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Modelling the molecular composition and nuclear-spin chemistry of collapsing prestellar sources*

P. Hily-Blant[1,2]†, A. Faure[2], C. Rist[2], G. Pineau des Forêts[3,4], D. R. Flower[5]
[1] *Institut Universitaire de France*
[2] *Université Grenoble Alpes, CNRS, IPAG, F-38000 Grenoble, France*
[3] *IAS (UMR 8617 du CNRS), Bâtiment 121, Université de Paris Sud, F-91405 Orsay, France*
[4] *LERMA (UMR 8112 du CNRS), Observatoire de Paris, 61 Avenue de l'Observatoire, F-75014 Paris, France*
[5] *Physics Department, The University, Durham DH1 3LE, UK*

ABSTRACT

We study the gravitational collapse of prestellar sources and the associated evolution of their chemical composition. We use the *University of Grenoble Alpes Astrochemical Network* (UGAN), which includes reactions involving the different nuclear–spin states of H_2, H_3^+, and of the hydrides of carbon, nitrogen, oxygen, and sulfur, for reactions involving up to seven protons. In addition, species-to-species rate coefficients are provided for the ortho/para interconversion of the $H_3^+ + H_2$ system and isotopic variants. The composition of the medium is followed from an initial steady state through the early phase of isothermal gravitational collapse. Both the freeze–out of the molecules on to grains and the coagulation of the grains were incorporated in the model. The predicted abundances and column densities of the spin isomers of ammonia and its deuterated forms are compared with those measured recently towards the prestellar cores H-MM1, L16293E, and Barnard B1. We find that gas–phase processes alone account satisfactorily for the observations, without recourse to grain-surface reactions. In particular, our model reproduces both the isotopologue abundance ratios and the ortho:para ratios of NH_2D and NHD_2 within observational uncertainties. More accurate observations are necessary to distinguish between full scrambling processes—as assumed in our gas-phase network—and direct nucleus- or atom-exchange reactions.

Key words:
Stars: formation—Molecular processes and data—Astrochemistry—ISM: abundances, molecules—ISM: individual objects H-MM1, L16293E, Barnard B1

1 INTRODUCTION

The gravitational collapse of gas and dust, which can lead ultimately to the formation of a star and planets, can be observed, in its early stages, through the molecular lines that are emitted by the contracting object. Many such observations have been performed in recent years, by means of ground-based and satellite observatories, and the ALMA array is now providing unprecedented angular resolution. Furthermore, there are converging lines of evidence that cometary ices carry signatures of prestellar core chemistry. Most recently, unexpectedly large abundances of O_2 and volatile S_2 in the coma of comet 67P/C-G were reported (Bieler et al. 2015; Calmonte et al. 2016), while observations with ground-based interferometers and with the submillimeter ESA/Herschel observatory indicate that more than about 80% of water from the prestellar core actually remains in solid form during the collapse of the protostellar envelope towards the protoplanetary disk (van Dishoeck et al. 2014).

As the object collapses, its density increases, and changes in the rates of physical and chemical processes cause the composition of the medium to evolve. These changes can be followed by means of models that incorporate both the dynamical processes associated with the collapse and the physical chemistry of the gas. Given that the timescale for gravitational collapse and those of many of the chemical processes are comparable, it is desirable that the numerical model should be able to solve simultaneously the dynamical and the chemical rate equations.

Our previous models of prestellar objects have either neglected the dynamics and assumed that the chemical com-

* This paper is dedicated to the memory of Charles Malcolm Walmsley, outstanding astrophysicist and friend.
† E-mail: pierre.hily-blant@univ-grenoble-alpes.fr

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position attains steady–state at a given density (Le Gal et al. 2014), or followed the contraction of the radius, R, of a core of mass M by means of the equation of gravitational free–fall,

$$\frac{1}{R}\frac{\mathrm{d}R}{\mathrm{d}t} \equiv \frac{1}{x}\frac{\mathrm{d}x}{\mathrm{d}t} = -\frac{\pi}{2\tau_{\rm ff}x}\left(\frac{1}{x}-1\right)^{1/2} \quad (1)$$

(Flower et al. 2005), where t is the time and $x \equiv R/R_0 \leq 1$. The initial radius, R_0, of the condensation is given by

$$R_0 = \left(\frac{3M}{4\pi\rho_0}\right)^{1/3} \quad (2)$$

with ρ_0 the initial mass density. The timescale, $\tau_{\rm ff}$, for free–fall collapse is

$$\tau_{\rm ff} = \left(\frac{3\pi}{32G\rho_0}\right)^{1/2} \quad (3)$$

(Spitzer 1978). By integrating Equ. (1) in parallel with the chemical rate equations, the chemical composition of the medium may be derived, as a function of the (time–dependent) density of the cloud.

Seminal studies of the gravitational collapse of condensations of material in interstellar clouds (Larson 1969, 1972; Penston 1969) have shown that, in the initial isothermal phase, the collapsing core becomes surrounded by an envelope whose density varies as r^{-2}, where r is the radial distance to a point in the condensation. The central object subsequently acquires mass via an outwards–propagating expansion shock wave (Shu 1977). This model was adopted by Visser et al. (2009, 2011) in order to simulate the chemical evolution of a molecular medium that is undergoing gravitational collapse. Their (two–dimensional) simulation assumes the condensation to be rotating, and consequently some of the infalling material accumulates in a disk. More recently, Keto et al. (2015) have applied a one–dimensional ("Larson-Penston") dynamical model in their study of the chemistry of collapsing prestellar cores.

In our approach, we distinguish between a central object ("core"), whose initial mass is equal to the Jeans mass and which is undergoing free–fall collapse, and the surrounding object ("envelope"), which forms through mass–loss from the core; the total mass of the core plus the envelope remains constant and equal to the Jeans mass. As the core evolves, its density increases but its mass decreases. The increasing density leads to an enhanced rate of adsorption of the molecular gas on to the grains, whilst an increasing fraction of the molecular column density is contributed by the surrounding envelope. We simulate the structure and chemical composition of the envelope by means of a time–dependent chemical model, assuming a r^{-2} density profile in the envelope and a constant temperature throughout. The column densities of atomic and molecular species are computed in the core and the envelope, and comparisons are made with the corresponding values observed in prestellar sources.

Our treatment of the chemistry of the medium distinguishes itself from other studies of protostellar collapse (Lesaffre et al. 2005; Visser et al. 2011; Aikawa et al. 2012; Keto et al. 2015) by including explicitly the various nuclear–spin states of the carbon, nitrogen, oxygen, and sulfur hydrides and their abundant deuterated forms. It has been known for over a decade that the (observed) deuterium enrichment of molecules such as ammonia is mediated by reactions with the deuterated forms of H_3^+ and is intimately linked to the evolution of ortho:para abundance ratios. Our model combines a chemistry of prestellar objects that incorporates isotopic and nuclear–spin modifications of the relevant species with a dynamical simulation of the initial phase of gravitational collapse that results in the formation of the prestellar object. The dynamical and chemical rate equations are solved numerically, in parallel, thereby allowing, in a self-consistent manner, for departures of the physical and chemical states of the medium from steady–state.

In Section 2, we summarize the characteristics of the model; Section 3 contains our results and comparisons with observations of prestellar objects, and Section 4 our concluding remarks.

2 THE MODEL

2.1 A new dynamical model

We consider a spherically–symmetric, isothermal, non-rotating medium, consisting of neutral, positively– and negatively–charged gas and dust. The mass contained in the collapsing sphere is

$$M_0 = \frac{4\pi}{3}R_0^3\rho_0$$

where R_0 is the initial radius and ρ_0 is the initial, uniform, mass density. Both the Jeans mass, $M_{\rm J}$, and the critical mass for stability of a Bonnor–Ebert sphere, $M_{\rm crit}$, are of the same order, given by

$$M_{\rm J} \approx M_{\rm crit} \approx \left(\frac{\pi k_{\rm B}T}{\mu G}\right)^{3/2}\left(\frac{1}{\rho_0}\right)^{1/2},$$

where $\mu = 2.33 m_{\rm H} = 3.9\times10^{-24}$ g is the mean molecular mass and $T = 10$ K is the kinetic temperature of the gas. Taking $\rho_0 \equiv n_0\mu = 1.4 n_{\rm H} m_{\rm H}$, where $n_0 = 6.0\times10^3$ cm^{-3} is the initial number density of the gas (corresponding to molecular gas with $n_{\rm H} = n({\rm H}) + 2n({\rm H_2}) = 10^4$ cm^{-3} and $n({\rm He})/n_{\rm H} = 0.10$), yields $M_{\rm J} \approx 7$ M$_\odot$; the corresponding free–fall time is $\tau_{\rm ff} = 4.4\times10^5$ yr.

We compute the chemical evolution of a fluid particle that flows inwards, at speed, $v(R)$, where R is the radius of the free–falling core. Following the early study of Larson (1969), the free–falling core, of radius R, has a uniform density ρ and is progressively surrounded by an envelope whose density $\rho_{\rm env}$ evolves as

$$\rho_{\rm env}(R_{\rm env}) = \rho_0\left(\frac{R_0}{R_{\rm env}}\right)^2 = \rho\left(\frac{R}{R_{\rm env}}\right)^2, \quad (4)$$

which implies that the mass of the core is

$$M(R) = M_0\frac{R}{R_0}. \quad (5)$$

The equation of motion under conditions of free–fall gravitational collapse is

$$\frac{d^2R}{dt^2} = -\frac{GM(R)}{R^2} \quad (6)$$

where G is the gravitational constant. Using Equ. (5), Equ. (6) may be integrated, yielding

$$v(R) = \frac{dR}{dt} = -\left[\frac{2GM_0}{R_0}\ln\left(\frac{R_0}{R}\right)\right]^{1/2}. \quad (7)$$

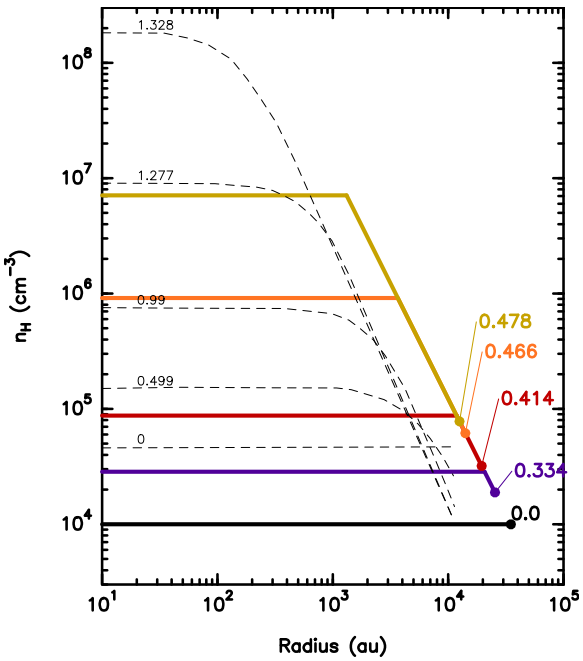

Figure 1. The evolution, in our "Larson-Penston" model, of the density profile of the gas (full curves), $n_{\rm H}$, as a function of the radius for a mass $M_0 = 7\,{\rm M}_\odot$ and an initial density of $n_{\rm H} = 10^4\,{\rm cm}^{-3}$. The time elapsed from the initial configuration (in Myr) is indicated for each curve. The filled circles indicate the location of the outer edge of the envelope, which varies with the core radius, in order that the total mass is conserved. The results of Larson (1969), for a $1\,{\rm M}_\odot$ contracting cloud of initial density and radius $n_{\rm H}$=4.7$\times 10^4$ cm^{-3} and 1.1$\times 10^4$ au respectively, are also shown for comparison (broken curves, labeled with the times in units of 10^{13} s).

with the initial condition that $v(R) = 0$ when $R = R_0$.

We note that Equs. (4) and (5) have the form of the density and mass distributions of the "singular isothermal sphere" considered by Shu (1977) (his Equ. (2)). When transformed to his dimensionless variables, the infall velocity that we compute exhibits a profile that is similar to the isothermal collapse solutions plotted in his Fig. 3.

Our calculation traces the free–fall collapse of a particle at the edge of the core but is not truly Lagrangian. The flux of matter escaping outwards, across the boundary, R, of the collapsing condensation, is given by

$$4\pi R^2 \rho u = -\frac{{\rm d}M}{{\rm d}t} = -M_0 v(R)/R_0 \tag{8}$$

which can be written in the form

$$4\pi R_0^2 \rho_0 u = -\frac{{\rm d}M}{{\rm d}t} = -\frac{4\pi}{3} R_0^2 \rho_0 \frac{{\rm d}R}{{\rm d}t}. \tag{9}$$

It follows that the speed at which matter crosses the surface of the sphere is

$$u = -v(R)/3 \tag{10}$$

and hence the flow speed of this matter in an inertial frame is $2/3\,v(R)$. The outer radius $R_{\rm out}$ of the envelope contracts at this same speed (see Fig. 1), thereby ensuring conservation of the total mass of the core and the envelope.

In the following, comparisons to observations will be based on both abundances and column densities. To compute the column densities, we note that during a time interval dt, the core contracts by a distance $-dR$ and the column density of any species in the envelope increases by

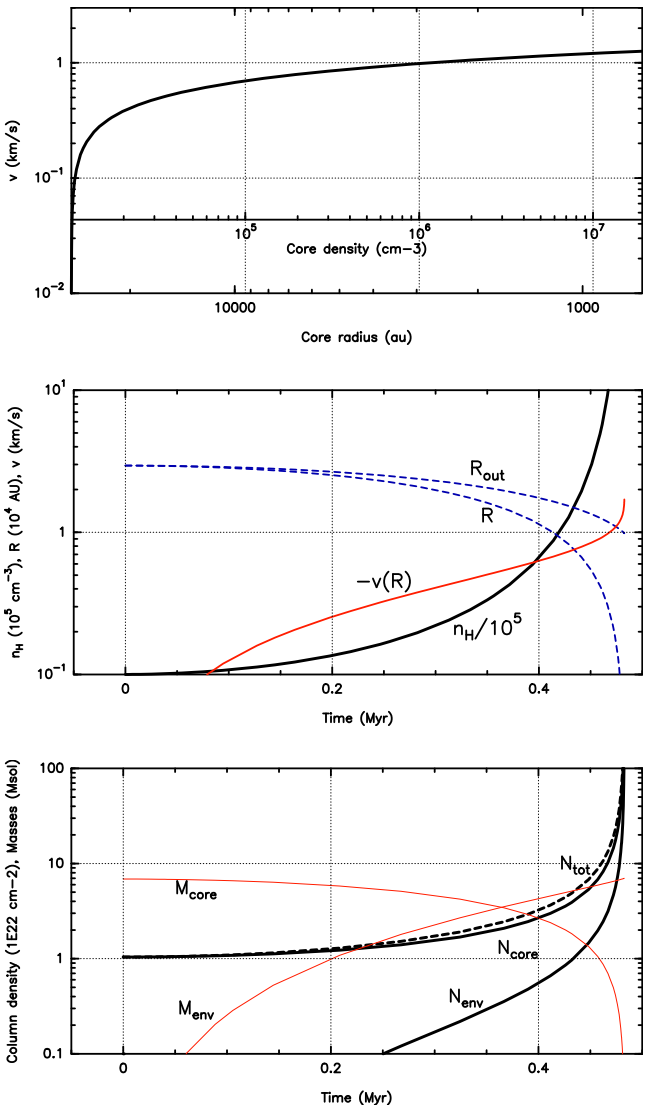

Figure 2. Our "Larson-Penston" model. *Top panel:* the velocity profile of the inner collapsing core as a function of its radius (in au) and its central density (in cm^{-3}). *Middle panel:* the temporal profiles of the total H nuclei density $n_{\rm H}$ (in units of $10^5\,{\rm cm}^{-3}$), of the radii (in astronomical units) of the core (R) and the outer edge of the cloud ($R_{\rm out}$), and of the infall velocity ($-v(R)$, Equ. 7). The parameters are those of Table 1. *Bottom panel:* contributions of the core and the envelope to the mass (in ${\rm M}_\odot$), $M_{\rm core}$ and $M_{\rm env}$, and to the total column density (in units of $10^{22}\,{\rm cm}^{-2}$), $N_{\rm core}$ and $N_{\rm env}$. In all panels, the time is expressed in Myr.

$$dN_{\rm env} = -\frac{1}{3} n_{\rm H}(R) X(R) dR, \tag{11}$$

where $n_{\rm H}(R)$ and $X(R)$ represent the density and the abundance, with respect to total H nuclei, at radius R, respectively. Integration of that quantity thus gives the contribution of the envelope to the total column density. On the other hand, the column density of the uniform collapsing core is

Table 1. Initial parameters of the Flower et al. (2006b) (F06) and of the reference model used in our "Larson-Penston" collapse.

Parameter	Notation	Unit	Value	
			F06	Reference
Mass	M_0	$M_\odot$	–	7
Initial cloud radius	R_0	au[§]	–	3.5×10^4
Initial Density	n_H	cm^{-3}	10^4	10^4
Kinetic temperature	T	K	10	10
Cosmic ray ionization rate[†]	ζ	s^{-1}	1×10^{-17}	3×10^{-17}
Initial radius of the refractory grain core	a_g	μm	0.05	0.10
Initial free–fall time	τ_{ff}	Myr	0.43	0.43

§ The abbreviation "au" is used here for the astronomical unit of distance (1.5×10^{13} cm).

† ζ is the rate of cosmic-ray ionization of H_2, namely the sum of the ionization and dissociative ionization of H_2.

simply

$$N_{\rm core}(R) = n_{\rm H}(R)X(R)R. \tag{12}$$

Note that in our approach, the chemical composition of the envelope is not computed explicitly but is determined by that of the free–falling inner core (see Section 3.3.3). In the following, the contributions to the column densities from both the front and the rear of the cloud are included, assuming spherical symmetry. Although the mass of the envelope becomes greater than that of the contracting core early in the collapse process—when the density, $n_{\rm H}$, of the core is about 2×10^4 cm^{-3}—the total column density remains dominated by the contracting core. As will be seen below, this is not necessarily the case for the chemical species, owing to freeze-out.

Our approach simulates well the density profile and, qualitatively, the velocity profile calculated by Larson (1969): the evolution of the density profile of the envelope and core is shown in Fig. 1. Initially, when $R = R_0$, the gas is at rest in an inertial frame. Subsequently, the infall velocity increases as R decreases, as may be seen from Equ. (7) and the results in Fig. 2, in which the contributions of the collapsing core and of the envelope to the total column density and mass are also shown. On the other hand, the infall velocity predicted by the "Larson-Penston" solution of Keto et al. (2015) increases with R. Furthermore, the gas is not initially at rest, which is inconsistent with one of the conditions specified by Larson (1969). Thus, whilst the profile of the density of the gas that we calculate is analogous to that of Keto et al., the velocity profile is qualitatively different.

The reason for the discrepancy in the velocity profiles is that the "Larson-Penston" profile of Keto et al. derives from the similarity solution considered in Appendix C of Larson (1969) and not from his numerical results. The similarity solution for the infall speed tends, at large radius, to a value of 3.28 times the isothermal sound speed; but Larson notes that the computed velocity profile approaches the similarity solution only slowly, and the collapse must be followed over at least 12 orders of magnitude in density to approach the limiting value. In practice, we are concerned with the early stage of the collapse process, during which the density increases by only a few orders of magnitude from its initial value and the gas at large radius remains approximately at rest.

In our model, the differential equations are solved where R is the only variable. The elapsed time is then computed as $t = \int_{R_0}^{R} dx/v(x)$. The equation of mass conservation applied to each of the neutral, positively- and negatively-charged fluids in the free–falling core takes the generic form

$$\frac{1}{\rho}\frac{{\rm d}\rho}{{\rm d}R} = \frac{S}{\rho\dot{R}} - \frac{2}{R} \tag{13}$$

where $\rho(R)$ is the mass density, $S(R)$ is the rate of production of mass per unit volume, for the appropriate fluid, and $\dot{R} = v(R)$. In the case of a free–falling core with no envelope, such as in F06, the second term on the right hand side would be $3/R$. In our case, the core loses mass, hence building up the envelope (see Equ. 5), such that $dM/M = dR/R$ which yields $d\rho/\rho = -2dR/R$ instead of $-3dR/R$.

Chemical processes result in mass exchange amongst the three fluids (e.g. in the production of a neutral by recombination of a positive and a negative species), but overall mass conservation is maintained, i.e. $S_{\rm n} + S_+ + S_- \equiv 0$. The three fluids are assumed to have a common flow speed, v, and kinetic temperature, T.

As the core contracts, from R_0 to R, its composition evolves. This chemical evolution is followed by means of

$$\frac{1}{n}\frac{{\rm d}n}{{\rm d}R} = \frac{N}{n\dot{R}} - \frac{2}{R} \tag{14}$$

where $n(R)$ is the number density of the species and $N(R)$ is its rate of (chemical) formation per unit volume. Over 200 species, comprising gas- and solid-phase atomic and molecular species and grains, participate in a set of over 3000 chemical reactions, which change the composition and degree of ionization of the medium, notably by the freeze-out of neutral species (including, where relevant, nuclear-spin variants and deuterated forms) on to the surfaces of grains.

The first–order differential equations representing the dynamical and physico-chemical processes were integrated by means of the DVODE algorithm for solving, in particular, "stiff" differential equations (Hindmarsh 1983). We allowed for the coagulation of grains during the collapse, following the description of this process by Flower et al. (2005) and using the measurements of Poppe & Blum (1997). Coagulation reduces the total surface area of the grains and hence the rate of adsorption of the neutral species on to the grains.

The physical parameters used for the two series of models—labeled "F06" and "reference"—of our study are summarized in Table 1. We adopted the initial distribution of the elements amongst the gas and solid phases summarized in Tables 2 and 3 (**?**)see also][]flower2005; the solid phase consists of grains with a refractory core and an ice mantle that increases in size during the collapse process, owing to freeze-out.

Table 2. Fractional elemental abundances, with respect to H nuclei, and their partitioning into volatiles (gas and grain mantles) and refractory (grain cores), and the corresponding levels of depletion (δ, in %) from the gas phase. Numbers in parentheses are powers of 10.

Element	Total	Volatile		Refractory	δ
		Gas	Mantles		
H	1.0	1.0			0
He	1.00(-1)	1.00(-1)			0
C	3.55(-4)	8.27(-5)	5.55(-5)	2.17(-4)	77
N	7.94(-5)	6.39(-5)	1.55(-5)		20
O	4.42(-4)	1.24(-4)	1.78(-4)	1.40(-4)	72
S	1.86(-5)	6.00(-7)	1.82(-5)		98
Mg	3.70(-5)			3.70(-5)	100
Si	3.37(-5)			3.37(-5)	100
Fe	3.23(-5)	1.50(-9)		3.23(-5)	100

Table 3. Initial fractional abundances in the grain mantles, expressed relative to the total H nuclei density $n_{\rm H}=10^4\,{\rm cm}^{-3}$. Numbers in parentheses are powers of 10.

Species	Fractional abundance
H_2O	1.03(-4)
CO	8.27(-6)
CO_2	1.34(-5)
CH_4	1.55(-6)
CH_3OH	1.86(-5)
H_2CO	6.20(-6)
HCOOH	7.24(-6)
NH_3	1.55(-5)
H_2S	1.80(-5)
OCS	2.07(-7)

2.2 A new chemical network

Since the Flower et al. (2006b) (hereafter F06) paper, there have been significant changes to the rate coefficients for chemical reactions, notably those determining ortho↔para inter-conversion, e.g. for $H_3^+ + H_2$ and isotopic variants (see below). In addition, new THz facilities have provided the abundances of spin isomers of several hydride molecules, such as H_2D^+, which motivated a complete revision of the spin-separated astrochemical network of F06. In the process, the rates of cosmic–ray–induced photo-reactions, which are significant in establishing the steady–state abundances, have also been revised. We provide here a summary of the most salient features of the new University of Grenoble Alpes Astrochemical Network (`UGAN`), while full details, and the entire network, can be found in the Appendices.

2.2.1 New conversion rates for $H_3^+ + H_2$ and isotopic variants

An important addition to the reaction network is the exoergic proton–exchange reaction

$$oH_3^+ + oH_2 \longrightarrow pH_3^+ + oH_2 \qquad (15)$$

which was excluded from the reaction set of F06 on the grounds that the change of proton spin orientation in the H_3^+ ion must be accompanied by $oH_3^+ + oH_2 \longrightarrow pH_3^+ + pH_2$, yielding para-$H_2$. However, both forms of H_2 can be represented by the combinations of the "spin-up" (α) and "spin-down" (β) single–particle nuclear spin functions, namely $2^{-\frac{1}{2}}(\alpha_1\beta_2 + \alpha_2\beta_1)$ and $2^{-\frac{1}{2}}(\alpha_1\beta_2 - \alpha_2\beta_1)$ for the ortho and para H_2 respectively, where the subscripts 1 and 2 label the protons. It follows that a quantum-statistical calculation, such as that undertaken by Hugo et al. (2009), can give rise to non-zero rate coefficients for processes that would be excluded in a more simplistic approach. In fact, Hugo et al. obtained a rate coefficient for reaction (15) that is 4 times larger than for the reaction leading to pH_2. As a consequence, the ortho:para-H_3^+ ratio calculated using their data may be expected to be lower than when reaction (15) is neglected, as in F06. This expectation is confirmed by the results of the steady–state calculations, as may be seen in Table 5: even though the ortho:para-H_2 ratio is lower, the ortho:para-H_3^+ ratio is also lower than was calculated by F06[1].

For the important ortho↔para inter-conversion reactions in the $H_3^+ + H_2$ system and isotopic variants, we replaced the ground-state–to–species kinetic rates, published by Hugo et al. (2009) and used extensively in the astrophysical community, by *species-to-species* rates. To do so, the state-to-state rate coefficients computed by Hugo et al. (2009) were averaged, adopting LTE level populations for temperatures up to 50 K. For each reaction, the (logarithm of the) resulting temperature-dependent rates were fitted by a modified Arrhenius law. While the modifications are small for the lightest species—H_2, H_3^+, and H_2D^+—they become more important for the heavier, doubly- or triply-deuterated species. We note that our rates agree to within a factor of two with the species-to-species rates calculated by Sipilä et al. (2017) using a similar procedure. We also checked that our new rates correctly recover thermalized ortho-to-para ratios for H_3^+ and its deuterated analogs, at temperatures larger than ≈ 16 K (Le Bourlot 1991; Flower et al. 2006a). These new rates are provided in Tables D7–D10.

2.2.2 State-of-the-art, fully separated hydride chemistry

Faure et al. (2013); Rist et al. (2013) and Le Gal et al. (2014) have revisited and revised the chemistry of nitrogen–bearing species, which now includes specifically the various nuclear-spin states of the carbon, nitrogen, oxygen, and sulfur hydrides and their abundant deuterated forms. The nuclear-spin state separation was performed using the permutation symmetry approach of Quack (1977). During this process, the rate coefficients of many bi-molecular reactions were updated, following a literature survey. Full details of the assumptions behind this new chemical network are provided in Appendices B and C. In Appendix D we specify the rate coefficients for these reactions that have been adopted in the present calculations, including the steady–state computations reported in columns 3 and 4 of Table 4.

2.2.3 Grain-surface processes

It should be noted that no explicit grain–surface reactions are included in the chemical network (except the formation of H_2 and isotopologues). The rates of adsorption of neutral

[1] Available at `http://massey.dur.ac.uk/drf/protostellar/chemistry_species`

Table 4. Steady–state abundances, expressed relative to $n_{\rm H} = n({\rm H}) + 2n({\rm H_2}) = 10^4\,{\rm cm^{-3}}$, as calculated using the chemical reaction set of Flower et al. (2006b) (F06) and our present, updated chemistry. Two values of the cosmic-ray ionization rate, ζ, and of the initial refractory grain core, $a_{\rm g}$, have been used, which are indicated. Where the nuclear–spin state is not specified (e.g. NH_2D), the fractional abundance is the sum of the abundances of the individual nuclear–spin states. Numbers in parentheses are powers of 10.

Species	F06[§]	Present	
	$\zeta = 1\times10^{-17}\,{\rm s^{-1}}$	1×10^{-17}	3×10^{-17}
	$a_{\rm g} = 0.05\mu{\rm m}$	0.05	0.10
H	2.2(-05)	2.3(-05)	6.9(-05)
pH_2	5.0(-01)	5.0(-01)	5.0(-01)
oH_2	1.4(-03)	4.1(-04)	5.4(-04)
N	1.2(-05)	5.3(-06)	8.4(-06)
pNH_3	4.1(-08)	2.3(-09)	5.0(-09)
oNH_3	1.4(-08)	1.2(-09)	2.7(-09)
NH_2D	4.6(-09)	2.6(-09)	4.7(-09)
NHD_2	2.1(-11)	6.6(-11)	1.0(-10)
ND_3	2.0(-14)	2.7(-13)	4.1(-13)
CN	9.2(-09)	2.0(-09)	7.4(-09)
HCN	1.1(-07)	1.6(-09)	2.8(-09)
HNC	1.4(-07)	1.4(-09)	2.9(-09)
N_2	2.6(-05)	2.9(-05)	2.8(-05)
pH_3^+	7.4(-10)	1.5(-09)	4.1(-09)
oH_3^+	1.1(-09)	5.5(-10)	1.8(-09)
oH_2D^+	2.0(-11)	9.6(-11)	2.7(-10)
pH_2D^+	3.4(-12)	5.1(-11)	1.3(-10)
oHD_2^+	1.4(-12)	2.2(-11)	5.9(-11)
pHD_2^+	5.2(-13)	7.2(-12)	1.9(-11)
oD_3^+	3.0(-14)	8.8(-13)	2.2(-12)
mD_3^+	3.8(-14)	8.2(-13)	2.1(-12)
pD_3^+		4.3(-14)	1.1(-13)
N_2H^+	5.0(-10)	5.2(-10)	9.3(-10)
N_2D^+	2.5(-12)	1.8(-11)	3.1(-11)

[§]http://massey.dur.ac.uk/drf/protostellar/chemistry_species

Table 5. *Top:* steady–state ortho:para (and also m:p in the cases of D_3^+ and ND_3) abundance ratios for the species listed in Table 4. Also given are the corresponding thermalized ratios at 10 K and in the limit of high temperature. *Bottom:* abundances of the deuterated isotopologues of ammonia, relative to NH_3. The abundances are sums over the contributions of the individual nuclear–spin states. Numbers in parentheses are powers of 10.

Species	Present		F06[§]	Thermalized	
	1×10^{-17}	3×10^{-17}	1×10^{-17}	10 K	∞
H_2	7.4(-4)	1.1(-3)	2.8(-3)	3.5(-7)	3
H_3^+	3.6(-1)	4.3(-1)	1.4	7.5(-2)	1
H_2D^+	1.8	2.1	5.8	1.9(-3)	3
HD_2^+	3.0	3.1	2.7	9.8(1)	2
D_3^+ (o:p)	20.9	19.5		4.1(2)	16
D_3^+ (m:p)	19.2	19.3		1.8(3)	10
NH_3	5.9(-1)	5.4(-1)	3.4(-1)	3.7	1
NH_2D	1.7	1.7		2.9	3
NHD_2	2.1	2.1			2
ND_3 (o:p)	16.6	16.5			16
ND_3 (m:p)	10.8	10.7			10
NH_3	1.0	1.0	1.0		
NH_2D	3.3(-1)	2.2(-1)	8.3(-2)		
NHD_2	8.2(-3)	4.6(-3)	3.8(-4)		
ND_3	4.3(-5)	1.9(-5)	3.6(-7)		

[§]http://massey.dur.ac.uk/drf/protostellar/chemistry_species

species were computed with allowance for the contribution of the grain mantle to the grain cross section, as described in appendix B of Walmsley et al. (2004). Our treatment of the thermal desorption of molecules, following cosmic ray impact, follows Section 5 of Flower et al. (1995). Ortho- and para-H_2 are assumed to form on grains in the statistical 3:1 ratio of their corresponding nuclear spin states, $I = 1$ and $I = 0$. On the other hand, an ortho-to-para equal to unity is assumed for all other species upon desorption. The desorption of molecules by the cosmic ray–induced ultraviolet radiation field (see Appendix A) is also included.

2.2.4 *H_2-driven non-LTE ortho:para ratios*

The thermal equilibrium (LTE) ratio of the population densities of the lowest ortho and para states of H_3^+ is

$$\frac{n(J_K = 1_0)}{n(J_K = 1_1)} = \frac{4}{2}\exp\left(-\frac{32.9}{T}\right)$$

where 4 and 2 are the statistical weights of the ortho and para states, respectively, and 32.9 K is the energy of the lowest ortho state above that of the lowest para state. At a kinetic temperature $T = 10$ K, the LTE ortho:para-H_3^+ ratio is 0.075; Tables 4 and 5 show that their populations are indeed strongly inverted (i.e. the population ratio exceeds its value in LTE). This inversion is a consequence of the dominance of ortho-H_2 in establishing the relative populations of the ortho- and para-H_3^+ states and the inversion of the populations of the $I = 1$ and $I = 0$ states of ortho- and para-H_2, respectively, through the grain–formation process. Similarly strong deviations from LTE (thermalized) ratios are found for most species (Faure et al. 2013).

3 RESULTS AND DISCUSSION

The initial distribution of the elements is specified in Tables 2 and 3.

3.1 Steady–state composition

It is instructive to compare the initial (steady–state) abundances of species incorporated in the model with the values obtained by F06 for a cloud having a uniform density ($n_{\rm H}$=$10^4\,{\rm cm^{-3}}$) and kinetic temperature (T = 10 K). In these models, the cosmic-ray ionization rate of H_2 is $\zeta = 10^{-17}\,{\rm s^{-1}}$ and the initial radius of the refractory grain core is $a_{\rm g} = 0.05\mu{\rm m}$ (see Table 1).

