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## THE FORCE OF ONE POUND.

*Elements of Mechanics.* By Thomas Wallace Wright, M.A., Ph.D. Pp. v + 372. (New York: Van Nostrand. London: Spon, 1896.)

THIS is a good elementary treatise; not too elementary, and yet a book that hard-working students may use from the beginning of their studies. It is a pity that the author ignores altogether the sort of work that is now getting to be very common, even in the older universities—experimental laboratory work in mechanics—but we have here an excellent text-book, even for students who are following an experimental course.

The author wisely assumes that some knowledge of the calculus may accompany a very elementary acquaintance with algebra and trigonometry, and he introduces calculus symbols freely in places where other authors are apt to evade their use, through a wrong notion that two pages of algebra and Euclid afford better mental training than a line of integration. I think that he is right, for every student possesses the fundamental idea of the calculus, and knows the use of squared paper before he knows algebra, and it is very easy to teach him the use of the symbols of differentiation and integration. The more advanced subjects include S.H. motion, forces in hinged structures, moments of inertia, D'Alembert's principle, the dynamics of rigid bodies, strain and impact. The exercises are very numerous; most of them are good, and many of them are of an original and taking kind.

On the other hand, I must say that I could not have believed the book to be a new edition of an older work, had the author not made the statement. It is in need of much correction, and not only of printer's errors, such as errors in decimal points. Then there is a mistake calculated to work great harm at page 12, line 6; the curve representing velocity of a piston as ordinate and space as abscissa, ought not to be like a curve of sines or cosines, being really nearly circular. Such mistakes as "That this principle (the independence of forces in producing accelerations) is not axiomatic, is evident from the opinion of Descartes . . ." (page 49), are, I believe, due only to careless writing; for the author surely does not mean that the opinion of Descartes settles the matter. There is a different sort of carelessness in (page 62, line 17) "At the close of the last century, in different parts of the world, the word *pound* was applied to 391 units of weight, . . ." The author means "391 different kinds of unit. . ." As the book is not a metaphysical treatise, it seems hardly fair to put before a student the exercise, "Discuss the argument of Zeno of Elea against motion"; "Since an arrow cannot move where it is not, and since it cannot move where it is, it therefore follows that it cannot move at all." There is a reference for help to vol. iv. page 263 of Carlyle's "Friedrich"; but as I have only one edition of Carlyle, the reference is not of much value. The author is disappointing in his *parallelogram of forces*. Seeing that all metaphysical proof has failed, we must frankly adopt the plan of T and T', and say that the parallelogram of forces is included

in Newton's laws of motion. It is interesting to note the disappearance, from all books, of the older proofs of fundamental principles which used to form so large a part of the student's work. They were generally based upon the assumption that because we could not conceive of something or other, therefore it could not exist; thus giving a premium to the limitation of our faculties. The method of reasoning is still much followed, but it is not usual to state it so ingenuously; Maxwell uses the method twice in his "Matter and Motion." In page 80, the author takes a line EF to represent the "force of the wind" (whatever that may be, outside the leading article of a daily paper), and he says that the component GF of EF, perpendicular to the sail, is the effective component in propelling the ship. These statements are wrong in such various ways that it might be thought they could do no harm, but in truth statements could hardly be framed to do more harm. The exercise in which a student is asked to criticise Hiawatha's achievements, reads as if the author had not made any attempt to understand the most transparent of poets; and I am sorry to say that some others of the original exercises are really only enlivening because they show that, like Silas Wegg, the author is fond of "dropping into" literature.

If there are these faults, how does it come that I like the book, and recommend it for the use of students? Because it is the work of a man who really thinks about the pedagogy of science; and a man who really thinks, is not to be met with every day; he is a good teacher, even if there is a mistake in every page. The author knows his T and T' well (I imagine), and does not much depart from their excellent methods. The book is one of the best introductions that I have seen, to the study of applied mechanics, and therefore, as an engineer, I like it. It has the fault (to me), but in a less degree than all the best English treatises, of being what is sometimes called "orthodox" in regard to the "British unit."

