D. A. O'Donnell, S.J.

S.J.B.

A. M. D. G.

BULLETIN

of the

American Association of Jesuit Scientists

(Eastern Section)

For Private Circulation

LOYOLA COLLEGE
BALTIMORE, MARYLAND

VOL. XI MARCH, 1934 NO. 3

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EDITORIAL

Even though educational, industrial and governmental economy curtailed many research activities, nevertheless the *march of science* progresses steadily. Although the measured pace of time records another cycle, still its accounts show progress in all phases of science.

Investigation of the field of subatomics has given evidence of a new infinitesimal particle, the positron, which added to the electrons, protons, neutrons and photons makes our concept of the constitution of matter more complicated. The positron is a positive charge of the approximate mass of the electron. Research in this field has dealt with atomic disintegrations and transmutations, and has been carried into the stratosphere in studies of cosmic radiation.

Progress has been made in discovering and relating the effects of interaction between cosmic rays and matter. In numerous laboratories the production of secondary energetic rays were studied, mainly through ionization counters and Wilson chambers. Regener detected cosmic rays at still greater depths in water, thus proving the existence of more energetic or more penetrating rays than had been found before. Millikan and others estimated from existing data that the energy passing through universal space in the form of cosmic rays exceeds that in the form of starlight and radiant heat. As to the nature of the rays, it is not possible to exclude photons or particles. There is increasing evidence that charged particles are present. Johnson has found that many of the particle rays are positively charged.

For research on the atomic nucleus an electrostatic, high voltage, continuous current generator was completed by Van de Graaf, a potential of several million volts was attained. Brasch and Lange used an impulse generator for similar research and potentials of over a million volts were available.

Of outstanding importance is the discovery and preparation of the isotope of hydrogen, named "deuterium" (mass-two hydrogen). Deuterium was discovered by Urey, Brickwedde and Murphy, and its quantity production was first achieved by E. W. Washburn. Mass-one hydrogen is henceforth to be called "protium." Enough of the "heavy water" is now available for extensive research. This will include the study of nuclear disintegration and possibly synthesis, the structure of molecules as revealed by band spectra of molecules in which protium atoms have been replaced by deuterium atoms, and many other problems of importance in physics and chemistry.

Two new isotopes of mercury with atomic weights 197 and 203 were discovered by Aston of Cambridge University. The year's chemical research announces a synthetic maleic acid; a new type of sulphur; a new method for producing solid carbon dioxide; diazodinitrophenol as a detonator in high explosives; improvements effecting the manufacture of vinyl resin, acetamide, leather, paper, rubber, and many others too numerous to mention here.

In botany, we note the advance made in growth regulators, the effect of plant and animal life in "heavy water", the origin of cellulose membrane in plants and the transmission of the virus of streak disease of maize.

Truly, 'tis the march of science. R. B. S.

SCIENCE AND PHILOSOPHY

MASS AND MATTER

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

Although the electron has recently been characterized variously as a pilot wave, a singularity in wave phenomena, and even as a mere probability function, we still find in the new edition (1933) of the Smithsonian Physical Tables (as well as in most modern texts on Atomic Physics) that the electron possesses a *mass* of 8.994×10^{-28}gm.

When it is said that the ultimate negative charge of electricity is endowed with a mass of the order of magnitude just given, what exactly is meant?

Without entirely subscribing to the "operational viewpoint" of Bridgman, it is difficult to see how else we can explain what is meant, unless we describe the actual experiments by which the mass term was determined.

However such a description in any detail is unnecessary here, as the classical experiments of J. J. Thompson and Millikan are too well known to require more than mere mention of the particular type involved.

The deflection method of Thompson determined the ratio of charge to mass of a stream of "cathode ray particles" by the application of an electromagnetic and electrostatic field, and the results give a constant value for e/m for electron velocities less than 1/10 that of light. Knowing the value "e" from Millikan's oil drop experiment the value of m could be easily calculated.

The answer to the above question: "What is meant by the mass of an electron?'' must therefore be given as follows:—All that can be meant is that the force (electromagnetic in nature) which is required to give "cathode ray particles" a definite deflection has been evaluated, and the fundamental Newtonian equation $F=ma$ has been solved for the numerical value of m.

One often finds the statement that "the entire mass of the electron is electromagnetic", but before examining the evidence for such statements let us attempt to analyze the implications involved.

Let us ask the question for example: Is every body, endowed with mass, matter? Or is electromagnetic mass something so well understood that we can definitely say that a body which rejoices in mass exclusively of this type is not matter?

The answers to these questions depend entirely on our definition of mass and matter, and since we are here concerned exclusively with Newtonian mechanics we must return to Newton for some light on the subject.

When Sir Isaac Newton stated that "mass is the quantity of matter in a body'' he gave the world of Physics something to work on. But until we know what he meant by matter we are not in a position to criticize the accuracy of his definition.

Notice that Newton does not identify mass and matter, but merely makes mass the *measure* of the *quantity* of matter. Excluding all but physical considerations we can safely say that mass and inertia are used as convertible terms by all physicists. That these represent identities is another question.

We all know how inertia as the measure of mass, and therefore the measure of the ''quantity of matter'' in a body, came to be regarded as a fundamental property of matter, and therefore a criterion for its identification.

It may be further elucidated by an analysis of the idea of inertia itself. As Father Sohon has shown, in a yet unpublished paper, the idea of inertia can be reduced to some such proposition: A body is inert in as much as it has no tendency to change. Inertia is really an absence of a tendency, a lagging quality which results in the diminution of the force producing motion by an amount necessary to accelerate the body possessing inertia. That there is such a quality we know from Newton's 1st Law of Motion. That it is subject to quantification is evident from any experiment employed to verify his 2d. Law of Motion.

In other words wherever greater inertia is displayed there we find what we are pleased to term greater mass, and since each body of ponderable size always maintained its individual inertia, it was concluded (up until the time of Lorentz) that inertia was a property of bodies which was both invariant and additive. It was therefore chosen as a suitable measure of mass.

However, Plank[1] has shown that inertia can not be classed as a force according to the Newtonian formulation even though it acts as a resistance to other forces.

So the question now arises: is this inertial resistance really an adequate and suitable property for the measurement of the "amount of matter in a body"?

At this point it must be confessed, a definite but arbitrary position must be taken. We might join wholeheartedly with Einstein in admitting mass variation and conversion, admitting that the phrase "amount of matter in a body" is relative with respect to velocity and energy content.

Let us instead (if only for the sake of seeing where it will lead us) retain the notion that the "amount of matter in a body" must remain

(1) General Mechanics, Pp. 104-105

constant, and then consider the question whether or not inertial resistance gives us a true measure of that quantity. It will do so only if inertia is invariant in two senses; 1st. The reaction of any particular body to all forces of the same numerical magnitude must be identical; 2d. The inertial reaction of a particular body must always be the same to a given force, under all possible conditions of rest or motion, be it uniform or accelerated.

If we consider the electron as the particular body in question there seems to be good reason for saying that the 1st. criterion is satisfied: namely that the inertial resistance to electromagnetic and mechanical forces is identical, within the limits of experimental error. This statement can be made as a result of the work of Tolman and Stewart[2]. Their purpose was to examine what we might call the "mechanical inertia" of electrons. If the usual theory of "free electrons" in metals (used to explain conductivity) be true, then they argued, it should be possible to develop an electromotive force by suddenly stopping a wire which is moving with high velocity in the direction of its length.

The experiment was attempted by rotating many turns of thin wire about an axis perpendicular to the plane of the coil, and then stopping it suddenly.

The interesting result of this experiment was the value of e/m thus obtained *was in substantial agreement with the value found by the electromagnetic deflection method of J. J. Thompson.* Thus the statement quoted above, and found in so many books on atomic physics; that the mass of the electron is "purely electromagnetic", is by this very experiment demonstrated as false.

In fact since the same value is found for both the electromagnetic and mechanical inertia of the electron (allowing for the experimental errors of condition and observation), there seems to be no sufficient reason for making a real distinction between the two so-called types of inertial reactions, and their corresponding "masses". Is there any logical justification for calling inertia (which is only an absence of tendency to change) "electromagnetic" or "mechanical", merely because the force by which the inertia of the electron in question was measured happened to be electromagnetic in one case and mechanical in the other?

It seems that the extension of the use of these adjectives from the measuring force to the inertia (which is not a force in the Newtonian sense) is entirely without warrant except as an extrinsic denomination. We wanted to find out if the electron had inertia, because in that way we believed we could determine its mass. We employed two methods, and found that each yielded the same value for the inertia.

If we consider the evidence of the experiments cogent all that we can conclude is that the electron has mass in the above sense,—no more and no less.

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(2) Jauncey, Modern Physics P. 493

Let us turn now to the second condition necessary to maintain inertia as a true measure of "the amount of matter" in a body.

In the cathode ray tube of J. J. Thompson, if the accelerating voltage applied to the electrons give velocities considerably greater than 1/10 that of light, the constancy of the ratio of charge to mass breaks down. From the decrease in that ratio we know that either the charge decreases or the inertia increases. For theoretical reasons the latter alternative has been universally accepted as the preferable conclusion. The immediate deduction usually made is that: "the electromagnetic mass" increases with velocity. Granted that the whole question may reduce to one of definitions and terminology, still would it not be better to say that the inertial resistance to electromagnetic forces is not constant under conditions of varying velocities, than to attempt to explain away the otherwise necessary conclusion that "the amount of matter" in a body is a function of its velocity.

There is an additional reason for making such a distinction, for the work of Bucherer and others[3] has shown that the experimental values for the increase of inertia of the electron, for velocities from about 3/10 to more than 8/10 that of light, lie along the curve whose path was calculated on the assumption *that the entire inertial resistance is of only one kind, viz: such that it all varies with changing velocity,*—whereas this curve and these experimental values deviate appreciably from the theoretical curves worked out on the assumption that part of the inertia is electromagnetic (and therefore variable), and part invariant in nature.

We must conclude therefore, that since the experiments of Tolman and Stewart give us no positive reason for distinguishing between electromagnetic inertia and mechanical inertia, between electromagnetic mass and mechanical mass, and since the work of Bucherer indicates that whatever inertia an electron has, it is variable *in its entirety*, with variable high velocities,—inertia, as such, is not a property which is invariant in the second sense mentioned above, and does not therefore satisfy one of our criterions for the measure of "the amount of matter" in a body.

It will be well to notice that the line of argument developed above is entirely independent of the postulates of the restricted theory of Relactivity. The apparent variation of mass with velocity (whether considered from a mechanical or electromagnetic viewpoint) in no way affects the conclusion that inertia does not seem to give a true measure of the "amount of matter" in a body; in fact it seems rather to confirm that view.

But to return to our first question; have we established the right to affirm or deny that the electron is matter? The answer must be in the hypothetical mode. If (as Newton implied) everything which has inertia is matter, then the electron is matter. But as a matter of fact we have found ineria to be a poor criterion for the *measure* of matter,

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(3) Outline of Atomic Physics, U. of P. Staff. Pp. 31-35

and it would be well to be cautious in using it as an indicator for the presence of matter; for we know that photons display momentum, which has enabled a *mass* of 3×10^{-33} gram to be assigned to a quantum (for example) of red light. We are scarcely therefore justified in concluding that light is matter.

While there is no prospect of finding some absolute invariant as a substitute for inertia as the measure of our fundamental unit of mass, nevertheless, if for philosophical reasons only, it would seem preferable to adopt a definition of matter which avoids the difficulties inherent in the concept of inertia.

Such for example is the one given by Jeans[4] which sidesteps many other difficulties also, by pushing them back from cosmology to epistemology and psychology. "Matter", he says, "is that which is capable of originating objective sensations." By adding the word *naturally* before capable, we have a descriptive or "working" definition which is not unlike that given in Scholastic Philosophy.

(4) New Backgrounds of Science, P. 12

WHAT ARE ESSENTIAL AND ACCIDENTAL DIFFERENCES?

REV. J. JOSEPH LYNCH, S.J.

Is the color red essentially different from the color green? Off-hand one might be inclined to say yes. On second thought it might be better to distinguish. Physically or causally I would say they do not differ essentially—and formally, I would say they do; i. e., our sensation of redness is essentially different from that of greenness. Physically, the redness or greenness can be reduced to a number—a number of vibrations per second—as we increase the number of vibrations per second we go from red to green. There is no real dividing line between red and green, hence I would be inclined to say that physically the two colors do not differ essentially, but formally they do.

These two colors may be likened to two notes. If one note is treble and the other bass they may be readily distinguished by the ear but they differ only in the number of vibrations per second which strike the ear. As the frequency, or number of vibrations per second, is increased the note changes from bass to treble but there is no sharp dividing line between treble and bass. Physically the two notes could scarcely be called essentially different any more than a small heap of salt could be called essentially different from a large heap. In the two heaps of salt there is a difference in the number of grains; in the two notes or the two colors there is a difference in the number of vibrations per second.

Physically therefore it would seem that two colors or two notes are not to be considered essentially but only accidentally different. Formally however there would seem to be an essential difference. The two heaps of salt produce the same sensation of taste in us though the larger heap would produce the sensation for a longer time. The two colors or the two notes however do not produce the same sensation. Two notes of the same frequency or pitch; i. e., two treble notes, but of different volume or amplitude would correspond to our two heaps of salt of different quantity. Two notes of different pitch or two different colors would seem to correspond to two heaps of two different substances, i. e., sugar and salt. If we call sugar and salt essentially different we should then call the two formal sounds or colors essentialy different. But is the physical difference between sugar and salt of a different order from that between two different notes or two different colors?

Let us consider some other differences such as shape and state.

For the sake of simplicity let us consider a piece of ice or a piece of iron. No matter what its shape it is still ice or iron and in this sense we say that its shape is accidental. It is not in the nature of ice or iron to demand this shape rather than that shape—(I prescind now from the definite crystalline structure demanded by many substances)—hence since the shape is not attributed to the nature or essence of ice or iron, we say it is not essential but accidental. The shape can be changed at will by external force, e. g., pressure. Shape thus would seem to be purely accidental.

But these same external forces can do more than change the shape of the ice. They can change its state from solid to liquid. Pressure applied to the ice will do this; friction produced by rubbing the ice will likewise do it. Can we say that the state of the body is accidental as was the shape?

Before answering this question a word on the states of matter. The physical difference between the solid, liquid and gaseous states is one of distance between the molecules.

Consider a room full of lively tennis balls. If they have such freedom that they can bounce back and forth as individual balls, they give us a picture of a gas wherein the molecules roam around—or rather buzz around—as individual molecules. If the same number of tennis balls, retaining their liveliness, be confined in a large sized trunk they can no longer roam around as individual tennis balls—their freedom has been curtailed. They can still move around in a limited way as the trunk is jostled back and forth or tipped upside down. They represent a liquid wherein the molecules are held too close together to permit of their moving as individuals but they may still move as layers or groups—they can flow.

Suppose that they are packed into this trunk still more tightly—so tightly and under such pressure that they melt partly and stick to each other—so that motion of any kind is now impossible (except a slight vibratory motion) this will give a crude picture of a solid. The molecules are held so close together that they have to stay with the same partners all the time.

Physically, the difference between the three states is one of molecular distance. Are we to call the difference between the three states essential or accidental? Physically the difference would seem to be purely accidental—just as compressed cocoa differs only accidentally from powdered cocoa.

