

A. M. D. G.

# BULLETIN

of the

## American Association of Jesuit Scientists

(Eastern Section)



For Private Circulation

GEORGETOWN UNIVERSITY  
WASHINGTON, D. C.

Vol. VI

No. 4



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## CHEMICAL EQUIPMENT AND COURSES AT WESTON COLLEGE

The chemistry lecture room at Weston College is located in the eastern end of the ground floor of the Philosophers' wing; the laboratory occupies three rooms below in the basement. The general laboratory, immediately under the lecture room, is provided with two tables with a total of 44 lockers, each with a drawer above it. This laboratory is used especially for the general chemistry course taken by the 1st year Philosophers, who are given two hours a week lecture and two hours a week laboratory work. The text book at present is Newell's. The tables in this laboratory were not made by any of the manufacturers of standard laboratory furniture, and after less than a year's service in the rather damp basement went to pieces and had to be entirely rebuilt at considerable expense to the building contractor. It looks now as if they would stand up during the coming summer—we hope for the best. These tables are supplied with compressed air, vacuum, water, gas, and alternating current. The vacuum and air are supplied by two Lammert rotary oil pumps located in a separate room nearby—each pump is chain-driven by a 220-volt 3-phase 2-H.P. motor and is connected to a large tank serving as a storage reservoir. The pumps maintain the vacuum and air at some determined value by means of automatic switches.

In all the laboratories are side-tables along the walls supplied as are the main tables, with the exception of water; there is also available 110 volt direct current which may be had by starting a motor-generator set located in the pump room by means of remote-control switches located at several convenient points in the science departments.

Gas is supplied from two Pyrofax tanks outside the building. One is kept full, and as soon as one is empty the service company is notified and a new tank is delivered in a day or two at a renewal cost of \$16.00. We use up a tank about every six weeks on the average. Once specially adapted burners are at hand, this Pyrofax gas (supposed to be a hydrocarbon gas consisting chiefly of butane) is entirely satisfactory, but it is difficult to get a blast-lamp to operate on it. We use a Fisher No. 4-156 blast-lamp and a small No. 00 hand-torch purchased through a local supply house to supplement it; between the two we can do most of the ordinary jobs of glass-blowing. We have not as yet been able to use this gas with oxygen, however, hence we cannot do any practical glass-blowing with Pyrex.

Along the walls of the general laboratory and the next room, which is equipped with a sort of adapted lecture table, are shelves and cabinets for the storage of the complete sets of reagents and chemicals to accompany Newell's Laboratory Manual and Noyes' Qualitative Analysis. We have a very complete collection of all the ordinary inorganic chemicals for general and analytical chemistry, also a few standard samples of Diack and Smith for quantitative analysis which we have found on the whole very reliable. We also have an exceptionally fine collection of organic chemicals, especially those of the Eastman Research Laboratory, including very complete series of alcohols, acids, and essential oils; typical dyestuff intermediates; a few perfumes and explosives; and even samples of chloracetophenone, xylyl bromide, and chlorpicrin to represent the war gases.

In addition to a complete assortment of ordinary Pyrex glassware, the general equipment includes: a Barnstead electric still with a capacity of one gallon per hour of distilled water; an electric combustion furnace with all accessories for the ultimate analysis of organic compounds for carbon, hydrogen, and nitrogen; a chainomatic balance with notched beam and autodex index, besides an ordinary analytical balance and a heavy-duty balance sensitive to about 50 milligrams at a load of two kilos; several electric stoves; a Bureau of Standards thermometer with certificate; several types of extraction apparatus, including a rotary extractor sent from Fordham by Dr. Carl P. Sherwin; a Cenco Hyvac pump; tanks of oxygen, hydrogen, sulphur, dioxide, acetylene, and a welding torch for the latter; a set of LaMotte buffer solutions and indicators for the colorimetric determination of pH, and also a complete Bovie hydrogen-ion potentiometer for determining pH electrometrically; a heavy-duty Cenco stirring motor; also many smaller pieces of apparatus such as a Westphal balance, quartz crucibles, a complete equipment of filter paper of all sizes and grades, etc. We hope eventually to have a good colorimeter, a prism spectroscope, a medium-sized centrifuge, a muffle furnace, a vacuum oven, a constant-temperature bath, and a complete equipment of our own for electrometric measurements, although at present through the kindness of Fr. Brock we are allowed to use his standard cell, type K Potentiometer, and galvanometer.

We also have a very fine chemical library which is continually being expanded with most of the best recent books on analytical, organic, and physical chemistry. We have our own set of the *Minerva*, the German year-book of universities, colleges, and learned societies throughout the world; and we share with the Physics department a set of the *International Critical Tables*. Of course, until we have complete sets of the *Centralblatt*, *Beilstein*, and *Mellor* we cannot claim to have everything necessary,

but we are hoping to acquire these expensive volumes gradually. Through the kindness of the authorities at the Massachusetts Institute of Technology we are able to borrow freely from their excellent library, and one of the Scholastics also has the same access to the book stacks there as have the members of the Institute staff.

The courses outside that of general chemistry are conducted according to the usual custom of academies although no set time for laboratory work is assigned. Lectures, however, on some phase of chemistry (this year on organic chemistry and stoichiometry) are usually given on Sunday morning. The whole procedure of courses is not as yet stabilized, but as it stands now, those Philosophers who have done well in general chemistry during first year and who are interested in following up the subject may, with the permission of the Prefect of Studies, do qualitative analysis (using Noyes' book) during the summer following first year; then during second year a man can do some of the experiments in Chapin's Second Year Chemistry and most of the standard quantitative procedures in Talbot's text. During the following summer a course in organic can be taken, the lectures following Lowy and Harrow's Introduction to Organic Chemistry, and the laboratory syntheses conducted for the most part from Cohen's Practical Organic Chemistry. Last summer and during the first months of this year we actually carried a course of this kind, following in the synthetic work the system of using each compound whenever possible as the raw material for the next synthesis, according to the following scheme.

The original raw material is in the extreme left-hand column; and compounds offset to the right of one of the derived compounds were synthesized from this derived compound. Thus, for example glycine and ethyl malonate were both formed from the monochloroacetic acid which had been previously obtained in a chlorination of acetic acid.

Most of the syntheses were conducted according to Cohen's directions, but we also made use at appropriate times of the laboratory manuals of Lowy and Baldwin, Gattermann, Heidelberg, and Alexyeff's Principles of Organic Synthesis.



## Aliphatic Syntheses

Starting Materials	Derivatives
Ethyl alcohol	Ether Ethylene bromide Ethyl acetate Ethyl bromide Acetaldehyde
Acetic acid	Monochloroacetic acid Ethyl malonate Glycine Acetyl chloride Acetamide Acetonitrile Methylamine hydrochloride
Sugar	Oxalic acid
Oxalic acid and Glycerol	Formic acid
Potassium cyanide	Urea
Prototein (hoofs) (commercial casein)	Tyrosine and leucine

## Aromatic Syntheses

Starting Materials	Derivatives
Benzene	Nitrobenzene Aniline Acetanilide p-nitraniline p-nitraniline red Sulphanilic acid Methyl orange Sodium benzene sulphonate Phenol
Phenol	o- and p-nitrophenol Picric acid Salicylaldehyde Coumarin
p-toluidine	p-cresol p-bromtoluene Malachite green
Dimethylaniline and Benzaldehyde	
Anthranilic acid	Methyl anthranilate



During third year a Philosopher can continue this organic work, including some combustions for carbon, hydrogen, and nitrogen on our electric combustion furnace; or he may do the laboratory work necessary for his M.A. thesis in case he writes it on a chemical subject.

Thus a man leaving Weston to teach chemistry will have seen enough of the usual branches to enable him to fit in profitably in the chemistry departments of any of our colleges, and if he is given in addition a good course in physical chemistry he should be ready to do graduate work at any of the Universities for his doctor's degree. He will be familiar with most of the standard books on his subject and he will have been in contact with enough of the research work usually going on at odd times in the laboratory to understand the fundamental importance of this sort of work and to understand at least how to go about it on his own account later. Three of the third year Philosophers going out to teach this year have had the opportunities mentioned in this article and have made the fullest use of them consistent with the more important duty of thoroughly preparing for their third year examination.

Any description of the chemical equipment and courses at Weston would be incomplete without paying the proper tribute to the man directly responsible for the very satisfactory position of the laboratory at present, namely, Rev. Michael J. Ahern, S.J. Without the encouragement which he has always given to younger men and without his extraordinary energy in providing apparatus, chemicals, and books, the work herein described could never have been carried out.

FRANCIS W. POWER, S.J.  
Weston College,  
Weston, Mass.

## SOME FIGURES FROM VOLUMETRIC ANALYSIS

In the course of a good many standardizations of volumetric solutions I have collected some data which may prove of interest to readers of the BULLETIN.

The first group of figures refers to the check obtained in the standardization of hydrochloric acid by means of silver nitrate as compared with the same factor determined by titration against pure sodium carbonate, using methyl orange as indicator. I have also included the checks between the different pairs of determinations in a given series. All these determinations were run with the ordinary care as regards purity of reagents, calibration of apparatus, and analytical procedure which is usually used in quantitative analysis and which is to be found in any of the standard works on this subject; although some of the figures, as can be seen, are not much to brag about.

The determinations with silver were all run in Gooch crucibles. The check and percent check for any series of determinations of the factor is the average discrepancy between the two members of every possible pair of determinations in the given series.

Standardization of normal HCl—Weston, 1927.

