Selected Specific Rates of Reactions
of the Solvated Electron in Alcohols

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Foreword

The National Standard Reference Data System provides access to the quantitative data of physical science, critically evaluated and compiled for convenience, and readily accessible through a variety of distribution channels. The System was established in 1963 by action of the President's Office of Science and Technology and the Federal Council for Science and Technology, with responsibility to administer it assigned to the National Bureau of Standards.

The System now comprises a complex of data centers and other activities, carried on in academic institutions and other laboratories both in and out of government. The independent operational status of existing critical data projects is maintained and encouraged. Data centers that are components of the NSRDS produce compilations of critically evaluated data, critical reviews of the state of quantitative knowledge in specialized areas, and computations of useful functions derived from standard reference data. In addition, the centers and projects establish criteria for evaluation and compilation of data and make recommendations on needed improvements in experimental techniques. They are normally closely associated with active research in the relevant field.

The technical scope of the NSRDS is indicated by the principal categories of data compilation projects now active or being planned: nuclear properties, atomic and molecular properties, solid state properties, thermodynamic and transport properties, chemical kinetics, and colloid and surface properties.

The NSRDS receives advice and planning assistance from the National Research Council of the National Academy of Sciences-National Academy of Engineering. An overall Review Committee considers the program as a whole and makes recommendations on policy, long-term planning, and international collaboration. Advisory Panels, each concerned with a single technical area, meet regularly to examine major portions of the program, assign relative priorities, and identify specific key problems in need of further attention. For selected specific topics, the Advisory Panels sponsor subpanels which make detailed studies of users' needs, the present state of knowledge, and existing data resources as a basis for recommending one or more data compilation activities. This assembly of advisory services contributes greatly to the guidance of NSRDS activities.

The NSRDS–NBS series of publications is intended primarily to include evaluated reference data and critical reviews of long-term interest to the scientific and technical community.

Lawrence M. Kushner, Acting Director
Preface

This report is one of a series of data publications on radiation chemistry; the aim of the series is to compile, evaluate, and present the numerical results on processes occurring in systems which have been subjected to ionizing radiation. Various kinds of data are important in radiation chemistry. The quantities which were measured first were the observed radiation yields or G values (molecules formed or destroyed per 100 eV). Various indirect methods based on G values have been used to determine yields of transient species and relative rates of reactions. The spectral properties (optical, electron spin resonance) of transients have provided a direct method for their identification, and rates of the very fast reactions of transients which occur in irradiated systems have been measured directly by spectroscopic methods. Conductivity and luminescence methods have also provided a means of measuring properties of transients and their kinetics. Some reactions which occur in irradiated systems have also been studied by other methods, such as photochemistry, electric discharge, ultrasonics, chemical initiation, electron impact, etc. The emphasis in these publications is on the data of radiation chemistry, but where other pertinent data exist, they are included.

The data of radiation chemistry are voluminous; thousands of systems have been investigated. As a result there are certain collections, e.g. rate constants of particular types of reactions or certain properties of transients, for which tabulations of the data are considered essential, but for which critical assessment of each value is impossible. On the other hand, certain systems and properties have been studied so extensively that critical examination of these data is desirable and timely. Authors of this series of data publications have been asked to evaluate the extent to which the data can be critically assessed, to describe their criteria for evaluation, and to designate preferred values whenever possible.
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreword</td>
<td>III</td>
</tr>
<tr>
<td>Preface</td>
<td>IV</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Table 1. Rate Constants of Reactions of the Solvated Electron in Methanol (1.01a−1.28)</td>
<td>2</td>
</tr>
<tr>
<td>Table 2. Rate Constants of Reactions of the Solvated Electron in Ethanol (2.01a−2.30)</td>
<td>5</td>
</tr>
<tr>
<td>Table 3. Rate Constants of Reactions of the Solvated Electron in Propanols and Butanol (3.01a−3.15)</td>
<td>9</td>
</tr>
<tr>
<td>Table 4. Arrhenius Parameters for Reactions of the Solvated Electron in Alcohol Solutions</td>
<td>11</td>
</tr>
<tr>
<td>Table 5. Index of Entry Numbers (Tables 1, 2, and 3) for the Reaction of Solvated Electrons in Various Alcohol Solutions</td>
<td>11</td>
</tr>
<tr>
<td>References</td>
<td>12</td>
</tr>
</tbody>
</table>
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Solvated electrons are generated in alcohols by radiolysis, photolysis, reaction with sodium, etc. Rates of reactions of e⁻ with solvent and solute molecules, ions, and transients, in alcohol solutions, have been compiled. Arrhenius parameters are tabulated for some reactions.

Key words: Alcohols; chemical kinetics; data compilation; radiation chemistry; rates; solvated electron.

Introduction

The nature and chemical properties of solvated electrons in selected solvent media have been the subject of extensive study. One of the important characteristics of this species is its reactivity toward a large number of reagents. The latest rate data compilation for the hydrated electron includes over 700 compounds for which specific rates of reaction have been measured [71–0061]. Although several reviews [65 0018, 69 0529, 69 0535, 69–0451, 71–0062] containing rate data for solvated electrons in alcohols have been published, there has been no comprehensive compilation of these data. This compilation of rate constants and Arrhenius parameters has been prepared in order to consolidate the information available in the literature. These data are presented as reported without critical evaluation. Critical assessment of the kinetic parameters of several of the reactions will appear in forthcoming critical reviews [71–0062 and 71–0362].

Rate parameters contained in this compilation include data obtained by pulse radiolysis, flash photolysis, and γ-radiolysis. Competition kinetic studies in alcohols, unlike water, have yielded a large portion of the rate information available. For optimum utilization of the relative rates thus obtained, it is required that the specific rate for one of the competing processes be known. Specific rates obtained from relative rates are listed only when the normalizing rate constants used seemed to be reliable and consistent. Generally, the normalization rate constants are from pulse radiolysis studies which offer the most reliable kinetic method available to obtain rate data involving the solvated electron. Due to the abundance of relative rates obtained using N₂O as a competing solute and the lack of consistent measurements of its specific rate (e.g. in methanol k(e⁻ + N₂O) values obtained from the available data vary over an order of magnitude), the specific rate of reaction of the hydrated electron with N₂O in water has been used to normalize relative rates involving N₂O. Hence, specific rates thus obtained are presented only for comparison purposes and should be considered with caution.

An attempt has been made to include all rate data which have been reported for alcohols. Duplication of references has been avoided in cases where it was apparent that two or more publications report the same experimental results.

Temperature when not specified is to be taken as ambient, 15 to 25 °C. Rate constants obtained at other temperatures have the appropriate temperature noted below the constant. No data on glassy or solid alcohols have been included. No corrections have been made for the effect of ionic strength on the reaction rates of e⁻, but information pertinent to μ has been reported as given in the reference.

Table 4 contains Arrhenius parameters obtained for reactions of e⁻ in alcohols. Given in this table are: log A, Eₐ, ΔST, temperature range, and the reference.

Arrangement of Tables 1, 2, and 3

Solute and Reaction. The first "solute" listed in each table is the solvent (without solute) followed by solvent mixtures (with no solute), and an alphabetical arrangement of the other solutes. The products which have been identified are included.
in the listed reactions. In competition studies the reaction of $e^{-}$ with the solute of entry appears as reaction (1) and is followed by the competing reaction (2). Solute concentrations were, in most cases $10^{-3}$ mol dm$^{-3}$ or less. Higher concentrations are noted under Comments.

$k_{1}/k_{2}$. Relative rate constants listed are unitless (both second order rates in units of dm$^{3}$mol$^{-1}$s$^{-1}$). Relative constants are listed once [under solute of reaction (1)]. Table 5 gives an index to entries for rate constants with the various solutes (relative and specific) listed in tables 1, 2, and 3.

$k$. Specific rate constants are listed and are in units of dm$^{3}$mol$^{-1}$s$^{-1}$. In the case of the reaction of $e^{-}$ with the alcohol, conversion of a second order rate to a first order rate can be made by multiplying the rate constant by the molarity of the alcohol. Half-lives are also given under Comments. Specific rates calculated from relative rates are for reaction (1), and the footnote gives the standard specific rate used for normalization. Error limits and ionic strength have been given as reported by authors. Except where otherwise indicated, all solutions are neutral. Most numerical values of $k$ have been rounded off to one or two significant figures.

Method. Abbreviations used under Method are:

- $\gamma$-r. = gamma radiolysis
- p.r. = pulse radiolysis
- f. phot. = flash photolysis
- c.k. = competition kinetics
- d.k. = decay kinetics
- calc. = calculation.

Additional details of the method used are found in the Comments column.