If we take a non-crystalline substance such as glass the difference would seem to be certainly accidental—there is no sharp dividing line between the liquid and the solid states. It can be seen more clearly in the case of pitch. On a cold day it is brittle—on a warm day it is almost liquid—the difference between the two states is clearly accidental due to a change in temperature.

In crystalline substances this is not so. There is a sharp dividing line between the liquid and the solid states. Moreover each crystalline substance crystallizes out in a solid state according to a definite and peculiar pattern.

If we define as essential that which the nature or essence of a thing demands, we would have to say that the crystalline structure or pattern of a substance is not accidental but essential. It is of the essence of rock salt, for instance, to form crystals of a definite pattern—it is of the nature of ice to form crystals of a different pattern, and so on. From this viewpoint then, it would seem that we should consider the difference between the solid and the liquid state in the case of crystalline substances as essential and in the case of non-crystalline substances as accidental. (Temperature and pressure of course influence such configurations, but do not cause this or that specific configuration.)

Since the layman has no means of telling a crystalline from a non-crystalline substance—glass and ice seem similar solids to him—it seems ridiculous to state that the difference between liquid and solid glass is accidental while the difference between liquid and solid water is essential.

It seems most logical, taking everything into consideration, to say then that the solid and liquid states of a substance whether they be crystalline or not differ only accidentally. While it is true that it is in the nature of pitch or water at a certain temperature to be solid (in the case of water, crystalline) and at another temperature to be liquid, it cannot be said to be in the nature of the pitch or water itself to be solid or liquid;—the state depends on external conditions and therefore may logically be classed as accidental. However, I'll come back to this later.

Going now from change of state to change of substance, the force producing change of state could and in many cases has produced change of substance. Physically, the difference between two substances can be reduced to a difference between the number of positive and negative particles in the molecules. The atom of the inert gas Neon differs but slightly in composition from that of the active metal Sodium. Neon has twelve positive particles balanced by twelve negative particles in the atom while Sodium has thirteen of each. Potassium on the other hand has twenty-one of each yet Sodium and Neon are as unlike in their properties as night and day, whereas Sodium and Potassium are very much alike. We would be inclined to say that there is a greater difference between Neon and Sodium than between Sodium and Potassium, yet physically or structurally there is a difference of only one brick in the structures of Sodium and Neon and a difference of eight bricks in the structures of Sodium and Potassium. Again, we could theoretically (and in one or two cases practically) take equal heaps of positive and negative particles and by applying to each different amounts of the same force, produce two totally different substances such as gold and mercury. Physically, we would have the same number of elementary bricks in the two structures—we would have exactly the same number of positive and negative particles in the two materials—yet one we call gold and the other mercury. They were produced by the same force but in different quantities. Are we to call them accidental or essentially different? Are we right in calling them two different substances? I think we are—and though physically they may be reduced to the same number of positive and negative particles, we are warranted in calling them essentially different.

Let us take a parallel illustration on a larger scale. We could take equal quantities of, let us say iron and wood and by the employment of different quantities of force produce on the one hand an automobile and on the other hand an aeroplane. Both contain the same amount of materials but the materials are so differently arranged under the influence of the manufacturer's force that in the one case we have an automobile and in the other case an aeroplane. Do these differ essentially or accidentally? There is a difference between a Dodge and a Ford; but both are automobiles. They differ accidentally if you wish! There is a bigger difference between a Ford car and an aeroplane—they differ essentially but perhaps not all would agree to this. If we *do* call an automobile essentially different from an aeroplane then we have to say that gold is essentially different from mercury; but if we claim only an accidental difference for the former, it seems we should logically postulate the same difference for the latter.

To draw a brief conclusion, I would like to suggest:—

Any change which does not affect the molecular structure of a substance should be classified as purely accidental.

Any change which affects the molecular structure should be classified as essential.

If the objection be urged that two substances of different molecular structure are simply two different accidental chains of electrical particles, I would assent and say that therefore physically or structurally they differed only accidentally but formally—having in view the way they affect our senses—they differed essentially as do two colors or two notes of different pitch.

With regard to change of state—I would classify the crystalline state as essentially different from the liquid state—but the non-crystalline solid state as only accidentally different from the liquid though I admit this has a serious objection already mentioned in the early part of this paper.

The question of liquid crystals offers a hurdle which we will avoid for the present.

Now for the brick-bats!

ASTRONOMY

METEOR OBSERVATIONS AT WOODSTOCK OBSERVATORY

WALTER J. MILLER, S.J.

During three nights in the middle of November 1933, the Woodstock College Observatory and volunteer assistants cooperated with a national network of observing stations (including the Flower Observatory of the University of Pennsylvania, the United States Naval Observatory, Georgetown College Observatory, Harvard College Observatory and many others) in preparation for the expected return of the Leonid Meteors. Fragments

METEOR OBSERVERS

of a disintegrated comet (sky dust, as the magazine supplements have it), the Leonid Meteors take 33 years to complete their circumsolar orbit, which is grazed each November by the earth in its own yearly orbit around the sun. Some Leonids are generally visible each year, but swarms (estimated as high as a hundred thousand an hour) were seen in 1833 and 1866. Although the shower was visible to a much lesser extent around 1900, there was a chance that the magnificent spectacle might be repeated this year. Even though the shower turned out to be disappointing, the results achieved by the well-organized chain of stations promise to be better than ever before, though as yet the reductions and discussion of the observations have not been completed for publication. And the successful cooperation of the Philosophers of Woodstock College has shown that without burdening any one man unduly, valuable scientific results can be obtained in our scholasticates in the field of meteoric research on nights when the annual showers are active. The stimulation of the spirit of research and the desirability of making a first-hand acquaintance with the night skies suggest other reasons for such cooperation.

The Woodstock observations were made from the flat roof of the new O'Rourke Memorial Library, which commands a view to the horizon in nearly every direction. The time for the vigils was specified to be from 11 P. M. or midnight to four or five A. M. on November 14-15, 15-16, 16-17. About twenty of the Philosophers were engaged in the work, though only about eight were present at any one time. Temporary tables were erected, equipped with shaded red lights, drawing boards, etc. The maps were provided by the American Meteor Society. These charts are drawn on the gnomonic projections and so have the useful property that all lines observed as straight in the heavens are still straight in spite of being now seen on the flat surface of the paper. A single map covering the whole sky may seem more convenient and tempting; its projections, however, makes it worthless for the determination of radiants, and its scale makes it difficult to use for accurate train drawings. Eleven different American Meteor Society maps constitute a set, but at any one time only three or four are required. These standard 8″ x 10″ maps can be conveniently clipped on cardboards of the same size, and then tacked to the drawing board to be safe from the wind. On the charts a penciled arrow with an accompanying number was used to identify the numbered descriptive notes on separate pages. Holes were bored in the top of each pencil so that a string could be used to tie the pencil to another thumb tack on the board. Little details like that make quite a difference on a cold, dark, wind-swept roof when even gloved hands soon become numb.

The directions for systematic plotting and recording of annual-shower meteors are gladly furnished to anyone by Charles P. Olivier, the President of the American Meteor Society, with headquarters at the University of Pennsylvania's Flower Observatory, Upper Darby, Penna. The time of the meteor's appearance has to be known accurately, an error of ten seconds practically precluding the possibility of recognizing duplicate observations made by two or more stations in the local network. Although you see only one meteor during an interval of a minute, several more may actually be visible in the same region of the sky. Consequently, it was found better to rate two watches very carefuly by the Arlington time signals, and then have one experienced person do nothing else but call out the time in minutes and seconds whenever anyone called "TIME!" after seeing a meteor flash through the sky. Otherwise, each observer would have the double duty of remembering and plotting the apparent path of the meteor through the constellations, and bending down to his watch to ascertain the accurate time. Incidentally, a request for our precise observations of the time of the meteors' appearance has come from a radio investigator at the Bureau of Standards who was trying to correlate signal strength and static with the meteoric phenomena.

It is better for the observers to work in pairs. The one who does not see the meteor can record the time, and then start watching the sky again; while the other man is plotting the apparent path in pencil on the charts and jotting down brief descriptive notes. The observations should be centered at altitude 50°, the watcher being presumed to see about a quadrant of the sky with any given direction central. If many men are available, it is well to have two men assigned to each quadrant of the sky, so as to secure not only a count of the shower meteors coming from the radiant point, but also the numbers of the chance or sporadic meteors.

In addition to the visual work, preparations were made to observe photographically. A number of f:4.5 cameras were provided with super-sensitive-panchromatic roll films and cut films, and the stars were allowed to trail for a definite time of half an hour or an hour. In order to be able to measure fractions of the exposure interval, a distinct identifying break in the star trails was made 2 minutes after the beginning and before the end of the exposure, by holding a cardboard over the lens for one minute. A home-made prism spectrograph with 30° prism mounted rigidly in front of the camera lens and set at the angle of minimum deviation, was intended for any chance bright meteors in the field of view.

It was found that a brief class before the start of observations was sufficient to enable each one to identify the chief stars for comparison purposes in plotting the meteor paths, and of course more experienced men were able to help out on identifications in odd moments. In fact, few of the men who (in spite of layer after layer of sweaters and overcoats) patiently and cheerfully *froze* through the hours of those nights will forget the winter and spring constellations! The weather was exceptionally clear, especially on the second and third nights; but the temperatures were around ten or fifteen above!

The meteoric display was unexpectedly poor. The most important event on the program was to be the plotting of the position, shape and displacement of the trains left by very bright meteors. But in the 1933 Leonid shower there was not a single fireball or long-enduring train, and the number of genuine Leonid Meteors was disappointing. However, due to our being able to watch each quadrant of the sky nearly all the while, the following hourly meteor counts were made:

November 14-15		November 15-16		November 16-17	
12 to 1	3 (cloudy)	11 to 12	7	12 to 1	32
1 to 2	23	12 to 1	45	1 to 2	58
2 to 3	22	1 to 2	41	2 to 3	76
3 to 4	45	2 to 3	49	3 to 4	77
4 to 5	44	3 to 4	87	4 to 5	110
		4 to 5	86		
Total	137	Total	315	Total	353

This makes a total of 805, of which possibly half were also plotted, frequently on two or three charts. The camera men were not lucky enough to record any of these in the star fields toward which their cameras were pointing.

Perhaps the best commentary on the worth of the observations, would be the following letter from the author of the standard work in English on meteors, Dr. Charles P. Olivier, Director of the Flower Observatory and President of the American Meteor Society, who organized the national observing network for the Leonids.

UNIVERSITY OF PENNSYLVANIA

PHILADELPHIA

FLOWER ASTRONOMICAL OBSERVATORY

Headquarters, American Meteor Society,
Charles P. Olivier, Director.

December 7, 1933.

Rev. Walter J. Miller, S.J.
Georgetown College,
Washington, D. C.

Dear Father Miller:

We have now progressed far enough for me to give you a little information as to what our campaign accomplished. But first let me again thank you for your splendid cooperation, and that of the students at Woodstock. Of all groups in our network, your 800 odd meteors make the greatest total observed. To stand such long watches, in such cold weather, certainly deserves the highest commendation, especially when very good results were obtained.

Not yet having received the Georgetown observations and only this afternoon those from Haverford, I am unable to give the full total of chances for duplicates. But with those tabulated, about 150 seem possible. It would be most strange if less than 100 turned out real. Of course your Woodstock group will be very largely represented therein.

Your results will also be of use in giving a chance to compare plots of men, side by side, made on the same meteors. Altogether you sent us probably the most valuable set received.

The results of the computations will be published in due time but it will take some months to finish them. Our campaign was a success, thanks to the enthusiasm of so many workers and better organization, when the meteors themselves were so few. The trouble will not have been wasted. Also we will have numerous results from other groups in different parts of the country—probably more heights of Leonids than ever before secured on one occasion.

Again thanking you for your most valuable help and the promptness with which you got the data to us, I remain.

Very sincerely yours,

CHARLES P. OLIVIER.

P.S. Please thank each of your helpers in my name for their valuable assistance.

Too much credit cannot be given to the Philosophers for their generous cooperation in the program, at the cost of sleepless hours on bitterly cold nights. The least we can do is to record the names of those who did most to make the work a success. They are: Lawrence C. McHugh, S.J., William G. Perry, S.J., A. Robert Thoman, S.J., John C. Baker, S.J., Ernest B. Clements, S.J., Joseph F. Cohalan, S.J., John V. Curry, S.J., Francis J. Diamond, S.J., James B. Hayes, S.J., Ralph E. Lynch, S.J., John T. McCarthy S.J., Michael F. McPhelin, S.J., Joseph W. Murray, S.J., Malcolm L. Stewart, S.J., Richard T. Zegers, S.J., Theodore A. Zegers, S.J.

Even a person who does not plan systematic observations of meteors may have the good fortune to see a great meteor or fireball at night or, more rarely, by day. He should know just what data to record, and hence a few practical notes on fireball reports will be taken from Bulletin 13 of the Flower Observatory. As the number of fireballs seen in the average lifetime is very small, great pains should be taken to make as accurate observations as possible. The records must give the observer's name, the place from which the object was seen (the position of the observer's station must be given as exactly as he can find it, i. e., to within a mile if possible), and the hour and minute when the object appeared.

For the fireball itself, the fundamental data are the point in the sky at which it appeared, and the point at which it disappeared. If it was seen at night, and the observer knows the constellations, these points can at once be described accurately with regard to neighbouring stars. If, as usual, the person seeing the fireball does not know any stars or constellations, the beginning and end points can be fixed only by their directions and their angular heights above the horizon. Everyone knows what is meant by directions, but few can fix them accurately. However, particularly if the observer is in a familiar place, he can fix the points with regard to trees, poles, houses, etc. Then with the help of a friend who can determine angles, he can measure off the directions and altitudes quite simply. If no such assistance is available, the best thing to do is to use a compass or if possible to check up the directions from some map of the surrounding territory. As for altitudes, it is 90 degrees from the horizon to the zenith; hence one must make the best estimate of what part of 90 degrees each of the altitudes is. "The Pointers" of the Big Dipper are five degrees apart; the Belt of Orion is three degrees long. Either will help in estimating a distance in degrees.

Warning should be here given that the use of miles, yards, feet or inches to describe the heights or lengths of paths of meteors or fireballs has no possible meaning and the words are wasted. As a check on the direction of the path, it is always useful to give the angle of the path with the horizon—in degrees, or by a diagram,—of course saying which way the meteor was going. The object's size should be compared with that of the full Moon or some planet or bright star. Here again the use of "inches" in describing diameters has absolutely no meaning, nor has the comparison of meteors with balls of fruit. If possible, the duration of flight should be estimated in seconds, and if an explosion is *seen*, one should time carefully how many minutes or seconds elapse before it is *heard*. This is an excellent check on other observations.

If the object is seen in daylight, exactly the same notes should be made, except that here it is impossible to use the stars as reference points. In all cases, additional notes as to color, trains left, peculiar motion, etc., are useful.

A report which has only part of the desired data may be very valuable; please send in everything noted about the fireball, whether it is much or little. Your observations may include just the one point lacking in reports from other people, and so may make possible a solution of the heights and orbit.

For the information of the casual observer the following data concerning the principal annual meteor showers are given. For leap years the dates should be one day earlier than those listed here. All dates are those of the evening on which the maximum is due, even though the shower appears after midnight and therefore on the next calendar date. For the average year the Perseids are the richest stream, followed in order by the Geminids and Orionids. The American Meteor Society is always glad to receive accurate hourly counts of meteors made by one person on any of the nights when annual streams are active.