Factor via $\text{AgNO}_3$	Factor via $\text{Na}_2\text{CO}_3$
1.0204	1.0200
1.0192	1.0204
av. 1.0198	av. 1.0202

Factor via carbonate exceeds that via silver  
by  $0.0004 = 0.04\%$

These results were so good that no further determinations were made for fear of spoiling the check!

Standardization of a half-normal HCl—Weston, 1927.

Factor via $\text{AgNO}_3$	Factor via $\text{Na}_2\text{CO}_3$
0.49761	0.4988
.49884	.4956
.49910	.5010
.49843	.4984
av. 0.49850	.4994
	.4981
av. check among the	.4983
individual determinations:	.4975
.0008 = $0.17\%$	.4980
	.4989

Factor via silver exceeds that via  
carbonate by  $0.0001 = 0.02\%$

av. check among the  
individual determinations:  
 $.0015 = 0.30\%$

This acid whose factor via silver in Oct., 1927, was found to be 0.4985 was used up in about five months, and in March, 1928, when it was nearly all gone, it was again run with silver and the factor 0.4988 was obtained, a difference of  $0.0003 = 0.06\%$ , despite the many openings and closings of the bottle with consequent loss of water by evaporation. The acid was kept in a 10 liter carboy.

Standardization of a tenth-normal HCl—Weston, March, 1928.

Factor via  $\text{AgNO}_3$

This acid was not run with  $\text{Na}_2\text{CO}_3$

0.10140  
 .10159  
 .10146  
 .10129  
 av. .10144

av. check among the individual determinations,  $0.00016 = 0.16\%$

Like the preceding, this acid was kept in a 10 liter carboy and used off and on for the regular laboratory work, but it lasted a year, and in Feb., 1929, another 9 liter batch was made up to replace it. Before doing so, however, the 970cc. of the old acid whose factor with silver had been found in Mar., 1928, to be 0.10144, was again run with silver Feb. 25, 1929, and an average factor of 0.10164 was obtained, an increase of  $0.00020 = 0.20\%$  during the year, the increase being due presumably to slight losses of water by evaporation.

The three following series were run at Fordham, 1924-1926:

Standardization of a tenth-normal HCl.

Factor via  $\text{AgNO}_3$

Factor via  $\text{Na}_2\text{CO}_3$

0.08968  
 .08974  
 .09003  
 av. 0.08982

0.0893  
 .0898  
 .0888  
 .0900  
 .0892  
 .0893  
 .0883  
 .0883  
 .0906  
 av. 0.0893

Av. check among the individual determinations:  
 $0.00026 = 0.30\%$

Factor via silver exceeds that via carbonate by  $0.00053 = 0.59\%$

av. check among the individual determinations:  $0.0009 = 1.01\%$

As may be seen, the checks among the carbonate determinations are very poor. If I were doing it over I would never give a class in quantitative analysis a tenth-normal acid to standardize by means of sodium carbonate, as I find the end-point with methyl orange in the case of such weak acids very hard to observe. In the case of this particular acid, the students would come to me to ask me to call the end-point for them, only to find that I was none too sure of it myself. I now standardize my tenth-normal acids by the gravimetric method only.

#### Standardization of a half-normal HCl.

Factor via $\text{AgNO}_3$	Factor via $\text{Na}_2\text{CO}_3$
0.49916	0.50030
.49768	.50027
.49886	.49900
	.49932
av. 0.49857	av. 0.49972
av. check among the individual determinations:	av. check among the individual determinations:
.00099 = 0.20%	.00081 = 0.16%

Factor via carbonate exceeds that  
via silver by 0.00115 = 0.23%

#### Standardization of a half-normal HCl.

Factor via $\text{AgNO}_3$	Factor via $\text{Na}_2\text{CO}_3$
0.50160	0.50157
.50221	.50283
.50181	.50444
av. 0.50187	av. 0.50295
av. check among the individual determinations:	av. check among the individual determinations:
.00041 = 0.08%	.00191 = 0.38%

In connection with these figures there is at hand one comparison between a half-normal alkali solution standardized directly with resublimed benzoic acid and the same factor obtained by titration against a standard hydrochloric acid:

Factor via HCl	Factor via $\text{C}_6\text{H}_5\text{COOH}$
0.44650	0.44595
.44690	.44580
.44600	.44501
av. 0.44647	av. 0.44559
av. check among the individual determinations:	av. check among the individual determinations:
0.13%	0.14%



It will be seen that under normal conditions there is a tendency for the factor of hydrochloric acid obtained by titration with sodium carbonate to be slightly larger than that obtained by a gravimetric method. In the case where the reverse was true, the difference in favor of the silver factor was extremely small. The figures with tenth-normal acid are not considered, for the reason given. It is also seen that the checks among the individual determinations are twice as good for the gravimetric method than for the volumetric, which is about what one would expect. The tendency in titrating is to call the end point a little too soon, due probably to the fear that one will not call it soon enough.

The second group of figures records two interesting comparisons with iodine and thiosulphate solutions.

We made up a tenth-normal iodine solution and standardized it against resublimed arsenic trioxide; also a corresponding thiosulphate solution and standardized this against potassium bromate and also resublimed iodine. The two solutions, iodine and thiosulphate, were then titrated directly against one another; the ratio thus obtained was then compared with the ratio of the factors of the corresponding solutions. The results, which, of course, should be the same, show a surprisingly large discrepancy, as will be seen.

Group one—Fordham, 1925

Thiosulphate factor via $\text{KBrO}_3$	Iodine factor via $\text{As}_2\text{O}_3$
0.10390	0.09810
.10446	.10341
.10348	.10324
.10364	.09937
.10418	.10221
	.10309
av. 0.10399	av. 0.10157
same, via I	
0.10399	
.10387	

$$\text{Ratio: } \frac{\text{thiosulphate factor}}{\text{iodine factor}} = \frac{.10397}{.10157} = 1.0236$$

$$\text{Ratio: } \frac{\text{cc. iodine factor}}{\text{cc. thiosulphate}} = 1.0017$$

$$\text{Difference, } 0.0219 = 2.2\%$$

Group two—Weston, 1928

Thiosulphate factor via $\text{KBrO}_3$	Iodine factor via $\text{As}_2\text{O}_3$
0.11320	
.11348	.10054
.11331	.10077
.11309	.09936
av. 0.11327	av. 1.0022
same, via I	
0.11232	
.11272	
.11337	
av. 0.11277	

$$\text{Ratio: } \frac{\text{thiosulphate factor}}{\text{iodine factor}} = \frac{0.11302}{1.10022} = 1.1277$$

$$\text{Ratio: } \frac{\text{cc. iodine}}{\text{cc. thiosulphate}} = 1.1112$$

$$\text{Difference, } 0.0165 = 1.65\%$$

This comparison is suggested as an indoor sport for students of quantitative analysis when they come to the operations of iodimetry. They need not be told, of course, what the object of the procedure is, but it would no doubt serve as a good exercise on the whole process. Perhaps some other readers of the BULLETIN have had some experience of this kind which would be of common interest.

Finally, to "drag in" some more figures obtained in volumetric work, I will cite the results we got at Weston on some of Diack and Smith's analyzed samples.

Sample number	Sodium carbonate	
	% carbonate D. & S.	% carbonate F.W.P.
3	63.66	62.91
5	54.00	54.08
7	45.02	44.90
9	33.92	34.40
	Soluble chloride	
	% chlorine D. & S.	% chlorine F.W.P.
1078	32.02	32.88
1080	37.04	36.45
1082	40.75	40.78
1084	44.84	44.69

The soluble chlorides were run by Volhard's method, the silver chloride being filtered off before titrating with thiocyanate for the end-point. The average discrepancy between our results

and those of the company in 0.75% of the content of sodium carbonate and 0.60% of the chlorine in the soluble chloride. It should be noted that their direction to dry the sample an hour at 100° before analysis does not give sufficient drying in the case of the carbonate—for this we found 2 hours at 120° or one and one-half hours at 140° necessary—ordinary soda ash if allowed to come to equilibrium with the moisture of the air in our laboratory (which was quite damp at the time) picked up no less than 21.5% of its weight in the form of moisture.

On one of their limestones (No. 1001) we obtained the following results:

Determination	Percent by Mr. E. S. Hauber	Percent, D. & S.
MgO	3.76	3.93
CaO	47.98	48.01
R <sub>2</sub> O <sub>3</sub>	0.45	0.40
SiO <sub>2</sub>	5.26	5.00
CO <sub>2</sub>	41.51 (42.87 by Mr. A. G. Carroll)	42.30
Moisture	0.11	("Loss on ignition")
Total	99.07	99.64

Although a teacher of quantitative analysis should be very cautious about using "analyzed samples" for his students unless they have been checked in his own laboratory, the Diack and Smith samples we have met so far seem to have been run with more than usual care.

FRANCIS W. POWER, S.J.,  
Weston College,  
Weston, Mass.

## TEST FOR METHANOL

A sensitive qualitative and quantitative test for methanol is very practical at this day and age. The tests based upon physical constants are not very reliable for small quantities of methanol. The United States Internal Revenue Bureau, after years of experimental research, gives us a sensitive and reliable test.

