

ferent as matter and force, it may be said that the two are in reality one definition. Suppose that a piece of metal, the standard pound, is hung on a spring balance. The position of the pointer on the scale is then marked 1 pound. A second piece of metal is substituted for the first, and if it brings the pointer to the same mark we say its weight is 1 pound. The 1-pound mark indicates two things at the same time, viz., that the quantity of matter in the second piece of metal is 1 pound, and that the force with which it is attracted by gravity is 1 pound. The word weight is thus logically and accurately defined by what may appear to be a double definition. No useful purpose is gained by applying another word "mass" to mean one part of this definition; on the contrary, the use of the word "mass" in this sense is the chief cause of all the confusion to which students are subjected in their study of dynamics.

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SPECIAL ARTICLES

A STRENGTH AND ENDURANCE TEST

SOME time ago one of the newspapers in Kankakee, Ill., arranged a strength and endurance test in which the contestants were to walk 10 miles, each carrying on his back a sack of sand weighing 100 pounds. The course was laid out over the city streets around several blocks, and to complete the test a contestant must cover it 12 times. According to the estimate of the county surveyor, the course was 4,320 feet (1,316.7 meters) in length, and the 12 laps fixed upon for the contest would, therefore, give a total of 9 miles and 4,320 feet (15.8 kilometers), or approximately $9\frac{1}{2}$ miles, instead of the estimated 10 miles. The contest required about 4 hours, beginning about two o'clock in the afternoon and closing at dark, which would be about six o'clock on a November day. Prizes were offered to all who completed the test, and special prizes of smaller value to all who completed one or more rounds. The contest was a public affair, and was witnessed by a large gathering of people who lined the streets

through which the contestants walked. A stand was arranged for the judges, and in every way provision seems to have been made to insure accuracy as regards entries, distance covered by each contestant, and so on.

Forty-eight men entered the contest. Of these 44 finished the first round, 25 the second round, 22 the third, 19 the fourth, 15 the fifth, 13 the sixth, 11 the seventh, 10 the eighth, 9 the ninth and 8 the tenth, while 6 completed the 12 rounds and fulfilled all the conditions of the contest.

The ages of the six successful contestants ranged from 21 to 52 years, four of them being 36 years old or over. Their body weight ranged from 150 to 255 pounds, the average being 189 pounds (86 kilograms). Of the 38 other contestants who completed one lap the ages ranged from 17 to 61 years, the majority being 30 years or over, while eight were over 40 years old. The body weights ranged from 120 to 200, being on an average 162.4 pounds (74 kilograms).

As shown by the account of the contest published in the Kankakee press, each of the six men who completed the course felt that he was in condition to continue for a longer distance, but this the management did not permit.

The men who entered the contest were residents of Kankakee and were of different nationalities, including Germans, Scandinavians, French Canadians, a Pole and a Turk, while, judging by the published list of names, about one third of them were Americans. The newspaper¹ under whose auspices the contest was held published a list of the winners, with names and addresses, and data regarding their age and weight, as well as a general description of the affair.

Through the courtesy of the editor of the paper, and by correspondence with a number of the contestants, including four of the six who completed the contest, additional data were secured, particularly with reference to the dietary habits of the men and their condition as regards training when they entered the contest. A circular letter of inquiry was sent to the successful contestants and to those

¹ *Kankakee Republican*, 1907, November 29, p. 1.

who completed one lap. Of the replies received four were from the successful contestants, and two from the group completing one lap, while one was unsigned and consequently the group to which the writer belonged is uncertain. It has seemed a fair assumption in discussing the results that he belonged to the larger group; that is, those completing one round and not the entire course. The circular letter made inquiry as to the number of meals eaten per day and as to whether the subject considered himself a medium, hearty or light eater, whether he was fond of athletics and kept in training, and whether his usual occupation involved any considerable amount of physical work. To obtain more specific data regarding the food, one of the questions was "Do you use all the ordinary foodstuffs and beverages such as are given in the following list? If there are any which you do not use, please cross them out." The list included bread, cereal foods, butter, milk, cheese, eggs, meat, vegetables, fruit, sugar, tea and coffee.

The majority of those who answered the questions considered themselves hearty eaters, and all habitually took three meals a day. One considered himself a medium hearty and one a light eater, while one did not specify.