Name	Duration in Days	Date of Maximum	Hourly Number of all meteors on this date
Quadrantids	four	January 2	twenty-eight
Lyrids	four	April 21	seven
Eta Aquarids	eight	May 4	seven
Pons-Winnecke	?	June 28	?
Delta Aquarids	three	July 28	twenty-seven
Perseids	twenty-five	August 11	sixty-nine
Orionids	fourteen	October 19	twenty-one
Leonids	seven	November 16	twenty-one
Andromedes	two	November 20	?
Geminids	fourteen	December 12	twenty-three

BIOLOGY

CAROTID SINUS AND BLOOD PRESSURE

Rev. Charles E. Shaffrey, S.J.

Attention has been directed in the past few years to a possible relation between the carotid sinus and blood pressure, and to a less extent between the sinus and respiration. By the carotid sinus is understood a bulbous enlargement to be found in the cammon carotid artery just below the bifurcation. As early as 1836 Sir Astley Cooper observed that ligation of the common carotid arteries caused an increase in the heart-rate and in the blood pressure. Until recent years the phenomena were thought to be due to a change in the cerebral circulation, but this explanation was abandoned when it was shown that all of the branches of the carotid artery could be tied off without any change in the general blood pressure, and this even if the vertebral arteries were tied off as well. About 1924 Hering conceived the idea that the effect on the blood pressure was produced by a peripheral rather than a central stimulus. By a few very simple experiments he came to the conclusion that the phenomena were due to a stimulation of the carotid sinus. He proved this to himself by clamping the common carotid in dogs, and finding that the decreased pressure in the sinus caused the heart-rate to increase, the blood pressure to rise and the respiration increase. He then cut away the nervous connections of the sinus and found that then the clamping of the carotid had no effect. Then too, he found that an increase in the pressure within the sinus on the other hand decreased the heart-rate, lowered the blood pressure and decreased the respiratory rate. Hence the stimulation of the nerves of the sinus produce depressor reflexes. Normally the sinus nerves seem to have a tonic effect on the blood vessels for sectioning of the nerves results in a permanent hypertension. So it would seem that the normal stimulation of the sinus by the stretching of the fibres by the arterial pressure causes depressor reflexes while the relaxation of the stretching caused by low pressure removes the stimulus for the inhibitory reflex and permits the pressure to rise. Recent work done by some Chinese investigators verifies the work of Hering and supports his explanations. They found that maximal stimulation of the inhibitory nerves of the sinus had the effect of reducing the general blood pressure to a point which is below the minimal stimulus. For example, if the maximal stimulus is 160 mm. of Hg. and the minimal is 60 mm. of Hg., then a stimulus of 160 mm. of Hg. acting on the sinus would reduce the general blood pressure below 60 mm. of Hg. Hence they conclude that the normal blood pressure is determined as a resultant of these two forces, that is, the vasomotor tonus on the one hand and the inhibition of the carotid sinus reflexes plus the reflexes from the arch of the aorta on the other. They have shown that when the sinu-aortic inhibition is eliminated by denervation, maximal vasomotor tonus emerges, resulting in a rise of blood pressure to 150 to 160 mm. of Hg. Since 150 to 160 mm. of Hg. is approximately the maximal stimulus for the reflexes, and since such a stimulus causes the pressure to fall below the threshold stimulus, i. e., 60 mm. of Hg., it is evident that the full effect of either component is to permit the maximum action of the other.

From the above facts there comes the suggestion that hypertension may be due to a disturbance in the carotid sinus nerves.

ON BIOLOGICAL STAINS

JOSEPH P. LYNCH, S.J.

Dyes are of two general types, the natural and the artificial. We know little or nothing about the natural days. The artificial we synthesize. Explanation of why a dye dyes is best approximated by discussing the artificial.

The dyes we make are all from coal tar, that is, are synthesized with the benzene ring as foundation. Sometimes they are called the anilin dyes, simply because the first were made from anilin. Many made now have no connection with this compound. Call them coal-tar dyes and be more accurate.

So, the dyes are benzene compounds, derivatives of the corbohydrate $C_6 H_6$. Benzene and its derivatives will be colorless. But, certain radicals combined with benzene derivatives give color to the compound. These radicals are called Chromophores. The compounds are designated Chromogens. Chromogens, though colored, are not color-giving. They have no affinity for fibers or tissues, and so are not dyes. For a chromogen to become a dye it has to acquire the property of electrolytic dissociation. This property it gets by combining together with the chromogen a chemical group of elements known as Auxochromes. Auxochromes give the compound the property of electrolytic dissociation, that is, furnish it with salt-forming properties. A dye will be, therefore, "An organic compound which contains chromophoric and auxochromic groups attached to benzene rings, the color being attributable to the chromophores and the dyeing property to the salt-forming auxochromes." This is H. J. Conn's definition. It is a good one.

Dyes are basic and acidic, depending, usually, on the type of auxochrome. The amino group ($-NH_2$) of auxochromes, for example, is basic due to the fact that as in the case of ammonia its nitrogen becomes pentavalent by addition of the elements of water (or of an acid). The hydroxyl group (-OH) is acidic since it can furnish hydrogen ions by electrolytic dissociation. But sometimes it is the chromophore which has the acid or basic character. Some basic chromophores are the following groups: Azo (in methyl orange and Bismarck Brown), Azin (in the safranins), Indamin (in methylene blue, etc.). Acid chromophores are such as: the Nitro group $-NO_2$ (in picric acid) and the quinoid benzene ring (in fuchsin, methyl green, methyl violet, etc.).

All chromophores have one thing in common, besides the usual need of auxochromes. It is that they have unsatisfied affinities for hydrogen, that is, are easily reducible. Reduction destroys the color. Usually, however, this is a reversable action.

There is a general rule that the simple anilin dyes, such as all already mentioned, are useful as biological stains because of their basic or acidic character. The basic react with the acid parts of the protoplasm (chromatin) and the acidic react with the basic parts (cytoplasm). The dyes, it must be remembered, are not sold and used as free acids or free bases. The acid dyes come as sodium or potassium salts; the basic as chlorides (or salts of some other colorless acid).

There are also natural dyes. They result from the interchange of ions when, for example, the sodium salt of an acid dye and a chloride of a basic dye are mixed in water solution. Eosin with methylene blue is a good example. The neutral dye is insoluble in plain water and so precipitated. Solutions of the neutral dyes will therefore be alcoholic. But alcohol solutions do not stain well. Solvents other than alcohol, however, may be used, such as excess acid or excess base in water; or else acetone or methylal. In Wright's stain the solvent is ethyl or methyl alcohol, and the stain after being applied to the slide is diluted with water causing a dissociation that results in the production of several different dye compounds which stain selectively. It is supposed that the compound (neutral) dyes act on the protoplasm somewhat as follows: The neutral stain is taken up as such by certain parts of the cells having an affinity for it; acid parts desiring the basic contents of the dye split the compound neutral dye and join the basic portion or if there is already dissociation take up the basic part directly; and other parts of the cell's protoplasm having affinity for acid stains take the acid portion. Differentiation is excellent with neutral dyes when there are present in the cell the cell structure types of neutrophile, basophile and oxyphile portions.

In addition to the coal-tar dyes there are others, the natural dyes, used by biologists. As said in the introduction to this article, we know little or nothing about these natural dyes. They have not been successfully analyzed, and hence, of course, have never been synthesized. The most important of these natural dyes are: The Indigo group, such as indigo (indigo blue) which is fermented from the glucoside Indican produced in certain plants; and indigo-carmin. The Cochineal group, such as cochineal obtained from the female of a tropical insect, and used successfully only with a metal mordant; also Carmin, obtained by treating the cochineal with alum. The Lichen group, such as Orcein and Litmus both of which are derived from certain colorless lichens which develop them after being treated with ammonia and exposed to the air. The Wood group, such as haematoxylin and brazilin extracted from the bark of two tropical trees, the logwood and brazil wood respectively. These are the most important of the natural dyes. They are still much employed. But nevertheless it is the coal-tar stains that are of outstanding utility. Alizarin was important once as a natural dye. It is now made best and most economically by man himself. Indigo is still listed as a natural dye, though it has been synthesized artifically. Iodine, too, of course, may be included as a natural dye. Its use, though, is not extensive.

Up to date there is no universally accepted theory of dyeing, of how the stains actually "take" on tissues. The theories proposed are in general the Physical and the Chemical. The men holding the chemical explanations point chiefly to the fact that the dyes combine very firmly with the tissues stained by them, also that a dye penetrating different cell elements equally well, though coming out easily from some parts, comes out only with great difficulty or not at all from other parts. Those favoring a physical explanation have in their favor the fact that no new substance is formed by combination of the stain and tissue (so far as the eye can see), and that all or nearly all the color can be extracted by water or brief alcohol immersion, also the fact that a tissue never removes the dye completely from the solution—the action never continuing till one or the other is exhausted. Tissue is porous, the dye is absorbed due to osmotic pressure,—say the physicists. They maintain, too, that absorption explains selectivity, the solid body drawing ions of the solution to itself which then remain in solid solution as does gold in ruby glass,—pointing out that as a matter of fact the tissue's color is not that of the dry dye but of the dye when in solution, for example: fuchsin when dry is green; in solution, red; and fuchsin-stained tissues are always red even when dried to the utmost.

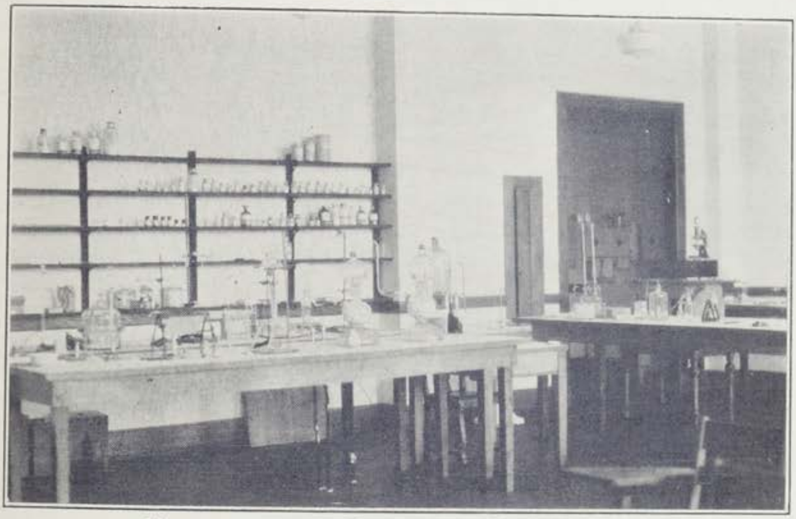
No fully satisfactory hypothesis is well established. The accepted one, it seems, will have to be a combination of physical and chemical principles. Dyes may penetrate by absorption and diffusion, and there may be "solid solutions"; but activity such as that of the iodine and methyl violet in Gram positive bacteria and also that of mordants would seem to indicate chemical reactions. The chemical reactions need not necessarily be between the dye and tissue directly. There might be precipitation inside of the cell elements caused by acids or bases, this explaining mordants if we think of the mordant as precipitating the dye. Perhaps something similar happens with the Gram stain, the iodine and methyl violet combining within the cell to make a molecule so large it cannot be taken back through the membrane. It is good to remember that water and alcohol are not absolutely inert; also that there are some instances where chemical reactions do not continue till one or the other of the reacting substances is exhausted. Undoubtedly certain parts of a cell are definitely acid and other parts basic. The color in basic dyes is in the kation, while in the acid dyes it is in the anion. There is no reason for denying chemical reaction when there is possibility for such. It is a difficult thing, this accounting for all that goes on when a stain "takes" on a tissue. The subject still remains rather obscure. It is as difficult as Cell Chemistry. Histologists and microchemists working in collaboration may yet solve it for us,—or at least give us sufficient sure knowledge to construct a satisfactory working hypothesis, a successful hypothesis that may change the attitude of the biologist in regard to his bottles of stains, making him think of them not as so much "paint" but as definite chemical re-agents to be employed for reaction with other definite chemical compounds in the tissues he treats. On this may follow discoveries solving many of the obscure problems of the nature of the cell and its contents.

CHEMISTRY

MICROCHEMICAL ANALYSIS

REV. RICHARD B. SCHMITT, S.J.

Only the student of microchemical analysis can fully realize the rapid progress of micro methods in chemical analysis. Our current chemical literature is sufficient proof of the invasion of micro methods in educational and industrial chemistry. There is a steady increase in the number of articles in the various chemical journals, showing the great variety and application to microanalytical methods.



MICRO-ANALYTICAL LABOATORRY, LOYOLA COLLEGE

Quantitative microchemical methods may be divided into the usual classes of inorganic and organic analysis. The technique for inorganic quantitative microanalysis is principally the work of Friedrich Emich (Graz) and his co-workers. Inorganic qualitative microanalysis has been worked out by Fritz Faigl (Vienna) and his colleagues. The work of Pregl in organic microanalysis is well known. In theory and practice the methods of quantitative organic analysis are essentially the same as the macromethods; but the technique is essentially the work of Pregl. From 1910 to 1912 more than ten thousand experiments were directed by Pregl and his co-workers. In 1916, the first edition of Pregl's book was published. The second edition appeared in 1922 with new and improved methods in gravimetric and volumetric analysis. Pregl received the Nobel Prize in Chemistry in 1923 for his development of these micro methods.

The success of these methods was dependent upon the development of a balance which was capable of weighing microsamples with at least the same precision as the ordinary analytical balance is capable of weighing macrosamples. The main contributor to this development was W. H. F. Kuhlmann of Hamburg, Germany. His first balances had a capacity of 20 grams and weighed accurately to 0.01 to 0.02 mg. At the suggestion of Pregl, and with advice offered by him, Kuhlmann attempted to increase the sensitivity one more decimal point by improving the grinding of the knife edges and using the utmost care in having the agate bearings not only all in one plane but also absolutely plane parallel. In 1911 Kuhlmann assembled the first balance having a sensitivity of 0.001 mg., the last two decimal places being read on the fixed scale in front of the pointer. Thus it became possible for an experienced microanalyst to weigh a 2 mg. sample with approximately the same precision (1 part in 2000) as one could formerly weigh a 0.2 gram sample on an ordinary analytical balance; by using 3 to 5 mg. of substance the error is less than that made when weighing a 0.2 gram sample on an analytical balance. Despite its high sensitivity, this balance has proved very durable and there are cases where it has been in daily use in industrial laboratories for six years, with 36,000 estimated weighings being made before any adjustments, other than periodic cleaning, were necessary. Several other firms now make microchemical balances but, besides the Kuhlmann balance, the only other balance recommended by Pregl is that of Starke and Kammerer of Vienna. This balance has two interchangeable sensitivities (0.01 and 0.001 mg.), so that it is unnecessary to arrest the balance and move the rider so often, which makes for less wear on the knife edges, agate bearing, and other moving parts.

The other apparatus for organic microanalysis was developed by Pregl during the progress of each investigation; the glass apparatus was made originally by Pregl himself and later by the firm of Paul Haack in Vienna, under Pregl's supervision. The refined chemicals were at first purified by Pregl, but later E. Merck & Co., furnished them according to his specifications. At present this apparatus may be purchased from Paul Haack in Vienna. The authorized American agent is: Microchemical Service, 30 Van Zandt Ave., Douglaston, Long Island, New York. This agent can supply the Kuhlmann and Starle—Kammerer microchemical balances, apparatus and special reagents.

