

In professional gambling, dice are thrown along a plane surface of correct texture such as a billiard table. A die near the end of its course with just sufficient momentum to overturn it, if arrested by the surface will, if its frictional resistance is low, slip forward without overturning, but if sufficiently retarded by friction will turn over on to the next face. The result of this can be more easily seen by considering dice marked, as they frequently are, black and white on opposite faces. If the black faces have low and the white higher frictional resistance, a die on its black face will slip forward and stay on that face when one with the same momentum but on its white face will turn on to one of the four adjoining faces, two of which are white and two black. Assuming that there is equal probability of a die being on any one of its six faces before frictional resistance is operative, friction can thus cause a large bias, of limiting probability 3 to 1 in favour of the die coming to rest with one of the faces of higher resistance on top.

In order to test this effect of frictional resistance, I marked plain, transparent coloured dice of the modern type with a small black dot on three adjoining faces and a small white dot on the three opposite faces, and treated the faces having black dots in various ways with the view of increasing resistance to slip without leaving visible signs of treatment. Excellent results were obtained with a specially prepared slow-drying colourless varnish, undetectable

by appearance on the treated dice. When the varnish had hardened sufficiently, a slight difference of touch was detectable though not obvious. Numerous trials with treated dice thrown on a suitable surface, best on a billiard table, showed a most pronounced bias in favour of the treated sides with black dots turning up. The bias decreased as the varnish became harder, and was much smaller twenty-four hours later. The following throws made with a single die and grouped into hundreds are typical:

$$\frac{\text{black}}{\text{white}} = \frac{65}{35} + \frac{74}{26} + \frac{69}{31} + \frac{62}{38} + \frac{67}{33} + \frac{69}{31} + \frac{65}{35} + \frac{61}{39} = \frac{1.9}{1}$$

If two such dice are thrown, as in a common form of gambling, the probability of a pair of black against a pair of white is $1.9^2 = 3.6$ to 1.

With ordinary numbered dice with conical or hemispherical holes, it is possible that the frictional resistance may be increased or diminished with the number of holes according as the edges of the holes are sharp or rounded. Consequently, any observed bias cannot be attributed to displacement of centre of gravity unless the possibility of such bias being due to difference of frictional resistance has been eliminated.

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Points from Foregoing Letters

The uniform time of radioactive decay is identified by G. J. Whitrow with the t -time of kinematical relativity, according to which the 'age of the universe' is of the order 2×10^9 years. Since this is not the uniform time of dynamics, according to which the 'age of the universe' is infinite, a comparison is made between the dates assigned to various geological epochs by radioactive methods and the corresponding dates in dynamical time. It is found that the two measures of the whole fossil period differ by an amount not much greater than the probable error in estimating its duration by the present methods.

D. H. T. Gant has bombarded uranium with high energy deuterons, and by studying the decay curve of the recoiling fragments he has obtained evidence suggesting that radioactive nuclei are projected from the uranium target with a range of the order of 2 cm., due to a fission of the uranium nucleus. The threshold for the fission process appears to lie at about 8 Mv. and the cross-section increases rapidly in the range 8-9 Mv.

G. B. B. M. Sutherland and W. T. Tutte report that appreciable absorption in the infra-red region of the spectrum between 3μ and 10μ is exhibited by polymolecular films only a few hundred molecules thick. This rather surprising result opens up a new field of research in the application of infra-red spectroscopy to the structure of surface films, and may be of importance in studying protein molecules.

K. Imahori describes a photographic method of frequency analysis which can be applied to sound.

From powder photographs by A. Westgren and H. Åstrand, H. Perlitz and R. Aavakivi have calculated the atomic parameters of γ -silver-cadmium, finding by the method of successive approximations

values which gave calculated intensities in good agreement with those observed experimentally.

E. E. Broda, C. F. Goodeve, R. J. Lythgoe and E. Victor find that the iso-electric point of visual purple is 4.47 pH units, and that it undergoes a shift by 0.1 pH units to the alkaline side on bleaching to indicator yellow. This is taken to suggest that bleaching results in an increase to the number of alkaline groups available for ionization.

A special type of cell membrane is dealt with by E. J. Conway and P. J. Boyle which is both anion- and cation-permeable up to certain size limits of the ions. Potassium, for example, is considered permeable and sodium impermeable. In contact with ionic media like blood plasma, such a membrane will result in a high internal potassium concentration being in equilibrium with a low value outside, and certain relationships can be deduced which are shown to apply to excised muscle. A relation with carbohydrate metabolism, and the manner of the original entrance of potassium into cells, are suggested.

A. L. Hodgkin and A. F. Huxley describe a method for inserting an electrode into a living nerve fibre. They have recorded action potentials of 90 mv. across the surface of the fibre.

Respiration studies made by F. E. Allison *et al.* show that the inner tissues of legume root nodules are usually partially anaerobic. Both nodule and root tissues may produce or oxidize ethyl alcohol, depending upon the oxygen supply. The rates of carbohydrate consumption under ordinary atmospheric conditions by nodule and young root tissues are usually about the same. Attempts to obtain nitrogen fixation by detached nodules were unsuccessful.