# SCIENCE

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The American Association for the Advancement of Special Articles: Science: Overturning and Anchoring of Monolayers: Dr. IRVING LANGMUIR Scientific Events: Report of the Trustees of the Banting Research Foundation; Channel Islands National Monument; BANCROFT H. BROWN ... The Endowment of the Biological Sciences at the University of Chicago; The Annual Meeting of the American Society for Testing Materials; Vernon Lyman Kellogg; Recent Deaths Scientific Notes and News ...... lished every Friday by Discussion: Science and General Education: Professor Paul B. Sears. Grants in Support of Research on the Biological Effects of Radiation: Professor B. M. Lancaster, Pa. Duggar. Newton's Third Law: Dr. V. F. Lenzen 506 Annual Subscription, \$6.00 Societies and Meetings: Southwestern Division of the American Association

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## OVERTURNING AND ANCHORING OF MONOLAYERS\*

By Dr. IRVING LANGMUIR

ASSOCIATE DIRECTOR OF THE RESEARCH LABORATORY, GENERAL ELECTRIC COMPANY

In some studies of the mechanism of the flotation process made several years ago1 monolayers of oleic acid were spread on water, and by a dipping process were deposited upon solid surfaces of glass, platinum, mica, calcite, sphalerite and galena. With each of these solids no monolayer was deposited on the downtrip into the water, but on the up-trip the surface came out of the water initially wet and on top of the water film there was a monolayer of oleic acid. After the draining out or evaporation of the water film the hydrophilic groups in the oriented oleic acid molecules were brought into contact with the solid surface to which they adhered more or less firmly, depending on the nature of the solid. Repeated dipping into a clean water surface, dusted lightly with tale, proved that for all the surfaces except mica little or none of the oleic acid monolayer escaped onto the water.

for the Advancement of Science: VEON C. KIECH 508

Address of the vice-president and chairman of the Section of Chemistry, American Association for the Advancement of Science, Indianapolis, December 28, 1937.

<sup>1</sup> I. Langmuir, Trans. Faraday Soc., 15: 62, 1920, reprinted in G-E Rev., 24: 1025, 1921.

Two methods were used for detecting and studying the properties of these deposited monolayers: observations of the lubricating properties and of the contact angles given by drops of water placed on the surface.

The monolayers on the solid surfaces had an enormous effect upon the static friction of small glass sliders placed on the surface. On glass without the film the sliding angle was over 60°, but this was reduced to about 6° by the monolayer.

Drops of water placed upon a clean surface of any of these solids spread over the surface, wetting it completely, thus giving a zero contact angle, 0. The clean surfaces are therefore hydrophilic. After the oleic acid monolayers had been deposited, the surfaces became hydrophobic and the contact angles depended greatly upon the character of the underlying solid. With mica the angle was 18°, 45° for glass, 65° for platinum, 70° for calcite, 82° for sphalerite and 86° for galena.

Mica behaved differently from the other substances

quent than from the external callus. Most shoots arose from external callus produced by the pith and by the phloem, though in some cases the xvlem and endodermis also were involved to a small extent. These regenerated shoots always established organic union with the vascular tissue of the decapitated shoot and became functional.

This observation of shoot regeneration by cabbage following treatment with Beta (3) indole-acetic acid is not an instance of induction of a new characteristic by a chemical agent. Occasionally (very rarely) decapitated control cabbage plants produced shoots without application of the acid. The chemical treatment apparently merely induces the internal conditions requisite for expression of a capacity which normally rarely comes to expression in the cabbage plant.

ETHEL GOLDBERG

DEPARTMENT OF BOTANY, UNIVERSITY OF CHICAGO

### EXACT PROBABILITIES IN CARD-MATCHING PROBLEMS

A DECK of mn playing-cards composed of m suits of n cards each, may be arranged in (mn)!/(n!)m ways. If one of these is compared with some standard order, the number of coincidences is called the score. The frequency of any score r may be denoted by (r; m,n). Huntington<sup>1</sup> gave the values of (r; 3,3) and (r; 4,4). He considered the labor in the determination of (r;