The scope of microanalytical methods cover most of the known microprocedures. The following is a brief outline of the vast field of microanalytical methods:

Scope of Micro Analysis

Carbon—Hydrogen	Molecular Weight (Elevation of b.p.)
Nitrogen (Dumas)	Molecular Weight (Rast method)
Nitrogen (Kjeldahl)	Specific Gravity: solids and liquids
Halogens—Sulphur (Combustion)	Inorganic Compounds (Quantitative)
Halogens—Sulphur (Carius)	Inorg. Ions of all groups (Qualitative)
Halogens—Sulphur (Bomb)	Gas Analysis
Methoxyl group	Coal Analysis
Ethoxyl group	Calcium in Sea-water
Methylimino group	Inorg. Iodine in biological materials
Phosphorous in Org. Substances	Iodine in eggs
Arsenic in Org. Substances	Microfractionating Column
Carboxyl group	Spectroscopic Tests
Triaryl Carbonils	Colorimetric Tests
Residue or Ash	Nephelometric Tests

Recently a new method for the rapid and accurate micro determination of halogens in organic compounds has been developed by Elek and Hill, at the Rockefeller Institute for Medical Research, New York City. It is based upon the oxidation of the compound with sodium peroxide in a modification of the Parr sulphur bomb. The following analyses show the accuracy of this method.

Substance	Sample mg.	Halide % found	Halide % calcd.
Hexachlorethane	3.445	89.44	89.87
Chloracetamide	6.315	37.96	37.94
Bromcamphor	3.510	34.53	34.60
Ethyl Chloroacetate	3.281	28.80	28.98
Ethyl Bromoacetate	3.829	47.81	47.88
Iodoform	5.216	96.59	96.70

From the variety of substances analyzed, the method appears to be applicable to all kinds of halogenated organic compounds. This laboratory also reports the use of the bomb for quantitative determinations of sulphur, phosphorous and arsenic.

To show the use of microanalysis in industrial laboratories, we quote Kirner of The Carnegie Institute of Technology, Pittsburg, Pa. A criticism often directed against microchemical methods is that it is impossible to get a true representative of the whole sample in very small amounts of material necessary for microanalysis. Kirner has shown definitely that for coal analysis, the micro methods are just as accurate as the macro methods.

Comparative Determinations

Coal	Carbon	Macrosample Hydrogen	Ash	Water
	%	%	%	%
Sample 1................	41.01	3.50	6.38	25.80
Sample 2................	52.26	6.75	13.39	16.13
Sample 3................	67.50	4.81	3.97	11.81

Coal	Carbon	Microsample Hydrogen	Ash	Water
	%	%	%	%
Sample 1................	41.33	3.58	6.21	25.92
Sample 2................	52.40	6.77	13.50	16.27
Sample 3................	67.76	4.67	4.02	11.97

The authors conclude that micromethods are not only more simple and rapid but are more exact and more general than macromethods. Adoption of micromethods is not confined to research laboratories but industrial are also using these methods with an appreciable saving in time, reagents and labor.

MATHEMATICS

LESSONS IN THE USE OF THE SLIDE RULE

Sydney J. Judah, S.J.

This article is occasioned by the Experience that many hours may be wasted in fumbling with the Rule because initial practice with it had not been more systematic and thorough than the ordinary treatise demands. It is not intended that every one of the lessons or steps suggested, should occupy a whole hour of class, but at least six examples should be worked in each; the student should be made to compose his own as extra-class work. The degree of ease with which the examples are solved will be a measure of the degree of ease with which the Rule will be used in a practical problem. If a student takes ten minutes or more to find the value of tan 55°/tan 60°, for instance, one may easily judge how long he will take to solve a triangle involving these functions. Thorough practice, therefore, should be given in working out abstract examples before the Rule is used for practical problems, except by the teacher, to prove its striking utility, and to maintain interest.

Much time may be wasted in trying to teach, in the beginning, the theory of the Rule, use of the folding scales and the short methods supplied in handbooks for proportion, reciprocals, etc. Let these be left to the last, if time permits, and to the students' own initiative, if it does not. Some facility in the fundamental methods of working out examples in continued multiplication and division, roots, powers and trigonometric functions, will be enough to make the Rule of real use to him; while if he knows the formulae for multiples of π, but finds it much easier to use tables when dealing with tangents, he can scarcely be said to know how to use the Rule.

The experienced teacher will not be impatient when the need is urged of taking nothing for granted. I have found difficulties arising from confusion in the student's mind, over the terms "index" and "indicator", when the latter is used for "hunner"; while "slide for "sliding rule" or "slip-stick" is apt to be taken to mean the runner. These terms should be translated every time they are used till habitual understanding of them is patent. Return more than once or twice to the fact that the right index, no less than the left, may be regarded as unity. Mention of a third trap for the unwary (i. e. the average student) belongs later, perhaps, in the article, but may as well be made here, scl., the wrong combination of two perfectly right ideas;

$$\text{Tan A} = \frac{I}{\text{Cot A}}, \text{ and Tan A} = \text{Cot (90-A), but Tan A is not } \frac{I}{\text{Cot (90-A)}} \text{ !}$$

It should be impressed on the student that the trigonometric functions are real numbers, and must be multiplied and divided as such. Mastery of the Rule will be in sight, when he understands that he is to apply to them the same rules of multiplication and division, which he learnt in his first lessons; that his problem, therefore, is simply to find the function of an angle, and place it on the scale on which he would place the same pure number for a similar operation. Practice in evaluating anti functions is very necessary, but seems to be generally disregarded in handbooks.

Lessons, or Steps in learning to use the Slide Rule:

I. Multiplication on the C and D scales.

II. The same on the A and B scales. Several Factors.

III. Division on the C and D. Make special note of dividing I by a number.

IV. The same on the A and B scales.

V. Combided multiplication and division of several numbers on scales A—D. Mr. Fiekers' method of placing the decimal point is recommended. cf. Bulletin Vol. x, No. 4, p. 204.

VI. Squares and square roots.

VII. The Logarithm scale for other roots and powers.

VIII. Problems involving all the above.

IX. Sines of angles greater than 36′. Angles greater than 90 should be treated. The student will not remember for long the formulae for these, he should therefore have a thorough understanding of the diagram from which they are derived. This should be supposed from the trigonometry class, but it will probably be a vain supposition.

X. n Sin A, Sin A Sin B.

XI. $\frac{\text{Sin A}}{\text{n}}, \frac{\text{n}}{\text{Sin B}}$. Note particular case of: $\frac{I}{\text{Sin A}}$. (n=1) $\frac{\text{Sin A}}{\text{Sin B}}$

XII. Cosines, as for Sines.

XIII. Sines and Cosines greater than 36′.

XIV. Secants and Cosecants.

XV. Anti-sines, anti-cosines. N. B. Negative quantities.

XVI. Tan A, when A is between 5° 44′ and 45°. If more than one method is given, a full set of examples should be worked in each.

XVII. n tan A.

XVIII. $\frac{\text{Tan A}}{n}$, $\frac{n}{\text{Tan A}}$, N. B. $\frac{I}{\text{Tan A}}$.

Both here and in XI several examples in each operation should be worked.

XIX. Tan A Tan B, $\frac{\text{Tan A}}{\text{Tan B}}$,

XX. Tan A, where A is greater than 45°.

XXI. Operations XVII to XIX for all angles greater than 5° 44′.

XXII. Tan A, when A is less than 5° 44′.

XXIII. $\frac{\text{n tan A}}{\text{m tan B}}$ for any angle.

XXIV. Cotangents as for tangents.

XXV. Anti-tangents, anti-cotangents. N. B. Negative quantities.

If this scheme seems too long, it should be considered that either the examples will be worked as quickly as they are presented, or they will present some difficulty. If the first, there will be no harm in spending the minute or two required; if the second, the practice is evidently necessary.

INTEGRAL SIDED TRIANGLES

Fr. J. M. Kelley, S.J. (Proceedings—A. A. J. S., September, 1933) and F. R Brown (School Science and mathematics, January, 1934) have given us an interesting discussion of the formulae for integral-sided right-angled triangles The question naturally arises as to the possibility of a similar discussion in the case of the oblique triangle. An article on this topic by one of our members would be welcomed by the readers of the Bulletin.

A different approach to these problems can be found in many treatises on the Theory of Numbers. (Cf. for a simple treatment: Introduction to the Theory of Numbers. . . . . L. E. Dickson. Univ. of Chicago Press, 1929.)

METEOROLOGY

ALONG THE EASTERN FRONT

REV. CHARLES E. DEPPERMAN, S.J.

Now that Father Doucette has arrived, and our year of actual forecasting has so quickly come to an end, we can afford to sit back for a moment and reflect how far expectations with reference to the adaptability of Norwegian methods to the Philippines have been fulfilled.

In brief, the fundamental Norwegian ideas are these: a) There exist large bodies or masses of air which have almost the same fundamental characteristics throughout. b) Large cyclonic storms and typhoons occur only along the dividing line or front between these different air masses.

What are the different air masses to be expected in the Philippines? A study made at Washington of Werenskiold's "Mean Monthly Air Transport over the North Pacific Ocean," (Geofysiske Publikationer, Vol. II, No. 9) brought the conviction that there should be three main air masses:——1) the northeast monsoon in autumn, winter and spring, coming from the Asiatic high pressure area, and reaching the Islands in directions varying from north to east; 2) the trade wind, coming originally from the tropical high pressure area near California and swinging westward all the way across the Pacific, and reaching our coasts on and off even during the autumn, winter and early spring, dominant in the late spring and early summer, and a frequent visitor for the rest of the year when not ousted by the SW monsoon; 3) the so-called SW monsoon, being simply the SE trade wind of the southern hemisphere which, on crossing the equator from May to October, takes on usually a SW direction due to the effect of the earth's rotation.

The main characteristics of these three air masses are: 1) the NE monsoon originally is very dry and cold when it comes from the Asiatic deserts, but it rapidly picks up moisture in its lower layers as it rushes down the Pacific towards our Islands. This moisture is precipitated copiously along the eastern shores of our Islands, as it is forced aloft along the mountainous shore line. Manila usually gets the northers already "washed out" and hence during the winter months enjoys a dry season, but if the NE monsoon should reach the city from an easterly direction, the city is not protected by mountains, and "dirty" weather results. 2) The trade wind is only pleasantly moist at the base, gets a bit wetter as we go aloft to the height of the lower cumuli, and then, in the region of the antitrade, it turns decidedly dry. Hence it generally gives fine but warm weather, although in the late spring and summer months its moisture is precipitated during the frequent, practically daily thunderstorms.

3) The SW monsoon is very moist on reaching us. It probably originally had a structure like our trades, but due to the heavy convection it is subjected to in crossing the equatorial regions it becomes by the time it reaches us wet as far up as airplane flights in Manila have reached, i. e., some four kilometers. It therefore usually gives abundand rains, and as it rushes towards a typhoon it produces many squalls due to its moist instability. We see, therefore, by experience, that the predicted qualities of our three air masses have been verified.

What about fronts and the storms that arise along them? First, let us take the front between the trade and the northeast monsoon. A favorite place for this front is just outside the east coast of Japan and the Loochoos Islands, and then either through the Philippines or just north of it over to Indo-China. In the winter months, in the vicinity of Formosa, very many depressions start, since the trade is warm and the northeast monsoon cold. These depressions travel rapidly along the front, increasing in intensity as they go, in a northeast or easterly direction towards the Aleutian low pressure area near Alaska. We do not mention, as being outside our scope, the depressions that come either from Europe or mid-Asia and cross Japan and thence run on to the Aleutian deep.

With regard to the front between the trades and the SW monsoon, it now seems quite certain that most typhoons originate therein somewhere to the east or south of the Caroline and Ladrone Islands. It is too early yet to state the exact nature of a typhoon, but it seems very probable that in the beginning the SW monsoon forms a V-shaped wedge or sector, upside down, with the corner at or near the center of the typhoon. It also seems quite certain that the main energy for the typhoon comes from the latent heat of condensation of the moisture of the SW monsoon. While I was in Norway, the eminent Norwegian meteoroligsts thought that this wedge or sector should point the opposite way with the trade wind inside, but this does not seem to be true. Their reason was that they considered the trade warmer than the SW monsoon, but apparently the temperature difference, if any, at the *surface*, is too slight to be of importance compared with the moisture-energy of the monsoon. In fact, with the release of the warmth of the latent heat of condensation, it may well be that *aloft* the SW monsoon is the warmer air mass. In the beginning, therefore, we have a long front, the tropical or equatorial front as it is called, with trade wind to the north and SW monsoon to the south. As the typhoon travels westward, this front can be distinctly traced in the Philippines. Should the typhoon recurve, then near the Loochoos Islands an interesting change takes place. The winds from the north are reached and the SW monsoon is forced out; the final result is that the typhoon after recurving continues on a new front, the polar front between the trade wind and the northern air, and wends its way usually to the Aleutian low. The SW monsoon may even be forced out earlier in the game, and then, quite some distance south of the typhoon, we may get an interesing "triple point", i. e., meeting place of SW monsoon, northern air, and trade, which may give rise to secondary depressions or even typhoons. In the autumn, while the NE monsoon is building up, the SW monsoon may meet the "northers" directly, in the China Sea, and a typhoon may result. If the reader is interested in some actual cases along the lines given above, he is referred to the writer's articles in the Monthly Weather Review, Washington, commencing in the June or July number.

Of course, all these ideas have not yet been proven to the hilt, but they seem to be very probable indeed; they certainly have been a great help in forecasting, for they gave a *picture* of just what was happening on the "Eastern Front." The benefit to be derived from these ideas is considerably lessened by the lack of sufficient data especially from ships, and this is a disadvantage which will probably not be overcome for many years. However, it is hoped that an extended search into past records of the Observatory, which is now being carried on, will bring to light enough material on which to base solid forecasting principles along Norwegian lines, and to give more detailed information as to the structure of the typhoon.

NOTES ON WOODSTOCK'S WEATHER FOR THE YEAR 1933

Pressure

Highest—771.5 mm.,
Dec. 29, 10 A. M.
Lowest—726.0 mm.,
Aug. 23, 9 P. M.
Difference—45.5 mm.,
(1.79 in.)

Greatest continuous change:

Upward—32 mm. in 43 hrs.,
Feb. 8-10.
Downward—28.3 mm. in 46 hrs.,
Mar. 6-8.

Snow

Last in spring—April 12.
First in fall—Nov. 11.
Total number of days on which snow fell—18.

Temperature

Highest—100°F., June 9, 4 P. M.
Lowest—0°F., Dec. 28, 00 A. M. and Dec. 29, 11:30 P. M.
Greatest 24 hr. change—43°F., June 3.
Greatest 5 min. change—20°F., May 27, 1 P. M.

Thunderstorms

First lightning and thundershower—March 14.
Last thundershower—Oct. 1.
Last lightning—Dec. 24.

Wind

Velocity of 30 m.p.h. or more—25 days.
Direction on 17 of those days—NW.
Velocity of 40 m.p.h. or more—

Day		Direction
Jan. 29	—	NW
Feb. 8	—	NW
Feb. 26	—	NW
Mar. 9	—	W
May 27	—	WSW
June 7	—	NNW
Aug. 23	—	NE
Dec. 11	—	NW

Direction during rain, exclusive of thundershowers, approx. 90% of time—E, NE or SE.

