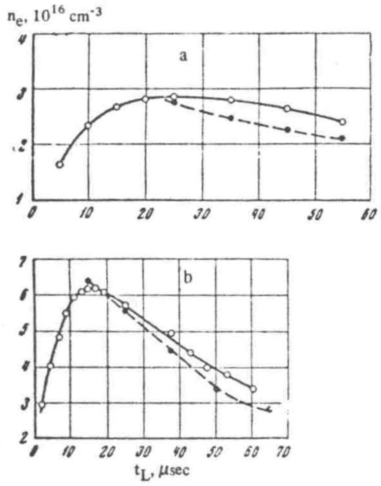

FIG. 4

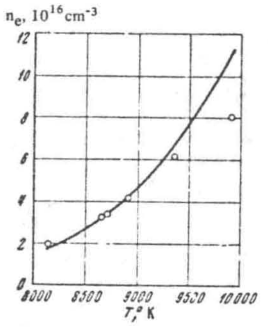

FIG. 5

FIG. 4. Distribution of electron density behind the front of a shock wave in xenon; p_1 = 3 mm Hg. (laboratory time); O–experiment, ●–Saha equations; a–M = 11.2, b–M = 12.7.

FIG. 5. Temperature dependence of equilibrium concentration of electrons in xenon; p_1 = 3 mm Hg; points–experimental values, curve–calculation result.

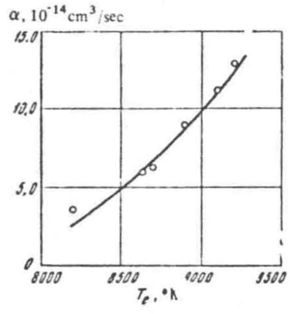

FIG. 6

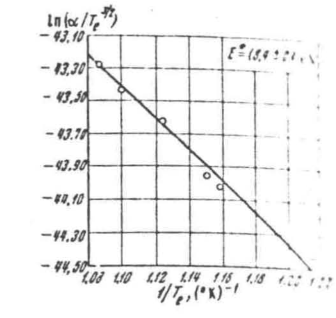

FIG. 7

FIG. 6. Dependence of the ionization rate constant of xenon on the electron temperature.

FIG. 7. Dependence of $\ln(\alpha/T_e^{3/2})$ on $10^4/T_e$ in xenon.

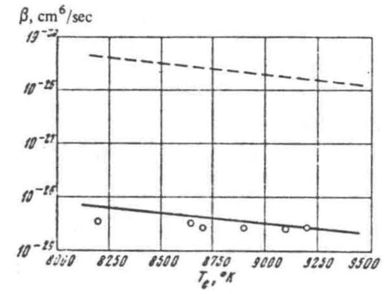

FIG. 8. Temperature dependence of the recombination rate constant of Xe^+ in triple collisions: points–experimental values, solid curves–theoretical value [17], dashed–theoretical value [14].

wave also passes through a maximum. The drop of the electron density after the equilibrium values are reached is also connected with radiative cooling of the plasma. The form and the position of the maxima of the electron density depend in this case on the intensity of the shock waves; at M = 12.7 the maximum turns out to be more strongly pronounced, whereas at M = 11.2 the gradients of the electron density are much smaller in magnitude. It must be noted first of all that the experimental equilibrium values of the electron density are in good agreement with the calculated values based on the shock adiabat, as can be seen from the data shown in Fig. 5. At T > 9000°K, the experimental values turned out to be somewhat smaller, and this may possibly be connected with the influence of radiative losses. Figure 4 shows the total profiles of the electron density, including the region where it decreases after reaching the maximum. It has turned out here that the experimental values are also in satisfactory agreement with the calculated values of the electron density obtained from the Saha equation using the experimental temperature profile.

Using the obtained profile of the electron density and the electron temperature T_e behind the front of the shock wave, we have determined with the aid of formula (11) the values of the ionization rate constant α in the electron temperature interval 8200–9200°K. The results of these measurements are shown in Fig. 6, from which it is seen that α increases rapidly with increasing temperature. If we plot $\ln(\alpha/T_e^{3/2})$ against $1/T_e$ (Fig. 7), then we can easily obtain the activation energy E* of the ionization process. It turns out to equal (8.4 ± 0.4) eV, corresponding to the excitation energy of the first electronic level of the xenon atom. Knowing the activation energy of the ionization processes, we can determine the second parameter in the expression for the excitation cross section, C_e. To this end, we use formula (12) and the distributions of n_e and T_e behind the shock-wave front. The values of C_e obtained in this manner at T_e = 8200–9200°K turn out to be approximately the same: $(5.7-5.8) \times 10^{-18}$ cm^2/eV. This is approximately one-third the value recently obtained in[13] for the total cross section for inelastic electron-atom collisions in xenon.

The coefficients α and β are connected by relation (10), making it possible to calculate the recombination coefficient. It turned out that in the temperature interval 8200–9200°K the value of β changes in the range $(3.6-2.8) \times 10^{-29}$ cm^6/sec.

It is of interest to compare the values of the recombination coefficient obtained in this manner with the theoretical values.

In the theoretical analysis of the recombination process, there are two approaches. In the first[11,14] one solves the system of balance equations for the levels of the atom, assumed to be discrete, while in the second[15,16] the recombination is regarded as a Brownian motion of the electron in continuous energy space. In[17] a modified diffusion approximation is used, in which the discrete structure of the energy spectrum is retained.

The results of[15,16] pertain to the region of sufficiently low temperatures (T < 3000°K), so that the experimental data will be compared with the conclusions of[14,17] (Fig. 8). It follows from the analysis of Fig. 8 that the experimental values of β, obtained in this paper, are in good agreement with the conclusions of the theory of Biberman, Vorob'ev, and Yakubov[17] and deviate greatly (by three orders of magnitude) from the calculations of Chen[14], carried out in accordance with the scheme of Bates, Kingston, and McWhirter[11].

In conclusion, the authors are deeply grateful to Yu.