### Preliminary Remarks

Almost all proposed tests for methanol depend upon the same principle, namely: the oxidation of the methanol present to formaldehyde and the subsequent detection of this product by a suitable reagent. The adequacy of the test implies, first, the efficiency of the oxidation of methanol, and second, the use of a sensitive reagent to detect formaldehyde by producing a compound giving an easily recognized color. For this second reaction a rosaniline-sulfurous acid reagent is used. This conclusion was reached only after many preliminary experiments. As oxidizing agents, hydrogen peroxide, chromic acid, ammonium persulfate, hot copper spiral and potassium permanganate were tried, but all except potassium permanganate were rejected as unsatisfactory. The chromic acid came next in the order of desirable oxidizing agents, but gave a green color when no methanol was present, and this color is undesirable because a violet color produced by small amounts of methanol may be obscured. While oxidation of methanol takes place more rapidly with chromic acid as the oxidizing agent, the test is not so sensitive and hence not so desirable as oxidation with potassium permanganate. The copper spiral was discarded because a positive test was obtained with ethyl alcohol. Hydrogen peroxide apparently has no effect on methanol and was therefore rejected. Ammonium persulfate was not sufficiently sensitive and gave a color for a negative result. Rosaniline was found to be best suited for the detection of formaldehyde because it may be made into a stable, nearly colorless reagent. It is very sensitive and an easily recognized violet color is produced with formaldehyde. Thus after trying various reagents, both for oxidation and for the condensation of the formaldehyde to a color those given below, based upon the work of Chapin, Elvolve and Deniges were found to be best suited.

*Reagents:* 1) Potassium Permanganate. Dissolve 3 grams of potassium permanganate in 100 cc of water previously distilled over potassium permanganate, and containing 15 cc of phosphoric acid. By using water thus distilled, this reagent can be kept for a long time.



2) Oxalic Acid Solution. Dissolve 5 grams of oxalic acid in a solution made by diluting 50 cc of sulfuric acid (1.84) to 100 cc.

3) Modified Schiff's Reagent. Dissolve 0.2 gram of rosaniline, or an equivalent weight of its salt, in 120 cc of hot water, cool, and add this to a solution of 2 grams sodium bisulfite in 20 cc of water. Finally add 2 cc of concentrated hydrochloric acid and dilute the whole to 200 cc.

*Determination:* Place 2 cc of the sample in a test tube and add 1 cc of the potassium permanganate solution. Allow to stand 10 minutes. Then decolorize by adding 1 cc of the oxalic acid solution, followed by 2 cc of the modified Schiff's reagent and mix thoroughly. Allow to stand 20 minutes; if methanol is present a violet color is developed.

No specific percentage of alcohol is recommended, for while the test is somewhat more sensitive in dilute solutions, it is sufficiently sensitive in any concentration for qualitative work.

*Quantitative tests:* Methods based upon physical constants are not applicable to the estimation of small quantities of methanol in alcohol because of the small margin of difference in physical properties. This method, however, by colorimetric comparison, is applicable to the estimation of even the smallest amounts of methanol. Using 5 per cent ethyl alcohol solution, the standards recommended for comparison are: 0.00, 0.01, 0.05, 0.1, 0.2 and 0.4 per cent methanol. It is quite necessary that standard conditions prevail—namely, 1) 5 per cent alcohol; 2) The same kind and amount of reagents; 3) 10 minutes for oxidation with potassium permanganate; 4) uniform temperature; 5) length of time, 20 minutes in making comparisons after the addition of the modified Schiff reagent.

RICHARD B. SCHMITT, S.J.

Loyola College,  
Baltimore, Md.

## A CONFIRMATORY TEST FOR ALUMINUM

In the *Journal of the American Chemical Society* (Vol. 47, page 142) is described a new and very sensitive reagent for Aluminum. This is the ammonium salt of aurin tricarboxylic acid, known under the trade name of Aluminon. In this article they recommend the use of a one-tenth per cent solution but this is not nearly as satisfactory as a one-half per cent solution (suggested in a later issue of the *Journal of Chemical Education* (Vol. III, page 182)), at least in Qualitative Analysis.

We tried Aluminon from the Fales Chemical Co., of New York, which was readily soluble in this amount. As the price (\$6.00 for 10 grams) seemed exorbitant we transferred our patronage to the Eastman Kodak Co., which supplies aurin tricarboxylic acid at a much lower price (\$8.00 for 100 grams).

A new difficulty now arose. The new chemical left a large amount of insoluble matter behind which made us wonder if we had gained anything after all! A little reflection however, showed the difficulty. We had the dye itself and not the ammonium salt of the dye. After some experimenting we found that it was readily soluble in the ordinary ammonium acetate reagent in the laboratory and as this particular solution had to be added in the course of the actual test for Aluminum we decided to combine them in one solution. Thus we obtained the necessary ammonium salt, the acetate buffer and simplified the procedure all at one stroke!

Briefly the test may be stated as follows: 1) Add enough dilute hydrochloric acid to dissolve the aluminum hydroxide, 2) Add the combined solution of ammonium acetate and aurin tricarboxylic acid and let stand a short while for the lake to form, 3) Make alkaline with ammonium carbonate (adding ammonium hydroxide if necessary). A bright red precipitate is the test for the presence of Aluminum. More complete details of the procedure may be found in the *Journal of the American Chemical Society*, Vol. 49, page 2394.

REV. JOHN A. BLATCHFORD, S.J.,  
Holy Cross College,  
Worcester, Mass.

## ACID ANALYSIS—A PROBLEM AND ITS SOLUTION

A time limit of only three hours per week in qualitative analysis including laboratory and lecture has made it impossible for us here to follow a thorough and systematic scheme for acid analysis such as the one in use for the basic analysis.

Under these and similar difficulties a plan has been worked out in the laboratory for two successive years and has proven more successful than had been at first anticipated.

A very brief outline is submitted below to give some general idea of what the scheme is like.

### I. The "Volatile" Acids

$\text{CO}_3$ ; S; CN;  $\text{NO}_3$ ; Ac; I; Br; Cl.

1. THE ORIGINAL SUBSTANCE (Whether solid or solution): Mix a small portion of it with a very small piece of Zn in a  $\frac{3}{4}$ -in. test tube. Fit the test tube with a two-holed stopper carrying a safety tube and delivery tube. Insert the delivery tube into another  $\frac{3}{4}$ -in. test tube containing about 20 cc. of 1-N NaOH (not stronger). Set the apparatus thus ready in a test tube rack for collecting acid vapors in the NaOH.
2. THE NaOH SOLUTION: Fit a short-stem funnel to the safety tube and pour in gradually fresh 5 cc. portions of 6-N  $\text{H}_2\text{SO}_4$  until no more bubbles are given off in the NaOH solution. This solution contains the Na salts of the corresponding acids.
3. THE RESIDUE IN THE GENERATOR-TEST TUBE: Reserve this to test for SCN and  $\text{BO}_3$  below, and also for I and Br as directed.
4. CARBONATE: Take 1 cc. from No. 2 above, test with  $\text{Ca}(\text{OH})_2$  and reserve the mixture.
5. SULPHIDE: The ppt-mixture from No. 4 is acidified with HAc and  $\text{Pb}(\text{Ac})_2$  added to detect S. ( $\text{SO}_3$  and  $\text{S}_2\text{O}_3$  are detected by interpreting the results given with HAc! This is covered in the lecture notes.)
6. CYANIDE: One fresh cc. portion from No. 2 is made alkaline with NaOH, powdered  $\text{FeCl}_2$  and  $\text{FeCl}_3$  added and the mixture is boiled. HCl is added and Prussian Blue shows CN.
7. NITRATE: One fresh cc. portion from No. 2 is made just acid with  $\text{H}_2\text{SO}_4$  and  $\text{Ag}_2\text{SO}_4$  added until precipitation is complete. The precipitated cyanides and halides are rejected and the clear filtrate made strongly alk. with

NaOH, and boiled (to remove any  $\text{NH}_3$ ). Add Al turnings to the hot sol. and test escaping vapors with  $\text{Hg}_2\text{Cl}_2$  on filter paper. Black  $\text{NH}_2\text{HgCl}$  shows  $\text{NH}_3$ ; also shows  $\text{NO}_3$ .

8. ACETATE: Three cc. from No. 2 are made exactly neutral with  $\text{HNO}_3$  and then slight excess  $\text{NH}_4\text{OH}$  with boiling to remove excess  $\text{NH}_3$  and to this neutral sol.  $\text{FeCl}_3$  is added to deep redness! The deep red sol. is diluted with much water and boiled until basic ferric acetate ppts.
9. IODIDE: One fresh cc. from No. 2 is made just acid with  $\text{H}_2\text{SO}_4$ , a drop of  $\text{NaNO}_2$  added and 5 cc. of  $\text{CS}_2$  with shaking. If the purple color does not appear immediately add to this mixture a drop or two of the aqueous layer from the generator and shake vigorously. The iodine has been retained and may even be forced over into the NaOH absorbing test tube by applying careful and vigorous heat.
10. BROMIDE: Remove one cc. of the water layer in No. 9, add fresh  $\text{CS}_2$ , a drop of CONC.  $\text{H}_2\text{SO}_4$  cool and shake. If the orange color fails to appear use some aqueous sol. from the generator as was done with the iodine.
11. CHLORIDE: Remove one cc. of the water layer in No. 10, make acid with  $\text{HNO}_3$ , boil to remove any Br and any cyanides and treat the resulting clear sol. with  $\text{AgNO}_3$  and  $\text{NH}_4\text{OH}$  as usual.

## II. The "Non-Volatile" Acids

$\text{SCN}$ ;  $\text{BO}_3$ ;  $\text{SO}_4$ ;  $\text{CrO}_4$ ; F.

