gineering students, and the other to classical, chemical and literary students. Personally I believe it is highly desirable to make this distinction.

The problem of the inequality of student interest and capacity is one that confronts college teachers of physics in an unusual degree. It does not always (and, perhaps, not usually) follow that the poorest students in physics are the poorest in other subjects; it is simply that the charms of physics reveal themselves only to those who are willing to work hard and long over its perplexities. A course in history or civics may appeal to a student who expects to go into business when he leaves college, but optical interference and magnetic hysteresis are likely to appeal only to the specialist.

As a rule these two classes are clearly defined. Students who are expecting to use physics as a foundation for technical branches will master its difficulties as a matter of course; while the other class think themselves aggrieved that they should be burdened with mathematical theories and problems.

There results a very unfortunate state of affairs when these classes of students are reciting in the same division. The question, therefore, arises, Is there not some remedy for the difficulty? And the only possible solution becomes an easy solution if we are ready to answer affirmatively the question propounded in the heading of this article.

Leaving out of consideration the question of ease or difficulty in teaching, does it not seem fitting that physics should be presented to a student who is looking towards civil or electrical engineering, somewhat differently than to one who is preparing for law, theology or business? To be more specific, it seems to the writer that the mathematical treatment of physical subjects is undesirable in cases where the student is not looking forward to further work along this line. It is unfortunate that a subject so delightful under certain conditions should be made the bugbear of the course by insistence upon rigid mathematical applications. For example, Hastings and Beach's textbook, to which I can not pay a higher compliment than to say that I use it each year with about eighty engineering students, is, in my opinion, absolutely unadapted to students in classical, literary or chemical courses.

What is the purpose of the training in physics which these latter students receive? In the first place it develops their reasoning faculties in a very high degree; secondly, it makes (or ought to make) them familiar with the historical development of the various physical theories which are commonly accepted at the present time; thirdly, it gives them an insight into the laws and processes of nature. If these points are well taken, it may be admitted that for the development of logical methods and processes nothing can surpass the applications of mathematics to physics; but such a large amount of similar training must of necessity come from the various mathematical courses usually pursued that the first need not be insisted upon. It is rather the second and third statements of the advantages of physics for general students that appeal to us. And these are very distinct from the purposes of a course for technical students. It would without doubt be a poor technical course which entirely neglected the historical development or other general features of the subject, but, on the whole, the purposes of general and technical courses are diverse. One who is looking forward to the law as a profession ought to know the conditions under which the law of gravitation was discovered, and something of the development of the doctrine of the conservation of energy. But there is no occasion for his mastering, or better, life is too short for him to stop to master, the mathematical development of simple harmonic motion or the kinetic theory of gases.

The fact that so many institutions prescribe the same courses in physics for students in all departments would indicate that there must be good reasons for so doing. This note is written by one who pursues the opposite policy with the hope that some of these reasons may be published in a future number of SCIENCE.

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COMET *a* 1904.

THIS comet, discovered by Professor W. R. Brooks on the night of April 16, has an orbit worthy of note. Lick Observatory Bulletin No. 54 gives elliptic elements computed by Messrs. Curtiss and Albrecht. The extraordinarily small eccentricity (0.17733) together with the major axis ($\log a = 0.31970$) at once suggests asteroidal orbits. In fact, so far as size is concerned, the orbit is seen to lie between the orbits of Mars and Jupiter, the comet's perihelion distance being slightly greater than the aphelion distance of Mars. It will also be noticed that the eccentricity is less than that of Mercury's orbit, and, indeed, less than the eccentricities of the orbits of many of the minor planets, including Eros. But the inclination, more than 126,° with consequent retrograde motion, of course sharply distinguishes it from any known planetary orbit.

However disappointing the comet may be in its physical appearance and characteristics, it is to be hoped that a number of observations may be secured and a study of the orbit made, with especial reference to the comet's past and future relations to Mars and Jupiter when in or near its line of nodes.

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SPECIAL ARTICLES.

THE WATER-SOLUBLE PLANT FOOD OF SOILS.*

DATA were given showing the amount of phosphoric acid removed by crops, particularly wheat, at different stages of growth. In the case of wheat it was shown that from one square yard of soil 1,106 grams of dry matter, containing 10.18 grams of phosphoric acid, were secured. Does all of this come from water soluble forms? Reference was made to Hellriegel's exhaustive work, showing that 359 grams of water are required to produce one gram of dry matter in the form of spring wheat. It was found that the quantity of water required to produce 1,106 grams of wheat could dissolve only 1.9 grams of phosphoric acid from the soil upon which the wheat was grown. In determining the water soluble phosphoric acid the quantities of soil and water recommended by Whitney and Cameron in Bulletin No. 22, Division of Soils, U. S. Department of Agriculture, were used. The soil was left in contact with the water for fifteen days.

It was shown that if all the water taken from the soil was in the form of a saturated soil solution by physical action alone only 1.9 grams could have been supplied out of a total of 10.18 grams, in water-soluble forms. The conclusion was reached that over 81 per cent. of the phosphoric acid of the wheat crop was secured from forms insoluble in water. Similar data for oats, peas, corn and flax showed that the water-soluble phosphoric acid was only a minor factor in the food supply of the crops.

Some of the data in Bulletin No. 22 were examined. The experiments by Birner and Lucanus were reviewed, and it was shown that all of the data were not given. Instead of being a normal oat crop, as claimed by Whitney and Cameron, it was shown that Birner and Lucanus secured from three to six times as much organic matter when more plant food than that secured in the well water was supplied. There were abnormal amounts of plant food, particularly nitrates, in the well water; over sixty parts per million were present. This was shown to be more than is found in London sewage. The work of Birner and Lucanus can not be questioned, but the application of their results was shown to be inconsistent. It was noted on one page (10) that 'with the chemical methods then available it was realized that the small amount of plant food contained in a soil extract could not be determined with sufficient accuracy to justify the formation of any definite conclusion,' and then on a subsequent page the results of Birner and Lucanus, obtained in 1863–1866, by such methods, are cited as the only evidence that plants obtain all of their food from water-soluble forms.

The action of plant roots upon limestone is accounted for by Whitney and Cameron by the soil water being charged with carbon dioxide. It has been shown that the same result was secured when most seeds were germi-

* Presented at the St. Louis (1903) meeting of the Society for the Promotion of Agricultural Science.