V. MATHEMATICAL FORMULATIONS AND MATHEMATICAL DEVELOPMENTS

The most vitally important parts of any physics text for beginners are the parts that are introductory to mathematical formulations; note that I say *mathematical formulations,* not *mathematical developments,* for it is the actual tying of mathematics to physics that is all-important. Mathematical developments *follow* mathematical formulations, and mathematical developments are easy.

Of course much use must be made of precise ideas and conceptions in the important business of reducing physics to mathematical forms, and what is said in Section III applies here also. The parts of a text that are introductory to mathematical formulations must be highly specific, they must have a vivid appeal to sense and to intuition, and they must be free from premature and meaningless (for the immediate purpose) generalizations. These vitally important parts of a physics text (which are introductory to mathematical formulations) are (a) often non-existent; (b) they are sometimes present in a text but rendered ineffective by premature generalizations, and (c) they are sometimes completely submerged and lost in elaborate mathematical developments. I could give extreme examples of all three cases, but I refrain from doing so.

Of all the generalizations of physics the principle of the conservation of energy and the closely associated ideas of energy transformation lend themselves most easily to verbal discussion, and in my opinion purely verbal allusions to energy conservation and energy transformations make for unintelligibility more than anything else in elementary physics discussions. Physics is, after all, *mechanism,* and if you do not "look at" the mechanism you get nowhere.

VI. REAL AND ADVENTITIOUS DIFFICULTIES ENCOUNTERED BY THE STUDENT OF PHYSICS

Professor P. G. Tait says in the preface to his small book on heat that "the student who expects to find this book, elementary though it is, everywhere easy reading will be deservedly disappointed. No branch of science is without real difficulties even in its elements."

This is certainly true, but many elementary analytical texts are unnecessarily difficult, and the unnecessary difficulties are nearly always due to unintelligibility. The student does not "see" what the author is talking about. One must talk sense if one is to build up precise ideas and conceptions; one must talk sense if one is to establish mathematical formulations; one must talk sense if one is to lead a student to apply to a new problem the precise ideas and concepts that already exist in his mind; and, however far a student is carried forward in his analytical studies, one must continue to dwell among things without abstracting or setting the mind farther from them than makes their images meet.

VII. THE AROUSING OF INTEREST AMONG STUDENTS OF PHYSICS

I know from experience that most of our students like physics when the teaching is directed insistently towards the development and use of precise ideas or towards what may be called training in analytical thinking; and I know that our students can be carried far in this mildly difficult but highly profitable business. In fact I have always found my students to be so eager and enthusiastic that I could not wish them to be more eager or more enthusiastic.

In my opinion and according to my experience interest in the study of physics is *not* dependent upon the introduction of descriptive physics or on the application of any of the principles to practical engineering problems except of the simplest and most familiar kind; an almost purely analytical course in elementary physics arouses intense interest if one heeds Bacon's admonition and connects every detail of analytical method with actual conditions and things. The greatest fault of an earnest, hard-working teacher is to be exacting—and unintelligible.

VIII. THE OBJECTIVE OF UNDERGRADUATE COURSES IN PHYSICS FOR ENGINEERING STUDENTS

Every good musical composition is supposed always to come back at the end to the initial chord, and I end this brief discussion after the canons of musical art, changing only the plural *objectives* to the singular form. The only objective worth talking about is training in analytical thinking. Increase of our powers of thought is the greatest gift of the sciences to mankind.

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SCIENTIFIC EVENTS

INCREASE OF NATIONAL FOREST UNITS

PLANS for the acquisition of 9,600,000 acres of land in accordance with the general program of national-forest purchases are being completed, according to an oral statement made by L. F. Kneipp, Assistant Forester in charge of the branch of lands of the Forest Service, and reported in the *U. S. Daily.*

Mr. Kneipp pointed out that the areas for purchase are approved by the National Forest Reserva-

tion Commission and the lands are bought by the Forest Service of the Department of Agriculture. Areas that have not yet been submitted for the approval of the commission include lands in Mississippi, Kentucky and eastern North Carolina.