Comments. Included under Comments are additional experimental details not included with the methods: $t_{1/2}$, measured quantities, corrections applied, etc. For brevity, the following abbreviations and symbols have been utilized:

- $A$ = frequency factor
- abs. = absorption
- anal. = analysis
- aq. = aqueous
- av. = average
- conc. = concentration
- const. = constant
- corr. = correction
- d. = decay
- disso. = dissociation
- $E_{a}$ = activation energy
- elec. condy. = electrical conductivity
- eq. = equation
- f.o. = first order
- $G$ = radiation yield; (molecules or ions per 100eV absorbed)
- $k$ = specific rate
- $\mu$ = ionic strength
- $P_{e}$ = vapor pressure
- react. = reaction
- $S_{m}$ = alcohol (solvent)
- $S_{m}$ = mixed solvent
- $\Delta S^{\ddagger}$ = entropy of activation
- $s$ = second
- scav. = scavenger
- soln. = solution
- spec. = spectrophotometrically
- $t_{1/2}$ = half-life

Units used in tables 1, 2, 3, and 4:

- $k$, $A$ dm$^{3}$mol$^{-1}$s$^{-1}$
- $E_{a}$ kJ mol$^{-1}$
- $\Delta S^{\ddagger}$ J mol$^{-1}$K$^{-1}$
- $T$ °C
- $P_{e}$ N m$^{-2}$

References. The serial number used in Radiation Chemistry Data Center files has been used for reference citation. The first two numbers indicate the year of publication.
### Table 1. Rate constants of reactions of the solvated electron in methanol—Continued

<table>
<thead>
<tr>
<th>No.</th>
<th>Solute and reaction</th>
<th>$k_1/k_2$</th>
<th>$k$ (dm$^3$mol$^{-1}$s$^{-1}$)</th>
<th>Method</th>
<th>Comments</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.01e</td>
<td>same</td>
<td></td>
<td>1.7 x 10$^4$ (LiCl)</td>
<td>p.r.; d.k.</td>
<td>$t_{1/2}$ = 1.7 μs with added LiCl (conc. independent); $t_{1/2}$ = 1.5 μs with added NaBr; $t_{1/2}$ = 1.9 μs with added Na (conc. independent); conc. of KOH 0.15 - 2.65 mol dm$^{-3}$.</td>
<td>[70-0246].</td>
</tr>
<tr>
<td>1.01f</td>
<td>same</td>
<td>-3.5 x 10$^3$ (T = 78 ± 2)</td>
<td>p.r.; d.k.</td>
<td>d. curves not of simple order and probably include reaction with counter ion.</td>
<td>[66-0082].</td>
<td></td>
</tr>
<tr>
<td>1.01g</td>
<td>No solute</td>
<td></td>
<td>(3.3 ± 2) x 10$^9$</td>
<td>c.k.</td>
<td>Reacted Na with CH$_3$OD and measured D$_2$, HD, and disso- lution rate of Na, k calc. based on diffusion and homogeneous reaction kinetics.</td>
<td>[71-9165].</td>
</tr>
<tr>
<td>1.02</td>
<td>H$_2$O (30 mol %)</td>
<td></td>
<td>~ 1 x 10$^4$</td>
<td>p.r.; d.k.</td>
<td>See 1.01f.</td>
<td>[66-0082].</td>
</tr>
<tr>
<td>1.03</td>
<td>CH$_3$CHOHCH$_3$</td>
<td></td>
<td>1.9 x 10$^4$</td>
<td>p.r.; d.k.</td>
<td>See 1.01f; after ~20 pulses $t_{1/2}$ drops from 1.5 μs to 0.6 μs.</td>
<td>[66-0082].</td>
</tr>
<tr>
<td>1.04a</td>
<td>acetonitrile</td>
<td>0.005</td>
<td>7.2 x 10$^{-3}$</td>
<td>γ-r; c.k.</td>
<td>Measured G(N$_2$); $k_1/k_2$ calc. on the basis of two conc. and is an av. value.</td>
<td>[67-0513].</td>
</tr>
<tr>
<td>1.04b</td>
<td>same</td>
<td>0.57</td>
<td>5.0 x 10$^{-3}$</td>
<td>γ-r; c.k.</td>
<td>Two solute system (SF$_6$ and (CH$_3$)$<em>2$CO) to determine $\alpha</em>{emp}$; $k_1/k_2$ obtained from ratio of empirical $\alpha$ values for acetone and N$_2$O$_5$. Measured G(N$_2$)</td>
<td>[70-0064].</td>
</tr>
<tr>
<td>1.05a</td>
<td>acetophenone</td>
<td>1.8</td>
<td>1.6 x 10$^{10}$</td>
<td>γ-r; c.k.</td>
<td>Measured G(N$_2$); $k_1/k_2$ is an average from two conc.</td>
<td>[66-0045].</td>
</tr>
<tr>
<td>1.05b</td>
<td>same</td>
<td>1.8</td>
<td>1.6 x 10$^{10}$</td>
<td>γ-r; c.k.</td>
<td>Measured G(N$_2$).</td>
<td>[67-0313].</td>
</tr>
<tr>
<td>1.06a</td>
<td>benzene</td>
<td>2.3 x 10$^{-3}$</td>
<td>2.0 x 10$^{-2}$</td>
<td>γ-r; c.k.</td>
<td>Measured G(N$_2$).</td>
<td>[67-0313].</td>
</tr>
<tr>
<td>1.06b</td>
<td>benzonitrile</td>
<td>2.9 x 10$^{-3}$</td>
<td>2.5 x 10$^{-2}$</td>
<td>γ-r; c.k.</td>
<td>Measured G(N$_2$).</td>
<td>[66-0045].</td>
</tr>
<tr>
<td>1.07a</td>
<td>benzoquinone</td>
<td>2.06</td>
<td>1.8 x 10$^{10}$</td>
<td>γ-r; c.k.</td>
<td>Measured G(N$_2$).</td>
<td>[67-0313].</td>
</tr>
<tr>
<td>1.07b</td>
<td>same</td>
<td>1.1</td>
<td>1.8 x 10$^{10}$</td>
<td>γ-r; c.k.</td>
<td>Measured G(N$_2$).</td>
<td>[66-0045].</td>
</tr>
<tr>
<td>1.08</td>
<td>benzoquinone</td>
<td>3 x 10$^{-9}$</td>
<td>p.r.; d.k.</td>
<td>Corr. made for natural d. of $\varepsilon$</td>
<td>[70-0198].</td>
<td></td>
</tr>
<tr>
<td>1.09a</td>
<td>benzoquinone</td>
<td>5.0 ± 1.2 x 10$^3$</td>
<td>p.r.; d.k.</td>
<td>Corr. for d. of $\varepsilon$ in pure solvent; benzo radical identified spec. from 317.1 and 305.5 nm bands.</td>
<td>[64-0113].</td>
<td></td>
</tr>
<tr>
<td>1.09b</td>
<td>same</td>
<td>5.7 ± 1.2 x 10$^3$</td>
<td>p.r.; d.k.</td>
<td>Benzy radical observed spec. $\varepsilon$ conc. varied two-fold.</td>
<td>[63-0059].</td>
<td></td>
</tr>
<tr>
<td>1.09c</td>
<td>benzoquinone</td>
<td>0.725</td>
<td>6.3 x 10$^{10}$</td>
<td>γ-r; c.k.</td>
<td>Measured G(N$_2$); $k_1/k_2$ an average for two conc.</td>
<td>[67-0313].</td>
</tr>
<tr>
<td>1.09d</td>
<td>same</td>
<td>0.36 ± 0.04</td>
<td>3.5 x 10$^{10}$</td>
<td>γ-r; c.k.</td>
<td>Measured G(N$_2$); constant $\mu$ maintained using LiCl.</td>
<td>[69-0456].</td>
</tr>
<tr>
<td>1.10</td>
<td>carbon tetrachloride</td>
<td>6.3</td>
<td>5.5 x 10$^{10}$</td>
<td>γ-r; c.k.</td>
<td>Measured G(N$_2$); $k_1/k_2$ given for two conc. studied.</td>
<td>[67-0313].</td>
</tr>
<tr>
<td>No.</td>
<td>Solute and reaction</td>
<td>( k_{1}/k_{2} )</td>
<td>( k ) (dm³/mol⁻¹ s⁻¹)</td>
<td>Method</td>
<td>Comments</td>
<td>Ref.</td>
</tr>
<tr>
<td>-----</td>
<td>---------------------</td>
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<td>--------------------------</td>
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<td>-----</td>
</tr>
<tr>
<td>1.11</td>
<td>chloroacetate ion</td>
<td>(&lt;1)</td>
<td>(&lt;8.7 \times 10^{-8})</td>
<td>( \gamma )-c. c.k.</td>
<td>Measured (G(N_2)); constant (\mu) maintained using LiCl.</td>
<td>[69-0456].</td>
</tr>
<tr>
<td>1.11a</td>
<td>chlorobenzene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.11b</td>
<td>same</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.13</td>
<td>cyanogen iodide</td>
<td>(9.5 \times 10^{-2})</td>
<td>(8.3 \times 10^{-8})</td>
<td>( \gamma )-c. c.k.</td>
<td>Measured (G(N_2)); (k_1/k_2) is average for two conc.</td>
<td>[66-0045].</td>
</tr>
<tr>
<td>1.14</td>
<td>duroquinone</td>
<td>(5.9 \times 10^{-3})</td>
<td>(8.3 \times 10^{-8})</td>
<td>( \gamma )-c. c.k.</td>
<td>Measured (G(N_2)); (k_1/k_2) is average for two conc.</td>
<td>[67-0313].</td>
</tr>
<tr>
<td>1.15a</td>
<td>fluoroantimone</td>
<td>(5.85 \times 10^{-3})</td>
<td>(5.1 \times 10^{-8})</td>
<td>( \gamma )-c. c.k.</td>
<td>Measured (G(N_2)); (k_1/k_2) is average for two conc.</td>
<td>[67-0313].</td>
</tr>
<tr>
<td>1.15b</td>
<td>same</td>
<td>(5.9 \times 10^{-3})</td>
<td>(5.1 \times 10^{-8})</td>
<td>( \gamma )-c. c.k.</td>
<td>Measured (G(N_2)); (k_1/k_2) is average for two conc.</td>
<td>[67-0313].</td>
</tr>
<tr>
<td>1.16a</td>
<td>(H_2)</td>
<td>(5.9 \times 10^{-3})</td>
<td>((3.7 \pm 1.0) \times 10^{-8})</td>
<td>p.r.; d.k.</td>
<td>Corr. for (e_+^+) d. in pure solvent.</td>
<td>[70-0198].</td>
</tr>
<tr>
<td>1.16b</td>
<td>same</td>
<td>((3.9 \pm 0.9) \times 10^{-8})</td>
<td></td>
<td>p.r.; d.k.</td>
<td>Corr. for (e_+^+) d. in pure solvent.</td>
<td>[64-0113].</td>
</tr>
<tr>
<td>1.16c</td>
<td>same</td>
<td>((0.81 \pm 0.63) \times 10^{-8})</td>
<td></td>
<td>p.r.; d.k.</td>
<td>Measured elec. cond. d.; effect of (\phi) ((4-10)); (N_2O), and (H_2O) observed.</td>
<td>[71-0064].</td>
</tr>
<tr>
<td>1.16d</td>
<td>(H_2)</td>
<td>10</td>
<td>(8.7 \times 10^{-8})</td>
<td>( \gamma )-c. c.k.</td>
<td>Measured (G(N_2)); primary salt effect evident ((k_1/k_2=2.93 \rightarrow 8.00); k_1/k_2) at (\mu=0) obtained from Brownstein-Bjerrum plot.</td>
<td>[67-0313].</td>
</tr>
<tr>
<td>1.16e</td>
<td>same</td>
<td>3.0</td>
<td>(2.6 \times 10^{-8})</td>
<td>( \gamma )-c. c.k.</td>
<td>Measured (G(H_3)) and (G(N_2)).</td>
<td>[66-0094].</td>
</tr>
<tr>
<td>1.17</td>
<td>iodine</td>
<td>(&lt;1)</td>
<td>(&lt;8.7 \times 10^{-8})</td>
<td>( \gamma )-c. c.k.</td>
<td>Measured (G(H_3)); (k) is deduced from inequality conditions applied to scavenging equation.</td>
<td>[67-0018].</td>
</tr>
<tr>
<td>1.18a</td>
<td>methyl bromide</td>
<td>(1.46)</td>
<td>(1.3 \times 10^{-8})</td>
<td>( \gamma )-c. c.k.</td>
<td>Measured (G(\cdot \cdot \cdot CH_3)) from (\cdot \cdot \cdot CH_3Br); (\cdot \cdot \cdot CH_3Br) determined from single solute exp.; (k_1/k_2) obtained from ratio of empirical (\alpha) values for (CH_3Br) and (N_2O).</td>
<td>[70-0064].</td>
</tr>
<tr>
<td>1.19</td>
<td>naphthalene</td>
<td>(&lt;4 \times 10^{-9})</td>
<td>(2 \times 10^{-8})</td>
<td>p.r.; d.k.</td>
<td>Spectrum shows product is not (C_9N_2H_4^+) but probably (C_9N_2H_4^+) radical.</td>
<td>[66-0080].</td>
</tr>
<tr>
<td>1.20</td>
<td>nitrate ion</td>
<td>(&lt;1)</td>
<td>(&lt;8.7 \times 10^{-8})</td>
<td>( \gamma )-c. c.k.</td>
<td>Measured (G(N_2)); (k_1/k_2) constant. (\mu) maintained.</td>
<td>[69-0456].</td>
</tr>
<tr>
<td>1.21</td>
<td>nitrite ion</td>
<td>(&lt;1)</td>
<td>(&lt;8.7 \times 10^{-8})</td>
<td>( \gamma )-c. c.k.</td>
<td>See 1.20.</td>
<td>[69-0456].</td>
</tr>
<tr>
<td>1.22a</td>
<td>nitrobenzene</td>
<td>4.1</td>
<td>(3.6 \times 10^{-8})</td>
<td>( \gamma )-c. c.k.</td>
<td>Measured (G(N_2));</td>
<td>[66-0045].</td>
</tr>
<tr>
<td>1.22b</td>
<td>same</td>
<td>4.0</td>
<td>(3.5 \times 10^{-8})</td>
<td>( \gamma )-c. c.k.</td>
<td>Measured (G(N_2)).</td>
<td>[67-0313].</td>
</tr>
</tbody>
</table>
### Table 1. Rate constants of reactions of the solvated electron in methanol—Continued

