly the purpose of the course is to give our students who want a science training four years of Catholic atmosphere and religion. The purpose is culture and mental and moral development of the student. Formation is the major part of the course and not information. Yet the student must be prepared to enter graduate work in Physics with the same training that he would receive in the many colleges in this area. The selection of studies to obtain this purpose then must be the same in science as other colleges, yet it is different as we demand a cultural training and a study of truth in religion and philosophy. As a result the number of hours of class is high compared to other courses. We cannot cut down the credits in Chemistry, Mathematics and Physics, as the student needs these credits to enter a Graduate School. Justice demands that we give these credits, if we announce that the course prepares the student for graduate work. On the other hand in the four years there are over sixty credits in English, History, German, Religion and Philosophy.

After ten years we have had very fine results from our graduates who have gone on to graduate work in the graduate schools. They needed all the courses in the four years of undergraduate Physics. In the Freshman there is a general course, and in Sophomore Physical Optics and Thermodynamics. In Junior there are two required courses; Advanced Mechanics and Acoustics and Theory of Measurements and Mechanical Drawing. In Senior there are also two required courses; Electricity and Modern Physics and Philosophy, also four years of mathematics have been necessary. In Freshman there is a general course that prepares for the advanced work, in Sophomore Differential and Integral Calculus, in Junior Differential Equations and Advanced Calculus and in Senior Partial Differential Equations of Physics and Vector Analysis. Also in Freshman and Sophomore there is a course in General Chemistry and Qualitative and Quantitative Analysis. It would be very difficult to drop any of these courses as we require them or their equivalent for our own graduate students. They are also needed for students who go into research work in the industrial laboratories.

The first error that we had to correct was lack of interest in this type of work. This is solved after Freshman, as only the interested students go on in this course. The second was the use of the bound and current periodicals in the library. By conferences and seminars we made the students use the library. The third was the long hours of active work in the laboratory so that a graduate would have some technique when he started his graduate work. This depends on the teacher. The best schedule in the world means nothing if the teachers do not put the spark of interest into the student. Faculty, Library and Laboratory are great sources of error in this course. The last error that we corrected is the interest in this work after graduation. This was corrected by a fraternity that meets once a month. The results from our M. S. graduates have justified this organized and coordinated schedule in the B. S. in Physics. Their success and enthusiasm and loyalty have made the work worth while.

FREQUENCY MODULATION IN RADIO TRANSMISSION

(Abstract)

LAURENCE C. LANGGUTH, S.J.

This summer marks the beginning of commercial use of Major Edwin H. Armstrong's system or frequency modulation, developed within the past few years. In this system the signal, instead of being carried by changes in the amplitude of the carrier wave, is carried by changes in its frequency, over a broad bandwidth of about 120 kilocycles. Carrier waves in the ultra-high frequency region are used, between 40 and 130 megacycles. The system boasts numerous advantages over conventional amplitude modulation, among them being a much higher field strength relative to the rated power of the station. It practically eliminates all kinds of background noise, such as thermal noises from the tubes, and man-made as well as atmospheric 'static'. It affords much higher fidelity in the reproduction not alone of the original audio frequency, but of the original volume of the signal as well.

THE CYCLOTRON

(Abstract)

JOSEPH P. CROWLEY, S.J.

The impracticability of radium bombardment and the difficulty of insulating high voltage X-Ray machines have led to the development of the cyclotron.

The cyclotron, a bombardment gun, based on the principle of magnetic resonance, is one of the most effective weapons in the assault on the atom. A vacuum chamber is placed between the two poles of a magnet. Within this chamber charged particles, (deutrons), in this magnetic field, have orbital motions. Under the influence of two hollow electrodes, of rapidly changing polarity, the particles gradually build up a speed sufficient to overcome the restraining force of the magnet. When the desired speed is obtained, the particles are deflected into the disintegration chamber where they come into contact with organized matter, become lodged within the valence electrons and cause loss of identity or the transmutation of the organized matter.

The effectiveness of this instrument lies principally in the strength of the magnet. The recently perfected small (6" x 8") magnet, capable of developing a field of 120,000 gauss by using a small water-cooled coil and 12,000 amperes, exceeds in duration and magnitude the eighty-five ton magnet used by Dr. Lawrence. This new magnet, it seems, will bring about a more compact and more efficient cyclotron.