As may be seen from a comparison of columns 2 and 3 of Table 4, the recent revisions to the chemistry have repercussions on the composition of the gas. The corresponding ortho:para ratios are listed in the upper part of Table 5. Faure et al. (2013) calculated, in steady state at $T = 10$ K, an ortho:para-H_2 ratio of 9×10^{-4}, for a model that is similar to that considered in Tables 4 and 5; their ortho:para-NH_3 ratio was 0.7. As might be expected, these values are closer to the present results than those of F06. In the lower part of Table 5 are the degrees of deuteration of ammonia, which are seen to be greater in the present calculations than in those of F06. This deuteration process is mediated by the deuterated forms of H_3^+, which are produced in reactions of H_3^+ with HD; these reactions were also studied by Hugo

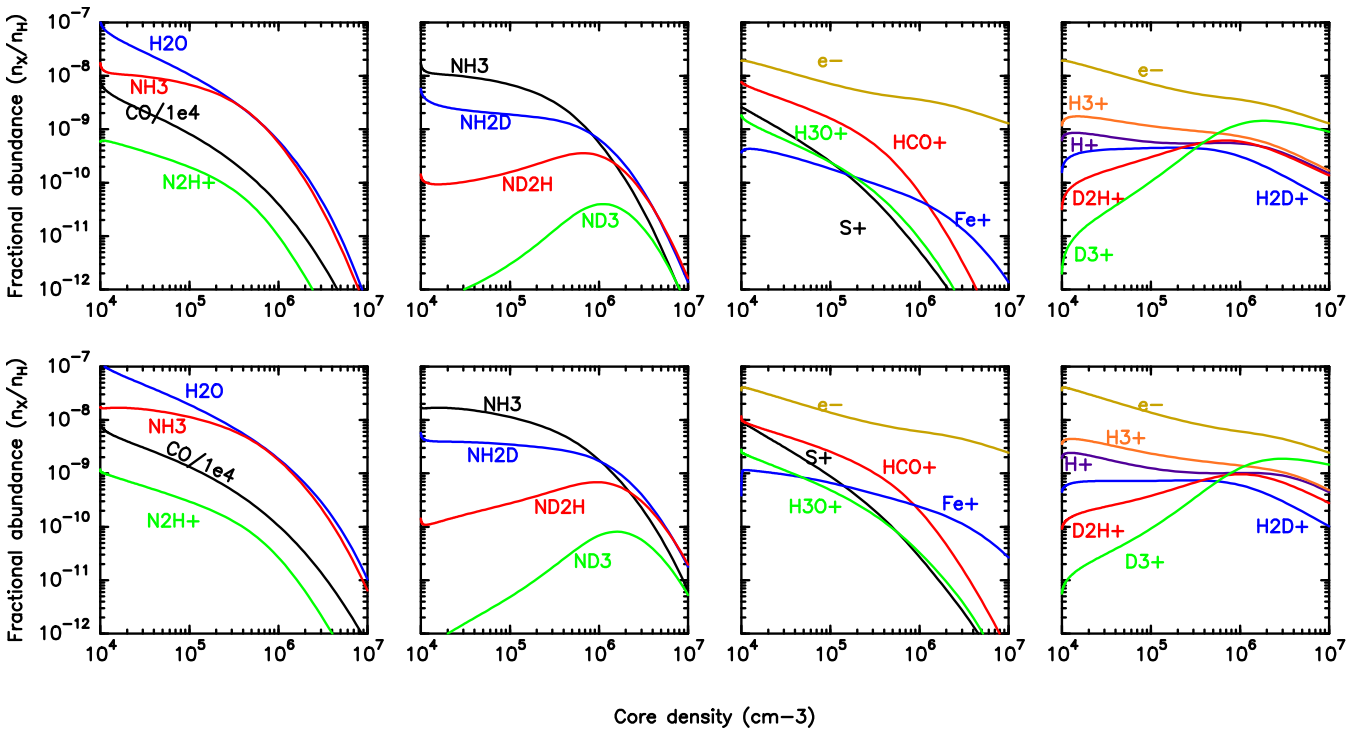

Figure 3. Evolution of the fractional abundances of selected chemical species—expressed relative to $n_{\rm H}$—in a cloud that is undergoing contraction in a free–fall collapse (four upper panels), and from our "Larson-Penston" model (four lower panels). In each case, the two left (right) panels focus on neutral (charged) species. The chemical network is described in Section 3.1 and Appendix D. *Upper panels:* models with $\zeta = 1 \times 10^{-17}$ s^{-1}, and an initial radius of the refractory grain core $a_{\rm g} = 0.05$ μm. *Lower panels:* initial parameters of the *reference* model of Table 1.

et al. (2009). It is the revisions to these rate coefficients that lead to higher abundances of the deuterated isotopologues of ammonia in the present study.

The significance of the steady–state fractional abundance of any given species depends on the associated equilibrium timescale, which can attain values in excess of 1 Myr under the conditions considered here. Although condensations may remain close to a quasi-static equilibrium for timescales as long as 500 kyr (Brünken et al. 2014), it is unlikely that the chemical composition of the cloud will evolve unperturbed over such long periods of time. Indeed, the timescale for free–fall collapse of the cloud is less than 1 Myr. It follows that the steady–state composition of the gas has limited relevance to observations of prestellar cores. Instead, the composition must be computed under conditions appropriate to collapse, as is described in the following Sections. Both our free–fall and Larson-Penston simulations assume an initial steady-state composition for the physical conditions of our reference model (see Table 1), except where otherwise specified.

3.2 Free–fall simulation

It is instructive to consider first the case of free–fall collapse, which provides a point of reference for subsequent models. In Fig. 3 are shown the variations with the collapsing cloud density, $n_{\rm H}$, of the fractional abundances of selected species, notably some of those containing nitrogen.

The variations of the fractional abundances with the density of the medium that are seen in Fig. 3 are qualitatively similar to the results of Flower et al. (2005), who also considered a free–fall model. For the purpose of this comparison, we adopt the same values of the cosmic–ray ionization rate ($\zeta = 1 \times 10^{-17}$ s^{-1}) and the initial radius of the refractory grain core ($a_{\rm g} = 0.05$ μm) as Flower et al. (2005). On the other hand, there are quantitative differences, notably for H_3^+ and its isotopologues, which relate to the revisions of the chemistry, as discussed in Section 3.1.

3.3 Larson-Penston simulation

At the onset of gravitational collapse, an envelope begins to form around a core that is initially the principal contributor to the total column densities of the molecular species. As the collapse proceeds, the core contracts according to Equ. (6) and its density increases from its initial value; the density profile of the envelope follows from Equ. (4). The envelope becomes increasingly important and, as we shall see, its contribution ultimately dominates the total column densities—in part because the total mass of material advected into the envelope from the core during free–fall is greater than the residual mass of the core.

3.3.1 Fractional abundances

In Fig. 3 are shown the variations in the fractional abundances of selected neutral and charged species as functions of the current density, $n_{\rm H}$, of the core (and hence at the

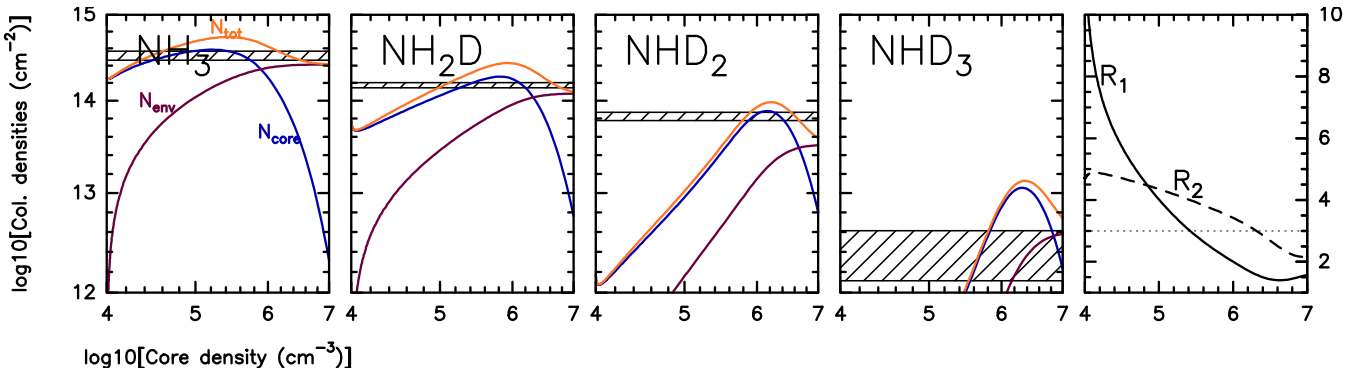

Figure 4. Contributions, in our reference "Larson-Penston" collapse model (Table 1), of the core, $N_{\rm core}$, and the envelope, $N_{\rm env}$, to the total column density $N_{\rm tot} = N_{\rm core} + N_{\rm env}$ of the ammonia molecule and its deuterated forms, as functions of the density of the core. The column densities are evaluated as described in Section 2. The LTE column densities in the starless core Ophiuchus/H-MM1 (Harju et al. 2017) are shown for comparison (see also Table 6.) *Far right panel:* the column density double-ratios, R_1 and R_2, defined in Equs. (16) and (17).

current interface between the core and the envelope). As the density increases, atoms and molecules are adsorbed by the grains, whose radius (of the core and the ice mantle) increases from its initial value of 0.13 μm as more ice is deposited. In these calculations, we assumed the same value, $S = 1$, of the "sticking coefficient"[2] for all adsorbing species. As is evident from Fig. 3, the depletion timescale is slightly longer in the L-P than in free–fall model, as a consequence of the following factors: in the L-P model, the contraction timescale is 4.8×10^5 yr, 10% longer than the free–fall time, and the value of ζ (and hence the cosmic–ray desorption rate) is three times larger; but, most significant, the initial radius of the grain core is smaller by a factor of 2 (and the total grain surface area correspondingly larger) in the free–fall than in the L-P model.

3.3.2 Total column densities

In order to illustrate the transition from the preponderance of the core to the preponderance of the envelope, we compare, in Fig. 4, the contributions of the core, $N_{\rm core}$, and the envelope, $N_{\rm env}$, to the column density of the ammonia molecule, NH_3, and its deuterated forms, NH_2D, NHD_2, ND_3. Column densities in the core and in the envelope are evaluated as described in Section 2. The total column densities, $N_{\rm tot} = N_{\rm core} + N_{\rm env}$, are also plotted, as are the column densities deduced by Harju et al. (2017) from their observations of the starless core Ophiuchus/H-MM1 by assuming a single excitation temperature and statistical ortho:para ratios (see Table 6).

It is clear from Fig. 4 that the total column density comes to be dominated by the contribution of the envelope, as the core contracts and its density increases but its mass decreases. The composition of the envelope is not uniform, as may be seen from Fig. 3: in the vicinity of the core, adsorption on to the grains depletes the neutral species, which has consequences for the degree of ionization of the gas. Agreement, to better than a factor of 2, with the observed column densities of the ammonia molecule and all of its deuterated forms is found at a density, $n_{\rm H}$, in the range $5-10 \times 10^5$ cm^{-3}. Furthermore, since deriving mass, age, or size is not the chief objective of this work, no attempt was made to actually find the best fit to the data. This suggests that gas–phase processes can account for the deuteration of NH_3, without the necessity of invoking additional grain–surface reactions, as concluded by Le Gal et al. (2014). In any case, our gas–grain chemistry is dominated by the adsorption of neutral species in the course of gravitational collapse; desorption processes occur too slowly to affect significantly the gas–phase molecular abundances. On the other hand, if molecules were returned to the gas phase by a mechanism that is intrinsically faster than the cosmic ray–induced desorption processes considered here, the molecular column densities might become dependent on chemical reactions on the surfaces of grains. Furthermore, surface processes, and especially those possibly involved in spin conversion, are still poorly constrained (Turgeon et al. 2017), and the impact of such processes on the observed gas-phase ortho:para ratios is difficult to anticipate. Finally, we note that the agreement with the observations is obtained at densities for which the main contribution to the column density of ammonia and deuterated analogs comes from the free–falling core, before freeze-out begins to be dominant.

3.3.3 Column densities of spin isomers

Column densities of specific isomers of ammonia and its deuterated forms have been measured towards starless and prestellar cores (Daniel et al. 2016; Harju et al. 2017). Figure 5 shows the comparison with the column densities predicted by our reference isothermal collapse model (see Table 1). We note first that agreement to better than a factor 3 is obtained for all sources and species. In the case of H-MM1, the agreement is obtained at core densities in the range $0.3-1 \times 10^6\,{\rm cm}^{-3}$, as compared with the value of $1.2 \times 10^6\,{\rm cm}^{-3}$ derived from the dust emission (Harju et al. 2017). Similarly, in the case of Barnard B1, our model suggests core densities above approximately $10^6\,{\rm cm}^{-3}$, consistent with the value of $3 \times 10^6\,{\rm cm}^{-3}$ determined by Daniel

[2] The sticking coefficient S is not to be confused with the mass production rate in Equ. (13).

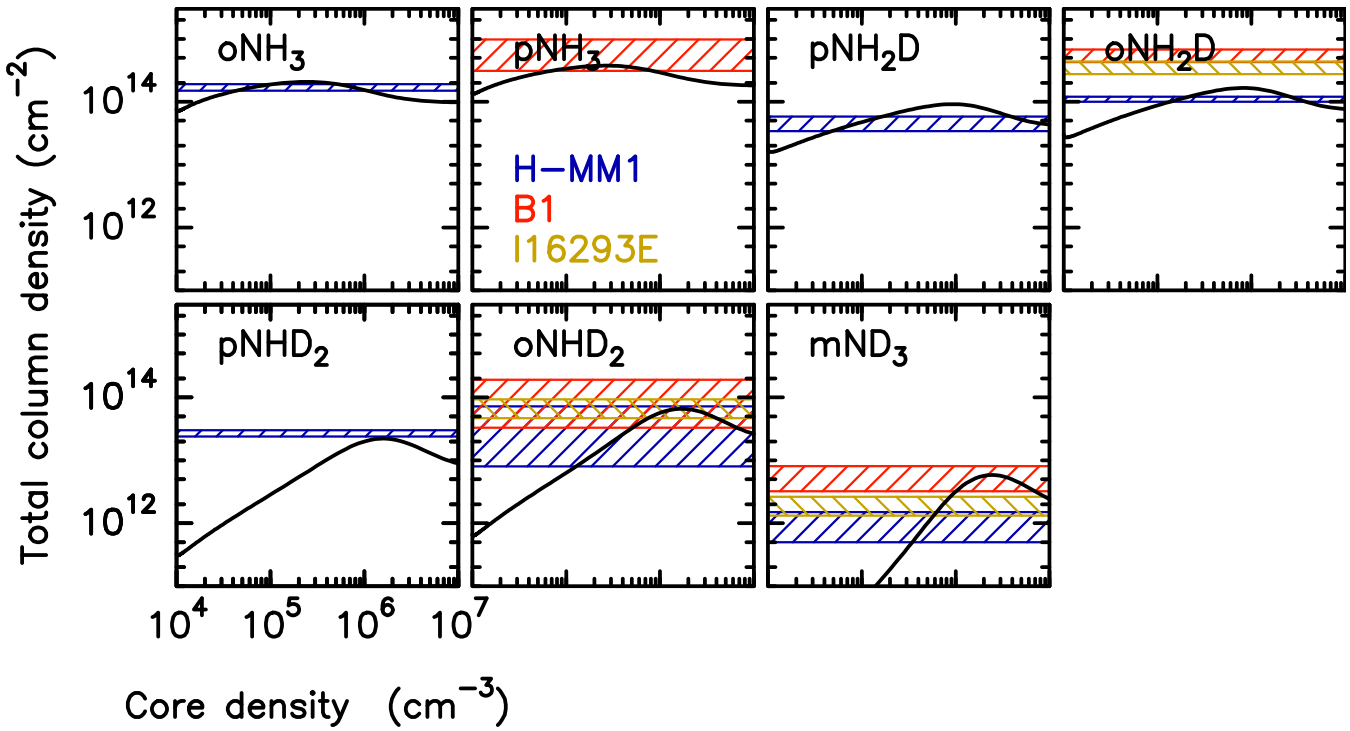

Figure 5. Column densities of ammonia and its deuterated forms, as predicted from our "Larson-Penston" collapse model (full lines) and from observations (hashed regions) of the I16293E, Barnard-B1, and H-MM1 prestellar cores (Daniel et al. 2016; Harju et al. 2017) (see Table 6). The initial parameters are those of Table 1.

et al. (2013). The observation that the core density is higher in B1 than in H-MM1 is correctly reproduced. However, Barnard B1 is likely to be at a more advanced stage of evolution than is described by our model (Gerin et al. 2015), and the agreement that we obtain suggests that ammonia is not tracing the innermost and densest regions. In addition, our calculations slightly under-produce p$-NH_3$ and o$-NH_2D$, which may indicate that gas–depletion through freeze–out is proceeding too rapidly in the model. Finally, in the case of the I16293E starless core, our model intercepts the observed ranges of column densities for o$-NHD_2$ and m$-ND_3$ at two densities, between approximately 10^6 and $10^7\,\mathrm{cm}^{-3}$. Although the latter density may seem too high for this type of object, we note that it is close to the value of $1.4\times10^7\,\mathrm{cm}^{-3}$ obtained from the dust-emission profiles (Bacmann et al. 2016). Overall, the level of agreement with the observations reported in Fig. 5 (and in Fig. 4) lends credence to the validity of the gas–phase chemical network.

Further support for our gas–phase network comes from the deuteration of ammonia, from NH_3 through to ND_3. In the far right panel of Fig. 4, we have plotted the ratios

$$R_1 = \frac{NH_2D/NH_3}{NHD_2/NH_2D} \tag{16}$$

and

$$R_2 = \frac{NHD_2/NH_2D}{ND_3/NHD_2} \tag{17}$$

Observationally, both ratios are close to 3, within their uncertainties (Daniel et al. 2016; Harju et al. 2017). If hydrogenation and deuteration were determined by statistics only—as is presumably the case in ices—both these ratios would be exactly equal to 3. However, as Fig. 4 shows, ratios close to 3 can be produced by gas–phase chemistry at the core densities relevant to prestellar cores. It follows that ratios of 3 are not reliable indicators of deuteration taking place in ices, rather than in the gas–phase (Harju et al. 2017). We note also that these ratios evolve significantly from their steady–state values as the density increases.

Whilst our simulation of the Larson-Penston collapse enables us to include the contribution of the envelope to the column densities of the chemical species, the temporal evolution of the chemical composition of the envelope is not calculated explicitly; this approximation could lead to overestimating the contribution to the column densities of the outer regions of the envelope, owing to an underestimation of freeze-out. However, as freeze-out occurs least rapidly at the densities (lower than $10^5\,\mathrm{cm}^{-3}$) prevailing in the outer envelope, and because the envelope contributes only marginally to the total column density until massive freeze-out in the core takes place, this approximation was verified to have negligible impact on our results.

3.3.4 Ortho-to-para ratios

In Fig. 6, we plot the spin-isomer abundance ratios of NH_3 and H_3^+ and of their deuterated analogues. The calculated H_3^+ ortho:para ratio tends to approximately 0.7 as the core density increases. In the case of NH_3, our assumption that the deuteration reactions proceed via long–lived intermediate complexes, in which complete scrambling of the nuclei occurs, leads to values of the ortho:para ratio of NH_2D and

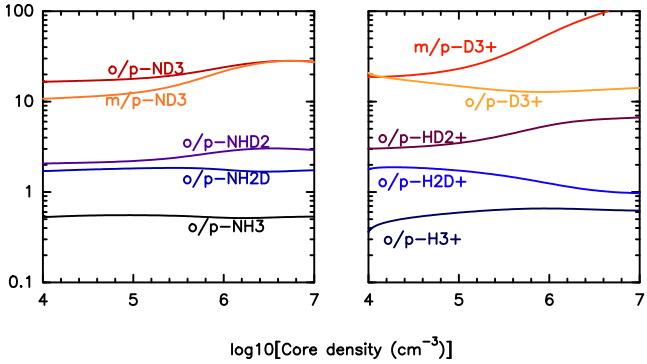

Figure 6. Variation with the core density of the ratios of the total column densities of the various nuclear spin states of NH_3 (left) and H_3^+ (right), and of their respective deuterated analogs. For reference, the corresponding thermalized ratios at 10 K are given in Table 5.

NHD_2 of approximately 1.8 and $2.0-2.8$, respectively, over the density range 10^5-$10^6\,\mathrm{cm}^{-3}$.These values are consistent, within observational uncertainties, with the ratios measured in H-MM1 and listed in Table 6. The chemical model of Harju et al. (2017) predicts a similar ortho:para ratio for NH_2D, but a significantly larger one (in the range $3-5$) for NHD_2. On the other hand, the observed ratios are also consistent with the statistical values of 3 and 2, respectively. Ortho:para ratios close to their statistical values were observed by Daniel et al. (2016) in Barnard B1b also.

Statistical ratios could indicate that direct gas-phase proton/deuteron hops or hydrogen/deuterium abstraction—instead of full scrambling of nuclei in an intermediate reaction complex—plays an important role in the deuteration process (Harju et al. 2017). Deuteration was indeed found to inhibit the permutation of protons in the H_5^+ ion (Lin & McCoy 2015) thus preventing the full scrambling scheme adopted in the Harju et al. and our networks. To investigate the origin of the different predictions for NHD_2 from our model and from Harju et al. (2017), we have tested the influence of the reaction $NH_3+D_3^+ \longrightarrow NH_2D_2^+ + HD$ which eventually leads to NHD_2 upon dissociative recombination. This, and similar, reactions are not included in our network because we assume that single particle (H, H^+, D or D^+) hop is the dominant outcome of the complex forming reaction. This particular reaction results is an increase of the ortho:para ratio of NHD_2 by less than 10%. Although other similar reactions have not been included in our network, it appears unlikely that the factor of 1.5-2 difference between our results and those of Harju et al. (2017) arises only from these reactions. We also checked that the difference is not due to the new species-to-species inter-conversion rates (see Section 2.2.1). Alternatively, it could be related to differences in the raw, unfractionated and unseparated, chemical networks. Furthermore, we emphasize that the details of the nuclear spin selection rules in deuteration reactions such as $NH_3+D_3^+$ are currently not known, and the observational error bars are too large to allow a distinction to be made between complete scrambling and particle hop.

Table 6. Column densities (or their $\log_{10}$) of ammonia and its deuterated forms towards three prestellar cores.

Source	Species	N cm^{-2}	o/p
H-MM1†	oNH_3	$1.7\pm0.2\times10^{14}$	
	oNH_2D	$1.1\pm0.1\times10^{14}$	2.4 ± 0.7
	pNH_2D	$4.6\pm1.2\times10^{13}$	
	$oNHD_2$	$4.0\pm3.2\times10^{13}$	1.5 ± 1.2
	$pNHD_2$	2.7×10^{13}	
	mND_3	$1.0\pm0.5\times10^{12}$	
B1§	pNH_3	14.74 ± 0.25	
	oNH_2D	14.73 ± 0.10	~3
	$oNHD_2$	13.90 ± 0.38	
	mND_3	12.71 ± 0.20	
I16293E§	oNH_2D	14.54 ± 0.10	
	$oNHD_2$	13.82 ± 0.15	
	mND_3	12.27 ± 0.15	

† LTE column densities from Harju et al. (2017).

§ $\log_{10}$ values from Daniel et al. (2016).

3.3.5 Depletion and collapse timescales

There remains an underlying issue with the dynamical model: the flow velocity, u (Equ. 10), increases too rapidly as a function of the density of the gas, attaining approximately 1 km s^{-1} when $n_H = 10^6\,\mathrm{cm}^{-3}$; such velocities exceed the limiting values, of the order of 0.1 km s^{-1}, that are deduced from the observed line profiles (**?**)cf.][]bergin2007 and are predicted by hydrodynamical calculations (Foster & Chevalier 1993; Lesaffre et al. 2005; Keto et al. 2015). We remark that the singular isothermal–sphere model of Shu (1977) also produces excessive values of the collapse velocity over a significant fraction of the cloud. As pointed out by Keto et al. (2015), it is the velocity towards the outer edge of the cloud that is responsible for the differences in the shape of the emergent spectral lines. Although the velocity at large radii in our model is probably too high, radiative–transfer calculations are needed to confirm this conclusion.

A consequence of reducing the collapse velocity, and hence extending the duration of the collapse, is to deplete molecules on to grains more rapidly, as a function of n_H, resulting in molecular column densities that are lower than observed. This issue is unlikely to be resolved by slowing the freeze–out process, which would require improbably low sticking coefficients or high rates of grain coagulation. It seems more likely that molecules are returned to the gas phase at a rate which exceeds that of desorption by secondary photons (Appendix A) or as a consequence of heating by cosmic-ray impact (Leger et al. 1985), which are the only desorption processes presently incorporated in the model.

4 CONCLUDING REMARKS

We have studied the chemical composition of gas under the physical conditions that are believed to be appropriate to collapsing prestellar cores. A set of chemical reactions has been assembled that not only comprises the most recent determinations of the rates of gas–phase reactions but also discriminates between the various nuclear–spin states of H_2, H_3^+, and the abundant carbon, nitrogen, oxygen, and sulfur hydrides and their deuterated forms. The composition of the

medium has been investigated under both steady–state conditions and during the initial stage of gravitational collapse, which ultimately leads to the formation of a low–mass star. The freeze–out of the gas on to grains and the coagulation of the grains themselves are taken into account.

We compared the computed values of the column densities of key molecular species, notably of NH_3 and its deuterated forms, with the values observed in starless cores and found that the gas–phase chemistry alone yields satisfactory agreement between the model and the observations, without recourse to grain–surface reactions. Regarding the relative column densities of different nuclear-spin states of NH_3 and its deuterated forms, we find that our full scrambling assumption for proton and deuteron exchange yields good agreement with the observations, in contrast with the proposition of Harju et al. (2017) that direct nucleus– or atom–exchange reactions dominate the deuteration process. However, accurate observational measurements are needed to disentangle between the two processes.

The dynamical model that we used derives from the studies of gravitational collapse by Larson (1969, 1972) and Penston (1969). The gravitationally collapsing core loses mass to the surrounding envelope at a rate that ensures that the density profile in envelope $\rho_{\rm env}(R_{\rm env}) \propto R_{\rm env}^{-2}$, where $R_{\rm env}$ is the radius; the total mass of the core and envelope is conserved. This simple model not only simulates the Larson–Penston density profile but also reproduces qualitatively their velocity profile. In order to test more quantitatively the kinematical aspects of the model, we are currently extending our study by computing the line profiles of key species such as CN and HCN and their isotopologues, including their hyperfine structure.

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APPENDIX A: COSMIC–RAY–INDUCED PHOTO-REACTIONS

As was discussed by Gredel et al. (1989), secondary electrons produced by cosmic–ray ionization of hydrogen can collisionally excite H_2 molecules in the gas, giving rise to ultraviolet photons in the subsequent radiative decay. Most of these photons are absorbed by dust, but some ionize atoms and dissociate or ionize molecules in the medium.

Equ. (5) of Gredel et al. (1989)—for the rate $R_{\rm M}$ per unit volume of ionization/dissociation of species M by the secondary photons—should read

$$R_{\rm M} = \zeta n_{\rm H_2} \frac{X({\rm M}) \int \sigma_{\rm M}(\nu) P(\nu) {\rm d}\nu}{(1-\omega) X({\rm g}) \sigma_{\rm g} + \sum_{\rm M} X({\rm M}) \int \sigma_{\rm M}(\nu) P(\nu) d\nu}$$

where $\zeta n_{\rm H_2}$ is the rate per unit volume of production of the secondary electrons, and the ratio is the relative probability that a photon is absorbed by an atomic or molecular species, M, rather than the grains, g; ω is the grain albedo, and $n_{\rm H}$ is the total number density of hydrogen nuclei. This equation may be rewritten

$$R_{\rm M} = \zeta \frac{X({\rm H_2}) n({\rm M}) \int \sigma_{\rm M}(\nu) P(\nu) d\nu}{(1-\omega) X({\rm g}) \sigma_{\rm g} + \sum_{\rm M} X({\rm M}) \int \sigma_{\rm M}(\nu) P(\nu) d\nu} \qquad \text{(A1)}$$

which becomes

$$R_{\rm M} \approx \zeta X({\rm H_2}) n({\rm M}) \frac{p_{\rm M}}{(1-\omega)}$$

in the limit in which absorption of the secondary photons by the dust dominates; $p_{\rm M}$ is a photo-ionization or -dissociation probability. The factor $X({\rm H_2})$ in this expression was omitted by Gredel et al. (1989), as was recognized by Woodall et al. (2007; section 3.6) and Flower et al. (2007; Appendix A); $X({\rm H_2}) = 0.5$ in mainly molecular gas. We have used Equ. A1, together with the more recent determinations of the photo-ionization/dissociation probabilities, $p_{\rm M}$, of Heays et al. (2017) (Table 20), and adopted $\omega = 0.5$.

During the collapse, $X({\rm g})\sigma_{\rm g}$, where $\sigma_{\rm g} = \pi a_{\rm g}^2$ is the geometrical cross section of the grain, will tend to decrease, given that $X({\rm g}) \propto a_{\rm g}^{-3}$ and that the grain radius, $a_{\rm g}$, increases owing to coagulation. However, the fractional abundances $X({\rm M})$ also decrease, owing to freeze–out on to the grains.

The cosmic–ray–induced photons also desorb molecules ${\rm M}^*$ in the ice mantles, returning them to the gas phase. The rate of this process is given by

$$R^*_{\rm M} \approx \zeta X({\rm H_2}) \frac{n({\rm M}^*)}{\sum_{\rm M^*} n({\rm M}^*)} n_{\rm H} \frac{\int Y(\nu) P(\nu) d\nu}{(1-\omega)} \qquad \text{(A2)}$$

where $Y(\nu)$ is the desorption yield (probability of any molecule in the mantle being desorbed, per photon incident on the grain). Taking $\zeta = 1\times10^{-17}$ s^{-1}, $n_{\rm H} = 10^4$ cm^{-3}, $Y(\nu) = 10^{-3}$, independent of ν (Hollenbach et al. 2009), and estimating $\int P(\nu){\rm d}\nu \approx 0.4$ from fig. 1 of Gredel et al. (1989), yields a timescale (in yr) for this process

$$\frac{n({\rm M}^*)}{R^*_{\rm M}} \approx 10^9$$

which is too long to be significant in the context of star formation. We note that Hollenbach et al. (2009) overestimate the rate of this process by about 2 orders of magnitude: they calculate the flux of the far–ultraviolet secondary photons, $F_{\rm FUV}$, to be of the order of 10^5 cm^{-2} s^{-1}, whereas

$$F_{\rm FUV} \approx \zeta \frac{\int P(\nu) d\nu}{\langle n_{\rm g}\sigma_{\rm g}\rangle / n_{\rm H}}$$

and, taking $\zeta = 1\times10^{-17}\,{\rm s}^{-1}$ and $\langle n_{\rm g}\sigma_{\rm g}\rangle/n_{\rm H} = 2\times10^{-21}$ cm^2 from Gredel et al. (1989), as did Hollenbach et al., we obtain $F_{\rm FUV} \approx 2\times10^3$ cm^{-2} s^{-1}. We note that this value of $F_{\rm FUV}$ agrees with that derived from Fig. 4 of Shen et al. (2004; $E_0 = 400$ MeV, corresponding to $\zeta = 3.1\times10^{-17}$ s^{-1}), when scaled to the same value of ζ. Hollenbach et al. (2009) appear to have been unaware of the work of Shen et al. (2004).

APPENDIX B: THE UGAN CHEMICAL NETWORK

The *University of Grenoble Alpes Astrochemical Network* (UGAN) is a significantly upgraded version of the gas-phase network of F06, which included reactions involving species containing H, D, He, C, N, O and S. F06 distinguished between the different nuclear–spin states of H_2, H_2^+, H_3^+ and their deuterated isotopologues, and between those of nitrogen hydrides. Nuclear-spin branching ratios were derived from simple statistical considerations (and conservation of the total nuclear spin) but without recourse to symmetry conservation. A first update of the F06 network consisted in a revision of nitrogen hydrides chemistry (excluding deuterated species) (Le Gal et al. 2014), with special attention to the most recent experimental results—in particular, for the conversion of N to N_2 through radical–radical reactions and for the dissociative recombination of the NH_n^+ (n=2-4) ions. The nuclear–spin selection rules were derived by the method of Oka (2004), as described in Rist et al. (2013) and Faure et al. (2013). These rules result from the conservation of the total nuclear–spin of identical nuclei and the conservation of their permutation symmetry (Quack 1977) or, alternatively, of their rotational symmetry (Oka 2004). Although conceptually different, the two methods are closely related and predict the same spin statistics when applied to multiple H nuclei (fermions). However, in the case of deuterium nuclei (bosons), the one–to–one correspondence between the nuclear–spin angular momentum and the permutation symmetry breaks down. A new method unifying the rotational and permutation symmetries was proposed recently (Schmiedt et al. 2016).

The present network extends the work of Le Gal et al. (2014) to the entire F06 chemical network in a systematic fashion for all hydrides containing C, N, O, and S atoms, and their deuterated forms. Nuclear–spin selection rules were derived from the permutation symmetry approach of Quack (1977), as explained below. Furthermore, many reaction rate coefficients were updated from a literature survey, including recommendations from the KIDA (KInetic Database for Astrochemistry[3]) data sheets.

After spin isomer separation on H and D, the complete new network contains 207 species—including grains (neutral and charged) and adsorbed species—and 3266 reactions (when including adsorption and desorption). The

[3] http://kida.obs.u-bordeaux1.fr/

unseparated—or condensed—network contains 151 species and 1136 reactions. The list of chemical species and the corresponding chemistry files are provided in Appendix D.

B1 Nuclear-spin-state separation

In principle, all molecules with identical nuclei of non-zero spin in equivalent positions should be treated as distinct nuclear–spin isomers. However, distinguishing between nuclear–spin states leads to a large increase in the number of chemical reactions that have to be considered, especially when deuterated species are included. Therefore, we have restricted the spin–state separation to hydrides and their deuterated isotopologues, i.e. to molecules with a single heavy atom and two or more hydrogen or deuterium nuclei; this includes molecules like $NH_2D_2^+$ but excludes species like C_3H_2.

B1.1 Exothermic reactions

For strongly exothermic reactions, we assume (i) conservation of the total nuclear spin and (ii) full scrambling of hydrogen and/or deuterium nuclei in the intermediate or activated complex. In such reactions, we assume that the intermediate complex is highly energetic and decays statistically to the many rotational states of the products. To obtain the nuclear–spin branching ratios, the probabilities of forming an intermediate complex in a given nuclear–spin state are multiplied by the probabilities for this complex to decay towards the nuclear–spin states of the products. In the process, the conservation of the total nuclear spin and of the permutation symmetry of identical nuclei is taken into account. The results of these calculations are then summed. This procedure also requires the nuclear-spin–symmetry statistical weights for reactions involving many (here up to seven) identical particles (**?**)see Appendix C and][]sipila2015b. In practice, for a reaction involving identical hydrogen or deuterium nuclei,

$$R_i + R_j \rightarrow C_n \rightarrow P_k + P_l, \tag{B1}$$

where $n = i + j = k + l$ is the total number of identical particles, one needs to determine the possible permutation–symmetry species for the reactants ($\Gamma_i \otimes \Gamma_j$, where $\otimes$ denotes a direct product), of the intermediate complex (Γ_n) and of the products ($\Gamma_k \otimes \Gamma_l$) in their respective permutation–symmetry groups ($S_i \otimes S_j, S_n$ and $S_k \otimes S_l$). One also needs the correlation tables between the symmetry group of the complex and the symmetry subgroups representing the reactants and the products. These tables, or matrices, are obtained using group theory and provide the required induction and subduction statistical weights $W_{(\Gamma_i \otimes \Gamma_j \uparrow \Gamma_n)}$. The statistical weights are the number of independent states of symmetry Γ_n induced from the Γ_i and Γ_j symmetries of the reactants. We note that the induction and subduction statistical weights are equal according to the Frobenius reciprocity theorem (Quack 1977). The correlation tables are given in Appendix C (**?**)see also][]hugo2009, sipila2015b. From these tables, simplified expressions for the nuclear-spin branching ratios can be derived which involve matrix products only:

$$P_{(\Gamma_i \otimes \Gamma_j \rightarrow \Gamma_k \otimes \Gamma_l)} = \frac{\sum_{\Gamma_n} W_{(\Gamma_i \otimes \Gamma_j \uparrow \Gamma_n)} \times W_{(\Gamma_k \otimes \Gamma_l \uparrow \Gamma_n)}}{(\sum_{\Gamma'_n} W_{(\Gamma_i \otimes \Gamma_j \uparrow \Gamma'_n)}) \times (\sum_{\Gamma'_k \Gamma'_l} W_{(\Gamma'_k \otimes \Gamma'_l \uparrow \Gamma_n)})}, \tag{B2}$$

with $\sum_{\Gamma_k \Gamma_l} P_{(\Gamma_i \otimes \Gamma_j \rightarrow \Gamma_k \otimes \Gamma_l)} = 1$[4]. Based on this formalism, we developed an automated FORTRAN routine, `spinstate.f90`, to calculate the branching ratios for reactions involving up to seven hydrogen (e.g. $CH_4 + H_3^+$) and six deuterium nuclei (e.g. $D_3^+ + ND_3$).

It should be noted that because hydrogen and deuterium nuclei are distinguishable, reactions involving both multiple hydrogen and multiple deuterium nuclei were divided into two parts, each with separate branching ratios that were combined (multiplied) afterwards. In addition, for exothermic reactions involving a hydride and a non-hydride—but "separable"—species whose nuclear–spin isomers are ignored (e.g. C_3H_2), we adopted the above procedure to compute the branching ratios. Where the non-hydride species is a reactant, we assume equal abundances of the nuclear–spin isomers of the non-hydride species, while, if it is a product, the associated nuclear–spin branching ratios are summed. Finally, for charge–exchange reactions, we assumed that the nuclear spin of each reactant isomer is conserved.

