Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Constitution of Tungsten.

AFTER many earlier unsuccessful attempts, I have now obtained the mass-spectrum of tungsten. As in the cases of the lighter members of the same group, chromium and molybdenum, success was made possible by the preparation of the volatile carbonyl, $W(CO)_6$, by Dr. A. v. Grosse, of Berlin. It was to be expected from the greater atomic weight that the photographic effect would be feeble, and only by means of very sensitive plates were lines of satisfactory intensity obtained.

Tungsten proves to have four isotopes, of which the strongest two give lines of practically identical intensity. The mass numbers and provisional relative abundances are as follows :

Mass number . .	182	183	184	186
Percentage abundance	22·6	17·2	30·1	30·0

The packing fraction has not been measured with accuracy, but the position of the lines relative to those of mercury proves their correspondence to whole numbers within one part in two thousand, and the packing fraction curve also suggests a zero value. Adopting this, we get for the atomic weight on the chemical scale 183·96, in good agreement with the value 184·0 now in use. F. W. ASTON.

Cavendish Laboratory,
Cambridge, Nov. 28.

The X-Ray Interpretation of the Structure and Elastic Properties of Hair Keratin.

RECENT experiments,[1] carried out for the most part on human hair and various types of sheep's wool, have shown that animal hairs can give rise to two X-ray 'fibre photographs' according as the hairs are unstretched or stretched, and that the change from one photograph to the other corresponds to a reversible transformation between two forms of the keratin complex. Hair rapidly recovers its original length on wetting after removal of the stretching force, and either of the two possible photographs may be produced at will an indefinite number of times. Both are typical 'fibre photographs' in the sense that they arise from crystallites or pseudo-crystallites of which the average length along the fibre axis is much larger than the average thickness, and which are almost certainly built up in a rather imperfect manner of molecular chains—what Meyer and Mark [2] have called *Hauptvalenzketten*—running roughly parallel to the fibre axis.

Hair photographs are much poorer in reflections than are those of vegetable fibres, but it is clear that the α-keratin, that is, the unstretched form, is characterised by a very marked periodicity of 5·15 A. along the fibre axis and two chief side-spacings of 9·8 A. and 27 A. (? mean value), respectively; while the β-keratin, the stretched form, shows a strong periodicity of 3·4 A. along the fibre axis in combination with side-spacings of 9·8 A. and 4·65 A., of which the latter is at least a second-order reflection. The β-form becomes apparent in the photographs at extensions of about 25 per cent and continues to increase, while the α-form fades, up to the breaking extension in cold water, which is rarely above 70 per cent. Under the action of steam, hair may be stretched perhaps still another 30 per cent, but no other fundamentally new X-ray photograph is produced. The question is thus immediately raised as to what is the significance of a crystallographically measurable transformation interpolated between two regions of similar extent where no change of a comparable order, so far as X-ray photographs show, can be detected.

The elastic properties of hair present a complex problem in molecular mechanics which up to the present has resisted all efforts at a satisfactory explanation, either qualitative or quantitative. Space forbids a detailed discussion here of the almost bewildering series of changes that have been observed, and we shall merely state what now, after a close examination of the X-ray and general physical and chemical data, appear to be the most fundamental.

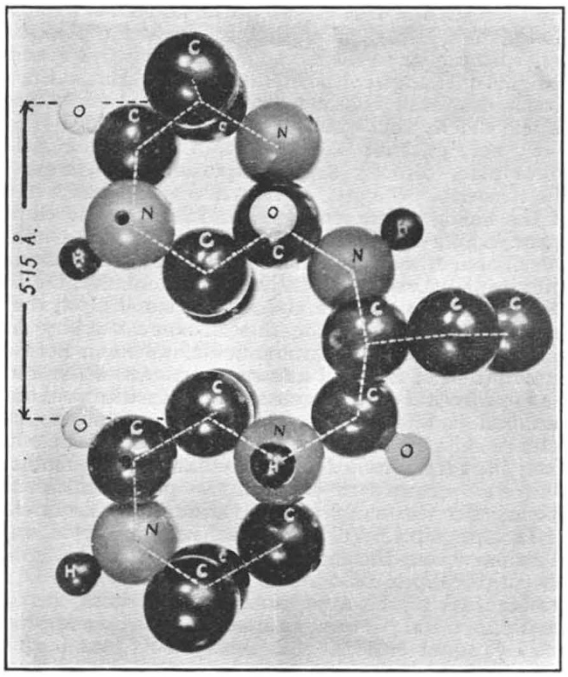

FIG. 1.

(1) Hair in cold water may be stretched about twice as far, and hair in steam about three times as far, as hair which is perfectly dry. (2) On the average, hair may be stretched (in steam) to about twice its original length without rupture. (3) By suitable treatment with steam the discontinuities in the load/extension curve may be permanently smoothed out, the original zero is lost, so that the hair may be even contracted by as much as one-third of its original length, and elasticity of form may be demonstrated *in cold water* over a range of extensions from −30 per cent to +100 per cent. (4) The elastic behaviour in steam is complicated by 'temporary setting' of the elastic chain and ultimately by a 'permanent setting' of that part which gives rise to the fibre photograph. (5) That part of the elastic chain which is revealed by X-rays acts *in series* with the preceding and subsequent changes.

On the basis of these properties and the X-ray data, it is now possible to put forward a 'skeleton' of the keratin complex which gives a quantitative interpretation of the fundamentals, and may later lead to a correct solution of the details. The skeleton model is shown in Fig. 1. It is simply a peptide chain folded into a series of hexagons, with the precise