When Aristotle did quote the results of observations of physical events he had an instinct for seizing on what we know today to have been the "wrong" ones. He must have seen very light and heavy bodies falling through air and water; he concentrated on the terminal velocities and concluded that the speeds of bodies varied proportionally to their weights and inversely as the resistances of the media. It followed logically that their speeds through vacuum would be infinite, and since infinities are objectionable he was driven to the conclusion that no vacuum can exist in nature. Later generations extended this line of reasoning: if matter is composed of ultimate atoms, these particles must exist in a vacuum. But since a vacuum cannot exist, atoms cannot either. . . . Aristotle himself did not reach a definite conclusion whether matter was a continuum or not, though he tended to think that it was. He even managed to dismiss the powerful argument that the expansions and contractions of bodies are evidence for vacuum between the particles, stating that if bodies changed their volumes, it is merely because they were capable of doing so. Indeed this last attitude, which to us can only seem curiously perverse, comes from his method of dealing with the whole problem of *change*—of how an object can alter in some way while still remaining the same thing. Thus Aristotle discussed change of position on much the same basis as change of color, change from a state of rest to one of movement in the same way as one from illness to health. He assumed that nature always had some end in view and never did anything in vain. Thus the expansion of a solid, which to the imagination of the Ionians suggested an atomic constitution, to Aristotle merely meant that the body could expand, in the same way as a sick man could get better.

Aristotle starts each section of his book with a careful and up-to-date analysis of the meanings of the words he uses: what is meant by saying that an object is "in" a certain place, what is meant by "luck" and "chance" and so on. It is a tribute to the extraordinary skill and knowledge of the translator, the late Professor Richard Hope of the University of Pittsburgh, that even these passages, which depend critically on the nature of the Greek language, should appear meaningful and relevant.

But a physicist cannot help regretting that it was Aristotle's *Physics* which survived while the work of Democritus was lost.

Unpublished Scientific Papers of Isaac Newton. Edited and Transl. by A. Rupert Hall and Marie Boas Hall. 416 pp. Cambridge Univ. Press, New York, 1962. $11.00. *Reviewed by R. Bruce Lindsay, Brown University.*

NEWTON was one of the greatest scientists of all time and probably the greatest to have been born in the British Isles. It is therefore all the more strange and deplorable that no complete edition of his writings has ever been issued. The last printed selection, col-

Isaac Newton (*The Bettmann Archive*)

lected and edited by Samuel Horsley, was published between 1779 and 1785. Perhaps modern scholars have been deterred by the enormous mass of manuscript material which Newton left behind and the uncertainty regarding what he intended to be taken seriously. Fortunately, a move in the right direction is being taken by the Royal Society of London which has a program now under way to publish Newton's correspondence. The present volume, edited by two distinguished historians of science, is the first addition, in nearly 125 years, to the published collection of Newton's scientific writings. Hopefully, it will stimulate further efforts along the same line.

From the famous Portsmouth collection of Newton's papers in the Cambridge University Library, the authors have selected some twenty-two items covering his work in mathematics, mechanics, theory of matter, manuscripts relating to the *Principia*, and popular science and education. A few of these are rather substantial tracts consisting of thirty to fifty pages of text, but most are short pieces or even fragments. Some are in Latin and the rest are in English. The authors have included both the original Latin text (without correcting Newton's errors) and a translation in English of their own. In the English pieces they have retained the quaint and uncertain spelling of Newton's time. Evidently he worried no more about this than his contemporaries!

The modern reader will find the reading of many of the selections rather difficult, largely because of the unfamiliar notation of the mathematical analysis. For example, in the long piece "To resolve problems by motion", in which Newton applied his calculus method to draw tangents to curves, to find the lengths of curves and the areas under them, and to calculate centers of gravity, he is still apparently uncertain as to the best notation in which to express his results, and consequently, the analysis appears clumsy and laborious. Nevertheless, the germ of the fluxion notation is there for anyone interested to see. The authors have conferred a great boon on the reader by prefacing each selection with an extensive introduction, explaining not only the historical status and significance of the piece but also its mathematical and physical meaning.

The physicist will probably find greatest interest in the papers on mechanics, to which about 100 pages are devoted. Here the longest piece is "De Gravitatione et Aequipondio Fluidorum" (on gravity and the equilibrium of fluids), which contains principally a vigorous criticism of Descartes' physics and vortex theory of cosmology, with a heavy leaning on theological arguments. In spite of the title, there is little hydrostatics in it. The physicist will also examine with interest the pieces containing Newton's notions on the constitution of matter. Here, he left no doubt about his belief in some kind of corpuscular theory, but his writing indicates considerable indecision with respect to the kinds of forces needed to explain the observed properties of materials, presumably rooted in his unhappiness over the "action at a distance" idea, in spite of its formal success in his gravitational theory of the solar system.

Present-day university educators and administrators will read with wry satisfaction the fragment "Of Educating Youth in the Universities", probably dating from 1690. In his suggestions for university reform, Newton showed scant sympathy for students who were indolent, drank too freely, and would not pay their bills!

The authors are to be congratulated on this splendid addition to the body of Newton's published works.

Concepts of Mass in Classical and Modern Physics. By Max Jammer. 230 pp. Harvard Univ. Press, Cambridge, Mass., 1961. $6.00. *Reviewed by M. W. Friedlander, Washington University.*

IN much of our teaching, "mass" is skimmed over—some sort of patched-up definition in the freshman year and all too rarely a deeper look in the junior year. A quick check through the definitions of mass given in a few of the standard, freshman-level best sellers will bring home this point. How often do we indicate in our teaching the conceptual difficulties? How often do we examine really critically the foundations of our subject or even take advantage of the efforts of one who has?

Mass is one of the most important physical concepts. We use it constantly and with great precision in our physical computations. Yet—its definition still eludes us. Over the centuries, mass has been viewed in many ways, but it was not until the mechanistic revolution of the 16th and 17th centuries that the modern aspects of mass could be discerned emerging from the philosophical and mystical-scientific undergrowth. Jammer traces the evolution of the concept, from Biblical times to the present, in a fascinating account bristling with scholarship.

After a discussion of the etymology of the word itself, the early approaches to recognition of the concept are traced. Then, from the important stage of "quantitas materiae", the thread is followed via Galileo, Kepler, and Newton to Mach, to the modern aspects and diffi-