B1.2 Inter-conversion reactions

For inter-conversion reactions involving H_2 or D_2 (e.g. H^+ + para-H_2 $\leftrightarrow$ H^+ + ortho-H_2), rate coefficients were taken from either specific calculations or measurements in the literature, or estimated on a case–by–case basis. Indeed, for such "nearly thermo-neutral" reactions, the previous approach no longer applies because the full scrambling hypothesis is not guaranteed as the intermediate complex has small excess energy, and only a small amount of this energy is available for the products (Rist et al. 2013). In this case, a state–to–state (rotationally resolved) analysis is required to derive the nuclear–spin branching ratios. We have adopted a number of recent theoretical results from the literature for the inter-conversion of H_2 and D_2. We note that inter-conversion processes were neglected in reactions involving highly–exothermic channels (e.g. $NH_3^+ + H_2$) because the reactive channels (in this example, leading to $NH_4^+ + H$) proceed much faster than the inter-conversion (**?**)see][and references therein]faure2013. Specifically, for the reactions between all isotopic variants of H_3^+ and H_2, we have employed the state–to–state rate coefficients calculated by Hugo et al. (2009). These rate coefficients were used to derive *species-to-species* rate coefficients by assuming thermal population of the rotational levels within each nuclear–spin species; this supposes local thermal equilibrium (LTE), which should apply at densities above approximately 10^5 cm^{-3}. An alternative would be to use *ground–state–to–species* rate coefficients, assuming that all isotopologues are in their ground

[4] We note that the two sums in the denominator of Eq. (B2) can be expressed from dim(Γ) and $f(\Gamma)$, the dimension and frequency of the Γ permutation symmetry representation, as $f(\Gamma_i \otimes \Gamma_j) \times \dim(\Gamma_i) \times \dim(\Gamma_j)$ and $f(\Gamma_k \otimes \Gamma_l) \times \dim(\Gamma_k) \times \dim(\Gamma_l)$, respectively.

rotational states. Intermediate situations are also possible, as discussed in the recent work of Sipilä et al. (2017). However, only the LTE situation allows us to track anomalies in nuclear–spin isomer ratios, i.e. departures from thermal equilibrium ratios.

For the inter-conversion reaction between H^+ and H_2, we have employed state–to–state rate coefficients (Honvault et al. 2011, 2012), assuming that only the ground states of para-H_2 ($j = 0$) and ortho-H_2 ($j = 1$) are populated at low temperature. For the deuterated variant, $D^+ + D_2$, a statistical method was applied (Rist et al. 2013). This method—inspired by the work of Gerlich (1990)—was found to yield satisfactory agreement (typically better than a factor of 2) with time–independent quantum calculations (Honvault et al. 2011). The same statistical method was applied to the inter-conversion reactions between HCO^+ and H_2 and DCO^+ and D_2.

B1.3 Endothermic reactions and exothermic reactions with an activation barrier

For endothermic reactions or exothermic reactions with an activation barrier, our strategy was to include only those reactions whose activation energy is less than 1000 K. The spin–state separation of the original network of F06 was restricted to reactions that are significant at low temperatures (in practice, below 50 K). These reactions are generally of secondary importance; but we note the exception of $N^+ + H_2$, which is at the root of the ammonia chemistry. For this reaction, we adopted the rate coefficients of Dislaire et al. (2012), as did Le Gal et al. (2014). For the deuterated variant $N^+ + HD$, we used the experimental rate coefficient of Marquette et al. (1988).

B2 Condensed network

An unseparated or "condensed" network, where the distinction between nuclear–spin states is removed, is also provided for applications where ortho:para ratios are not required. In doing so, some prescriptions are necessary for a number of reactions whose rate coefficients depend on the ortho:para ratio(s) of the reactant(s). A good example is $N^+ + H_2$ (**?**)see[]dislaire2012. In such case, the KIDA value—when validated by experts—is generally adopted by default. For the deuterated variants of $H_3^+ + H_2$, we adopt representative values of the rate coefficients at low temperature (~ 10 K), based on a close inspection of the individual nuclear-spin reactions.

APPENDIX C: NUCLEAR SPIN SYMMETRY INDUCTION AND SUBDUCTION MATRICES

We recall the pure nuclear spin symmetry induction (and subduction) statistical weights matrices for several hydrogen systems and for several deuterium systems used in the chemistry network. These matrices give the total number of nuclear spin states allowed from permutation symmetry conservation in reactions involving $n > 1$ identical nuclei. We denote the induction weight $W_{\Gamma_i \otimes \Gamma_j \uparrow \Gamma_{n=i+j}}$, the number of "complex" spin states in a symmetry species Γ_n formed from two reactants respectively in the symmetry species Γ_i and Γ_j. The corresponding subduction weight $W_{\Gamma_{n=i+j} \downarrow \Gamma_i \otimes \Gamma_j}$ gives the number of allowed products spin states respectively in the symmetry species Γ_i and Γ_j from the decay of a complex in the symmetry species Γ_n. The reciprocity Froebenius theorem shows that $W_{\Gamma_{n=i+j} \downarrow \Gamma_i \otimes \Gamma_j} = W_{\Gamma_i \otimes \Gamma_j \uparrow \Gamma_{n=i+j}}$.

Table C1. Pure permutation symmetry induction/subduction statistical weights $W_{\Gamma_n \otimes \Gamma_1 \uparrow \Gamma_{n+1}} = W_{\Gamma_{n+1} \downarrow \Gamma_n \otimes \Gamma_1}$ for $H_n + H \longrightarrow H_{n+1}$.

$H + H \rightarrow H_2$ (Hugo et al. 2009)			
	A	B	Total
A A	3	1	4
Total	3	1	$4 = 2^2$

$H_2 + H \rightarrow H_3$ (Hugo et al. 2009)			
	A_1	E	Total
A A	4	2	6
B A	0	2	2
Total	4	4	$8 = 2^3$

$H_3 + H \rightarrow H_4$ (Hugo et al. 2009)				
	A_1	E	F_1	Total
A_1 A	5	0	3	8
E A	0	2	6	8
Total	5	2	9	$16 = 2^4$

$H_4 + H \rightarrow H_5$ (this work)				
	A_1	G_1	H_1	Total
A_1 A	6	4	0	10
E A	0	0	4	4
F_1 A	0	12	6	18
Total	6	16	10	$32 = 2^5$

$H_5 + H \rightarrow H_6$ (this work)					
	A_1	H_1	H_4	L_1	Total
A_1 A	7	5	0	0	12
G_1 A	0	20	0	12	32
H_1 A	0	0	5	15	20
Total	7	25	5	27	$64 = 2^6$

$H_6 + H \rightarrow H_7$ (this work)					
	A_1	I	X	Y	Total
A_1 A	8	6	0	0	14
H_1 A	0	30	0	20	50
H_4 A	0	0	10	0	10
L_1 A	0	0	18	36	54
Total	8	36	28	56	$128 = 2^7$

C1 Multi Hydrogen systems

See Tables C1 to C3.

C2 Multi Deuterium systems

See Tables C4 and C5.

Table C2. Pure permutation symmetry induction/subduction statistical weights $W_{\Gamma_n \otimes \Gamma_2 \uparrow \Gamma_{n+2}} = W_{\Gamma_{n+2} \downarrow \Gamma_n \otimes \Gamma_2}$ for $H_n + H_2 \longrightarrow H_{n+2}$.

$H_2 + H_2$		$\rightarrow$	H_4 (Hugo et al. 2009)			
			A_1	E	F_1	Total
A	A		5	1	3	9
A	B		0	0	3	3
B	A		0	0	3	3
B	B		0	1	0	1
Total			5	2	9	$16 = 2^4$

$H_3 + H_2$		$\rightarrow$	H_5 (Hugo et al. 2009)			
			A_1	G_1	H_1	Total
A_1	A		6	4	2	12
A_1	B		0	4	0	4
E	A		0	8	4	12
E	B		0	0	4	4
Total			6	16	10	$32 = 2^5$

$H_4 + H_2$		$\rightarrow$	H_6 (Sipilä et al. 2015)				
			A_1	H_1	H_4	L_4	Total
A_1	A		7	5	0	3	15
A_1	B		0	5	0	0	5
E	A		0	0	0	6	6
E	B		0	0	2	0	2
F_1	A		0	15	3	9	27
F_1	B		0	0	0	9	9
Total			7	25	5	27	$64 = 2^4$

$H_5 + H_2$		$\rightarrow$	H_7 (this work)				
			A_1	I	X	Y	Total
A_1	A		8	6	0	4	18
A_1	B		0	6	0	0	6
G_1	A		0	24	8	16	48
G_1	B		0	0	0	16	16
H_1	A		0	0	10	20	30
H_1	B		0	0	10	0	10
Total			8	36	28	56	$128 = 2^7$

Table C3. Pure permutation symmetry induction/subduction statistical weights $W_{\Gamma_n \otimes \Gamma_3 \uparrow \Gamma_{n+3}} = W_{\Gamma_{n+3} \downarrow \Gamma_n \otimes \Gamma_3}$ for $H_n + H_3 \longrightarrow H_{n+3}$.

$H_3 + H_3$		$\rightarrow$	H_6 (Sipilä et al. 2015)				
			A_1	H_1	H_4	L_1	Total
A_1	A_1		7	5	1	3	16
A_1	E		0	10	0	6	16
E	A_1		0	10	0	6	16
E	E		0	0	4	12	16
Total			7	25	5	27	$64 = 2^6$

$H_4 + H_3$		$\rightarrow$	H_7 (Sipilä et al. 2015)				
			A_1	H_1	H_4	L_1	Total
A_1	A_1		7	5	0	3	15
A_1	E		0	5	0	0	5
E	A_1		0	0	0	6	6
E	E		0	0	2	0	2
F_1	A_1		0	15	3	9	27
F_1	E		0	0	0	9	9
Total			7	25	5	27	$64 = 2^6$

Table C4. Pure permutation symmetry induction/subduction statistical weights $W_{\Gamma_n \otimes \Gamma_1 \uparrow \Gamma_{n+1}} = W_{\Gamma_{n+1} \downarrow \Gamma_n \otimes \Gamma_1}$ for $D_n + D \longrightarrow D_{n+1}$.

D + D		$\rightarrow$	D_2 (Hugo et al. 2009)		
			A	B	Total
A	A		6	3	9
Total			6	3	$9 = 3^2$

D_2 + D		$\rightarrow$	D_3 (Hugo et al. 2009)			
			A_1	A_2	E	Total
A	A		10	0	8	18
B	A		0	1	8	9
Total			4	4		$27 = 3^3$

D_3 + D		$\rightarrow$	D_4 (Hugo et al. 2009)				
			A_1	E	F_1	F_2	Total
A_1	A		15	0	15	0	30
A_2	A		0	0	0	3	3
E	A		0	12	30	6	48
Total			15	12	45	9	$81 = 3^4$

D_4 + D		$\rightarrow$	D_5 (this work)					
			A_1	G_1	H_1	H_2	I	Total
A_1	A		21	24	0	0	0	45
E	A		0	0	30	6	0	36
F_1	A		0	72	45	0	18	135
F_2	A		0	0	0	9	18	27
Total			21	96	75	15	36	$243 = 3^5$

APPENDIX D: THE UGAN REACTION RATE COEFFICIENTS

In this section, we provide our separated *University of Grenoble Alpes Astrochemical Network* (UGAN). Our convention for the names of the isotopologues follows Maue's rule (Maue 1937), namely that ortho species—noted with prefix o—have the largest statistical weight, and para species—with prefix p—have the smallest statistical weight. Species with intermediate degeneracy have prefix m, l, etc... in increasing order. Furthermore, for species that are separable with respect to both hydrogen and deuterium—such as NH_2D_2—the isomers are indicated with one letter for each nucleus. In such instances, two letters are used with the previous convention applying equally to H and D, e.g. $ooNH_2D_2$.

In the following Tables, the rate coefficients are given in the traditional form of a modified Arrhenius law,

$$k(T) = \alpha (T/300)^{\beta} \exp(-\gamma/T) \quad \mathrm{cm^3\,s^{-1}}.$$

Note however that the reactions of formation of H_2, HD, and D_2, which occur on dust surfaces, are computed as bimolecular reactions using a rate coefficient which is not given by the modified Arrhenius law, but which is computed internally from the density and the grain parameters. In the following Tables, the species noted γ represents a photon (not to be confused with the exo/endothermicity), CRP are

Table C5. Pure permutation symmetry induction/subduction statistical weights $W_{\Gamma_n \otimes \Gamma_2 \uparrow \Gamma_{n+2}} = W_{\Gamma_{n+2} \downarrow \Gamma_n \otimes \Gamma_2}$ for $\mathrm{D_n + D_2 \longrightarrow D_{n+2}}$ and $W_{\Gamma_n \otimes \Gamma_3 \uparrow \Gamma_{n+3}} = W_{\Gamma_{n+3} \downarrow \Gamma_n \otimes \Gamma_3}$ for for $\mathrm{D_n + D_3 \longrightarrow D_{n+3}}$.

D_2 + D_2		D_4 (Hugo et al. 2009)				
		A_1	E	F_1	F_2	Total
A	A	15	6	15	0	18
A	B	0	0	15	3	18
B	A	0	0	15	3	9
B	B	0	6	0	3	9
Total		15	12	45	9	$81 = 3^4$

D_3 + D_2		D_5 (Hugo et al. 2009)					
		A_1	G_1	H_1	H_2	I	Total
A_1	A	21	24	15	0	0	60
A_1	A	0	24	0	0	6	30
A_2	A	0	0	0	0	6	6
A_2	B	0	0	0	3	0	3
E	A	0	48	30	6	12	96
E	A	0	0	30	6	12	48
Total		21	96	75	15	36	$243 = 3^5$

D_4 + D_2		D_6 (Sipilä et al. 2015)							
		A_1	H_1	H_3	H_4	L_1	M_1	S	Total
A_1	A	28	35	0	0	27	0	0	90
A_1	A	0	35	0	0	0	10	0	45
E	A	0	0	2	0	54	0	16	72
E	A	0	0	0	20	0	0	16	36
F_1	A	0	105	0	30	81	30	24	270
F_1	B	0	0	0	0	81	30	24	135
F_2	A	0	0	0	0	0	30	24	54
F_2	B	0	0	3	0	0	0	24	27
Total		28	175	5	50	243	100	128	$729 = 3^6$

D_3 + D_3		D_6 (Sipilä et al. 2015)							
		A_1	H_1	H_3	H_4	L_1	M_1	S	Total
A_1	A_1	28	35	0	10	27	0	0	100
A_1	A_1	0	0	0	0	0	10	0	10
A_1	E	0	70	0	0	54	20	16	160
A_2	A_1	0	0	0	0	0	10	0	10
A_2	A_1	0	0	1	0	0	0	0	1
A_2	E	0	0	0	0	0	0	0	16
E	A_1	0	70	0	0	54	20	0	160
E	A_1	0	0	0	0	0	0	0	16
E	E	0	0	4	40	108	40	0	256
Total		28	175	5	50	243	100	128	$729 = 3^6$

primary cosmic-ray particles (essentially protons), and γ_2 are secondary photons.

Table D1. Species of our non-separated network (total: 151).

1	H	H_2	D	HD	D_2	He	O	OH
2	O_2	OD	H_2O	HDO	D_2O	C	CH	CH_2
3	CH_3	CH_4	C_2	C_2H	C_2H_2	C_3	C_3H	C_3H_2
4	N	N_2	NH	NH_2	NH_3	ND	NHD	ND_2
5	NH_2D	NHD_2	ND_3	S	SH	H_2S	CO	NO
6	CN	SO	CS	HNC	HCN	CO_2	SO_2	OCS
7	H_2CO	CH_3OH	HCO_2H	H^+	D^+	He^+	H_2^+	HD^+
8	D_2^+	H_3^+	H_2D^+	HD_2^+	D_3^+	O^+	OH^+	H_2O^+
9	OD^+	O_2^+	HDO^+	D_2O^+	H_3O^+	H_2DO^+	HD_2O^+	D_3O^+
10	C^+	CH^+	CH_2^+	CH_3^+	CH_4^+	CH_5^+	C_2^+	C_2H^+
11	$C_2H_2^+$	$C_2H_3^+$	C_3^+	C_3H^+	$C_3H_3^+$	$C_3H_2^+$	N^+	NH^+
12	ND^+	N_2^+	N_2H^+	NH_2^+	NH_4^+	N_2D^+	NH_3^+	NHD^+
13	ND_2^+	NH_3D^+	NH_2D^+	NHD_2^+	ND_3^+	$NH_2D_2^+$	NHD_3^+	ND_4^+
14	S^+	SH^+	SD^+	H_2S^+	H_3S^+	HCO^+	HCS^+	HCO_2^+
15	SO^+	CO^+	CS^+	DCO^+	NO^+	HCN^+	C_2N^+	$HCNH^+$
16	HNO^+	CN^+	HSO^+	$HOCS^+$	DCO_2^+	HSO_2^+	H_2NC^+	Fe
17	Fe^+	Gr	Gr^-	Gr^+	CH_4^*	H_2O^*	O_2^*	CO^*
18	CO_2^*	N^*	NH_3^*	N_2^*	H_2S^*	OCS^*	Fe^*	HDO^*
19	D_2O^*	NH_2D^*	NHD_2^*	ND_3^*	CH_3OH^*	H_2CO^*	HCO_2H^*	

Notes:

Species labeled with '*' are species adsorbed in grain mantles.

Table D2. Separated species (total: 207).

1	H	oH_2	pH_2	D	HD	oD_2	pD_2	He
2	O	OH	O_2	OD	oH_2O	pH_2O	HDO	oD_2O
3	pD_2O	C	CH	oCH_2	pCH_2	oCH_3	pCH_3	mCH_4
4	pCH_4	oCH_4	C_2	C_2H	C_2H_2	C_3	C_3H	C_3H_2
5	N	N_2	NH	oNH_2	pNH_2	oNH_3	pNH_3	ND
6	NHD	oND_2	pND_2	oNH_2D	pNH_2D	$oNHD_2$	$pNHD_2$	mND_3
7	pND_3	oND_3	S	SH	oH_2S	pH_2S	CO	NO
8	SO	CN	CS	HNC	HCN	CO_2	SO_2	OCS
9	H_2CO	CH_3OH	HCO_2H	Fe	H^+	D^+	He^+	oH_2^+
10	pH_2^+	HD^+	oD_2^+	pD_2^+	oH_2D^+	pH_2D^+	oH_3^+	pH_3^+
11	oHD_2^+	pHD_2^+	mD_3^+	oD_3^+	pD_3^+	O^+	O_2^+	OH^+
12	oH_2O^+	pH_2O^+	OD^+	HDO^+	oD_2O^+	pD_2O^+	oH_3O^+	pH_3O^+
13	oH_2DO^+	pH_2DO^+	oHD_2O^+	pHD_2O^+	mD_3O^+	oD_3O^+	pD_3O^+	C^+
14	CH^+	oCH_2^+	pCH_2^+	C_2^+	C_2H^+	$C_2H_3^+$	C_3^+	C_3H^+
15	oCH_3^+	pCH_3^+	pCH_5^+	oCH_5^+	mCH_5^+	mCH_4^+	pCH_4^+	oCH_4^+
16	$C_2H_2^+$	$C_3H_3^+$	$C_3H_2^+$	N^+	N_2^+	ND^+	NH^+	N_2H^+
17	N_2D^+	oNH_2^+	pNH_2^+	mNH_4^+	oNH_4^+	pNH_4^+	oNH_3^+	pNH_3^+
18	NHD^+	oND_2^+	pND_2^+	oNH_3D^+	pNH_3D^+	oNH_2D^+	pNH_2D^+	$oNHD_2^+$
19	$pNHD_2^+$	mND_3^+	oND_3^+	pND_3^+	$ooNH_2D_2^+$	$poNH_2D_2^+$	$opNH_2D_2^+$	$ppNH_2D_2^+$
20	$mNHD_3^+$	$oNHD_3^+$	$pNHD_3^+$	lND_4^+	oND_4^+	pND_4^+	mND_4^+	S^+
21	SH^+	SD^+	oH_2S^+	pH_2S^+	oH_3S^+	pH_3S^+	HCO^+	HCO_2^+
22	SO^+	CO^+	CS^+	NO^+	CN^+	HCS^+	DCO^+	HCN^+
23	C_2N^+	$HCNH^+$	HNO^+	HSO^+	$HOCS^+$	DCO_2^+	HSO_2^+	H_2NC^+
24	Fe^+	Gr	Gr^-	Gr^+	CH_4^*	H_2O^*	O_2^*	CO^*
25	CO_2^*	N^*	NH_3^*	N_2^*	H_2S^*	OCS^*	Fe^*	HDO^*
26	D_2O^*	NH_2D^*	NHD_2^*	ND_3^*	CH_3OH^*	H_2CO^*	HCO_2H^*	

Notes:

o: ortho; m:meta; p:para; The statistical weights are such that $p < m < l < o$, i.e. lND_4^+ has a statistical weight larger than that of mND_4^+ and smaller than oND_4^+;

$poNH_2D_2$: the first letter, p, refers to D nuclei symmetry, and the second, o, refers to symmetry of the H nuclei wavefunction.

Species labeled with '*' are species adsorbed in grain mantles.

Table D3. Sample of the "condensed" version of the UGAN chemical network (total: 1136 reactions).

#	Reactants		Products			α $cm^3\,s^{-1}$	β	γ K
1	H	H	H_2			1.0e+00		
2	H	D	HD			1.0e+00		
3	D	D	D_2			9.9e-01		
4	H	CRP	H^+	e^-		4.6e-01	0.00	0.0
5	D	CRP	D^+	e^-		4.6e-01	0.00	0.0
6	He	CRP	He^+	e^-		5.0e-01	0.00	0.0
7	H_2	CRP	H	H		1.0e-01	0.00	0.0
8	H_2	CRP	H^+	H	e^-	2.3e-02	0.00	0.0
9	H_2	CRP	H_2^+	e^-		9.8e-01	0.00	0.0
10	HD	CRP	H^+	D	e^-	2.0e-02	0.00	0.0
11	HD	CRP	D^+	H	e^-	2.0e-02	0.00	0.0
12	HD	CRP	H	D		1.5e+00	0.00	0.0
13	HD	CRP	HD^+	e^-		9.6e-01	0.00	0.0
14	D_2	CRP	D^+	D	e^-	4.0e-02	0.00	0.0
15	D_2	CRP	D	D		1.5e+00	0.00	0.0
16	D_2	CRP	D_2^+	e^-		9.6e-01	0.00	0.0
17	H	H_2^+	H_2	H^+		6.4e-10	0.00	0.0
18	H	H_3^+	H_2^+	H_2		2.1e-09	0.00	20000.0
19	H	HD^+	H^+	HD		6.4e-10	0.00	0.0
20	H	HD^+	H_2^+	D		1.0e-09	0.00	154.0

Table D4. Sample of the "separated" version of the UGAN chemical network (total: 3266 reactions split into 43 tables).

#	Reactants		Products			α $cm^3\,s^{-1}$	β	γ K
1	H	H	oH_2			7.5e-01		
2	H	H	pH_2			2.5e-01		
3	H	D	HD			1.0e+00		
4	D	D	oD_2			6.6e-01		
5	D	D	pD_2			3.3e-01	0.50	0.0
6	H	CRP	H^+	e^-		4.6e-01	0.00	0.0
7	D	CRP	D^+	e^-		4.6e-01	0.00	0.0
8	He	CRP	He^+	e^-		5.0e-01	0.00	0.0
9	oH_2	CRP	H	H		1.0e-01	0.00	0.0
10	pH_2	CRP	H	H		1.0e-01	0.00	0.0
11	oH_2	CRP	H^+	H	e^-	2.3e-02	0.00	0.0
12	pH_2	CRP	H^+	H	e^-	2.3e-02	0.00	0.0
13	oH_2	CRP	oH_2^+	e^-		9.8e-01	0.00	0.0
14	pH_2	CRP	pH_2^+	e^-		9.8e-01	0.00	0.0
15	HD	CRP	H^+	D	e^-	2.0e-02	0.00	0.0
16	HD	CRP	D^+	H	e^-	2.0e-02	0.00	0.0
17	HD	CRP	H	D		1.5e+00	0.00	0.0
18	HD	CRP	HD^+	e^-		9.6e-01	0.00	0.0
19	oD_2	CRP	D^+	D	e^-	4.0e-02	0.00	0.0
20	pD_2	CRP	D^+	D	e^-	4.0e-02	0.00	0.0

Table D5. The "condensed" version of the UGAN chemical network (total: 1136 reactions split into 15 Tables).

#	Reactants		Products			α	β	γ
1	H	H	H_2			1.0e+00		
2	H	D	HD			1.0e+00		
3	D	D	D_2			9.9e-01		
4	H	CRP	H^+	e^-		4.6e-01	0.00	0.0
5	D	CRP	D^+	e^-		4.6e-01	0.00	0.0
6	He	CRP	He^+	e^-		5.0e-01	0.00	0.0
7	H_2	CRP	H	H		1.0e-01	0.00	0.0
8	H_2	CRP	H^+	H	e^-	2.3e-02	0.00	0.0
9	H_2	CRP	H_2^+	e^-		9.8e-01	0.00	0.0
10	HD	CRP	H^+	D	e^-	2.0e-02	0.00	0.0
11	HD	CRP	D^+	H	e^-	2.0e-02	0.00	0.0
12	HD	CRP	H	D		1.5e+00	0.00	0.0
13	HD	CRP	HD^+	e^-		9.6e-01	0.00	0.0
14	D_2	CRP	D^+	D	e^-	4.0e-02	0.00	0.0
15	D_2	CRP	D	D		1.5e+00	0.00	0.0
16	D_2	CRP	D_2^+	e^-		9.6e-01	0.00	0.0
17	H	H_2^+	H_2	H^+		6.4e-10	0.00	0.0
18	H	H_3^+	H_2^+	H_2		2.1e-09	0.00	20000.0
19	H	HD^+	H^+	HD		6.4e-10	0.00	0.0
20	H	HD^+	H_2^+	D		1.0e-09	0.00	154.0
21	H	HD^+	H_2D^+	γ		1.2e-17	1.80	-20.0
22	H	D^+	H^+	D		1.0e-09	0.00	0.0
23	H	D^+	HD^+	γ		3.9e-19	1.80	-20.0
24	H	H_2D^+	H_3^+	D		1.0e-09	0.00	597.8
25	H	HD_2^+	H_2D^+	D		1.0e-09	0.00	549.8
26	H	D_2^+	HD^+	D		1.0e-09	0.00	430.0
27	H	D_2^+	D_2	H^+		6.4e-10	0.00	0.0
28	H	D_3^+	HD_2^+	D		1.0e-09	0.00	642.3
29	H_2	He^+	H^+	H	He	3.3e-15	0.00	0.0
30	H_2	He^+	H_2^+	He		9.6e-15	0.00	0.0
31	H_2	H^+	H	H_2^+		6.4e-10	0.00	21300.0
32	H_2	H_2^+	H_3^+	H		2.1e-09	0.00	0.0
33	H_2	HD^+	H_2D^+	H		1.1e-09	0.00	0.0
34	H_2	HD^+	H_3^+	D		1.1e-09	0.00	0.0
35	H_2	D^+	H^+	HD		2.1e-09	0.00	0.0
36	H_2	D_2^+	H_2D^+	D		1.1e-09	0.00	0.0
37	H_2	D_2^+	HD_2^+	H		1.1e-09	0.00	0.0
38	HD	He^+	H^+	D	He	5.5e-14	-0.24	0.0
39	HD	He^+	D^+	H	He	5.5e-14	-0.24	0.0
40	HD	H^+	D^+	H_2		1.0e-09	0.00	464.0
41	HD	H_2^+	H_2D^+	H		1.1e-09	0.00	0.0
42	HD	H_2^+	H_3^+	D		1.1e-09	0.00	0.0
43	HD	HD^+	H_2D^+	D		1.1e-09	0.00	0.0
44	HD	HD^+	HD_2^+	H		1.1e-09	0.00	0.0
45	HD	D^+	H^+	D_2		1.0e-09	0.00	0.0
46	HD	D_2^+	HD_2^+	D		1.1e-09	0.00	0.0
47	HD	D_2^+	D_3^+	H		1.1e-09	0.00	0.0
48	D	H^+	D^+	H		1.0e-09	0.00	41.0
49	D	H^+	HD^+	γ		3.9e-19	1.80	-20.0
50	D	H_2^+	H_2	D^+		6.4e-10	0.00	0.0
51	D	H_2^+	H_2D^+	γ		7.0e-18	1.80	-20.0
52	D	H_2^+	HD^+	H		1.0e-09	0.00	0.0
53	D	H_3^+	H_2D^+	H		1.0e-09	0.00	0.0
54	D	HD^+	D_2^+	H		1.0e-09	0.00	0.0
55	D	HD^+	D^+	HD		6.4e-10	0.00	0.0
56	D	H_2D^+	HD_2^+	H		1.0e-09	0.00	0.0
57	D	HD_2^+	D_3^+	H		1.0e-09	0.00	0.0
58	D	D_2^+	D_2	D^+		6.4e-10	0.00	0.0
59	D_2	He^+	D^+	D	He	1.1e-13	-0.24	0.0
60	D_2	He^+	D_2^+	He		2.5e-14	0.00	0.0
61	D_2	H^+	D^+	HD		2.1e-09	0.00	405.0
62	D_2	H_2^+	H_2D^+	D		1.1e-09	0.00	0.0
63	D_2	H_2^+	HD_2^+	H		1.1e-09	0.00	0.0
64	D_2	HD^+	HD_2^+	D		1.1e-09	0.00	0.0
65	D_2	HD^+	D_3^+	H		1.1e-09	0.00	0.0
66	D_2	D_2^+	D_3^+	D		2.1e-09	0.00	0.0
67	Fe	H^+	Fe^+	H		7.4e-09	0.00	0.0
68	Fe	H_3^+	Fe^+	H_2	H	4.9e-09	0.00	0.0
69	Fe	H_2D^+	Fe^+	H_2	D	4.9e-09	0.00	0.0
70	Fe	HD_2^+	Fe^+	D_2	H	1.6e-09	0.00	0.0
71	Fe	HD_2^+	Fe^+	HD	D	3.3e-09	0.00	0.0
72	Fe	D_3^+	Fe^+	D_2	D	4.9e-09	0.00	0.0
73	H^+	e^-	H	γ		3.6e-12	-0.75	0.0
74	H_2^+	e^-	H	H		2.5e-07	-0.50	0.0

Table D5 – *continued* (part 2)

Reactants			Products				α	β	γ	
75	H_2^+	e^-	H_2	γ				2.2e-07	-0.40	0.0
76	HD^+	e^-	H	D				9.0e-09	-0.50	0.0
77	D^+	e^-	D	γ				3.6e-12	-0.75	0.0
78	He^+	e^-	He	γ				4.5e-12	-0.67	0.0
79	H_2^+	γ_2	H^+	H				6.1e+02	0.00	0.0
80	H^+	Gr^-	Gr	H				1.6e-06	0.50	0.0
81	H_3^+	Gr^-	Gr	H_2	H			4.6e-07	0.50	0.0
82	H_3^+	Gr^-	Gr	H	H	H		4.6e-07	0.50	0.0
83	He^+	Gr^-	Gr	He				8.0e-07	0.50	0.0
84	H^+	Gr	Gr^+	H				1.6e-06	0.50	0.0
85	H_3^+	Gr	Gr^+	H_2	H			4.6e-07	0.50	0.0
86	H_3^+	Gr	Gr^+	H	H	H		4.6e-07	0.50	0.0
87	He^+	Gr	Gr^+	He				8.0e-07	0.50	0.0
88	D^+	Gr^-	Gr	D				1.1e-06	0.50	0.0
89	H_2D^+	Gr^-	Gr	H_2	D			1.3e-07	0.50	0.0
90	H_2D^+	Gr^-	Gr	HD	H			2.7e-07	0.50	0.0
91	H_2D^+	Gr^-	Gr	D	H	H		4.0e-07	0.50	0.0
92	D^+	Gr	Gr^+	D				1.1e-06	0.50	0.0
93	H_2D^+	Gr	Gr^+	H_2	D			1.3e-07	0.50	0.0
94	H_2D^+	Gr	Gr^+	HD	H			2.7e-07	0.50	0.0
95	H_2D^+	Gr	Gr^+	D	H	H		4.0e-07	0.50	0.0
96	HD_2^+	Gr^-	Gr	HD	D			2.4e-07	0.50	0.0
97	HD_2^+	Gr^-	Gr	D_2	H			1.2e-07	0.50	0.0
98	HD_2^+	Gr^-	Gr	D	D	H		3.6e-07	0.50	0.0
99	HD_2^+	Gr	Gr^+	HD	D			2.4e-07	0.50	0.0
100	HD_2^+	Gr	Gr^+	D_2	H			1.2e-07	0.50	0.0
101	HD_2^+	Gr	Gr^+	D	D	H		3.6e-07	0.50	0.0
102	D_3^+	Gr^-	Gr	D_2	D			3.3e-07	0.50	0.0
103	D_3^+	Gr^-	Gr	D	D	D		3.3e-07	0.50	0.0
104	D_3^+	Gr	Gr^+	D_2	D			3.3e-07	0.50	0.0
105	D_3^+	Gr	Gr^+	D	D	D		3.3e-07	0.50	0.0
106	O	CRP	O^+	e^-				2.8e+00	0.00	0.0
107	O	OH	O_2	H				4.0e-11	0.00	0.0
108	O^+	H_2	OH^+	H				1.2e-09	0.00	0.0
109	O^+	H	H^+	O				6.0e-10	0.00	0.0
110	O	H^+	O^+	H				6.0e-10	0.00	227.0
111	O	H_2^+	OH^+	H				1.5e-09	0.00	0.0
112	O	H_3^+	OH^+	H_2				8.0e-10	-0.16	1.4
113	O	H_3^+	H_2O^+	H				3.4e-10	-0.16	1.4
114	O	H_2D^+	OH^+	HD				5.3e-10	0.00	0.0
115	O	H_2D^+	OD^+	H_2				2.7e-10	0.00	0.0
116	O	HD_2^+	OH^+	D_2				2.7e-10	0.00	0.0
117	O	HD_2^+	OD^+	HD				5.3e-10	0.00	0.0
118	O	D_3^+	OD^+	D_2				8.0e-10	0.00	0.0
119	O_2	He^+	O^+	O	He			1.0e-09	0.00	0.0
120	O_2	H^+	O_2^+	H				1.2e-09	0.00	0.0
121	OH	He^+	OH^+	He				5.5e-10	0.00	0.0
122	OH	He^+	O^+	H	He			5.5e-10	0.00	0.0
123	OH	H^+	OH^+	H				2.1e-09	0.00	0.0
124	OH	H_2^+	H_2	OH^+				7.6e-10	0.00	0.0
125	OH	H_3^+	H_2O^+	H_2				1.3e-09	0.00	0.0
126	OH	H_2D^+	H_2O^+	HD				8.7e-10	0.00	0.0
127	OH	H_2D^+	HDO^+	H_2				4.3e-10	0.00	0.0
128	OH	HD_2^+	H_2O^+	D_2				4.3e-10	0.00	0.0
129	OH	HD_2^+	HDO^+	HD				8.7e-10	0.00	0.0
130	OH	D_3^+	HDO^+	D_2				1.3e-09	0.00	0.0
131	OD	He^+	OD^+	He				5.5e-10	0.00	0.0
132	OD	He^+	O^+	D	He			5.5e-10	0.00	0.0
133	OD	H^+	OD^+	H				2.1e-09	0.00	0.0
134	OD	H_3^+	HDO^+	H_2				1.3e-09	0.00	0.0
135	OD	H_2D^+	HDO^+	HD				8.7e-10	0.00	0.0
136	OD	H_2D^+	D_2O^+	H_2				4.3e-10	0.00	0.0
137	OD	HD_2^+	HDO^+	D_2				4.3e-10	0.00	0.0
138	OD	HD_2^+	D_2O^+	HD				8.7e-10	0.00	0.0
139	OD	D_3^+	D_2O^+	D_2				1.3e-10	0.00	0.0
140	H_2O	He^+	OH^+	H	He			2.3e-10	-0.94	0.0
141	H_2O	He^+	H_2O^+	He				4.9e-11	-0.94	0.0
142	H_2O	He^+	H^+	OH	He			1.6e-10	-0.94	0.0
143	H_2O	H^+	H	H_2O^+				8.2e-09	0.00	0.0
144	H_2O	H_2^+	H_2	H_2O^+				3.9e-09	0.00	0.0
145	H_2O	H_2^+	H_3O^+	H				3.4e-09	0.00	0.0
146	H_2O	H_3^+	H_3O^+	H_2				4.3e-09	0.00	0.0
147	H_2O	H_2D^+	H_3O^+	HD				2.9e-09	0.00	0.0
148	H_2O	HD_2^+	H_2DO^+	HD				2.9e-09	0.00	0.0