Areas recently approved by the commission, which are being bought by the Forest Service, Mr. Kneipp explained, are 100,000 acres in southern Vermont, and areas near Lake City, Florida; in Wisconsin, the upper peninsula of Michigan, upper Minnesota, other parts of Michigan, Louisiana, and eastern South Carolina, and privately-owned lands within the National Forests of Choctawhatchasee and Ocala, Florida.

The general program of national-forest purchases, according to the National Forest Reservation Commission, divides the 9,600,000 acres to be acquired into the following four subdivisions:

Consolidation of federal ownership within national-forest units heretofore approved by the commission, and situated on the headwaters of navigable streams; approximate area to be acquired, 4,000,000 acres.

Establishment of necessary additional national-forest units for protection of headwaters of navigable streams and reduction of floods thereon; approximate area to be acquired, 2,000,000 acres.

Consolidation of federal ownership within national-forest units on watersheds of navigable streams heretofore approved by the commission in Michigan and Minnesota, primarily to aid in timber production and demonstrate forestry practice; approximate area to be acquired, 1,100,000 acres.

Creation of a limited number of additional national-forest units in southern pine region and northern Lake States, primarily to aid in timber production and demonstrate forestry practice; approximate area to be acquired, 2,500,000 acres.

INSTITUTE OF TROPICAL MEDICINE AT THE UNIVERSITY OF CALIFORNIA

TENTATIVE plans for the University of California Institute of Tropical Medicine have been announced at the Hooper Foundation, research center of the medical school, providing for lectures in the summer of 1930, according to a statement made by Dr. Alfred C. Reed, professor of tropical medicine.

The purpose of the new organization is threefold, Dr. Reed explains. It will provide the only western center for the treatment and study of tropical diseases and for research in general problems of health and food preservation in the tropics or locally as a result of conditions having their origin in the tropics.

Research, public education and treatment of individuals suffering from tropical diseases are given as the three phases of work to be carried on.

Under research are included the practical problems of health and disease in tropical countries; the problems arising from shipping between the United States and tropical countries, both as regards cargo and the personnel of the ships, passengers and crew, and the problems presented by epidemics of tropical diseases such as meningitis, cholera, yellow fever, etc.

Under public education Dr. Reed lists four lines of endeavor. First, regular courses in tropical medicine for graduate physicians from every part of the world. Second, courses in tropical public health service for nurses going to tropical countries or on ships touching at tropical ports. Third, courses on tropical medicine for students in the University Medical School, as desired. Fourth, public instruction in tropical hygiene and public health through popular lectures and a course for prospective travelers, merchants, soldiers and others intending to visit tropical countries.

Under treatment of individuals is included all such treatment as can not well be taken care of elsewhere. It is thought that the university center will care for people in all parts of the west, as the next closest center for the treatment of tropical diseases is in Galveston. Another is in New Orleans, but the rest are on the Atlantic seaboard. None of them, Dr. Reed says, is as wide in scope as that planned for the University of California.

Concerning the shipping problems to be studied, San Francisco, Los Angeles and other Pacific Coast ports are unloading places for innumerable cargoes of tropical goods, from copra, oil, forest products and foodstuffs on down. This commerce not only offers a means of entry for tropical diseases and parasites of many kinds, but is itself often hampered by the action of parasites in cargoes *en route*. This is particularly true in the case of cargoes of foodstuffs, recent reports having been received of the spoilage of large cargoes of cocoa-beans by an insect parasite.

CENSUS OF MIGRATORY WATERFOWL

DATA on the bulk movement of migratory waterfowl, such as ducks, geese, swans and coots, during their spring and fall migration, and on the limited areas of their winter concentration, are being accumulated through waterfowl censuses under the leadership of the Biological Survey of the Department of Agriculture. This census taking, which was inaugurated about eighteen months ago, is carried on through the cooperation of about 3,500 volunteer observers.

The waterfowl are widely distributed at various seasons throughout North America. In order to get definite information regarding their occurrence, numbers and migratory movements, direct observations must be made at regular intervals at a great number