<table>
<thead>
<tr>
<th>No.</th>
<th>Solute and reaction</th>
<th>(k_i/k_0)</th>
<th>(k_{\text{dm}^3\text{mol}^{-1}\text{s}^{-1}})</th>
<th>Method</th>
<th>Comments</th>
</tr>
</thead>
</table>
| 1.23a | nitrous oxide  
(1) \(e^- + N_2O \rightarrow N_2 + O^-\)  
(2) \(e^- + S \rightarrow\) | 2.7 \times 10^4  
(\(T = 97\)) | 2.4 \times 10^{14}  
(\(T = 150\)) | \(\gamma\)-c. | Measured \(G(N_2);\) at \(T = 150; P = 1.32 \times 10^3\) N m\(^{-2}\); see Table 4 for Arrhenius parameters. |
| 1.23b | nitrous oxide | > 4.55 \times 10^4  
(\(\mu = 0; T = 0\)) | > 4.1 \times 10^{14}  
(\(\mu = 0; T = 0\)) | \(\gamma\)-c. | Measured \(G(N_2);\) \(k_i/k_0\) measured as function of \(\mu\). Corr. for counter ion contribution (~ 3%). |
| 1.23c | oxygen  
(1) \(e^- + N_2O \rightarrow N_2 + O^-\)  
(2) \(e^- + H_2 \rightarrow H\) | 0.120 | 1.95 \times 10^{14}  
(\(\mu = 0; T = 0\)) | \(\gamma\)-c. | Measured \(G(N_2);\) \(k_i/k_0\) measured as function of \(\mu\). Corr. for counter ion contribution (~ 3%). |
| 1.24a | oxygen  
(1) \(e^- + O_2 \rightarrow O_2\)  
(2) \(e^- + F^- \rightarrow F^-\)| (2.7 \pm 0.4) \times 10^{10} | p.r.; d.k. | Corr. for \(e^-\) d. in pure solvent. |
| 1.24b | oxygen  
(1) \(e^- + O_2 \rightarrow O_2\)  
(2) \(e^- + F^- \rightarrow F^-\)| 0.36 \pm 0.11 | 1.6 \times 10^{14b} | \(\gamma\)-c. | Measured \(G(H_2).\) |
| 1.24c | sulfur hexafluoride  
(1) \(e^- + SF_4 \rightarrow SF_4\)  
(2) \(e^- + N_2O \rightarrow N_2 + O^-\)| 3.2 | 2.8 \times 10^{14c} | \(\gamma\)-c. | Measured \(G(CH_4);\) used to determine \(\alpha_{\text{e,nf}}\); \(k_i/k_0\) from ratio of \(\alpha_{\text{e,nf}}\) to \(\alpha_{\text{e,oh}}.\) |
| 1.25 | silver ion  
(1) \(e^- + Ag^+ \rightarrow Ag^+\)  
(2) \(e^- + N_2O \rightarrow N_2 + O^-\)| 2.4 | 4.7 \times 10^{14e} | \(\gamma\)-c. | Measured \(G(N_2);\) \(k_i/k_0\) measured as function of \(\mu.\) |
| 1.26 | sulfur hexafluoride  
(1) \(e^- + SF_4 \rightarrow SF_4\)  
(2) \(e^- + N_2O \rightarrow N_2 + O^-\)| 2.4 | 28 \times 10^{14e} | \(\gamma\)-c. | Measured \(G(CH_4);\) used to determine \(\alpha_{\text{e,nf}}\); \(k_i/k_0\) from ratio of \(\alpha_{\text{e,nf}}\) to \(\alpha_{\text{e,oh}}.\) |
| 1.27a | toluene  
(1) \(e^- + C_6H_6 \rightarrow C_6H_6\)  
(2) \(e^- + N_2O \rightarrow N_2 + O^-\)| 7.2 \times 10^{-1} | 6.3 \times 10^{14c} | \(\gamma\)-c. | Measured \(G(N_2).\) |
| 1.27b | toluene  
(1) \(e^- + C_6H_6 \rightarrow C_6H_6\)  
(2) \(e^- + N_2O \rightarrow N_2 + O^-\)| 5.9 \times 10^{-1} | 5.1 \times 10^{14c} | \(\gamma\)-c. | Measured \(G(N_2);\) \(k_i/k_0\) from single conc. exp. |
| 1.28 | ubiquinone (Q)'  
\(\epsilon^- + Q \rightarrow Q^-\)| 1.7 \times 10^{10}  
(\(\pm 20\%\)) | p.r.; d.k. | Corr. for natural d. of \(\epsilon^-; k\) dependent on conc. of Q; absorption spectrum of radical anion observed. |

\(^a k(\epsilon^- + S) = 9 \times 10^{-1} \text{dm}^3\text{mol}^{-1}\text{s}^{-1};\) cf. 1.01c.

\(^b k(\epsilon^- + H_2) = 4 \times 10^{10} \text{dm}^3\text{mol}^{-1}\text{s}^{-1};\) cf. 1.16a, 1.16b.