12. THIOCYANATE: Remove one cc. from the upper layer in the generator, make acid with  $\text{HCl}$ , and add a pinch of  $\text{FeCl}_3$ . The usual deep red test.
13. BORATE: Evaporate the residue remaining in the generator to dryness, cool, make a paste with  $\text{CH}_3\text{OH}$ , add a drop of CONC.  $\text{H}_2\text{SO}_4$ , and boil to copious vapors! Ignite the vapors from a piece of glass tubing, etc. The green ester-flame.
14. SULPHATE: Make a cold dil. sol. of the original substance with  $\text{HNO}_3$ , shake and digest a while. Use the clear sol. resulting for the remaining tests. The usual  $\text{BaCl}_2$  test gives the ordinary fine ppt. of  $\text{BaSO}_4$ . Let stand and before examining in cases of colored interfering substances.
15. CHROMATE: Dilute one fresh cc. of the  $\text{HNO}_3$  sol. of the original substance with 5 cc. of water, add  $\text{H}_2\text{O}_2$  and shake. The deep blue perchromic acid test.



16. FLUORIDE: About 3 cc. of the fresh  $\text{HNO}_3$  sol. of the original is made strongly alk. with  $\text{NH}_4\text{OH}$ ,  $\text{CaCl}_2$  is added until precipitation is complete, the ppt. is dried, mixed with silica and pushed into an old piece of glass tubing sealed at one end. One or two drops of CONC.  $\text{H}_2\text{SO}_4$  are poured upon the dry mixture and the  $\text{SiF}_4$  which is generated is caught by a drop of water above the solid layer. Gelatinous  $\text{H}_2\text{SiO}_3$  shows F.

So much for the scheme! It includes only 16 ions.

Among those omitted may be mentioned arsenite, arsenate, chlorate, ferricyanide, ferrocyanide, hypochlorite, nitrite, oxalate, phosphate, sulphite, tartrate, thiosulphate, not to mention many more less common ions.

Some reasons may be given in justification of such omissions. Arsenic has already been taken up in detail in the basic analysis. Whenever any practical need arises direct tests for distinguishing between arsenite and arsenate may be easily found in any reference book. Besides, the interpretation of the various results and observations in the preliminary, basic and acid analyses respectively will always furnish sufficient evidence in ordinary cases. This consideration is developed in the analytic lectures. The same may be said for chlorate, hypochlorite, nitrite, sulphite and thiosulphate, as was indicated above under No. 5.

As regards the remaining organic acids, it may be stated that these have been studied in detail in organic chemistry which the students of analytic chemistry are required to study at the same time. So that tests for these are already familiar to them and analytical considerations were mingled in the organic lectures and quizzes.

The scheme is far from complete and far from systematic. However, when we attempted its application to such substances as the natural waters here, the various soils, simple crystals, tobacco ashes and, on the other hand, to commercial articles like tooth-powders and tooth pastes slightly modified by the instructor, special soaps, baking powders, etc., results were so uniformly successful that we felt sufficiently justified working as we are under our own difficulties in adopting the simple method we have just tried to describe. It might not do at all probably in some other circumstances.

However, the account is merely submitted with the view of recalling a problem which seems to the author to be a common enough one in most of our colleges. What shall we do about it?

FRANCIS D. DOINO, S.J.

Ateneo de Manila, P. I.

## POST-GRADUATE WORK IN CHEMISTRY AT GEORGETOWN UNIVERSITY

At the present time three men are working for their Doctorates in Chemistry and four are preparing for their Masters Degree. The Theses being prepared in partial fulfillment of the requirements for the Doctor of Philosophy degree in Chemistry are as follows:

A Quantitative Determination of Carbon Monoxide in the Blood. Arthur A. Espenschied.

The Synthesis of an Adrenalin-Caffein Compound Protracting the Stimulating Effect of Adrenalin on the heart. Francis P. Wilson.

The Synthesis of an Adrenalin-Ephredrine Compound Protracting the Stimulating Effects of Adrenalin on the Heart. John J. Connolly.

The Theses being prepared in partial fulfillment of the requirements for the Master of Science degree are as follows:

A Quantitative Determination of the Relative Values of Group III Separations in Basis Analysis. Alfred C. Huntsinger.

A Quantitative Evaluation of the Different Methods for the Separation of Tin and Antimony. Thomas J. McGinn.

A Quantitative Evaluation of the Different Methods for the Separation of Aluminum and Zinc. John A. Simpson.

An Evaluation of the Effects of Certain Synthetic and Natural Drugs. John Cavanaugh.

In order to provide working quarters for the above, another small research laboratory, with a capacity for five men, was built in a room adjoining the stockroom.

This year for the first time the Junior B.S. students are being given a full-year course in Organic Chemistry. These same students will be given a course in Physical Chemistry next year, their Senior year. When this class graduates in 1930, it will contain the first students who received a four-year course in Chemistry at Georgetown.

LAWRENCE C. GORMAN,, S.J.,  
Georgetown University,  
Washington, D. C.

## THE NEW BIOLOGY DEPARTMENT AT WOODSTOCK

A dream has been finally realized—a well equipped department of Biology at Woodstock. Occupying the basement of the new Science Building, it consists of a large lecture-room, an ample laboratory, and a stockroom conveniently opening into the laboratory. A generous number of windows insure plenty of light. The lecture-room, equipped with the latest kind of lecture chairs for fifty students, boasts of a Bausch & Lomb Balopticon, a Microprojector of the latest type, which often serves as a general microscope for all at one time. A roll curtain and a daylight screen near the lecture table, with a large slate blackboard along the south wall of the room, complete the Professor's apparatus for visual instruction. Two show cases contain in symmetrical jars a collection of 65 species of fungi, 50 species of mosses, and representatives of all the phyla of plants and animals, excluding the mammals and birds. Another case displays nine Denoyer-Geppert human models. Along the north and west walls are lab-tables for six students. Behind the lecture table against the east wall stands a large soapstone sink.

The laboratory easily accommodates at present 20 students. The lab-tables, made by Wiese, are of wood, with black tops. The lab equipment consists of a dozen latest model microscopes, sixteen dissecting microscopes, one medium-size Precision Autoclave, a small Lietz Sterilizer, a large Incubator, a Rotary Microtome. Each laboratory student is equipped with a dissecting set, a dissecting pan and a box of slides and cover glasses. The walls of the two rooms display eight Ward models, five Jung-Koch plant charts, three Frohse and one Johnston anatomical charts, three Jewell models of Mitosis in the *Ascaris*, ten Jewell models of the stages of growth of the frog-egg can be found in the case of human models.

In the laboratory one show-case houses the microscopes, another the chemicals, skeletons of the cat, frog, fish, bird, dried specimens of fungi, life-history of the silkworm, etc., and a fair reference library for those interested in adding to our Museum collection. Representatives of most of the fungi and mosses around Woodstock are now classified and encased in the lecture room show-cases. Last but not least, the Woodstock Biology Department boasts of a new Bausch & Lomb Micro-Camera, by means of which the ambitious student can prepare slides for future lectures in the colleges. Later we expect to write of the contents of our Museum collection.

H. L. FREATMAN, S.J.,  
Woodstock College,  
Woodstock, Md.



## “EVOLUTION”—ITS EARLY USE IN ITS DERIVATIVE

Though science generally is greatly indebted to the Greek and Latin tongues for much of its nomenclature, this is strikingly true of the science of biology. Not a few texts emphasize this in appending to the texts these derivatives. Notably are the German scholars fond of so doing. Accordingly, as is to be expected, where reference is made to the word evolution, the term is indicated as derived from *evolvere* or *evolutio*. I need not indicate that the Romans never used the word in its present biological sense. More than this, its occurrence in classical Latin is seldom, and so in post-Augustan literature. The meaning attached to the word by Cicero is clear from the following passage read in his “*De Legibus*”: *Quid historia, cognitioque rerum, quid poetarum evolutio*. Du Cange in his “*Glossarium Mediae et Infimae Latinitatis*” has no reference to an added significance of the word. Yet in a letter written by Robert Kilwardby, O.P., who from 1248-1261, was professor at Oxford, from 1261-1272 was provincial of his order, afterwards to become Archbishop of Canterbury, one finds: “*Item Augustinus ponit duo genera divinarum operationum, scilicet opera conditionis et administrationis, vocans opera sex primorum dierum conditionis et opera temporalis explicationis per secula administrationem, dicens, quod simul creata sunt universa corporalia in se vel in causis suis originalibus. Evolutio illarum rationum et explicatio per res actuales fit per secula. Qui etiam vult, quod, sicut ab originalibus rationibus forme (sic) producuntur per generationem, sic in eas reducuntur per corruptionem. Et istud idem, ni fallar, est idem intellectum Aristotelis et vera philosophia in naturalibus.*”

Again further on in the same letter we read: “*Item, si non sunt originales (sic) potentie (sic) utcunque active in materia naturali, tunc falsum est quidquid ponit Augustinus de rationibus sive originibus fiendorum. Item tunc falsum est, quod ponit, omnia corporalia simul esse creata in operibus conditionis, que (sic) postmodum opere nature (sic) *evoluntur* per opera administrationis.*”

“*Intelligenda est igitur materia naturalis prima, non sicut quedam (sic) proxima inchoatio, nichil (sic) forme (sic) habens nec aliquid actualitatis aut compositionis, sed est quid dimensiones habens corporeas, impregnatum originalibus rationibus sive potentiis, ex quibus producendi sunt actus omnium specificorum corporum sive simplicium sive compositorum sive mixtorum per operationem nature (sic). Que (sic) enim tractu temporis disponuntur, ut fiant specifica corpora, operatione nature (sic) fiunt. Que (sic) autem subito iussu Verbi eterni ex-*



eunt, creantur, sicut prima elementa et prima elementata prodiisse cognoscimus nos, qui fidem habemus, quod mundus non fuit eternus nec motus."

