Letters to the Editor.

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Mersenne's Numbers.

IN my presidential address to Section A of the British Association, reprinted in NATURE (September 16), I stated that 137 was the least value of n for which the prime or composite character of $2^n - 1$ was still undecided. Mr. W. W. Rouse Ball has pointed out to me that this is incorrect, as $2^{137} - 1$ has been shown to be composite by M. A. Gérardin (*Comptes rendus du Congrès des Sociétés Savantes*, 1920, pp. 53-55). The result is quoted in *The American Mathematical Monthly*, vol. 28, 1921, p. 380. The number 139 should therefore be substituted for 137 wherever it occurs in my address.

The authorities on which I relied were Prof. L. E. Dickson's "History of the Theory of Numbers" (vol. 1, Washington, 1919) and the seventh edition of Mr. Rouse Ball's "Mathematical Recreations" (1917, now superseded by the tenth). My quotation from Mr. Rouse Ball was taken, as I stated, from a pamphlet written thirty years ago, and is, of course, not to be interpreted as an expression of his present view.

G. H. HARDY.

New College, Oxford, October 4.

Animal Mechanism.

THE notion that the legs of animals behave as pendulums is ascribed to the brothers Weber. I can find no indication that the notion was more than a general one, and, in the general sense, when pointed out, it is obvious to a student of dynamics, for legs have inertia and weight and dynamics is reasonably near to the truth.

A better view may arise from the supposition that animals may be regarded as dynamical systems with many natural modes and frequencies, and that animals adapt their methods of locomotion and other actions to suit these fundamental characteristics. As examples, we have the lounging gait of very tall men and the apparently energetic step of short men. The tripping, half running step of women and children is also in point. Apart from mere legs the moment of inertia about the feet must be important, as may be seen in the stately carriage of quite short women in the East when carrying water vessels on the head. Sir George Greenhill has given several examples of this in his notes on dynamics, among them being interesting examples of the carrying of soldiers' kit.

A further point of interest arises in regarding legs a little closely, for they are not simple but multiple pendulums with more than one natural mode. When a horse or man is walking the leg appears to vibrate in the slowest mode of the pendulum and the joints are or appear to be on one side of the vertical. In the running gait, however, the thigh points forward while the lower parts point backwards. Probably the "reason" why a horse's forelegs are more flexible than the hind legs is to make him nimble in balance and steering; a horse could not stumble with his stiff hind legs.

The dynamics of locomotion is of interest to the student of engine balancing, for in the natural gaits of man and horse there is a utilisation of balancing principles. In man the right leg moves forward while the right arm moves backward, in the horse the right legs are always moving in opposition and similarly the left legs, of course. This holds for the walk, the trot, and the gallop, all natural modes. In the amble, an artificial stride due to the trainer, the legs on either side are in phase and an ungainly motion results, though it is comfortable for the rider. This amble stride is natural to the giraffe, but the latter has a long neck to give it poise. The balancing view of animal locomotion may be realised at once by any one who will try to run with stiff arms or will try to walk with his arms tucked up in the running posture. The runner is compelled by dynamics to move his legs in a quicker mode than when walking. His arms are so jointed that he cannot alter their type of vibration, and he is therefore compelled to reduce their inertia in order that they may oscillate in time with his legs. The balance from the engineer's point of view is imperfect, and thus stresses are imposed in the trunk. Hence sprinters are well-bodied men and horses need girth for speed. As a final example of these facts, let any one try to run to the station with a heavy suit-case in his hand. Porters usually carry such things on their shoulders and stride rather slowly.

There is a further point of interest in connexion with the viscera. If dynamics is true, the various internal organs have inertia and their attachments have elasticity; thus they must possess natural frequencies. This being so, they must be subject more or less to the phenomena of resonance. Is sea-sickness, subjective agencies apart, to be explained in this way? Some people before embarking have a copious meal, others pin their faith and hope to a single bottle of stout, while yet others proceed fasting. Is this a phase of dynamical tuning? In 1914 I read a short paper on the dynamics of the human foot at the British Medical Association's summer meeting. The outcome of the discussion was that tonicity was more potent than mechanics, or, in other words, living tissue may vary in its properties on account of tone or debility to a degree which will exceed the influence of configuration. The contention would be that while astringents or food may alter the effects of a sea voyage, the action is due to dynamical effects; the inertia of the stomach or the stiffness of its suspension is varied—opiates and such like are here excluded.

A medical writer of some eminence recently advocated walking because "Nature has ordained that the finest exercise of all is that which she bestows." While this is reminiscent of Heine's "Harzreise," the greenness of grass and the length of a donkey's ears, there is in it matter for reflection. Motor car designers, led by Dr. Lanchester, have found that the most comfortable predominant natural frequency of a motor car is between 80 and 100 per minute; it is a curious coincidence that this is also the frequency of the ordinary walking step. Has the human system, enforced by dynamics to walk in a certain rhythm, acquired an internal system and a nervous organisation to meet this rhythm? It is worthy of note that in certain cars several dogs and children have been actually and violently sick and in other cars sprung to vibrate with a different natural period they are immune. Shall we, disagreeing with Shylock, say, "It is not their humour, but their natural frequency"?

H. S. ROWELL,
Director of Research,
Research Association of British Motor and Allied Manufacturers.

15 Bolton Road, W.4, September 20.