I think that the only act of the late Prof. James Thomson which was not altogether excellent, was the invention of the word "poundal." But he did not invent the unit to which the name is given; the inventor of the unit has caused it to be true that students are never *sure* in their dynamics calculations. Engineering students dare not for their lives speak of foot-poundals of work and poundals of force among workmen or foremen; and in what place these quantities are familiarly used or needed, except examination rooms, I do not know. To support an artificial and unnecessary system, the old and excellent term "the force of a pound" is maligned in every text-book. It is said to be a variable unit, and according to the definitions of its enemies, it is a variable unit. As if when I say that a certain force is a pound, I mean the gravitational force on a certain piece of metal if it were on the moon or at the centre of the earth. When an engineer says that the pressure of steam is 100 pounds per square inch, there is absolutely no vagueness about his statement. For twenty-six years I have used as my unit of force the gravitational force *at London* on a certain piece of metal called by law a weight of one pound, kept in London. My unit of mass is the mass to which unit force gives an acceleration of 1 foot per second per second, and my students use these as engineers' absolute units. When they are told "a

projectile is 20 lbs., and moves with the velocity of 1000 feet per second," before they start on their dynamical work they say : the mass or inertia in engineers' units is  $20 \div 32.18$ , and they use  $\frac{1}{2}mv^2$  and get their answer at once—not in foot-pounds or other absurd units—but in the foot-pound units in which they think and talk. Such students have no troubles and make no mistakes, for they use an absolute system in which their answers are in the language of their daily life, and not *Choctaw*. Clerk Maxwell said, "In fact, the only occasions in common life, in which it is required to estimate weight considered as a force, is when we have to determine the strength required to lift or carry things, or when we have to make a structure strong enough to support their weight." Very well then, in the "common life" of an engineer these are the most frequent occasions. He almost never needs to speak of the inertia of a body by itself; when he needs the idea, it is when on his way to a calculation of force or energy. The physicist uses the other set of so-called absolute units, the C.G.S., and cannot make mistakes; all the other readers of books on dynamics, almost all the readers of Maxwell's "Heat," in which the above passage occurs, are engineers. And all such engineers as do not openly scoff at the teaching of science colleges, have had their lives filled with worry through the misery of having to use the poundal in examinations, and of hearing men who know nothing about engineering or engineers, or their lives or their needs, declaiming against the want of scientific knowledge shown by the engineer. The evils created by mere want of humour in a few influential men have been very great. These men speak of the pull of a tram-car in pounds, and their students need to use pounds of force continually in their laboratories, and they never by any chance use the poundal, or need to use it, except in working academic written answers to academic questions, and in working with an Atwood's machine. When a student speaks of so many pounds of sugar or coals, he is not thinking, nor does he need to think, about its inertia, and the use of the pound in this connection could do no harm, even if  $g$  varied ever so much more than it does on the surface of the earth. I see no great objection to the use of the word *weight* as meaning the attraction of the earth for a body, anywhere. Of course this is a variable force, and for practical purposes the weight of a pound anywhere on the earth is a force of one pound.

We are always being told that the pound is legally a quantity of stuff, and so it is; but note the actual wording of the Act, "The weight in vacuo of the platinum weight declared to be the imperial standard shall be the legal standard of weight. . . ." Now I would ask whether the inertia of the standard body is different in vacuo from what it is elsewhere. But I refrain from trying to take an advantage from the wording of the Act; and besides, I do need for my case the words inserted after vacuo "in London," if the legal weight is to be taken as the force of one pound. As the standard piece of metal is kept in London, and is not likely to rust or decay, and possibly its inertia keeps constant and is not affected by temperature, as Prof. Fitzgerald has suggested, perhaps we may concede the following as a definition of our absolute unit of force: the force of one pound is that which would give to a body of 32.18 times the inertia of the standard object

kept in London, an acceleration of 1 foot per second per second.