APPLICATIONS OF THE MULTIVIBRATOR CIRCUIT

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

(Abstract)

The adaptability of the multivibrator circuit for use as an oscillator of variable frequency which actuates a neon stroboscope was demonstrated with a unit built from standard radio parts according to the design of Edgerton and Germeshausen.

The modification of the same circuit used to control the discharge of Geiger-Muller counters was also briefly discussed.

A PROJECTED EXPERIMENT WITH ZONE PLATES

(Abstract)

MERRILL F. GREENE, S.J.

The proposed experiment consists in determining what increase in resolving power, if any, will be afforded a telescopic system of lenses through the use of a zone plate. The system is arranged on an optical bench for ease of focal adjustments. The procedure is simple: find the resolving power of the zoneless system in the usual manner, using monochromatic light, a double slit at the objective. Then insert the zone plate, preferably of larger diameter than the objective and of the phase-reversal type, with proper regard for focal considerations. The plate may be placed on either side of the adjustable slit, and the results compared. In either case the slit is readjusted and the change in the resolving power computed. It is also suggested that a chromatic arrangement might be worked out, whereby we might take our improved system out of the light laboratory into the ordinary polychromatic light of day. (A discussion of zone plates and how to make them may be found in Wood's "Physical Optics.")

DEMONSTRATIONS WITH THE CATHODE-RAY OSCILLOGRAPH

(Abstract)

JOHN F. FITZGERALD, S.J.

Circuit diagrams and procedure hints were presented for several lecture-table demonstrations. The phenomena described included: Lissajou's figures produced by two a. c. waves of the same frequency but differing by a phase angle continuously variable between zero and 180 degrees; the charging and discharging curves of a condenser; the rise and decay of e. m. f. in an inductive circuit; the discharge of a condenser through an inductance and a resistance. In the last three demonstrations the manipulation of circuit constants to permit qualitative measurements was indicated.

ARCHITECTURAL ACOUSTICS

(Abstract)

JOHN J. McCARTHY, S.J.

The first important research in architectural acoustics was carried out in the William Hayes Fogg Art Museum now Hunt Hall at Harvard University by Wallace Sabine. Plotting the time that it took a sound from an organ pipe to die out against the absorbing material brought into the room in the form of cushions from the nearby Sanders Theatre, he discovered that for rooms of various sizes the following relation held:

$$At = KV$$

where A is the absorbing material of the room, floor, ceiling, walls, chairs, etc., in terms of the cushions, "t" is the reverberation time, i. e., the time that it took the sound to fall sixty decibels in intensity, V is the volume of the room, and K is a constant to be determined experimentally from the values of A, t, and V. Since cushions were not a very satisfactory unit of absorption for general use, Sabine conceived the idea of expressing the absorption power of the room in terms of open windows. Thus any material could be said to absorb as much sound, or a third or a quarter as much, as an open window of the same area. This ratio expressed as a decimal is called the absorption coefficient. Expressing A as the sum of all the areas of the absorbing materials in the room multiplied by their respective absorption coefficients, experiment leads to the value of 0.05 for K. The equation for reverberation may then be written:

$$t = 0.05v/aS$$

where S is the area of the absorbing material and "a" is its absorption coefficient.

SEISMOLOGY

THE SEISMOLOGISTS' PROBLEM AND THE METHOD OF ST. HILAIRE

(Abstract)

JOSEPH F. COHALAN, S.J.

Recognizing the fact that the problem of the seismologist in determining an epicenter by means of its great circle distance from a number of serving stations is the same as the problem of a navigator in determining his position at sea from simultaneous observations on celestial objects, it is proposed to investigate how far the method of Saint Hilaire can be applied to the problem of the seismologist and in particular to try

1) the usual navigator's plotting charts
2) the semialgebraic stereographic methods recently developed at Georgetown
3) special stereographic plotting charts constructed with a primitive radius of 50 cms, and with the primitive zenith in various latitudes.

THE REVEREND EDITOR

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Extend Hearty Congratulations to

Reverend Michael Joseph Ahern, S.J.

ON THE OCCASION OF HIS TENTH ANNIVERSARY AS DIRECTOR OF THE CATHOLIC TRUTH PERIOD, A WEEKLY BOADCAST FROM STATION W N A C, BOSTON, MASSACHUSETTS AND THE ASSOCIATED STATIONS OF THE YANKEE NETWORK.