Relative Humidity during August

Mean at 8 A M	—	84%
Mean at noon	—	65%
Mean at 8 P. M.	—	89%
Average mean	—	81%

Difference from Baltimore, average 16% higher.

Dense Fogs—Visability too poor to see objects more than 220 yds. away—on 22 days.

Precipitation

Jan.	—	3.81 in.
Feb.	—	3.41
Apr.	—	6.65
May	—	5.66
June	—	2.60
July	—	3.51
Aug.	—	11.53 in.
Sept.	—	4.63
Oct.	—	2.05
Nov.	—	0.75
Dec.	—	2.05
TOTAL	—	50.72 in.

PHYSICS

SOME RECENT ADVANCES IN PHOTOGRAPHY

Rev. Eugene A. Gisel, S.J.

In looking over the field of photography for the past year or two the interested observer will find no revolutionary innovations, but he will notice several new commercial and scientific applications.

Cameras making a small size picture are enjoying tremendous popularity, as is evidenced by the fact that photographic publications are devoting a special department to users of this type of camera. The large, bulky camera seems to be doomed, except for special kinds of work, e. g., for copying, where sharpness is a prime requisite and a long bellows draw is required to get a large size image; for interiors, when composition on the ground-glass screen and a long exposure are needed; and finally for studio work. For most other purposes, even for newspaper photography, the field is being yielded to the small-size cameras. These, for the sake of convenience, can be divided into the *miniature* camera, using standard (35 mm.) motion picture film, and the *small-size* camera, taking a picture 1⅝ x 2½ inches (vest pocket) up to 2¼ x 3¼ inches in size.

Of the *miniature* cameras, the Leica, which has been on the market for several years, and the Contax, a newcomer, both importations from Germany, are the most popular examples. These products of expert workmanship are equipped with focal plane shutter, and large aperture lenses working at f. 3.5, 2.7, and 2, interchangeable with other lenses of varying focal length. The built-in automatic range finder has all the advantages for focussing that the ground-glass screen of the reflex camera has; and lately the Leica has been adapted to give slow exposures down to one second. The small lenses used on these cameras can be made free of optical defects; their short focal length gives a tremendous depth of focus. As a result clear, sharp negatives are obtained, rather small for contact prints (1 x 1½ inches), but capable of being enlarged to 12 x 18 inches without showing much grain. The latter is possible when fine-grain film is used, such as Eastman Panatomic, Gevaert or Perutz, developed in a fine-grain developer.

In the *small-camera* field two of the finest products are the Rolleiflex (pictures 4cm. x 4cm., and 6cm. x 6cm.) and Voigtlander Superb Reflex (pictures 6cm. x 6cm., equal to 2¼ x 2¼ inches.) These are similar in structure, being box reflex cameras, using standard roll film Eastman #120, equipped with focal plane shutter, high speed lens, and ground-glass screen for focussing and composing the picture, and showing same size image as the picture will be when finished.

A photograph can be ruined because of poor composition, incorrect focussing or incorrect exposure; the first two of these three possible errors can be eliminated by a reflex camera, such as described above. The third can be avoided by the use of a proper exposure meter. The most accurate instrument manufactured for determining correct exposure is the Weston Exposure Meter. This makes use of a photo-electric cell to measure the light reflected from the object to be photographed; when held up facing the object, the correct exposure is indicated on a dial at the rear of the instrument. The use of this instrument does not entirely eliminate the personal equation, but it does reduce it more than other exposure meters.

Large aperture *lenses* are being used more and more on hand cameras made in America. Lenses with an opening of f.4.5 or 3.5 for pocket cameras were for a long time common in Europe, but only recently have they been manufactured in this country. Extreme aperture lenses of f.99 made by an English firm a few years ago were speedily withdrawn from the market, but Zeiss now comes forward with the announcement of perhaps the fastest lens ever made, namely f.0.85, which means that the diameter of the lens is *greater* than the distance from its center to the film. The focal length is 45 mm., sufficiently great to be used on a 16 mm. motion picture camera for taking X-ray pictures, that being the purpose for which the lens was made.

There have been notable developments in *negative emulsions*. The Superspeed Panchromatic film introduced by Eastman two years ago for motion pictures can now be had in roll film and film packs. If this film is used in a hand camera having a 6.3 or 4.5 lens, snapshots can be taken indoors at night if the scene is illuminated by two or three *Photoflood* lamps. These lamps are of low voltage, and when used on an ordinary house circuit of 110 volts, give a brilliant light; their life is necessarily short, about two hours or so.

The *Verichrome* film of Eastman, and the *Plenachrome* of Agfa-Ansco are now in almost universal use by the owners of roll-film cameras. These films are quite similar in composition, i. e. double coated and backed. The film base is coated first with a slow emulsion, then a fast emulsion, the former toning down the highlights in the picture, while the latter catches detail in the shadows; the resulting negative has a remarkable range of tones, and is therefore especially useful when the object to be photographed has considerable contrast, viz. some parts very light, others very dark. The picture-taking quality of these films is further enhanced by a colloid substance used to back the film, thus preventing halation; this substance dissolves off in the developer.

For some time now much publicity has been given in the newspapers and scientific press to the fact that *photographs* can be taken *in the dark*, that is, with no visible light present. Some kind of energy is of course necessary, and this can be gotten from the radiations beyond either end of the visible spectrum. As a source of long-wave, *ultra violet light* the Westinghouse Co. manufactures a lamp made of cobalt glass that absorbs 99% of visible light and transmits 80 to 85% of ultra violet light. The radiations of this lamp being rich in actinic value enable photos to be taken with no other light source present. With superspeed film and a lens stop of 4.5 the exposure required is about ½ second.

The use of *ultra violet light in photomicrographic work* is not new, but experimentation up to now has been conducted with ultra violet light from a point in the spectrum rather remote from the visible light. The system worked out lately by Trivelli of Eastman Kodak and Foster of Bausch & Lomb uses light closer to the visible, yet with a gain in resolving power of 20% over the visible light. This would permit the use of ordinary, not quartz, lenses and of ordinary biological slides.

The publication during the past year of photographs taken by means of *infra-red radiation* has brought popular attention to this method of photography. The new technique involves one of two methods: a) the object is illuminated by infra-red rays, whose source is either a red hot object, for example a flat iron, or ordinary tungsten bulbs covered with a filter that transmits only infra-red rays, e. g. Wratten 87 filter; there is no visible light present, hence the photograph is taken "in the dark." In the second method b) the object is illuminated by visible light, but the camera lens is covered with a filter transmitting only infra-red rays; e. g. Wratten A 25 filter; only these rays affect the photographic plate. The infra-red plates now on the market are dyed with mesocyanine and xenocyanine to make them sensitive to these short wave radiations. The fact that moisture in the atmosphere does not scatter infra-red rays as much as rays of white light enables the airplane photographer to get pictures of *distant landscapes* that are clear, distinct and free from haze. For such pictures the exposure required is about 1/25th of a second at 6.3. *Portraits* can be taken in total darkness by using two pairs of 500 watt tungsten lamps covered with Wratten 87 filters. When these lamps are placed 5 and 7 feet respectively from the object, an exposure of 1½ second is required at 4.5. Such pictures show the flesh tones chalky, the lips light, the eyes small black circles, and the lines of the face much exaggerated. These portraits do not flatter the sitter but this method of photography may prove of use in criminal detection. There have been a number of applications of infra-red photography in *industry*. Thus, for example, the textil industry uses it to detect faults in dark colored materials; also to determine the best dye-stuffs for dark colored cloth which is to be as cool as possible in summer. Since infra-red rays are heat rays, a dye that reflects them better and hence photographs lighter should result in a cooler cloth, other things being equal.

The number of patents for new processes *in color photography* is continually mounting. The oldest successful company, Lumiere, now supplies its product in the form of cut film, and 33 mm. film for the Leica and Contax cameras. The Agfa Color Plate is very popular, but the Finlay

Color Process, a newcomer, is finding an increasing number of users. In the Finlay process the original plate is developed into, and remains a negative. Any number of positive copies can be made from this original negative, much as lantern slides are made. In the other two processes mentioned above, the Agfa and the Lumiere, the original negative is reversed to a positive, and only this one positive results. In any case the final color plate must be viewed as a transparency, and the photographic world still awaits the inventor who will make the easy duplication of colored photographs a possibility.

LECTURE AND LABORATORY SUGGESTIONS

Soldering and Brazing.................................Newman-Clay.
(London: Journal of Scientific Instruments, November, 1933.)

Soldering and Brazing
(London: Journal of Scientific Instruments, December, 1933 under 'Correspondence'.)

Improvements in the "Schlieren" Method ('an old but little-known method of rendering visible either colorless fluids, which have a different refractive index from their surrounding medium, or variations of refractive index or thickness of transparent solids') Taylor-Waldram.
(London: Journal of Scientific Instruments, December, 1933.)

Piccin—a gastight and watertight cement for laboratory apparatus. (m.p. 176°F.)
(New York: Schrader & Ehlers, 239 Fourth Ave.)

Lubriseal—a lubricant for glass or metal stopcocks. (m.p. 104°F.)
(Philadelphia: A. H. Thomas Co.)

On the Astigmatism of the Concave Grating................G. H. Dieke.
(Journal of the Optical Society of America, August, 1933.)

SCIENCE AND RELIGION

A CATHOLIC SCIENTIFIC REVIVAL

John F. Carroll, S.J.

"Has Science Discovered God?"; most emphatically it has not, I said to myself upon concluding Edward H. Cotton's book which bears as its title, the above question. His book is a compilation of the "credos" professed by some outstanding modern scientists. In this unique theological volume, published about two years ago, are to be found the religious convictions of sixteen of the aristocrats of science, or at any rate the most popular. The roster of the symposiasts reads like the secretarial roll-call at an international scientific convention. There are Eddington and Einstein, Millikan and Mather, Conklin and Curtis, Huxley and Lodge, Pupin, Thompson and six lesser luminaries of the scientific firmament.

Among these sixteen names, however, I searched in vain for a single, recognized Catholic scientist. Was this omission accidental or purposive? Because Catholics profess to have discovered God, were they on that account not included in this cosmic treasure-hunt; lest perchance, one of their number might give away the secret and thereby spoil the game? Did Mr. Cotton fear a teleological or theological discussion from a scientific Scholastic philosopher or competent theologian? That can hardly be said,—for the object of his compilation was Scientifico—Theological in its scope. The solution at which I arrived finally, was this; he wished Theology discussed scientifically by prominent scientists, and not by (as he falsely supposed) tedious Theologians,—those designers of distinctions and *a priori* unscientific conclusions.

This patent by-passing of Catholic priests and scientists in a work that poses as scientific, recalled a statement I once came across, somewhere or other in my readings. I believe it was uttered by Bonaparte before the Council of State. "The Clergy," he said, "have lost their pre-eminence in the Sciences; it has passed to the civil order." Now, at that time, as history will attest, this indictment was most unjust. For a great number of the Clergy had been previously swept away by the wave of the Revolution into prison or into the service of the continental wars. The few who remain free were scarcely sufficient to tend to the many spiritual and temporal needs of their flocks. Their time and energies were devoted to the noblest of sciences,—the science of humanity and the service of souls. While the priests were spending their lives in relieving suffering mankind in Europe, laboring among the distant heathens and savages, and aiding in the establishment of the Church in our land; our enemies making capital of these facts and of our Suppression, took possession of the fields of science, which we had been forced temporarily to abandon. Having seized the citadel, they threw-up a strong breast-work of fact and theory, from behind which they frequently train their malevolent mortars against us, against the Rock of Peter and even against Almighty God Himself.

This was the condition of things in the early 19th Century; today, we are well advanced into the 20th; but has the state of things scientific (quoad nos) changed greatly? To face the facts, I do not think that it has. But how are we to remedy our standing? How shall we help to clear-up the present scientific atmosphere and inject into the stream of scientific thought ideas of sanity and sanctity? Simply by regaining the position of eminence held by Nicholas of Cusa, Copernicus, Ricci, Schall, Veribest and Boscovitch. But these men lived two hundred or more years ago. Whom of note have we had in scientific circles since them? Doubtlessly some will say that my judgment is out-of-focus. Have you never heard of our own Father Secchi of Georgetown? He was one of the first to bring photography to the aid of Astronomy. His intricate meteorograph merited for him the Grand Prix and the Cross of the Legion of Honor. These forerunners of the Nobel Prize were conferred at the Paris Universal Exposition of 1867. He brought his science to the aid of Religion when he used the spectroscope to prove that the famous phial of Milan contained the human blood of Saint Januarius. What of the learned Father Perry, an outstanding member of the Royal Astronomical Society? Have you not heard it said of Father De la Croix, that he made more archaeological discoveries in ten years, than twenty other archaeologists would make in a lifetime? Are you unaware of the fact that Admiral Dewey highly esteemed the meteorological reports and typhoon predictions given him by Father Algue? What of that eminent German biologist, Father Enric Wasmann? All of the examples cited are true indeed and we take pride in these men; however, the luminosity of these single stars is lost in the nebulae formed by the galaxy of the other leaders in science.

Thus, it is my firm conviction that if more Priests were engaged in scientific research, the number of Atheists, Materialists, Mechanists, Pantheists and what-nots among the leaders of science would be appreciably lowered. Firstly, the numerical proportions would change. Furthermore, that scrawny skeleton which is constantly falling from its closet,—"the conflict between Church and Science"—would be sublimated by the ardor of a Catholic Scientific Revival,—once and for all. And lastly, a point most important, by our frequent contacts with these men and a mutual interchange of ideas and philosophies, they would come to ascertain the truth,—that Church and Science are two supplementary bodies which tend to the perfection of mankind,—the latter by advancing him materially, the former spiritually.

In addition to procuring a better hearing for the Catholic Church in scientific circles, we would have a great advantage over the men who have been leading the scientific field for many years. For we already possess that for which many of them are earnestly striving. In the explanted tissue, in the test-tube, in the interior of the proton, in the stratosphere, in the bathysphere,—they are searching for a Prime Mover, or if that smacks too much of the Scholastic, they are at least looking for an answer to the WHENCENESS, the WHYNESS and the WHERENESS of things in general and of LIFE in particular. We who know Who is the Way, the Truth and the Light, have the answer. While the modern scientists stands befuddled at the cross-roads of life, not knowing whether he should make a right or left turn,—his only guide being the warped signpost of his own self-sufficiency braced by reason unaided,—we would be miles ahead of him in pursuit of the goal.

This apparent antagonism between Religion and Science, is to my mind attributable to two causes. The first is a lack of the scientific attitude in the mind of many Catholics. While the other cause may be laid to an ignorance of past history on the part of the antagonized scientists. And until such defects are deleted, contact without conflict appears impossible.

An example of what I mean by the absence of the true scientific attitude among many learned Catholics, may be indicated in the contents of the famous Stonyhurst Series. When this presentation of philosophical subjects was contemplated, Logic, Psychology, Natural Theology and such like matters received a just treatment at the hands of experts. But where in this series do we find the Queen Mother of modern science,—Cosmology? Forty years ago, Cosmology as a science was not deemed sufficiently important to warrant a specific treatment or synthesis. The old attitude that scientific knowledge was too uncertain and fluctuating and that the time-tested proofs of the Schoolmen would answer most scientific difficulties prevailed. Now, anyone who is acquainted with the history of science, knows that the most undreamt of discoveries and remarkable researches have occurred within the last half century. At the very time when Catholics were debating as to whether or not the new vehicle would run; the experimental amateur climbed into the front seat, seized the controls and is today serenely steering the cosmos almost without fear of being overtaken. The results have been decidedly disastrous to the interests of Catholic Natural Philosophy. And today, we are found without a Scientific Catholic Cosmology on the English market.

