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OVERTURNING AND ANCHORING OF MONOLAYERS*

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IN some studies of the mechanism of the flotation process made several years ago[1] 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 down-trip 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 talc, proved that for all the surfaces except mica little or none of the oleic acid monolayer escaped onto the water.

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, θ. 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

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

[1] I. Langmuir, *Trans. Faraday Soc.*, 15: 62, 1920, reprinted in *G–E Rev.*, 24: 1025, 1921.

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 xylem 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.

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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[1] gave the values of (r ; 3,3) and (r ; 4,4). He considered the labor in the determination of (r ; 5,5) to be prohibitive. Sterne[2] found the values of (21 ; 5,5) up to (25 ; 5,5) but knew of no way to determine these for smaller r. Greville[3] has recently found all values of (r ; 5,5); his solutions are correct, but involve much labor.

TABLE 1

	6×6							
Score	Frequency							
0 ...	4	165	949	769	769	961	828	425
1 ...	28	996	446	742	915	700	420	640
2 ...	98	700	744	213	619	952	591	700
3 ...	218	864	808	829	456	293	367	200
4 ...	355	341	281	078	962	422	086	175
5 ...	450	116	994	274	568	927	912	160
6 ...	462	909	014	435	100	202	332	336
7 ...	397	123	967	735	823	016	052	640
8 ...	289	793	784	100	001	073	868	710
9 ...	182	524	670	735	530	786	230	560
10 ...	100	344	596	349	272	804	505	000
11 ...	48	575	943	371	163	005	793	504
12 ...	20	851	099	196	639	140	076	850
13 ...	7	980	545	109	018	220	394	400
14 ...	2	735	656	277	729	448	992	400
15 ...		842	844	533	954	374	188	000
16 ...		234	038	576	801	926	712	520
17 ...		58	693	462	370	532	698	400
18 ...		13	313	942	477	144	955	600
19 ...		2	734	372	820	642	421	600
20 ...			508	679	897	516	240	400
21 ...			85	715	584	272	352	800
22 ...			13	076	448	757	088	400
23 ...			1	804	316	455	605	600
24 ...				224	849	404	787	850
25 ...				25	255	852	293	600
26 ...				2	550	498	318	360
27 ...					230	827	143	200
28 ...					18	656	661	150
29 ...					1	339	048	800
30 ...						85	377	840
31 ...						4	709	664
32 ...							243	135
33 ...							8	640
34 ...								540
35 ...								0
36 ...								1
	2 670	177	736	637	149	247	308	800

Sterne, SCIENCE, 86: 500–501.

The problem is by no means as difficult as these papers imply. Macmahon[4] 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.

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[1] Huntington, SCIENCE, 86: 499–500.
[2] 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

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

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

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Scientific Reports of the Great Barrier Reef Expedition, 1928–29; Vol. V, No. 5, by OSKAR CARLGREN, *Cerianthria and Zoantharia.* Pp. 177–207. 34 figures. 1 plate; Vol. VI, No. 1, by ROBERT GURNEY, *The Larvae of the Decapod Crustacea Palaemonidae and Alpheidae.* Pp. 40. 265 figures. British Museum, London. 5/ 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. 15–81. 16 figures. 5/. Vol. V, No. 1, by H. G. STUBBINGS, *Phyllirhoidae.* Pp. 14. 5 figures. 2/. 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.* Pp. xi + 221. Illustrated. Dutton. $3.00.

SMITH, ALPHEUS W. *The Elements of Physics.* Fourth edition. Pp. xix + 790. 789 figures. McGraw-Hill. $3.75.

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

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