"Denique verba ultima propositi versus vestri: *non enim potentia active in materia intelligitur sine aliqua forma, licet confusa et incompleta* sonare videntur veritatem, si recte intelligantur. Noveritis igitur, quod prohibita est hec (sic) assertio: potentia active ad formam non est in materia, quia non potest referri verbum nisi ad materiam naturalem. Potentia enim active materie (sic) precedentis actum in solis naturalibus est."

The meaning of "evolutio" and "evolvuntur" is in no wise equivocal. The occasion of the writing of this letter was a visit made by Kilwardby to the University of Oxford in 1276 with the express purpose of ascertaining errors being taught there. There seems some dispute as to whom the letter was directed. The more likely opinion seems to be that it was addressed to one Petrus de Conflato.

In the Archive für Litteratur und Kirchen Geschichte, by Denifle and Ehrle, the citation appears under the caption of: "Ueber die Einheit der Lebensform in Menschen." We have here a very early record of the word "Evolution" in its derivative. Possibly the first.

FRANCIS A. TONDORF, S.J.,  
Georgetown University,  
Washington, D. C.

## BIOLOGY COURSES

Our last Biology Sectional Meeting was an interesting one in many ways. No doubt the discussion as to which biology courses should be offered in accordance with the B.S. schedule was the most important bit of work taken up at that meeting. The discussion had one drawback, however, which was that too few of the members present entered into it. With a view to keeping this fruitful discussion going during the long period between our short and infrequent meetings, I am making the following observations.

Fr. Hull in his admirable book, "A Practical Philosophy of Life," proposes a panacea for all human differences of opinion; it is the simple, extremely practical method of "writing it down." I suggest that we follow this method in our discussion. If each member wrote down his opinion as to which courses should be offered, which of obligation and which elective, together with reasons why one course should be offered in preference to another and why one should be obligatory in a certain course another elective, and if these lists of courses and reasons were sent to the BULLETIN, all the members would have an opportunity to study and compare them, and the discussion if any would be much simplified at the next meeting.

### A Proposed Outline of Biology Courses

The Province B.S. Schedule lists the Pre-Med Course as B.S. I., and the B.S. course with Biology as a major as B.S. II. This terminology will be followed in this outline.

First of all, why have a standardized schedule of biology courses at all, when in many cases it would be years before it could all be put in practice? We should have it for the following reasons. 1. The most important part of such a schedule, i.e., the first two years containing most of the obligatory courses could be put in practice immediately in all our colleges. Then we would all be giving not only the same courses, but the ones the biologists themselves decided were the best and most suited to our purpose. Furthermore, from a number of biologists teaching the same courses it is probable we would have another need fulfilled, namely, province biology textbooks. 2. The third year of biology with its 14 possible credits would probably consist largely of electives and could be added when possible, the selection of which electives would be offered out of an approved list remaining entirely with the teacher. Thus a Standardized Schedule of Biology Courses, although it would in many cases remain ideal for many years to come, would, however, immediately have its beneficial effect on the biology we now have and would be a constant stimulation towards expansion.

<i>Course</i>	<i>Credits</i>	<i>Obligatory or Elective</i>
(A) General Biology	8	Obl. B.S. I. & B.S. II
(B) Mammalian Anatomy	4	Obl. B.S. I. & B.S. II
(C) Fundamental Embryology	4	Obl. B.S. I
(D) Histology	4	Elective
(E) Bacteriology	4	"
(F) Genetics	4	"
(G) Plant Physiology	4	"
(H) Protozoology	4	"
(I) Cytology	4	"
(J) Microtechnique	4	"
(K) Neurology and Osteology	4	"

#### Reasons for the Above Courses

(A) and (B)—A discussion arose at our last meeting as regards the matter for the first two years of biology. Some held that a year should be given to Invertebrate Zoology and the second year to Comparative Vertebrate Anatomy; others held that the first year should be General Biology and the second year or half year be given to Mammalian Anatomy. I shall give some reasons for the second opinion in the hope that they will be supplemented by others from men of more experience. Let me first briefly tell what Course A would comprehend: three months of botany, including such principles as the Cell Doctrine, photosynthesis, and plant reproduction, illustrated by the form study of examples of the four plant phyla. The rest of the year would be devoted to zoology, consisting of the form study of such examples of the animal phyla as: amoeba, etc., hydra, rotifers, earthworm, starfish, crayfish, perch and frog, the last named very thoroughly on large specimens, accompanied by lectures on the physiological systems of vertebrates; the other forms also illustrating principles as irritability, reproduction, regeneration, etc. Lectures on heredity and evolution are also given. Such a course has been given for the last three years at Loyola. Course B consists of two lab. periods a week for a half year. A thorough dissection of the different organic systems of the cat is made. I think Course A as outlined is better than a year of Invertebrate Zoology for the following reasons: (I) It gives the fundamental principles of plant life which are essential to a proper understanding of biology, whereas Invertebrate Zoology does not, and anyone taking the latter course would logically have to take a separate supplementary course in botany which very few would do. I furthermore think giving three months to botany in the General Biology course is better than giving a half year to botany and a half year to zoology, since zoology with its more numerous significant forms and its more important biological principles logically demands more time than botany.

(II) The inclusion of the study of two vertebrates, perch



and frog (the latter thoroughly), provides an opportunity to give more adequate treatment to such physiological processes as digestion, circulation, etc., than is possible if invertebrates are studied alone. In short, the General Biology Course is a unified whole and gives a complete picture of life principles and processes, Invertebrate Zoology requires previous and subsequent courses before this end is attained.

(III) I think that a course in Mammalian Anatomy (cat) is better than a course in Comparative Vertebrate Anatomy for the following reasons: by making a thorough and detailed study of the anatomy of one large form (cat), a more thorough knowledge is gained of the structures by which the various physiological processes are carried on than by a less detailed study of several vertebrate forms. I think that teaching the student the "scientific method" of thoroughness and accuracy in observation is as much an aim of college biology as the mere collection of facts, and that this thoroughness and accuracy is better attained by the intensive study of one complicated vertebrate than from the less intensive study of several vertebrate forms. Let me give a concrete example: after finishing the course in General Biology and easily winning the biology medal for the year, one of my students was so interested that he spent the summer at an internationally known university here taking a course in Comparative Vertebrate Anatomy (including the cat). He did so well in the course that he received ten credits instead of the eight usually given for this course; in September he returned to Loyola and began Mammalian Anatomy, and I soon found out that while he might have known the hypothetical development of the spinal column from the notochord of Amphioxus and through the cartilaginous skeleton of the Elasmobranch, he certainly did not know the muscles of the cat! In an effort to find out the aim and purpose of the Comparative Vertebrate Anatomy course, I thought I would be perfectly fair and go to the proponents of this course for information. I accordingly picked up "A Laboratory Manual for Comparative Vertebrate Anatomy," by Hyman, and on page three of this book I found the following illuminating statement: "The whole aim of comparative anatomy is to discover what structures are homologous and to trace the modifications of such homologous structures in the course of evolution." Is this aim sufficiently in accord with our aim and purpose to justify our setting a whole year aside for its attainment? For the above mentioned reasons and for others which space and time forbid my including here, I think that Course A and B as outlined should be obligatory for B.S. I and B.S. II. Reasons for electives will follow.

CHARLES A. BERGER, S.J.,  
Loyola College, Baltimore, Md.



## AN ANOMALY IN COCOON BUILDING

We are told that the function of a cocoon is to protect the chrysalis from the rigors of winter, the cold and moisture, the sudden changes in temperature. A profound miracle is being enacted in that mummy cases, complex and delicate chemical processes are reshaping from a crawling larva a winged being of beauty and infinite complexity. No precaution to guard against the vicissitudes of winter can be too great. So we understand and applaud the insect's instinct to shroud itself in a warm, waterproof air-insulated cocoon. This much I knew when one time late in August a friend of mine asked me to secure for him some cocoons of the Ant-lion. An easy assignment, I thought. My books, and I looked at a good many of them, told me nothing about the time when the cocoon is spun. But I knew several haunts of the ant-lion. I would wait until about December and then a few pokes with a stick in the sand of the colony and there would be the cocoons. So December 19th I fared forth to do my poking but I found the funnels apparently all set for operation. These funnels keep their form a long time I thought for I felt confident that instead of a larva there would be a cocoon at the base of them. But my stick disclosed only larvae and only healthy ones at that. I was surprised and decided that I had come too early even though we had had some cold weather. You see I knew cocoons were used as a winter protection. To make double sure of success I did not visit the colony until the following February 16th. I saw no funnels but my stick brought from the sand as large and fat and lively an ant-lion as I have ever seen. Three more were shortly uncovered. Here the only signs of life were a twitching of a leg or a slight head movement. But they were only playing possum. I put all three on their backs and they played dead perfectly, two of them for ten minutes while the third meant to keep it up longer. I blew on him and he hopped up onto his legs like a flash. Where were the cocoons?

We had had very cold weather. Several times the temperature had dropped to six degrees above and most of the time it had been below freezing. There was no covering of snow to temper the cold, the sand of the colony was perfectly dry. I had begun to suspect that these ant-lion had a two-year larval period. Consulting my books I found one that verified my suspicion. These then must be larvae in their first year of grubhood. But granted that these were only baby larvae it didn't seem likely that all the larvae of the several colonies I knew were first year larvae. Some ought to be in their second year and these should have spun their cocoons long ago. There ought, therefore, to be some cocoons in the colonies and I decided to find them. But

it was only on March 3rd that I again visited my friends. Then all I could find was five funnels newly constructed since February 16th. A wide-awake lion was at the bottom of each. My job of finding cocoons was beginning to look hopeless.