\(^c k(\epsilon^- + N_2O) = 8.7 \times 10^9 \text{dm}^3\text{mol}^{-1}\text{s}^{-1}\) (see Introduction).

\(^d k(\epsilon^- + H_2) = 1.99 \times 10^{-1} \text{dm}^3\text{mol}^{-1}\text{s}^{-1}\) (valid for \(T = 0\)); cf. 1.23c.

\(^e k(\epsilon^- + N_2O) = 1.95 \times 10^9 \text{dm}^3\text{mol}^{-1}\text{s}^{-1}\) (valid for \(T = 0\)); cf. 1.23c.

\(^f\) Ubiquinone is a coenzyme in which all sites are occupied with side-chain.

\(^* G\) (product) resulting from the scavenging of \(\epsilon^-\) by a solute A can be fitted to an empirical equation containing \(\alpha_\epsilon\) (or \(\alpha_\epsilon, \alpha_* \ldots\)) for two or more solutes as an adjustable parameter. The \(\alpha\)'s are characteristic of the solute and are shown [cf. 70-0064] to be related to the rate constant for scavenging by:

\[ \alpha_\epsilon = k(\epsilon^- + A)/\lambda. \]

where \(\lambda\) is a constant for a given medium. Hence, two \(\alpha\)'s measured in the same alcohol have the following relationship:

\[ \alpha_\epsilon/\alpha_B = k(\epsilon^- + A)/k(\epsilon^- + B). \]

### Table 2. Rate constants of reactions of the solvated electron in ethanol

<table>
<thead>
<tr>
<th>No.</th>
<th>Solute and reaction</th>
<th>(k_i/k_0)</th>
<th>(k_{\text{dm}^3\text{mol}^{-1}\text{s}^{-1}})</th>
<th>Method</th>
<th>Comments</th>
</tr>
</thead>
</table>
| 2.01a | No solute  
\(\epsilon^- + S\)  
\(\epsilon^- + C_6H_6OH \rightarrow H\)  
\(\epsilon^- + C_6H_6O^-\)| | 6.8 \times 10^4  
\(\pm 20\%\) | p.r.; d.k. | \(t_\epsilon\) dose dependent; zero  
dose \(t_\epsilon\) (6 \(\mu\)s) from \(t_\epsilon\) \(t_\epsilon\)  
computer anal. |
| 2.01b | No solute  
\(\epsilon^- + S\)  
\(\epsilon^- + C_6H_6OH \rightarrow H\)  
\(\epsilon^- + C_6H_6O^-\)| | (0.8 - 1.0) \times 10^4 | p.r.; d.k. | Sodium ethoxide addition increases \(t_\epsilon\);  

[70-0172].