Table D5 – *continued* (part 3)

Reactants		Products				α	β	γ
149	H_2O	HD_2^+	H_3O^+	D_2		1.4e-09	0.00	0.0
150	H_2O	D_3^+	H_2DO^+	D_2		4.3e-09	0.00	0.0
151	H_2O	H_2D^+	H_2DO^+	H_2		1.4e-09	0.00	0.0
152	HDO	He^+	OD^+	H	He	2.3e-10	-0.94	0.0
153	HDO	He^+	HDO^+	He		4.9e-11	-0.94	0.0
154	HDO	He^+	H^+	OD	He	1.6e-10	-0.94	0.0
155	HDO	H^+	HDO^+	H		8.2e-09	0.00	0.0
156	HDO	H_3^+	H_2DO^+	H_2		4.3e-09	0.00	0.0
157	HDO	H_2D^+	H_2DO^+	HD		2.9e-09	0.00	0.0
158	HDO	H_2D^+	HD_2O^+	H_2		1.4e-09	0.00	0.0
159	HDO	HD_2^+	HD_2O^+	HD		2.9e-09	0.00	0.0
160	HDO	HD_2^+	H_2DO^+	D_2		1.4e-09	0.00	0.0
161	HDO	D_3^+	HD_2O^+	D_2		4.3e-09	0.00	0.0
162	D_2O	He^+	OD^+	D	He	2.3e-10	-0.94	0.0
163	D_2O	He^+	D_2O^+	He		4.9e-11	-0.94	0.0
164	D_2O	He^+	D^+	OD	He	1.6e-10	-0.94	0.0
165	D_2O	H^+	D_2O^+	H		8.2e-09	0.00	0.0
166	D_2O	H_3^+	HD_2O^+	H_2		4.3e-09	0.00	0.0
167	D_2O	H_2D^+	HD_2O^+	HD		2.9e-09	0.00	0.0
168	D_2O	H_2D^+	D_3O^+	H_2		1.4e-09	0.00	0.0
169	D_2O	D_3^+	D_3O^+	D_2		4.3e-09	0.00	0.0
170	D_2O	HD_2^+	D_3O^+	HD		2.9e-09	0.00	0.0
171	D_2O	HD_2^+	HD_2O^+	D_2		1.4e-09	0.00	0.0
172	OH^+	H_2	H_2O^+	H		1.0e-09	0.00	0.0
173	OH^+	HD	HDO^+	H		5.1e-10	0.00	0.0
174	OH^+	HD	H_2O^+	D		5.1e-10	0.00	0.0
175	OD^+	H_2	HDO^+	H		1.0e-09	0.00	0.0
176	OD^+	HD	D_2O^+	H		5.1e-10	0.00	0.0
177	OD^+	HD	HDO^+	D		5.1e-10	0.00	0.0
178	OD^+	D_2	D_2O^+	D		1.1e-09	0.00	0.0
179	H_2O^+	H_2	H_3O^+	H		8.3e-10	0.00	0.0
180	H_2O^+	HD	H_2DO^+	H		4.2e-10	0.00	0.0
181	H_2O^+	HD	H_3O^+	D		4.2e-10	0.00	0.0
182	HDO^+	H_2	H_2DO^+	H		8.3e-10	0.00	0.0
183	HDO^+	HD	HD_2O^+	H		4.2e-10	0.00	0.0
184	HDO^+	HD	H_2DO^+	D		4.2e-10	0.00	0.0
185	HDO^+	D_2	HD_2O^+	D		8.3e-10	0.00	0.0
186	D_2O^+	D_2	D_3O^+	D		8.3e-10	0.00	0.0
187	D_2O^+	H_2	HD_2O^+	H		8.3e-10	0.00	0.0
188	D_2O^+	HD	HD_2O^+	D		4.2e-10	0.00	0.0
189	D_2O^+	HD	D_3O^+	H		4.2e-10	0.00	0.0
190	H_3O^+	Fe	Fe^+	H_2O	H	3.1e-09	0.00	0.0
191	O_2^+	Fe	Fe^+	O_2		1.1e-09	0.00	0.0
192	O^+	e^-	O	γ		3.4e-12	-0.64	0.0
193	O_2^+	e^-	O	O		2.0e-07	-0.70	0.0
194	OH^+	e^-	O	H		3.7e-08	-0.50	0.0
195	H_2O^+	e^-	OH	H		7.8e-08	-0.50	0.0
196	H_2O^+	e^-	O	H_2		3.4e-08	-0.50	0.0
197	H_2O^+	e^-	O	H	H	1.5e-07	-0.50	0.0
198	H_3O^+	e^-	OH	H	H	2.6e-07	-0.50	0.0
199	H_3O^+	e^-	H_2O	H		1.1e-07	-0.50	0.0
200	H_3O^+	e^-	OH	H_2		6.0e-08	-0.50	0.0
201	H_3O^+	e^-	H_2	H	O	5.6e-09	-0.50	0.0
202	OD^+	e^-	O	D		3.7e-08	-0.50	0.0
203	HDO^+	e^-	OD	H		3.1e-08	-0.50	0.0
204	HDO^+	e^-	OH	D		1.5e-08	-0.50	0.0
205	HDO^+	e^-	O	HD		1.5e-08	-0.50	0.0
206	HDO^+	e^-	O	H	D	8.9e-08	-0.50	0.0
207	D_2O^+	e^-	OD	D		7.8e-08	-0.50	0.0
208	D_2O^+	e^-	O	D_2		3.4e-08	-0.50	0.0
209	D_2O^+	e^-	O	D	D	1.5e-07	-0.50	0.0
210	H_2DO^+	e^-	OD	H	H	8.6e-08	-0.50	0.0
211	H_2DO^+	e^-	OH	D	H	1.7e-07	-0.50	0.0
212	H_2DO^+	e^-	H_2O	D		3.6e-08	-0.50	0.0
213	H_2DO^+	e^-	HDO	H		7.2e-08	-0.50	0.0
214	H_2DO^+	e^-	OD	H_2		2.0e-08	-0.50	0.0
215	H_2DO^+	e^-	OH	HD		4.0e-08	-0.50	0.0
216	H_2DO^+	e^-	HD	H	O	3.7e-09	-0.50	0.0
217	H_2DO^+	e^-	H_2	D	O	1.9e-09	-0.50	0.0
218	HD_2O^+	e^-	OH	D	D	8.6e-08	-0.50	0.0
219	HD_2O^+	e^-	OD	D	H	1.7e-07	-0.50	0.0
220	HD_2O^+	e^-	D_2O	H		3.6e-08	-0.50	0.0
221	HD_2O^+	e^-	HDO	D		7.2e-08	-0.50	0.0
222	HD_2O^+	e^-	OH	D_2		2.0e-08	-0.50	0.0

Table D5 – *continued* (part 4)

Reactants		Products					α	β	γ	
223	HD_2O^+	e^-	OD	HD				4.0e-08	-0.50	0.0
224	HD_2O^+	e^-	HD	D	O			3.7e-09	-0.50	0.0
225	HD_2O^+	e^-	D_2	H	O			1.9e-09	-0.50	0.0
226	D_3O^+	e^-	OD	D	D			2.6e-07	-0.50	0.0
227	D_3O^+	e^-	D_2O	D				1.1e-07	-0.50	0.0
228	D_3O^+	e^-	OD	D_2				6.0e-08	-0.50	0.0
229	D_3O^+	e^-	D_2	D	O			5.6e-09	-0.50	0.0
230	OH	γ_2	O	H				4.7e+02	0.00	0.0
231	OH^+	γ_2	O^+	H				8.6e+00	0.00	0.0
232	H_2O	γ_2	OH	H				1.0e+03	0.00	0.0
233	H_2O	γ_2	H_2O^+	e^-				2.3e+01	0.00	0.0
234	O_2	γ_2	O	O				7.8e+02	0.00	0.0
235	O_2	γ_2	O_2^+	e^-				2.8e+01	0.00	0.0
236	O_2^+	γ_2	O^+	O				7.0e+01	0.00	0.0
237	H_3O^+	Gr	Gr^+	H_2O	H			3.7e-07	0.50	0.0
238	H_3O^+	Gr^-	Gr	H_2O	H			3.7e-07	0.50	0.0
239	O	H_2	OH	H				1.5e-13	2.80	2980.0
240	O_2	H	OH	O				1.6e-09	-0.90	8750.0
241	OH	H	O	H_2				7.0e-14	2.80	1950.0
242	OH	H_2	H_2O	H				9.5e-13	2.00	1490.0
243	H_2O	H	OH	H_2				5.2e-12	1.90	9265.0
244	H_3O^+	H	H_2O^+	H_2				6.1e-10	0.00	20500.0
245	C^+	H	CH^+	γ				7.0e-17	0.00	0.0
246	C^+	H_2	CH_2^+	γ				2.0e-16	-1.30	23.0
247	C^+	CH	C_2^+	H				3.8e-10	0.00	0.0
248	C^+	CH	CH^+	C				3.8e-10	0.00	0.0
249	C^+	CH_2	CH_2^+	C				5.2e-10	0.00	0.0
250	C^+	CH_2	C_2H^+	H				5.2e-10	0.00	0.0
251	C^+	CH_4	$C_2H_2^+$	H_2				3.3e-10	0.00	0.0
252	C^+	CH_4	$C_2H_3^+$	H				9.8e-10	0.00	0.0
253	C^+	C_2H	C_3^+	H				1.0e-09	0.00	0.0
254	C^+	C_2H_2	C_3H^+	H				2.2e-09	0.00	0.0
255	C^+	Fe	Fe^+	C				2.6e-09	0.00	0.0
256	CH^+	H	C^+	H_2				1.5e-10	0.00	0.0
257	CH^+	H_2	CH_2^+	H				1.2e-09	0.00	0.0
258	CH_2^+	H_2	CH_3^+	H				7.0e-10	0.00	0.0
259	CH_3^+	H_2	CH_5^+	γ				3.8e-16	-2.30	21.5
260	CH_4^+	H	CH_3^+	H_2				2.0e-10	0.00	0.0
261	CH_4^+	H_2	CH_5^+	H				4.0e-11	0.00	0.0
262	C_2^+	H_2	C_2H^+	H				1.4e-09	0.00	0.0
263	C_2H^+	H_2	$C_2H_2^+$	H				1.7e-09	0.00	0.0
264	C_3^+	H_2	C_3H^+	H				3.0e-10	0.00	0.0
265	C_3H^+	H_2	$C_3H_3^+$	γ				3.0e-13	-1.00	0.0
266	C	CRP	C^+	e^-				1.8e+00	0.00	0.0
267	C	H	CH	γ				1.0e-17	0.00	0.0
268	C	H_2^+	CH^+	H				2.4e-09	0.00	0.0
269	C	H_3^+	CH^+	H_2				2.0e-09	0.00	0.0
270	CH	H	C	H_2				1.2e-10	0.26	0.0
271	CH	He^+	C^+	H	He			1.1e-09	0.00	0.0
272	CH	H^+	H	CH^+				1.9e-09	0.00	0.0
273	CH	H_2^+	H_2	CH^+				7.1e-10	0.00	0.0
274	CH	H_2^+	CH_2^+	H				7.1e-10	0.00	0.0
275	CH	H_3^+	CH_2^+	H_2				1.2e-09	0.00	0.0
276	CH	H_2D^+	CH_2^+	HD				1.2e-09	0.00	0.0
277	CH	HD_2^+	CH_2^+	D_2				1.2e-09	0.00	0.0
278	CH_2	H	CH	H_2				2.2e-10	0.00	0.0
279	CH_2	He^+	C^+	H_2	He			7.5e-10	0.00	0.0
280	CH_2	He^+	CH^+	H	He			7.5e-10	0.00	0.0
281	CH_2	H^+	CH^+	H_2				1.4e-09	0.00	0.0
282	CH_2	H^+	H	CH_2^+				1.4e-09	0.00	0.0
283	CH_2	H_2^+	CH_3^+	H				1.0e-09	0.00	0.0
284	CH_2	H_2^+	H_2	CH_2^+				1.0e-09	0.00	0.0
285	CH_2	H_3^+	CH_3^+	H_2				1.7e-09	0.00	0.0
286	CH_2	H_2D^+	CH_3^+	HD				1.7e-09	0.00	0.0
287	CH_2	HD_2^+	CH_3^+	D_2				1.7e-09	0.00	0.0
288	CH_3	He^+	CH^+	H_2	He			9.0e-10	0.00	0.0
289	CH_3	He^+	CH_2^+	H	He			9.0e-10	0.00	0.0
290	CH_3	H^+	H	CH_3^+				3.4e-09	0.00	0.0
291	CH_3	H_3^+	CH_4^+	H_2				2.1e-09	0.00	0.0
292	CH_3	H_2D^+	CH_4^+	HD				2.1e-09	0.00	0.0
293	CH_3	HD_2^+	CH_4^+	D_2				2.1e-09	0.00	0.0
294	CH_4	He^+	H^+	CH_3	He			4.0e-10	0.00	0.0
295	CH_4	He^+	CH^+	H_2	H		He	2.6e-10	0.00	0.0
296	CH_4	He^+	CH_2^+	H_2	He			8.5e-10	0.00	0.0

Table D5 – *continued* (part 5)

Reactants		Products				α	β	γ
297	CH_4	He^+	CH_3^+	H	He		8.0e-11	0.00	0.0
298	CH_4	He^+	CH_4^+	He			1.6e-11	0.00	0.0
299	CH_4	H^+	CH_3^+	H_2			2.3e-09	0.00	0.0
300	CH_4	H^+	H	CH_4^+			1.5e-09	0.00	0.0
301	CH_4	H_3^+	CH_5^+	H_2			1.9e-09	0.00	0.0
302	CH_4	H_2D^+	CH_5^+	HD			1.9e-09	0.00	0.0
303	CH_4	HD_2^+	CH_5^+	D_2			1.9e-09	0.00	0.0
304	C	H_2D^+	CH^+	HD			2.0e-09	0.00	0.0
305	C	HD_2^+	CH^+	D_2			2.0e-09	0.00	0.0
306	C_2	H^+	C_2^+	H			3.1e-09	0.00	0.0
307	C_2H	He^+	C^+	CH	He		5.1e-10	0.00	0.0
308	C_2H	He^+	CH^+	C	He		5.1e-10	0.00	0.0
309	C_2H	He^+	C_2^+	H	He		5.1e-10	0.00	0.0
310	C_2H	H^+	C_2^+	H_2			1.5e-09	0.00	0.0
311	C_2H	H^+	C_2H^+	H			1.5e-09	0.00	0.0
312	C_2H	H_3^+	$C_2H_2^+$	H_2			1.7e-09	0.00	0.0
313	C_2H	H_2D^+	$C_2H_2^+$	HD			1.7e-09	0.00	0.0
314	C_2H	HD_2^+	$C_2H_2^+$	D_2			1.7e-09	0.00	0.0
315	C_3H	He^+	C_3^+	H	He		2.0e-09	0.00	0.0
316	C_3H	H^+	C_3^+	H_2			2.0e-09	0.00	0.0
317	C_3H	H^+	C_3H^+	H			2.0e-09	0.00	0.0
318	C_3H	H_3^+	$C_3H_2^+$	H_2			2.0e-09	0.00	0.0
319	C_3H	H_2D^+	$C_3H_2^+$	HD			2.0e-09	0.00	0.0
320	C_3H	HD_2^+	$C_3H_2^+$	D_2			2.0e-09	0.00	0.0
321	C_2H_2	He^+	CH^+	CH	He		7.7e-10	0.00	0.0
322	C_2H_2	He^+	C_2^+	H_2	He		1.6e-09	0.00	0.0
323	C_2H_2	He^+	C_2H^+	H	He		8.7e-10	0.00	0.0
324	C_2H_2	He^+	$C_2H_2^+$	He			2.4e-10	0.00	0.0
325	C_2H_2	H^+	C_2H^+	H_2			2.0e-09	0.00	0.0
326	C_2H_2	H^+	$C_2H_2^+$	H			2.0e-09	0.00	0.0
327	C_2H_2	H_3^+	$C_2H_3^+$	H_2			2.9e-09	0.00	0.0
328	C_2H_2	H_2D^+	$C_2H_3^+$	HD			2.9e-09	0.00	0.0
329	C_2H_2	HD_2^+	$C_2H_3^+$	D_2			2.9e-09	0.00	0.0
330	C_3H_2	H^+	C_3H^+	H_2			2.0e-09	0.00	0.0
331	C_3H_2	H^+	$C_3H_2^+$	H			2.0e-09	0.00	0.0
332	C_3H_2	He^+	C_3H^+	H	He		1.0e-09	0.00	0.0
333	C_3H_2	He^+	C_3^+	H_2	He		1.0e-09	0.00	0.0
334	C_3H_2	H_3^+	$C_3H_3^+$	H_2			2.0e-09	0.00	0.0
335	C_3H_2	H_2D^+	$C_3H_3^+$	HD			2.0e-09	0.00	0.0
336	C_3H_2	HD_2^+	$C_3H_3^+$	D_2			2.0e-09	0.00	0.0
337	C^+	e^-	C	γ			4.4e-12	-0.61	0.0
338	CH^+	e^-	C	H			1.5e-07	-0.42	0.0
339	CH_2^+	e^-	C	H_2			1.2e-07	-0.50	0.0
340	CH_2^+	e^-	CH	H			1.2e-07	-0.50	0.0
341	CH_3^+	e^-	C	H_2	H		3.0e-07	-0.30	0.0
342	CH_3^+	e^-	CH	H	H		1.6e-07	-0.30	0.0
343	CH_3^+	e^-	CH	H_2			1.4e-07	-0.30	0.0
344	CH_3^+	e^-	CH_2	H			4.0e-07	-0.30	0.0
345	CH_4^+	e^-	CH_3	H			3.0e-07	-0.50	0.0
346	CH_4^+	e^-	CH_2	H	H		3.0e-07	-0.50	0.0
347	CH_5^+	e^-	CH	H_2	H_2		8.7e-08	-0.30	0.0
348	CH_5^+	e^-	CH_2	H_2	H		8.7e-08	-0.30	0.0
349	CH_5^+	e^-	CH_3	H_2			8.7e-08	-0.30	0.0
350	CH_5^+	e^-	CH_4	H			8.7e-08	-0.30	0.0
351	C_2^+	e^-	C	C			3.0e-07	-0.50	0.0
352	C_2H^+	e^-	C_2	H			1.4e-07	-0.50	0.0
353	C_2H^+	e^-	CH	C			1.4e-07	-0.50	0.0
354	$C_2H_2^+$	e^-	C_2H	H			1.5e-07	-0.50	0.0
355	$C_2H_2^+$	e^-	CH	CH			1.5e-07	-0.50	0.0
356	$C_2H_3^+$	e^-	C_2H	H_2			1.4e-07	-0.50	0.0
357	$C_2H_3^+$	e^-	CH_2	CH			1.4e-07	-0.50	0.0
358	$C_2H_3^+$	e^-	C_2H_2	H			3.0e-08	-0.50	0.0
359	C_3^+	e^-	C_2	C			3.0e-07	-0.50	0.0
360	C_3H^+	e^-	C_2	CH			1.5e-07	-0.50	0.0
361	C_3H^+	e^-	C_2H	C			1.5e-07	-0.50	0.0
362	$C_3H_2^+$	e^-	C_3H	H			1.5e-07	-0.50	0.0
363	$C_3H_2^+$	e^-	C_2H	CH			1.5e-07	-0.50	0.0
364	$C_3H_3^+$	e^-	C_3H_2	H			1.5e-07	-0.50	0.0
365	$C_3H_3^+$	e^-	C_2H_2	CH			1.5e-07	-0.50	0.0
366	C	γ_2	C^+	e^-			2.6e+02	0.00	0.0
367	CH	γ_2	C	H			1.1e+03	0.00	0.0
368	CH	γ_2	CH^+	e^-			5.8e+02	0.00	0.0
369	CH_2	γ_2	C	H_2			2.9e+02	0.00	0.0
370	CH_3	γ_2	CH	H_2			2.8e+02	0.00	0.0

Table D5 – *continued* (part 6)

Reactants		Products				α	β	γ
371	CH_3	γ_2	CH_3^+	e^-		3.8e+02	0.00	0.0
372	CH_4	γ_2	CH_3	H		1.5e+03	0.00	0.0
373	CH_4	γ_2	CH_4^+	e^-		2.2e+01	0.00	0.0
374	CH^+	γ_2	C	H^+		2.2e+02	0.00	0.0
375	CH_2^+	γ_2	CH^+	H		8.9e+01	0.00	0.0
376	CH_4^+	γ_2	CH_3^+	H		2.7e+01	0.00	0.0
377	C_2	γ_2	C	C		1.8e+02	0.00	0.0
378	C_2	γ_2	C_2^+	e^-		2.5e+02	0.00	0.0
379	C_2H	γ_2	C_2	H		1.1e+03	0.00	0.0
380	C_2H_2	γ_2	C_2H	H		3.5e+03	0.00	0.0
381	C_2H_2	γ_2	$C_2H_2^+$	e^-		3.8e+02	0.00	0.0
382	C_3	γ_2	C_2	C		6.9e+03	0.00	0.0
383	C_3H	γ_2	C_3	H		3.0e+03	0.00	0.0
384	C_3H_2	γ_2	C_3H	H		3.4e+03	0.00	0.0
385	C^+	Gr	Gr^+	C		4.6e-07	0.50	0.0
386	C^+	Gr^-	Gr	C		4.6e-07	0.50	0.0
387	C	H_2	CH	H		1.2e-09	0.50	14100.0
388	CH	H_2	CH_2	H		2.4e-10	0.00	1760.0
389	CH_2	H_2	CH_3	H		5.2e-11	0.17	6400.0
390	CH_3	H_2	CH_4	H		3.0e-10	0.00	5460.0
391	C_2	H_2	C_2H	H		1.6e-10	0.00	1419.0
392	C_2H	H_2	C_2H_2	H		1.1e-11	0.00	950.0
393	CH_3	H	CH_2	H_2		5.2e-11	0.17	5600.0
394	CH_4	H	CH_3	H_2		3.0e-10	0.00	6560.0
395	C^+	H_2	CH^+	H		1.5e-10	0.00	4640.0
396	CH_2^+	H	CH^+	H_2		1.2e-09	0.00	2700.0
397	CH_3^+	H	CH_2^+	H_2		7.0e-10	0.00	10560.0
398	CH_3^+	H_2	CH_4^+	H		2.0e-10	0.00	32500.0
399	CH_5^+	H	CH_4^+	H_2		4.0e-11	0.00	2200.0
400	C_2^+	H_2	H^+	C_2H		1.5e-09	0.00	1260.0
401	$C_2H_2^+$	H_2	$C_2H_3^+$	H		5.0e-10	0.00	800.0
402	C_3H^+	H_2	$C_3H_2^+$	H		1.0e-09	0.00	500.0
403	$C_3H_2^+$	H_2	$C_3H_3^+$	H		1.0e-10	0.00	2000.0
404	N	CRP	N^+	e^-		2.1e+00	0.00	0.0
405	N	NH	N_2	H		5.0e-11	0.10	0.0
406	N	NH_2	N_2	H	H	1.2e-10	0.00	0.0
407	N^+	H_2	NH^+	H		4.2e-10	0.00	41.9
408	N^+	HD	ND^+	H		4.2e-10	0.00	0.0
409	N_2^+	H_2	N_2H^+	H		2.0e-09	0.24	0.0
410	NH^+	H_2	NH_2^+	H		1.3e-09	0.00	0.0
411	NH^+	H_2	H_3^+	N		2.2e-10	0.00	0.0
412	NH^+	H	N^+	H_2		6.5e-10	0.00	0.0
413	N_2H^+	NH_3	NH_4^+	N_2		2.3e-09	0.00	0.0
414	N_2H^+	D	N_2D^+	H		1.0e-09	0.00	0.0
415	NH_2^+	H_2	NH_3^+	H		2.7e-10	0.00	0.0
416	NH_3^+	H_2	NH_4^+	H		2.4e-12	0.00	0.0
417	ND^+	H_2	NHD^+	H		1.3e-09	0.00	0.0
418	ND^+	H_2	H_2D^+	N		2.2e-10	0.00	0.0
419	ND^+	HD	NHD^+	D		6.3e-10	0.00	0.0
420	ND^+	HD	ND_2^+	H		6.3e-10	0.00	0.0
421	N_2D^+	H	N_2H^+	D		1.0e-09	0.00	170.0
422	N_2D^+	NH_3	NH_3D^+	N_2		2.3e-09	0.00	0.0
423	NHD^+	H_2	NH_2D^+	H		2.7e-10	0.00	0.0
424	NHD^+	HD	NH_2D^+	D		1.3e-10	0.00	0.0
425	NHD^+	HD	NHD_2^+	H		1.3e-10	0.00	0.0
426	ND_2^+	H_2	NHD_2^+	H		2.7e-10	0.00	0.0
427	ND_2^+	HD	NHD_2^+	D		1.3e-10	0.00	0.0
428	ND_2^+	HD	ND_3^+	H		1.3e-10	0.00	0.0
429	NH_2D^+	H_2	NH_3D^+	H		2.4e-12	0.00	0.0
430	NH_2D^+	HD	NH_3D^+	D		1.2e-12	0.00	0.0
431	NH_2D^+	HD	$NH_2D_2^+$	H		1.2e-12	0.00	0.0
432	NHD_2^+	H_2	$NH_2D_2^+$	H		2.4e-12	0.00	0.0
433	NHD_2^+	HD	$NH_2D_2^+$	D		1.2e-12	0.00	0.0
434	NHD_2^+	HD	NHD_3^+	H		1.2e-12	0.00	0.0
435	ND_3^+	H_2	NHD_3^+	H		2.4e-12	0.00	0.0
436	ND_3^+	HD	NHD_3^+	D		1.2e-12	0.00	0.0
437	ND_3^+	HD	ND_4^+	H		1.2e-12	0.00	0.0
438	N	H_3^+	NH_2^+	H		0.0e+00	0.00	0.0
439	N_2	H_3^+	N_2H^+	H_2		1.3e-09	0.00	0.0
440	NH	He^+	N^+	H	He	1.1e-09	0.00	0.0
441	NH	H^+	NH^+	H		2.1e-09	0.00	0.0
442	NH	H_3^+	NH_2^+	H_2		1.3e-09	0.00	0.0
443	NH_2	He^+	NH^+	H	He	8.0e-10	0.00	0.0
444	NH_2	He^+	N^+	H_2	He	8.0e-10	0.00	0.0

Table D5 – *continued* (part 7)

Reactants		Products				α	β	γ
445	NH_2	H^+	H	NH_2^+		2.9e-09	0.00	0.0
446	NH_2	H_3^+	NH_3^+	H_2		1.8e-09	0.00	0.0
447	NH_3	He^+	NH_3^+	He		2.6e-10	0.00	0.0
448	NH_3	He^+	NH_2^+	H	He	1.8e-09	0.00	0.0
449	NH_3	He^+	NH^+	H_2	He	1.8e-10	0.00	0.0
450	NH_3	H^+	H	NH_3^+		5.2e-09	0.00	0.0
451	NH_3	H_3^+	NH_4^+	H_2		9.1e-09	0.00	0.0
452	NH	H_2D^+	NH_2^+	HD		8.7e-10	0.00	0.0
453	NH	H_2D^+	NHD^+	H_2		4.3e-10	0.00	0.0
454	NH	HD_2^+	NH_2^+	D_2		4.3e-10	0.00	0.0
455	NH	HD_2^+	NHD^+	HD		8.7e-10	0.00	0.0
456	NH	D_3^+	NHD^+	D_2		1.3e-09	0.00	0.0
457	NH_2	H_2D^+	NH_3^+	HD		1.2e-09	0.00	0.0
458	NH_2	H_2D^+	NH_2D^+	H_2		6.0e-10	0.00	0.0
459	NH_2	HD_2^+	NH_3^+	D_2		6.0e-10	0.00	0.0
460	NH_2	HD_2^+	NH_2D^+	HD		1.2e-09	0.00	0.0
461	NH_2	D_3^+	NH_2D^+	D_2		1.8e-09	0.00	0.0
462	NH_3	H_2D^+	NH_4^+	HD		6.1e-09	0.00	0.0
463	NH_3	H_2D^+	NH_3D^+	H_2		3.0e-09	0.00	0.0
464	NH_3	HD_2^+	NH_4^+	D_2		3.0e-09	0.00	0.0
465	NH_3	HD_2^+	NH_3D^+	HD		6.1e-09	0.00	0.0
466	NH_3	D_3^+	NH_3D^+	D_2		9.1e-09	0.00	0.0
467	ND	H_3^+	NHD^+	H_2		1.3e-09	0.00	0.0
468	ND	H_2D^+	NHD^+	HD		8.7e-10	0.00	0.0
469	ND	H_2D^+	ND_2^+	H_2		4.3e-10	0.00	0.0
470	ND	HD_2^+	NHD^+	D_2		4.3e-10	0.00	0.0
471	ND	HD_2^+	ND_2^+	HD		8.7e-10	0.00	0.0
472	ND	D_3^+	ND_2^+	D_2		1.3e-09	0.00	0.0
473	NHD	H_3^+	NH_2D^+	H_2		1.8e-09	0.00	0.0
474	NHD	H_2D^+	NH_2D^+	HD		1.2e-09	0.00	0.0
475	NHD	H_2D^+	NHD_2^+	H_2		6.0e-10	0.00	0.0
476	NHD	HD_2^+	NH_2D^+	D_2		6.0e-10	0.00	0.0
477	NHD	HD_2^+	NHD_2^+	HD		1.2e-09	0.00	0.0
478	NHD	D_3^+	NHD_2^+	D_2		1.8e-09	0.00	0.0
479	ND_2	H_3^+	NHD_2^+	H_2		1.8e-09	0.00	0.0
480	ND_2	H_2D^+	NHD_2^+	HD		1.2e-09	0.00	0.0
481	ND_2	H_2D^+	ND_3^+	H_2		6.0e-10	0.00	0.0
482	ND_2	HD_2^+	NHD_2^+	D_2		6.0e-10	0.00	0.0
483	ND_2	HD_2^+	ND_3^+	HD		1.2e-09	0.00	0.0
484	ND_2	D_3^+	ND_3^+	D_2		1.8e-09	0.00	0.0
485	NH_2D	H^+	NH_2D^+	H		5.2e-09	0.00	0.0
486	NH_2D	H_3^+	NH_3D^+	H_2		9.1e-09	0.00	0.0
487	NH_2D	H_2D^+	NH_3D^+	HD		6.1e-09	0.00	0.0
488	NH_2D	H_2D^+	$NH_2D_2^+$	H_2		3.0e-09	0.00	0.0
489	NH_2D	HD_2^+	NH_3D^+	D_2		3.0e-09	0.00	0.0
490	NH_2D	HD_2^+	$NH_2D_2^+$	HD		6.1e-09	0.00	0.0
491	NH_2D	D_3^+	$NH_2D_2^+$	D_2		9.1e-09	0.00	0.0
492	NHD_2	H^+	NHD_2^+	H		5.2e-09	0.00	0.0
493	NHD_2	H_3^+	$NH_2D_2^+$	H_2		9.1e-09	0.00	0.0
494	NHD_2	H_2D^+	$NH_2D_2^+$	HD		6.1e-09	0.00	0.0
495	NHD_2	H_2D^+	NHD_3^+	H_2		3.0e-09	0.00	0.0
496	NHD_2	HD_2^+	$NH_2D_2^+$	D_2		3.0e-09	0.00	0.0
497	NHD_2	HD_2^+	NHD_3^+	HD		6.1e-09	0.00	0.0
498	NHD_2	D_3^+	NHD_3^+	D_2		9.1e-09	0.00	0.0
499	ND_3	H^+	ND_3^+	H		5.2e-09	0.00	0.0
500	ND_3	H_3^+	NHD_3^+	H_2		9.1e-09	0.00	0.0
501	ND_3	H_2D^+	NHD_3^+	HD		6.1e-09	0.00	0.0
502	ND_3	H_2D^+	ND_4^+	H_2		3.0e-09	0.00	0.0
503	ND_3	HD_2^+	NHD_3^+	D_2		3.0e-09	0.00	0.0
504	ND_3	HD_2^+	ND_4^+	HD		6.1e-09	0.00	0.0
505	ND_3	D_3^+	ND_4^+	D_2		9.1e-09	0.00	0.0
506	N_2	H_2D^+	N_2H^+	HD		8.7e-10	0.00	0.0
507	N_2	H_2D^+	N_2D^+	H_2		4.3e-10	0.00	0.0
508	N_2	HD_2^+	N_2H^+	D_2		4.3e-10	0.00	0.0
509	N_2	HD_2^+	N_2D^+	HD		8.7e-10	0.00	0.0
510	N_2	D_3^+	N_2D^+	D_2		1.3e-09	0.00	0.0
511	N^+	e^-	N	γ		3.8e-12	-0.62	0.0
512	NH^+	e^-	N	H		2.0e-07	-0.50	0.0
513	NH_2^+	e^-	NH	H		1.2e-07	-0.50	0.0
514	NH_2^+	e^-	N	H_2		1.2e-08	-0.50	0.0
515	NH_2^+	e^-	N	H	H	1.7e-07	-0.50	0.0
516	NH_3^+	e^-	NH_2	H		1.5e-07	-0.50	0.0
517	NH_3^+	e^-	NH	H	H	1.5e-07	-0.50	0.0
518	NH_4^+	e^-	NH_2	H_2		1.9e-08	-0.60	0.0

Table D5 – *continued* (part 8)