TABLE 1

$6 \times 6$									
Score	Frequency								
0 1 2 3 4 5 6 7 8 9 10		4 28 98 218 355 450 462 397 289 182 100 48	165 996 700 864 341 116 909 123 793 524 344 575	949 446 744 808 281 994 014 967 784 670 596 943	769 742 213 829 078 274 435 735 100 735 349 371	769 915 619 456 962 568 100 823 001 530 272 163	961 700 952 293 422 927 202 016 073 786 804 005	828 420 591 367 086 912 332 052 868 230 505 793	425 640 700 200 175 160 336 640 710 560 000 504
112 12 13 14 15 16 17 18 19 20 21 22 2		48 20 7 2	879 851 980 735 842 234 58 13 2	943 099 545 656 844 038 693 313 734 508 85 13	371 196 109 277 533 576 462 942 372 679 715 076 804 224 25 2	163 639 018 729 954 801 370 477 820 897 584 448 316 849 255	140 220 448 374 926 532 144 642 516 272 757 454 498	793 076 394 992 188 712 698 955 421 240 352 088 605 787 293	850 400 400 520 400 600 600 400 800 850 600 360
26 28 29 30 31 32 33 34 35					2	230 18 1	827 656 339 85 4	143 661 048 377 709 243 8	200 150 800 840 664 135 640 540
	2	670	177	736	637	149	247	308	800

5,5) to be prohibitive. Sterne<sup>2</sup> found the values of (21; 5,5) up to (25; 5,5) but knew of no way to determine these for smaller r. Greville<sup>3</sup> has recently found all values of (r; 5,5); his solutions are correct, but involve much labor.

The problem is by no means as difficult as these papers imply. Macmahon4 gave a direct method of attack by which Greville's results may be checked with about 12 hours of machine calculation. I have recently determined the values of (r; m,n) for all m and n less than 7 (m and n not being necessarily equal). The frequencies for the case in which both m and n are 6 are given in Table 1.

BANCROFT H. BROWN

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DARTMOUTH COLLEGE

- 1 Huntington, Science, 86: 499-500.
- <sup>2</sup> Sterne, SCIENCE, 86: 500-501.
- 3 Greville, Journal of Parapsychology, March, 1938. 4 Macmahon, Combinatory Analysis, Vol. 1, p. 99-112, Cambridge, 1915.

#### **BOOKS RECEIVED**

DARLING, F. FRASER. Bird Flocks and the Breeding Pp. viii + 124. Cambridge University Press. Macmillan. \$1.75.

HILL, M. A. and J. BURTON LINKER. Introduction to College Mathematics. Pp. xii + 373 + 93. 188 figures. Holt. \$2.40.

HORVATH, A. A. The Soybean Industry. Pp. vi + 221. Chemical Publishing Company of New York.

The Kelley Statistical Tables. Pp. KELLEY, TRUMAN L. Macmillan. \$4.50.

KILBY, CLINTON M. Introduction to College Physics. Second edition. Pp. ix + 398. 389 figures. \$3.25. Nostrand.

SWORTH P. The American Species of Pssi-Pp. 335-613. Field Museum. \$2.50. KILLIP, ELLSWORTH P. floraceae.

MASSEY, H. S. W. Negative Ions; Cambridge Physical

Tracts, No. 1. Pp. xii + 105. 19 figures. Cambridge University Press. Maemillan. \$1.75.

Scientific Reports of the Great Barrier Reef Expedition, 1928-29; Vol. V, No. 5, by OSKAR CARLGREN, Ceriantharia and Zoantharia. Pp. 177-207. 34 figures. 1 plate; Vol. VI, No. 1, by ROBERT GURNEY, The Larvae of the December Courteen Release and Alpheidae. of the Decapod Crustacea Palaemonidae and Alpheidae. Pp. 40. 265 figures. British Museum, London. each.

Scientific Reports of the John Murray Expedition, 1933-34; Vol. II, No. 2, by E. F. THOMPSON and H. CARY GILSON, Chemical and Physical Investigations. Pp. Vol. V, No. 1, by H. G. Pp. 14. 5 figures. 2/. 15-81. 16 figures. 5/. STUBBINGS, *Phyllirhoidae*. Vol. V, No. 5, by M. RAMADAN, The Astacura and Palinura. Pp. 123-145. 12 figures. 2/6. Vol. V, No. 6, by W. T. Calman, Pycnogonida. Pp. 147-166.

10 figures. 2/6. British Museum, London. SEAVER, GEORGE. Edward Wilson; Nature Lover. xi + 221. Illustrated. Dutton. \$3.00. xi + 221. Illustrated. Dutton. \$3.00. SMITH, ALPHEUS W. The Elements of Physics.

Pp. xix + 790. 789 figures. McGraw-Hill. edition. \$3.75.

TARR, W. A. Introductory Economic Geology. Pp. xi + 645. edition. 257 figures. McGraw-Hill. \$5.00.

An Introduction to Chemistry. TIMM, JOHN A. edition. Pp. xvii + 568. 162 figures. McGraw-Hill. \$3.50.

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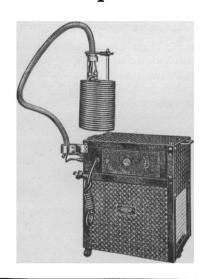
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