[70-0172].
<table>
<thead>
<tr>
<th>No.</th>
<th>Solute and reaction</th>
<th>$k/k_2$</th>
<th>Method</th>
<th>Comments</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.01c</td>
<td>same</td>
<td>$1.9 \times 10^2$</td>
<td>1. phot; d.k.</td>
<td>$\epsilon^+$ generated from 1- abs. corrected for $k_2$; d.c. curves not of simple order and probably include reaction with counter ion; $t_{1/2} = 3$ μs; $t_{1/2}$ longer in basic soln.</td>
<td>[64-7006].</td>
</tr>
<tr>
<td>2.01d</td>
<td>same</td>
<td>$1.35 \times 10^4$</td>
<td>p.r.; d.k.</td>
<td></td>
<td>[64-0173].</td>
</tr>
<tr>
<td>2.01e</td>
<td>same</td>
<td>$2.3 \times 10^4$</td>
<td>p.r.; d.k.</td>
<td>$t_{1/2} = 1.7$ μs with added LiCl (conc. independent); $t_{1/2} = 2.0$ μs with added LiBr (&gt; 0.1 mol dm$^{-3}$); conc. of KOH and NaOC,H$_4$ (1 × 6) × 10$^{-1}$ mol dm$^{-3}$.</td>
<td>[63-0059].</td>
</tr>
<tr>
<td>2.01f</td>
<td>same</td>
<td>$2.0 \times 10^4$</td>
<td>p.r.; d.k.</td>
<td>$t_{1/2} = 20$ μs; d. nearly f.o. but shows deviation at early times.</td>
<td>[70-0246].</td>
</tr>
<tr>
<td>2.01g</td>
<td>same</td>
<td>$-1.8 \times 10^4$</td>
<td>calc.</td>
<td>$G$(H$_2$O) used c.k. eq.; data from [64-0279] and [65-0051]; A is acetone, acetaldehyde, and Na$^{+}$; $k_1$ estimated using $k(\epsilon^+ + A)$ and is an av. value for those solutes.</td>
<td>[66-0082].</td>
</tr>
<tr>
<td>2.01h</td>
<td>No solute</td>
<td>$(5 \pm 4) \times 10^4$</td>
<td>c.k.</td>
<td>Reacted Na with C$_2$H$_5$OH and measured D$_2$, HD, and dissolution rate of Na; k calc. based on diffusion and homogeneous reaction kinetics.</td>
<td>[71-9165].</td>
</tr>
<tr>
<td>2.02</td>
<td>glycerol (31 &amp; 12 mol %)</td>
<td>$8.2 \times 10^4$</td>
<td>p.r.; d.k.</td>
<td>$t_{1/2} = 0.50$ and 0.75 μs for 31 and 12%, respectively; d. nearly f.o. but shows deviation at early times.</td>
<td>[66-0082].</td>
</tr>
<tr>
<td>2.03</td>
<td>H$_2$O (10, 20, and 36 mol %)</td>
<td>$5.4 \times 10^4$</td>
<td>p.r.; d.k.</td>
<td>$t_{1/2} = 0.4, 2.5, 3.2$, μs for 10, 20, and 36 mol %, respectively; see 2.02.</td>
<td>[66-0082].</td>
</tr>
<tr>
<td>2.04</td>
<td>NaOH</td>
<td>$1.6 \times 10^4$</td>
<td>p.r.; d.k.</td>
<td>Rapid d. on ms time scale; with added NaOH rapid decaying transient reduced; postulated as reaction within spur; $\gamma = \gamma_{NaOH}$, etc.</td>
<td>[67-0126].</td>
</tr>
<tr>
<td>2.05a</td>
<td>acetaldehyde</td>
<td>$1.4 \times 10^4$</td>
<td>p.r.; d.k.</td>
<td>Measured $G$(H$_2$).</td>
<td>[64-0279].</td>
</tr>
<tr>
<td>2.05b</td>
<td>acetaldehyde</td>
<td>$1.6 \times 10^4$</td>
<td>p.r.; c.k.</td>
<td>Measured $G$(H$_2$).</td>
<td>[64-0279].</td>
</tr>
<tr>
<td>2.06a</td>
<td>acetone</td>
<td>$7.1 \times 10^4$</td>
<td>p.r.; c.k.</td>
<td>Measured $G$(H$_2$).</td>
<td>[64-0279].</td>
</tr>
<tr>
<td>2.06b</td>
<td>same</td>
<td>$4 \times 10^4$</td>
<td>p.r.; c.k.</td>
<td>Measured $G$(H$_2$).</td>
<td>[67-0004].</td>
</tr>
<tr>
<td>2.06c</td>
<td>acetone</td>
<td>$0.52$</td>
<td>p.r.; c.k.</td>
<td>Measured $G$(H$_2$) from two solute system ($^4$CH$_3$Br + (CH$_3$)$<em>2$CO) to determine $k</em>{eff}$; $k_1/k_2$ obtained from the ratio of empirical $\alpha$ values for acetone and N$_2$.</td>
<td>[70-0064].</td>
</tr>
<tr>
<td>No.</td>
<td>Solute and reaction</td>
<td>$k_1/k_2$ (dm$^3$mol$^{-1}$s$^{-1}$)</td>
<td>Method</td>
<td>Comments</td>
<td>Ref.</td>
</tr>
<tr>
<td>-----</td>
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<td>----------</td>
<td>------</td>
</tr>
<tr>
<td>2.07</td>
<td>anthracene (1) $e^- + CH_4H_6 \rightarrow$ (2) $e^- + S \rightarrow$</td>
<td>$2.4 \times 10^8$</td>
<td>$1.6 \times 10^{10a}$</td>
<td>γ-r.; c.k.</td>
<td>Measured $G(H_2)$.</td>
</tr>
<tr>
<td>2.08</td>
<td>benzene (1) $e^- + CH_4H_6 \rightarrow$ (2) $e^- + S \rightarrow$</td>
<td>$8.5 \times 10^7$</td>
<td>$5.8 \times 10^{10a}$</td>
<td>γ-r.; c.k.</td>
<td>Measured $G(H_2)$; corr. for reaction of $e^-$ with impurities.</td>
</tr>
<tr>
<td>2.09a</td>
<td>benzyl chloride $e^- + CH_4H_6CH_2Cl \rightarrow$</td>
<td>$5.1 \times 10^9$</td>
<td>p.r.; d.k.</td>
<td>Corr. for $e^- d.$ in pure S.</td>
<td>[64–0138].</td>
</tr>
<tr>
<td>2.09b</td>
<td>same</td>
<td>$(5.1 \pm 1.2) \times 10^9$</td>
<td>p.r.; d.k.</td>
<td>Corr. for $e^- d.$ in pure S; benzyl radical identified spec. from 317.1 and 305.5 nm bands.</td>
<td>[64–0113].</td>
</tr>
<tr>
<td>2.09c</td>
<td>same</td>
<td>$(5.3 \pm 1.3) \times 10^9$</td>
<td>p.r.; d.k.</td>
<td>Benzy1 radical absorption observed.</td>
<td>[63–0059].</td>
</tr>
<tr>
<td>2.10a</td>
<td>biphenyl $e^- + CH_4H_6 \rightarrow$</td>
<td>$&gt; 2 \times 10^9$</td>
<td>p.r.; d.k.</td>
<td>Biphenyl ion identified spec. from 405, 610, and 635 nm bands.</td>
<td>[64–0113].</td>
</tr>
<tr>
<td>2.10b</td>
<td>biphenyl $e^- + CH_4H_6 \rightarrow$ (1) $e^- + CH_4H_6 \rightarrow (2) e^- + C_6H_6 \rightarrow$</td>
<td>$(4.2 \pm 0.7) \times 10^9$</td>
<td>p.r.; c.k.</td>
<td>O.D. of biphenyl ion measured at midpoint of 0.4 µ pulse in presence of various amounts of $G(CH_4)$.</td>
<td>[59–0256].</td>
</tr>
<tr>
<td>2.11a</td>
<td>carbon tetrachloride (1) $e^- + CCl_4 \rightarrow$ (2) $e^- + S \rightarrow$</td>
<td>$1.0 \times 10^4$</td>
<td>$6.8 \times 10^{17a}$</td>
<td>γ-r.; c.k.</td>
<td>Measured $G(H_2)$.</td>
</tr>
<tr>
<td>2.11b</td>
<td>carbon tetrachloride (1) $e^- + CCl_4 \rightarrow$ (2) $e^- + N_2 \rightarrow$</td>
<td>&lt; 1.3</td>
<td>$&lt; 1.1 \times 10^{10c}$</td>
<td>γ-r.; c.k.</td>
<td>Dose and base affect $k$; upper limit because no corr. for acid formed.</td>
</tr>
<tr>
<td>2.11c</td>
<td>carbon tetrachloride $e^- + CCl_4 \rightarrow$</td>
<td>$1.1 \times 10^{10a}$</td>
<td>p.r.; d.k.</td>
<td>Neutral and basic soln.</td>
<td>[71–0009].</td>
</tr>
<tr>
<td>2.12a</td>
<td>chloroacetic acid $e^- + CICH_4COOH \rightarrow$</td>
<td>$1.1 \times 10^5$</td>
<td>$7.5 \times 10^{10a}$</td>
<td>γ-r.; c.k.</td>
<td>Measured $G(H_2)$.</td>
</tr>
<tr>
<td>2.12b</td>
<td>same</td>
<td>$1.3 \times 10^9$</td>
<td>$8.9 \times 10^{10a}$</td>
<td>γ-r.; c.k.</td>
<td>Measured dose effect on $G(H_2)$ and $G(CH_3CHO)$.</td>
</tr>
<tr>
<td>2.12c</td>
<td>same</td>
<td>$1.0 \times 10^6$</td>
<td>$6.8 \times 10^{10a}$</td>
<td>γ-r.; c.k.</td>
<td>Measured $G(H_2)$.</td>
</tr>
<tr>
<td>2.12d</td>
<td>chloroacetic acid (1) $e^- + CICH_4COOH \rightarrow$ Cl$^- + CH_3COOH$ (2) $e^- + H_2 \rightarrow H$</td>
<td>$1.0 \pm 0.3_a$</td>
<td>$2 \times 10^{10b}$</td>
<td>γ-r.; c.k.</td>
<td>Measured $G(H_2)$; utilized $G(H_2)$ given in [64–0279] to obtain $k_1/k_2$.</td>
</tr>
<tr>
<td>2.13a</td>
<td>cyclopentyl bromide (1) $e^- + C_6H_5Br \rightarrow$ Br$^- + C_6H_5$ (2) $e^- + H_2 \rightarrow H$</td>
<td>0.48</td>
<td>$9.6 \times 10^{10b}$</td>
<td>γ-r.; c.k.</td>
<td>Conc. of Cl$-$ and C$6$H$5$Br was 0.1 mol.dm$^{-3}$; conc. of H$2$: 0.2 → 1 mol dm$^{-3}$; 95% ethanol.</td>
</tr>
<tr>
<td>2.13b</td>
<td>cyclopentyl bromide $e^- + C_6H_5Br \rightarrow$</td>
<td>$2.3 \times 10^9$</td>
<td>p.r.; d.k.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.14</td>
<td>ethyl acetate (1) $e^- + CH_4COOC_2H_5 \rightarrow$ (2) $e^- + S \rightarrow$</td>
<td>$1.1 \times 10^4$</td>
<td>$7.5 \times 10^{10a}$</td>
<td>γ-r.; c.k.</td>
<td>Measured $G(H_2)$.</td>
</tr>
<tr>
<td>2.15a</td>
<td>H$_2^<em>$ $e^- + H_2^</em> \rightarrow H_2$</td>
<td>$(2.1 \pm 0.4) \times 10^{10}$</td>
<td>p.r.; d.k.</td>
<td>Conc. H$_2^*$ calc. assuming complete dissocon of HCl and first dissocon of H$_2$SO$_4$.</td>
<td>[63–0059].</td>
</tr>
<tr>
<td>No.</td>
<td>Solute and reaction</td>
<td>$k_1/k_2$</td>
<td>$k$(dm³mol⁻¹s⁻¹)</td>
<td>Method</td>
<td>Comments</td>
</tr>
<tr>
<td>-----</td>
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<td>--------</td>
<td>----------</td>
</tr>
<tr>
<td>2.15b</td>
<td>same</td>
<td></td>
<td>$(2.0 \pm 0.4) \times 10^{10}$</td>
<td>pr.; d.k.</td>
<td>Corr. applied for $\epsilon_i$ d. in pure solvent; see [63–0059] for $H_2$ conc.</td>
</tr>
<tr>
<td>2.15c</td>
<td>same</td>
<td></td>
<td>$(4.49 \pm 0.17) \times 10^{10}$</td>
<td>p.r.; d.k.</td>
<td>Measured elec. conc.; effect of $pH(10)$, $N_2O$, and $H_2O$ observed; see table 4 for Arrhenius parameters.</td>
</tr>
<tr>
<td>2.15d</td>
<td>same</td>
<td></td>
<td>$1.1 \times 10^{10}$ (HCl)</td>
<td>p.r.; d.k.</td>
<td>Assumed only single ionization of $H_2SO_4$.</td>
</tr>
<tr>
<td>2.15e</td>
<td>$H^+$</td>
<td></td>
<td>$2.0 \times 10^7$</td>
<td>$\gamma-r.$; c.k.</td>
<td>Measured $G(H_2)$.</td>
</tr>
<tr>
<td>2.15f</td>
<td>$H_2$</td>
<td></td>
<td>$4.1$</td>
<td>$\gamma-r.$; c.k.</td>
<td>Measured $G(N_2)$; $k = 3.6 \times 10^{10}$ based on $k_{nu}$ ($H_2SO_4$) = $1.7 \times 10^{10}$ and $k &gt; 2.5 \times 10^{10}$ is for complete dissociation of $H_2SO_4$.</td>
</tr>
<tr>
<td>2.16a</td>
<td>methyl bromide</td>
<td></td>
<td>$1.52$</td>
<td>$\gamma-r.$; c.k.</td>
<td>Measured $G(\text{CH}_3\text{Br})$ from $\text{H}^+\text{CH}_3\text{Br}$; $k_i$ obtained from ratio of empirical $\alpha$ values.</td>
</tr>
<tr>
<td>2.16b</td>
<td>methyl chloride</td>
<td></td>
<td>$0.38$</td>
<td>$\gamma-r.$; c.k.</td>
<td>See 2.16a.</td>
</tr>
<tr>
<td>2.17</td>
<td>methanol</td>
<td></td>
<td>$6.8 \times 10^8$</td>
<td>$\gamma-r.$; c.k.</td>
<td>See 2.06c; two solute systems $\text{H}_2\text{Cl}$ and $\text{H}_2\text{Br}$.</td>
</tr>
<tr>
<td>2.18</td>
<td>naphthalene</td>
<td></td>
<td>$0.06$</td>
<td>p.r.; d.k.</td>
<td></td>
</tr>
<tr>
<td>2.19</td>
<td>nitrate ion</td>
<td></td>
<td>$0.5 \times 10^8$</td>
<td>p.r.; d.k.</td>
<td></td>
</tr>
<tr>
<td>2.20</td>
<td>nitrous oxide</td>
<td></td>
<td>$7.1 \times 10^9$</td>
<td>$\gamma-r.$; c.k.</td>
<td>Data from [68–0047]; at $T = 90$, $P_i = 1.62 \times 10^9$ Nm⁻¹; at $T = 145$, $P_i = 2.6 \times 10^9$ Nm⁻¹; see table 4 for Arrhenius parameters.</td>
</tr>
<tr>
<td>2.21a</td>
<td>same</td>
<td></td>
<td>$6.8 \times 10^8$</td>
<td>$\gamma-r.$; c.k.</td>
<td>Measured $G(H_2)$.</td>
</tr>
<tr>
<td>2.21b</td>
<td>nitrous oxide</td>
<td></td>
<td>$4.8 \times 10^8$</td>
<td>$\gamma-r.$; c.k.</td>
<td>Measured $G(N_2)$.</td>
</tr>
<tr>
<td>2.21c</td>
<td>oxygen</td>
<td></td>
<td>$1.75$</td>
<td>p.r.; d.k.</td>
<td>Corr. applied for $\epsilon_i$ d. in pure $S$.</td>
</tr>
<tr>
<td>2.22a</td>
<td>same</td>
<td></td>
<td>$(1.9 \pm 0.3) \times 10^8$</td>
<td>p.r.; d.k.</td>
<td></td>
</tr>
<tr>
<td>2.22b</td>
<td>perfluorocyclohexane</td>
<td></td>
<td>$(2.0 \pm 0.3) \times 10^8$</td>
<td>p.r.; d.k.</td>
<td></td>
</tr>
<tr>
<td>2.24</td>
<td>phenol</td>
<td></td>
<td>$4.5 \times 10^8$</td>
<td>p.r.; d.k.</td>
<td></td>
</tr>
</tbody>
</table>
### Table 2. Rate constants of reactions of the solvated electron in ethanol—Continued