I tried once more on March 26th but my visit to the colony showed me just twice as many funnels, 10 in all. It seemed to me as that the ant-lions were trying to give me the laugh. And right then and there I determined that I would get at the bottom of this mystery, for I couldn't get myself to believe that there were no second year larvae here hiding in their cocoons. I dug long and systematically in the neighborhood of these funnels and had my first bit of success. I uncovered several old cocoons each with a depressed hole. They were about  $\frac{1}{2}$  to  $\frac{3}{4}$  inch below the surface. But greater success was about to crown my persistence. My stick brought up a very large ant-lion with a net of silk clinging to him. At least here was a clue. It might mean that the larvae were about to spin their cocoons. This was in the morning. In the afternoon I dug up another larvae—there was no sign of a funnel as there had been none in the previous case—and this larvae was completely enclosed in a bag of silk. The clue was proving true. There was no shape or consistency to the bag so I judged it to be a cocoon in the making. It seemed that I had solved the mystery of when the cocoon is built.

To make sure I took both of these larvae indoors and put them in a box of sand after freeing them of their silk shrouds. For four days they played mole burrowing under the surface and my hopes waned. I had interrupted them in their spinning if spinning they had been and they couldn't begin over.

On a chance I searched this sand box on April 5th and found what I had been looking for for six months, two perfect cocoons all dotted over with small pebbles and bits of stone as though these had been used as a basis on which to build the silk skeleton. I did not know there was such stones in the sand and it almost looks as though the ant-lion had first collected them and placed them in position.

Now for the hatching. One of these cocoons hatched during the night of May 10th, the other on the night of May 12th. By this time I had collected several fresh cocoons, and of these one hatched on May 11th, another May 14th, another during the day of May 15th. Two newly hatched cocoons were found on May 12th. Here then was the solution of when the cocoon is spun and when the imago hatches. Our cocoon hunt has revealed the following facts: Ant-lions live through at least two winters in the larval stage, spin their cocoons about March 25th of the second year and emerge as imagos about May 10th.

One point remains to be noted. Why should the larvae go to all the trouble of spinning a thick warm cocoon during the last week of March and in the vicinity of Washington when the Japanese cherry trees are getting ready to bloom! Winter has gone and warm spring is here. No need to protect against the cold and moisture and changes of temperature. The only answer that suggests itself is that the cocoon here serves as a protection against enemies who would find the unprotected pupa an easy prey. While in the larval state the only part of its body that is ever exposed are the curved mandibles, needle-sharp sucking tubes. The only approach to them is down a steep unstable incline that will precipitate any invader in a heap into those waiting jaws. But as a pupa the ant-lion might be in danger, at least so it seemed to be with my colonies. Because occupying the same site as the ant-lion is a species of small ant very active at this time of the year, and they might make short shrift of an unprotected pupa. How well the cocoon protects the pupa would seem evidenced by the fact that no parasite has ever been reported for the ant-lion.

JOHN A. FRISCH, S.J.  
Georgetown University,  
Washington, D. C.



## STUDENTS' HEALTH PROBLEM

The problem of students' health has been interesting the authorities in most of the non-Catholic schools and colleges, both public and private, for so many years, that the extremely small amount of attention as yet given to the subject in many of our Catholic schools is arousing considerable comment. The Catholic child, in learning the answer to the question, "Of which must we take more care, our body or our soul?" is apparently receiving an impression that the body is to be more or less neglected.

In the days when life was lived more calmly, and a good deal of muscular exertion in the open air was a matter of necessity for most people, whether students or not, the subject may not have been of such importance. But nowadays, when individual activity and healthful reaction to discomfort have become reduced to a minimum, it has almost universally been found advisable to institute special measures for keeping the bodily standard of health up to the highest level of efficiency.

The city of Boston ranks rather high among the cities of the country for the care bestowed on the health of students in the schools; and yet a somewhat recent survey disclosed surprising conditions. In some places, there were no facilities for the simple and necessary operation of washing the hands; in some, only cold water was provided; or where hot water was to be had, there was no soap; or if both the water and soap were supplied, no towels could be found. In some school rooms, the temperature was above 80 degrees; in others, ventilation was deficient; in still others, the lighting was poor; elsewhere, sanitary conditions were far from satisfactory. The committee appointed for the purpose, reported their observations to the authorities, and as a result, the abuses were in most cases corrected. Of course, all the facts had long been known to the various teachers employed in those particular places, but no remedy was supplied until an efficient committee got to work.

Today in a great many schools, physical examinations are obligatory for all the pupils; and those are not merely routine, but sufficiently accurate and exact to elicit the real conditions about the entire bodily structure of each individual. In some schools, this takes place every month; in others, two or three times a year. In all the larger universities, there is provided an infirmary-suite, where each student must report at stated times each year, and where a sufficiently large staff awaits him, to ensure a successful outcome to his visit. His diet is investigated, his habits are learned, and when he is not living at home, his rooms are visited, as well as the places where he takes his meals, in order that all possible sources of physical debility



may be discovered, and if needed, corrected. In addition to this, lectures are given on various subjects pertaining to health, and these have not only succeeded in eradicating erroneous notions about the human body, but are eliciting enquiries concerning private and public health, which are helpful to individual and social body alike.

Should we do anything more in our schools, preparatory, as well as college, than we are doing at present in this regard? Is the Prefect of Health in our houses qualified to handle such a matter? Can the Prefect of Discipline reasonably be expected to add the subject of student-health to his already overburdened schedule? Many of the physicians who are serving on the Student Health Boards in the large universities have complained that difficulty in arousing interest in a normal state of health is never found among the students, but is frequently found among members of the faculty, who because they have survived their own youthful ignorance and its consequences, are inclined to fancy that any attention bestowed on health among students today will result in nothing more serious than hypochondriasis. What do you think?

F. J. DORE, S.J.  
Boston College,  
Boston, Mass.

## PROGRESS IN THE WORK OF OCCULTATION REDUCTION

The readers of the article by Father F. W. Sohon in the March number of the BULLETIN, entitled "Reduction of an Occultation," may be interested in learning what has been done in this line already. "The Astronomical Journal" for May 8, 1929, carries an article by Professor Ernest W. Brown (in charge of the reduction work), and Dirk Brouwer, of the Yale University Observatory, under the title "Compilation and Discussion of 418 Occultations Observed in 1927."

Table I. of the above mentioned article contains the names of the Observatories contributing observations for this purpose, and the number of observations sent in by each. The list is headed by the Union Observatory of Johannesburg, South Africa, with 114 reduced observations. Georgetown College Observatory is second with 32 reduced observations, while the United States Naval Observatory is third with 31 observations not reduced. In making comparisons between these figures, however, it should be noted that the South African Observatory had the observation of occultations as a part of its regular program of work during the whole year, and that a number of the stars occulted were predicted privately, since their magnitudes were below the limits set for inclusion in the Nautical Almanac. Furthermore, some of the occultations were observed by as many as five or six observers, each observation being reduced separately. At Georgetown, on the other hand, no concerted effort was made to obtain observations of this kind until after the middle of the year, with the result that only six of the thirty-two stars were observed during the first six months. No serious attempt was made to predict the occultations of stars not included in the list of the American Ephemeris until the beginning of 1928. Only one observation of each star was reduced.

The second table gives the results of those observations which had not been elsewhere published, among them being those of the Naval Observatory, which were reduced by members of the American Association of Variable Star Observers. A comparison of these results of the Naval Observatory observations with those of Georgetown shows that twelve stars were observed in common at the two observatories, and, of these, ten agree within  $0''.2$  in the value of  $\sigma' - \sigma$  (see the March number of the BULLETIN, page 18).

The difference in the longitude of the Moon as determined from 30 bright limb observations and from 388 dark limb observations is found to be  $+ 1''.5$ . A number of solutions are

found 1) using all the data sent in, 2) neglecting the bright limb observations, 3) neglecting the bright limb observations and those for which the residual  $\sigma'-\sigma$  is greater than  $2.''9$ , and 4) neglecting the bright limb observations and those for which the  $\sin(x-p)$  is greater than  $.70$ . The best solution is found to be that in which a bright limb observation or one with a residual over  $2.''9$  is given half-weight. From this method the tabular correction to the longitude of the moon is found to be  $+ 6.''92 \pm 0.''0.6$ , taking into account the  $7.''00$  already added to the mean longitude by means of steps 21—26, (I. c., page 23).

In a note in the same issue of the "Astronomical Journal," Professor Brown states that from the preliminary discussion of the occultations observed during 1928, the mean error of the tables is very close to  $6.''4$ , and that during the year 1929, it is expected to be close to  $6.''0$ . This means that the corrections  $.212\Delta\alpha$  and  $.212\Delta\delta$ , (steps 22 and 25, I. c., page 23), are to be replaced by the closer approximations,  $.182\Delta\alpha$  and  $.182\Delta\delta$

THOMAS D. BARRY, S.J.,

Weston College,

Weston, Mass.

## THE PERFECT MAGIC SQUARE

The purpose of the present series of papers is to present some original investigations concerning a particular type of magic square. It will be seen that the 49 cell square is missing from the discussion, and as I have no prospect of completing the program an opportunity is left for some one to pick up the work where I left off. It is partly with this hope that the matter has been submitted to the BULLETIN.

