

(1) A river is flowing at three miles an hour. If two steamers are ascending the river, making headway at the rate of three miles an hour, one propelled by the action of paddle wheels or a screw, and the other pulling itself up by means of a chain laid along the bed of a river, the former will have to exert twice the horse-power of the latter, although the resistance overcome and the distance travelled in any given time are the same in both cases. Why is this?

(2) If a man is standing in an express train going at sixty miles an hour, he will have to perform exactly the same amount of work to throw a body of mass 1 lb. forwards with a relative velocity of sixty miles an hour as if he threw it backwards with the same relative velocity.

Yet in the former case the kinetic energy of the mass is increased from 121 to 484 foot pounds, while in the latter it is decreased from 121 foot pounds to zero. The actual work done by the man is in every case 121 foot pounds. This result has the appearance of being in contradiction with the principle of work.

I have known many Cambridge lecturers who, when they attempted to solve problems of a similar character, arrived at very different results. I am able to account for the apparent contradictions of the principle of conservation of energy, although I did not learn to do so from text-books. The majority of readers of NATURE are also, doubtless, competent to explain them in their own way and to their own satisfaction. But a student reared on the conventional text-book cannot fail to think (if he exercises his thinking powers at all on the subject) that the laws of dynamics must be at fault somewhere.

G. H. BRYAN.

The Universities and Technical Education.

HAVING just read Prof. Perry's address on "Oxford and Science," I am tempted to give my own views on technical education for the Government service, and especially for the service of India, with which I have been connected since 1869. My qualifications for this discussion are chiefly that I was Director of the Imperial Forest School at Dehra Dun, in India, for five years, and Deputy Director of that school for four years, and during those nine years I always instructed the students personally in one of their branches of study. The excellence of the Dehra Dun Forest School has lately been recognised by the French Government, which has decided to send its Tonquin and Cochin China foresters there to complete their technical training, after having learned European forestry at Nancy.

My experience in India has been that men who have taken university honours degrees in science make the best scientific Government servants, but need special training at a technical college to complete their education for the public service, just as candidates selected for the Indian Medical Service, after receiving a thorough European medical training, complete their education at Netley. The Government of India fully recognises the advantages of a university training for its administrative and judicial service, commonly known as the Indian Civil Service, of which it is the most important branch, also for its Educational and Geological Departments, and the head of the Indian Meteorological Department always comes from a university. Why not also candidates for its Engineering and Forestry Departments? For these important departments, at present, boys are recruited chiefly from the public schools, where they may or may not have acquired the rudiments of scientific knowledge. Surely better candidates could be obtained if the age-limit were raised, and men trained in science and who have obtained an honours degree at a university were taught the technical part of their business at a well equipped Government college, such as the Royal Indian Engineering College, Coopers Hill.

At present there is too much overlapping of studies at technical colleges, and immature students are hurried through their preliminary scientific studies and have not the necessary time to devote to subjects which will form their future life-work. The London medical schools are instances of this. With the best clinical instruction available at the London hospitals, each of these institutions maintains with difficulty a more or less complete staff to teach botany, physiology, &c., which should be taught at a central university. There would be a great saving of expenditure at technical colleges, and much greater efficiency, were the

scientific education which is a necessary preliminary to technical knowledge acquired under the distinguished guidance of university professors. By passing through a university, candidates for the higher posts in the Government service would experience the excellent social atmosphere of the university by mixing with men who are preparing for all the different professions and positions in life, and would have a much broader training than is possible at a purely technical college, where there is always the danger of narrow views, and of the overcrowding of subjects of instruction.

I hear that men who have taken a degree at Cambridge in the excellent mechanical school there are readily admitted without paying fees to complete their technical training in large engineering workshops, and surely a wider knowledge of engineering could be obtained at a Government college, such as Coopers Hill, than at any private engineering workshop, where the work done must be of too special a character for Government service. The University of Cambridge does not contemplate being able to turn out finished engineers, but only men preliminarily trained for engineering, neither does it contemplate educating practical foresters, but merely men who have obtained a diploma in the theory of agriculture and forestry. There is a demand in the colonies, as well as in India and Egypt, and by some foreign countries, for English-speaking professors of engineering and forestry, as well as for trained engineers and foresters, and at present the supply of such men is quite inadequate, and frequently these appointments are given to foreigners, simply because properly trained men from our country are not available.

Forestry can be admirably taught at Coopers Hill, with 14,000 acres of the Windsor Forest at our doors, and with examples of forests at Alice Holt Wood, in the Chiltern Hills, and elsewhere, easily accessible by train. The splendid forests of the north of France are within a day's journey, while, after a six months' practical training in the German forests, no forester in the world can be better equipped than are our students. Were our first year students university men instead of schoolboys, America and the colonies would be tempted to send us more students, and one of the finest technical colleges in the world might be easily established.

Coopers Hill, January 1. W. R. FISHER.

Prof. Johannsen on Heredity.

I SHOULD be glad if you would allow me space for some remarks on two recent reviews of Prof. Johannsen's "Erblichkeit in Populationen," in the last issues of *Biometrika* and of NATURE (December 17) respectively, the former signed by Prof. Pearson and Prof. Weldon.

I find it difficult to understand Prof. Johannsen's book in the sense in which the reviewers have, apparently, read it. In both notices it is stated that, if the author's views were correct, the correlation between mother and daughter plants should be perfect. As I take it, however, Prof. Johannsen's view does not imply, and is not consistent with, such a hypothesis; he believes, and adduces evidence to show, that within the pure line "Der Rückschlag ist vollkommen, ganz bis zum Typus der Linie," and explains the result on the hypothesis that the germ-plasm structure (or whatever we may term it) for the pure line is constant, the variations purely somatic. Neither the existence of zero correlation between parent and offspring nor the assumed somatic character of variations, within the pure line, is consistent with perfect correlation between parent and offspring for the race at large. This misunderstanding, in my view, is fundamental.

With reference to the concluding paragraph of the review in NATURE, it may be pointed out that Prof. Johannsen undertook the definite task, clearly stated, of elucidating the nature of intra-racial heredity by the study of heredity within the pure line, *i.e.* the offspring of one self-fertilised individual. He has shown that the intensity of heredity between the first two generations sprung from such a single individual may be vanishingly small, although it is quite sensible within the race at large. The result is of great importance both as regards the theory of heredity and the practice of breeding, and the work cannot be termed in any sense a failure.

One would, certainly, wish that Prof. Johannsen had employed more advanced statistical methods, and one may