Sunday, September 9th, the entire Broadcast was a celebration of this accomplishment. Messages were read from:

HIS EMINENCE, WILLIAM CARDINAL O'CONNELL

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Benedetto, Francis A., 1939, Fordham University (New Orleans Prov.)
Ball, Harry W., 1937, Weston College.
Barry, Rev. Thomas D., 1926, Weston College.
Berry, Rev. Edward B., 1922, Fordham University.
Caulfield, John F., 1939, Boston College.
Cohalan, Joseph F., 1934, Woodstock College.
Connolly, Rev. James K., 1933, St. Robert's Hall.
Crowley, Joseph P., 1939, Cranwell Academy.
Depperman, Rev. Charles E., 1923, Manila Observatory.
Dineen, Edward H., 1938, Georgetown University.
Donohoe, Francis J. 1937, Weston College.
Donohoe, Joseph J., 1934, Weston College.
Doucette, Rev. Bernard F., 1925, Manila Observatory.
Duross, Rev. Thomas A., 1932, Xavier High School.
Dooley, Rev. Joseph C., 1934, Weston College.
Dutram, Rev. Francis B., 1935, Boston College.
Eiardi, Anthony J., 1935, Weston College.
George, Rev. Severin E., Woodstock College.
Gough, Raymond, 1938, Xavier High School.
Greene, Merrill F., 1939, Boston College.
Hennessey, James J., 1933, Woodstock College.
Judah, Rev. Sidney J., 1934, Jamaica, B. W. I.
Kelley, Rev. Joseph M., 1922, Loyola High School.
Love, Rev. Thomas J., 1923, St. Joseph's College.
MacDonnell, Robert F., 1937, Weston College.
McCarthy, John J., 1938, Boston College.
McCauley, Charles E., 1934, Woodstock College.

McCormick, Rev. James T., 1923, Weston College.
McDevitt, Rev. Edward L., 1933, Woodstock College.
McGrath, Rev. Philip H., 1932, St. Peter's College.
McNally, Rev. Paul A., 1923, Georgetown University.
Merrick, Rev. Joseph P., 1923, Baghdad, Iraq.
Morgan, Rev. Carroll H., 1933, St. Robert's Hall.
Mulchay, John J., 1938, Boston College High School.
Murray, Rev. Joseph P., 1928, Boston College High School.
Murray, John P., 1939, Boston College.
Neuner, Charles M., 1938, Georgetown University.
Nuttall, Rev. Edmund J., 1925, Manila Observatory.
O'Brien, Kevin J., 1933, Woodstock College.
O'Callahan, Rev. Joseph T., 1929, Holy Cross College.
O'Donnell, Rev. George A., 1923, Boston College.
Phillips, Rev. Edward C., 1922, Woodstock College.
Quigley, Rev. Thomas H., 1925, Holy Cross College.
Repetti, Rev. William C., 1922, Manila Observatory.
Rocks, Rev. Thomas J., 1937, Woodstock College.
Rooney, Rev. Albert T., 1933, Woodstock College.
Schweder, William H., 1933, Woodstock College.
Smith, Rev. John P., 1923, Loyola College High School.
Smith, Rev. Thomas J., 1925, Weston College.
Sheehan, Rev. William D., 1928, Baghdad, Iraq.
Sohon, Rev. Frederick W., 1924, Georgetown University.
Sweeney, Rev. Joseph J., 1930, Boston College High School.
Wessling, Rev. Henry J., 1923, Boston College High School.

THE PHILOSOPHY OF SCIENCE

Ahern, Rev. Michael J., 1922, Weston College.
Cotter, Rev. Anthony C., 1936, Weston College.
Coyne, Rev. Francis J., 1926, Boston College.
Dooley, Rev. Edward, 1936, Canisius College.
Eiardi, Anthony J., 1935, Weston College.
Glose, Rev. Joseph C., 1930, Woodstock College.
Kelly, Rev. Joseph P., 1931, Weston College,
Lynch, Rev. J. Joseph, 1925, Fordham University.
Murphy, Rev. John J., 1936, Boston College.
O'Beirne, Rev. Stephen, 1935, Woodstock College.
O'Callahan, Rev. Joseph T., 1929, Holy Cross College.
O'Conor, Rev. John S., 1928, Woodstock College.
Ring, James W., 1935, Weston College.
Schoberg, Rev. Ferdinand W., 1936, Loyola College.
Sohon, Rev. Frederick W., 1924, Georgetown University.
Tobin, Rev. John A., 1923, Boston College.
Toohey, Rev. John J., 1934, Georgetown University.