As regards the ordinary foods included in the list, the answers received from the contestants show that, making allowance for some individual preferences, all these men lived on a mixed diet composed of the ordinary food materials, and it is probable that those who replied were fair representatives of the whole number participating in the contest. As regards individual peculiarities of diet, three of those who furnished information stated that they did not use cereal breakfast foods, and one that he used them only sparingly. One of the men ate little fruit except apples, and two used no cheese, while two used neither tea nor coffee and one other no tea.

In the case of the four winners of the contest it seems worth while to summarize in somewhat more detail the data furnished.

F. G., who was 24 years old and weighed 120 pounds (54 kilograms), stated that he was fond of athletics, and while enlisted in the

Illinois National Guards had military training once a week. He also stated that he walked to and from work, one and a fourth miles, four times daily, and considered that a good deal of physical labor was required in his daily occupation as a shipping clerk in a retail grocery house, as goods had to be looked over, checked and handled, and the various baskets of goods sent out weighed on an average from 5 to 100 pounds. He used all of the foods mentioned but stated that only a little cereal breakfast food was used and that apples were the fruit commonly eaten.

C. H. C., whose age was 40 years and whose weight was 255 pounds (116 kilograms), stated that he used all the foods mentioned in the list, but that as regards vegetables, turnips and cabbage were only used raw, while onions were not eaten at all. He stated further that he had not engaged in any form of athletics since 18 years of age. He believed that his ordinary work involved considerable muscular labor, but further details were not given.

J. B., who was 52 years of age and who weighed 180 pounds (82 kilograms), stated that he did not engage regularly in any athletic exercises, but believed that considerable muscular work was required by his daily occupation. No further details were given on this point. As regards the character of his food, he stated that he used bread, cereal breakfast foods in limited quantity, butter, milk, cheese very sparingly, eggs, meat (mostly salt pork), vegetables, fruit, sugar, and both tea and coffee in limited quantity. A diet in which salt pork is the principal meat, with eggs, bread, fruit and vegetables would seem to resemble more closely than any of the others the diet which was once very characteristic of farms in many localities, but which is less common now than formerly, owing to a greater abundance of ice for keeping fresh foods and to improved methods of transportation and other modern conveniences. J. B., who was the oldest of the successful contestants, believed that he could have carried the load of 100 pounds for 15 miles.

G. H., the remaining successful candidate who supplied data, stated that he was 21 years

old and weighed 150 pounds (68 kilograms). He was not fond of athletics and did not keep in training, though he believed that his usual occupation involved a considerable amount of physical work. As regards food, he stated that he used bread, butter, cheese, eggs, meat, fruit and coffee, and that he did not use cereal foods, milk, vegetables, sugar and tea. He considered that he ate a medium amount, as distinguished from the other three successful contestants quoted, who stated that they were "hearty eaters."

Judging from the data summarized, it appears that although there were some individual peculiarities in the selection of food, all four of the successful contestants who supplied data used a mixed diet, made up of the ordinary food materials, and the same was true of the other three men who furnished information.

The question of energy expenditure in walking has been exhaustively studied under a variety of conditions by Zuntz and his associates. According to the data obtained by Zuntz and Schumburg² with soldiers marching on a level, the energy expenditure for motion of forward progression averages 0.52 calorie per kilogram of body weight per 1,000 meters. Practically the same figures for energy expended in walking on a level have been reported by Durig,³ in his study of respiratory quotient and energy expenditure of men marching on a level, at low and high altitudes.

When consulted regarding the probable energy expenditure under the conditions of the Kankakee contest, Professor Zuntz stated that he was of the opinion that a special factor should be used for the load carried, and that not less than 0.6 calorie, perhaps even 0.7 calorie, per kilogram of load per 1,000 meters of distance covered would be a proper factor.

Taking into account the above-mentioned values, the calculated average energy expenditure of the six successful contestants would be

²"*Physiologie des Marsches*," Berlin, 1901, p. 299.

³*Denkschriften der Mathematisch-Naturwissenschaftlichen Klasse der Kaiserlichen Akademie der Wissenschaften*, 86 (1909), pp. 242-291.

1,137 calories, of which 707 would represent the energy expended in moving 86 kilograms, the average body weight, over a distance of 15.8 kilometers, and 430 calories the energy expended in moving over this distance the load which was carried.