But as it would be most unfair, in an examination of the causes of this antagonism between Church and Science, to analyze only the Catholic apathy towards things scientific, let us see a few examples of scientific cynicism towards things religious. Here is the "scientific" attitude of John Langdon-Davies; "the conflict between science and fundamentalism is very real, only it began earlier than most fundamentalists realize; it began long before Darwin; before Copernicus even. Perhaps the first fundamentalist was the early Church Father, Lactantius, who proved from the bible that the earth was not round,—for science, almost from its start, was able to give mankind a loftier concept to put in its place [the God of Religion], the concept of a great artificer, a first rate mathematician, an artist to the finger tips, instead of an irritable old gentleman believing in corporal punishment.'' I am inclined to believe that Mr. Davies never perused the Cosmologico-Teleological arguments of the Scholastics for the existence of God. Perhaps he never heard it fully explained, as it is set forth in Father William Brosnan's, ''God and Reason''.

Next in order of insolence we have the Darwinian theologian, Julian S. Huxley, who tells us that; ''God, in any but a purely philosophical, and one is almost tempted to say, a Pickwickian sense, turns out to be a product of the mind. As an independent or unitary being, active in the affairs of the universe, he does not exist.''

Another proof of the reliability of the human mind divorced from Revelation, or the need Science has of Religion, is had from the words of that portly pantheist and mathematician extraordinary, Albert Einstein. He says: ''I cannot imagine a God who rewards and punishes the objects of his creation, whose purposes are modelled after our own [do we claim that they are?] Neither can I believe that the individual survives the death of his body, although feeble souls harbor such thought through fear or religious egotism.'' And somewhat more directly to my purpose, he says; ''It is, therefore quite natural that the churches have always fought against science and have persecuted its supporters.'' Will that Galileo incident ever be studied with an achromatic mental microscope?

And lastly, let us consider one more contributing cause to this antagonism. We will find it in a theory set forth by Kirtley F. Mather, Geologist at Harvard. Mr. Mather says in part; ''For the Christian religion, the scale of values is provided by our beliefs about Jesus of Nazareth. The Christian assumes that the teaching and life of Jesus, as he believed them to have been, represent truly the finest qualities of universal energy thus far displayed to man, and thus set the standard by which each individual may gauge his own ideals of conduct and philosophy of life. This assumption concerning Jesus cannot be proved by any process of logic, but even as we may justify or validate a scientific assumption by trying it out to see how it works, so we may justify or validate this religious assumption by putting it to the practical test and observing how it works. Is the truly Christian way of life the finest and the best? There is only one method of answering the question, the scientific method,—try it and see.'' This statement is beyond me; how a man who devoted his lifetime to poking about for Palaeozoic pebbles could possibly escape barking his shins on the Petrean Rock. According to Professor Mather's criterion the Catholic Church merits a permanent possession of the Nobel and other prizes for her lengthy scientific experiments in the ways of sanctity. She has studied the methods of Jesus Christ fōr 1900 years; She has proved and demonstrated this proposition to the entire world,—the doctrines of Jesus Christ really and truly work.

To one who wishes to be fair to both sides of the controversy, it is most annoying to read in scientific articles the names of Copernicus, Galielo, Newton and Pasteur arranged in the ascendancy for the purpose of widening, as with a wedge, the gap between Religion and Science. Some pseudo-scientific writers trot out these men, as of old Knut Rockne would send in his first-string backfield to rip wide holes in their opponents' defense. Yet an historical appreciation would inform these popular writers that Copernicus the demolisher of the Aristotelico-Ptolemaic universe was a priest of the Church of "ex cathedra" pronouncements; that Galileo, despite his unpleasant interviews with some unscientific Cardinals, was nevertheless, a good Catholic; that Newton, although not a spiritual subject of Rome, was a most devout Christian, while Pasteur brought to the laboratory what Ozanam brought to the Paris poor. Simply because a few rugged fundamentalists, let us say down in Tennessee, would stop the biologist biologizing, this unscientific attitude is immediately attributed to the Catholic Church. Have these writers of the present ever heard of that great Doctor and Saint of the past,—Augustine, Bishop of Hippo? Are they acquainted with his theory of evolution? A mere scientific anachronism,—just 1500 years before the dawn of Darwinism!

Abridged as is this treatment of the contributing causes to the apparent antagonism between Religion and Science, one important need is most evident,—"A CATHOLIC SCIENTIFIC REVIVAL". The past twenty-five years have witnessed a Catholic Revival in Literature; why not a corresponding movement in Scientific Fields and Literature? Among the enterprises which occur to me while I write, as conducive to this Revival, are the renewed interest in Science among our Fathers which culminated in the formation of "The American Association of Jesuit Scientists" and the publication of their BULLETIN, the splendid radio broadcasts conducted by Father Michael J. Ahern and his chemical associates of New England, the remarkable results obtained by Father Paul A. McNally and the members of Georgetown Observatory during the last solar eclipse and the publicity they received in the National Geographic Magazine. Lastly, I might mention the observational work done during the Leonid showers by the embryo astronomers here at Woodstock, under the direction of Mr. Walter J. Miller. Speaking of scientific publicity, recently there appeared an article in the Scientific American (the first noteworthy Jesuit contribution in at least three years) by Father Ignatius Cox of Fordham. Although Father Cox is not professedly a scientist, he handled his subject most scientifically. These few facts enumerated at random will help to procure recognition for Catholic scientists and ought to go a long way towards reconciling the apparently contradictory notes (in some minds), the Catholic Church and Science. For that is the prime purpose of the Catholic Scientific Revival.

PEDAGOGY

NOTES ON SCIENCE-CLASS ACTIVITIES

J. Franklin Ewing, S.J.

Some emphasis is to be placed on the words "Class" and "Activities" in the title. These notes on various ways of interesting a science class and making them realize science, all show that the whole class can be brought into the activities, which are readily capable of becoming graded projects.

These activities are more than interest-getters. They are ways of learning. Their objectives may be briefly summarized thus: 1) To impress the students with the important fact that the science in question is dynamic rather than static and to cause them to look for the future of the science: this will condition their later attitude toward science for the better; 2) To help link up science in the class-room with actuality, thus making it enter vitally into their world-picture; 3) To serve as projects for the superior students and an expression of unity for the class; 4) Consequently, to increase the self-activity so necessary and yet so difficult of maintenance in a crowded curriculum. Incidental are the facts that the apperceptive method is so universal in them and that there can be garnered a modicum of publicity for the school.

These activities are by no means original. The aim of this paper is to compile the most likely and to provide a few simple rules for each. Fuller treatment will be found in the articles listed in the bibliography. The only thing original is an occasional note which was learned from sufficiently sad experience. Many things look obvious on paper which may well be forgotten in the stress of preparation.

Of prime importance is the need of definiteness and persistency. A few minutes spent in thinking out and writing down a schedule of action will save trouble and possible humiliation later. The case is analogous to the need of charting the position of actors before the actual coaching of a play begins.

All the instances are from chemistry, and the bibliography is from the Journal of Chemical Education, the like of which in other sciences may well be desiderated. However, this Journal is recommended to the professors of other sciences. Not only do biological and physical articles occur frequently, but ideas for teaching need only to have their name changed to become your fable.

Exhibits

The Exhibit, or the Open-House, is the best of the larger projects and on the whole the most instructive and profitable. The exhibitors themselves learn an immense amount, the parents and friends are impressed, the rest of the class cooperates, and the resulting knowledge and esprit de corps make the labor worthwhile. Most of the teacher's labor, by the way, is spent on the first one. Once the idea is caught, the students will do most of the work.

1) **What the Exhibit is.** In general the object of the exhibit is to show the audience the wonders of chemistry, biology, etc., the practical results of the same, and while entertaining and mystifying the audience, at the same time impart real information. To this purpose movies, posters, apparatus and the personality of the exhibitor are used. While the exhibitor learns real science, one must remember that ''Omne tulit punctum qui miscuit utile dulci.''

This is an outline of one exhibit, with one table in detail. The title is "Much Ado About Nothing". The first table is devoted to Oxygen. On the wall in back of the table are hung posters with startling pictures of fires and fire-fighters, the mechanics of the lungs during breathing, industrial uses of oxygen and so on, with the chemical reason or simple equations beneath each picture. The Exhibitor will show a line-up something like this: Various methods for the preparation and testing of oxygen; a model of Lavoisier's famous experiment, with a balance to emphasize the effect of quantitative work on chemistry; experiments with liquid oxygen, fire-works from a cigar, a mercury hammer, etc.; a dust explosion; oxy-acetylene torch and burner (not in active use!); leaves producing oxygen under water; model of lungs; the use of the pulmotor; starting a fire with water; the eternal flame; fire extinguishers; and the like.

The next table has for its subject Water. It shows the purification and properties and importance of water. The next table is contributed by the Army and shows chemical warfare methods. Other organizations will no doubt also contribute, if asked.

Then comes the Atomic Theory, with all the unusual things that that can offer. Models of atoms, spectra, Crooke's tubes. . . A blaze of red marks the table of the Inert Gases. Helium, neon, argon are the subjects of discussion. The final table is labelled Laboratory Technique, and with very little trouble was rigged up so that on one side there was an Alchemist's work-shop and on the other a contrast with modern methods. Alchemy is always a great favorite. In the middle of the exhibit space a movie is being shown on the steam engine, or some other subject connected with one of the sections of the exhibit. There is a table with popular chemical literature. This is an exhibit concerned with only one science. If the other sciences have their share the result is even better.

The essential points in a successful presentation, physically speaking, are color and above all something moving. Each exhibitor should have several experiments, preferably dealing with light, which will attract and mystify the audience.

2) **Name.** The name should be popular, yet accurate. Instances might be: "Vital Gases" (for Oxygen, Hydrogen, Nitrogen); "The Marvels of Metals".

3) **Size.** The size depends on the local ground rules. Five tables give enough variety, but more will be welcomed. It would seem that well-differentiated sections and tables are better than a haphazard arrangement. Important is the point of easy access for the public. Sometimes the laboratory itself is the only available location, but the auditorium or some other quasi-gala spot is better.

4) **Traffic Rules.** These are very important, as many a show has been spoiled by people treading on each other, unable to see and hear everything. A system of ushers, a map, and personal supervision will solve most jams.

5) **Time.** At first it may be wise to run the exhibit just before the school play, or some other event, or incorporate it in "Parents' Day". After it has proved itself, however, it becomes an event in its own right. Separate showings for the school and the public may be necessary.

6) **Schedule of Preparation.** a) General Announcement to Class, giving idea of exhibit, reasons for having it, general outline of what it will be like; selecting exhibitors and telling them each to pick one assistant. b) Second Announcement to Class, the distributing of invitations, the selection of ushers and other assistants. Publicity attended to. c) First Meeting of Exhibitors: Explain more in detail the ideal and the idea of an exhibit, their share of tables and posters. The date for the preliminary examination should be assigned, to be sure they have studied the matter as far as the texts go; also the date for the tentative sketch of their table and posters. The date of the dress rehearsal and final exam should be announced with solemnity. Give out references: books, magazines, pictures of other exhibits, instructions for the preparation of chemicals to be exhibited. The more things made by the students themselves that they have to show, the more their proprietary interest in the exhibit. Give the students letters of introduction to managers of firms who will lend material, or who will allow visits to factories. Hansen (1932) has a very helpful list of companies which will send material. d) A constant check-up on the progress of the exhibitors is a sine qua non of success. e) For the dress rehearsal, which should be held under conditions as nearly like those of the final event as possible, it would help to have other faculty members, especially the non-scientists, in to examine the students, as they will ask difficult questions and yet more like those of the audience. The dress rehearsal is as important (if not more important) for the exhibit, as it is for the dramatic production. f) The

day of the exhibit: a deadline to make sure that everything is ready; a rest period immediately before the doors open.

7) **Accidentals.** It helps to have the audience vote. Each visitor is given a vote, which is also useful in checking attendance, containing a space for the section voted best and a space for the reason. This last is often helpful in preparing the next exhibit. The Dean might be persuaded to give a medal or some form of recognition to the winner. Those of the class not formally in the exhibit could be required to write a short essay on what they learned at the exhibit or some similar topic. The best posters, voted by the class, could decorate the class-room wall, and the name of the exhibitors posted in some more or less permanent form. Refreshments (sold?) and movies help out.

8) **Publicity.** If the publicity is worked up with good journalistic mechanics, it can have surprising results. The less scientific-minded but literary members of the class here have a field for their talents. Feature stories, e. g., on the role of the metals in civilization, stories containing the names of the companies cooperating, or of the judges if any are had, all combined with the school name and the names of the exhibitors will make real news. The event must be pictured as unique, to be news, and then so prepared as to be really unique!

Thus as exhibitors, assistants, ushers, publicity men, the whole class participates, and the exhibit is really a **class** activity.

Scrap Books and Magazines

Scrap-Books are not so childish as they sound. They make for interest, for self-activity, and form a useful exercise in the application of the principles of a science to current events. The students watch the papers and magazines and clip articles dealing with the science, and are astounded to find how often that science makes news. The following rules may be helpful: 1) The Scrap-Books should be classified, i. e., divided into logically coherent groups, not scattered. 2) Variety can be obtained by allowing first a general one, then a series on special fields, such as "Industry", "The Home", "Clothing". Or a "Before and After" idea may be used, showing, e. g., the influence of the chemist in industries, etc. 3) They should be attractive, neat, with colored pictures (such magazines as the Post are mines of material), imaginative but scientific. 4) They should give the reason for each clipping, and if possible, the reactions, in the case of chemistry. Clippings with, e. g., the chemical words underlined and their meaning given in the margin, are instructive. 5) Limit the size to fifty pages. Otherwise too much time may be spent on them. Monthly seems to be the highest possible frequency. One each six weeks, or one a semester, seems preferable. 6) They should be bound together in some simple but effective way. The best could be shown in the school library or at exhibits.

The Magazine could be run in much the same way as the Scrap-Book, allowing different sections of the class to edit it in rotation. They lend themselves to a wider variety than the scrap-books. Students assigned to "cover" different periodicals could also keep a Bulletin Board loaded with pertinent clippings.

All the talent in the class can be used in these, artistic, literary, scientific. Chiddix (1931) has a good survey of the topic.

Lectures

Here we are dealing not with lectures given by invited guests, although these are of the utmost importance, but with lectures given by the students. A program, a la specimen, can be put on with good results. About four fairly short lectures seems all the wires will carry. Experiments should accompany each, running concomitantly and illustrating what the lecturer is talking about. This gives the orators and tinkerers an opportunity to "shine". The same care with a schedule of preparation must be used. Outlines handed in, corrected, speeches handed in, corrected, dress rehearsal. Invitations should be spread in plenty of time. The judges should be prominent, as well as the company or person giving the medal. A sample of a series of lectures: "An Expose of the Electronic Aspect of Chemistry". Four lectures, under two headings—"The Approach" and "The Moot Point": "Alchemy", "Modern Chemistry", "Electrons", "Molecules".