Reactants		Products				α	β	γ
519	NH_4^+	e^-	NH_2	H	H	1.2e-07	-0.60	0.0
520	NH_4^+	e^-	NH_3	H		8.0e-07	-0.60	0.0
521	N_2^+	e^-	N	N		3.6e-08	-0.42	0.0
522	N_2H^+	e^-	N_2	H		2.8e-07	-0.74	0.0
523	N_2H^+	e^-	NH	N		2.1e-08	-0.74	0.0
524	ND^+	e^-	N	D		2.0e-07	-0.50	0.0
525	NHD^+	e^-	N	H	D	1.5e-07	-0.50	0.0
526	NHD^+	e^-	NH	D		7.5e-08	-0.50	0.0
527	NHD^+	e^-	ND	H		7.5e-08	-0.50	0.0
528	ND_2^+	e^-	ND	D		1.5e-07	-0.50	0.0
529	ND_2^+	e^-	N	D	D	1.5e-07	-0.50	0.0
530	NH_2D^+	e^-	NH_2	D		1.0e-07	-0.50	0.0
531	NH_2D^+	e^-	NHD	H		2.0e-07	-0.50	0.0
532	NHD_2^+	e^-	ND_2	H		1.0e-07	-0.50	0.0
533	NHD_2^+	e^-	NHD	D		2.0e-07	-0.50	0.0
534	ND_3^+	e^-	ND_2	D		3.0e-07	-0.50	0.0
535	NH_3D^+	e^-	NH_2	HD		2.5e-07	-0.50	0.0
536	NH_3D^+	e^-	NHD	H_2		2.5e-07	-0.50	0.0
537	NH_3D^+	e^-	NH_3	D		1.9e-07	-0.50	0.0
538	NH_3D^+	e^-	NH_2D	H		5.7e-07	-0.50	0.0
539	$NH_2D_2^+$	e^-	NH_2	D_2		8.5e-08	-0.50	0.0
540	$NH_2D_2^+$	e^-	NHD	HD		3.4e-07	-0.50	0.0
541	$NH_2D_2^+$	e^-	ND_2	H_2		8.5e-08	-0.50	0.0
542	$NH_2D_2^+$	e^-	NH_2D	D		3.8e-07	-0.50	0.0
543	$NH_2D_2^+$	e^-	NHD_2	H		3.8e-07	-0.50	0.0
544	NHD_3^+	e^-	NHD	D_2		2.5e-07	-0.50	0.0
545	NHD_3^+	e^-	ND_2	HD		2.5e-07	-0.50	0.0
546	NHD_3^+	e^-	ND_3	H		1.9e-07	-0.50	0.0
547	NHD_3^+	e^-	NHD_2	D		5.7e-07	-0.50	0.0
548	ND_4^+	e^-	ND_2	D_2		5.1e-07	-0.50	0.0
549	ND_4^+	e^-	ND_3	D		7.6e-07	-0.50	0.0
550	N_2D^+	e^-	N_2	D		2.8e-07	-0.74	0.0
551	N_2D^+	e^-	ND	N		2.1e-08	-0.74	0.0
552	NH^+	γ_2	N^+	H		2.2e+01	0.00	0.0
553	N_2	γ_2	N	N		3.9e+01	0.00	0.0
554	NH	γ_2	N	H		3.7e+02	0.00	0.0
555	NH	γ_2	NH^+	e^-		7.1e+00	0.00	0.0
556	NH_2	γ_2	NH	H		7.2e+02	0.00	0.0
557	NH_2	γ_2	NH_2^+	e^-		1.4e+02	0.00	0.0
558	NH_3	γ_2	NH	H_2		1.1e+03	0.00	0.0
559	NH_3	γ_2	NH_3^+	e^-		2.2e+02	0.00	0.0
560	ND	γ_2	N	D		3.7e+02	0.00	0.0
561	ND	γ_2	ND^+	e^-		7.1e+00	0.00	0.0
562	NHD	γ_2	NH	D		3.6e+02	0.00	0.0
563	NHD	γ_2	ND	H		3.6e+02	0.00	0.0
564	NHD	γ_2	NHD^+	e^-		1.4e+02	0.00	0.0
565	ND_2	γ_2	ND	D		7.2e+02	0.00	0.0
566	ND_2	γ_2	ND_2^+	e^-		1.4e+02	0.00	0.0
567	NH_2D	γ_2	NH	HD		4.5e+02	0.00	0.0
568	NH_2D	γ_2	ND	H_2		2.2e+02	0.00	0.0
569	NH_2D	γ_2	NHD	H		2.9e+02	0.00	0.0
570	NH_2D	γ_2	NH_2	D		1.4e+02	0.00	0.0
571	NH_2D	γ_2	NH_2D^+	e^-		2.2e+02	0.00	0.0
572	NHD_2	γ_2	ND	HD		4.5e+02	0.00	0.0
573	NHD_2	γ_2	NH	D_2		2.2e+02	0.00	0.0
574	NHD_2	γ_2	NHD	D		2.9e+02	0.00	0.0
575	NHD_2	γ_2	ND_2	H		1.4e+02	0.00	0.0
576	NHD_2	γ_2	NHD_2^+	e^-		2.2e+02	0.00	0.0
577	ND_3	γ_2	ND	D_2		6.7e+02	0.00	0.0
578	ND_3	γ_2	ND_2	D		4.3e+02	0.00	0.0
579	ND_3	γ_2	ND_3^+	e^-		2.2e+02	0.00	0.0
580	NH_4^+	Gr	Gr^+	NH_3	H	3.8e-07	0.50	0.0
581	NH_4^+	Gr^-	Gr	NH_3	H	3.8e-07	0.50	0.0
582	N_2H^+	Gr	Gr^+	N_2	H	1.0e-07	0.50	0.0
583	N_2H^+	Gr	Gr^+	NH	N	1.9e-07	0.50	0.0
584	N_2H^+	Gr^-	Gr	N_2	H	1.0e-07	0.50	0.0
585	N_2H^+	Gr^-	Gr	NH	N	1.9e-07	0.50	0.0
586	N_2D^+	Gr	Gr^+	N_2	D	3.0e-07	0.50	0.0
587	N_2D^+	Gr^-	Gr	N_2	D	3.0e-07	0.50	0.0
588	N	H_2	NH	H		8.7e-10	0.50	14600.0
589	NH	H_2	NH_2	H		5.2e-12	0.79	6700.0
590	NH	H	N	H_2		8.7e-10	0.50	2400.0
591	NH_2	H_2	NH_3	H		6.2e-11	0.50	6300.0
592	NH_2	H	NH	H_2		5.2e-12	0.79	2200.0

Table D5 – *continued* (part 9)

Reactants		Products				α	β	γ
593	NH_3	H	NH_2	H_2		6.2e-11	0.50	5700.0
594	NH_2^+	H	NH^+	H_2		1.3e-09	0.00	24000.0
595	NH_3^+	H	NH_2^+	H_2		2.2e-10	0.00	12800.0
596	NH_4^+	H	NH_3^+	H_2		1.0e-09	0.00	11000.0
597	NH_4^+	N_2	N_2H^+	NH_3		2.3e-09	0.00	44000.0
598	N_2H^+	H	N_2^+	H_2		2.1e-09	0.00	30300.0
599	N_2H^+	H_2	H_3^+	N_2		1.8e-09	0.00	8300.0
600	S	H^+	S^+	H		1.0e-15	0.00	0.0
601	S	H_3^+	SH^+	H_2		2.6e-09	0.00	0.0
602	SH	H	S	H_2		2.5e-11	0.00	0.0
603	SH	He^+	S^+	H	He	1.7e-09	0.00	0.0
604	SH	H^+	SH^+	H		1.6e-09	0.00	0.0
605	SH	H^+	S^+	H_2		1.6e-09	0.00	0.0
606	SH	H_3^+	H_2S^+	H_2		1.9e-09	0.00	0.0
607	H_2S	He^+	S^+	H_2	He	3.6e-09	0.00	0.0
608	H_2S	He^+	SH^+	H	He	4.8e-10	0.00	0.0
609	H_2S	He^+	He	H_2S^+		3.1e-10	0.00	0.0
610	H_2S	H^+	H	H_2S^+		7.6e-09	0.00	0.0
611	H_2S	H_3^+	H_3S^+	H_2		3.7e-09	0.00	0.0
612	S^+	Fe	Fe^+	S		1.8e-10	0.00	0.0
613	SH^+	H	S^+	H_2		1.1e-10	0.00	0.0
614	SH^+	H_2	H_3S^+	γ		1.0e-15	0.00	0.0
615	SH^+	S	S^+	SH		9.7e-10	0.00	0.0
616	SH^+	H_2S	H_3S^+	S		5.0e-10	0.00	0.0
617	SH^+	Fe	Fe^+	SH		1.6e-09	0.00	0.0
618	H_2S^+	H	SH^+	H_2		2.0e-10	0.00	0.0
619	H_2S^+	S	H_2S	S^+		1.1e-09	0.00	0.0
620	H_2S^+	SH	H_2S	SH^+		5.0e-10	0.00	0.0
621	H_2S^+	Fe	H_2S	Fe^+		1.8e-09	0.00	0.0
622	H_3S^+	H	H_2S^+	H_2		6.0e-11	0.00	0.0
623	S	H_2D^+	SH^+	HD		1.7e-09	0.00	0.0
624	S	H_2D^+	SD^+	H_2		8.7e-10	0.00	0.0
625	S	HD_2^+	SH^+	D_2		8.7e-10	0.00	0.0
626	S	HD_2^+	SD^+	HD		1.7e-09	0.00	0.0
627	S	D_3^+	SD^+	D_2		2.6e-09	0.00	0.0
628	SH	H_2D^+	H_2S^+	HD		1.9e-09	0.00	0.0
629	SH	HD_2^+	H_2S^+	D_2		1.9e-09	0.00	0.0
630	H_2S	H_2D^+	H_3S^+	HD		3.7e-09	0.00	0.0
631	H_2S	HD_2^+	H_3S^+	D_2		3.7e-09	0.00	0.0
632	S^+	Gr	Gr^+	S		2.8e-07	0.50	0.0
633	S^+	Gr^-	Gr	S		2.8e-07	0.50	0.0
634	H_3S^+	Gr	Gr^+	H_2S	H	2.7e-07	0.50	0.0
635	H_3S^+	Gr^-	Gr	H_2S	H	2.7e-07	0.50	0.0
636	S^+	e^-	S	γ		3.9e-12	-0.63	0.0
637	SH^+	e^-	S	H		2.0e-07	-0.50	0.0
638	H_2S^+	e^-	SH	H		1.5e-07	-0.50	0.0
639	H_2S^+	e^-	S	H	H	1.5e-07	-0.50	0.0
640	H_2S^+	e^-	H_2S	γ		1.1e-10	-0.70	0.0
641	H_3S^+	e^-	H_2S	H		3.0e-07	-0.50	0.0
642	H_3S^+	e^-	SH	H_2		1.0e-07	-0.50	0.0
643	SD^+	e^-	S	D		2.0e-07	-0.50	0.0
644	S	γ_2	S^+	e^-		8.0e+02	0.00	0.0
645	SH	γ_2	S	H		1.1e+03	0.00	0.0
646	SH	γ_2	SH^+	e^-		3.4e+01	0.00	0.0
647	H_2S	γ_2	SH	H		3.4e+03	0.00	0.0
648	H_2S	γ_2	H_2S^+	e^-		6.2e+02	0.00	0.0
649	SH^+	γ_2	S^+	H		4.6e+02	0.00	0.0
650	S	H_2	SH	H		1.0e-10	0.13	9620.0
651	SH	H_2	H_2S	H		6.4e-12	0.09	8050.0
652	H_2S	H	SH	H_2		6.6e-11	0.00	1350.0
653	S^+	H_2	SH^+	H		2.2e-10	0.00	9860.0
654	SH^+	H_2	H_2S^+	H		1.9e-10	0.00	8500.0
655	SH^+	H_2S	H_2S^+	SH		5.0e-10	0.00	1000.0
656	H_2S^+	H_2	H_3S^+	H		1.4e-11	0.00	2300.0
657	O	CH	HCO^+	e^-		2.4e-14	0.50	0.0
658	O	CH	CO	H		6.6e-11	0.00	0.0
659	O	CH_2	CO	H	H	1.0e-10	0.00	0.0
660	O	CH_2	CO	H_2		4.0e-11	0.00	0.0
661	O	CH_3	CO	H_2	H	1.8e-10	0.50	0.0
662	O	C_2	CO	C^-		2.0e-10	-0.12	0.0
663	O	C_2H	CO	CH		1.0e-10	0.00	250.0
664	O	C_3	CO	C_2		5.0e-11	0.50	0.0
665	O	C_3H	C_2H	CO		5.0e-11	0.50	0.0
666	O	C_3H_2	C_2H_2	CO		5.0e-11	0.50	0.0

Table D5 – *continued* (part 10)

Reactants		Products				α	β	γ
667	O	NH	NO	H		6.6e-11	0.00	0.0
668	O	NH_2	NH	OH		7.0e-12	-0.10	0.0
669	O	CN	CO	N		5.0e-11	0.00	0.0
670	O	HNC	CO	NH		2.0e-10	0.50	200.0
671	O	SH	OH	S		1.7e-11	0.67	956.0
672	O	SH	SO	H		1.6e-10	0.00	0.0
673	O	CS	CO	S		2.6e-10	0.00	760.0
674	O	CH_3^+	HCO^+	H_2		3.1e-10	0.00	0.0
675	O	CH_3^+	H_3^+	CO		1.3e-11	0.00	0.0
676	O	CH_5^+	H_3O^+	CH_2		2.2e-10	0.00	0.0
677	O	HCO_2^+	HCO^+	O_2		1.0e-09	0.00	0.0
678	O	SH^+	SO^+	H		2.9e-10	0.00	0.0
679	O	SH^+	S^+	OH		2.9e-10	0.00	0.0
680	O	H_2S^+	SH^+	OH		3.1e-10	0.00	0.0
681	O	H_2S^+	SO^+	H_2		3.1e-10	0.00	0.0
682	O	HCS^+	HCO^+	S		1.0e-09	0.00	0.0
683	C	OH	CO	H		3.1e-11	-0.36	0.0
684	C	O_2	CO	O		3.3e-11	0.50	0.0
685	C	NH	CN	H		1.2e-10	0.00	0.0
686	C	NH_2	HCN	H		3.0e-11	-0.20	-6.0
687	C	NH_2	HNC	H		3.0e-11	-0.20	-6.0
688	C	NO	CN	O		6.0e-11	-0.16	0.0
689	C	NO	CO	N		9.0e-11	-0.16	0.0
690	C	SH	CS	H		2.0e-11	0.00	0.0
691	C	SO	CO	S		7.2e-11	0.00	0.0
692	C	SO	CS	O		1.7e-10	0.00	0.0
693	C	H_3O^+	HCO^+	H_2		1.0e-11	0.00	0.0
694	C	HCO^+	CH^+	CO		1.1e-09	0.00	0.0
695	C	O_2^+	CO^+	O		5.2e-11	0.00	0.0
696	C	O_2^+	C^+	O_2		5.2e-11	0.00	0.0
697	C	SH^+	CS^+	H		9.9e-10	0.00	0.0
698	C	H_2S^+	HCS^+	H		1.0e-09	0.00	0.0
699	C	H_2DO^+	DCO^+	H_2		1.0e-11	0.00	0.0
700	C	HD_2O^+	DCO^+	HD		1.0e-11	0.00	0.0
701	C	D_3O^+	DCO^+	D_2		1.0e-11	0.00	0.0
702	N	CH	CN	H		1.4e-10	0.41	0.0
703	N	CN	N_2	C		8.8e-11	0.42	0.0
704	N	NO	N_2	O		7.3e-11	0.44	12.7
705	N	CH_2	HCN	H		5.0e-11	0.17	0.0
706	N	CH_2	HNC	H		3.0e-11	0.17	0.0
707	N	CH_3	HCN	H_2		1.3e-11	0.50	0.0
708	N	OH	NO	H		5.0e-11	0.00	6.0
709	N	O_2^+	NO^+	O		7.8e-11	0.00	0.0
710	N	CH_2^+	HCN^+	H		9.4e-10	0.00	0.0
711	N	C_2H^+	C_2N^+	H		8.3e-10	0.00	0.0
712	N	CH_3^+	HCN^+	H_2		6.7e-11	0.00	0.0
713	N	CH_3^+	$HCNH^+$	H		6.7e-11	0.00	0.0
714	N	$C_2H_2^+$	CH^+	HCN		2.5e-11	0.00	0.0
715	N	SO	NO	S		1.7e-11	0.50	750.0
716	S	CH	CS	H		1.1e-12	0.00	0.0
717	S	OH	SO	H		1.0e-10	0.00	100.0
718	S	O_2	SO	O		5.2e-12	0.00	265.0
719	S	CH^+	S^+	CH		4.7e-10	0.00	0.0
720	S	CH^+	SH^+	C		4.7e-10	0.00	0.0
721	S	CH^+	CS^+	H		4.7e-10	0.00	0.0
722	S	CH_3^+	HCS^+	H_2		1.4e-09	0.00	0.0
723	S	CH_5^+	SH^+	CH_4		1.3e-09	0.00	0.0
724	S	HCO^+	SH^+	CO		3.3e-10	0.00	0.0
725	S	O_2^+	SO^+	O		5.4e-10	0.00	0.0
726	S	O_2^+	S^+	O_2		5.4e-10	0.00	0.0
727	S	HNO^+	SH^+	NO		1.1e-09	0.00	0.0
728	S	N_2H^+	SH^+	N_2		1.1e-09	0.00	0.0
729	CO	He^+	C^+	O	He	1.5e-09	0.00	0.0
730	SO	He^+	O^+	S	He	8.3e-10	0.00	0.0
731	SO	He^+	S^+	O	He	8.3e-10	0.00	0.0
732	NO	He^+	N^+	O	He	1.4e-09	0.00	0.0
733	NO	He^+	O^+	N	He	2.2e-10	0.00	0.0
734	CN	He^+	C^+	N	He	8.8e-10	0.00	0.0
735	CN	He^+	N^+	C	He	8.8e-10	0.00	0.0
736	CS	He^+	C^+	S	He	1.3e-09	0.00	0.0
737	CS	He^+	S^+	C	He	1.3e-09	0.00	0.0
738	N_2	He^+	N^+	N	He	7.9e-10	0.00	0.0
739	N_2	He^+	N_2^+	He		4.1e-10	0.00	0.0
740	HCN	He^+	CN^+	H	He	1.5e-09	0.00	0.0

Table D5 – *continued* (part 11)

Reactants		Products				α	β	γ
741	HCN	He^+	CH^+	N	He	6.2e-10	0.00	0.0
742	HCN	He^+	C^+	NH	He	7.8e-10	0.00	0.0
743	HCN	He^+	N^+	CH	He	2.5e-10	0.00	0.0
744	HNC	He^+	CN^+	H	He	1.6e-09	0.00	0.0
745	HNC	He^+	C^+	NH	He	1.6e-09	0.00	0.0
746	CO_2	He^+	CO^+	O	He	7.7e-10	0.00	0.0
747	CO_2	He^+	O^+	CO	He	1.8e-10	0.00	0.0
748	CO_2	He^+	C^+	O_2	He	4.0e-11	0.00	0.0
749	SO_2	He^+	S^+	O_2	He	8.6e-10	0.00	0.0
750	SO_2	He^+	SO^+	O	He	3.4e-09	0.00	0.0
751	OCS	He^+	CS^+	O	He	7.6e-10	0.00	0.0
752	OCS	He^+	S^+	CO	He	7.6e-10	0.00	0.0
753	OCS	He^+	CO^+	S	He	7.6e-10	0.00	0.0
754	OCS	He^+	O^+	CS	He	7.6e-11	0.00	0.0
755	CH	SH^+	CH_2^+	S		5.8e-10	0.00	0.0
756	H_2O	CH_5^+	H_3O^+	CH_4		3.7e-09	0.00	0.0
757	H_2O	$C_2H_2^+$	H_3O^+	C_2H		2.2e-10	0.00	0.0
758	H_2O	$C_2H_3^+$	H_3O^+	C_2H_2		1.1e-09	0.00	0.0
759	H_2O	C_3H^+	HCO^+	C_2H_2		2.5e-10	0.00	0.0
760	H_2O	C_3H^+	$C_2H_3^+$	CO		2.0e-10	0.00	0.0
761	H_2O	NH_3^+	NH_4^+	OH		2.5e-10	0.00	0.0
762	H_2O	N_2H^+	H_3O^+	N_2		2.6e-09	0.00	0.0
763	H_2O	HNO^+	H_3O^+	NO		2.3e-09	0.00	0.0
764	H_2O	SH^+	H_3O^+	S		6.3e-10	0.00	0.0
765	H_2O	H_2S^+	H_3O^+	SH		8.1e-10	0.00	0.0
766	NH_3	SH^+	SH	NH_3^+		5.3e-10	0.00	0.0
767	NH_3	SH^+	NH_4^+	S		9.8e-10	0.00	0.0
768	NH_3	H_2S^+	NH_4^+	SH		1.4e-09	0.00	0.0
769	NH_3	H_2S^+	H_2S	NH_3^+		3.4e-10	0.00	0.0
770	NH_3	H_3S^+	NH_4^+	H_2S		1.9e-09	0.00	0.0
771	NH_3	SO^+	NH_3^+	SO		1.3e-09	0.00	0.0
772	NH_3	O_2^+	NH_3^+	O_2		2.0e-09	0.00	0.0
773	CO	OH	CO_2	H		4.4e-13	-1.15	390.0
774	CO	H_2^+	HCO^+	H		2.2e-09	0.00	0.0
775	CO	H_2^+	CO^+	H_2		6.4e-10	0.00	0.0
776	CO	H_3^+	HCO^+	H_2		1.7e-09	0.00	0.0
777	CO	CH_5^+	HCO^+	CH_4		9.9e-10	0.00	0.0
778	CO	H_2D^+	HCO^+	HD		1.1e-09	0.00	0.0
779	CO	H_2D^+	DCO^+	H_2		5.7e-10	0.00	0.0
780	CO	HD_2^+	HCO^+	D_2		5.7e-10	0.00	0.0
781	CO	HD_2^+	DCO^+	HD		1.1e-09	0.00	0.0
782	CO	D_3^+	DCO^+	D_2		1.7e-09	0.00	0.0
783	SO	OH	SO_2	H		2.0e-10	-0.17	0.0
784	SO	H^+	SO^+	H		3.2e-09	0.00	0.0
785	SO	H_3^+	HSO^+	H_2		1.9e-09	0.00	0.0
786	SO	CH^+	OH^+	CS		1.0e-09	0.00	0.0
787	SO	CH^+	SH^+	CO		1.0e-09	0.00	0.0
788	SO	CH_3^+	$HOCS^+$	H_2		9.5e-10	0.00	0.0
789	SO	HCO^+	HSO^+	CO		7.5e-10	0.00	0.0
790	NO	CH	HCN	O		1.2e-11	-0.13	0.0
791	NO	H^+	NO^+	H		1.9e-09	0.00	0.0
792	NO	H_3^+	HNO^+	H_2		1.1e-09	0.00	0.0
793	NO	HCO_2^+	HNO^+	CO_2		1.0e-10	0.00	0.0
794	NO	O_2^+	NO^+	O_2		4.4e-10	0.00	0.0
795	NO	SH^+	NO^+	SH		3.3e-10	0.00	0.0
796	NO	H_2S^+	NO^+	H_2S		3.7e-10	0.00	0.0
797	NO	H_2D^+	HNO^+	HD		7.3e-10	0.00	0.0
798	NO	HD_2^+	HNO^+	D_2		3.7e-10	0.00	0.0
799	CN	NH_3	NH_2	HCN		2.8e-11	-0.85	0.0
800	CN	H_3^+	HCN^+	H_2		1.0e-09	0.00	0.0
801	CN	H_3^+	$HCNH^+$	H		1.0e-09	0.00	0.0
802	CN	H_3O^+	$HCNH^+$	OH		4.5e-09	0.00	0.0
803	CN	H_2D^+	$HCNH^+$	D		1.0e-09	0.00	0.0
804	CN	H_2D^+	HCN^+	HD		1.0e-09	0.00	0.0
805	CS	OH	OCS	H		1.7e-10	0.00	0.0
806	CS	OH	CO	SH		3.0e-11	0.00	0.0
807	CS	H^+	CS^+	H		4.9e-09	0.00	0.0
808	CS	H_3^+	HCS^+	H_2		2.9e-09	0.00	0.0
809	CS	H_2D^+	HCS^+	HD		2.9e-09	0.00	0.0
810	CS	HD_2^+	HCS^+	D_2		2.9e-09	0.00	0.0
811	SO	H_2D^+	HSO^+	HD		1.9e-09	0.00	0.0
812	SO	HD_2^+	HSO^+	D_2		1.9e-09	0.00	0.0
813	HCN	H^+	HCN^+	H		1.1e-08	0.00	0.0
814	HCN	H_3^+	$HCNH^+$	H_2		9.5e-09	0.00	0.0

Table D5 – *continued* (part 12)

Reactants		Products			α	β	γ
815	HCN	H_3O^+	$HCNH^+$	H_2O	4.5e-09	0.00	0.0
816	HCN	H_3S^+	$HCNH^+$	H_2S	1.9e-09	0.00	0.0
817	HCN	HCO^+	$HCNH^+$	CO	3.7e-09	0.00	0.0
818	HCN	H_2D^+	$HCNH^+$	HD	9.5e-09	0.00	0.0
819	HNC	H	HCN	H	1.0e-15	0.00	0.0
820	HNC	H^+	H^+	HCN	1.0e-09	0.00	0.0
821	HNC	H_3^+	$HCNH^+$	H_2	9.5e-09	0.00	0.0
822	HNC	H_2D^+	$HCNH^+$	HD	9.5e-09	0.00	0.0
823	HNC	H_3O^+	$HCNH^+$	H_2O	4.5e-09	0.00	0.0
824	HNC	HCO^+	$HCNH^+$	CO	3.7e-09	0.00	0.0
825	HNC	CH_5^+	$C_2H_3^+$	NH_3	1.0e-09	0.00	0.0
826	CO_2	H^+	HCO^+	O	4.2e-09	0.00	0.0
827	CO_2	H_3^+	HCO_2^+	H_2	2.0e-09	0.00	0.0
828	CO_2	H_2D^+	HCO_2^+	HD	1.3e-09	0.00	0.0
829	CO_2	H_2D^+	DCO_2^+	H_2	6.7e-10	0.00	0.0
830	CO_2	HD_2^+	HCO_2^+	D_2	6.7e-10	0.00	0.0
831	CO_2	HD_2^+	DCO_2^+	HD	1.3e-09	0.00	0.0
832	CO_2	D_3^+	DCO_2^+	D_2	2.0e-09	0.00	0.0
833	CO_2	N_2D^+	DCO_2^+	N_2	1.4e-09	0.00	0.0
834	SO_2	H_3^+	HSO_2^+	H_2	1.3e-09	0.00	0.0
835	SO_2	H_2D^+	HSO_2^+	HD	1.3e-09	0.00	0.0
836	SO_2	HD_2^+	HSO_2^+	D_2	1.3e-09	0.00	0.0
837	OCS	H^+	SH^+	CO	5.9e-09	0.00	0.0
838	OCS	H_3^+	$HOCS^+$	H_2	1.9e-09	0.00	0.0
839	OCS	HCO^+	$HOCS^+$	CO	1.1e-09	0.00	0.0
840	H_2S	H_3O^+	H_3S^+	H_2O	1.9e-09	0.00	0.0
841	SH	HCO^+	H_2S^+	CO	8.2e-10	0.00	0.0
842	CS	HCO^+	HCS^+	CO	1.2e-09	0.00	0.0
843	H_2S	HCO^+	H_3S^+	CO	1.6e-09	0.00	0.0
844	H_2S	O_2^+	H_2S^+	O_2	1.4e-09	0.00	0.0
845	H_2S	NH_3^+	NH_4^+	SH	6.0e-10	0.00	0.0
846	OCS	H_2D^+	$HOCS^+$	HD	1.9e-09	0.00	0.0
847	OCS	HD_2^+	$HOCS^+$	D_2	1.9e-09	0.00	0.0
848	S	N_2D^+	SD^+	N_2	1.1e-09	0.00	0.0
849	H_2O	N_2D^+	H_2DO^+	N_2	2.6e-09	0.00	0.0
850	CO	N_2D^+	DCO^+	N_2	8.8e-10	0.00	0.0
851	C^+	S	S^+	C	5.5e-12	0.86	681.0
852	C^+	OH	CO^+	H	8.0e-10	0.00	0.0
853	C^+	OH	H^+	CO	8.0e-10	0.00	0.0
854	C^+	H_2O	HCO^+	H	2.4e-09	-0.63	0.0
855	C^+	O_2	O^+	CO	5.1e-10	0.00	0.0
856	C^+	O_2	CO^+	O	3.1e-10	0.00	0.0
857	C^+	CO_2	CO^+	CO	1.1e-09	0.00	0.0
858	C^+	NH	CN^+	H	7.8e-10	0.00	0.0
859	C^+	NH_2	HCN^+	H	1.1e-09	0.00	0.0
860	C^+	NH_3	NH_3^+	C	5.3e-10	0.00	0.0
861	C^+	NH_3	H_2NC^+	H	7.8e-10	0.00	0.0
862	C^+	NH_3	$HCNH^+$	H	7.8e-10	0.00	0.0
863	C^+	NH_3	HCN^+	H_2	2.1e-10	0.00	0.0
864	C^+	HCN	C_2N^+	H	3.4e-09	0.00	0.0
865	C^+	HNC	C_2N^+	H	3.4e-09	0.00	0.0
866	C^+	NO	NO^+	C	3.4e-09	0.00	0.0
867	C^+	NO	N^+	CO	9.0e-10	0.00	0.0
868	C^+	SH	CS^+	H	1.1e-09	0.00	0.0
869	C^+	H_2S	HCS^+	H	1.3e-09	0.00	0.0
870	C^+	H_2S	H_2S^+	C	4.2e-10	0.00	0.0
871	C^+	SO	S^+	CO	2.6e-10	0.00	0.0
872	C^+	SO	CS^+	O	2.6e-10	0.00	0.0
873	C^+	SO	SO^+	C	2.6e-10	0.00	0.0
874	C^+	SO	CO^+	S	2.6e-10	0.00	0.0
875	C^+	SO_2	SO^+	CO	2.3e-09	0.00	0.0
876	C^+	CS	CS^+	C	1.6e-09	0.00	700.0
877	C^+	OCS	CS^+	CO	1.6e-09	0.00	0.0
878	C^+	OD	CO^+	D	8.0e-10	0.00	0.0
879	C^+	OD	D^+	CO	8.0e-10	0.00	0.0
880	C^+	HDO	DCO^+	H	1.2e-09	-0.63	0.0
881	C^+	HDO	HCO^+	D	1.2e-09	-0.63	0.0
882	C^+	D_2O	DCO^+	D	2.4e-09	-0.63	0.0
883	N^+	O_2	O_2^+	N	2.8e-10	0.00	0.0
884	N^+	O_2	NO^+	O	2.4e-10	0.00	0.0
885	N^+	O_2	O^+	NO	3.3e-11	0.00	0.0
886	N^+	CO	CO^+	N	8.3e-10	0.00	0.0
887	N^+	CO	NO^+	C	1.5e-10	0.00	0.0
888	N^+	NO	NO^+	N	4.5e-10	0.00	0.0

Table D5 – *continued* (part 13)

Reactants		Products				α	β	γ	
889	N^+	NO	N_2^+	O			7.9e-11	0.00	0.0
890	S^+	CH	CS^+	H			6.2e-10	0.00	0.0
891	S^+	CH_2	HCS^+	H			1.0e-11	0.00	0.0
892	S^+	OH	SO^+	H			6.1e-10	0.00	0.0
893	S^+	NO	NO^+	S			3.2e-10	0.00	0.0
894	S^+	NH_3	NH_3^+	S			1.6e-09	0.00	0.0
895	S^+	O_2	SO^+	O			2.3e-11	0.00	0.0
896	S^+	NH_2D	NH_2D^+	S			1.6e-09	0.00	0.0
897	S^+	NHD_2	NHD_2^+	S			1.6e-09	0.00	0.0
898	S^+	ND_3	ND_3^+	S			1.6e-09	0.00	0.0
899	CO^+	H_2	HCO^+	H			1.3e-09	0.00	0.0
900	CO^+	H	H^+	CO			7.5e-10	0.00	0.0
901	HCO^+	CH	CH_2^+	CO			6.3e-10	0.00	0.0
902	HCO^+	CH_2	CH_3^+	CO			8.6e-10	0.00	0.0
903	HCO^+	H_2O	H_3O^+	CO			2.5e-09	0.00	0.0
904	HCO^+	OH	HCO_2^+	H			1.0e-09	0.00	0.0
905	HCO^+	C_2H	$C_2H_2^+$	CO			7.8e-10	0.00	0.0
906	HCO^+	C_2H_2	$C_2H_3^+$	CO			1.4e-09	0.00	0.0
907	HCO^+	C_3H	$C_3H_2^+$	CO			1.4e-09	0.00	0.0
908	HCO^+	C_3H_2	$C_3H_3^+$	CO			1.4e-09	0.00	0.0
909	HCO^+	NH	NH_2^+	CO			6.4e-10	0.00	0.0
910	HCO^+	NH_2	NH_3^+	CO			8.9e-10	0.00	0.0
911	HCO^+	NH_3	NH_4^+	CO			1.9e-09	0.00	0.0
912	HCO^+	Fe	Fe^+	CO	H		1.9e-09	0.00	0.0
913	HCO_2^+	CO	HCO^+	CO_2			1.0e-09	0.00	0.0
914	HCO_2^+	CH_4	CH_5^+	CO_2			7.8e-10	0.00	0.0
915	H_3O^+	CH	CH_2^+	H_2O			6.8e-10	0.00	0.0
916	H_3O^+	CH_2	CH_3^+	H_2O			9.4e-10	0.00	0.0
917	H_3O^+	C_3H	$C_3H_2^+$	H_2O			2.0e-09	0.00	0.0
918	H_3O^+	C_3H_2	$C_3H_3^+$	H_2O			3.0e-09	0.00	0.0
919	H_3O^+	NH_3	NH_4^+	H_2O			2.2e-09	0.00	0.0
920	CN^+	H_2	HCN^+	H			1.0e-09	0.00	0.0
921	HCN^+	H_2	$HCNH^+$	H			9.8e-10	0.00	0.0
922	$HCNH^+$	CH	CH_2^+	HCN			3.1e-10	0.00	0.0
923	$HCNH^+$	CH	CH_2^+	HNC			3.1e-10	0.00	0.0
924	$HCNH^+$	CH_2	CH_3^+	HCN			4.3e-10	0.00	0.0
925	$HCNH^+$	CH_2	CH_3^+	HNC			4.3e-10	0.00	0.0
926	$HCNH^+$	NH_2	NH_3^+	HCN			4.5e-10	0.00	0.0
927	$HCNH^+$	NH_2	NH_3^+	HNC			4.5e-10	0.00	0.0
928	$HCNH^+$	NH_3	NH_4^+	HCN			1.1e-09	0.00	0.0
929	$HCNH^+$	NH_3	NH_4^+	HNC			1.1e-09	0.00	0.0
930	$HCNH^+$	H_2S	H_3S^+	HCN			1.7e-10	0.00	0.0
931	$HCNH^+$	H_2S	H_3S^+	HNC			1.7e-10	0.00	0.0
932	N_2H^+	CO	HCO^+	N_2			8.8e-10	0.00	0.0
933	N_2H^+	CO_2	HCO_2^+	N_2			1.4e-09	0.00	0.0
934	N_2H^+	NO	HNO^+	N_2			3.4e-10	0.00	0.0
935	C_2N^+	NH_3	N_2H^+	C_2H_2			1.9e-09	0.00	0.0
936	NO^+	Fe	Fe^+	NO			1.0e-09	0.00	0.0
937	HNO^+	C	CH^+	NO			1.0e-09	0.00	0.0
938	HNO^+	CO	HCO^+	NO			1.0e-10	0.00	0.0
939	HNO^+	CO_2	HCO_2^+	NO			1.0e-10	0.00	0.0
940	HNO^+	OH	H_2O^+	NO			6.2e-10	0.00	0.0
941	SO^+	Fe	Fe^+	SO			1.6e-09	0.00	0.0
942	CS^+	H_2	HCS^+	H			4.8e-10	0.00	0.0
943	HCO^+	Gr	Gr^+	CO	H		3.0e-07	0.50	0.0
944	HCS^+	Gr	Gr^+	CS	H		2.4e-07	0.50	0.0
945	HCO^+	Gr^-	Gr	CO	H		3.0e-07	0.50	0.0
946	HCS^+	Gr^-	Gr	CS	H		2.4e-07	0.50	0.0
947	CO^+	e^-	C	O			1.0e-07	-0.46	0.0
948	HCO^+	e^-	CO	H			2.4e-07	-0.69	0.0
949	HCO_2^+	e^-	CO_2	H			2.2e-07	-0.50	0.0
950	HCO_2^+	e^-	CO	OH			1.2e-07	-0.50	0.0
951	CN^+	e^-	C	N			1.8e-07	-0.50	0.0
952	C_2N^+	e^-	C_2	N			1.0e-07	-0.50	0.0
953	C_2N^+	e^-	CN	C			2.0e-07	-0.50	0.0
954	HCN^+	e^-	CN	H			1.5e-07	-0.50	0.0
955	HCN^+	e^-	CH	N			1.5e-07	-0.50	0.0
956	$HCNH^+$	e^-	HCN	H			9.6e-08	-0.65	0.0
957	$HCNH^+$	e^-	HNC	H			9.6e-08	-0.65	0.0
958	$HCNH^+$	e^-	CN	H	H		9.1e-08	-0.65	0.0
959	H_2NC^+	e^-	HNC	H			1.8e-07	-0.50	0.0
960	H_2NC^+	e^-	CN	H	H		1.8e-08	-0.50	0.0
961	NO^+	e^-	N	O			4.3e-07	-0.37	0.0
962	HNO^+	e^-	NO	H			3.0e-07	-0.50	0.0

