

It should be emphasized that these effects are produced by audible sound, the frequencies (1000–15,000) being of a far different order than any hitherto reported as influencing chemical reactions. Because of the relative ease of producing high energy densities in this range, it seems likely that such methods will prove to be useful.

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#### THE FORMULAS OF ANTIMONIC ACID AND THE ANTIMONATES

Sir:

In my recent discussion of antimonic acid [THIS JOURNAL, **55**, 1895 (1933)] I stated that its formula had not been previously recognized to be  $\text{HSb}(\text{OH})_6$ . I have just learned that this statement is incorrect, for in 1929 Professor L. P. Hammett, in an interesting discussion of amphoteric hydroxides ["Solutions of Electrolytes," McGraw-Hill Book Co., New York, 1929, p. 108], wrote: ". . . the sodium antimonate whose crystallization is used as a test for sodium has exactly the right content of water so that it can be written  $\text{NaSb}(\text{OH})_6$ ."

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#### EXPERIMENTAL EVIDENCE FOR ACTIVATED ADSORPTION OF HYDROGEN BY CHARCOAL

Sir:

It was shown recently by Kingman [*Trans. Faraday Soc.*, **28**, 269 (1932)] and by Burstein and Frumkin [*ibid.*, **28**, 273 (1932)] that hydrogen is slowly sorbed by charcoal at higher temperatures (above  $100^\circ$ ), whereas at room temperature only van der Waals adsorption is observed. The experiments described below give in our opinion a direct proof that hydrogen sorbed at higher temperatures remains on the charcoal surface and is not dissolved in the interior of the solid, as it was suggested for similar cases by Steacie and Ward.

Burstein and Frumkin [*Z. physik. Chem.*, **141**, 158 (1929)] found that charcoal heated in hydrogen to  $1000^\circ$  and cooled to room temperature adsorbs small quantities of alkali from an aqueous solution if protected from contact with oxygen. The mechanism of this process consists in an ionization of the hydrogen, the negative charge of the charcoal surface attracting the cations of the solution.

In connection with the problem of activated adsorption, it appeared

worth while to investigate under what conditions adsorbed hydrogen acquires the property of passing into the ionic state. The experimental method has been described in a previous paper [*Z. physik. Chem.*, **150**, 421 (1930)]. The charcoal<sup>1</sup> was outgassed at 950° for forty-eight hours and then cooled to the temperature of hydrogen adsorption. After a certain quantity of hydrogen had been adsorbed, the charcoal was brought at room temperature into contact with an outgassed solution of sodium hydroxide and after five hours the change of concentration determined. These experiments showed that hydrogen adsorbed at low temperatures (20–100°) is not exchanged against sodium ions, whereas hydrogen adsorbed in the temperature region of activated adsorption (300° and 800°) readily reacts with the alkaline solution. In this case, if the quantity adsorbed is small, the whole of the adsorbed hydrogen is exchanged. In one experiment 1 g. of charcoal adsorbed 0.100 millieq. of hydrogen at 300° and afterward, 0.090 millieq. of alkali; in another (temperature of hydrogen adsorption 800°) the corresponding quantities were 0.064 and 0.066. If the amount of adsorbed hydrogen becomes larger, only a part of it is exchanged.

The adsorption of alkali depends only on the quantity of hydrogen adsorbed at high temperature. An excess of hydrogen in the gaseous phase during the interaction between the charcoal and the solution has not the slightest influence on the results of the experiments and if the charcoal has not been previously heated in hydrogen until activated adsorption sets in, the adsorption of alkali is nil.

The fact that hydrogen adsorbed at high temperatures can be exchanged at room temperature quantitatively against sodium ions seems to prove definitely that the hydrogen remains on the charcoal surface (probably in an atomic form) and does not diffuse into the interior of the solid.

(1) We used activated sugar charcoal prepared as described by Bruns and Frumkin [*Z. physik. Chem.*, **141**, 145 (1929)]. It contained 0.05% ash. A control experiment carried out with a charcoal specimen with an ash content of only 0.005%, which was prepared from distilled materials [*cf. Low, Phys.*, **2**, 505 (1932)] gave the same results.

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## AN ARRANGEMENT OF ATOMIC NUCLEI AND THE PREDICTION OF ISOTOPES

Sir:

The regularities observed in the existence and abundance of atomic nuclei have been commented on by Harkins, Beck, Barton, Latimer, Johnston, Urey and others.<sup>1</sup> From such regularities attempts have been

(1) Harkins, *THIS JOURNAL*, **39**, 859 (1917); **42**, 1976 (1920); **43**, 1050 (1921); *Phys. Rev.*, **15**, 85 (1920); *Phil. Mag.*, **42**, 305 (1921); *Chem. Rev.*, **5**, 371 (1928); Beck, *Z. Physik*, **47**, 407 (1928); Barton, *Phys. Rev.*, **35**, 408 (1930); Latimer, *THIS JOURNAL*, **53**, 981 (1931); Johnston, *ibid.*, **53**, 2866 (1931); Urey, *ibid.*, **53**, 2872 (1931).