Essay Contest

Each month a short essay can be demanded, the prize being offered to the school magazine. Topics may be selected from the lists of the American Chemical Society, or simply on the point in last month's class the individual found most interesting—with extra points for extra reading. The first month an essay on "What I expect to learn from Chemistry" will give surprising results! Good models are found all through the Journal of Chemical Education.

Field Trips

Much has been said on this subject, and we can do no better than recommend the article by Read (1931). For illustrating how lab methods are translated into industry, and for pointing out the acuteness of an industry's debt to a science, they are invaluable. But there are so many difficulties, that even with precautions, these trips must necessarily be few and used to spice the program. The theory must be well learned before the visit, and a written report demanded after it. Factories must be selected where most of the process is visible, and the guide met beforehand and the right questions prepared. Crowding and roistering must be guarded against. Of course, a visit to a farm could be combined with a class picnic.

N.B.—The Bibliography will be published in the next issue.

Plays

Plays are not easily lined up with the class work or with the objective of the year, it would seem, and must be regarded as an entertainment with a faint aroma of the science. However, for a program or a party they can be very interesting. They must be short; not more than a half to three-quarters of an hour. Otherwise the labor of preparation is all out of proportion with the results. With plenty of color and tricks they can do much to overcome prejudices at the beginning of a program.

RECENT BOOKS

The books mentioned in this column are recommended by our Science Professors as suitable for the Science Libraries.

BIOLOGY

Introduction to Cytology, by Lester W. Sharp, Third Edition. McGraw-Hill Book Co., N. Y.

Termites and Termite Control, by Charles A. Kofoid, Editor in Chief. University of California Press, Berkeley, California.

Manual of Rusts in the United States and Canada, by J. C. Arthur. Purdue Research Foundation, Lafayette, Indiana.

An Introduction to the Study of Fossils, by H. W. Shuner. The Macmillan Co., N. Y.

CHEMISTRY

Industrial Chemistry. An Elementary Treatise for the Student and General Reader. Revised Edition; by Emil Riegel. The Chemical Catalog Co., Inc., N. Y.

The Romance of Research, by L. V. Redman.
The Williams & Wilkins Co., Baltimore, Md.

Chemical Economics, by William Haynes.
D. Van Nostrand Co., Inc., N. Y.

Organische Farbstoffe, Dr. R. Wizinger, Privatdozent an der Universität Bonn. Fred. Dumulers Verlag, Berlin und Bonn.

Principles of Metallurgy, by Donald M. Liddell and Gilbert E. Doan. McGraw-Hill Book Co., N. Y.

Fundamentals of Physical Chemistry, by Earl C. H. Davies.
P. Blakiston Son & Co., Philadelphia, Pa.

Wave Mechanics, Elementary Theory, by J. Frenkel.
Oxford University Press, 114 Fifth Ave., N. Y. C.

Thermostatica, von Prof. J. E. Verschoffelt, "De Sikkel", Antwerp, Belgium. P. Noordhoff N. V. Groningen, Holland.

Organic Chemistry for Medical Students, by George Barger, F. R. S.
Gurney and Jackson, 33 Paternoster Row, London, E. C., England.

Chemical Embryology, by Joseph Needham, In three volumes.
The Macmillan Co., N. Y.

MATHEMATICS

Differentialgeometrie .... L. Bieberbach
Leipzig: Teubner, 1932 (R.M. 6.)

Projektive Geometrie .... L. Bieberbach
Leipzig: Teubner, 1931 (R.M. 7.80)

Mathematische Grundlagen der Quantenmechanik......J. v. Neumann
Berlin: Springer, 1932 (R.M. 18)

The Fourier Integral and certain of its applications........N. Weiner
Macmillan, 1933 ($3.25)

Anschauliche Geometrie ....Hilbert-Cohn-Vossen
Berlin: Springer, 1932 (gb. R.M. 25.80)

Die gruppentheoretische Methode in der Quantenmechanik
B. van der Waerden
Berlin: Springer. 1932 (gb. R.M. 9.90)

PHYSICS

Physical Optics ....Robert W .Wood
Macmillan: (3rd. ed.) 1934 ($7.50)

Capitoli di Fisica Contemporanea................G. Gianfranceschi, S.J.
Rome: Piazza Della Pilotta, 1932

Theoretical Physics: ....W. Wilson
Volume II: Electromagnetism and Optics
New York: E. P. Dutton & Co. ($5.75)

The Practice of Spectrum Analysis with Hilger Instruments..F. Twyman
London: Adam Hilger, Ltd. (6th. ed.) 1933 (3/6d.)

Optik (Ein Lehrbuch des Elektromagnetischen Lichttheorie)..Max Born
Berlin: Springer, 1933 (gb. R.M. 38)

Kleiner Leitfaden der Praktischen Physik..........Kohlrausch-Kruger
Leipzig: Teubner (5. Aufl.) 1932 (gb. R.M. 14.80)

Hydrodynamics ....H. Lamb
Macmillan, (6th. revised ed.) 1932 ($12.00)

Die Faden Elektrometer...........................Theodor Wulf, S.J.
Berlin: F. Dummlers Verlag, 1933 (R.M. 6)

Lehrbuch der Glasblaserei............................Carl Woytacek
Berlin: Springer (R.M. 22.50)

Examples in Physics ....W. G. Davies
London: E. Arnold & Co.

La projection de noyaux atomiques par un rayonnement tres penetrant; l'existence du neutron............................I. Curie et F. Joliot
Paris: Hermann et Cie, (6, Rue due Sorbonne, 6) 1932

Sur une forme plus restrictive des relations d'incertitude..L. deBroglie
Paris: Hermann et Cie, 1932

BOOK REVIEWS

SECOND YEAR COLLEGE CHEMISTRY. By William H. Chapin, Professor of Chemistry in Oberlin College. Third edition, revised. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, 1933. xiii+374 pp. 40 figs. 15×23.5 cm. Price $3.00.

Since the first printing of the second edition of this book, the author has added a set of 200 problems, transposed the chapters on Homogeneous Equilibrium and Neutralization Indicators, brought forward the chapter on Colloids, and revised or expanded the discussion of the Solubility Product Principle, Ph and Chemical E. M. F.

This book is primarily intended to serve as the basic text of a second year inorganic course, the first course having included such qualitative analysis as the author considers desirable. This text has been, and continues to be, a pioneer in this arrangement of the chemical curriculum, and it remains one of the very best books for those who follow this arrangement.

"Second Year College Chemistry" may be acceptably employed as a guide to an elementary course in theoretical or physical chemistry for college juniors where a minimum of theory has been introduced with qualitative and quantitative analysis, and where a supplementary course in physical chemistry is given.

In the opinion of the reviewer this book might find some use in supplementing or paralleling a thorough-going course in qualitative analysis, a course which realizes some of the important possibilities that have been neglected in too many courses in this subject, and omitted or inadequately developed in this text, such as, well-organized study of family relationships through a modern periodic classification based on atomic structure, the relation of modern x-ray crystallography to the nature of solids and solutions, and the significance of different types of valence; the ion association theory, proton chemistry, and the application of these topics to the explanation of different types of reactions, especially in solution.

While commending, in general, the success of the author in preparing a text for the special arrangement of chemical courses he favors, the reviewer is critical of over-emphasis and the tendency in chemical education to introduce prematurely the study of theoretical generalizations at the expense of indispensable knowledge of the facts of chemistry, which can, in part, be acquired through qualitative analysis.

C. R. H.

FUNDAMENTALS OF PHYSICAL CHEMISTRY. By Earl C. H. Davies, Professor of Physical Chemistry at West Virginia University. P. Blakiston Son and Co., Inc., 1012 Walnut St., Philadelphia, Pa., 1932. vii+370 pp. 78 figs. 15×22cm. Price, $2.75.

The volume is designed to serve as an introductory course in physical chemistry for second year college students having the usual amount of general chemistry and algebra. The author has not written expressly for the student intending to specialize in chemistry, but convinced of the general educational value of the subject, he has aimed to give a broad and comprehensive survey of Physical Chemistry.

The book is well written and covers a wide range of topics in an interesting manner. The objective of the author to prepare the student to understand and profit more fully from all his science courses is well attained.

The first chapters present the usual classical topics, not failing to call to attention, where apropos, the most recent advances. The two principles of thermodynamics receive too brief attention and the periodic law might with advantage have been given a more modern setting. Also the table of isotopes is that of the Table International des Isotopes for 1926. Considering, however, the purpose for which the book was written the author has met the very difficult task of selection of material with insight and a sensitive appreciation of the difficulties confronting the novice in science. The inclusion of photographs of a number of men of science makes a pleasing addition to this attractive book.

F. G. K.

NEWS ITEMS

The American Association For The Advancement of Science

Catholic Round Table of Science; meeting at Boston College, Dec. 28, 1933.

Rev. Louis J. Gallagher, S.J., President of Boston College, was host to sixty members of the Catholic Round Table of Science at a luncheon served in the Senior Assembly Hall of the Administration Building at University Heights Thursday afternoon, December 28th, at 1.00 o'clock.

The Catholic Round Table of Science is composed of Catholic members of the American Association for the Advancement of Science. This larger body held its annual meeting in Boston December 27-30th and, as is customary, the Catholic members also held their own Round Table. The members of the Round Table come from every section of the country and are prominent leaders in research in physics, chemistry, biology, geology, medicine and engineering.

Rev. John A. Tobin, S.J., Head of the Department of Physics at Boston College, and a Fellow of the American Association for the Advancement of Science, arranged an attractive program for the luncheon.

Father Tobin as chairman read a letter blessing the meeting from His Eminence William Cardinal O'Connell, who was unable to be present. Rev. Louis J. Gallagher, S.J., President of Boston College then gave an address of welcome. The Rev. Georges Lemaitre then gave a very interesting talk on research work from the view of a Catholic. He said: "Religious conviction may ever give background for science. Science is a technical business. In a remote way, philosophic convictions help in attacking a scientific problem. Scientists want to produce and to continue work. Religious background gives them an optimistic attitude. Scientific attitude may be discouraging in the fact that the universe is so large, that the atoms are very small, and that the stars are very far away. We Catholics are not astonished at this; we are convinced that the world is not too large for us, in fact, for example, we may thank God that He placed us in this world and at the right place to make scientific observations on this universe. Religion gives us a saner attitude. Scientists today seem content to find mystery at the end of their search. We have a full share of mystery in religion, so that when we sart in research, we do not want to end in mystery. We want to arrive at a definite conclusion."

Dr. William J. Fordrung of Hunter College New York, gave the next address on research work for Catholic Doctors. Rev. Dr. Anselm Keefe of Wisconsin then gave some interesting statistics about Catholics and research work. In the general discussion that followed, scientists from Johns Hopkins, Princeton, Cornell, Harvard, M.I.T., Georgetown, Fordham, Holy Cross and Boston College gave their views, as many others from Notre Dame, Wisconsin, Ohio and other colleges in the country. Before the luncheon, the visiting scientists visited the library and science building and were very generous in their praise of the equipment in the Science Laboratories.

Rev. Louis J. Gallagher was a member of the Local Committee of the A.A.A.S. and received a note of thanks for his cooperation.

Rev. James B. MacElwane, S.J., of St. Louis University, was elected Chairman of the Section of Geology and Geography, and Vice-president of the American Association for the Advancement of Science.

Editor's Note: The "Science Bulletin" takes this occasion to congratulate Father MacElwane on his scientific achievements and on the high esteem he is held by the American Scientific Societies.

Fordham University—Seismology Department

A number of earthquakes of varied location and unusual characteristics have been recorded recently. January started off with two of the deep focus type—one in the Sea of Okhotsk on the 3rd and the other near Greece on the 11th. The destructive shock near Patna, India, on the 15th of January left a record of great intensity but was peculiar in that the preliminary phases had very small initial amplitudes. The record of the Mexican quake of the 28th was one of the best and most sharply defined of recent months. The seismogram of the Nevada shock of the 30th was marked by the large amplitude of the surface waves and the complete absence of the P waves.

A popular article on Seismology will appear in an early issue of the Scientific American. A radio talk on this subject was recently given by Rev. J. Joseph Lynch, S.J., over Station WINS, New York City.

The Seismological Society of America, Eastern Section, will meet at Fordham University on Monday and Tuesday, April 30 and May 1. The meetings will be held in the Psysics Building.

Fordham University—Chemistry Department

By reason of a gift, designated for research, extensive additions have been made to the Chemistry Department Library here. Anyone whose business it is to buy journals and books for a chemistry library, soon discovers that it requires a small fortune to buy complete back numbers and to subscribe for current issues of all the journals useful to the chemist. A selection must necessarily be made. Due to the revaluation of the dollar, many of the German journals have become prohibitive in their subscription cost. This is particularly unfortunate when we consider that the same field is often covered by two or more journals in German over and above the English, American and French publications. In fact, the advanced cost of these German journals became so critical that a meeting of librarians was held in Chicago last summer in which the librarians agreed to cut down on the subscriptions for German journals unless the price was lowered. Representatives from the German publishings houses agreed to lower the price on the journals during the current year to as much as 30%. In spite of this it is quite impossible, financially, to subscribe for all the journals in which articles appear that may be of interest to research students. Where the facilities of large city libraries are available, it seems that the most useful journals to buy are the abstracting journals. Students may then go to the larger libraries to consult the journals on file which contain the original articles. With this idea in mind, the following journals were purchased which cover the field of Biochemistry from its earliest date to the present. With these journals added to our present list, the student has a complete summary, either by title or in abstract form, of all articles pertaining to Biochemistry and the related fields of Physiology, Biology, Medicine, Pharmacology and Pathology.

"Berichte der gesamten Physiologie und experimentellen Pharmakologie." Vol. 1-64.

"Biochemisches Zentralblatt". Vol. 1-9.

"Zentralblatt fuer Biochemie". Vol. 10-23.

"Jahresberichte ueber die gesamte Physiologie und experimentelle Pharmakologie". Vol. 1-10.

"Jahrenberichte ueber die Fortschritte der Tierchemie". Vol. 1-49.

The research student has access to current and in most cases complete issues of the following journals:

Journal of the American Chemical Society.
Chemical Abstracts.
Journal of Industrial and Chemical Engineering.
Journal of Industrial and Chemical Engineering (Anal. Edition.)
Journal of Chemical Education.
Chemistry Leaflet.
Science.
Science News.
Scientific Monthly.
Journal of Biological Chemistry.
British Biochemical Journal.
Zeitschrift fuer Physiologische Chemie.
Journal of Nutrition.
Annalen.
Berichte der Deutsche Chemischen Gesellschaft.
Mikrochemie.
Physiological Reviews.
Chemical Reviews.
Ergebinesse der Physiologie.
Cumulative Quarterly Index Medicus.
Journal of the American Medical Association.
Chemischen Zentralblatt.

Georgetown University

Graduate Students

Four Fathers and four Scholastics are making graduate scientific studies at Georgetown this year. Father Walter Burke-Gaffney, S.J., from the Upper Canadian Province; Father Thomas D. Barry, S.J., from the New-England Province; and Father Edmund J. Nuttall, S.J., and Mr. Walter J. Miller, S.J., from the Maryland-New York Province,—are all making special studies at the Astronomical Observatory. Father Nuttall spent the month of October at the United States Naval Observatory, chiefly in the Transit and Time-Signal Departments, studying their routine methods in preparation for his assignment to the Manila Observatory. Father Raymond Buckley, S.J., from the California Province, is doing special work in seismology and mathematics. Mr. Arthur L. McNeil, S.J., from the Oregon Province, is working towards a Ph.D. in Chemistry at Catholic University, and Mr. Alvin A. Hufnagle, S.J., is doing the same at Georgetown University. Mr. Philip H. McGrath, S.J., is specializing in mathematics under the direction of Father Frederick W. Sohon, S.J. By a strange coincidence, Fathers Barry, Buckley, Burke-Gaffney and Nuttall, each one from a different Province, took their Last Vows at Georgetown on February 2nd.

