to the elementary laws of density, statics and dynamics, heat, calorimetry and the properties of liquids, gases and vapors. The chemical portion includes the fundamentals of the atomic and molecular theories and information about hydrogen, oxygen, chlorine, nitrogen, sulfur and carbon. Each part includes a considerable number of problems and the whole should furnish an excellent basis for the further study of the subjects in a college or university.

It is well worth while for American educators to consider whether a year in the high school given to the study of the two subjects would not be better than a year devoted exclusively to one or the other. Certainly every high school student should have as good a knowledge of both subjects as can be acquired from this book.

W. A. NOYES

SCIENTIFIC APPARATUS AND LABORATORY METHODS

OPTIMUM CONDITIONS FOR MUSIC IN ROOMS

MUSICIANS complain that rooms are usually ruined for music if they are adjusted by sound-absorbing materials to give "perfect" acoustics. On the other hand, rooms left reverberant so that musicians find it "easy" to play and to sing are quite objectionable for satisfactory listening.

This apparent contradiction has puzzled the writer for a number of years, so that recently a series of experiments was conducted to discover the facts, if possible. One experiment consisted in having musicians play first in a very "dead" room, and then later as the reverberation was progressively increased by removing portions of sound-absorbing material. At first it was "hard to play" in the room, but it became easier as the reverberation increased, until finally the notes "ran together" and several instruments could hardly be played in proper time in concert because of the overlapping sounds; but it was still easier to play than before. At the same time, listeners in the room found the conditions worse and worse as the reverberation increased. An experiment conducted in the reverse order, with the room very reverberant at first and then made successively deader, led to the same conclusions.

Further experiments were conducted in other rooms, the volumes varying from about twelve thousand to two hundred thousand cubic feet, and it was again found that musicians found reverberant conditions satisfactory for playing, but that listeners heard better in portions of halls that were deadened.

A crucial experiment was then devised in which a small studio was adjusted by sound-absorbing materials to give "perfect" conditions for listening in accordance with optimum data.[1] Expert musicians forming a string quartet were interested to assist in the experiment and play in the room. Their comment was immediately adverse. Some of the sound-absorbing material near them was then moved to the far end of the room and the playing resumed. The conditions for playing were "better," and listeners in the room decided the music sounded better. More material was moved in the same manner with greater improvement. Finally all the material about the musicians was transferred to the other end of the room. The room was then regarded as quite perfect for both playing and listening.

This simple experiment makes it clear why deadening a room in the usual manner ruins it for music. Musicians find it hard to play if surrounded by sound-absorbing materials, and the resultant music is not acceptable for listeners, so that the effect is unsatisfactory to all. By shifting the sound absorbents to one end of the room, a reverberant space is left for the easy generation of music—the musicians find free expression for the finer details of compositions and the listeners are doubly fortunate in having good music to listen to and in having a deadened surrounding which makes listening enjoyable. In other words, the conditions in the same room must be quite different for playing and listening. The time of reverberation was found to be the same in all parts of the room, but the intensity of sound was much greater near the musicians than in the deadened end of the room.

The results of this experiment should find application in many halls that are now unsatisfactory in acoustic effect. For instance, in a concert hall, the stage should be left quite reverberant, but the audience section should be deadened in accordance with the optimum data already mentioned.

One concert that was puzzling to the writer is now easily explained. In a large auditorium at the university, a piano concert was given by Paderewski. Preliminary calculations indicated that "perfect" conditions would obtain if six thousand seven hundred auditors were present, because of the absorption of sound by the clothing worn. Actually five thousand five hundred people attended, yet Paderewski stated the hall was "wonderful in its response," and the audience regarded the hearing conditions as "fine." What happened was that a considerable space was left vacant about the platform upon which the piano was placed, and this space together with nearby reverberant walls and ceiling gave acceptable conditions for playing. The audience was packed closely

[1] Wallace Sabine, "Collected Papers on Acoustics," page 76; F. R. Watson, "Acoustics of Buildings," page 30; S. Lifshitz, *Physical Review*, Vol. 27, page 618, 1926.

in the other end of the hall and furnished a considerable amount of sound-absorption. The effect would doubtless have been improved by more absorbing material in the portion occupied by the audience, but further experiments are desired to determine more closely the optimum conditions for these special conditions.