Table D5 – *continued* (part 14)

Reactants		Products				α	β	γ
963	CS^+	e^-	C	S		2.0e-07	-0.50	0.0
964	HCS^+	e^-	CS	H		7.0e-07	-0.50	0.0
965	SO^+	e^-	S	O		2.0e-07	-0.50	0.0
966	HSO^+	e^-	SO	H		2.0e-07	-0.50	0.0
967	HSO_2^+	e^-	SO	H	O	1.0e-07	-0.50	0.0
968	HSO_2^+	e^-	SO	OH		1.0e-07	-0.50	0.0
969	$HOCS^+$	e^-	OH	CS		2.0e-07	-0.50	0.0
970	$HOCS^+$	e^-	OCS	H		2.0e-07	-0.50	0.0
971	Fe^+	e^-	Fe	γ		3.7e-12	-0.65	0.0
972	DCO^+	e^-	CO	D		2.4e-07	-0.69	0.0
973	DCO_2^+	e^-	CO_2	D		2.2e-07	-0.50	0.0
974	DCO_2^+	e^-	CO	OD		1.2e-07	-0.50	0.0
975	CO_2	γ_2	CO	O		6.0e+02	0.00	0.0
976	CO	γ_2	C	O		4.6e+01	0.00	0.0
977	CO	γ_2	CO^+	e^-		1.4e+01	0.00	0.0
978	H_2CO	γ_2	CO	H_2		1.3e+03	0.00	0.0
979	CH_3OH	γ_2	CH_3	OH		1.6e+03	0.00	0.0
980	HCO^+	γ_2	CO^+	H		3.3e+00	0.00	0.0
981	CO^+	γ_2	C^+	O		7.7e+01	0.00	0.0
982	CN	γ_2	C	N		4.5e+02	0.00	0.0
983	CN	γ_2	CN^+	e^-		8.3e+00	0.00	0.0
984	HCN	γ_2	CN	H		2.0e+03	0.00	0.0
985	HCN	γ_2	HCN^+	e^-		1.4e+00	0.00	0.0
986	HNC	γ_2	CN	H		2.0e+03	0.00	0.0
987	NO	γ_2	N	O		3.0e+02	0.00	0.0
988	NO	γ_2	NO^+	e^-		2.4e+02	0.00	0.0
989	SO	γ_2	S	O		5.5e+03	0.00	0.0
990	SO	γ_2	SO^+	e^-		4.5e+02	0.00	0.0
991	CS	γ_2	S	C		1.9e+03	0.00	0.0
992	CS	γ_2	CS^+	e^-		2.0e+01	0.00	0.0
993	OCS	γ_2	CO	S		5.2e+03	0.00	0.0
994	SO_2	γ_2	SO	O		2.7e+03	0.00	0.0
995	O	NH_3	NH_2	OH		2.5e-12	0.00	3020.0
996	O	NO	O_2	N		7.5e-13	1.00	16000.0
997	O	N_2H^+	OH^+	N_2		1.4e-10	0.00	1400.0
998	O	H_2S	SH	OH		1.4e-11	0.00	1920.0
999	O	SO	S	O_2		6.6e-13	0.00	2760.0
1000	O	SO_2	SO	O_2		9.3e-11	-0.46	9140.0
1001	O	OCS	SO	CO		2.6e-11	0.00	2250.0
1002	C	SH	CH	S		1.2e-11	0.58	5880.0
1003	N	O_2	NO	O		3.3e-12	1.00	3150.0
1004	N	$C_2H_2^+$	CH^+	HNC		2.5e-11	0.00	2600.0
1005	S	CH	SH	C		1.7e-11	0.50	4000.0
1006	S	H_3O^+	SH^+	H_2O		3.2e-10	0.00	4930.0
1007	OH	NH_3	NH_2	H_2O		3.5e-12	0.00	925.0
1008	OH	NH_4^+	NH_3^+	H_2O		2.5e-10	0.00	3400.0
1009	OH	H_2S	SH	H_2O		6.1e-12	0.00	80.0
1010	OH	S^+	SH^+	O		2.9e-10	0.00	8820.0
1011	OH	SH^+	H_2S^+	O		3.1e-10	0.00	7500.0
1012	OH	SH^+	H_2O^+	S		4.3e-10	0.00	9200.0
1013	CO	H	OH	C		1.1e-10	0.50	77700.0
1014	CO	NH_2^+	HCO^+	NH		6.4e-10	0.00	6100.0
1015	CO	N^+	C^+	NO		9.0e-10	0.00	15400.0
1016	CO	SH	OCS	H		5.9e-14	1.12	8330.0
1017	CN	H_2	HCN	H		5.7e-13	2.45	1130.0
1018	CN	H^+	CN^+	H		2.1e-09	0.00	6150.0
1019	HCN	CH_5^+	$C_2H_3^+$	NH_3		1.0e-09	0.00	5120.0
1020	HCN	H^+	H^+	HNC		1.0e-09	0.00	7850.0
1021	HNC	O_2	CO_2	NH		2.0e-11	0.50	2000.0
1022	SO	H	OH	S		5.9e-10	-0.31	11100.0
1023	SO	O_2	SO_2	O		1.4e-12	0.00	2820.0
1024	SO_2	H	SO	OH		9.3e-09	-0.74	14700.0
1025	OCS	H	SH	CO		1.7e-11	0.00	2000.0
1026	HCO^+	H	CO^+	H_2		1.3e-09	0.00	24500.0
1027	HCO^+	CH_3	CH_4^+	CO		1.4e-09	0.00	9060.0
1028	HCO^+	CH_4	CH_5^+	CO		9.9e-10	0.00	4920.0
1029	HCO^+	O_2	HCO_2^+	O		1.0e-09	0.00	1450.0
1030	HCO^+	CO_2	HCO_2^+	CO		1.0e-09	0.00	5000.0
1031	HCO^+	N_2	N_2H^+	CO		8.8e-10	0.00	11200.0
1032	HCO_2^+	H	HCO^+	OH		1.0e-09	0.00	7500.0
1033	HCO_2^+	N_2	N_2H^+	CO_2		1.4e-09	0.00	6400.0
1034	H_3O^+	C_2H	$C_2H_2^+$	H_2O		2.2e-10	0.00	4100.0
1035	H_3O^+	C_2H_2	$C_2H_3^+$	H_2O		1.0e-09	0.00	7330.0
1036	HCN^+	H	CN^+	H_2		1.0e-09	0.00	15800.0

Table D5 – *continued* (part 15)

Reactants		Products				α	β	γ	
1037	$HCNH^+$	H	HCN^+	H_2			9.8e-10	0.00	34400.0
1038	$HCNH^+$	H_2O	H_3O^+	HCN			4.5e-09	0.00	2460.0
1039	$HCNH^+$	H_2O	H_3O^+	HNC			4.5e-09	0.00	10300.0
1040	SO^+	H	S^+	OH			6.1e-10	0.00	11380.0
1041	H_3^+	HD	H_2D^+	H_2			1.7e-09	0.00	0.0
1042	H_3^+	D_2	HD_2^+	H_2			8.0e-10	0.00	0.0
1043	H_3^+	D_2	H_2D^+	HD			8.0e-10	0.00	0.0
1044	H_2D^+	H_2	H_3^+	HD			9.4e-11	-0.79	154.6
1045	H_2D^+	HD	HD_2^+	H_2			1.3e-09	0.00	0.0
1046	H_2D^+	HD	H_3^+	D_2			1.1e-11	-0.49	106.9
1047	H_2D^+	D_2	D_3^+	H_2			3.0e-10	-0.00	0.0
1048	H_2D^+	D_2	HD_2^+	HD			1.0e-09	0.00	-0.0
1049	HD_2^+	H_2	H_2D^+	HD			3.3e-10	-0.55	144.3
1050	HD_2^+	H_2	H_3^+	D_2			3.5e-11	-0.82	249.9
1051	HD_2^+	HD	H_2D^+	D_2			6.8e-11	-0.27	113.0
1052	HD_2^+	HD	D_3^+	H_2			6.3e-10	0.00	0.0
1053	HD_2^+	D_2	D_3^+	HD			1.0e-09	0.00	0.0
1054	D_3^+	H_2	H_2D^+	D_2			1.5e-10	-0.85	315.3
1055	D_3^+	H_2	HD_2^+	HD			9.2e-10	-0.59	197.8
1056	D_3^+	HD	HD_2^+	D_2			4.2e-10	-0.85	259.0
1057	H_3^+	e^-	H_2	H			2.3e-08	-0.52	0.0
1058	H_3^+	e^-	H	H	H		4.4e-08	-0.52	0.0
1059	H_2D^+	e^-	H	H	D		5.6e-07	0.44	-2.8
1060	H_2D^+	e^-	HD	H			1.3e-07	0.44	-2.8
1061	H_2D^+	e^-	H_2	D			5.2e-09	0.44	-2.8
1062	HD_2^+	e^-	D	D	H		9.4e-08	0.66	-12.5
1063	HD_2^+	e^-	HD	D			1.2e-08	0.66	-12.5
1064	HD_2^+	e^-	D_2	H			1.1e-08	0.66	-12.5
1065	D_2^+	e^-	D	D			2.3e-08	-0.69	0.0
1066	D_3^+	e^-	D	D	D		2.2e-08	-0.73	0.0
1067	D_3^+	e^-	D_2	D			1.3e-08	-0.73	0.0
1068	Gr	γ_2	Gr^+	e^-			6.3e+07	0.00	0.0
1069	Gr^-	γ_2	Gr	e^-			4.2e+08	0.00	0.0
1070	Gr	e^-	Gr^-	γ			6.9e-05	0.50	0.0
1071	Gr^+	e^-	Gr	γ			6.9e-05	0.50	0.0
1072	Fe	γ_2	Fe^+	e^-			4.8e+02	0.00	0.0

Table D6. The separated version of the UGAN chemical network (total: 3266 reactions split into 43 Tables).

#	Reactants		Products			α	β	γ
1	H	H	oH_2			7.5e-01		
2	H	H	pH_2			2.5e-01		
3	H	D	HD			1.0e+00		
4	D	D	oD_2			6.6e-01		
5	D	D	pD_2			3.3e-01		
6	H	CRP	H^+	e^-		4.6e-01	0.00	0.0
7	D	CRP	D^+	e^-		4.6e-01	0.00	0.0
8	He	CRP	He^+	e^-		5.0e-01	0.00	0.0
9	oH_2	CRP	H	H		1.0e-01	0.00	0.0
10	pH_2	CRP	H	H		1.0e-01	0.00	0.0
11	oH_2	CRP	H^+	H	e^-	2.3e-02	0.00	0.0
12	pH_2	CRP	H^+	H	e^-	2.3e-02	0.00	0.0
13	oH_2	CRP	oH_2^+	e^-		9.8e-01	0.00	0.0
14	pH_2	CRP	pH_2^+	e^-		9.8e-01	0.00	0.0
15	HD	CRP	H^+	D	e^-	2.0e-02	0.00	0.0
16	HD	CRP	D^+	H	e^-	2.0e-02	0.00	0.0
17	HD	CRP	H	D		1.5e+00	0.00	0.0
18	HD	CRP	HD^+	e^-		9.6e-01	0.00	0.0
19	oD_2	CRP	D^+	D	e^-	4.0e-02	0.00	0.0
20	pD_2	CRP	D^+	D	e^-	4.0e-02	0.00	0.0
21	oD_2	CRP	D	D		1.5e+00	0.00	0.0
22	pD_2	CRP	D	D		1.5e+00	0.00	0.0
23	oD_2	CRP	oD_2^+	e^-		9.6e-01	0.00	0.0
24	pD_2	CRP	pD_2^+	e^-		9.6e-01	0.00	0.0
25	H	oH_2^+	oH_2	H^+		6.4e-10	0.00	0.0
26	H	pH_2^+	pH_2	H^+		6.4e-10	0.00	0.0
27	H	HD^+	H^+	HD		6.4e-10	0.00	0.0
28	H	HD^+	oH_2D^+	γ		9.0e-18	1.80	-20.0
29	H	HD^+	pH_2D^+	γ		3.0e-18	1.80	-20.0
30	H	D^+	H^+	D		1.0e-09	0.00	0.0
31	H	D^+	HD^+	γ		3.9e-19	1.80	-20.0
32	H	oD_2^+	HD^+	D		1.0e-09	0.00	430.0
33	H	pD_2^+	HD^+	D		1.0e-09	0.00	430.0
34	H	oD_2^+	oD_2	H^+		6.4e-10	0.00	0.0
35	H	pD_2^+	pD_2	H^+		6.4e-10	0.00	0.0
36	oH_2	He^+	H^+	H	He	3.3e-15	0.00	0.0
37	pH_2	He^+	H^+	H	He	3.3e-15	0.00	0.0
38	oH_2	He^+	oH_2^+	He		9.6e-15	0.00	0.0
39	pH_2	He^+	pH_2^+	He		9.6e-15	0.00	0.0
40	oH_2	H^+	oH_2^+	H		6.4e-10	0.00	21300.0
41	pH_2	H^+	pH_2^+	H		6.4e-10	0.00	21300.0
42	oH_2	oH_2^+	oH_3^+	H		1.4e-09	0.00	0.0
43	oH_2	oH_2^+	pH_3^+	H		7.0e-10	0.00	0.0
44	oH_2	pH_2^+	oH_3^+	H		7.0e-10	0.00	0.0
45	oH_2	pH_2^+	pH_3^+	H		1.4e-09	0.00	0.0
46	pH_2	oH_2^+	oH_3^+	H		7.0e-10	0.00	0.0
47	pH_2	oH_2^+	pH_3^+	H		1.4e-09	0.00	0.0
48	pH_2	pH_2^+	pH_3^+	H		2.1e-09	0.00	0.0
49	oH_2	HD^+	oH_2D^+	H		8.7e-10	0.00	0.0
50	oH_2	HD^+	pH_2D^+	H		1.7e-10	0.00	0.0
51	pH_2	HD^+	oH_2D^+	H		5.3e-10	0.00	0.0
52	pH_2	HD^+	pH_2D^+	H		5.3e-10	0.00	0.0
53	oH_2	HD^+	oH_3^+	D		7.0e-10	0.00	0.0
54	oH_2	HD^+	pH_3^+	D		3.5e-10	0.00	0.0
55	pH_2	HD^+	pH_3^+	D		1.1e-09	0.00	0.0
56	oH_2	D^+	H^+	HD		2.1e-09	0.00	0.0
57	pH_2	D^+	H^+	HD		2.1e-09	0.00	0.0
58	oH_2	oD_2^+	oH_2D^+	D		1.1e-09	0.00	0.0
59	oH_2	pD_2^+	oH_2D^+	D		1.1e-09	0.00	0.0
60	pH_2	oD_2^+	pH_2D^+	D		1.1e-09	0.00	0.0
61	pH_2	pD_2^+	pH_2D^+	D		1.1e-09	0.00	0.0
62	oH_2	oD_2^+	oHD_2^+	H		1.1e-09	0.00	0.0
63	oH_2	pD_2^+	pHD_2^+	H		1.1e-09	0.00	0.0
64	pH_2	oD_2^+	oHD_2^+	H		1.1e-09	0.00	0.0
65	pH_2	pD_2^+	pHD_2^+	H		1.1e-09	0.00	0.0
66	HD	He^+	H^+	D	He	5.5e-14	-0.24	0.0
67	HD	He^+	D^+	H	He	5.5e-14	-0.24	0.0
68	HD	oH_2^+	oH_2D^+	H		8.7e-10	0.00	0.0
69	HD	oH_2^+	pH_2D^+	H		1.7e-10	0.00	0.0
70	HD	pH_2^+	oH_2D^+	H		5.3e-10	0.00	0.0
71	HD	pH_2^+	pH_2D^+	H		5.3e-10	0.00	0.0
72	HD	oH_2^+	oH_3^+	D		7.0e-10	0.00	0.0
73	HD	oH_2^+	pH_3^+	D		3.5e-10	0.00	0.0
74	HD	pH_2^+	pH_3^+	D		1.1e-09	0.00	0.0

Table D6 – *continued* (part 2)

#	Reactants		Products			α	β	γ
75	HD	HD^+	oH_2D^+	D		7.9e-10	0.00	0.0
76	HD	HD^+	pH_2D^+	D		2.6e-10	0.00	0.0
77	HD	HD^+	oHD_2^+	H		7.0e-10	0.00	0.0
78	HD	HD^+	pHD_2^+	H		3.5e-10	0.00	0.0
79	HD	D^+	oD_2	H^+		6.7e-10	0.00	0.0
80	HD	D^+	pD_2	H^+		3.3e-10	0.00	0.0
81	HD	oD_2^+	oHD_2^+	D		8.2e-10	0.00	0.0
82	HD	oD_2^+	pHD_2^+	D		2.3e-10	0.00	0.0
83	HD	pD_2^+	oHD_2^+	D		4.7e-10	0.00	0.0
84	HD	pD_2^+	pHD_2^+	D		5.8e-10	0.00	0.0
85	HD	oD_2^+	mD_3^+	H		5.8e-10	0.00	0.0
86	HD	oD_2^+	oD_3^+	H		4.7e-10	0.00	0.0
87	HD	pD_2^+	pD_3^+	H		1.2e-10	0.00	0.0
88	HD	pD_2^+	oD_3^+	H		9.3e-10	0.00	0.0
89	D	H^+	D^+	H		1.0e-09	0.00	41.0
90	D	H^+	HD^+	γ		3.9e-19	1.80	-20.0
91	D	oH_2^+	oH_2	D^+		6.4e-10	0.00	0.0
92	D	pH_2^+	pH_2	D^+		6.4e-10	0.00	0.0
93	D	oH_2^+	oH_2D^+	γ		7.0e-18	1.80	-20.0
94	D	pH_2^+	pH_2D^+	γ		7.0e-18	1.80	-20.0
95	D	oH_2^+	HD^+	H		1.0e-09	0.00	0.0
96	D	pH_2^+	HD^+	H		1.0e-09	0.00	0.0
97	D	oH_3^+	oH_2D^+	H		1.0e-09	0.00	0.0
98	D	pH_3^+	oH_2D^+	H		5.0e-10	0.00	0.0
99	D	pH_3^+	pH_2D^+	H		5.0e-10	0.00	0.0
100	D	HD^+	oD_2^+	H		6.7e-10	0.00	0.0
101	D	HD^+	pD_2^+	H		3.3e-10	0.00	0.0
102	D	HD^+	D^+	HD		6.4e-10	0.00	0.0
103	D	oH_2D^+	oHD_2^+	H		6.7e-10	0.00	0.0
104	D	oH_2D^+	pHD_2^+	H		3.3e-10	0.00	0.0
105	D	pH_2D^+	oHD_2^+	H		6.7e-10	0.00	0.0
106	D	pH_2D^+	pHD_2^+	H		3.3e-10	0.00	0.0
107	D	oHD_2^+	mD_3^+	H		5.6e-10	0.00	0.0
108	D	oHD_2^+	oD_3^+	H		4.4e-10	0.00	0.0
109	D	pHD_2^+	pD_3^+	H		1.1e-10	0.00	0.0
110	D	pHD_2^+	oD_3^+	H		8.9e-10	0.00	0.0
111	D	oD_2^+	oD_2	D^+		6.4e-10	0.00	0.0
112	D	pD_2^+	pD_2	D^+		6.4e-10	0.00	0.0
113	oD_2	He^+	D^+	D	He	1.1e-13	-0.24	0.0
114	pD_2	He^+	D^+	D	He	1.1e-13	-0.24	0.0
115	oD_2	He^+	oD_2^+	He		2.5e-14	0.00	0.0
116	pD_2	He^+	pD_2^+	He		2.5e-14	0.00	0.0
117	oD_2	H^+	D^+	HD		2.1e-09	0.00	405.0
118	pD_2	H^+	D^+	HD		2.1e-09	0.00	405.0
119	oD_2	oH_2^+	oH_2D^+	D		1.1e-09	0.00	0.0
120	pD_2	oH_2^+	oH_2D^+	D		1.1e-09	0.00	0.0
121	oD_2	pH_2^+	pH_2D^+	D		1.1e-09	0.00	0.0
122	pD_2	pH_2^+	pH_2D^+	D		1.1e-09	0.00	0.0
123	oD_2	oH_2^+	oHD_2^+	H		1.1e-09	0.00	0.0
124	pD_2	oH_2^+	pHD_2^+	H		1.1e-09	0.00	0.0
125	oD_2	pH_2^+	oHD_2^+	H		1.1e-09	0.00	0.0
126	pD_2	pH_2^+	pHD_2^+	H		1.1e-09	0.00	0.0
127	oD_2	HD^+	oHD_2^+	D		8.2e-10	0.00	0.0
128	oD_2	HD^+	pHD_2^+	D		2.3e-10	0.00	0.0
129	pD_2	HD^+	oHD_2^+	D		4.7e-10	0.00	0.0
130	pD_2	HD^+	pHD_2^+	D		5.8e-10	0.00	0.0
131	oD_2	HD^+	mD_3^+	H		5.8e-10	0.00	0.0
132	oD_2	HD^+	oD_3^+	H		4.7e-10	0.00	0.0
133	pD_2	HD^+	pD_3^+	H		1.2e-10	0.00	0.0
134	pD_2	HD^+	oD_3^+	H		9.3e-10	0.00	0.0
135	oD_2	oD_2^+	mD_3^+	D		1.2e-09	0.00	0.0
136	oD_2	oD_2^+	oD_3^+	D		9.3e-10	0.00	0.0
137	oD_2	pD_2^+	mD_3^+	D		5.8e-10	0.00	0.0
138	oD_2	pD_2^+	pD_3^+	D		1.2e-10	0.00	0.0
139	oD_2	pD_2^+	oD_3^+	D		1.4e-09	0.00	0.0
140	pD_2	oD_2^+	mD_3^+	D		5.8e-10	0.00	0.0
141	pD_2	oD_2^+	pD_3^+	D		1.2e-10	0.00	0.0
142	pD_2	oD_2^+	oD_3^+	D		1.4e-09	0.00	0.0
143	pD_2	pD_2^+	pD_3^+	D		2.3e-10	0.00	0.0
144	pD_2	pD_2^+	oD_3^+	D		1.9e-09	0.00	0.0
145	Fe	H^+	Fe^+	H		7.4e-09	0.00	0.0
146	Fe	oH_3^+	oH_2	H	Fe^+	4.9e-09	0.00	0.0
147	Fe	pH_3^+	oH_2	H	Fe^+	2.5e-09	0.00	0.0
148	Fe	pH_3^+	pH_2	H	Fe^+	2.5e-09	0.00	0.0

Table D6 – *continued* (part 3)

#	Reactants		Products				α	β	γ
149	Fe	oH_2D^+	oH_2	Fe^+	D		4.9e-09	0.00	0.0
150	Fe	pH_2D^+	pH_2	Fe^+	D		4.9e-09	0.00	0.0
151	Fe	oHD_2^+	oD_2	Fe^+	H		1.6e-09	0.00	0.0
152	Fe	pHD_2^+	pD_2	Fe^+	H		1.6e-09	0.00	0.0
153	Fe	oHD_2^+	HD	D	Fe^+		3.3e-09	0.00	0.0
154	Fe	pHD_2^+	HD	D	Fe^+		3.3e-09	0.00	0.0
155	Fe	mD_3^+	oD_2	D	Fe^+		4.9e-09	0.00	0.0
156	Fe	pD_3^+	pD_2	D	Fe^+		4.9e-09	0.00	0.0
157	Fe	oD_3^+	oD_2	D	Fe^+		2.5e-09	0.00	0.0
158	Fe	oD_3^+	pD_2	D	Fe^+		2.5e-09	0.00	0.0
159	H^+	e^-	H	γ			3.6e-12	-0.75	0.0
160	oH_2^+	e^-	H	H			2.5e-07	-0.50	0.0
161	pH_2^+	e^-	H	H			2.5e-07	-0.50	0.0
162	oH_2^+	e^-	oH_2	γ			2.2e-07	-0.40	0.0
163	pH_2^+	e^-	pH_2	γ			2.2e-07	-0.40	0.0
164	HD^+	e^-	H	D			9.0e-09	-0.50	0.0
165	D^+	e^-	D	γ			3.6e-12	-0.75	0.0
166	He^+	e^-	He	γ			4.5e-12	-0.67	0.0
167	oH_2^+	γ_2	H^+	H			6.1e+02	0.00	0.0
168	pH_2^+	γ_2	H^+	H			6.1e+02	0.00	0.0
169	H^+	Gr^-	Gr	H			1.6e-06	0.50	0.0
170	oH_3^+	Gr^-	oH_2	H	Gr		4.6e-07	0.50	0.0
171	pH_3^+	Gr^-	oH_2	H	Gr		2.3e-07	0.50	0.0
172	pH_3^+	Gr^-	pH_2	H	Gr		2.3e-07	0.50	0.0
173	oH_3^+	Gr^-	H	H	H	Gr	4.6e-07	0.50	0.0
174	pH_3^+	Gr^-	H	H	H	Gr	4.6e-07	0.50	0.0
175	He^+	Gr^-	Gr	He			8.0e-07	0.50	0.0
176	H^+	Gr	Gr^+	H			1.6e-06	0.50	0.0
177	oH_3^+	Gr	oH_2	H	Gr^+		4.6e-07	0.50	0.0
178	pH_3^+	Gr	oH_2	H	Gr^+		2.3e-07	0.50	0.0
179	pH_3^+	Gr	pH_2	H	Gr^+		2.3e-07	0.50	0.0
180	oH_3^+	Gr	H	H	H	Gr^+	4.6e-07	0.50	0.0
181	pH_3^+	Gr	H	H	H	Gr^+	4.6e-07	0.50	0.0
182	He^+	Gr	Gr^+	He			8.0e-07	0.50	0.0
183	D^+	Gr^-	Gr	D			1.1e-06	0.50	0.0
184	oH_2D^+	Gr^-	oH_2	Gr	D		1.3e-07	0.50	0.0
185	pH_2D^+	Gr^-	pH_2	Gr	D		1.3e-07	0.50	0.0
186	oH_2D^+	Gr^-	HD	H	Gr		2.7e-07	0.50	0.0
187	pH_2D^+	Gr^-	HD	H	Gr		2.7e-07	0.50	0.0
188	oH_2D^+	Gr^-	H	H	Gr	D	4.0e-07	0.50	0.0
189	pH_2D^+	Gr^-	H	H	Gr	D	4.0e-07	0.50	0.0
190	D^+	Gr	Gr^+	D			1.1e-06	0.50	0.0
191	oH_2D^+	Gr	oH_2	Gr^+	D		1.3e-07	0.50	0.0
192	pH_2D^+	Gr	pH_2	Gr^+	D		1.3e-07	0.50	0.0
193	oH_2D^+	Gr	HD	H	Gr^+		2.7e-07	0.50	0.0
194	pH_2D^+	Gr	HD	H	Gr^+		2.7e-07	0.50	0.0
195	oH_2D^+	Gr	H	H	Gr^+	D	4.0e-07	0.50	0.0
196	pH_2D^+	Gr	H	H	Gr^+	D	4.0e-07	0.50	0.0
197	oHD_2^+	Gr^-	HD	D	Gr		2.4e-07	0.50	0.0
198	pHD_2^+	Gr^-	HD	D	Gr		2.4e-07	0.50	0.0
199	oHD_2^+	Gr^-	oD_2	Gr	H		1.2e-07	0.50	0.0
200	pHD_2^+	Gr^-	pD_2	Gr	H		1.2e-07	0.50	0.0
201	oHD_2^+	Gr^-	D	D	Gr	H	3.6e-07	0.50	0.0
202	pHD_2^+	Gr^-	D	D	Gr	H	3.6e-07	0.50	0.0
203	oHD_2^+	Gr	HD	D	Gr^+		2.4e-07	0.50	0.0
204	pHD_2^+	Gr	HD	D	Gr^+		2.4e-07	0.50	0.0
205	oHD_2^+	Gr	oD_2	Gr^+	H		1.2e-07	0.50	0.0
206	pHD_2^+	Gr	pD_2	Gr^+	H		1.2e-07	0.50	0.0
207	oHD_2^+	Gr	D	D	Gr^+	H	3.6e-07	0.50	0.0
208	pHD_2^+	Gr	D	D	Gr^+	H	3.6e-07	0.50	0.0
209	mD_3^+	Gr^-	oD_2	D	Gr		3.3e-07	0.50	0.0
210	pD_3^+	Gr^-	pD_2	D	Gr		3.3e-07	0.50	0.0
211	oD_3^+	Gr^-	oD_2	D	Gr		1.6e-07	0.50	0.0
212	oD_3^+	Gr^-	pD_2	D	Gr		1.6e-07	0.50	0.0
213	mD_3^+	Gr^-	D	D	D	Gr	3.3e-07	0.50	0.0
214	pD_3^+	Gr^-	D	D	D	Gr	3.3e-07	0.50	0.0
215	oD_3^+	Gr^-	D	D	D	Gr	3.3e-07	0.50	0.0
216	mD_3^+	Gr	oD_2	D	Gr^+		3.3e-07	0.50	0.0
217	pD_3^+	Gr	pD_2	D	Gr^+		3.3e-07	0.50	0.0
218	oD_3^+	Gr	oD_2	D	Gr^+		1.6e-07	0.50	0.0
219	oD_3^+	Gr	pD_2	D	Gr^+		1.6e-07	0.50	0.0
220	mD_3^+	Gr	D	D	D	Gr^+	3.3e-07	0.50	0.0
221	pD_3^+	Gr	D	D	D	Gr^+	3.3e-07	0.50	0.0
222	oD_3^+	Gr	D	D	D	Gr^+	3.3e-07	0.50	0.0

Table D6 – *continued* (part 4)

#	Reactants		Products			α	β	γ
223	O	CRP	O^+	e^-		2.8e+00	0.00	0.0
224	O	OH	O_2	H		4.0e-11	0.00	0.0
225	O^+	oH_2	OH^+	H		1.2e-09	0.00	0.0
226	O^+	pH_2	OH^+	H		1.2e-09	0.00	0.0
227	O^+	H	H^+	O		6.0e-10	0.00	0.0
228	O	H^+	O^+	H		6.0e-10	0.00	227.0
229	O	oH_2^+	OH^+	H		1.5e-09	0.00	0.0
230	O	pH_2^+	OH^+	H		1.5e-09	0.00	0.0
231	O	oH_3^+	oH_2	OH^+		8.0e-10	-0.16	1.4
232	O	pH_3^+	oH_2	OH^+		4.0e-10	-0.16	1.4
233	O	pH_3^+	pH_2	OH^+		4.0e-10	-0.16	1.4
234	O	oH_3^+	oH_2O^+	H		3.4e-10	-0.16	1.4
235	O	pH_3^+	oH_2O^+	H		1.7e-10	-0.16	1.4
236	O	pH_3^+	pH_2O^+	H		1.7e-10	-0.16	1.4
237	O	oH_2D^+	OH^+	HD		5.3e-10	0.00	0.0
238	O	pH_2D^+	OH^+	HD		5.3e-10	0.00	0.0
239	O	oH_2D^+	oH_2	OD^+		2.7e-10	0.00	0.0
240	O	pH_2D^+	pH_2	OD^+		2.7e-10	0.00	0.0
241	O	oHD_2^+	oD_2	OH^+		2.7e-10	0.00	0.0
242	O	pHD_2^+	pD_2	OH^+		2.7e-10	0.00	0.0
243	O	oHD_2^+	OD^+	HD		5.3e-10	0.00	0.0
244	O	pHD_2^+	OD^+	HD		5.3e-10	0.00	0.0
245	O	mD_3^+	oD_2	OD^+		8.0e-10	0.00	0.0
246	O	pD_3^+	pD_2	OD^+		8.0e-10	0.00	0.0
247	O	oD_3^+	oD_2	OD^+		4.0e-10	0.00	0.0
248	O	oD_3^+	pD_2	OD^+		4.0e-10	0.00	0.0
249	O_2	He^+	O^+	O	He	1.0e-09	0.00	0.0
250	O_2	H^+	O_2^+	H		1.2e-09	0.00	0.0
251	OH	He^+	OH^+	He		5.5e-10	0.00	0.0
252	OH	He^+	O^+	H	He	5.5e-10	0.00	0.0
253	OH	H^+	OH^+	H		2.1e-09	0.00	0.0
254	OH	oH_2^+	oH_2	OH^+		7.6e-10	0.00	0.0
255	OH	pH_2^+	pH_2	OH^+		7.6e-10	0.00	0.0
256	OH	oH_3^+	oH_2O^+	oH_2		9.8e-10	0.00	0.0
257	OH	oH_3^+	oH_2O^+	pH_2		1.6e-10	0.00	0.0
258	OH	oH_3^+	pH_2O^+	oH_2		1.6e-10	0.00	0.0
259	OH	pH_3^+	oH_2O^+	oH_2		4.9e-10	0.00	0.0
260	OH	pH_3^+	oH_2O^+	pH_2		3.3e-10	0.00	0.0
261	OH	pH_3^+	pH_2O^+	oH_2		3.3e-10	0.00	0.0
262	OH	pH_3^+	pH_2O^+	pH_2		1.6e-10	0.00	0.0
263	OH	oH_2D^+	oH_2O^+	HD		7.2e-10	0.00	0.0
264	OH	oH_2D^+	pH_2O^+	HD		1.4e-10	0.00	0.0
265	OH	pH_2D^+	oH_2O^+	HD		4.3e-10	0.00	0.0
266	OH	pH_2D^+	pH_2O^+	HD		4.3e-10	0.00	0.0
267	OH	oH_2D^+	oH_2	HDO^+		3.6e-10	0.00	0.0
268	OH	oH_2D^+	pH_2	HDO^+		7.2e-11	0.00	0.0
269	OH	pH_2D^+	oH_2	HDO^+		2.2e-10	0.00	0.0
270	OH	pH_2D^+	pH_2	HDO^+		2.2e-10	0.00	0.0
271	OH	oHD_2^+	oD_2	oH_2O^+		3.2e-10	0.00	0.0
272	OH	pHD_2^+	pD_2	oH_2O^+		3.2e-10	0.00	0.0
273	OH	oHD_2^+	oD_2	pH_2O^+		1.1e-10	0.00	0.0
274	OH	pHD_2^+	pD_2	pH_2O^+		1.1e-10	0.00	0.0
275	OH	oHD_2^+	HDO^+	HD		8.7e-10	0.00	0.0
276	OH	pHD_2^+	HDO^+	HD		8.7e-10	0.00	0.0
277	OH	mD_3^+	oD_2	HDO^+		1.3e-09	0.00	0.0
278	OH	pD_3^+	pD_2	HDO^+		1.3e-09	0.00	0.0
279	OH	oD_3^+	oD_2	HDO^+		6.5e-10	0.00	0.0
280	OH	oD_3^+	pD_2	HDO^+		6.5e-10	0.00	0.0
281	OD	He^+	OD^+	He		5.5e-10	0.00	0.0
282	OD	He^+	O^+	D	He	5.5e-10	0.00	0.0
283	OD	H^+	OD^+	H		2.1e-09	0.00	0.0
284	OD	oH_3^+	oH_2	HDO^+		1.3e-09	0.00	0.0
285	OD	pH_3^+	oH_2	HDO^+		6.5e-10	0.00	0.0
286	OD	pH_3^+	pH_2	HDO^+		6.5e-10	0.00	0.0
287	OD	oH_2D^+	HDO^+	HD		8.7e-10	0.00	0.0
288	OD	pH_2D^+	HDO^+	HD		8.7e-10	0.00	0.0
289	OD	oH_2D^+	oD_2O^+	oH_2		2.9e-10	0.00	0.0
290	OD	oH_2D^+	pD_2O^+	oH_2		1.4e-10	0.00	0.0
291	OD	pH_2D^+	oD_2O^+	pH_2		2.9e-10	0.00	0.0
292	OD	pH_2D^+	pD_2O^+	pH_2		1.4e-10	0.00	0.0
293	OD	oHD_2^+	oD_2	HDO^+		3.4e-10	0.00	0.0
294	OD	oHD_2^+	pD_2	HDO^+		9.6e-11	0.00	0.0
295	OD	pHD_2^+	oD_2	HDO^+		1.9e-10	0.00	0.0
296	OD	pHD_2^+	pD_2	HDO^+		2.4e-10	0.00	0.0