If, however, engineers are to undergo any continuation of the persistent scorn of the last thirty years, let our scorers show some scientific knowledge of our position, and let us hear no more of the engineers' unit of force being the force of gravity anywhere or everywhere upon the standard weight.

As for our useful term *centrifugal force*, even our worst opponents are beginning to find out that there was a third of Newton's laws of motion, and that we may ask: If a body is acted upon by centripetal force, there is an equal and opposite force acting; and if it is not the body that exerts this force, what is it? If the body exerts this force, surely we have a right to call it the centrifugal force of the body.

I would, therefore, make an appeal to our academic enemies: Your students are nearly all young engineers of one kind or another. Why not be satisfied with teaching them about absolute units only—the C.G.S. and the foot, second, force of one pound, system?

You now use three others: the so-called British or poundal system, the gramme gravitational and the pound gravitational systems. It is only, after all, an error of judgment, like the crime of Surajah Dowlah or the St. Bartholomew, and you probably do not know what a complicated mess you make of a young engineer's mind; and we are quite willing to imagine that it is only ignorance and prejudice, and not antagonism to education that impels you to retain this want of system. But one effect is this. Your finished engineering students cannot get into works without paying high premiums; such is the prejudice of the experienced engineer against college-bred men, a prejudice which I myself would again have if I were again to act as a manager of works.

Every now and again an academic friend will say such things as these, "Well, if he cannot take in these ideas, he is not fitted to be an engineer." "If he has all that difficulty about Euclid, he is not fitted to be an engineer." And these academic statements are made about young men who are heaven-born engineers, fellows who never tire of fiddling with engineering things, and who are sure to succeed in actual engineering work, and who, when they do succeed, will scorn the idea that there is any use in a scientific education, and "what for no?" I am very thankful that entrance to all professions is not by examination. Our friends, worshipping the German soul-destroying educational fetish, insist on the very worst system of education for the average Englishman; and when a healthy young soul refuses to be destroyed, you punish its owner by shutting him out of the very professions for which he is best fitted by your wretched examinations. You say he cannot think, and you actually make him believe it too, because he refuses your Duchaylus' proofs and the metaphysics of Alexandrian philosophers. He ought, I suppose, to be grateful that you do not insist on his spending a year in learning the Trirème method of multiplication, or what right he has to say that one line is twice the length of another. Alice's White Knight was not more protected from imaginary dangers than the young men who now are being prepared for their life's work by a wasteful and pedantic trifling

with the metaphysics of physics: Euclid, logic, and the snakes of Iceland!

Although I feel so strongly about the necessity for experimental or kindergarten methods of education being adopted, I do not wish to blame the author of this book. Teachers of mechanics will find it an excellent textbook.

JOHN PERRY.

#### THE FORMATION OF THE FAMILY.

*Die Formen der Familie und die Formen der Wirthschaft.*

Von Ernst Grosse. Pp. 245. (Freiburg and Leipzig: Mohr, 1896.)

