The difference in mercury levels obtainable in this manometer is made slightly greater than the pressure required to force the mercury to the proper level in the capillary of the gauge.

In cases where compressed air is not available, a rubber atomizer bulb with a convenient releasing valve, such as is used by physicians with sphygmomanometers, will be found very satisfactory.

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SPECIAL ARTICLES

EXCITATION POTENTIALS OF THE SPECTRA ARGON II AND NEON II[1]

A PAPER now being written by the author gives some critical potential data obtained by a new method. The photo-ionization produced by the radiation from a thermionic discharge was measured by the effect of the photo-ions on the space charge in a second thermionic unit in the same tube but electrically shielded from the discharge. The present note covers only the results bearing on the excitation of the rare gas spark spectra. Argon showed three sharply defined increases in photo-ionization at $32.2 \pm .2$, $34.8 \pm .5$ and $39.6 \pm .5$ volts. The first point measures a spark excitation potential, the second gives the work required to remove two electrons (each from a 3_2 orbit), while the third point probably measures the work required to remove one 3_1 electron. Spectroscopic studies by Dejardin[2] and others show that the second spectrum of argon appears in a low current discharge, near the second point. With higher currents this spectrum is excited near nineteen volts, the difference being equal to the first ionization potential. This furnishes definite evidence that the second spectrum is a first spark spectrum and gives the basis for the above interpretation of the critical potentials. Photo-ionization measurements in neon showed two critical potentials at 48.0 ± 1 and 54.9 ± 1 volts. For the interpretation of these points it was important to know the excitation potential of the neon II spectrum. Merton[3] discovered this spectrum and it has since been studied by L. and E. Bloch and Dejardin,[4] but it has never been observed under conditions of controlled voltage. I have photographed the thermionic discharge in a simple three electrode tube using currents of a few milli-amperes and a pressure of .05 mm. The second spectrum is absent at 54 volts and distinctly visible at 55. The conspicuous lines as shown by a quartz spectrograph are between 3,700A and 3,300A. I conclude that 54.9 volts measures the work required to remove two 2_2 electrons. The first ionization potential is 21.5 volts; hence, the ionization potential of the ion is $54.9 - 21.5 = 33.4$ volts. The 48 volt point probably measures the work required to remove one electron and displace another to a 3 quantum orbit of energy 26.5 volts. A 3 quantum electron in a hydrogenic ion has an ionization potential of 6 volts while the value derived from the observed potentials is $54.9 - 48.0 = 6.9$ volts. The 3 quantum states are probably the final states for all the lines between 3,700 and 3,300, while the strongest spark lines, with final state 2_2, will lie in the far ultraviolet between 470A and 370A. There will presumably be no lines of this spectrum between 1,800A and 470A. My results fail to give evidence as to the 2_1 level of neon, but lines associated with excitation from this level are to be expected in addition to the known arc spectrum and the first spark spectrum.

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[1] Published by permission of the director of the National Bureau of Standards of the U. S. Department of Commerce.

[2] *Annales de Phys.*, 11, pp. 241–327, 1924.

[3] *Proc. Roy. Soc.*, 89A, pp. 447–451, 1913–14.

[4] C. R., pp. 731–733, 1925.

SAND FLOTATION IN NATURE

EARLY in July, 1925, the writer visited the Ohio River ten miles above Cincinnati. A strong, warm breeze was blowing across the dry sand and mud flats and out upon the river. To my surprise the windward third of the river's width bore films of floating sediment, each of minute thickness but several at least one foot square. The ratio of covered to exposed water was about as 1 is to 16. The floating material proved to be sand with a few flakes of dark mica, the grains roughly 0.025 centimeters in diameter. Each patch rested in a very shallow meniscus on the water surface. No oily films were seen, which might have aided in this unusual mode of transport. As I watched more and more material was brought downstream in the same manner.

This phenomenon has been recorded by Graham, Simonds and Hovey.[1] Graham found the sand floated by splashing waves against a bar in the Connecticut River. Simonds attributed the setting adrift of the sand to the undermining of sand beds bordering the stream—in this case the Llano River. Similar instances are recorded in which the sand was washed off bars on islands by tidal currents. In the case here described the writer believes the sand was blown out upon the water surface by the wind, but evidence is not conclusive.

[1] Graham, J. C., *Am. Jour. Sci.*, III, 40, 476, 1890; Simonds, F. W., *Am. Geol.*, 17, 29–37, 1896; Simonds, F. W., SCIENCE, XI, 510–512, 1900; Hovey, E. O., SCIENCE, XI, 912–913, 1900.

