our national capital, might be a good place for experimentation.

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ASTIGMATIC IMAGES OF THE BOTTOM OF A POOL OF WATER.

IF light radiate from a point below the surface of water, it can pass out through the surface only within a circle forming the base of a right cone whose semi-angle is the critical angle.

Consider such rays lying in a vertical plane passing through the radiant point. The rays which have passed out into the air, if produced below the surface, are tangent to a virtual caustic. This caustic is a portion of the evolute of an ellipse, one cusp of which is in a vertical through the radiant point, and at a depth $\frac{d}{n}$, where d is the depth of the radiant point, and n is the index of refraction. The branches of the caustic are tangent to the surface in the circle determining the critical angle. Successive sets of consecutive rays having an increasing angle of incidence do not intersect at a common point, but they intersect at consecutive points on the caustic. If the vertical plane be rotated slightly in azimuth, the rays from the same radiant point will intersect in the caustic in its new position. This caustic from the same radiant point will always lie on a surface of revolution, formed by revolving the caustic in any vertical plane about the vertical line through the radiant point.

If the radiant point be viewed by an eye placed at a fixed point, the pupil of the eye may be conceived divided into vertical zonal elements. Rays from the radiant point in these various elements will intersect in a definite area upon the surface of revolution. The point would, therefore, appear as a hazy patch upon the caustic surface. The text-books all represent the apparent position of a coin seen through a water surface, as being lifted up and towards the eye of the observer, upon the caustic surface.

It is, however, evident that if the rays diverging from the radiant point in all azimuths, and at a fixed angle of incidence, be produced backwards after passing out into the air, they will all intersect in a common point upon the vertical line through the radiant point. If, therefore, the pupil of the eye be divided into horizontal zonal elements, all the rays entering the eye will have a virtual intersection on this vertical line. The focus of the upper zonal elements of the eye will be slightly below those of the lower. Nevertheless, the intersection of all rays entering the eye from the radiant point will be upon a line, instead of being spread out over an area as in the other case. The fact is that a plumb line deeply piercing still water appears straight throughout. The image upon the vertical line is much more distinct than that formed upon the caustic surface. The latter image imparts a haziness to the appearance of the body viewed, but the apparent position is determined by lines which intersect in a common point, rather than by those which do not.

With this view of the matter the writer in May, 1881, presented to the Academy of Science of St. Louis a discussion of the apparent form of the flat bottom of a pool as seen through the surface.* The appearance was found to be represented by a conchoid, which was related in a simple way to the conchoid of Nicomedes. The equations of both curves were deduced, and several other cases were discussed.

In a recent number of *Annalen der Physik*,† Mattheissen has deduced the equations of these two conchoids and has pointed out that the surface produced an astigmatic effect. He likewise deduces the equation for the nebulous image due to intersection upon the caustic. The minimum of this surface and that of the conchoid are coincident and tangent to each other, and they have the water surface as a common asymptote.

FRANCIS E. NIPHER.

NOTES ON INORGANIC CHEMISTRY.

THE earliest determinations of the density o sulfur vapor were by Dumas and Mitscherlich, and gave figures which pointed to the molecule S_6, and this has passed current until quite recent times. In 1860 Deville and Troost found

* *Trans. Acad. of Sc. of St. Louis*, Vol. IV., No. 2, p. 325.

† No. 10, 1901, S. 347.

that above 860° the sulfur molecule consists of two atoms, S_2. More recently by boiling point and freezing point methods the molecule of sulfur in solution has been found to contain eight atoms, S_8, and it has been inferred that the same molecule exists in sulfur vapor just above its boiling point. In the *Berichte* of the German Chemical Society, Biltz goes over the whole ground, especially examining the density of the vapor under diminished pressure at the boiling point. The greatest density he could obtain corresponded to the molecule S_7, but this was not found to be a constant point. The conclusion he draws is that two molecules only of sulfur exist, one S_8 and the other S_2, and that at the boiling point the molecule with eight atoms begins to decompose into molecules of two atoms. This decomposition is progressive, until at 850° it is complete, the gas at this temperature consisting wholly of the molecules S_2.

A PATENT has recently been taken out by the Clayton Aniline Company, limited, of Manchester, for the continuous concentration of sulfuric acid, which involves the use of cast-iron vessels in the place of platinum. The dilute acid is allowed to flow in a continuous stream on to the surface of a large mass of hot concentrated acid contained in a large cast-iron pan. The concentrated acid must be of a strength not less than ninety to ninety-three per cent. From the bottom of the pan the concentrated acid is drawn off at such a rate as to keep the level of the acid in the pan constant. The great advantages claimed for the process are the simplicity and the cheapness of the plant, and it has already been shown that for most uses the acid concentrated in iron pans is satisfactory.

ABOUT a year ago an article appeared in the *Comptes Rendus* by Gautier, in which the position was taken that arsenic in minute quantities is a normal constituent of the human body. By a new and very delicate method the author found and determined quantitatively arsenic in numerous organs of the body, notably in the pancreas, brain, thymus gland and skin. Since, after digestion of the pancreas with pepsin, the arsenic remained in the nuclein residue, the existence of an arsenic-nuclein was assumed. In the last number of the *Zeitschrift für Physiologische Chemie* there is a paper by Hödlmoser, combating Gautier in every point. In eighteen cases the pancreas and liver were examined by Gautier's method, and in fifteen other cases the same organs were examined by a method, pronounced by the author even more delicate, and in no case was any trace of arsenic found. Numerous other experiments were carried out, carefully following the work of Gautier, but always with negative results. No explanation is offered of the great discrepancy between the author's results and those of Gautier, but one is promised.

THE subject of the toxic action of boric acid is brought up anew by a description in the *Therapeutic Gazette*, by Dr. J. F. Rinehart, of two cases, occurring in his practice, of poisoning by boric acid. Each was after the administration of the acid in five-grain doses every four hours. The symptoms of poisoning appeared after several days and consisted chiefly of an erythematous eruption over the body, accompanied by extreme weakness. The patients recovered slowly on ceasing to administer the drug. The conclusion drawn by Dr. Rinehart is that "any use of boric acid as a preservative of foods should be prohibited by law, as the poisonous effect of any quantity sufficient to preserve food would appear to be proven." This conclusion would, however, seem to be somewhat overdrawn, as it is hardly probable that any such quantities of the acid as were administered in the above cases would ever be ingested from foods in which it was used as a preservative. The chief danger to be apprehended from the indiscriminate use of boric acid in foods, as was recently noticed in this column, is in the case of young children, where they are fed on milk preserved by borax. Here danger may well be apprehended. In any case food preserved by boric acid should be distinctly so labeled.

J. L. H.

CURRENT NOTES ON PHYSIOGRAPHY.

THE RIVER SYSTEM OF CONNECTICUT.

THE discovery of numerous parallel faults arranged in several systems in the small Triassic area of the Pomperaug valley in western Connecticut, and the coincidence of many