Physics: Foundations and Frontiers. By George Gamow and John M. Cleveland. 551 pp. Prentice-Hall, Inc., Englewood Cliffs, N. J., 1960. $7.95. *Reviewed by Norman Feather, University of Edinburgh.*

DR. George Gamow, the theoretical astrophysicist and senior author of this book, is well known to a wide circle of readers as an irrepressible cartoonist and a teller of fairy tales. . . .

Once upon a time there was a college freshman who wanted to know what physics was all about. He was big and hefty, and he hadn't much time to think things out for himself. At high school he had learned to multiply and divide; he had been taught the difference between plus and minus and up and down, between male and female and black and white, even between *meum* and *tuum* (which he remembered when someone was on hand to translate for him). Now he wanted to know the difference between energy and momentum, vectors and scalars, heat and temperature, electricity and magnetism, atoms and nuclei, muons and pions, Newton and Einstein, fission and fusion, waves and particles, Sodom and Gomorrah, life and death. . . .

In *Physics: Foundations and Frontiers,* Dr. Gamow and his coauthor seek to clarify all these dichotomies, or nearly all, and they bring a rare zest to their task. The cartoons are there, and so are the fairy tales. Archimedes (having, presumably, taken his bath in Syracuse) is discovered rushing "through the streets of Alexandria shouting 'Eureka'" (p. 20); Galileo, unabashed by the strictures of later historians, climbs to the top of the Leaning Tower to drop his accustomed bricks (the authors' tongues are in their cheeks, though: the experiment was only "alleged to have been performed," but it "disproved, once and for all, the belief of his [Galileo's] contemporaries"!) (p. 33); Torricelli, disdaining the bowl of mercury of the authentic account, sets up a long glass tube in a tub of water in the courtyard and is shown contemplating the ten-meter column in solitary splendor (p. 27); Thomas Young becomes "a great English engineer" (pp. 106, 271), Frederick Soddy "the British physicist" (p. 418), Ole Roemer masquerades as a "German astronomer" (p. 288). Telling fairy tales to college freshmen, in a good cause, is a relatively innocent occupation, or so it may be held, if the time is sufficiently long ago. But Soddy comes perilously near to the present—and the page given over to a circumstantial account of the discovery of radioactivity by Becquerel (p. 415) is pure invention. This is hardly good enough, because Becquerel's version of what really happened is still in the libraries.

From what has been said, it should be obvious that the student must not take this book too literally. Indeed, he is given several hints to that effect on the way. When he meets with Mr. Tompkins, or a legendary Russian philosopher, or a quotation from "Physics for Fools," he will doubtless be on his guard. Let him read the book cautiously then, all its 551 pages, and he will have traversed, without undue pain and with some entertainment, a skeleton course in physics, in its cosmic as well as its terrestrial aspects. He will not, of course, have built up for himself any tightly coherent structure of "laws", but he will at least have followed the authors as they set themselves masses of simple "sums", and work them out for his benefit. It is one way of getting a feeling for the subject! I wonder whether anything more can be claimed for the exercise: probably not. If that be so, I also wonder whether all the ingenuity which the authors display is really worthwhile. It must have been a laborious undertaking to parade so great a body of factual information—so much of it in fancy dress. If all these facts are going to be forgotten as soon as the page has been turned, is the ultimate gain, a vague feeling for the subject in the mind of the reader, sufficient recompense, I wonder, for this very considerable effort? Perhaps I should not hazard an opinion: in this country (Britain) we are moving towards the revision of syllabuses, but we have not as yet moved as far as the authors of this well-intentioned, but perhaps over-popularized book.

Fundamentals of Scientific Mathematics. By George E. Owen. 273 pp. The Johns Hopkins Press, Baltimore, Md., 1961. $5.00. *Reviewed by R. C. Alverson, Stanford Research Institute.*

IN recent years, the mathematics and physics courses offered by many secondary schools have undergone a significant change. Subject matter which previously had not been introduced until the student entered college or even delayed until the second or third year of college is now being taught in the secondary school. Among the mathematical disciplines which are now being offered are set theory, elements of abstract algebra, the concept of a function, and some calculus. The present book is an outgrowth of an experiment in the teaching of secondary-school mathematics which introduces the student to some of the elements of applied mathematics. The emphasis is on geometric interpretation and on the representation of physical phenomena through application of mathematical discipline.

The subject matter for such an introduction is well chosen. One chapter is devoted to each of these topics: geometry and matrices, vector algebra, analytic geometry, functions, and calculus. Each topic is amply illustrated by diagrams and a remarkable degree of continuity of subject matter has been achieved. For example, coordinate systems in Euclidean three space are introduced in the first chapter and after the idea of a rotation of coordinate systems has been developed the summation convention is employed. Then matrices are introduced and successive rotations of coordinate systems are used to develop matrix multiplication, while rotation back to the original coordinate system develops the inverse matrix. The chapter on analytic geometry is developed by use of vectors and the eigenvalues of a matrix are then introduced by finding the lengths of the semi-major and semi-minor axes of a

quadratic form. The final two chapters develop the notion of a continuous and discontinuous function, the derivative of a function as the slope and the integral as the area under a curve. Among the physical problems which are formulated are problems of motion with respect to a moving reference frame, modes of vibration of a mass-spring system and problems in kinematics.

