assumptions or deductions. Even granting that they could, if the pulse-pressure × pulse-rate product is made to vary in the same heart by artificial means, other factors may come into play, and I know no evidence to suggest that the equation would hold good under any but normal conditions; on the other hand, if only a few different hearts are compared under constant conditions, we are not dealing with mean values but with individuals.

The real point at issue is whether the pulse pressure is a factor at all in the actual work done. I cannot agree to the contention that the energy expended "is in no direct manner connected with the pulse pressure." It seems reasonable, however, that the mean pressure should also be taken into account. In the somewhat analogous problem of a pump working against gravity, the work done per "beat," ignoring the kinetic factor, is proportional to cross-section of pipe × mean height of fluid × change in level of fluid; and if the fluid level be restored to its original height by a siphon before the next beat, a further multiplication by number of beats per minute gives an expression for energy output per minute. Applying the analogy to the circulation, the mean cross-section of the arterial system at ages during growth may be assumed to vary as the mean cross-section of the body, or as the mean square of a linear measurement such as the stature at those ages, and the other factors in the expression are represented by mean blood pressure, pulse pressure, and pulse rate. The values of the fourfold product at ages from 10 to 21 (using smoothed figures from the curves and dividing the results throughout by 10^6) are :—

10. 4466.	13. 6863.	16. 11,264.	19. 10,992.
11. 5075.	14. 8155.	17. 11,765.	20. 10,670.
12. 5861.	15. 9927.	18. 11,465.	21. 10,490.

This method leads therefore to precisely the same conclusion as before, namely, that "when the age of 16 has been reached the average heart is performing as much or more gross work per minute than in adult life in spite of the fact that it has presumably not attained full size"; the maximum, as before, occurs about 17.

PERCY STOCKS.

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London, January 26.

I REALISE that Dr. Stocks, when making his initial assumption that the energy expended by the heart per minute was proportional to the product of the volume of blood expelled at each systole, the number of beats per minute and the pulse pressure, intended this assumption to apply merely to the relationship of the mean values of these factors in large groups of individuals. I do not see, however, how this makes the assumption any the more justifiable. The real point at issue is, as Dr. Stocks himself mentions in his letter, whether the pulse pressure is a factor in the expression for work done.

In the "somewhat analogous problem of a pump working against gravity," the work done per beat is admittedly proportional to the product of the capacity and intensity factors, namely, cross-section of pipe × change in level of fluid and the mean height of the fluid respectively. In the case of the heart the pulse pressure, if it is of any significance as an indication of energy expenditure, must be shown to be related to either the capacity or the intensity factor of this energy. There seems to be no justification for including it in the former, especially since the mean output per beat for large groups of growing individuals is assumed to vary directly as the mean body weight. Similarly, to include it in the latter seems equally unjustifiable, seeing that the intensity factor in cardiac work, as was pointed out in the review, is the mean blood pressure during the ejection phase of systole. Accurately to determine this mean it would, of course, be necessary to know the average time course and to take the integral of this. This is, however, impossible in man, but the true figure may be approximated to sufficiently accurately if we take in its stead the mean between systolic and diastolic pressures.

If this is done and the product of body weight and mean pressure between the systolic and diastolic levels determined for different age groups, it will be clear that the figures do *not* show any maximum at the age of 16 or 17 years. One may conclude from this that at no period during adolescence is the average heart performing as much work per beat, or taking pulse rate into consideration, per minute, as in adult life.

THE REVIEWER.

Diamagnetic Orientation.

GLASER, in a recent paper (*Ann. der Phys.*, 21, 459, 1924), of which a short account was given in NATURE, January 10, p. 64, has shown that the apparent molecular diamagnetic susceptibilities of H_2, N_2 and CO_2 are three times as great at low as at ordinary pressures. He attributes this to orientation, the tendency to orientate being counteracted at higher pressures by the effects of molecular collisions. He is unable, however, to account for the factor 3 in this way.

If the molecules tend to orientate with their axes along the direction of the field, this factor may be easily accounted for. Owing to the relatively large mass of the nuclei, it is only about the line joining them that the molecule will acquire an appreciable magnetic moment under the influence of the field, the effective field being the component of the external field along the direction of this axis. The ratio of the apparent susceptibility for fully orientated molecules to that for molecules orientated at random will then be $1/\int_0^{\pi/2} \cos^2\theta \sin\theta d\theta = 3$.

The importance of extending the measurements to monatomic gases need scarcely be emphasised.

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January 21.

Animal Mechanism.

WHEN a swan is rushing to the attack of an adversary, the head is lowered and the neck is protended almost horizontally. I had always associated this posture with mere anger, but, during the excessive Thames floods of last December, when swans could often be seen striving against the stream, sometimes, so far as could be judged, in the apathetic state of desperate exhaustion, the same pronation of the neck was frequently evident.

The explanation seems to be dynamical, for the reactions on the feet of the bird would, without the counterpoising action of the neck, tend to rotate the body about a horizontal axis, head backwards. Air resistance also plays a part.

It is of interest to note that the racing motor-cyclist, in his unreasoned but experimentally justified preference for forward weight, has found a solution akin to that of the swan. Many sprinters, especially when starting, use the same principle.

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February 11.