Table D6 – *continued* (part 5)

#	Reactants		Products			α	β	γ
297	OD	oHD_2^+	oD_2O^+	HD		6.7e-10	0.00	0.0
298	OD	oHD_2^+	pD_2O^+	HD		1.9e-10	0.00	0.0
299	OD	pHD_2^+	oD_2O^+	HD		3.9e-10	0.00	0.0
300	OD	pHD_2^+	pD_2O^+	HD		4.8e-10	0.00	0.0
301	OD	mD_3^+	oD_2O^+	oD_2		8.7e-11	0.00	0.0
302	OD	mD_3^+	oD_2O^+	pD_2		2.2e-11	0.00	0.0
303	OD	mD_3^+	pD_2O^+	oD_2		2.2e-11	0.00	0.0
304	OD	pD_3^+	oD_2O^+	pD_2		4.3e-11	0.00	0.0
305	OD	pD_3^+	pD_2O^+	oD_2		4.3e-11	0.00	0.0
306	OD	pD_3^+	pD_2O^+	pD_2		4.3e-11	0.00	0.0
307	OD	oD_3^+	oD_2O^+	oD_2		4.3e-11	0.00	0.0
308	OD	oD_3^+	oD_2O^+	pD_2		3.2e-11	0.00	0.0
309	OD	oD_3^+	pD_2O^+	oD_2		3.2e-11	0.00	0.0
310	OD	oD_3^+	pD_2O^+	pD_2		2.2e-11	0.00	0.0
311	oH_2O	He^+	OH^+	H	He	2.3e-10	-0.94	0.0
312	pH_2O	He^+	OH^+	H	He	2.3e-10	-0.94	0.0
313	oH_2O	He^+	oH_2O^+	He		4.9e-11	-0.94	0.0
314	pH_2O	He^+	pH_2O^+	He		4.9e-11	-0.94	0.0
315	oH_2O	He^+	H^+	OH	He	1.6e-10	-0.94	0.0
316	pH_2O	He^+	H^+	OH	He	1.6e-10	-0.94	0.0
317	oH_2O	H^+	oH_2O^+	H		8.2e-09	0.00	0.0
318	pH_2O	H^+	pH_2O^+	H		8.2e-09	0.00	0.0
319	oH_2O	oH_2^+	oH_2	oH_2O^+		3.9e-09	0.00	0.0
320	oH_2O	pH_2^+	oH_2	pH_2O^+		3.9e-09	0.00	0.0
321	pH_2O	oH_2^+	pH_2	oH_2O^+		3.9e-09	0.00	0.0
322	pH_2O	pH_2^+	pH_2	pH_2O^+		3.9e-09	0.00	0.0
323	oH_2O	oH_2^+	oH_3O^+	H		2.3e-09	0.00	0.0
324	oH_2O	oH_2^+	pH_3O^+	H		1.1e-09	0.00	0.0
325	oH_2O	pH_2^+	oH_3O^+	H		1.1e-09	0.00	0.0
326	oH_2O	pH_2^+	pH_3O^+	H		2.3e-09	0.00	0.0
327	pH_2O	oH_2^+	oH_3O^+	H		1.1e-09	0.00	0.0
328	pH_2O	oH_2^+	pH_3O^+	H		2.3e-09	0.00	0.0
329	pH_2O	pH_2^+	pH_3O^+	H		3.4e-09	0.00	0.0
330	oH_2O	oH_3^+	oH_3O^+	oH_2		2.7e-09	0.00	0.0
331	oH_2O	oH_3^+	oH_3O^+	pH_2		3.6e-10	0.00	0.0
332	oH_2O	oH_3^+	pH_3O^+	oH_2		1.0e-09	0.00	0.0
333	oH_2O	oH_3^+	pH_3O^+	pH_2		2.9e-10	0.00	0.0
334	pH_2O	oH_3^+	oH_3O^+	oH_2		1.1e-09	0.00	0.0
335	pH_2O	oH_3^+	oH_3O^+	pH_2		1.1e-09	0.00	0.0
336	pH_2O	oH_3^+	pH_3O^+	oH_2		2.1e-09	0.00	0.0
337	oH_2O	pH_3^+	oH_3O^+	oH_2		1.0e-09	0.00	0.0
338	oH_2O	pH_3^+	oH_3O^+	pH_2		7.2e-10	0.00	0.0
339	oH_2O	pH_3^+	pH_3O^+	oH_2		2.0e-09	0.00	0.0
340	oH_2O	pH_3^+	pH_3O^+	pH_2		5.7e-10	0.00	0.0
341	pH_2O	pH_3^+	oH_3O^+	oH_2		8.6e-10	0.00	0.0
342	pH_2O	pH_3^+	pH_3O^+	oH_2		1.7e-09	0.00	0.0
343	pH_2O	pH_3^+	pH_3O^+	pH_2		1.7e-09	0.00	0.0
344	oH_2O	oH_2D^+	oH_3O^+	HD		1.9e-09	0.00	0.0
345	oH_2O	oH_2D^+	pH_3O^+	HD		9.6e-10	0.00	0.0
346	oH_2O	pH_2D^+	oH_3O^+	HD		9.6e-10	0.00	0.0
347	oH_2O	pH_2D^+	pH_3O^+	HD		1.9e-09	0.00	0.0
348	pH_2O	oH_2D^+	oH_3O^+	HD		9.6e-10	0.00	0.0
349	pH_2O	oH_2D^+	pH_3O^+	HD		1.9e-09	0.00	0.0
350	pH_2O	pH_2D^+	pH_3O^+	HD		2.9e-09	0.00	0.0
351	oH_2O	oHD_2^+	oH_2DO^+	HD		2.4e-09	0.00	0.0
352	oH_2O	pHD_2^+	oH_2DO^+	HD		2.4e-09	0.00	0.0
353	oH_2O	oHD_2^+	pH_2DO^+	HD		4.8e-10	0.00	0.0
354	oH_2O	pHD_2^+	pH_2DO^+	HD		4.8e-10	0.00	0.0
355	pH_2O	oHD_2^+	oH_2DO^+	HD		1.4e-09	0.00	0.0
356	pH_2O	pHD_2^+	oH_2DO^+	HD		1.4e-09	0.00	0.0
357	pH_2O	oHD_2^+	pH_2DO^+	HD		1.4e-09	0.00	0.0
358	pH_2O	pHD_2^+	pH_2DO^+	HD		1.4e-09	0.00	0.0
359	oH_2O	oHD_2^+	oD_2	oH_3O^+		9.5e-10	0.00	0.0
360	oH_2O	pHD_2^+	pD_2	oH_3O^+		9.5e-10	0.00	0.0
361	oH_2O	oHD_2^+	oD_2	pH_3O^+		4.8e-10	0.00	0.0
362	oH_2O	pHD_2^+	pD_2	pH_3O^+		4.8e-10	0.00	0.0
363	pH_2O	oHD_2^+	oD_2	pH_3O^+		1.4e-09	0.00	0.0
364	pH_2O	pHD_2^+	pD_2	pH_3O^+		1.4e-09	0.00	0.0
365	oH_2O	mD_3^+	oD_2	oH_2DO^+		4.3e-09	0.00	0.0
366	oH_2O	pD_3^+	pD_2	oH_2DO^+		4.3e-09	0.00	0.0
367	oH_2O	oD_3^+	oD_2	oH_2DO^+		2.1e-09	0.00	0.0
368	oH_2O	oD_3^+	pD_2	oH_2DO^+		2.1e-09	0.00	0.0
369	pH_2O	mD_3^+	oD_2	pH_2DO^+		4.3e-09	0.00	0.0
370	pH_2O	pD_3^+	pD_2	pH_2DO^+		4.3e-09	0.00	0.0

Table D6 – *continued* (part 6)

#	Reactants		Products			α	β	γ
371	pH_2O	oD_3^+	oD_2	pH_2DO^+		2.1e-09	0.00	0.0
372	pH_2O	oD_3^+	pD_2	pH_2DO^+		2.1e-09	0.00	0.0
373	oH_2O	oH_2D^+	oH_2DO^+	oH_2		1.0e-09	0.00	0.0
374	oH_2O	oH_2D^+	oH_2DO^+	pH_2		1.6e-10	0.00	0.0
375	oH_2O	oH_2D^+	pH_2DO^+	oH_2		1.6e-10	0.00	0.0
376	oH_2O	oH_2D^+	pH_2DO^+	pH_2		7.9e-11	0.00	0.0
377	oH_2O	pH_2D^+	oH_2DO^+	oH_2		4.8e-10	0.00	0.0
378	oH_2O	pH_2D^+	oH_2DO^+	pH_2		4.8e-10	0.00	0.0
379	oH_2O	pH_2D^+	pH_2DO^+	oH_2		4.8e-10	0.00	0.0
380	pH_2O	oH_2D^+	oH_2DO^+	oH_2		4.8e-10	0.00	0.0
381	pH_2O	oH_2D^+	oH_2DO^+	pH_2		4.8e-10	0.00	0.0
382	pH_2O	oH_2D^+	pH_2DO^+	oH_2		4.8e-10	0.00	0.0
383	pH_2O	pH_2D^+	oH_2DO^+	oH_2		7.2e-10	0.00	0.0
384	pH_2O	pH_2D^+	pH_2DO^+	pH_2		7.2e-10	0.00	0.0
385	HDO	He^+	OD^+	H	He	2.3e-10	-0.94	0.0
386	HDO	He^+	HDO^+	He		4.9e-11	-0.94	0.0
387	HDO	He^+	H^+	OD	He	1.6e-10	-0.94	0.0
388	HDO	H^+	HDO^+	H		8.2e-09	0.00	0.0
389	HDO	oH_3^+	oH_2DO^+	oH_2		3.2e-09	0.00	0.0
390	HDO	oH_3^+	oH_2DO^+	pH_2		5.4e-10	0.00	0.0
391	HDO	oH_3^+	pH_2DO^+	oH_2		5.4e-10	0.00	0.0
392	HDO	pH_3^+	oH_2DO^+	oH_2		1.6e-09	0.00	0.0
393	HDO	pH_3^+	oH_2DO^+	pH_2		1.1e-09	0.00	0.0
394	HDO	pH_3^+	pH_2DO^+	oH_2		1.1e-09	0.00	0.0
395	HDO	pH_3^+	pH_2DO^+	pH_2		5.4e-10	0.00	0.0
396	HDO	oH_2D^+	oH_2DO^+	HD		2.4e-09	0.00	0.0
397	HDO	oH_2D^+	pH_2DO^+	HD		4.8e-10	0.00	0.0
398	HDO	pH_2D^+	oH_2DO^+	HD		1.4e-09	0.00	0.0
399	HDO	pH_2D^+	pH_2DO^+	HD		1.4e-09	0.00	0.0
400	HDO	oH_2D^+	oHD_2O^+	oH_2		7.9e-10	0.00	0.0
401	HDO	oH_2D^+	pHD_2O^+	oH_2		4.0e-10	0.00	0.0
402	HDO	oH_2D^+	oHD_2O^+	pH_2		1.6e-10	0.00	0.0
403	HDO	oH_2D^+	pHD_2O^+	pH_2		7.9e-11	0.00	0.0
404	HDO	pH_2D^+	oHD_2O^+	oH_2		4.8e-10	0.00	0.0
405	HDO	pH_2D^+	pHD_2O^+	oH_2		2.4e-10	0.00	0.0
406	HDO	pH_2D^+	oHD_2O^+	pH_2		4.8e-10	0.00	0.0
407	HDO	pH_2D^+	pHD_2O^+	pH_2		2.4e-10	0.00	0.0
408	HDO	oHD_2^+	oHD_2O^+	HD		2.2e-09	0.00	0.0
409	HDO	oHD_2^+	pHD_2O^+	HD		6.4e-10	0.00	0.0
410	HDO	pHD_2^+	oHD_2O^+	HD		1.3e-09	0.00	0.0
411	HDO	pHD_2^+	pHD_2O^+	HD		1.6e-09	0.00	0.0
412	HDO	oHD_2^+	oD_2	oH_2DO^+		8.3e-10	0.00	0.0
413	HDO	oHD_2^+	pD_2	oH_2DO^+		2.4e-10	0.00	0.0
414	HDO	pHD_2^+	oD_2	oH_2DO^+		4.8e-10	0.00	0.0
415	HDO	pHD_2^+	pD_2	oH_2DO^+		6.0e-10	0.00	0.0
416	HDO	oHD_2^+	oD_2	pH_2DO^+		2.8e-10	0.00	0.0
417	HDO	oHD_2^+	pD_2	pH_2DO^+		7.9e-11	0.00	0.0
418	HDO	pHD_2^+	oD_2	pH_2DO^+		1.6e-10	0.00	0.0
419	HDO	pHD_2^+	pD_2	pH_2DO^+		2.0e-10	0.00	0.0
420	HDO	mD_3^+	oHD_2O^+	oD_2		2.9e-09	0.00	0.0
421	HDO	mD_3^+	oHD_2O^+	pD_2		7.2e-10	0.00	0.0
422	HDO	mD_3^+	pHD_2O^+	oD_2		7.2e-10	0.00	0.0
423	HDO	pD_3^+	oHD_2O^+	pD_2		1.4e-09	0.00	0.0
424	HDO	pD_3^+	pHD_2O^+	oD_2		1.4e-09	0.00	0.0
425	HDO	pD_3^+	pHD_2O^+	pD_2		1.4e-09	0.00	0.0
426	HDO	oD_3^+	oHD_2O^+	oD_2		1.4e-09	0.00	0.0
427	HDO	oD_3^+	oHD_2O^+	pD_2		1.1e-09	0.00	0.0
428	HDO	oD_3^+	pHD_2O^+	oD_2		1.1e-09	0.00	0.0
429	HDO	oD_3^+	pHD_2O^+	pD_2		7.2e-10	0.00	0.0
430	oD_2O	He^+	OD^+	D	He	2.3e-10	-0.94	0.0
431	pD_2O	He^+	OD^+	D	He	2.3e-10	-0.94	0.0
432	oD_2O	He^+	oD_2O^+	He		4.9e-11	-0.94	0.0
433	pD_2O	He^+	pD_2O^+	He		4.9e-11	-0.94	0.0
434	oD_2O	He^+	D^+	OD	He	1.6e-10	-0.94	0.0
435	pD_2O	He^+	D^+	OD	He	1.6e-10	-0.94	0.0
436	oD_2O	H^+	oD_2O^+	H		8.2e-09	0.00	0.0
437	pD_2O	H^+	pD_2O^+	H		8.2e-09	0.00	0.0
438	oD_2O	oH_3^+	oHD_2O^+	oH_2		4.3e-09	0.00	0.0
439	pD_2O	oH_3^+	pHD_2O^+	oH_2		4.3e-09	0.00	0.0
440	oD_2O	pH_3^+	oHD_2O^+	oH_2		2.1e-09	0.00	0.0
441	pD_2O	pH_3^+	pHD_2O^+	oH_2		2.1e-09	0.00	0.0
442	oD_2O	pH_3^+	oHD_2O^+	pH_2		2.1e-09	0.00	0.0
443	pD_2O	pH_3^+	pHD_2O^+	pH_2		2.1e-09	0.00	0.0
444	oD_2O	oH_2D^+	oHD_2O^+	HD		2.2e-09	0.00	0.0

Table D6 – *continued* (part 7)

#	Reactants		Products		α	β	γ
445	oD_2O	oH_2D^+	pHD_2O^+	HD	6.4e-10	0.00	0.0
446	pD_2O	oH_2D^+	oHD_2O^+	HD	1.3e-09	0.00	0.0
447	pD_2O	oH_2D^+	pHD_2O^+	HD	1.6e-09	0.00	0.0
448	oD_2O	pH_2D^+	oHD_2O^+	HD	2.2e-09	0.00	0.0
449	oD_2O	pH_2D^+	pHD_2O^+	HD	6.4e-10	0.00	0.0
450	pD_2O	pH_2D^+	oHD_2O^+	HD	1.3e-09	0.00	0.0
451	pD_2O	pH_2D^+	pHD_2O^+	HD	1.6e-09	0.00	0.0
452	oD_2O	oH_2D^+	mD_3O^+	oH_2	7.9e-10	0.00	0.0
453	oD_2O	oH_2D^+	oD_3O^+	oH_2	6.4e-10	0.00	0.0
454	pD_2O	oH_2D^+	pD_3O^+	oH_2	1.6e-10	0.00	0.0
455	pD_2O	oH_2D^+	oD_3O^+	oH_2	1.3e-09	0.00	0.0
456	oD_2O	pH_2D^+	mD_3O^+	pH_2	7.9e-10	0.00	0.0
457	oD_2O	pH_2D^+	oD_3O^+	pH_2	6.4e-10	0.00	0.0
458	pD_2O	pH_2D^+	pD_3O^+	pH_2	1.6e-10	0.00	0.0
459	pD_2O	pH_2D^+	oD_3O^+	pH_2	1.3e-09	0.00	0.0
460	oD_2O	mD_3^+	mD_3O^+	oD_2	2.1e-09	0.00	0.0
461	oD_2O	mD_3^+	mD_3O^+	pD_2	4.3e-10	0.00	0.0
462	oD_2O	mD_3^+	oD_3O^+	oD_2	1.3e-09	0.00	0.0
463	oD_2O	mD_3^+	oD_3O^+	pD_2	4.3e-10	0.00	0.0
464	pD_2O	mD_3^+	mD_3O^+	oD_2	8.6e-10	0.00	0.0
465	pD_2O	mD_3^+	mD_3O^+	pD_2	1.0e-09	0.00	0.0
466	pD_2O	mD_3^+	pD_3O^+	oD_2	1.4e-10	0.00	0.0
467	pD_2O	mD_3^+	oD_3O^+	oD_2	2.0e-09	0.00	0.0
468	pD_2O	mD_3^+	oD_3O^+	pD_2	2.9e-10	0.00	0.0
469	oD_2O	pD_3^+	mD_3O^+	pD_2	7.2e-10	0.00	0.0
470	oD_2O	pD_3^+	pD_3O^+	oD_2	7.2e-10	0.00	0.0
471	oD_2O	pD_3^+	oD_3O^+	oD_2	1.4e-09	0.00	0.0
472	oD_2O	pD_3^+	oD_3O^+	pD_2	1.4e-09	0.00	0.0
473	pD_2O	pD_3^+	pD_3O^+	pD_2	8.6e-10	0.00	0.0
474	pD_2O	pD_3^+	oD_3O^+	oD_2	1.7e-09	0.00	0.0
475	pD_2O	pD_3^+	oD_3O^+	pD_2	1.7e-09	0.00	0.0
476	oD_2O	oD_3^+	mD_3O^+	oD_2	8.1e-10	0.00	0.0
477	oD_2O	oD_3^+	mD_3O^+	pD_2	6.3e-10	0.00	0.0
478	oD_2O	oD_3^+	pD_3O^+	oD_2	9.0e-11	0.00	0.0
479	oD_2O	oD_3^+	pD_3O^+	pD_2	5.4e-11	0.00	0.0
480	oD_2O	oD_3^+	oD_3O^+	oD_2	1.9e-09	0.00	0.0
481	oD_2O	oD_3^+	oD_3O^+	pD_2	8.2e-10	0.00	0.0
482	pD_2O	oD_3^+	mD_3O^+	oD_2	5.4e-10	0.00	0.0
483	pD_2O	oD_3^+	mD_3O^+	pD_2	1.8e-10	0.00	0.0
484	pD_2O	oD_3^+	pD_3O^+	oD_2	1.8e-10	0.00	0.0
485	pD_2O	oD_3^+	pD_3O^+	pD_2	1.1e-10	0.00	0.0
486	pD_2O	oD_3^+	oD_3O^+	oD_2	1.6e-09	0.00	0.0
487	pD_2O	oD_3^+	oD_3O^+	pD_2	1.6e-09	0.00	0.0
488	oD_2O	oHD_2^+	mD_3O^+	HD	1.6e-09	0.00	0.0
489	oD_2O	oHD_2^+	oD_3O^+	HD	1.3e-09	0.00	0.0
490	oD_2O	pHD_2^+	mD_3O^+	HD	8.0e-10	0.00	0.0
491	oD_2O	pHD_2^+	pD_3O^+	HD	1.6e-10	0.00	0.0
492	oD_2O	pHD_2^+	oD_3O^+	HD	1.9e-09	0.00	0.0
493	pD_2O	oHD_2^+	mD_3O^+	HD	8.0e-10	0.00	0.0
494	pD_2O	oHD_2^+	pD_3O^+	HD	1.6e-10	0.00	0.0
495	pD_2O	oHD_2^+	oD_3O^+	HD	1.9e-09	0.00	0.0
496	pD_2O	pHD_2^+	pD_3O^+	HD	3.2e-10	0.00	0.0
497	pD_2O	pHD_2^+	oD_3O^+	HD	2.6e-09	0.00	0.0
498	oD_2O	oHD_2^+	oHD_2O^+	oD_2	9.1e-10	0.00	0.0
499	oD_2O	oHD_2^+	oHD_2O^+	pD_2	2.0e-10	0.00	0.0
500	oD_2O	oHD_2^+	pHD_2O^+	oD_2	2.0e-10	0.00	0.0
501	oD_2O	oHD_2^+	pHD_2O^+	pD_2	1.2e-10	0.00	0.0
502	oD_2O	pHD_2^+	oHD_2O^+	oD_2	4.0e-10	0.00	0.0
503	oD_2O	pHD_2^+	oHD_2O^+	pD_2	4.8e-10	0.00	0.0
504	oD_2O	pHD_2^+	pHD_2O^+	oD_2	4.8e-10	0.00	0.0
505	oD_2O	pHD_2^+	pHD_2O^+	pD_2	7.9e-11	0.00	0.0
506	pD_2O	oHD_2^+	oHD_2O^+	oD_2	4.0e-10	0.00	0.0
507	pD_2O	oHD_2^+	oHD_2O^+	pD_2	4.8e-10	0.00	0.0
508	pD_2O	oHD_2^+	pHD_2O^+	oD_2	4.8e-10	0.00	0.0
509	pD_2O	oHD_2^+	pHD_2O^+	pD_2	7.9e-11	0.00	0.0
510	pD_2O	pHD_2^+	oHD_2O^+	oD_2	4.8e-10	0.00	0.0
511	pD_2O	pHD_2^+	oHD_2O^+	pD_2	1.6e-10	0.00	0.0
512	pD_2O	pHD_2^+	pHD_2O^+	oD_2	1.6e-10	0.00	0.0
513	pD_2O	pHD_2^+	pHD_2O^+	pD_2	6.4e-10	0.00	0.0
514	OH^+	oH_2	oH_2O^+	H	8.4e-10	0.00	0.0
515	OH^+	oH_2	pH_2O^+	H	1.7e-10	0.00	0.0
516	OH^+	pH_2	oH_2O^+	H	5.1e-10	0.00	0.0
517	OH^+	pH_2	pH_2O^+	H	5.1e-10	0.00	0.0
518	OH^+	HD	HDO^+	H	5.1e-10	0.00	0.0

Table D6 – *continued* (part 8)

#	Reactants		Products			α	β	γ
519	OH^+	HD	oH_2O^+	D		3.8e-10	0.00	0.0
520	OH^+	HD	pH_2O^+	D		1.3e-10	0.00	0.0
521	OD^+	oH_2	HDO^+	H		1.0e-09	0.00	0.0
522	OD^+	pH_2	HDO^+	H		1.0e-09	0.00	0.0
523	OD^+	HD	oD_2O^+	H		3.4e-10	0.00	0.0
524	OD^+	HD	pD_2O^+	H		1.7e-10	0.00	0.0
525	OD^+	HD	HDO^+	D		5.1e-10	0.00	0.0
526	OD^+	oD_2	oD_2O^+	D		8.6e-10	0.00	0.0
527	OD^+	oD_2	pD_2O^+	D		2.4e-10	0.00	0.0
528	OD^+	pD_2	oD_2O^+	D		4.9e-10	0.00	0.0
529	OD^+	pD_2	pD_2O^+	D		6.1e-10	0.00	0.0
530	oH_2O^+	oH_2	oH_3O^+	H		5.5e-10	0.00	0.0
531	oH_2O^+	oH_2	pH_3O^+	H		2.8e-10	0.00	0.0
532	oH_2O^+	pH_2	oH_3O^+	H		2.8e-10	0.00	0.0
533	oH_2O^+	pH_2	pH_3O^+	H		5.5e-10	0.00	0.0
534	pH_2O^+	oH_2	oH_3O^+	H		2.8e-10	0.00	0.0
535	pH_2O^+	oH_2	pH_3O^+	H		5.5e-10	0.00	0.0
536	pH_2O^+	pH_2	pH_3O^+	H		8.3e-10	0.00	0.0
537	oH_2O^+	HD	oH_2DO^+	H		3.5e-10	0.00	0.0
538	oH_2O^+	HD	pH_2DO^+	H		6.9e-11	0.00	0.0
539	pH_2O^+	HD	oH_2DO^+	H		2.1e-10	0.00	0.0
540	pH_2O^+	HD	pH_2DO^+	H		2.1e-10	0.00	0.0
541	oH_2O^+	HD	oH_3O^+	D		2.8e-10	0.00	0.0
542	oH_2O^+	HD	pH_3O^+	D		1.4e-10	0.00	0.0
543	pH_2O^+	HD	pH_3O^+	D		4.2e-10	0.00	0.0
544	HDO^+	oH_2	oH_2DO^+	H		6.9e-10	0.00	0.0
545	HDO^+	oH_2	pH_2DO^+	H		1.4e-10	0.00	0.0
546	HDO^+	pH_2	oH_2DO^+	H		4.2e-10	0.00	0.0
547	HDO^+	pH_2	pH_2DO^+	H		4.2e-10	0.00	0.0
548	HDO^+	HD	oHD_2O^+	H		2.8e-10	0.00	0.0
549	HDO^+	HD	pHD_2O^+	H		1.4e-10	0.00	0.0
550	HDO^+	HD	oH_2DO^+	D		3.1e-10	0.00	0.0
551	HDO^+	HD	pH_2DO^+	D		1.0e-10	0.00	0.0
552	HDO^+	oD_2	oHD_2O^+	D		6.5e-10	0.00	0.0
553	HDO^+	oD_2	pHD_2O^+	D		1.8e-10	0.00	0.0
554	HDO^+	pD_2	oHD_2O^+	D		3.7e-10	0.00	0.0
555	HDO^+	pD_2	pHD_2O^+	D		4.6e-10	0.00	0.0
556	oD_2O^+	oD_2	mD_3O^+	D		4.6e-10	0.00	0.0
557	oD_2O^+	oD_2	oD_3O^+	D		3.7e-10	0.00	0.0
558	oD_2O^+	pD_2	mD_3O^+	D		2.3e-10	0.00	0.0
559	oD_2O^+	pD_2	pD_3O^+	D		4.6e-11	0.00	0.0
560	oD_2O^+	pD_2	oD_3O^+	D		5.5e-10	0.00	0.0
561	pD_2O^+	oD_2	mD_3O^+	D		2.3e-10	0.00	0.0
562	pD_2O^+	oD_2	pD_3O^+	D		4.6e-11	0.00	0.0
563	pD_2O^+	oD_2	oD_3O^+	D		5.5e-10	0.00	0.0
564	pD_2O^+	pD_2	pD_3O^+	D		9.2e-11	0.00	0.0
565	pD_2O^+	pD_2	oD_3O^+	D		7.4e-10	0.00	0.0
566	oD_2O^+	oH_2	oHD_2O^+	H		8.3e-10	0.00	0.0
567	pD_2O^+	oH_2	pHD_2O^+	H		8.3e-10	0.00	0.0
568	oD_2O^+	pH_2	oHD_2O^+	H		8.3e-10	0.00	0.0
569	pD_2O^+	pH_2	pHD_2O^+	H		8.3e-10	0.00	0.0
570	oD_2O^+	HD	oHD_2O^+	D		3.2e-10	0.00	0.0
571	oD_2O^+	HD	pHD_2O^+	D		9.2e-11	0.00	0.0
572	pD_2O^+	HD	oHD_2O^+	D		1.8e-10	0.00	0.0
573	pD_2O^+	HD	pHD_2O^+	D		2.3e-10	0.00	0.0
574	oD_2O^+	HD	mD_3O^+	H		2.3e-10	0.00	0.0
575	oD_2O^+	HD	oD_3O^+	H		1.8e-10	0.00	0.0
576	pD_2O^+	HD	pD_3O^+	H		4.6e-11	0.00	0.0
577	pD_2O^+	HD	oD_3O^+	H		3.7e-10	0.00	0.0
578	oH_3O^+	Fe	oH_2O	H	Fe^+	3.1e-09	0.00	0.0
579	pH_3O^+	Fe	oH_2O	H	Fe^+	1.6e-09	0.00	0.0
580	pH_3O^+	Fe	pH_2O	H	Fe^+	1.6e-09	0.00	0.0
581	O_2^+	Fe	Fe^+	O_2		1.1e-09	0.00	0.0
582	O^+	e^-	O	γ		3.4e-12	-0.64	0.0
583	O_2^+	e^-	O	O		2.0e-07	-0.70	0.0
584	OH^+	e^-	O	H		3.7e-08	-0.50	0.0
585	oH_2O^+	e^-	OH	H		7.8e-08	-0.50	0.0
586	pH_2O^+	e^-	OH	H		7.8e-08	-0.50	0.0
587	oH_2O^+	e^-	oH_2	O		3.4e-08	-0.50	0.0
588	pH_2O^+	e^-	pH_2	O		3.4e-08	-0.50	0.0
589	oH_2O^+	e^-	H	H	O	1.5e-07	-0.50	0.0
590	pH_2O^+	e^-	H	H	O	1.5e-07	-0.50	0.0
591	oH_3O^+	e^-	OH	H	H	2.6e-07	-0.50	0.0
592	pH_3O^+	e^-	OH	H	H	2.6e-07	-0.50	0.0

Table D6 – *continued* (part 9)

#	Reactants		Products			α	β	γ
593	oH_3O^+	e^-	oH_2O	H		1.1e-07	-0.50	0.0
594	pH_3O^+	e^-	oH_2O	H		5.4e-08	-0.50	0.0
595	pH_3O^+	e^-	pH_2O	H		5.4e-08	-0.50	0.0
596	oH_3O^+	e^-	oH_2	OH		6.0e-08	-0.50	0.0
597	pH_3O^+	e^-	oH_2	OH		3.0e-08	-0.50	0.0
598	pH_3O^+	e^-	pH_2	OH		3.0e-08	-0.50	0.0
599	oH_3O^+	e^-	oH_2	H	O	5.6e-09	-0.50	0.0
600	pH_3O^+	e^-	oH_2	H	O	2.8e-09	-0.50	0.0
601	pH_3O^+	e^-	pH_2	H	O	2.8e-09	-0.50	0.0
602	OD^+	e^-	O	D		3.7e-08	-0.50	0.0
603	HDO^+	e^-	OD	H		3.1e-08	-0.50	0.0
604	HDO^+	e^-	OH	D		1.5e-08	-0.50	0.0
605	HDO^+	e^-	O	HD		1.5e-08	-0.50	0.0
606	HDO^+	e^-	O	H	D	8.9e-08	-0.50	0.0
607	oD_2O^+	e^-	OD	D		7.8e-08	-0.50	0.0
608	pD_2O^+	e^-	OD	D		7.8e-08	-0.50	0.0
609	oD_2O^+	e^-	oD_2	O		3.4e-08	-0.50	0.0
610	pD_2O^+	e^-	pD_2	O		3.4e-08	-0.50	0.0
611	oD_2O^+	e^-	D	D	O	1.5e-07	-0.50	0.0
612	pD_2O^+	e^-	D	D	O	1.5e-07	-0.50	0.0
613	oH_2DO^+	e^-	H	H	OD	8.6e-08	-0.50	0.0
614	pH_2DO^+	e^-	H	H	OD	8.6e-08	-0.50	0.0
615	oH_2DO^+	e^-	OH	H	D	1.7e-07	-0.50	0.0
616	pH_2DO^+	e^-	OH	H	D	1.7e-07	-0.50	0.0
617	oH_2DO^+	e^-	oH_2O	D		3.6e-08	-0.50	0.0
618	pH_2DO^+	e^-	pH_2O	D		3.6e-08	-0.50	0.0
619	oH_2DO^+	e^-	HDO	H		7.2e-08	-0.50	0.0
620	pH_2DO^+	e^-	HDO	H		7.2e-08	-0.50	0.0
621	oH_2DO^+	e^-	oH_2	OD		2.0e-08	-0.50	0.0
622	pH_2DO^+	e^-	pH_2	OD		2.0e-08	-0.50	0.0
623	oH_2DO^+	e^-	OH	HD		4.0e-08	-0.50	0.0
624	pH_2DO^+	e^-	OH	HD		4.0e-08	-0.50	0.0
625	oH_2DO^+	e^-	HD	H	O	3.7e-09	-0.50	0.0
626	pH_2DO^+	e^-	HD	H	O	3.7e-09	-0.50	0.0
627	oH_2DO^+	e^-	oH_2	D	O	1.9e-09	-0.50	0.0
628	pH_2DO^+	e^-	pH_2	D	O	1.9e-09	-0.50	0.0
629	oHD_2O^+	e^-	D	D	OH	8.6e-08	-0.50	0.0
630	pHD_2O^+	e^-	D	D	OH	8.6e-08	-0.50	0.0
631	oHD_2O^+	e^-	OD	D	H	1.7e-07	-0.50	0.0
632	pHD_2O^+	e^-	OD	D	H	1.7e-07	-0.50	0.0
633	oHD_2O^+	e^-	oD_2O	H		3.6e-08	-0.50	0.0
634	pHD_2O^+	e^-	pD_2O	H		3.6e-08	-0.50	0.0
635	oHD_2O^+	e^-	HDO	D		7.2e-08	-0.50	0.0
636	pHD_2O^+	e^-	HDO	D		7.2e-08	-0.50	0.0
637	oHD_2O^+	e^-	oD_2	OH		2.0e-08	-0.50	0.0
638	pHD_2O^+	e^-	pD_2	OH		2.0e-08	-0.50	0.0
639	oHD_2O^+	e^-	OD	HD		4.0e-08	-0.50	0.0
640	pHD_2O^+	e^-	OD	HD		4.0e-08	-0.50	0.0
641	oHD_2O^+	e^-	HD	D	O	3.7e-09	-0.50	0.0
642	pHD_2O^+	e^-	HD	D	O	3.7e-09	-0.50	0.0
643	oHD_2O^+	e^-	oD_2	H	O	1.9e-09	-0.50	0.0
644	pHD_2O^+	e^-	pD_2	H	O	1.9e-09	-0.50	0.0
645	mD_3O^+	e^-	OD	D	D	2.6e-07	-0.50	0.0
646	pD_3O^+	e^-	OD	D	D	2.6e-07	-0.50	0.0
647	oD_3O^+	e^-	OD	D	D	2.6e-07	-0.50	0.0
648	mD_3O^+	e^-	oD_2O	D		1.1e-07	-0.50	0.0
649	pD_3O^+	e^-	pD_2O	D		1.1e-07	-0.50	0.0
650	oD_3O^+	e^-	oD_2O	D		5.4e-08	-0.50	0.0
651	oD_3O^+	e^-	pD_2O	D		5.4e-08	-0.50	0.0
652	mD_3O^+	e^-	oD_2	OD		6.0e-08	-0.50	0.0
653	pD_3O^+	e^-	pD_2	OD		6.0e-08	-0.50	0.0
654	oD_3O^+	e^-	oD_2	OD		3.0e-08	-0.50	0.0
655	oD_3O^+	e^-	pD_2	OD		3.0e-08	-0.50	0.0
656	mD_3O^+	e^-	oD_2	D	O	5.6e-09	-0.50	0.0
657	pD_3O^+	e^-	pD_2	D	O	5.6e-09	-0.50	0.0
658	oD_3O^+	e^-	oD_2	D	O	2.8e-09	-0.50	0.0
659	oD_3O^+	e^-	pD_2	D	O	2.8e-09	-0.50	0.0
660	OH	γ_2	O	H		4.7e+02	0.00	0.0
661	OH^+	γ_2	O^+	H		8.6e+00	0.00	0.0
662	oH_2O	γ_2	OH	H		1.0e+03	0.00	0.0
663	pH_2O	γ_2	OH	H		1.0e+03	0.00	0.0
664	oH_2O	γ_2	oH_2O^+	e^-		2.3e+01	0.00	0.0
665	pH_2O	γ_2	pH_2O^+	e^-		2.3e+01	0.00	0.0
666	O_2	γ_2	O	O		7.8e+02	0.00	0.0