The book is well written and the presentation throughout achieves clarity of thought with a minimum of computational effort. The secondary-school teacher would do well to consult this book and to incorporate this material into his mathematics course as a supplement to, but not as a substitute for the more abstract mathematical topics now being offered.

Advances in the Astronautical Sciences, Volume 6. Meeting Proc. (New York, Jan. 1960). Horace Jacobs and Eric Burgess, eds. 898 pp. The Macmillan Co., New York, 1961. $25.00. *Reviewed by E. J. Öpik, University of Maryland.*

THREE days of meetings have produced an impressive collection of 57 technical papers on varied aspects of space flight, from celestial mechanics to biology, preceded by three policy-making or programming articles and a report on the proceedings of the panel discussion: "Man in Space, When?" (31 pp.), chiefly concerned with physiological hazards; the "when", however, remains unanswered.

Part 1 is concerned with space communications: demodulation methods, transmission efficiency, power supply and types of communication satellites.

Part 2 covers propulsion: the role of ion propulsion in load transfer between satellite orbits, to the Moon, and in manned flight to the planets, with payload and thrust data; ion sources for electrical propulsion, with melting, vaporization, and work-function tables for the metals concerned; application of nuclear rocket propulsion to interplanetary flight, with special consideration of Earth-Mars communication, radiation shielding of the crew, and control of the nuclear engine; straight-line flight conditions to Mars, with solar sail or electrical powerplant propulsion, the trip along a tangent line taking only about 100 days including escape and approach maneuvers, several times shorter than along the economical Hohmann orbits.

Part 3 discusses guidance and control: control of trajectory for landings on a planet having an atmosphere, with Earth to Mars example and wooden model; calculation of rendezvous and intercept conditions with a satellite; the equations of motion for attitude control of a rigid-body satellite; experimental investigation of attitude control by astronauts in simulated conditions—spin could be stopped in less than 10 seconds with an efficiency of 90 percent; theory of path control and errors in satellite rendezvous; mathematical analysis of the response to error disturbances in glider descent; trajectory predictions of the lost Lunik III, without sightings being available to substantiate theory; project of a fluorescence-phosphoresence P-7 detector for moving objects, which has a field of 30° and an estimated range of several thousand miles for vehicles of 2 feet in diameter; the feasibility of treating the motion of space probes by successive two-body approximations; a geocentric hyperbolic orbital arc within the sphere of action of the Earth, and a heliocentric elliptical arc outside it, in comparison with the more exact restricted three-body problem.

Part 4 treats problems of space medicine and astrobiology: life-preserving artificial cooling experiments with rats in hot environment (48–60°C); theoretical prediction of radiation dosages in passing the radiation belts; an account of unsuccessful experiments with biological material in Jupiter-rocket nose cones; a mathematical model of man's behavior (including "human caprice") in an *interstellar* station; systems of visual displays or auditory signals for guidance and information of astronauts; a system of soilless culture for space gardening, to provide eight different diets; experimental and theoretical studies of aerobic and anaerobic processing of human waste in closed self-sustained systems; experimental study of human factors in a long-range B-47 aircraft flight—after 36 hours of flight, 20 hours of rest were sufficient for full recovery toward active duty of test subjects, proving that "man is not the limiting factor in extended aerospace operation when properly designed equipment and biologistic support are adequately provided".

Part 5 deals with the relevant problems of celestial mechanics: orbital perturbations by an oblate Earth, with 22 pages of equations for accurate prediction of satellite positions; mathematical study of velocity impulses required in the beginning of a long coast to the target, to improve homing accuracy; rapid determination of orbital characteristics (without numerical integration) for intermediate elliptical orbits in landing maneuvers of a returning space craft; rapid and precise calculation (by numerical integration) of the relative motion of any two bodies in the solar system (e.g., motion of Venus relative to our Moon or a space craft, etc.); lunar theory as applied to the periodic trajectories of stable satellites, with application to a satellite of Venus having a period of about 3 months; the influence of gravity on the attitude, spin, and tumbling of an earth satellite; analytical solutions for motion and heat transfer in take-off or re-entry along a minor circle; minimum maneuver conditions for circularization of elliptic orbits; destructive effects from interstellar matter in travel at ultrahigh velocities approaching the speed of light ("the presence of matter in space effectively precludes the exploration . . . within a reasonable number of generations, of regions of space beyond a few hundred light years.").

Part 6 considers space vehicle design: radiator systems for the removal of heat from space vehicles; optimizing for total weight and volume of solar power plants; a new method for establishing exact gravity