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Benedetto, Francis A., 1939, Fordham University (New Orleans Prov.)
Berry, Rev. Edward B., 1922, Fordham University.
Brock, Rev. Henry M., 1922, St. Robert's Hall.
Burns, William F., 1935, Weston College.
Caufield, John F., 1939, Boston College.
Cohalan, Joseph F., 1934, Woodstock College.
Connolly, Rev. James K., 1933, St. Robert's Hall.
Crowley, Joseph P., 1939, Cranwell Academy.
Daley, Rev. Joseph J., 1930, Manresa Institute, Keyser Island.
Delaney, Rev. John P., 1923, Loyola College.
Depperman, Rev. Charles E., 1923, Manila Observatory.
Devlin, James J., 1934, Weston College.
Doherty, Rev. Joseph G., 1930, Cambridge University.
Dutram, Rev. Francis B., 1931, Boston College.
Fitzgerald, John F., 1935, Weston College.
Frohnhoefer, Rev. Frederick R., 1926, Xavier High School.
George, Rev. Severin, 1933, Woodstock College.
Greene, Merrill F., 1939, Boston College.
Guichetau, Rev. Armand J., 1932, Auriesville, N. Y.
Hearn, Rev. Joseph R., 1925, Georgetown University.
Hennessey, James J., 1933, Woodstock College.
Heyden, Rev. Francis J., 1931, 300 Newbury St., Boston, Mass.
Kelley, Rev. Joseph M., 1922., Loyola High School.
Kirsch, Simon C., 1937, Woodstock College.
Kolkmeyer, Rev. Emeran J., 1922, Canisius College.
Langguth, Laurence C., 1935, Weston College.
Linehan, Rev. Daniel, 1931, St. Robert's Hall.
Love, Rev. Thomas J., 1923, St. Joseph's College.
Lynch, Rev. J. Joseph, 1925, Fordham University.
MacDonnell, Robert F., 1937, Weston College.
McAree, Rev. Joseph F., 1922, Brooklyn Prep.
McCarthy, John J., 1938, Boston College.
McDevitt, Rev. Edward L., 1933, Woodstock College.
McGrath, Rev. P. H., 1932, St. Peter's College.
McKone, Rev. Peter J., 1931, Rome.
McNally, Rev. Herbert P., 1922, Gonzaga High School.
Merrick, Rev. Joseph P., 1923, Baghdad, Iraq.
Miller, Rev. Walter J., 1931, 300 Newbury St., Boston, Mass.
Morgan, Rev. Carol H., 1933, St. Robert's Hall.
Murray, Rev. Joseph L., 1928, Boston College High School.

Murray, John P., 1939, Boston College.
Nuttall, Rev. Edmund J., 1925, Manila Observatory.
O'Brien, Kevin J., 1933, Woodstock College.
O'Callahan, Rev. Joseph T., 1929, Holy Cross College.
O'Connor, Rev. Eric, 1936, Weston College.
O'Conor, Rev. John S., 1923, Inisfada.
Phalen, Robert P., 1935, Weston College.
Phillips, Rev. Edward C., 1922, Woodstock College.
Quigley, Rev. Thomas H., 1925, Holy Cross College.
Reardon, Rev. Timothy P., 1935, Woodstock College.
Ring, James W., 1935, Weston College.
Schweder, William H., 1933, Woodstock College.
Sheehan, Rev. William H., 1933, Baghdad, Iraq.
Smith, Rev. John P., 1923, Loyola College High School.
Smith, Rev. Thomas J., 1925, Weston College.
Thoman, A. Robert, 1933, Woodstock College.
Tobin, Rev. John A., 1923, Boston College.
Walsh, Rev. Lincoln J., 1931, Canisius High School.
Welch, Rev. Leo W., 1930, Manila Observatory.
Zegers, Theodore A., 1934, Woodstock College.

N. B. IF THERE ARE ANY ERRORS OR OMISSIONS IN THIS LIST PLEASE NOTIFY THE EDITOR.