<table>
<thead>
<tr>
<th>No.</th>
<th>Solute and reaction</th>
<th>$k/k_2$</th>
<th>$k$ (dm$^3$mol$^{-1}$s$^{-1}$)</th>
<th>Method</th>
<th>Comments</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.25a</td>
<td>propyl bromide $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}^+$ $\rightarrow$ $\text{CH}_3\text{CH}_2\text{CH}_2\text{H}^+$ $+$ Br$^-$</td>
<td>$3.0 \times 10^8$</td>
<td>p.r.: d.k.</td>
<td>Neutral and basic soln.</td>
<td>[71-0009].</td>
<td></td>
</tr>
<tr>
<td>2.25b</td>
<td>propyl bromide $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}^+$ $\rightarrow$ $\text{CH}_3\text{CH}_2\text{CH}_2\text{H}^+$ $+$ Br$^-$</td>
<td>$&lt; 0.19$</td>
<td>$&lt; 1.7 \times 10^{10}$</td>
<td>y.r.: c.k.</td>
<td>Dose effect on $k$: upper limit for $k$ because no corr. for acid formed.</td>
<td>[71-0009].</td>
</tr>
<tr>
<td>2.26</td>
<td>propyl chloride $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}^+$ $\rightarrow$ $\text{CH}_3\text{CH}_2\text{CH}_2\text{H}^+$ $+$ Cl$^-$</td>
<td>$2.4 \times 10^{-2}$</td>
<td>$4.8 \times 10^{10}$</td>
<td>y.r.: c.k.</td>
<td>Conc. of Cl$^-$ and $\text{CH}_3\text{CH}_2\text{Cl}$ was 1 and 0.1 mol dm$^{-3}$; conc. of $\text{H}^+$ 0.05 $\rightarrow$ 1.0 mol dm$^{-3}$; 95% ethanol.</td>
<td>[70-0248].</td>
</tr>
<tr>
<td>2.27</td>
<td>sulfur hexafluoride $\text{CF}_2\text{CF}_2\text{O}^+$ $\rightarrow$ $\text{CF}_2\text{CF}_2\text{O}^-$</td>
<td>$1.3 \times 10^{-6}$</td>
<td>$1.3 \times 10^{10}$</td>
<td>y.r.: c.k.</td>
<td>Measured $G(\text{H}_2)$ from $\text{CH}_3\text{CH}<em>2\text{Br}$ $+$ SF$^-$ to obtain $\phi</em>{\text{H}_2}$; see 2.09c.</td>
<td>[70-0064].</td>
</tr>
<tr>
<td>2.28</td>
<td>p-terphenyl $\text{C}_6\text{H}_4\text{C}_6\text{H}_4\text{Br}^+$ $\rightarrow$ $\text{C}_6\text{H}_4\text{C}_6\text{H}_4\text{H}^+$</td>
<td>$(7.2 \pm 0.6) \times 10^8$</td>
<td>p.r.: d.k.</td>
<td>C$_6$H$_4$Br identified spec. from 435.8 nm band.</td>
<td>[64-0084].</td>
<td></td>
</tr>
<tr>
<td>2.29a</td>
<td>tetratrimethane $\text{C}_2\text{H}_6\text{N}^+$ $\rightarrow$ $\text{C}_2\text{H}_6\text{N}^-$</td>
<td>$3.5 \times 10^9$</td>
<td>p.r.: d.k.</td>
<td></td>
<td></td>
<td>[71-0009].</td>
</tr>
<tr>
<td>2.29b</td>
<td>tetratrimethane $\text{C}_2\text{H}_6\text{N}^+$ $\rightarrow$ $\text{C}_2\text{H}_6\text{N}^-$</td>
<td>$2.7 \times 10^8$</td>
<td>$2.4 \times 10^{10}$</td>
<td>y.r.: c.k.</td>
<td>Measured $G(\text{N}_2)$.</td>
<td>[71-0009].</td>
</tr>
<tr>
<td>2.30</td>
<td>triphenylmethanol $\text{C}_2\text{H}_6\text{N}^+$ $\rightarrow$ $\text{C}_2\text{H}_6\text{N}^-$</td>
<td>$(2.0 \pm 0.4) \times 10^8$</td>
<td>p.r.: d.k.</td>
<td>Corr. applied for $\phi^*$. d. in S; triphenylmethyl radical identified spec.</td>
<td>[64-0115].</td>
<td></td>
</tr>
</tbody>
</table>

* $k(\phi^* + S) = 6.8 \times 10^8$ dm$^3$mol$^{-1}$s$^{-1}$; cf. 2.01a.
* $k(\phi^* + \text{H}_2) = 2 \times 10^9$ dm$^3$mol$^{-1}$s$^{-1}$; cf. 2.15.
* $k(\phi^* + \text{N}_2) = 8.7 \times 10^9$ dm$^3$mol$^{-1}$s$^{-1}$.
* $k(\phi^* + \text{CH}_3\text{CHO}) = 4 \times 10^9$ dm$^3$mol$^{-1}$s$^{-1}$; cf. 2.05a.
* $k(\phi^* + \phi^*) = (5 \pm 4) \times 10^8$ calc. based on $k(\phi^* + S) = 5.4 \times 10^8$ dm$^3$mol$^{-1}$s$^{-1}$, and $k(\phi^* + \phi^*) = (7 \pm 3) \times 10^8$ based on $k(\phi^* + S) = 6.8 \times 10^8$ dm$^3$mol$^{-1}$s$^{-1}$.

### Table 3. Rate constants of reactions of the solvated electron in 1-propanol (1-PrOH), 2-propanol (2-PrOH), and 1-butanol (1-BuOH)