PROFESSOR GROSSE, as appears from his preface, took up the anthropological problem of the development of the family, but soon judged the preliminary studies as yet available to be insufficient to enable him or any one else to carry out such a task. Therefore, as a contribution to the work, he set himself to examine the relation of the family systems of the world to one great factor of civilisation, namely the provision of subsistence. The task was judiciously chosen, and students will acknowledge that in his attempt to carry it out, Prof. Grosse makes a contribution of value to the clearing and ultimate solution of the problem. His plan is to divide mankind according to their "Wirthschaft," or economic life, into five classes—the lower and higher hunters, the herdsmen, and the lower and higher agriculturists. He then examines the correspondence between these stages of society and the different forms of family, class, and tribe. At the outset this comparison tells against a state of matriarchal anarchy having ever prevailed among the human species. The low tribes subsisting by hunting, fishing, gathering wild fruits and digging roots, a condition which apparently represents that of primitive man, tend to live in separate small families under a rude patriarchal system extremely unlike promiscuity or communal marriage. Prof. Grosse is enabled by this evidence to fall into line with the increasing number of anthropologists who reject theories of primitive promiscuity. Among modern systems of social development founded on this chaotic basis, that of Morgan in his "Ancient Society" is here mentioned as the most eminent, with a remark which will somewhat surprise English readers, that it has given the American sociologist a place of honour among the Fathers of German Social Democracy (p. 3). In England it is doubtful whether the artificial social scheme of Morgan's later years ever made converts to any serious extent, notwithstanding our high regard for his early work of observation and collection of facts. Considering that Morgan was an adopted Iroquois, living in a Seneca tribe for years as one of themselves, the statement here made (p. 152) is quite inadmissible, that his description of the Iroquois clan-system, which was the starting-point of his anthropological work, was founded on the remarks of Father Lafitau in the last century. Passing on to the chapter in which Prof. Grosse deals with the lower agricultural tribes, we find an important addition to the theory of the maternal or matriarchal system. As hunting and herding belong to the men, so at first agriculture belonged to the women, as it still does among the less civilised peoples. Out of the plant gathering, which is

the business of savage woman, arose the invention of agriculture. On this reasonable hypothesis Prof. Grosse accounts for the unquestionable fact that among the Iroquois the women were owners of the soil they tilled and the crops they reaped, and that similar cases are still to be met with among the Balonda in South Africa and the Kocch in Bengal, always in connection with inheritance on the mother's side. As Prof. Grosse reasons (p. 160), we have here a state of things out of which the maternal family, growing into the maternal clan, would naturally arise. The present reviewer has of late years advocated the opinion that the maternal form of society is mainly connected with the husband not taking his wife to his own home, but living in her family, so that her side of the house naturally prevails (see *Nineteenth Century*, July 1896). It is obvious that wherever the land belongs to the women, this would especially tend to happen. As, however, the maternal family and clan appear already among hunting tribes who do not till the soil, it is plain that the full origin of the matriarchal system cannot be sought in the modes of subsistence which come within Prof. Grosse's method of comparison. The same is true of the custom of exogamy, prevailing as it does among hunters, herdsmen, and tillers of the soil. Prof. Grosse's incidental remarks on exogamy, as derived from aversion to marriages of near kin, need not be criticised here, the value of his work being rather in his systematic comparison between the economic and the social sides of human life, which leads him to the conclusion that in every form of culture that form of family organisation prevails which is adapted to economic relations and wants (p. 245). Readers who cannot accept so extreme a claim for the effect of these economic influences, will at least admit their great importance.

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#### OUR BOOK SHELF.

*Annales de Géographie*, No. 23.—*Bibliographie de l'Année* 1895. I. Partie générale; II. Partie régionale. Avec un Index alphabétique des auteurs, analysés, et cités. Pp. 288. (Paris: Colin, 1896.)

THE problem of bibliography threatens to become the most absorbing practical question for all scientific workers. It is not yet quite the time to discuss a proposition to sweep away all previous records and begin afresh; but the time has come for at least producing some sort of classified subject index to all branches of contemporary work. The editors of the *Annales de Géographie*, the foremost French journal of scientific geography, have brought out as their September number a bibliography of geography for 1895. This does not profess or attempt to be exhaustive, but the 1087 titles recorded have been carefully selected, and nothing of the first order of importance seems to be omitted. Notes are appended to each title, not in the nature of criticism, but simply as an indication of the contents of each book or memoir; and these notes are admirably done. They are the work of forty-nine contributors, and each is signed.

The division of the subject is primarily into general and regional geography. The former is divided into *History of Geography*; *Mathematical Geography*; *Physical Geography*, subdivided into geology (*i.e.* in its geographical aspect) and orography, climatology, botanical geography, zoological geography, oceanography, rivers and lakes; and *Political Geography*, under the heads races, states