

tool. It is for this reason, and not because these points are commonly worked on a tortoise core, that I propose for them the name of "tortoise point." But although the point is triangular in section in typical specimens, it seems that the blow on the convex surface of the core was not always successful, and in these cases matters were improved by a good deal of secondary working, so that points like those shown in Fig. 1, iii., are not uncommon. Further, although the great majority of tortoise points were worked on tortoise cores, the "point" was at times produced independently; thus Fig. 1, iv., reproduces the front part of a roughly bilobed pebble upon which a particularly good tortoise point has been worked.

The form of these tortoise points indicates that they were used as a heavy drawing tool, *i.e.* used with a drawing or dragging motion while the hand exerted considerable pressure. Additional evidence for this view is offered by a certain number of specimens in which the distal portion of the crest, *i.e.* that nearest the point, shows minute abrasions. The only method of holding the implement allowing this that I have been able to discover is to grip the base of the stone between the bent fingers and the ball of the thumb, the convex surface of the tool being towards the palm. The point is then brought in contact with the surface it is desired to cut or grave, the implement being but slightly inclined and drawn steadily away from the body. The suggestion may be made that these tools were used for cutting hides; such a point would furrow or cut a stiff, sun-dried hide, such as those used by the Veddas, just as it does a piece of stout millboard.

This form of implement has not, so far as I can discover, been recognised in Europe hitherto; it is certainly uncommon, for the Abbé Breuil tells me that he does not know of any example. Its existence is, however, suggested by the reproduction by Commont ("Les Hommes Contemporains du Renne dans la Vallée de la Somme," 1914, Fig. 59) of two "instruments moustériens" from the St. Acheul loess, of which one at least seems to represent the "new" implement.

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Molecular Structure and Energy.

THE difficulties with the Lewis-Langmuir theory expressed by Prof. Partington in NATURE of April 7 have been felt by the writer, and doubtless by others. They may, perhaps, be met in part by the following considerations:—

(1) In the case of molecules such as carbon dioxide and nitrous oxide the central octet is postulated as tetrahedral, with pairs of electrons at each apex, rather than as cubic. Such an arrangement would diminish rigidity in the axis passing through the three atomic nuclei and permit a measure of rotational energy about this axis. Again, it must be recalled that at higher temperatures the ratio of the specific heats for even diatomic gases falls below 1.4, and that this can well be accounted for by the increasing importance of energy of intramolecular vibration—that is, to-and-fro oscillation of the component atoms. In the case of triatomic gases such as carbon dioxide, the specific heat is much more affected by rise of temperature than in diatomic gases, frequencies of vibration in this case corresponding doubtless to the three well-marked spectral bands of carbon dioxide in the infra-red. For this reason alone the value of γ for carbon dioxide might well be expected to turn out, even at ordinary temperatures, lower than that anticipated for a gas with molecules exhibiting only two degrees of rotational freedom, provided that

vibrational energy in this case is not negligible at ordinary temperatures in comparison with translational and rotational energies. The halogen gases consist of pairs of atoms sharing, according to the Lewis-Langmuir theory, only one pair of electrons, which acts as though it were located at a point. It is worth pointing out that this less rigid connection permits the ratio of the specific heats for these gases to fall well below 1.4 even at ordinary temperatures, in consonance with the above suggestion.

(2) In the case of nitrogen the specific heat data offer no difficulty if, as may be inferred from the models of Langmuir and of Sir J. J. Thomson, the positive nuclei in their ovoid electronic envelope are sufficiently far apart to allow an appreciable moment of inertia in two directions of rotation.

As the writer has already hinted elsewhere, however, an acetylenic type of union of the two octets concerned may indeed prove more satisfactory in explaining other facts, such as those of molecular dimensions as estimated by Perrin or Rankine or such as will be brought forward in a forthcoming publication from this laboratory by R. N. Pease.

ALAN W. C. MENZIES.

Princeton University, U.S.A., April 19.

British Laboratory and Scientific Glassware.

THE inclusion of scientific glassware in the proposed Key Industries Bill seems to have aroused a sense of apprehension in some quarters, partly on the ground that if Continental products are prohibited users may not be able to procure satisfactory apparatus, and partly because it is feared that, if given comparative security in the home market, manufacturers may lose their incentive to improve the quality of their goods and increase prices unduly.

The lack of confidence in British chemical glassware expressed in certain quarters is probably due to unfortunate experience with some of the earliest productions of the industry, when the experience of the blowers was practically negligible and the demand for the goods so urgent that nothing usable was allowed to be sorted out.

Increased experience, both on the part of the actual glass-blowers in the manipulation of the glass and on that of the technical staffs in the methods of obtaining desired results, has achieved great improvement in the quality of the products, and the better classes of British laboratory glassware compare favourably with any other.

As regards the quality of the glass itself, very thorough tests have been made by a trustworthy and impartial authority (see Journal of the Society of Glass Technology, 1917, vol. i., p. 153), and in the conclusions arrived at appears the statement: "Taking all the tests into consideration, the six best glasses are B, C, D, E, F, and G, and this list includes all the British glasses in the market. . . . *Jena glass, A, comes seventh on the list.*" Samples of post-war Jena laboratory ware with the well-known "Schott" stamp are inferior in all but appearance to the pre-war goods.

