said should be sufficient to exemplify the absurdities of the situation. Since the advent of radio engineering and the consequent revival of interest in matters musical among physicists and electrical engineers, the existence of a discrepancy like this becomes extremely important. In most of the scientific papers dealing with acoustical matters in which questions of pitch are taken up, the physicists' scale is used. One is driven to the conclusion that many scientific men are unaware that the scale which they are using is completely artificial and is nowhere used for the practical performance of music.

In matters relating to hearing, to levels of sensation, to discrimination of pitch and to the investigation of musical esthetics, it is obviously essential that all parties to such investigations should speak the same language. It is unfortunate that scientific men and musicians should seem to feel a sort of mutual antagonism, but the fact that their interests are now forcibly merged one with the other ought to bring about some sort of an "entente cordiale" between them. Such consummation is devoutly to be wished for the best interests of the new science of acoustics and for the big practical interests of the recording and reproduction of music. There is not the slightest excuse, save arithmetical convenience, for the persistent use by physicists and engineers of a scale that has not been used for the practical performance of music since the time of Handel. It is high time that when one reads in a scientific paper something about a certain musical note, one should be able to be sure that the writer of the paper means in sound what a pianist, violinist or clarinetist playing that note would actually evoke from his instrument.

I am not alone in the pleas expressed here. Dr. Dayton C. Miller, one of the greatest of American pioneers in the science of musical acoustics, long since called attention to the absurdities which I have ventured to describe once more. In his book "The Science of Musical Sounds," published in 1916, he devotes some space to the discrepancy mentioned, and makes a plea for uniformity and common sense.

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PHYSIOLOGY OF RARE GASES

IT is to be hoped that the article of Professor Hershey in SCIENCE of April 11 last on the "Components of Air in Relation to Animal Life" will command some attention. The idea that the rare gas fraction of the atmosphere has some physiological significance has had a great attraction for me during the past ten years, and as far as my acquaintance with the literature goes, Professor Hershey's work is outstanding in its direct bearing on the subject. The experiments of McDonald and Kellas,[1] Kellas,[2] Tolomei,[3] Regnard and Schlösing,[4] Zaleski,[5] Marcacci,[6] Cannon and Free,[7] Pictet, Scherrer and Helfer[8] and Hackspill, Rollet and Nicloux[9] when taken together have given no decisive answer to such a question.

In describing the results of experiments with nitrogen-oxygen mixtures, Professor Hershey was led to remark that "the rare gases seem to play a part in normal life equally as important as oxygen." On the other hand, when in the nitrogen-oxygen mixtures the latter gas was increased to a proportion of from 25 to 40 per cent., "the animals appeared to be normal and in a few cases better than in normal air." This leads to an inference that an apparent compensation for the absence of the rare gases was accomplished by an increase in oxygen and reciprocal decrease in nitrogen within certain limits.

Since in the complete absence of oxygen the duration of animal life is only a matter of minutes, while in certain mixtures of nitrogen and oxygen with an absence of the rare gases the duration was at least three weeks, the importance of these rare gases does not appear to be vital in the absolute sense unless a longer period of time is required for the demonstration. It may be, therefore, that we are presented with an analogy to the food requirements of the animal organism, where the bulky part or roughage corresponds with the nitrogen, the caloric value with the oxygen and the accessory food factors with the rare gases. Vitamin deficiency takes a much longer time to injure health and end life than the complete withdrawal of food. It may be possible too that the food is itself a means of compensation or source of error, for Tolomei's contribution to the problem was to show that argon is locked up in the root tubercles of legumes which are associated with nitrifying bacteria. In judging of a state of health that is "better than normal," general appearances must be considered, but without some quantitative guide, such as size and weight or rate of growth of the young, one must be wary. The slight flush and bright eye of a low fever may improve the appearance of the human being though he be impaired in health.

[1] "The Gases of the Atmosphere," Ramsay.
[2] *Proc. Roy. Soc.*, 59: 66.
[3] Chem. Cent. I, 1030 (abstract).
[4] *C. r. Acad. Sci.*, 124: 302.
[5] *B. Dtsch. Chem. Ges.*, 30: 965.
[6] *Mem. R. Ist. Lomb. Sc. e Lett., Sc. Mat. e Nat.*, 19–20, Ser. 3.
[7] Carnegie Inst. Yr. Bk., 20, 63.
[8] *Helv. Chim. Acta*, 8: 537.
[9] *C. r. Acad. Sci.*, 182: 719.

