The enzyme fraction was prepared from washed duck erythrocytes by precipitation with ammonium sulfate. The protein fraction obtained by adjusting the ammonium sulfate concentration to 52% of saturation (*p*H 7.5) was purified by washing with half-saturated ammonium sulfate and by reprecipitations with ammonium sulfate at 50% saturation, *p*H 8. Finally the protein fraction insoluble in 35% saturated ammonium sulfate was discarded. Therefore the enzyme preparation represents the 35–50% ammonium sulfate fraction.

It is further of interest that whereas human red cells are incapable of forming heme *in vitro*, we have found that they contain the enzymes capable of converting δ-aminolevulinic acid to porphobilinogen.

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RADIATION-CHEMICAL STUDIES WITH CYCLOTRON BEAMS[1]

Sir:

The use of cyclotron beams provides a powerful tool for studying the variation of radiation-chemical yields with ionization density—a datum of basic importance to the understanding of mechanisms of radiation effects, and to the interpretation of the effects of mixed radiations such as those present in nuclear reactors. The Brookhaven 60-inch cyclotron provides deuteron beams at 20 Mev. ($-dE/dX$ = 0.46 ev./Å. in H_2O) and alpha beams of 40 Mev. (1.88 ev./Å.). The energies may be reduced by absorbers so that rays having a great range of initial ionization densities can be introduced into solutions.

Figure 1 shows yields (G = molecules/100 ev.) of hydrogen gas from pure cyclohexane, and of ferric ion from 1 mM $FeSO_4$ solution in aerated aqueous 0.8 N H_2SO_4. The yields are plotted against the values of $-dX/dE$ (the reciprocal of the usual energy loss parameter) characterizing the particles as they enter the liquids. The dashed horizontal lines show the yields for the two reactions obtained with beams of 2 Mev. electrons from a Van de Graaff generator, for which $-dX/dE$ is very large; the yield curves should approach this value asymptotically. The ferrous sulfate curve includes yields reported for natural α-rays by McDonell and Hart,[2] and by Miller and Wilkinson.[3] Values near 6 are also reported by Lefort[4] and by Haissinsky and Anta.[5] The results show the expected continuous rise in G from the α-ray values to the electron yields. The α-ray and deuteron curves join together fairly well, although in theory a slight difference is expected in G for alphas and deuterons of the same initial energy loss parameter. By differentiation of the yields with respect to the initial beam energy, the instantaneous or "thin-target" value of G is found,[6] which at the highest deuteron energy used is only 13.3 and thus still lies well below the fast electron value of 15.5.

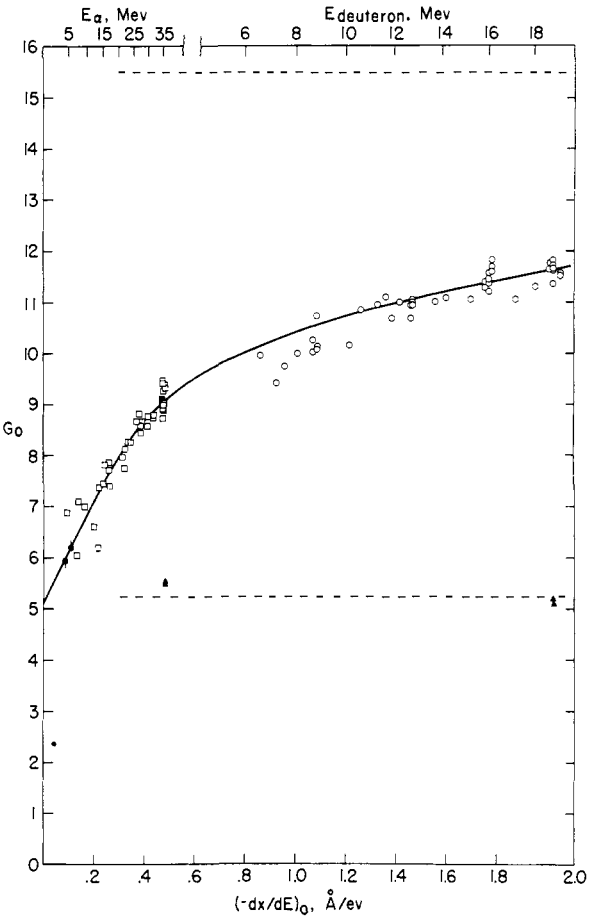

Fig. 1.—Radiation-chemical yields from deuterons and alpha particles: O, oxidation of $FeSO_4$ in air-saturated 0.8 N H_2SO_4 by deuterons; □, by cyclotron α's; ●, by α's from dissolved Po (McDonell and Hart[2]); ●, by α's from an external Po source (Miller and Wilkinson[3]); ▲, hydrogen gas yields from pure cyclohexane by cyclotron alphas and deuterons. The dotted lines are the values of G found for $FeSO_4$ oxidation (15.5) and H_2 production in cyclohexane (5.25) by 2-Mev. electron beams from a Van de Graaff generator.

In contrast to aqueous solutions, the behavior of the hydrocarbon appears to be independent of the type of radiation. A great difference evidently exists in the mechanism of action of radiation on water and on hydrocarbons.

A detailed description of the above experiments and a discussion of the results are presently in preparation. Further work on the effects of ionization density on radiation-chemical reactions is in progress.

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(1) Research carried out under the auspices of the U. S. Atomic Energy Commission.

(2) W. R. McDonell and E. J. Hart, THIS JOURNAL, **76**, 2121 (1954).

(3) N. Miller and J. Wilkinson, *Trans. Faraday Soc.*, **50**, 690 (1954).

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(6) A. O. Allen, *Radiation Research*, **1**, 85 (1954).