Further scientific investigation into the problem of annealing laboratory glassware and the adaptation by manufacturers of the information so obtained have led to great improvement in the direction of reduced liability to cracking in use due to temperature differences. This was formerly a frequent cause of complaint, but methods of annealing now in use are so efficient that British laboratory glassware will fulfil any reasonable requirements.

The average standard of British graduated apparatus is distinctly higher as regards accuracy of

graduation than similar pre-war German articles. The British firms manufacturing scientific glassware are controlled by trained men of science who have had long practical experience in the use of the articles produced and appreciate fully the essential features of particular pieces of apparatus.

Manufacturers are desirous of meeting the requirements of consumers so far as possible, and if users of chemical apparatus would acquaint manufacturers directly with their special requirements and difficulties or offer practical suggestions for improvement, further advances might soon be made.

The advances that have already been made can be maintained and extended only if some measure of security is afforded to manufacturers. Up to date the industry has been largely in the experimental stage, and manufacturing costs have consequently been high. Manufacturers are faced with competition by imported glassware which is frequently sold under cost price in order to regain the British market. This, together with the present rates of exchange, deprives them of any incentive to put down fresh plant or to design new furnaces specially adapted to the manufacture of scientific glassware, which would render the products at the same time cheaper and of better quality.

The British manufacturer should have an opportunity in reasonable security to develop under normal conditions the industry he established with such success in the stress and strain of the war period. Should there ever be another war it is certain that the extension of "chemical warfare" would be on a scale far greater than anything experienced in the late war, and the position of this country would indeed be hopeless if it were dependent on imports for supplies of essential scientific and laboratory glassware. There would not again be an opportunity given for the industry to be re-created in time to be efficient.

J. H. DAVIDSON.

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Barnsley, April 13.

Protozoa and the Evolution of the Gregarious Instinct.

IN the *résumé* given in NATURE of April 14, p. 222, of the proceedings of the Academy of Sciences of Paris on March 21, mention was made of the observation by Mme. Anna Drzewina and G. Bohn that certain aquatic animals (*Convoluta* and the larvæ of *Rana fusca*) become grouped together and appear to emit a protective substance as a defence against toxins introduced into the water. That the congregating of protozoa in such circumstances had a protective value of this nature was suggested by me in a note to *Country-Side* (August, 1913, vol. v., No. 8, p. 541), where I pointed out that the combined effort of a number of organisms massed together would no doubt produce a greater antitoxic effect than could a single isolated organism surrounded on all sides by water containing toxin.

The grouping of protozoa can easily be observed if a slide be prepared of living infusoria such as are found during warm weather in flower-vases and examined under the microscope, when it will be found on applying a little vinegar to the edge of the cover-slip that these organisms become arranged in clumps or clusters, each individual being in a state of vigorous vibration. As is well known, a similar phenomenon occurs with bacteria under somewhat the same conditions, and is made use of as a diagnostic test by pathologists. Agglutination in such circumstances is usually regarded as a purely physical occurrence due to surface tension.

It appears probable that the crowding together of protozoa as a protection against toxins represents the dawn of a gregarious instinct. Many modern psychologists are in agreement that evolution of body and evolution of mind are parallel; that is certainly the case with the nervous system and the mind of the higher vertebrates. We should, therefore, expect to find in the simplest animals the beginnings of mind; and purposive behaviour—the characteristic of mental activity as distinct from purely psychochemical reaction—has already been shown to occur in certain protozoa by Jennings and others (Jennings, "Behaviour of the Lower Organisms," Columbia University Biological Series, 1906). Animals the behaviour of which is purely upon the instinctive plane, e.g. instincts, are provided with innate dispositions tending to their own self-preservation and to the preservation of their race. On the part of protozoa, protection against toxins in the water is a necessary precaution that has to be taken to safeguard the individual, and therefore grouping together to produce antitoxins may have been an early mode of purposive behaviour in the first living organisms, when toxins in the water in which they lived must have been one of the chief dangers besetting them in the absence of larger enemies. Probably, then, we have in this crowding together of protozoa the dawn of the gregarious instinct—the beginnings of that instinct seen in so many different groups of the animal series and terminating in its most highly evolved and complex form as a fundamental element in the formation of human society.

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London, April 21.

The Nature of Vowel Sounds.

PROF. SCRIPTURE's arguments on this subject which appeared in NATURE for January 13 and 20 last seem to me to be open to criticism. It is true, no doubt, that a strongly damped resonator may be excited by periodic impulses even when its free period is not an exact submultiple of the period of the impulses. But it does not appear justifiable to argue from this that the vibration so excited is inharmonic to the fundamental period. As an illustration of the error in the argument, we may consider the somewhat analogous case of the vibrations of the resonator of a violin. The bridge, belly, and enclosed air of this instrument form a resonating system having a series of free modes of vibration, which, especially those of higher pitch, are strongly damped by reason of the communication of energy to the external atmosphere and otherwise. These free periods are, in general, inharmonic to the fundamental period of the string. It is easily shown from the known mode of action of the bow that the force exerted by the vibrating string on the bridge changes impulsively from a positive to a negative value once in each period. If Prof. Scripture's argument were valid, we should be entitled to argue that the response of the bridge and belly to these discontinuous changes of force should be inharmonic to the fundamental period of the string. Actually, however, we know that this is not the case. The overtones which fall near the free periods of the resonator are, no doubt, strongly reinforced, but the motion of every part of the violin continues to be in strictly harmonic relation to the period of the forces impressed by the bow.

So far as I can see, there is no very vital difference between the dynamical principles involved in this and