A Magic Square is an arrangement of  $n^2$  integers in the form of a square of  $n$  rows and  $n$  columns so that the sum of the integers in each column, row and diagonal will come out the same. The integers should be the arithmetical progression 1, 2, etc., up to  $n^2$ , though this condition is sometimes sacrificed. In this article the condition will be insisted upon. A Perfect Magic Square is a particular case of magic square in which in addition to the conditions just enumerated it is further required that each pair of numbers diametrically opposite and equally distant from the center shall always add up to twice the average of all the numbers. Thus if  $n$  is the number of columns or rows,  $n^2$  is the number of cells and  $\frac{1}{2}(1+n^2)$  is the average of all the numbers. The sum of a row or column must then be  $\frac{1}{2}n(1+n^2)$  and the sum of a pair of diametrically opposite numbers must be  $1+n^2$ . In an odd square the average number is an integer, and must occupy the central cell. The following is a perfect magic square having 16 cells:

1	15	14	4
12	6	7	9
8	10	11	5
13	3	2	16

The sum of each column and row is easily seen to be 34, while pairs of cells diametrically opposite and equally distant from the center add to 17. For an example of a magic square that is not perfect, take the 36 cell square:



36	32	3	4	5	31
7	29	27	10	26	12
19	14	22	21	17	18
13	23	16	15	20	24
30	11	9	28	8	25
6	2	34	33	35	1

whose columns, rows and diagonals add correctly to 115, but in which pairs that are diametrically opposite and equally distant from the center do not always add to 37. In the discussion of the perfect magic square no attention is paid to the diagonals, as their proper summation is already implied in the other conditions.

If  $n=1$  we get the one cell square having one row and one column containing the number 1 and this is a perfect magic square. If  $n=2$  the sum of a column or row must be 5. There would be but two members to each row, so that given any number A, its companion in the same column or row must be  $5-A$ . But if  $5-A$  is in the same row it cannot be in the same column as A. Hence there is no four cell square, perfect or imperfect. The discussion therefore begins with the nine cell square.

### The Nine Cell Square

The square is constructed from the following data:

Number of rows	3
Number of cells	9
Average number	5
Sum of a column or row	15
Sum of two opposite numbers	10

In the discussion of this square we first prove that the corners cannot be odd, then investigate the ways of putting even numbers in the corners, and finally consider whether or not these ways really lead to different squares. We then capitalize our results for use in connection with more involved squares.

Let us suppose one corner to be odd. Two opposite numbers must add to 10, an even number, hence opposite numbers must be either both even or both odd. Hence if one corner is odd, the

opposite corner is also odd. Since the sum of a row, 15, is odd, each column and row must contain either three odd numbers or one odd number and two even numbers. Now with 5 in the central cell and a pair of odd numbers in opposite corners, we have already an odd number in each column and in each row, with two odd numbers left over. In order to get an odd total, then, any row or column that gets one of these extra odd numbers must also get the other. But this requires that they go simultaneously in the same column and in the same row, which is impossible. It follows that the corner cells of the nine cell square must contain even numbers.

There are 8 ways of putting even numbers in the corners. There are four even numbers, and having selected one for the upper left-hand corner, the one in the lower right is automatically determined, leaving a choice of two for the upper right-hand corner. There are accordingly eight arrangements of numbers that satisfy the conditions laid down for a perfect nine cell magic square.

The eight solutions thus obtained are not independent. If we select 2 for the upper left, then we may put 4 in the upper right, with 6 opposite in the lower left, or 6 in the upper right and 4 in the lower left. Either solution is obtained from the other by revolving the square about the diagonal that passes through the upper left and lower right-hand corners. One of these solutions will be called a D transformation of the other. Now 2 must always occupy some corner, so that all the solutions will be obtained by rotating these two solutions through successive angles of  $90^\circ$ . Let R represent a rotation of the square counterclockwise through an angle of  $90^\circ$ , and let O represent the first solution. Our eight solutions may then be written

O, O-R, O-R-R, O-R-R-R, O-D, O-D-R, O-D-R-R, O-D-R-R-R  
and these are really the same solution in different positions.

### Superficial Transformations

It is quite clear that for all squares except the one cell square we must expect these eight positions of every solution, and it is therefore worth while to devise a notation to represent these relations.

A transformation is (active spectata) a process by which we obtain one solution of a given set of conditions from an already existing solution.

A superficial transformation is a transformation that handles the square as one piece.

A transformation (passive spectata) is the result obtained by applying a transformation (active spectata) to an original solution. There is nothing to be gained by inventing separate nota-

tions for these two meanings of a transformation, and so the symbols will signify either the operation or its result as determined by the context.

A superficial rotation is obtained by rotating the square in its own plane about its center. There are four of these:

$R$  = a  $90^\circ$  turn counterclockwise.

$C = R^2 = R \cdot R$  = a  $180^\circ$  turn counterclockwise.

$R^3 = R \cdot R \cdot R = R^3$  = a  $270^\circ$  turn counterclockwise.

$O = R^4$  = the original position of the square.

The remaining four are called superficial reflections, and are obtained by turning the square over about an axis lying in its own plane.

$V$  = reflection in a vertical axis.

$H$  = reflection in a horizontal axis.

$D$  = reflection in the axis through the upper left and lower right-hand corners.

$S$  = reflection in the axis through the lower left and upper right-hand corners.

The following properties may be verified experimentally:

- (1)  $C = R^2 = DS = SD = HV = VH$
- (2)  $CR = RC, C^2 = O, CR^3 = R^3C, CH = HC, CV = VC, \text{ etc.}$
- (3)  $CH = V, CV = H, CD = S, CS = D$
- (4)  $RV = S = VR^3 = HR = R^3H$   
 $RS = H = SR^3 = DR = R^3D$   
 $RH = D = HR^3 = VR = R^3V$   
 $RD = V = DR^3 = SR = R^3S$
- (5)  $R = VD = DH = HS = SV$   
 $R^3 = DV = HD = HS = VS$

The eight solutions of the nine cell square appear as follows:

2	7	6	6	1	8	8	1	6	6	7	2
9	5	1	7	5	3	3	5	7	1	5	9
4	3	8	2	9	4	4	9	2	8	3	4
	O			R			S			V	
4	9	2	8	3	4	4	3	8	2	9	4
3	5	7	1	5	9	9	5	1	7	5	3
8	1	6	6	7	2	2	7	6	6	1	8
	$R^3$			C			H			D	

these being the eight superficial transformations of the same magic square.

F. W. SOHON, S.J.,  
 Georgetown University,  
 Washington, D. C.

## NOTES AND NOTICES

Two new horizontal seismographs after the original pattern of Fuerst Galitzin have just been installed in a specially constructed chamber in the crypt of the Dahlgren Chapel of the University. This equipment was made possible through a very substantial gift made the director of the observatory by the Providence Chapter of the Georgetown University Alumni Association. These instruments were assembled by the Cambridge Instrument Co. of England, with offices also at Ossining, New York. Some four years ago there had been placed in the cave beneath the quadrangle a vertical seismograph of Galitzin, constructed by this same firm. The functionings of this machine prompted several modifications in the new instruments. These are the lamp house, the lamp itself, and particularly the armature. Repeated short circuitings in the armature, which consists of four coils in series, was at first linked up with basic cupric acetate deposits, (verdi-gris), through the coils of the armature. At first it was suspicioned that this was occasioned through the use of acid solder in connecting up the four coils. Accordingly, a new field was assembled in which a guaranteed acid-free solder was used. But in time the difficulty recurred. A very careful research into this matter by the Bureau of Standards led to the conviction that the interaction of the celluloid container of the coils on the coils was to be held responsible for the deposition. Accordingly, the new armatures have been incapsulated in bakelite and it is hoped that this difficulty has now been efficiently eliminated. Persistent tests made with electric bulbs for the illumination of the galvanometer mirror led to the adoption of the Street Lighting Service Lamp, marketed by the General Electric Company. This lamp is a single filament lamp running on 12 volts, 5.5 amperes, yielding an output of 1000 lumens (100 candlepower). The lamp requiring the special Mogul socket; a specially constructed lamp house becomes indispensable. It is worthy of notice that as this lamp is still used in many of our large cities it is easily procurable. As the drums which carry the photographic sheets are spring-driven, no little annoyance has been experienced in the past in reading the grams because of the varying time intervals. Negotiations are now on to drive these by electric motors, such as will insure a constant rate of travel. The present equipment places Georgetown Observatory in a class all its own. Besides it stands in open competition with the best equipped observatories of the world. Besides Georgetown is fortunate at this time in acquiring the able assistance of Mr. Jose Raphael



Goberna, S.J., who is in this country for the purpose of preparing himself to take over the directorship of our observatory in Havana.

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A very interesting and at the same time almost indispensable booklet containing much valuable information for those who went to the Philippine Islands to observe the eclipse of May 9, was published by Rev. Father Selga, S.J., Director of the Manila Observatory.

About three years ago, Fr. Selga presented before the Pan-Pacific Congress, held at Tokyo, a short paper on the Astronomical and meteorological conditions that would be likely to prevail at the time of the eclipse. This paper was published in the *Popular Astronomy* for April, 1927. Shortly after the publication of the article, two requests were received for more meteorological information; the first from the Eclipse Section of the International Astronomical Union through the President of Swarthmore College, the second from the superintendent of the United States Naval Observatory at Washington, D. C. The booklet was published in anticipation of further such requests.