As regards the individuals who completed the entire course, the calculated energy expenditure for F. G., who weighed 54 kilograms, would be 874 calories, of which 444 calories represents the energy expended in moving the body over the course, and 430 calories that for the load. The energy expenditure for C. H. C., who weighed 116 kilograms, was calculated to be 1,383 calories, of which 953 calories represents the expenditure for the body, and 430 calories that for the load. For J. B., who weighed 82 kilograms, the calculated energy expenditure would be 1,104 calories, 674 calories representing the expenditure for the body and 430 calories that for the load. G. H. weighed 68 kilograms, and in his case the energy expended in carrying the load over the full course would be 989 calories, of which 559 calories represents the expenditure for the body, and 430 calories the expenditure for the load.

In the case of the 38 other men, with an average weight of 73.8 kilograms, who completed one lap in the contest, the calculated energy expenditure would be 84 calories, of which 49 calories represented the energy expended for forward progression of the body, and 35 calories the energy expenditure involved in carrying the load.

Thirteen men completed half the course. Assuming that their average body weight was the same as the average for all the men who completed one round, namely, 75 kilograms, the calculated average energy expenditure would be 523 calories, of which 308 calories represents the expenditure for moving the body over the course, and 215 calories represents the energy expenditure for moving the load.

Like most towns in the middle west, the streets of Kankakee are comparatively level. However, in the account quoted it is stated that there is a grade of about 9 feet per hun-

dred on one of the streets over which a part of the course was laid. This, if it constituted any large part of the whole, would naturally increase the work performed, but apparently the greater part of the course was over streets with very little grade.

Since accurate data regarding the grade of the entire course are not accessible, it has seemed best to compute the results in detail without trying to take it into account. The organizers of the contest were of the opinion that the grade mentioned made the 10-mile course equivalent, in its demands upon the men, to a level course of 15 miles. If such an assumption be made, it would mean an average energy expenditure of 1,706 calories for those who completed the test.

As a result of the Department of Agriculture experiments with the respiration calorimeter, it has been calculated that a man at ordinary work, such as that of a mason or a carpenter, expends in the performance of his daily work, at least 1,200 calories. This means that the average energy expenditure of the man in performing the work of a contest which lasted four hours was greater than the above value for a day's work.

From a single test and so limited data it would be manifestly unfair to draw sweeping deductions regarding the character of the food in its relation to endurance. It is nevertheless a fact that the four successful candidates who furnished data lived on the ordinary mixed diet of the average citizen, and from all the information collected the same was true of all who entered the contest. This contest is of interest on this account and also because the endurance feat undertaken is comparable with the ordinary forms of muscular work which pertain to usual vocations, and so may be fairly considered as furnishing some indication of the fitness of the subjects for successfully engaging in occupations involving manual labor.

The total number completing the trial of strength is small (6 out of 48) in proportion to the total number of entries, but the number (44) of those who carried the 100-pound weight for nearly one mile is large, while it

was not until the men had passed the judges' stand four times that the number of contestants dropped below 20.

It seems fair to conclude that the men who engaged in the contest were, as regards their food, their occupation and their general living conditions, representative of the very large group of our population who are living comfortably and meeting their daily obligations in a creditable manner, who are, in fact, living the average life of the average man, with its varied activities and interests.

In so far as the recorded data throw light on the subject, they indicate that the average man living the average life is capable of meeting body demands of considerable severity—a conclusion which perhaps few would question, but which it is interesting to consider in the light of numerical data.

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THE USE OF ACID SOIL FOR RAISING SEEDLINGS OF
THE MAYFLOWER, *EPIGAEA REPENS*

MAYFLOWER or trailing arbutus (*Epigaea repens*), probably the best beloved of all the wild flowers of the eastern United States, is rarely seen in cultivation. It usually does not survive transplanting. No evidence has yet been found that flowering plants have ever actually been raised from the seed.

The development of a system of cultivating the swamp blueberry (*Vaccinium corymbosum*), by the use of acid soils,¹ suggested that a similar method might succeed with trailing arbutus, because the two plants have the same natural habitat, and because a symbiotic root fungus similar to the beneficial and probably indispensable root fungus of the blueberry was found to occur on trailing arbutus.

Seeds were procured in New Hampshire in July, 1909. They were sown in a mixture of kalmia peat, sand, and sphagnum. They germinated in August. After successive trans-

¹"Experiments in Blueberry Culture," 1910 (Bulletin 193, Bureau of Plant Industry, Department of Agriculture).