Other applications suggest themselves. A small music studio in a home should have one end reverberant for piano or other instruments, but the other end of the room should be deadened for listening. Possibly the listeners would find a better effect in adjacent rooms connected with the studio by an open door. It seems likely that broadcasting studios can be adjusted in the same manner, thus allowing musicians freer expression than at present, while the sound absorbent present in the room will tend to reduce any objectionable reverberation for broadcasting.

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SPECIAL ARTICLES

THE ATTENUATION OF PLANT VIRUSES AND THE INACTIVATING INFLUENCE OF OXYGEN[1]

THE possibility of the attenuation of viruses has received comparatively little attention in plant virus studies. Carsner[2] has reported attenuation in the case of curly-top of sugar beets, by passage through resistant plants. The writer has reported changing virulence in the viruses secured from apparently healthy potatoes.[3] Recently the writer has been able to attenuate the virus of tobacco mosaic and of other mosaics affecting tobacco by the use of heat. Plants soon after inoculation are placed in constant temperature chambers at a temperature between 35° to 37° C. for ten or more days. At this temperature the symptoms are wholly or partially masked. Transfers of the virus from such plants in comparison with that from plants unexposed to heat shows that a very decided attenuation has occurred. The attenuated virus usually gives only mild mottling and little or no malformation as compared with the marked symptoms of tobacco mosaic. Apparently this attenuation can be obtained in varying degrees, depending upon the temperature exposure within certain limits.

This attenuated virus can be repeatedly transferred serially through tobacco plants without apparently altering the attenuated condition.

The virus of tobacco mosaic may retain its vitality in soil for several months, but it is destroyed much more rapidly in some soils than in others. The longevity is much shorter in sand or sandy soils than in soils heavier in clay or organic matter. Preliminary experiments indicate that this variation is largely determined by oxygen relations. Evidently the virus of tobacco mosaic, remarkably resistant to various injurious conditions, is quite sensitive to the inactivating influence of oxygen when properly exposed to it in the moist condition.

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1 Published with the approval of the director of the Wisconsin Agricultural Experiment Station and the chief of the Bureau of Plant Industry, United States Department of Agriculture, Washington, D. C.

2 Carsner, E., "Attenuation of the Virus of Sugar Beet Curly-top." *Phytopath.*, 15: 745–756, 1925.

3 Johnson, James, "The Transmission of Viruses from Apparently Healthy Potatoes." Wis. Agr. Exp. Sta. Research Bul., 63, pp. 1–12, 1925.

THE NEBRASKA ACADEMY OF SCIENCE

THE thirty-sixth annual meeting of the Nebraska Academy of Science was held at Cotner College, Bethany, Nebraska, Thursday, Friday and Saturday, April 29, 30 and May 1, 1926. The meeting consisted of three general sessions, two business sessions and two periods for sectional meetings.

The first general session was occupied by a very interesting illustrated lecture by Dr. B. S. Hopkins, of the University of Illinois, on "The New Member of the Rare Earth Group." An illustrated lecture on "Morrill Hall," the new museum being built by the University of Nebraska, was given by Dr. E. H. Barbour, of the University of Nebraska. Dr. Paul B. Sears, of the University of Nebraska, delivered the past-president's address on the subject "Some Recent Comments on Science." This interesting address will appear in a later edition of SCIENCE. W. H. Pahl, engineer of the C. B. & Q. R. R., under the auspices of the Engineers Section, gave an illustrated lecture on "The World's Greatest Suspension Bridge," at the last general session.

At the business sessions the usual routine of business was carried on and the following officers elected for the next year:

President, Dr. G. L. Peltier, University of Nebraska
Vice-president, H. J. Wing, Doane College, Crete, Nebraska
Secretary, M. P. Brunig, University of Nebraska
Treasurer, P. K. Slaymaker, University of Nebraska
Councillor for three years, M. G. Gabã, University of Nebraska

M. P. BRUNIG,
Secretary