

circles, this version is a possible source of fruitful suggestions. Congruences, or two-parameter families, receive due attention, and the field partly developed is recommended for further exploration.

Famous problems in construction, the third chapter, is unique in the full discussion it gives of each problem with respect to Lemoine's characters of simplicity and exactness. The chief problems are those of Apollonius (to construct a circle tangent to three given circles), of Steiner (to construct a circle meeting three given circles at given angles), Malfatti's (to construct three circles, each of which shall touch the other two, and two sides of a given triangle), and two of Fiedler's. The chapter closes with an account of Mascheroni's geometry of the compasses.

Of later chapters, on more special themes, we mention those on pentaspherical space, on circle transformations and sphere transformations, on the oriented circle (and Laguerre transformations); on algebraic systems of circles in space, and on oriented circles in space. In particular we commend to readers the "suggestions" (page 473) that close the chapter on circle crosses; and the paragraph (page 482) on the pentacycle of Stephanos, and that which follows it.

The book has excellent indices, and an added page of errata and addenda. As a whole, it is a welcome gift to American and English geometers. It has in prospect a long career of usefulness as a compendium of accessible fact and as a source of stimulation and suggestion. Incidentally it affords the refreshing detached humor that marks it as authentic.

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SHORTER NOTICES.

Unified Mathematics. By L. C. KARPINSKI, H. Y. BENEDICT and J. W. CALHOUN. New York, D. C. Heath and Company, 1918. viii + 522 pp.

THE increasing popularity of a unified course in mathematics for college freshmen is reflected in the large number of text books covering this field which have recently been published. Moreover, the movement towards the general adoption of

such a course will undoubtedly be much accelerated by the variety of books available. This movement is clearly a logical one and in harmony with the general tendency in educational practice to avoid useless repetition and to emphasize the coordination of related ideas. A properly unified course should make for a better understanding of the nature of mathematics and a more usable knowledge of the mathematical principles that have been studied.

The work under consideration here has many excellent features. One of its principal merits may be found in the interesting way in which the theories developed are illustrated by numerous applications which are of real importance in the world of to day. This particular characteristic of the book is all the more commendable in view of the fact that many mathematical texts are rather lacking in this respect. As a result, it is quite possible for students who have completed a first course in calculus to have a very inadequate idea of the large number of useful applications of the theories they have learned. This ought not to be the case; there is just as good reason for discussing the applications in a course on mathematical theory as in a course on chemical theory.

It is the firm conviction of the reviewer that teachers of mathematics can do much toward fortifying the position of their subject in general education by writing and using texts that lay stress on the modern applications of mathematical theory. In this way courses in mathematics will become richer in content and more interesting for the average student, and the critics of mathematics will be largely disarmed. "Unified Mathematics" furnishes an excellent illustration of what can be done in this direction by writers who are willing to make the effort.

We will now consider the book somewhat more in detail. It may be stated in the first place that the subject matter includes all the more important topics of algebra, trigonometry and analytical geometry that are ordinarily treated in freshman courses. Moreover, excellent use has been made of the relationship between these three fields and a real unification has been achieved. The arrangement of material is good both from a logical and a pedagogical standpoint. Throughout the book a proper emphasis is laid on computation and one of the earlier chapters is devoted to showing how the application of certain algebraic formulas to arithmetical com-

putations serves to diminish considerably the labor of the computer. The introduction of sets of "timing exercises" in cases where the problems to be solved are of a rather mechanical nature, is a novel feature and ought to help in developing greater facility in mathematical technique on the part of the student.

As stated above, the book is unusually rich in applications. A list of the more important and novel ones will readily illustrate this fact. A treatment of compound interest is given in connection with the chapter on exponents and logarithms. A discussion of annuities, bonds at premium and discount, and sinking funds is found in the chapter on geometrical progressions. Railroad curves are treated in the chapter on right triangles and the laws for reflection and refraction of light are stated and applied in connection with the chapter on oblique triangles. In the chapters on the ellipse and parabola the uses of these curves in architecture is explained and problems connected with elliptical and parabolic arches are introduced. In a special chapter on applications of conic sections we find discussions of Kepler's laws, projectiles, reflectors, and elliptical gears. In the chapter on wave motion there is a brief discussion of sound waves, light waves, and electrical waves; a treatment of piston rod motion is also included. In a chapter entitled "Laws of Growth" various applications of the exponential function in connection with physical and biological phenomena are treated. Among the topics discussed are the law of organic growth, Halley's law for the decrease in air pressure, damped vibrations, and the curve of healing of a wound.

A student that has been made acquainted with such a wide range of applications for the theories he has learned will certainly have a great deal more respect for the usefulness of mathematical knowledge. Moreover, his interest in the subject will undoubtedly be stimulated and he will be more apt to continue his work in mathematics after the freshman year. As such results are undoubtedly desired by all serious minded teachers of mathematics, "Unified Mathematics" ought to be widely used.

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