tage of travelling abroad to exchange ideas with mathematicians in many different countries.

He contrasts the achievements of the rare mathematical genius with those of the ordinary mathematician who must remain satisfied with a few slight contributions. He modestly places himself in the latter category. Looking back over his life, with its successes and its failures, he reflects that his efforts have been "worth while in every way.... Probably one is happiest when engaged in congenial work." He compares the efforts and rewards of mathematical research with those of mountaineering. After retirement he is still active and takes a keen interest in the work done by others --- unlike Sir Isaac Newton, who separated himself completely from the subjects that made him immortal.

An Appendix gives the solution (involving a double integral) of a delightful little problem about the time of waiting for a bus.

The reviewer hopes that the above outline will convey something of the spirit of this highly enjoyable booklet. It has been beautifully printed (by the Cambridge University Press) and is adorned with an excellent portrait of the author.

H.S.M. Coxeter, University of Toronto

Dynamics and Non-linear Mechanics, by E. Leimanis and N. Minorsky. Surveys in Applied Mathematics II. John Wiley and Sons, New York, 1958. 206 pages. $7.75.

This is volume 2 of a series Surveys in Applied Mathematics, and the contributions of the two authors are quite distinct.

Leimanis surveys, in 108 pages, recent advances in some classical problems of Dynamics, notably the motion of a rigid body free to rotate about a fixed point, and the problem of three bodies: both, of course, with the customary idealizations. In each of these cases the problem as originally posed was to solve a set of differential equations, and in due course it appeared that solution by elementary processes was impossible; so the problem becomes, more vaguely, to find out what we can about the solution, or to see whether specialization of the data makes it more tractable. In the rigid body problem let A, B, C be the principal moments of inertia at the fixed point O, (x_o, y_o, z_o) the coordinates of the mass-centre and (p, q, r) the angular velocity relative to principal axes in the body at O. The special cases $A = B$, $x_o = y_o = 0$ (the gyroscope) and $x_o = y_o = z_o = 0$ ('Poinsot motion') are easy and classical - 18th century. Then in 1888 Kowalevskaya startled the mathematical world by show-

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ing that complete solution by elementary processes was possible also when $A = B = 2C$, $z_o = 0$. More recently, a number of cases have been discovered which are more special in that certain particular solutions, but not the general solution, are accessible. For example, if $y_o = 0$ and $A(B-C)x_o^2 = C(A-B)z_o^2$ there is a class of motions for which $Apx_o + Crz_o = 0$, so that the angular momentum vector is confined to a plane fixed in the body; and special motions can be explicitly found also when $A = B = 4C$ and $z_o = 0$. It is with such investigations that Leimanis's first chapter is concerned - a by-way of mathematics, but an amusing one.

Of the remaining chapters the most significant is that on capture in the problem of three bodies, which Russian authors have shown recently will happen when the initial conditions are suitable. They use justified analytical approximations for $t \sim -\infty$ (bodies approaching each other from infinity) and $t \sim +\infty$ (two bodies in quasi-elliptic orbits and the third receding from them), linked by numerical integration.

The author has written a valuable and far-reaching survey, but in the reviewer's opinion he would have done still better if he had been more selective. For example, he could have saved many pages devoted to erroneous work by Vernić, and used them to describe more fully the Russian work on capture and the physical motions of the rigid body which belong to the formulae of the first chapter.

In the second half of the book (87 pages) Minorsky gives an account of the work on non-linear oscillations which began in 1920 with van der Pol's idealization of triode oscillations in the equation

$$\ddot{x} + \mu(x^2 - 1)\dot{x} + x = 0$$

and his discussion of its solutions. From this there has arisen something of a renaissance in Differential Equations; for from physical contexts there have emerged equations of rather special forms, such as

$$\ddot{x} + x + \mu f(x, \dot{x}) = g(t) ,$$

which demand investigation, and the speciality of form has enabled mathematicians to prove theorems about their general solution, or about particular solutions such as periodic ones, resting sometimes on elaborate and ingenious approximations.

Minorsky's account is concerned with the classification of solution curves and with methods of approximation, in the main when μ is small. It has the virtue of being compact, and well organized in its main lines, with a good bibliography.

That, however, is the end. The exposition is marred by a devastating lack of feeling for mathematical proof and logical proprieties, and by frequent infelicities of expression, which range from trivial departures from customary usage (e.g. in the use of the word 'the') to misleading phrases (e.g. 'more conveniently' at the foot of p. 145, masking the logical necessity to justify an approximation) and errors (e.g. 'values' on p. 183, l. 24, in place of 'ranges'). In compensation, it may be admitted that these features are fairly harmless, for they will be apparent to all except the most naive readers.

T.M. Cherry, University of Melbourne

<u>Introduction</u> <u>to</u> <u>Logic</u> <u>and</u> <u>Sets</u>, by Robert R. Christian. Preliminary edition, Ginn and Company, Boston 1958. 70 pages, 90 cents.

We might as well face it, there is a growing conspiracy among the younger mathematics instructors on this continent to introduce some logic and algebra of sets into the first year mathematics program. While some of the "modern" text-books have devoted one or two chapters to these esoteric topics, we have here a more leisurely and systematic exploration of the new ground. This booklet may be used profitably alongside the usual treatise on Trigonometry etc. It is written in a refreshing style and contains many humorous exercises in the tradition of Lewis Carroll. The student is introduced gently to the propositional connectives, "if ... then" being studiously deferred to the end. There is a rigorous distinction between propositions and their truth-values; truth-tables are studied, but tautologies are not mentioned. Applications are made to black boxes and switching networks. (Why not follow this up by the construction of a binary adder?) Part II is devoted to operations on sets and the process of set-abstraction, quantifiers and de Morgan's Law. Let us hope that many a reader's appetite will be whetted for more.

J. Lambek, McGill University

<u>Integral</u> <u>Equations</u>, by F. Smithies. Cambridge Tracts in Mathematics and Mathematical Physics, No. 49, 1958. The Macmillan Company of Canada, Ltd. Canadian list price $4.70.

This, the latest addition to the series of Cambridge Tracts, is intended as a successor to M. Bôcher's tract "An Introduction to the Study of Integral Equations", which was published in 1909. It is most interesting to compare the contents and the methods of the two tracts, published at an interval of almost half a century. Much of the content of the earlier tract remains in the new; the Fredholm theory still retains its central position.