It is evident that long-continued experiments may be necessary, and in the case of specific mixtures of gases requiring the complete absence of the rare gases or their presence in definite proportions, the apparatus may become complicated and the technique very exacting, especially when any record is to be kept of metabolic changes. For some purposes a closed circuit is a necessity, and I am not sure but that such a system introduces some complicating conditions, possibly by gas adsorption upon walls or materials or by the cutting down of radiant energy from without. In my own efforts,[10] for example, results soon led from experiments with nitrogen-oxygen mixtures to a closer examination of what happened to animals when confined in a circuit of ordinary air. Frogs were the most convenient animals to use, and there was disclosed a peculiar fluctuation in the nitrogen-rare gas fraction of air which was apparently correlated with light and darkness.

It is the relative proportions of the various gases in an atmosphere that seems to me to be a matter of prime importance, and this is clearly indicated in Professor Hershey's experiments. The necessity for accurate gas analysis led me to discontinue respiration experiments in 1924 in order to develop an apparatus for the analysis of air samples in which the "inert" fraction could also be determined. As soon as attempts were made to increase accuracy, irregularities began to appear with such persistence that it seems possible that differences as low as .01 per cent. in oxygen estimations may have some significance other than technical error. The associated gases may, perhaps, play some part, for irregularities tended to be greater when using oxygen made by the liquid air process where the argon impurity was about 1.9 per cent. Results are still very confusing, but an anomaly seems to be developing which must be more clearly defined before reporting. That these irregularities are due to an isotope may be possible. The magnitude of change is such as to be perhaps too frequently ascribed to experimental error and on that account keeps the observer in a harassed state of mind.

The main object of this note is to give a word of praise and encouragement for these experiments of Professor Hershey. One of the chief difficulties in arousing interest in and support for such work is to present any reasonable mechanism by which the "inactive" gases may act upon the body. The possibility of finding a mechanism in the field of gas analysis has kept me away from the more physiological type of respiration experiment. While medical men may understand little concerning the rare gases, as Professor Hershey suggests, I have a suspicion that the chemist and physicist are likewise ignorant of some important relation between these noble gases and the commoner constituents of the atmosphere.

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[10] Univ. Toronto Studies, Physiol. Series No. 98.

SCIENTIFIC BOOKS

Manual of Meteorology, Vol. III. *The Physical Processes of Weather.* By SIR NAPIER SHAW, F.R.S., sometime director of the Meteorological Office, London, and president of the International Meteorological Committee. With the assistance of Elaine Austin, formerly of Newnham College, Cambridge. Cambridge University Press. American agent, Macmillan. 445 pages, 149 figures. Price $9.00.

THIS being an air-minded (not *aero*-minded) age with airports (not *aero*ports) and aviation instruction schools advertised by every ambitious town, we would expect to find airgraphics (not *aero*graphics) holding a prominent place in the curricula of our colleges and universities. Such is far from reality. Worse yet, no one feels responsible. Physicists are indifferent; engineers, not excluding aeronautical engineers, feel it is not up to them; chemists, biologists, geologists and even economists give themselves no concern, content perhaps with a daily weather map. Yet in every field of scientific endeavor, varying atmospheric conditions have direct and noticeable effects. We do not see how precise measurements, for example, can be made when only casual uncorrected readings of pressure and temperature are made.

By airgraphics we mean just what the word says, the science of the air, the description in full of atmospheric phenomena. It is more than the physics of meteorology, or the statistical methods of climatology, being in brief the detailed study of the earth's gas envelope, regarded as a tremendous thermal engine, with energy transformations of heat and motion. Sir Napier Shaw, retiring from a long and proved leadership of the Meteorological Office, set himself the heavy task of collating all that had been done in atmospheric physics and dynamics by divers workers in many lands, and seen from different angles. This has long been miscalled meteorology. (In the present volume [III] meteors are mentioned twice. In Vol. II there are two scant references, and in Vol. I, one.)

Vol. I, it will be recalled, gave a general survey of the atmosphere; Vol. II dealt with the physics of the air. The present volume (III) sets forth the dynamics and thermodynamics of circulation. Vol. IV has had a curious history, illustrating that the last shall be first, for it was issued in 1919 and dealt with the wind