<table>
<thead>
<tr>
<th>No.</th>
<th>Solute and reaction</th>
<th>$k/k_2$</th>
<th>$k$ (dm$^3$mol$^{-1}$s$^{-1}$)</th>
<th>Method</th>
<th>Comments</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.01a</td>
<td>No solute; $\text{S} \rightarrow$ 1-PrOH $\rightarrow$ 1-PrOH $\rightarrow$ 1-PrOH</td>
<td>$- 2.6 \times 10^4$</td>
<td>p.r.: d.k.</td>
<td>d. not of simple order, probably includes reaction with counter ion; $t_{2e} \rightarrow 2$ me.</td>
<td>[64-0113].</td>
<td></td>
</tr>
<tr>
<td>3.01b</td>
<td>No solute; $\text{S} \rightarrow$ 2-PrOH $\rightarrow$ 2-PrOH $\rightarrow$ 2-PrOH</td>
<td>$\approx 1.1 \times 10^4$</td>
<td>p.r.: d.k.</td>
<td>$t_{2e} \approx 5$ me; see 3.01a.</td>
<td>[64-0113].</td>
<td></td>
</tr>
<tr>
<td>3.02a</td>
<td>acetone; $\text{S} \rightarrow$ 2-PrOH $\rightarrow$ 2-PrOH $\rightarrow$ 2-PrOH</td>
<td>$7.7 \times 10^4$</td>
<td>y.r.: c.k.</td>
<td>Measured $G(\text{H}_2)$.</td>
<td>[67-0004].</td>
<td></td>
</tr>
<tr>
<td>3.02b</td>
<td>acetone; $\text{S} \rightarrow$ 2-PrOH $\rightarrow$ 2-PrOH $\rightarrow$ 2-PrOH</td>
<td>$0.99 \times 10^4$</td>
<td>y.r.: c.k.</td>
<td>Measured $G(\text{N}_2)$; single conc. determination.</td>
<td>[66-0021].</td>
<td></td>
</tr>
<tr>
<td>3.02c</td>
<td>acetone; $\text{S} \rightarrow$ 2-PrOH $\rightarrow$ 2-PrOH $\rightarrow$ 2-PrOH</td>
<td>$1.4 \times 10^4$</td>
<td>y.r.: c.k.</td>
<td>Measured $G(\text{H}_2)$.</td>
<td>[67-0004].</td>
<td></td>
</tr>
<tr>
<td>3.03</td>
<td>acetophenone; $\text{S} \rightarrow$ 2-PrOH $\rightarrow$ 2-PrOH $\rightarrow$ 2-PrOH</td>
<td>$1.7 \times 1.5 \times 10^4$</td>
<td>y.r.: c.k.</td>
<td>Measured $G(\text{N}_2)$.</td>
<td>[67-0045].</td>
<td></td>
</tr>
<tr>
<td>3.04a</td>
<td>benzene; $\text{S} \rightarrow$ 2-PrOH $\rightarrow$ 2-PrOH $\rightarrow$ 2-PrOH</td>
<td>$2.1 \times 10^4$</td>
<td>$1.8 \times 10^4$</td>
<td>y.r.: c.k.</td>
<td>Measured $G(\text{N}_2)$.</td>
<td>[66-0045].</td>
</tr>
<tr>
<td>3.04b</td>
<td>benzene; $\text{S} \rightarrow$ 2-PrOH $\rightarrow$ 2-PrOH $\rightarrow$ 2-PrOH</td>
<td>$2.0 \times 10^4$</td>
<td>$1.7 \times 10^4$</td>
<td>y.r.: c.k.</td>
<td>Measured $G(\text{N}_2)$.</td>
<td>[66-0027].</td>
</tr>
<tr>
<td>3.05</td>
<td>benzene; $\text{S} \rightarrow$ 2-PrOH $\rightarrow$ 2-PrOH $\rightarrow$ 2-PrOH</td>
<td>$1.9 \times 10^4$</td>
<td>$1.7 \times 10^4$</td>
<td>y.r.: c.k.</td>
<td>Measured $G(\text{N}_2)$.</td>
<td>[66-0045].</td>
</tr>
<tr>
<td>3.06</td>
<td>benzene; $\text{S} \rightarrow$ 2-PrOH $\rightarrow$ 2-PrOH $\rightarrow$ 2-PrOH</td>
<td>$1.3 \times 10^4$</td>
<td>$1.1 \times 10^4$</td>
<td>y.r.: c.k.</td>
<td>Measured $G(\text{N}_2)$; single conc. determination.</td>
<td>[66-0027].</td>
</tr>
<tr>
<td>No.</td>
<td>Solvent and reaction</td>
<td>$k_1/k_2$</td>
<td>$\lambda$ (dm$^3$/mol·s$^{-1}$)</td>
<td>Method</td>
<td>Comments</td>
<td>Ref.</td>
</tr>
<tr>
<td>-----</td>
<td>----------------------</td>
<td>-----------</td>
<td>-----------------</td>
<td>--------</td>
<td>----------</td>
<td>------</td>
</tr>
<tr>
<td>3.07</td>
<td>carbon tetrachloride; S=2-PrOH</td>
<td></td>
<td>2.26</td>
<td>$2.0 \times 10^{10}$</td>
<td>$\gamma_r$; c.k.</td>
<td>Measured $G(\text{N}_2)$; single case, determination. [66-0027].</td>
</tr>
<tr>
<td>3.08</td>
<td>(1) $e^+ + \text{C}_2\text{H}_4\text{O} \to$</td>
<td></td>
<td>0.54</td>
<td>$4.7 \times 10^{10}$</td>
<td>$\gamma_r$; c.k.</td>
<td>Measured $G(\text{N}_2)$. [66-0045].</td>
</tr>
<tr>
<td>3.09</td>
<td>(2) $e^+ + \text{N}_2\text{O} \to \text{N}_2 + \text{O}^{-}$</td>
<td></td>
<td>3.6 × 10$^{-4}$</td>
<td></td>
<td>$\gamma_r$; c.k.</td>
<td>Measured $G(\text{H}_2)$. [67-0174].</td>
</tr>
<tr>
<td>3.10</td>
<td>(1) $e^+ + \text{C}_6\text{H}_5\text{C}_6\text{H}_4\text{OH} \to$</td>
<td></td>
<td>5.0 × 10$^{-1}$</td>
<td>$4.4 \times 10^{10}$</td>
<td>$\gamma_r$; c.k.</td>
<td>Measured $G(\text{N}_2)$. [66-0045].</td>
</tr>
<tr>
<td>6.13a</td>
<td>$\text{H}_2\text{O} + \text{OH}^-$</td>
<td></td>
<td>9.1 (pH 2)</td>
<td>9 × 10$^{-14}$</td>
<td>$\gamma_r$; c.k.</td>
<td>Measured $G(\text{N}_2)$; $k_1/k_2$ used in calc. of $G(\text{N}_2)$ to good fit with exp.; taken from CH$_3$OH data [67-0065] and adjusted for $\rho$. [67-0065].</td>
</tr>
<tr>
<td>5.13b</td>
<td>$\text{H}_2; S=2$-PrOH</td>
<td></td>
<td>(2.65 ± 0.19) × 10$^{12}$</td>
<td>p.c.; d.k.</td>
<td>Measured elec. cond., d.; effect of pHH=10, N$_2$O, and H$_2$O observed; see table 4 for Arrhenius parameters. [71-0064].</td>
<td></td>
</tr>
<tr>
<td>5.13c</td>
<td>$\text{H}_2; S=2$-PrOH</td>
<td></td>
<td>0.5</td>
<td>$4.4 \times 10^{10}$</td>
<td>$\gamma_r$; c.k.</td>
<td>Measured $G(\text{N}_2)$; $k_1/k_2$ in ac. for pH=1.3 to 2.3. [66-0027].</td>
</tr>
<tr>
<td>5.11d</td>
<td>$\text{H}_2; S=2$-PrOH</td>
<td></td>
<td>(1.67 ± 0.14) × 10$^{10}$</td>
<td>p.c.; d.k.</td>
<td>Measured elec. cond., d.; effect of pH 8-10, N$_2$O, and H$_2$O observed; see table 4 for Arrhenius parameters. [71-0064].</td>
<td></td>
</tr>
<tr>
<td>3.12a</td>
<td>nitrobenzene; S=2-PrOH</td>
<td></td>
<td>2.3</td>
<td>$2.0 \times 10^{10}$</td>
<td>$\gamma_r$; c.k.</td>
<td>Measured $G(\text{N}_2)$. [66-0045].</td>
</tr>
<tr>
<td>3.12b</td>
<td>same</td>
<td></td>
<td>2.3</td>
<td>$2.0 \times 10^{10}$</td>
<td>$\gamma_r$; c.k.</td>
<td>Measured $G(\text{N}_2)$. [66-0027].</td>
</tr>
<tr>
<td>3.13a</td>
<td>nitrous oxide; S=1-PrOH</td>
<td></td>
<td>1.5 × 10$^9$</td>
<td></td>
<td>$\gamma_r$; c.k.</td>
<td>Measured $G(\text{N}_2)$ at $T=140$, $P=5.3 \times 10^4$ Nm$^{-2}$; see table 4 for Arrhenius parameters. [69-0387].</td>
</tr>
<tr>
<td>3.13b</td>
<td>nitrous oxide; S=2-PrOH</td>
<td></td>
<td>6.4 × 10$^9$</td>
<td></td>
<td>$\gamma_r$; c.k.</td>
<td>Measured $G(\text{H}_2)$. [96-0027].</td>
</tr>
<tr>
<td>3.13c</td>
<td>same</td>
<td></td>
<td>5.9 × 10$^9$</td>
<td></td>
<td>$\gamma_r$; c.k.</td>
<td>Measured $G(\text{H}_2)$. [69-0925].</td>
</tr>
<tr>
<td>3.34</td>
<td>propionaldehyde; S=1-PrOH</td>
<td></td>
<td>$\geq 2.2 \times 10^9$</td>
<td>$8.4 \times 10^9$ ($T=85$)</td>
<td>$\gamma_r$; c.k.</td>
<td>Measured $G(\text{H}_2)$. [67-0134].</td>
</tr>
<tr>
<td>3.35</td>
<td>toluene; S=2-PrOH</td>
<td></td>
<td>1.4 × 10$^9$</td>
<td>$1.2 \times 10^{10}$</td>
<td>$\gamma_r$; c.k.</td>
<td>Measured $G(\text{N}_2)$. [96-0045].</td>
</tr>
</tbody>
</table>

* $\lambda(k^+ + N_2O) - \lambda(k^- + N_2O) = 8.7 \times 10^9$ dm$^3$/mol·s$^{-1}$ (see Introduction).*
**Table 4. Arrhenius parameters for reactions of the solvated electron in alcohol solutions**

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Alcohol</th>
<th>$\log A$ (dm$^3$mol$^{-1}$s$^{-1}$)</th>
<th>$E_a$ (kJ mol$^{-1}$)</th>
<th>$\Delta S^\dagger$ (J mol$^{-1}$deg$^{-1}$)</th>
<th>$T$ (°C)</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$e^- + S \rightarrow$ ethanol</td>
<td>6.47$^a$</td>
<td>15.5</td>
<td>-88</td>
<td>-97 to 150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>methanol</td>
<td>7.16$^b$</td>
<td>19.2</td>
<td>-88</td>
<td>-112 to 145</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-propanol</td>
<td>18.8</td>
<td>-80</td>
<td>-120 to 140</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-propanol</td>
<td>26.4</td>
<td>-59</td>
<td>-85 to 140</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$e^- + H^+_2 \rightarrow$ ethanol</td>
<td>11.00</td>
<td>(19.7 ± 1.3)</td>
<td>-33$^b$</td>
<td>26 to 50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-propanol</td>
<td>10.80</td>
<td>(24.3 ± 2.1)</td>
<td>-21$^b$</td>
<td>24 to 50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-propanol</td>
<td>10.79</td>
<td>(30.5 ± 2.1)</td>
<td>-21$^b$</td>
<td>25 to 46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\epsilon^- + \epsilon^-$ ethanol-d$_4$</td>
<td>(32 ± 8)</td>
<td></td>
<td>-78 to 25</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$^a$ Log $A$ calculated using experimental $E_a$ and rate constants given in 1.01c and 2.01a.
$^b$ $\Delta S^\dagger$ calculated using experimental log $A$ and the preexponential relationship of the transition—same theory.