A mere glance at the publication will immediately assure one that the author left no stone unturned to supply all necessary data and certainly attained the end he had in view. Besides a thorough presentation of Astronomical and Meteorological conditions "there is another kind of information" to quote from the booklet, "that cannot be gathered in the office, but must be obtained in the field, the accessibility of the place, its hygienic conditions and housing facilities are most important factors in the selection of the site. Some parties will want electric power for running small motors; others may desire to be in close proximity to machine shops. To some parties it may be immaterial to have the station at sea level; others may require a hilly station overlooking the surrounding country. By May the fields of certain towns are green with sugar cane plantations; in other towns the fields lie fallow waiting for the rains of June to be planted with rice. It is evident that the owner of the first class of fields will be loath to part with a valuable piece of land for observation purposes, while the owner of the second class of fields will most unwillingly to accommodate observatory parties in the most suitable sectors of his idle farm."

To gain this kind of information which would enable astronomers to formulate plans, Fr. Selga during the Christmas season of 1927 went over all the towns between Iloilo in the province of Iloilo and San Jose de Buenavista in the province of Antique inspecting places and looking for sites that would be

of advantage in observing the eclipse. The results of his labors are summarized in the third part of the booklet under "Living Conditions," the first two parts being concerned with Astronomical and Meteorological Conditions.

The booklet contains a fund of information, briefly and clearly presented, anyone can readily see that eclipse expeditions were beneficial beyond expression and owe to Fr. Selga deep debt of gratitude.

It might be of interest to note that the Jesuit Fathers of the Philippines have always taken great interest in matters Astronomical and Meteorological. Three Ateneo Professors were the only scientists whose labors during the total eclipse of 1868 were crowned with success. Their drawings, photographs, and other observations were published at the time in the leading scientific review of Italy, they were republished by the Jesuit Astronomer Secchi in his famous work "The Sun," and have since reappeared in every standard work treating of Solar Eclipses.

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The Second Annual meeting of the Associated Clubs of Catholic Colleges was held at Holy Cross April 3-5. The following colleges were represented:

- Boston College, Boston, Mass.
- University of Detroit, Detroit, Mich.
- Fordham University, New York, N. Y.
- Georgetown University, Washington, D. C.
- Holy Cross College, Worcester, Mass.
- Manhattan College, New York, N. Y.
- Marquette University, Milwaukee, Wis.
- Notre Dame University, Notre Dame, Ind.
- St. Bonaventure College, St. Bonaventure, N. Y.
- St. Francis College, Brooklyn, N. Y.
- St. Francis College, Loretto, Pa.
- St. Mary's College, St. Mary's, Kansas.
- St. John's College, Brooklyn, N. Y.
- St. Vincent College, Latrobe, Pa.
- Seton Hall College, South Orange, N. J.

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Shortly after the publication of the last issue of this BULLETIN we received a program of the second semester activities of the Chemists' Club of Holy Cross College, Worcester, Mass. A glance at the subjects treated will assure one that "Activities" is the proper designation for the work that is being done in the Chemical Department at Holy Cross College.

Rate of Bromination of Organic Compounds.  
Surface Hardening of Steel by Nitrogen.  
The Walden Inversion.  
Direct Synthetic Ammonia Processes.  
The Preparation of Chloride Free Colloidal Ferric Oxide  
from Ferric Chloride.  
Recent advances in Iron Determinations.  
Positive Methods for the Determination of Oxygen.  
The Value of Analysis.  
The Chemistry of Leather Formation.  
Historical Introduction and Radioactive Considerations.  
Electrons and Positive Ray Analysis.  
The Nucleus and X-Ray Spectra.  
Extranuclear Electrons. Lewis-Langmuir and Bohr Theories.  
Bohr Theory and the Arrangement of the Elements in the  
Periodic System.  
Current Views on Atomic Structure and Valence.  
Chemistry of Enzymes and Enzymatic Reactions.  
Distribution of Enzymes.  
Esterases.  
Proteases and Peptidases.  
Carbohydrases.  
Practical Applications of Enzymem Activity.

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The leading article in the April issue of *The Ecclesiastical Review* is from the pen of Fr. Tondorf. The article is entitled "A New Date For Easter."

In *Roads And Road Construction*, published in London, England, there is an article entitled: "The Scientific Recording of Traffic Vibration," in which the author states: "The first serious tests made of traffic vibrations known to the author were carried out in 1925 by two American investigators, Messrs. Moore and Tondorf, acting in conjunction with the Seismological Department of the Georgetown University. It is to be noted that Mr. Moore is a captain in the Engineering Corps of the United States Army and Fr. Tondorf the director of the Earthquake Station at Georgetown. The original article referred to was edited in the *Military Engineer*, a publication of the U. S. Army, and was copied in a score of journals the world over.

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Rev. James B. Macelwane, S.J., Dean of the Graduate School of St. Louis University, has just been selected as the American



representative of the International Commission for Seismological Studies which was created at the Prague meeting of the International Geodetic and Geophysical Union.

Father Macelwane was also chosen recently as chairman of the Committee on Telegraphic Exchange of Earthquake Data of the International Geodetic and Geophysical Union.

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The Secretary of the Biological Section has sent to us the following Program for the next meeting of the Society:

The Life History of *Ammobia ichneumonia*, L. (Chairman's address), Fr. Frisch, S.J.

Demonstration of the Skeleton in vertebrates, Fr. Didusch, S.J.

Laboratory Furniture, Fr. Schaffrey, S.J.

Reasons for Biology in the A. B. Course, Fr. McCauley, S.J.  
College Museums, Fr. Reardon, S.J.

An Arboretum on the Grounds, Fr. Freatman, S.J.

Pools, Ponds and Their Construction, Fr. Frisch, S.J.

Further Hereditary Considerations, Mr. Berger, S.J.

The Habitat of Fungi and Mosses, Mr. Freatman, S.J.

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The London Month for February, 1929, had an article by Mr. V. Gookin of Weston College, entitled "A Guild of Catholic Dentists." It is an account of the foundation and of the work of the Guild of St. Apollonia, an organization of Catholic Dentists of Boston. It dates from 1920 and its purpose is the spiritual and professional advancement of its members and the exercise of practical charity especially toward poor children. Much good has been done among the parochial school children of the archdiocese. The guild began the publication of a quarterly "The Apollonian" in 1926. Mr. Gookin has been numbered among its contributors.

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Mr. J. W. Tynan of Fordham University has an article in "Instruments" for March, 1929, on "The Wilip-Galitzin Seismograph." It is an illustrated description of the Galitzin type as improved by Prof. Wilip of the University of Tartu in Esthonia.

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The Eastern Section of the Seismological Society of America held its meeting for the year 1929 at Fordham University April 30 and May 1. Scientists gathered from all parts of the East and the Middle West. Both physicists and geologists were there to discuss earthquakes. This combination of the two



sciences in the one interest has led to the use of the word Geophysics which would make Seismology the physics of the earth.

The meeting was opened by President James B. Macelwane, S.J., of St. Louis University. The point immediately brought to the attention of the members was the necessity of a scale for recording the intensity of tremors for practical use in determining the destructive qualities of earthquakes. One paper by Doctor Alexander McAdie of Blue Hill Observatory, Readville, Mass., offered a possible solution by the Cancani-McAdie scale which has been received enthusiastically by foreign seismologists. The Fordham gathering commented very favorably on the use of the scale.

Mr. Arthur Keith of the Geological Survey displayed a map of earthquakes that have occurred in New England. He attributed the Moodus noises familiar to the people of Connecticut to small earthquakes.

There were papers and addresses by Reverend Joseph Joliat, S.J., Director of the St. Louis University Station; Reverend Vincent Herr, S.J., of St. Xavier College, Cincinnati; Messrs. Kirtley F. Mather and L. Don Leet of Harvard; Mr. Ernest A. Hodgson, Director of the Canadian Observatory at Ottawa; Doctor Noel Oglivie of the Canadian Geodetic Survey; Commander N. H. Heck, government seismologist; Reverend Joseph Lynch, S.J., of Fordham University recently returned from study at Oxford; Director Arthur L. Day, head of the Department of Geophysics at Carnegie Foundation; Doctor Reginald A. Daley of Harvard; Doctor Frank Wenner, head of the Bureau of Standards and inventor of a seismograph; and Professor Arthur J. Weed, geologist from the University of Virginia. Several papers were read for the men who could not be present in person. An election of the Section officers was held and Dr. McAdie was chosen chairman to replace Ernest A. Hodgson, the retiring chairman. Rev. J. Joseph Lynch, S.J., was selected to fill Dr. McAdie's office of vice chairman. Commander Heck was re-elected to the office of secretary.

The scientists were received by the president of Fordham University, Reverend William J. Duane, who extended to the men the welcome of the university. On Wednesday evening he was host to the Society.

After the convention notice was received that Rev. J. Joseph Lynch was elected a Fellow of the American Association for Advancement of Science.

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The spring meeting of the American Association of Variable Star Observers was held at the National Academy of Science,

Washington, D. C., on May 17th and 18th. Rev. Paul A. McNally, S.J., director of the Georgetown University Astronomical Observatory, read a very interesting paper on "Chances for Amateurs in Observing the Herschel Areas." On Saturday, May 18th, the delegates paid a visit to the University and were entertained by Frs. McNally, Sohon, Tondorf and Mr. Goberna. Both the Astronomical Observatory and the Seismological Stations were thrown open for their inspection and they expressed themselves in the most complimentary terms on the work carried on at this institution.

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Rev. Francis A. Tondorf, S.J., director of the Georgetown University Seismological Observatory, read a paper before the students of Johns Hopkins University, Baltimore, Maryland, on May 5th, on "The Teaching of Genesis on the Creation of the World." Besides the students of Hopkins there were in attendance on the lecture a number of students from Goucher College, also located in Baltimore.

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Fr. Paul McNally, S.J., director of Georgetown University Observatory, has published a pamphlet on the Herschel Areas.