Tercentennial

On February 26th the Director and Assistants of Georgetown College Observatory will share in the Tercentennial Exercises commemorating the Founders of Georgetown University, by being hosts at a special "Secchi Evening" at the Observatory. In the display will be a lens brought by Father Angelo Secchi, S.J., from the Roman College to Georgetown in 1848. On January 14th, the College Juniors held a Tercentennial Commemoration in the form of an Academy on "God and The Sciences". The Academy consisted of talks on Comparative Sciences, The Physical Sciences and The Process of Philosophy. The specially invited lecturer was Dr. Hugh S. Taylor of the Department of Chemistry of Princeton University, whose topic was The Union of Religion and Science.

New Courses

Father Paul A. McNally, S.J., Director of the Georgetown College Observatory, has inaugurated a series of lectures on *Astronomy* for the third year Woodstock College Philosophers, as a part of the Scientific Questions course. Father Frederick W. Sohon, S.J., Director of the Seismic Observatory, is giving a course to Georgetown professors and graduate students on *Advanced Dynamics*. For this course it was often found advisable to replace Cartesian analysis by vector method, and frequent use was made of the calculus of variations. The best available reference text is the work of the late Professor Webster of Clark University, i. e., "Dynamics of a System of Particles" and "Dynamics of a Rigid Body", published in English at Innsbruck. The Advanced Dynamics will be followed by a course on the *Theory of Elasticity*.

In preparation for the World Longitude Operations of last October and November, a *constant temperature case* was secured for the No. 36 Riefler Clock, with the result that even during cold spells the temperature does not vary more than a fraction of a degree and the clock rate is maintained in the hundredths of a second column. For use with the Ertel transit, the United States Naval Observatory has very graciously loaned an *impersonal micrometer* made by the Werner and Swasey Company, thus making possible an accuracy hitherto unattainable in our time-sets. The Observatory's instrument maker has recently completed an elaborate *two-way plate-holder* for the twelve-inch telescope. It is provided with place for 4" x 5" plates, for any kind of colored filters and for a ground-glass focussing screen. One of its features is a two-way slow motion for both the plate-holder and the prismatic-eyepiece finder. For the recording of exposure times, there is automatic electric registration on the chronograph whenever the shutter is opened or closed. A special tiny shield can be inserted and locked in place to protect the plate from a very bright star, which would cause halation on a long exposure. Guiding on a bright star in the field to be photographed is made possible by the prismatic eyepiece sighting through the tube of the 12" telescope, so that the same lens which is used for photographing is used for following; thus the observor is not dependent upon a special finding telescope of much shorter focal length. In a field of activity in which Georgetown astronomers have long been conspicuous, a new record has been made, for the number of *occultations* observed during 1933 reached an all-time high of 134, in spite of very poor observing weather. Regular work is done on visual observations of long-period *variable stars*, and the photographic campaign takes care of short-period variables and the fainter long-period variables in special Mascart Areas. Experiments are also being continued on finding group *radial velocities* of stars, from spectrum plates secured with objective gratings of very fine wire. The reconditioning of instruments and unusually poor weather during the crucial months of October and November, combined to decrease the number of time-sets available for determining the *longitude variation*. The observations are now in process of reduction.

A "*Diploma Awarded For Exceptional Photographic Art*" has recently been presented to Georgetown College Observatory by the Century of Progress Exposition, for the solar eclipse plates taken by the Georgetown University Solar Eclipse Expedition to Fryeburg, Maine, on August 31, 1932, and exhibited at Chicago by request both in the Salon of Photography and at the Adler Planetarium. Professor Robert H. Baker, Director of the University of Illinois Observatory at Urbana, Illinois, and author of a standard text on "Astronomy", requested permission to publish the Georgetown picture of the eclipse in his new text. He subsequently wrote: "There is no doubt in my mind that the photograph is among the very best eclipse photographs ever secured."

Honors

The *Kober Lecturer* for 1934 will be Dr. Walter Bradford Cannon, Sc.D., LL.D., of Harvard. He is a physiologist of world-wide reputation, a member of the National Academy of Sciences and President of the Medical Research Society of America. Besides being author of "A Laboratory Course in Physiology", "The Mechanical Factors of Digestion", "Bodily Changes in Pain, Hunger, Fear and Rage", "Traumatic Shock"; he has contributed many articles on the movements of the stomach and intestines, internal secretions, effects of emotional excitement, surgical shock, etc.

The *Kober Medal* for 1934 will be presented to Dr. John Jacob Abel, D.Sc. LL.D., of the Johns Hopkins University Medical School. A pharmacologist of international standing, he is a member of the National Academy of Sciences, the editor of the Journal of Pharmacology and Experimental Therapeutics; and the author of many researches on animal tissues and fluids, and on the physiological and therapeutical action of various substances. Besides being nominated by the American Association of Physicians in 1925 to receive the first award of the lectureship of the Kober Foundation at Georgetown University, he has been awarded the Willard Gibbs' Medal of the American Chemical Society in 1926, and the Gold Medal of the Society of Apothecaries in London in 1928.

Dr. James Robertson, director of the Nautical Almanac office of the Naval Observatory, on November twenty-fourth, was given the degree of Doctor of Science by Georgetown University. The degree was conferred upon Dr. Robertson in recognition of his international reputation as one of the foremost astronomical mathematicians, in connection with his accuracy in calculating solar eclipses, and the preparation of the American Ephemeris and Nautical Almanac.

CHEMISTRY

The object of the Georgetown Chemical Society is to further knowledge of the industrial applications of chemistry. Regular meetings are held at which a paper is read on some subject of industrial importance. At the meeting of the Washington Section of the American Chemical Society held at Georgetown early in December, Professor Bagert of Columbia University spoke on "Scents and Dollars". Reverend Lawrence C. Gorman, S.J. is Moderator of the club.

DENTAL AND MEDICAL SCHOOL

Dr. William H. O. McGehee, M.D., D.D.S., has joined the faculty of the Dental School, and is in charge of Oral Diagnosis, on which subject he is writing a book. Dr. McGehee was professor of operative dentistry at New York University. At the last meeting of the American Association of Dental Schools, held in Chicago, Dr. McGehee was awarded the distinctive honor of F.A.C.D.

Dr. Theodore Koppanyi and Professor George A. Bennett have taken over the abstraction of Roux Archives der Entwickelungs' Mechanik for the biological abstracts of the University of Pennsylvania.

The Atlantic Seacoast Dermatological Society held its meeting this year at Georgetown Medical School on November eighteenth. About one hundred and fifty leading dermatologists attended.

Professor George A. Bennett has developed a department of Macro-and-Microscopic Photography consisting of two dark rooms, at the Medical School. In teaching histology and embryology Professor Bennett gives each student a photograph of a slide being studied, which the student preserves in his notes.

The Department of Pharmacology and Materia Medica has been doing extensive research work in the field of sleeping powders. The main interest of this department centers around the problem of veronal and its allies, commonly called barbituric acid derivatives.

Loyola College, Baltimore, Maryland

Chemistry Department

On December 5th, Dr. E. G. Zies of the Geophysical Laboratory, Carnegie Institution of Washington, D. C., lectured to the members of the Loyola Chemists' Club on the subject: "Chemical Aspects of Volcanic Activity." The lecture was illustrated with exceptionally fine stereoptican views.

''Chemistry in Water Purification'', was the subject of the lecture delivered by Edward S. Hopkins, Ph. D., Principal Sanitary Chemist of the Bureau of Water Supply, Baltimore, Maryland, on January 16th.

Dr. Alexander Weinstein, Associate in Biology of The Johns Hopkins University, lectured to a large audience in the Chemistry Lecture-hall on the subject: "The History of the Atomic Theory in Ancient and Modern Times." Not only the members of the Chemists' Club were present, but also representatives from the Departments of Physics and Philosophy.

Mathematics Department

A mathematical seminar is held each week under the direction of Professor Thomas J. Love, S. J., for the purpose of discussing problems complimentary to the regular class-work and to stimulate an interest for higher calculus.

Holy Cross College—Department of Chemistry

On February 2nd, Fr. Joseph J. Sullivan, S.J., Dean of the Department of Chemistry, spoke over Station WAAB and the Yankee Network, on the subject "Some Humane Aspects of Chlorine". February 9th, over the same network, he delivered another talk on "Some Uses of Aluminum."

Seminars

The faculty and students of the department of chemistry are continuing the series of seminars concerning recent advances in chemistry.

Woodstock College

Adoption of New Text in Physics

After comparison with most of the recently published texts, "College Physics", by Arthur L. Foley (Blakiston, 1933), appears to head the list as the nearest approach to the Physics Teacher's ideal.

In the last issue of the Bulletin it was noted that Georgetown had introduced it in both A. B. and B. S. courses.

This term at Woodstock, we have also been able to replace "Millikan, Gale and Edwards" by "Foley", and the reactions both in interest and results have been most satisfying, even with less than a month's use, in the regular 1st. year class.

For those who have not as yet had an opportunity to use the book, a list of reasons for its selection is subjoined.

While entirely up to date in all topics treated the author still preserves the classical divisions in the order; Mechanics, Heat, Electricity, Wave Motion, Sound and Light.

The allotment of space and material maintains a fine balance. Although the concepts of atoms and electrons are introduced quite early in the text, under the properties of matter, the fundamental aspects of Mechanics are not neglected, as for example in Miller's text put out in 1932.

Only one chapter is devoted to the "Modern Physics"; a sensible amount for a 1st. Course, since many colleges are finding it more satisfactory to leave the topics to be treated under that heading until second year; since it is scarcely possible to cover even the classical treatises in the assigned lecture periods.

In addition to the usual 10 to 20 problems (every other one of which is answered), at the end of each chapter there are two sets of study questions,—one directly on the text matter, the other of a more general nature; the first being rather a memory test, the latter a measure of the "thinking power" of the student.

The diagrams and plates are well chosen and clearly executed, especially those on light. Cf. for example diffraction on pp. 685-688, and the mirror diagram of p. 606.

Nor is the text a narrative of the "Physics made easy" type, such as is that of Loeb and Adams, who enhance the "human interest element", by going out of their way to explain "the end of Vitalism" in a Physics course. (Cf. "Development of Physical Thought", Wiley, 1933, p. 257.)

Foley, in the explosion of popular fallacies, by the application of elementary physical principles, and rigorous but clear reasoning, is at his best.

Examples of this type, developed in the text proper, appear in Mechanics on pp. 120-122, and pp. 182 and 188. But the true value of the book can only be realized by teaching it. The author in his preface mentions that he has reviewed as many as forty text books, and used seventeen to teach from; and it is evident that he has culled the best from all of them.

Like all first editions, there are a few misprints, but because of the very clarity of the book they are easily recognized.

The only adverse criticism, if such it be, is that perhaps "College Physics" leaves too little for the professor to say.

Attention is called to an article ''The Goal of the Physics Teacher'' by the same Professor Foley in the current issue of ''School Science and Mathematics.''

COOPERATIVE TESTING IN PHYSICS

Forms for the Cooperative Physics Test for College Students in Mechanics were received too late for the quarterly examination. The others in Heat, Light, Electricity, etc., will be used as occasion arises.

It would be interesting if not gratifying should all our colleges agree to use and publish, in the Science Bulletin only, the scores obtained in each.

If such a suggestion meets with approval, it might be arranged by communicating with the Editor, or Chairman of the Physics Section.

Weston College

At the recent meeting in Boston of the American Association for the Advancement of Science, the ten colleges and universities of the Metropolitan District of Boston acted as hosts of the meeting. Among these colleges were, Boston College and Weston College. Father Gallagher was on the Executive Committee for the meeting as representative of Boston College, and Father Ahern acted in a similar capacity for Weston. The latter was also in charge of the radio broadcasting of the address by Harlow Shapley, Director of the Harvard Observatory, who spoke on "The Anatomy of a Disordered Universe" on the Saturday night during this Convocation Week, on the occasion of his reception of the Rumford Medal. The official program of the meeting had the seals of all the host colleges on the front and back covers.

On December 1 the Chemical Broadcasts under the auspices of the Northeatern Section of the American Chemical Society were resumed on Friday evenings at 8.15 over the stations of the Yankee Network. These broadcasts now number over 130. Their success has stimulated emulation in other sections of the A. C. S. Father Ahern is a member of a national committee of the A. C. S. on broadcasting. The present plan of this committee is to form a library of broadcasts in the headquarters of the A. C. S. in Washington, which can be used for broadcasts under the auspices of the nearly eighty sections of the Society in the country.

A Home and College Institute has been formed in New England, for the purposes of organizing and conducting educational courses by radio over the Yankee Network. The Director of this Institute is Professor T. Lawrence Davis of Boston University. At a preliminary meeting held in Boston on February 1, at which Father Ahern represented Boston College, Holy Cross and Weston College, there were present representatives of Harvard, M. I. T., Wellesley, Radcliffe, Boston University, Tufts College, and of various educational agencies of Massachusetts. At this meeting Father Ahern was appointed Chairman of a committee to bring in a report on General Objectives. The other members of the committee are President Cousens of Tufts, Professor Elder of M. I. T., and Dr. Davis of Boston University.

In the Broadcast Series on Chemistry of the Northeastern Section of the A. C. S. Father Sullivan of Holy Cross College has given two lectures to date, Father Power of Fordham University one, Mr. McGuinn of Weston College one, Professors O'Donnell and McSheehy of Boston College one each. Each broadcast of this series is reprinted in full each week in the *Saturday Evening Transcript* of Boston.

New additions to the scientific equipment include a Spencer Binocular Microscope for work in Biology; and a Spencer Petrographic Microscope for the work in Geology. This is a polarizing microscope, and can be used also for work in chemical microscopy.

Manilla Observatory, Manila, Philippine Islands

Rev. Bernard F. Douchette, S.J., has been officially appointed on the Staff of the Weather Bureau by the Governor General Frank Murphy.

Shanghai, China

The China Journal announces the opening at Shanghai, as a public museum, of the Exposition of Natural History, known as the Heude Museum, in honor of the late Father Pierre Heude, S.J., who founded the Museum 50 years ago.

The Heude Museum, installed in the celebrated Aurora University, was founded in 1883 as a private collection of zoological material representing all the branches of animal life. The most remarkable part of the exhibit is the collection of the great mammalia of China and the neighboring regions of Manchuria, Korea, Indo-China, Japan, Siam, Malaysia, Java and even eastern Siberia and Kamchatka. Besides, there is an important collection of the small mammalia of China.

Father Courtois, successor to Father Heude, devoted a great part of his time to the collecting of birds and herbaceous specimens.

From a scientific point of view, the most important sections are those devoted to fluviatile molluscs and to insects. The former which was Father Heude's special interest, were discussed in one of his books.

Father Savio, the present director, is interested particularly in ornithology and coleopterous insects. His assistant, Father Octave Pical, specializes in the study of wasps and bees. One large hall is devoted entirely to entomological collections.

Besides the natural history exhibits, the museum has an excellent collection of ancient and modern art.