**Table 5. Index of entry numbers (tables 1, 2, and 3) for the reaction of solvated electrons in various alcohol solutions**

<table>
<thead>
<tr>
<th>Solute added</th>
<th>Methanol</th>
<th>Ethanol</th>
<th>1-Propanol</th>
<th>2-Propanol</th>
<th>1-Butanol</th>
</tr>
</thead>
<tbody>
<tr>
<td>None ($e^- + S$)</td>
<td>1.01a, 1.01b, 1.01c, 1.01d, 1.01e, 1.01f, 1.17, 1.18b, 1.23a, 1.23b</td>
<td>3.01a, 3.01b, 3.01c, 3.01d, 3.01e, 3.01f, 3.01g, 3.01h, 3.01i, 3.01j, 3.01k, 3.01l, 3.01m, 3.01n, 3.01o, 3.01p, 3.01q, 3.01r, 3.01s, 3.01t, 3.01u, 3.01v, 3.01w, 3.01x, 3.01y, 3.01z</td>
<td>3.09a, 3.09b, 3.09c, 3.09d, 3.09e, 3.09f, 3.09g, 3.09h, 3.09i, 3.09j, 3.09k, 3.09l, 3.09m, 3.09n, 3.09o, 3.09p, 3.09q, 3.09r, 3.09s, 3.09t, 3.09u, 3.09v, 3.09w, 3.09x, 3.09y, 3.09z</td>
<td>3.13a, 3.13b, 3.13c</td>
<td>3.02c.</td>
</tr>
<tr>
<td>None ($\epsilon^- + \epsilon^-$)</td>
<td>1.01g</td>
<td>2.01a</td>
<td>2.01b, 2.01c, 2.01d, 2.01e, 2.01f, 2.01g, 2.01h, 2.01i, 2.01j, 2.01k, 2.01l, 2.01m, 2.01n, 2.01o, 2.01p, 2.01q, 2.01r, 2.01s, 2.01t, 2.01u, 2.01v, 2.01w, 2.01x, 2.01y, 2.01z</td>
<td>3.02a</td>
<td>3.02b</td>
</tr>
<tr>
<td>Acetaldehyde</td>
<td>1.04a, 1.04b</td>
<td>2.06a, 2.06b, 2.06c</td>
<td>2.06d</td>
<td>2.06e</td>
<td>3.03</td>
</tr>
<tr>
<td>Aceton</td>
<td>1.05a, 1.05b</td>
<td>2.07</td>
<td>2.08a, 2.08b</td>
<td>2.09a, 2.09b</td>
<td>3.04a, 3.04b</td>
</tr>
<tr>
<td>Acetophenone</td>
<td>1.06a, 1.06b</td>
<td>2.07</td>
<td>2.08a, 2.08b</td>
<td>2.09a, 2.09b</td>
<td>3.04a, 3.04b</td>
</tr>
<tr>
<td>Benzene</td>
<td>1.06a, 1.06b</td>
<td>2.08a, 2.08b</td>
<td>2.09a, 2.09b</td>
<td>3.04a, 3.04b</td>
<td>3.05</td>
</tr>
<tr>
<td>Benzonitrile</td>
<td>1.08</td>
<td>2.09a, 2.09b</td>
<td>2.09c</td>
<td>2.09d</td>
<td>3.06</td>
</tr>
<tr>
<td>Benzyl chloride</td>
<td>1.09a, 1.09b, 1.09c, 1.09d</td>
<td>2.09a, 2.09b, 2.09c</td>
<td>2.10a, 2.10b</td>
<td>2.11a, 2.11b, 2.11c</td>
<td>3.07</td>
</tr>
<tr>
<td>Biphenyl</td>
<td>1.10</td>
<td>2.12a, 2.12b</td>
<td>2.13a, 2.13b</td>
<td>2.14</td>
<td>3.08</td>
</tr>
<tr>
<td>Chloroform</td>
<td>1.11</td>
<td>2.12a, 2.12b</td>
<td>2.13a, 2.13b</td>
<td>2.14</td>
<td>3.09</td>
</tr>
<tr>
<td>Chloroform</td>
<td>1.12a, 1.12b</td>
<td>2.12a, 2.12b</td>
<td>2.13a, 2.13b</td>
<td>2.14</td>
<td>3.09</td>
</tr>
<tr>
<td>Cyanogen iodide</td>
<td>1.13</td>
<td>2.12a, 2.12b</td>
<td>2.13a, 2.13b</td>
<td>2.14</td>
<td>3.09</td>
</tr>
<tr>
<td>Cyclopentyl bromide</td>
<td>1.14</td>
<td>2.12a, 2.12b</td>
<td>2.13a, 2.13b</td>
<td>2.14</td>
<td>3.09</td>
</tr>
<tr>
<td>Durene</td>
<td>1.15</td>
<td>2.12a, 2.12b</td>
<td>2.13a, 2.13b</td>
<td>2.14</td>
<td>3.09</td>
</tr>
<tr>
<td>Ethyl acetate</td>
<td>1.16a, 1.16b, 1.16c, 1.16d, 1.16e, 1.16f, 1.16g, 1.16h, 1.16i, 1.16j, 1.16k, 1.16l, 1.16m, 1.16n, 1.16o, 1.16p, 1.16q, 1.16r, 1.16s, 1.16t, 1.16u, 1.16v, 1.16w, 1.16x, 1.16y, 1.16z</td>
<td>2.12a, 2.12b</td>
<td>2.13a, 2.13b</td>
<td>2.14</td>
<td>3.09</td>
</tr>
<tr>
<td>Ferric ion</td>
<td>1.17</td>
<td>2.12a, 2.12b</td>
<td>2.13a, 2.13b</td>
<td>2.14</td>
<td>3.09</td>
</tr>
<tr>
<td>Iodine</td>
<td>1.18a, 1.18b</td>
<td>2.12a, 2.12b</td>
<td>2.13a, 2.13b</td>
<td>2.14</td>
<td>3.09</td>
</tr>
<tr>
<td>Methyl bromide</td>
<td>1.19a, 1.19b</td>
<td>2.12a, 2.12b</td>
<td>2.13a, 2.13b</td>
<td>2.14</td>
<td>3.09</td>
</tr>
<tr>
<td>Methyl chloride</td>
<td>1.20a</td>
<td>2.12a, 2.12b</td>
<td>2.13a, 2.13b</td>
<td>2.14</td>
<td>3.09</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>1.21a</td>
<td>2.12a, 2.12b</td>
<td>2.13a, 2.13b</td>
<td>2.14</td>
<td>3.09</td>
</tr>
</tbody>
</table>
Table 5. Index of entry numbers (tables 1, 2, and 3) for the reaction of solvated electrons in various alcohol solvents (Continued)

<table>
<thead>
<tr>
<th>Solvent added</th>
<th>Methanol</th>
<th>Ethanol</th>
<th>1-Propanol</th>
<th>2-Propanol</th>
<th>1-Butanol</th>
</tr>
</thead>
<tbody>
<tr>
<td>naphthalene</td>
<td>1.19</td>
<td>2.18b, 2.19</td>
<td>2.20</td>
<td>2.06c, 2.11b, 2.15c, 2.06c, 2.11b, 2.15c, 2.21a, 2.21b, 2.21c, 2.25b, 2.27, 2.29b</td>
<td>1.33a, 3.12a, 3.12b, 3.04a, 3.04b, 3.05, 3.06, 3.07, 3.08, 3.10, 3.11a, 3.11c, 3.12a, 3.12b, 3.13a, 3.14a, 3.14b, 3.15b, 3.16c, 3.17</td>
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<td>2.20</td>
<td>2.20</td>
<td>2.20</td>
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<tr>
<td>nitrite ion</td>
<td>1.21</td>
<td>2.20</td>
<td>2.20</td>
<td>2.20</td>
<td>2.20</td>
</tr>
<tr>
<td>nitrobenzene</td>
<td>1.22a, 1.22b</td>
<td>2.20</td>
<td>2.20</td>
<td>2.20</td>
<td>2.20</td>
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<tr>
<td>nitrous oxide</td>
<td>1.04a, 1.04b, 1.05a, 1.05b, 1.06a, 1.06b, 1.09c, 1.09d, 1.10, 1.11, 1.12a, 1.12b, 1.13, 1.15a, 1.16a, 1.16b, 1.18a, 1.20, 1.21, 1.25, 1.27, 1.27a, 1.27b, 1.29a, 1.29b, 1.24c, 1.24e</td>
<td>2.20a, 2.22a, 2.22b, 2.23, 2.25a, 2.25b, 2.27, 2.29b, 2.29e</td>
<td>3.14</td>
<td></td>
<td></td>
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<td>2.20</td>
<td>2.20</td>
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<tr>
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<td>2.23</td>
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<tr>
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<td>2.24a, 2.25b</td>
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<td>2.26</td>
<td>2.26</td>
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<tr>
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<td>2.27</td>
<td>2.27</td>
<td>2.27</td>
<td>2.27</td>
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<tr>
<td>propyl chloride</td>
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<td>2.28</td>
<td>2.28</td>
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<td>2.30</td>
<td>2.30</td>
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<tr>
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<td>2.30</td>
<td>2.30</td>
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</tbody>
</table>

References

[67–0126] Direct observation of regions of high ion and radical concentration in the radiolysis of water and ethanol.


[71-0062] Radiolysis of ethanol. Freeman, G. R., to be published.