The sand masses sank at once when splashed with water—in other words, when completely wetted.

EXPLANATION

The explanations of sand flotation have been varied. Nordenskiold[2] attributed considerable importance to gas bubbles attached to the sand. Simonds regarded this form of flotation as a surface tension phenomenon. Recent experiments by Coghill and Anderson show that plates of glass 0.3 cm thick and of indefinite length and breadth can be floated on water if the angle of contact between liquid and solid falls between broad limits. In prisms this tendency to float is especially favored by sharp edges.[3] The forces that balance the weight of the solid are probably at least in part due to the liquid displaced and to the hydrostatic load acting upon the lower surface of the solid.

The writer attempted experimental confirmation of the favorable effect of angularity upon the tendency to float. Angular fragments of quartz up to 3/16 x 1/8 x 1/32 inch could be readily floated on tap water without care in launching. On the other hand, clean St. Peter sand, well rounded, would not float if its size exceeded forty meshes per inch (diameter about .015 inch) and floated in quantity if finer than sixty-five mesh (about .0082 inch diameter).

Two sands, one well rounded, from Millington, Illnois, the other angular, from Gallipolis, Ohio, were screened to equal sizes—between forty and sixty-five meshes. The yellowish color and angular shape of the Gallipolis sand made its grains readily distinguished when mixed with the Illinois sand. Equal quantities by weight of the two sands were thoroughly mixed and dropped upon a water surface. Microscopic counts of the floated and sunk grains were made to determine the ratio of angular to round grains in each.

TABLE I

SHOWING RATIOS OF ANGULAR TO TOTAL GRAINS FLOATED AND SUNK

Experiment number	Total number grains counted	Per cent. angular grains among those floated	Per cent. angular grains among those sunk
1	4006	57.4	42.6
2	3925	56.0	44.0
3	3109	63.4	36.6

It is seen that angularity and hence probably also the orientation of the grain when it strikes the water surface are potent factors in flotation.

It was also found experimentally that the tendency to float decreases with the height of fall of the sand before striking the water surface.

TABLE II.

SHOWING THE EFFECT OF HEIGHT OF FALL UPON TENDENCY TO FLOAT

Height of fall, inches	Weight of sand taken, grams	Weight of sand floated, grams	Per cent. of sand floated
2	1.726	.163	9.44
4	2.052	.077	3.75
8	1.464	.041	2.80

IMPORTANCE OF PROCESS

At first thought this phenomenon of floating sand is a mere curiosity, and its importance may be underestimated. It can, of course, only take place under favorable conditions—namely, when dry sand, having fair angularity and not too coarse, is properly launched and not sunk by waves or ripples. Further, the films are thin and at most represent only a small tonnage.

On the other hand, that sand which is so transported travels with far greater speed than material leaping or rolling along the bottom. Careful estimates suggest that in one hour about 120 tons of material are thus transported past any point on the Ohio under the conditions observed. If, on the other hand, Gilbert's data[4] are resorted to and the available measurements of depth, width and mean velocity of the river nearest the point of observations used, the mass of the sediment transported by rolling along the stream bottom is only about one twentieth as much—six tons.

A similar comparison may be drawn with the material carried in suspension and in solution. Following computations by Dole and Stabler and by Fenneman,[5] the weights of dissolved and suspended matter transported past Cincinnati in one hour are respectively 1,560 and 3,168 tons—or quantities only thirteen and twenty-six times as great as the weight carried by flotation under favorable conditions.

CONCLUSIONS

Quartz sand may be transported by floating on the surface of streams without the aid of supporting media. Under favorable conditions the quantity thus floated is appreciable—especially so because of the rapidity with which it proceeds. The floating of the grains is dependent largely upon their size, their angularity, their orientation when alighting and the height from which they fall before the impact upon the water takes place. This type of flotation is a special surface tension phenomenon.

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[2] Nordenskiold, E., *Nature,* Jan. 18, p. 278, 1900.

[3] Coghill, W. H., and Anderson, C. O., U. S. Bur. Mines, Tech. Pap. 262, 27–30, 1923.

[4] Gilbert, G. K., U. S. Geol. Survey, Prof. Pap. 86, 91, 1914.

[5] Dole, R. B., and Stabler, H., U. S. Geol. Survey, Water Sup. Pap., 234, 89, 1909; Fenneman, N. M., Ohio Geol. Survey, Bull. 19, 77–8, 1914.