analysis of the courses of study in physics in the different institutions from which data were received. In his circular to laboratory directors, M. Weinberg tabulated some 910 typical practical exercises in physics and requested that those worked in the laboratories might be underlined. It has thus been possible to institute an instructive comparison between the methods of different countries. About four hundred physical laboratories, having five hundred professors and eight hundred demonstrators or assistants, are recorded for the whole of the institutions for higher education in the world. In about one-fifth of these, practical work in physical manipulations is not carried on; in the rest, there are about 25,000 students who pass eight hours a week in the laboratories during three semesters. In these four hundred hours passed in the laboratory a student, on the average, performs sixty different experiments, or about two-thirds of the work for which the laboratory makes provision.

SCIENTIFIC SERIALS.

American Journal of Science, October.—An experimental investigation into the existence of free ions in aqueous solutions of electrolytes, by Julius Olsen. The well-known experiment of Ostwald and Nernst, which has been held to prove experimentally the existence of ions in solution, is criticised, and it is held that the conclusion arrived at does not necessarily follow, and that further proof is needed. Experiments are described which show that an electrolyte which has never been acted upon by a current behaves as if it contained particles charged with electricity which are free to move, and these particles have not been produced by a current. This corresponds to the definition of free ions.—On the solution of problems in crystallography by means of graphical methods, based upon spherical and plane trigonometry, by S. L. Penfield. It is shown that with the addition of certain stereographic scales and protractors to a set of ordinary drawing instruments, the lengthy calculations usual in determining the crystallographic constants can be avoided or, as an alternative, checked. Several illustrated examples of the mode of application of this method are given.—The estimation of bromic acid by the direct action of arsenious acid, by F. A. Gooch and J. C. Blake. It is shown that bromates may be satisfactorily estimated by the direct action of arsenious acid, the few apparent discrepancies which were found being traced to the presence of chlorate as an impurity in the bromate.—Solubilities of some carbon compounds, the densities of their solutions, by Clarence L. Speyers. Seven or eight carbon compounds of different types were examined in various solvents, including water, methyl, ethyl and propyl alcohols, chloroform and toluene. The results are compared with those calculated from Schroeder's formula, but the agreement is not good.

Transactions of the American Mathematical Society.—Vol. iii. No. 3 (July).—L. E. Dickson, on the group defined for any given field by the multiplication table of any given finite group. The subject of this paper is much the same as that of Burnside's in *Proc.* L.M.S. xxix.; the results, however, are obtained by a different method, which does not involve the theory of continuous groups. The paper illustrates the importance of Frobenius's discovery of the group determinant. Two examples are given.—O. Stolz, postscript to a previous article on rectification of curves. A comparison is made with Jordan's treatment of the same theory.—O. Bolza, proof of the sufficiency of Jacobi's condition for a permanent sign of the second variation in the so-called isoperimetric problems.—H. E. Hawkes, on hypercomplex number systems. The author develops the methods of Peirce, and shows that they give an enumeration of all systems in less than six units which have moduli in more than one idempotent unit. The systems for five units with two idempotent units are worked out in detail. A discussion of nilpotent systems follows.—W. B. Fite, on metabelian groups.—L. P. Eisenhart, on conjugate rectilinear congruences.—D. N. Lehmer, constructive theory of the unicursal plane cubic by synthetic methods.—L. E. Dickson, on the groups of Steiner in problems of contact (continued from the January number).

Bulletin of the American Mathematical Society (2) ix., No. 1 (October).—O. Bolza, examples in the calculus of variations—E. R. Hadrick, on the sufficient conditions in the calculus of variations. A convenient summary, based on lectures by Hilbert.—E. B. Wilson, reviews of recent books on mechanics (Föppl, Volkmann, Picard).—E. V. Huntington, on a new edition of Stolz's "Allgemeine Arithmetik," with an account of Peano's definition of number.—E. J. Wilczynski, an obituary notice of Fuchs.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, October 31.—Prof. S. P. Thompson, president, in the chair.—A paper on the existence of a relationship between the spectra of some elements and the squares of their atomic weights, by Dr. W. M. Watts, was read by Prof. Everett. The author has detected two kinds of relation between the spectra of some allied elements. In the first kind, which is illustrated by comparisons between zinc, cadmium and mercury, and also between gallium and indium, the differences between the oscillation frequencies of certain lines of one element are to the differences between the oscillation frequencies of the corresponding lines of another as the squares of their atomic weights. In the second kind, the relation is not between two, but between three spectra, and is illustrated by the trio potassium, rubidium and cæsium, as well as by the trio calcium, strontium and barium. The element of greater atomic weight has the smaller frequency, and, in comparing corresponding lines, one from each of the three spectra, the differences of frequency are proportional to the differences between the squares of the atomic weights. If each of the spectral lines in question is represented by a point the coordinates of which are "frequency" and "square of atomic weight," the three points which represent three corresponding spectral lines will lie on one straight line in the diagram, and these straight lines will be parallel for all the components of a given set of corresponding groups. When a similar mode of plotting by points is employed to exhibit the first kind of relation, the joins of corresponding points meet in a point which lies on the axis of frequencies, in other words, on the line of zero atomic weight. This relation was indicated by Ramage about a year ago as holding for corresponding doublets and triplets.—A paper on the size of atoms was read by Mr. H. V. Ridout. This investigation deals with the size of dissociated atoms, or ions, and the results obtained refer to a dissociated atom as the smallest quantity of matter which can take part in an electrolytic action. The element chosen is hydrogen, and the author concludes that, in round numbers, 114½ million atoms are necessary to form a line one centimetre long. The method employed consists in finding a pair of spheres which would be charged by the quantity of electricity known to be necessary to electrolyse a given quantity of the body under examination—in this case water—to the known difference of potential of its ions. From this the size of the atoms is deduced, subject to certain assumptions enumerated and discussed in the paper. Lord Kelvin remarked that he had often concerned himself with the size of atoms, and pointed out that the value obtained by the author for the diameter of a hydrogen ion was almost exactly one-half of that which he had obtained for the diameter of a molecule of hydrogen. The fact, however, might be a coincidence. He had dealt with a sphere which would have the same effect as a double atom of hydrogen. While avoiding the assumption that atoms are hard and spherical, it was usual to treat them as such for purposes of calculation. The paper was an important one, but there were many assumptions which required looking into. Lord Kelvin said that, in dealing with the subject of atoms, it was necessary to consider the atoms of electricity. The atomic theory of electricity, now almost universally accepted, had been thought of by Faraday and Clerk-Maxwell and definitely proposed by Helmholtz. The atoms of electricity were very much smaller than the atoms of matter, and permeated freely through the spaces occupied by these greater atoms and also freely through space not occupied by them. An atom of electricity in the interior of an atom of matter experienced electric force towards the centre of the atom. We were forced to conclude that every kind of matter had electricity in it, and Lorenz had named electricity as the moving thing in atomic vibrations. If the electrons, or atoms of electricity, succeeded in getting out of the atoms of matter, they proceeded with the velocity of light and the body was radioactive. It was therefore not surprising that some bodies showed radioactive properties, but rather surprising that such properties were not shown by all forms of matter. Our knowledge of this subject,