Table D6 – *continued* (part 10)

#	Reactants		Products			α	β	γ
667	O_2	γ_2	O_2^+	e^-		2.8e+01	0.00	0.0
668	O_2^+	γ_2	O^+	O		7.0e+01	0.00	0.0
669	oH_3O^+	Gr	oH_2O	H	Gr^+	3.7e-07	0.50	0.0
670	pH_3O^+	Gr	oH_2O	H	Gr^+	1.8e-07	0.50	0.0
671	pH_3O^+	Gr	pH_2O	H	Gr^+	1.8e-07	0.50	0.0
672	oH_3O^+	Gr^-	oH_2O	H	Gr	3.7e-07	0.50	0.0
673	pH_3O^+	Gr^-	oH_2O	H	Gr	1.8e-07	0.50	0.0
674	pH_3O^+	Gr^-	pH_2O	H	Gr	1.8e-07	0.50	0.0
675	C^+	H	CH^+	γ		7.0e-17	0.00	0.0
676	C^+	oH_2	oCH_2^+	γ		2.0e-16	-1.30	23.0
677	C^+	pH_2	pCH_2^+	γ		2.0e-16	-1.30	23.0
678	C^+	CH	C_2^+	H		3.8e-10	0.00	0.0
679	C^+	CH	CH^+	C		3.8e-10	0.00	0.0
680	C^+	oCH_2	oCH_2^+	C		5.2e-10	0.00	0.0
681	C^+	pCH_2	pCH_2^+	C		5.2e-10	0.00	0.0
682	C^+	oCH_2	C_2H^+	H		5.2e-10	0.00	0.0
683	C^+	pCH_2	C_2H^+	H		5.2e-10	0.00	0.0
684	C^+	mCH_4	$C_2H_3^+$	H		9.8e-10	0.00	0.0
685	C^+	pCH_4	$C_2H_3^+$	H		9.8e-10	0.00	0.0
686	C^+	oCH_4	$C_2H_3^+$	H		9.8e-10	0.00	0.0
687	C^+	C_2H	C_3^+	H		1.0e-09	0.00	0.0
688	C^+	C_2H_2	C_3H^+	H		2.2e-09	0.00	0.0
689	C^+	Fe	Fe^+	C		2.6e-09	0.00	0.0
690	CH^+	H	oH_2	C^+		1.1e-10	0.00	0.0
691	CH^+	H	pH_2	C^+		3.7e-11	0.00	0.0
692	CH^+	oH_2	oCH_2^+	H		1.0e-09	0.00	0.0
693	CH^+	oH_2	pCH_2^+	H		2.0e-10	0.00	0.0
694	CH^+	pH_2	oCH_2^+	H		6.0e-10	0.00	0.0
695	CH^+	pH_2	pCH_2^+	H		6.0e-10	0.00	0.0
696	oCH_2^+	oH_2	oCH_3^+	H		4.7e-10	0.00	0.0
697	oCH_2^+	oH_2	pCH_3^+	H		2.3e-10	0.00	0.0
698	oCH_2^+	pH_2	oCH_3^+	H		2.3e-10	0.00	0.0
699	oCH_2^+	pH_2	pCH_3^+	H		4.7e-10	0.00	0.0
700	pCH_2^+	oH_2	oCH_3^+	H		2.3e-10	0.00	0.0
701	pCH_2^+	oH_2	pCH_3^+	H		4.7e-10	0.00	0.0
702	pCH_2^+	pH_2	pCH_3^+	H		7.0e-10	0.00	0.0
703	oCH_3^+	oH_2	pCH_5^+	γ		1.9e-16	-2.30	21.5
704	oCH_3^+	oH_2	oCH_5^+	γ		1.3e-16	-2.30	21.5
705	oCH_3^+	oH_2	mCH_5^+	γ		6.3e-17	-2.30	21.5
706	oCH_3^+	pH_2	oCH_5^+	γ		3.8e-16	-2.30	21.5
707	pCH_3^+	oH_2	oCH_5^+	γ		2.5e-16	-2.30	21.5
708	pCH_3^+	oH_2	mCH_5^+	γ		1.3e-16	-2.30	21.5
709	pCH_3^+	pH_2	mCH_5^+	γ		3.8e-16	-2.30	21.5
710	mCH_4^+	H	oCH_3^+	oH_2		1.4e-10	0.00	0.0
711	mCH_4^+	H	oCH_3^+	pH_2		2.0e-11	0.00	0.0
712	mCH_4^+	H	pCH_3^+	oH_2		4.0e-11	0.00	0.0
713	pCH_4^+	H	oCH_3^+	oH_2		4.0e-11	0.00	0.0
714	pCH_4^+	H	pCH_3^+	oH_2		8.0e-11	0.00	0.0
715	pCH_4^+	H	pCH_3^+	pH_2		8.0e-11	0.00	0.0
716	oCH_4^+	H	oCH_3^+	oH_2		4.7e-11	0.00	0.0
717	oCH_4^+	H	oCH_3^+	pH_2		3.3e-11	0.00	0.0
718	oCH_4^+	H	pCH_3^+	oH_2		9.3e-11	0.00	0.0
719	oCH_4^+	H	pCH_3^+	pH_2		2.7e-11	0.00	0.0
720	mCH_4^+	oH_2	pCH_5^+	H		2.1e-11	0.00	0.0
721	mCH_4^+	oH_2	oCH_5^+	H		1.4e-11	0.00	0.0
722	mCH_4^+	oH_2	mCH_5^+	H		4.4e-12	0.00	0.0
723	mCH_4^+	pH_2	pCH_5^+	H		8.0e-12	0.00	0.0
724	mCH_4^+	pH_2	oCH_5^+	H		3.2e-11	0.00	0.0
725	pCH_4^+	oH_2	oCH_5^+	H		1.8e-11	0.00	0.0
726	pCH_4^+	oH_2	mCH_5^+	H		2.2e-11	0.00	0.0
727	pCH_4^+	pH_2	mCH_5^+	H		4.0e-11	0.00	0.0
728	oCH_4^+	oH_2	pCH_5^+	H		4.4e-12	0.00	0.0
729	oCH_4^+	oH_2	oCH_5^+	H		2.4e-11	0.00	0.0
730	oCH_4^+	oH_2	mCH_5^+	H		1.2e-11	0.00	0.0
731	oCH_4^+	pH_2	oCH_5^+	H		1.8e-11	0.00	0.0
732	oCH_4^+	pH_2	mCH_5^+	H		2.2e-11	0.00	0.0
733	C_2^+	oH_2	C_2H^+	H		1.4e-09	0.00	0.0
734	C_2^+	pH_2	C_2H^+	H		1.4e-09	0.00	0.0
735	C_2H^+	oH_2	$C_2H_2^+$	H		1.7e-09	0.00	0.0
736	C_2H^+	pH_2	$C_2H_2^+$	H		1.7e-09	0.00	0.0
737	C_3^+	oH_2	C_3H^+	H		3.0e-10	0.00	0.0
738	C_3^+	pH_2	C_3H^+	H		3.0e-10	0.00	0.0
739	C_3H^+	oH_2	$C_3H_3^+$	γ		3.0e-13	-1.00	0.0
740	C_3H^+	pH_2	$C_3H_3^+$	γ		3.0e-13	-1.00	0.0

Table D6 – *continued* (part 11)

#	Reactants		Products			α	β	γ
741	C	CRP	C^+	e^-		1.8e+00	0.00	0.0
742	C	H	CH	γ		1.0e-17	0.00	0.0
743	C	oH_2^+	CH^+	H		2.4e-09	0.00	0.0
744	C	pH_2^+	CH^+	H		2.4e-09	0.00	0.0
745	C	oH_3^+	oH_2	CH^+		2.0e-09	0.00	0.0
746	C	pH_3^+	oH_2	CH^+		1.0e-09	0.00	0.0
747	C	pH_3^+	pH_2	CH^+		1.0e-09	0.00	0.0
748	CH	H	oH_2	C		9.3e-11	0.26	0.0
749	CH	H	pH_2	C		3.1e-11	0.26	0.0
750	CH	He^+	C^+	H	He	1.1e-09	0.00	0.0
751	CH	H^+	H	CH^+		1.9e-09	0.00	0.0
752	CH	oH_2^+	oH_2	CH^+		7.1e-10	0.00	0.0
753	CH	pH_2^+	pH_2	CH^+		7.1e-10	0.00	0.0
754	CH	oH_2^+	oCH_2^+	H		5.9e-10	0.00	0.0
755	CH	oH_2^+	pCH_2^+	H		1.2e-10	0.00	0.0
756	CH	pH_2^+	oCH_2^+	H		3.6e-10	0.00	0.0
757	CH	pH_2^+	pCH_2^+	H		3.6e-10	0.00	0.0
758	CH	oH_3^+	oCH_2^+	oH_2		9.0e-10	0.00	0.0
759	CH	oH_3^+	oCH_2^+	pH_2		1.5e-10	0.00	0.0
760	CH	oH_3^+	pCH_2^+	oH_2		1.5e-10	0.00	0.0
761	CH	pH_3^+	oCH_2^+	oH_2		4.5e-10	0.00	0.0
762	CH	pH_3^+	oCH_2^+	pH_2		3.0e-10	0.00	0.0
763	CH	pH_3^+	pCH_2^+	oH_2		3.0e-10	0.00	0.0
764	CH	pH_3^+	pCH_2^+	pH_2		1.5e-10	0.00	0.0
765	CH	oH_2D^+	oCH_2^+	HD		1.0e-09	0.00	0.0
766	CH	oH_2D^+	pCH_2^+	HD		2.0e-10	0.00	0.0
767	CH	pH_2D^+	oCH_2^+	HD		6.0e-10	0.00	0.0
768	CH	pH_2D^+	pCH_2^+	HD		6.0e-10	0.00	0.0
769	CH	oHD_2^+	oD_2	oCH_2^+		9.0e-10	0.00	0.0
770	CH	pHD_2^+	pD_2	oCH_2^+		9.0e-10	0.00	0.0
771	CH	oHD_2^+	oD_2	pCH_2^+		3.0e-10	0.00	0.0
772	CH	pHD_2^+	pD_2	pCH_2^+		3.0e-10	0.00	0.0
773	oCH_2	H	oH_2	CH		1.8e-10	0.00	0.0
774	oCH_2	H	pH_2	CH		3.7e-11	0.00	0.0
775	pCH_2	H	oH_2	CH		1.1e-10	0.00	0.0
776	pCH_2	H	pH_2	CH		1.1e-10	0.00	0.0
777	oCH_2	He^+	oH_2	C^+	He	7.5e-10	0.00	0.0
778	pCH_2	He^+	pH_2	C^+	He	7.5e-10	0.00	0.0
779	oCH_2	He^+	CH^+	H	He	7.5e-10	0.00	0.0
780	pCH_2	He^+	CH^+	H	He	7.5e-10	0.00	0.0
781	oCH_2	H^+	oH_2	CH^+		1.2e-09	0.00	0.0
782	oCH_2	H^+	pH_2	CH^+		2.3e-10	0.00	0.0
783	pCH_2	H^+	oH_2	CH^+		7.0e-10	0.00	0.0
784	pCH_2	H^+	pH_2	CH^+		7.0e-10	0.00	0.0
785	oCH_2	H^+	oCH_2^+	H		1.4e-09	0.00	0.0
786	pCH_2	H^+	pCH_2^+	H		1.4e-09	0.00	0.0
787	oCH_2	oH_2^+	oCH_3^+	H		6.7e-10	0.00	0.0
788	oCH_2	oH_2^+	pCH_3^+	H		3.3e-10	0.00	0.0
789	oCH_2	pH_2^+	oCH_3^+	H		3.3e-10	0.00	0.0
790	oCH_2	pH_2^+	pCH_3^+	H		6.7e-10	0.00	0.0
791	pCH_2	oH_2^+	oCH_3^+	H		3.3e-10	0.00	0.0
792	pCH_2	oH_2^+	pCH_3^+	H		6.7e-10	0.00	0.0
793	pCH_2	pH_2^+	pCH_3^+	H		1.0e-09	0.00	0.0
794	oCH_2	oH_2^+	oH_2	oCH_2^+		1.0e-09	0.00	0.0
795	oCH_2	pH_2^+	oH_2	pCH_2^+		1.0e-09	0.00	0.0
796	pCH_2	oH_2^+	pH_2	oCH_2^+		1.0e-09	0.00	0.0
797	pCH_2	pH_2^+	pH_2	pCH_2^+		1.0e-09	0.00	0.0
798	oCH_2	oH_3^+	oCH_3^+	oH_2		1.0e-09	0.00	0.0
799	oCH_2	oH_3^+	oCH_3^+	pH_2		1.4e-10	0.00	0.0
800	oCH_2	oH_3^+	pCH_3^+	oH_2		4.0e-10	0.00	0.0
801	oCH_2	oH_3^+	pCH_3^+	pH_2		1.1e-10	0.00	0.0
802	pCH_2	oH_3^+	oCH_3^+	oH_2		4.2e-10	0.00	0.0
803	pCH_2	oH_3^+	oCH_3^+	pH_2		4.2e-10	0.00	0.0
804	pCH_2	oH_3^+	pCH_3^+	oH_2		8.5e-10	0.00	0.0
805	oCH_2	pH_3^+	oCH_3^+	oH_2		4.0e-10	0.00	0.0
806	oCH_2	pH_3^+	oCH_3^+	pH_2		2.8e-10	0.00	0.0
807	oCH_2	pH_3^+	pCH_3^+	oH_2		7.9e-10	0.00	0.0
808	oCH_2	pH_3^+	pCH_3^+	pH_2		2.3e-10	0.00	0.0
809	pCH_2	pH_3^+	oCH_3^+	oH_2		3.4e-10	0.00	0.0
810	pCH_2	pH_3^+	pCH_3^+	oH_2		6.8e-10	0.00	0.0
811	pCH_2	pH_3^+	pCH_3^+	pH_2		6.8e-10	0.00	0.0
812	oCH_2	oH_2D^+	oCH_3^+	HD		1.1e-09	0.00	0.0
813	oCH_2	oH_2D^+	pCH_3^+	HD		5.7e-10	0.00	0.0
814	oCH_2	pH_2D^+	oCH_3^+	HD		5.7e-10	0.00	0.0

Table D6 – *continued* (part 12)

#	Reactants		Products			α	β	γ
815	oCH_2	pH_2D^+	pCH_3^+	HD		1.1e-09	0.00	0.0
816	pCH_2	oH_2D^+	oCH_3^+	HD		5.7e-10	0.00	0.0
817	pCH_2	oH_2D^+	pCH_3^+	HD		1.1e-09	0.00	0.0
818	pCH_2	pH_2D^+	pCH_3^+	HD		1.7e-09	0.00	0.0
819	oCH_2	oHD_2^+	oD_2	oCH_3^+		1.1e-09	0.00	0.0
820	oCH_2	pHD_2^+	pD_2	oCH_3^+		1.1e-09	0.00	0.0
821	oCH_2	oHD_2^+	oD_2	pCH_3^+		5.7e-10	0.00	0.0
822	oCH_2	pHD_2^+	pD_2	pCH_3^+		5.7e-10	0.00	0.0
823	pCH_2	oHD_2^+	oD_2	pCH_3^+		1.7e-09	0.00	0.0
824	pCH_2	pHD_2^+	pD_2	pCH_3^+		1.7e-09	0.00	0.0
825	oCH_3	He^+	oH_2	CH^+	He	9.0e-10	0.00	0.0
826	pCH_3	He^+	oH_2	CH^+	He	4.5e-10	0.00	0.0
827	pCH_3	He^+	pH_2	CH^+	He	4.5e-10	0.00	0.0
828	oCH_3	He^+	oCH_2^+	H	He	9.0e-10	0.00	0.0
829	pCH_3	He^+	oCH_2^+	H	He	4.5e-10	0.00	0.0
830	pCH_3	He^+	pCH_2^+	H	He	4.5e-10	0.00	0.0
831	oCH_3	H^+	oCH_3^+	H		3.4e-09	0.00	0.0
832	pCH_3	H^+	pCH_3^+	H		3.4e-09	0.00	0.0
833	oCH_3	oH_3^+	mCH_4^+	oH_2		1.1e-09	0.00	0.0
834	oCH_3	oH_3^+	mCH_4^+	pH_2		1.3e-10	0.00	0.0
835	oCH_3	oH_3^+	pCH_4^+	oH_2		8.7e-11	0.00	0.0
836	oCH_3	oH_3^+	pCH_4^+	pH_2		5.2e-11	0.00	0.0
837	oCH_3	oH_3^+	oCH_4^+	oH_2		6.0e-10	0.00	0.0
838	oCH_3	oH_3^+	oCH_4^+	pH_2		1.3e-10	0.00	0.0
839	oCH_3	pH_3^+	mCH_4^+	oH_2		3.5e-10	0.00	0.0
840	oCH_3	pH_3^+	mCH_4^+	pH_2		2.6e-10	0.00	0.0
841	oCH_3	pH_3^+	pCH_4^+	oH_2		1.7e-10	0.00	0.0
842	oCH_3	pH_3^+	oCH_4^+	oH_2		1.1e-09	0.00	0.0
843	oCH_3	pH_3^+	oCH_4^+	pH_2		2.6e-10	0.00	0.0
844	pCH_3	oH_3^+	mCH_4^+	oH_2		3.5e-10	0.00	0.0
845	pCH_3	oH_3^+	mCH_4^+	pH_2		2.6e-10	0.00	0.0
846	pCH_3	oH_3^+	pCH_4^+	oH_2		1.7e-10	0.00	0.0
847	pCH_3	oH_3^+	oCH_4^+	oH_2		1.1e-09	0.00	0.0
848	pCH_3	oH_3^+	oCH_4^+	pH_2		2.6e-10	0.00	0.0
849	pCH_3	pH_3^+	mCH_4^+	oH_2		1.7e-10	0.00	0.0
850	pCH_3	pH_3^+	pCH_4^+	oH_2		3.5e-10	0.00	0.0
851	pCH_3	pH_3^+	pCH_4^+	pH_2		2.1e-10	0.00	0.0
852	pCH_3	pH_3^+	oCH_4^+	oH_2		8.4e-10	0.00	0.0
853	pCH_3	pH_3^+	oCH_4^+	pH_2		5.3e-10	0.00	0.0
854	oCH_3	oH_2D^+	mCH_4^+	HD		1.2e-09	0.00	0.0
855	oCH_3	oH_2D^+	pCH_4^+	HD		1.4e-10	0.00	0.0
856	oCH_3	oH_2D^+	oCH_4^+	HD		7.4e-10	0.00	0.0
857	oCH_3	pH_2D^+	mCH_4^+	HD		5.3e-10	0.00	0.0
858	oCH_3	pH_2D^+	oCH_4^+	HD		1.6e-09	0.00	0.0
859	pCH_3	oH_2D^+	mCH_4^+	HD		3.5e-10	0.00	0.0
860	pCH_3	oH_2D^+	pCH_4^+	HD		2.8e-10	0.00	0.0
861	pCH_3	oH_2D^+	oCH_4^+	HD		1.5e-09	0.00	0.0
862	pCH_3	pH_2D^+	pCH_4^+	HD		8.4e-10	0.00	0.0
863	pCH_3	pH_2D^+	oCH_4^+	HD		1.3e-09	0.00	0.0
864	oCH_3	oHD_2^+	oD_2	mCH_4^+		1.3e-09	0.00	0.0
865	oCH_3	pHD_2^+	pD_2	mCH_4^+		1.3e-09	0.00	0.0
866	oCH_3	oHD_2^+	oD_2	oCH_4^+		7.9e-10	0.00	0.0
867	oCH_3	pHD_2^+	pD_2	oCH_4^+		7.9e-10	0.00	0.0
868	pCH_3	oHD_2^+	oD_2	pCH_4^+		5.3e-10	0.00	0.0
869	pCH_3	pHD_2^+	pD_2	pCH_4^+		5.3e-10	0.00	0.0
870	pCH_3	oHD_2^+	oD_2	oCH_4^+		1.6e-09	0.00	0.0
871	pCH_3	pHD_2^+	pD_2	oCH_4^+		1.6e-09	0.00	0.0
872	mCH_4	He^+	oCH_3	H^+	He	4.0e-10	0.00	0.0
873	pCH_4	He^+	pCH_3	H^+	He	4.0e-10	0.00	0.0
874	oCH_4	He^+	oCH_3	H^+	He	1.3e-10	0.00	0.0
875	oCH_4	He^+	pCH_3	H^+	He	2.7e-10	0.00	0.0
876	mCH_4	He^+	oCH_2^+	oH_2	He	8.5e-10	0.00	0.0
877	pCH_4	He^+	oCH_2^+	oH_2	He	4.2e-10	0.00	0.0
878	pCH_4	He^+	pCH_2^+	pH_2	He	4.2e-10	0.00	0.0
879	oCH_4	He^+	oCH_2^+	oH_2	He	2.8e-10	0.00	0.0
880	oCH_4	He^+	oCH_2^+	pH_2	He	2.8e-10	0.00	0.0
881	oCH_4	He^+	pCH_2^+	oH_2	He	2.8e-10	0.00	0.0
882	mCH_4	He^+	oCH_3^+	H	He	8.0e-11	0.00	0.0
883	pCH_4	He^+	pCH_3^+	H	He	8.0e-11	0.00	0.0
884	oCH_4	He^+	oCH_3^+	H	He	2.7e-11	0.00	0.0
885	oCH_4	He^+	pCH_3^+	H	He	5.3e-11	0.00	0.0
886	mCH_4	He^+	mCH_4^+	He		1.6e-11	0.00	0.0
887	pCH_4	He^+	pCH_4^+	He		1.6e-11	0.00	0.0
888	oCH_4	He^+	oCH_4^+	He		1.6e-11	0.00	0.0

Table D6 – *continued* (part 13)

#	Reactants		Products			α	β	γ
889	mCH_4	H^+	oCH_3^+	oH_2		1.6e-09	0.00	0.0
890	mCH_4	H^+	oCH_3^+	pH_2		2.3e-10	0.00	0.0
891	mCH_4	H^+	pCH_3^+	oH_2		4.6e-10	0.00	0.0
892	pCH_4	H^+	oCH_3^+	oH_2		4.6e-10	0.00	0.0
893	pCH_4	H^+	pCH_3^+	oH_2		9.1e-10	0.00	0.0
894	pCH_4	H^+	pCH_3^+	pH_2		9.1e-10	0.00	0.0
895	oCH_4	H^+	oCH_3^+	oH_2		5.3e-10	0.00	0.0
896	oCH_4	H^+	oCH_3^+	pH_2		3.8e-10	0.00	0.0
897	oCH_4	H^+	pCH_3^+	oH_2		1.1e-09	0.00	0.0
898	oCH_4	H^+	pCH_3^+	pH_2		3.0e-10	0.00	0.0
899	mCH_4	H^+	mCH_4^+	H		1.5e-09	0.00	0.0
900	pCH_4	H^+	pCH_4^+	H		1.5e-09	0.00	0.0
901	oCH_4	H^+	oCH_4^+	H		1.5e-09	0.00	0.0
902	mCH_4	oH_3^+	pCH_5^+	oH_2		8.8e-10	0.00	0.0
903	mCH_4	oH_3^+	pCH_5^+	pH_2		9.5e-11	0.00	0.0
904	mCH_4	oH_3^+	oCH_5^+	oH_2		5.4e-10	0.00	0.0
905	mCH_4	oH_3^+	oCH_5^+	pH_2		1.1e-10	0.00	0.0
906	mCH_4	oH_3^+	mCH_5^+	oH_2		2.0e-10	0.00	0.0
907	mCH_4	oH_3^+	mCH_5^+	pH_2		6.8e-11	0.00	0.0
908	pCH_4	oH_3^+	pCH_5^+	oH_2		1.4e-10	0.00	0.0
909	pCH_4	oH_3^+	oCH_5^+	oH_2		5.4e-10	0.00	0.0
910	pCH_4	oH_3^+	oCH_5^+	pH_2		5.4e-10	0.00	0.0
911	pCH_4	oH_3^+	mCH_5^+	oH_2		6.8e-10	0.00	0.0
912	oCH_4	oH_3^+	pCH_5^+	oH_2		2.0e-10	0.00	0.0
913	oCH_4	oH_3^+	pCH_5^+	pH_2		1.6e-10	0.00	0.0
914	oCH_4	oH_3^+	oCH_5^+	oH_2		9.0e-10	0.00	0.0
915	oCH_4	oH_3^+	oCH_5^+	pH_2		1.8e-10	0.00	0.0
916	oCH_4	oH_3^+	mCH_5^+	oH_2		3.4e-10	0.00	0.0
917	oCH_4	oH_3^+	mCH_5^+	pH_2		1.1e-10	0.00	0.0
918	mCH_4	pH_3^+	pCH_5^+	oH_2		2.4e-10	0.00	0.0
919	mCH_4	pH_3^+	pCH_5^+	pH_2		1.9e-10	0.00	0.0
920	mCH_4	pH_3^+	oCH_5^+	oH_2		9.8e-10	0.00	0.0
921	mCH_4	pH_3^+	oCH_5^+	pH_2		2.2e-10	0.00	0.0
922	mCH_4	pH_3^+	mCH_5^+	oH_2		2.7e-10	0.00	0.0
923	pCH_4	pH_3^+	oCH_5^+	oH_2		5.4e-10	0.00	0.0
924	pCH_4	pH_3^+	mCH_5^+	oH_2		6.8e-10	0.00	0.0
925	pCH_4	pH_3^+	mCH_5^+	pH_2		6.8e-10	0.00	0.0
926	oCH_4	pH_3^+	pCH_5^+	oH_2		6.2e-11	0.00	0.0
927	oCH_4	pH_3^+	oCH_5^+	oH_2		5.4e-10	0.00	0.0
928	oCH_4	pH_3^+	oCH_5^+	pH_2		2.5e-10	0.00	0.0
929	oCH_4	pH_3^+	mCH_5^+	oH_2		6.8e-10	0.00	0.0
930	oCH_4	pH_3^+	mCH_5^+	pH_2		3.7e-10	0.00	0.0
931	mCH_4	oH_2D^+	pCH_5^+	HD		1.0e-09	0.00	0.0
932	mCH_4	oH_2D^+	oCH_5^+	HD		6.8e-10	0.00	0.0
933	mCH_4	oH_2D^+	mCH_5^+	HD		2.1e-10	0.00	0.0
934	mCH_4	pH_2D^+	pCH_5^+	HD		3.8e-10	0.00	0.0
935	mCH_4	pH_2D^+	oCH_5^+	HD		1.5e-09	0.00	0.0
936	pCH_4	oH_2D^+	oCH_5^+	HD		8.4e-10	0.00	0.0
937	pCH_4	oH_2D^+	mCH_5^+	HD		1.1e-09	0.00	0.0
938	pCH_4	pH_2D^+	mCH_5^+	HD		1.9e-09	0.00	0.0
939	oCH_4	oH_2D^+	pCH_5^+	HD		2.1e-10	0.00	0.0
940	oCH_4	oH_2D^+	oCH_5^+	HD		1.1e-09	0.00	0.0
941	oCH_4	oH_2D^+	mCH_5^+	HD		5.6e-10	0.00	0.0
942	oCH_4	pH_2D^+	oCH_5^+	HD		8.4e-10	0.00	0.0
943	oCH_4	pH_2D^+	mCH_5^+	HD		1.1e-09	0.00	0.0
944	mCH_4	oHD_2^+	oD_2	pCH_5^+		1.1e-09	0.00	0.0
945	mCH_4	pHD_2^+	pD_2	pCH_5^+		1.1e-09	0.00	0.0
946	mCH_4	oHD_2^+	oD_2	oCH_5^+		7.6e-10	0.00	0.0
947	mCH_4	pHD_2^+	pD_2	oCH_5^+		7.6e-10	0.00	0.0
948	pCH_4	oHD_2^+	oD_2	mCH_5^+		1.9e-09	0.00	0.0
949	pCH_4	pHD_2^+	pD_2	mCH_5^+		1.9e-09	0.00	0.0
950	oCH_4	oHD_2^+	oD_2	oCH_5^+		1.3e-09	0.00	0.0
951	oCH_4	pHD_2^+	pD_2	oCH_5^+		1.3e-09	0.00	0.0
952	oCH_4	oHD_2^+	oD_2	mCH_5^+		6.3e-10	0.00	0.0
953	oCH_4	pHD_2^+	pD_2	mCH_5^+		6.3e-10	0.00	0.0
954	C	oH_2D^+	CH^+	HD		2.0e-09	0.00	0.0
955	C	pH_2D^+	CH^+	HD		2.0e-09	0.00	0.0
956	C	oHD_2^+	oD_2	CH^+		2.0e-09	0.00	0.0
957	C	pHD_2^+	pD_2	CH^+		2.0e-09	0.00	0.0
958	C_2	H^+	C_2^+	H		3.1e-09	0.00	0.0
959	C_2H	He^+	C^+	CH	He	5.1e-10	0.00	0.0
960	C_2H	He^+	CH^+	C	He	5.1e-10	0.00	0.0
961	C_2H	He^+	C_2^+	H	He	5.1e-10	0.00	0.0
962	C_2H	H^+	oH_2	C_2^+		1.1e-09	0.00	0.0

Table D6 – *continued* (part 14)

#	Reactants		Products			α	β	γ
963	C_2H	H^+	pH_2	C_2^+		3.7e-10	0.00	0.0
964	C_2H	H^+	C_2H^+	H		1.5e-09	0.00	0.0
965	C_2H	oH_2D^+	$C_2H_2^+$	HD		1.7e-09	0.00	0.0
966	C_2H	pH_2D^+	$C_2H_2^+$	HD		1.7e-09	0.00	0.0
967	C_2H	oHD_2^+	oD_2	$C_2H_2^+$		1.7e-09	0.00	0.0
968	C_2H	pHD_2^+	pD_2	$C_2H_2^+$		1.7e-09	0.00	0.0
969	C_3H	He^+	C_3^+	H	He	2.0e-09	0.00	0.0
970	C_3H	H^+	oH_2	C_3^+		1.5e-09	0.00	0.0
971	C_3H	H^+	pH_2	C_3^+		5.0e-10	0.00	0.0
972	C_3H	H^+	C_3H^+	H		2.0e-09	0.00	0.0
973	C_3H	oH_2D^+	$C_3H_2^+$	HD		2.0e-09	0.00	0.0
974	C_3H	pH_2D^+	$C_3H_2^+$	HD		2.0e-09	0.00	0.0
975	C_3H	oHD_2^+	oD_2	$C_3H_2^+$		2.0e-09	0.00	0.0
976	C_3H	pHD_2^+	pD_2	$C_3H_2^+$		2.0e-09	0.00	0.0
977	C_2H_2	He^+	CH^+	CH	He	7.7e-10	0.00	0.0
978	C_2H_2	He^+	C_2H^+	H	He	8.7e-10	0.00	0.0
979	C_2H_2	He^+	$C_2H_2^+$	He		2.4e-10	0.00	0.0
980	C_2H_2	H^+	$C_2H_2^+$	H		2.0e-09	0.00	0.0
981	C_3H_2	H^+	$C_3H_2^+$	H		2.0e-09	0.00	0.0
982	C_3H_2	He^+	C_3H^+	H	He	1.0e-09	0.00	0.0
983	C^+	e^-	C	γ		4.4e-12	-0.61	0.0
984	CH^+	e^-	C	H		1.5e-07	-0.42	0.0
985	oCH_2^+	e^-	oH_2	C		1.2e-07	-0.50	0.0
986	pCH_2^+	e^-	pH_2	C		1.2e-07	-0.50	0.0
987	oCH_2^+	e^-	CH	H		1.2e-07	-0.50	0.0
988	pCH_2^+	e^-	CH	H		1.2e-07	-0.50	0.0
989	oCH_3^+	e^-	oH_2	H	C	3.0e-07	-0.30	0.0
990	pCH_3^+	e^-	oH_2	H	C	1.5e-07	-0.30	0.0
991	pCH_3^+	e^-	pH_2	H	C	1.5e-07	-0.30	0.0
992	oCH_3^+	e^-	CH	H	H	1.6e-07	-0.30	0.0
993	pCH_3^+	e^-	CH	H	H	1.6e-07	-0.30	0.0
994	oCH_3^+	e^-	oH_2	CH		1.4e-07	-0.30	0.0
995	pCH_3^+	e^-	oH_2	CH		7.0e-08	-0.30	0.0
996	pCH_3^+	e^-	pH_2	CH		7.0e-08	-0.30	0.0
997	oCH_3^+	e^-	oCH_2	H		4.0e-07	-0.30	0.0
998	pCH_3^+	e^-	oCH_2	H		2.0e-07	-0.30	0.0
999	pCH_3^+	e^-	pCH_2	H		2.0e-07	-0.30	0.0
1000	mCH_4^+	e^-	oCH_3	H		3.0e-07	-0.50	0.0
1001	pCH_4^+	e^-	pCH_3	H		3.0e-07	-0.50	0.0
1002	oCH_4^+	e^-	oCH_3	H		1.0e-07	-0.50	0.0
1003	oCH_4^+	e^-	pCH_3	H		2.0e-07	-0.50	0.0
1004	pCH_5^+	e^-	oCH_3	oH_2		8.7e-08	-0.30	0.0
1005	oCH_5^+	e^-	oCH_3	oH_2		2.2e-08	-0.30	0.0
1006	oCH_5^+	e^-	oCH_3	pH_2		2.2e-08	-0.30	0.0
1007	oCH_5^+	e^-	pCH_3	oH_2		4.4e-08	-0.30	0.0
1008	mCH_5^+	e^-	oCH_3	oH_2		1.8e-08	-0.30	0.0
1009	mCH_5^+	e^-	pCH_3	oH_2		3.5e-08	-0.30	0.0
1010	mCH_5^+	e^-	pCH_3	pH_2		3.5e-08	-0.30	0.0
1011	pCH_5^+	e^-	mCH_4	H		8.7e-08	-0.30	0.0
1012	oCH_5^+	e^-	mCH_4	H		2.2e-08	-0.30	0.0
1013	oCH_5^+	e^-	oCH_4	H		6.6e-08	-0.30	0.0
1014	mCH_5^+	e^-	pCH_4	H		3.5e-08	-0.30	0.0
1015	mCH_5^+	e^-	oCH_4	H		5.3e-08	-0.30	0.0
1016	C_2^+	e^-	C	C		3.0e-07	-0.50	0.0
1017	C_2H^+	e^-	C_2	H		1.4e-07	-0.50	0.0
1018	C_2H^+	e^-	CH	C		1.4e-07	-0.50	0.0
1019	$C_2H_2^+$	e^-	C_2H	H		1.5e-07	-0.50	0.0
1020	$C_2H_2^+$	e^-	CH	CH		1.5e-07	-0.50	0.0
1021	$C_2H_3^+$	e^-	C_2H_2	H		3.0e-08	-0.50	0.0
1022	C_3^+	e^-	C_2	C		3.0e-07	-0.50	0.0
1023	C_3H^+	e^-	C_2	CH		1.5e-07	-0.50	0.0
1024	C_3H^+	e^-	C_2H	C		1.5e-07	-0.50	0.0
1025	$C_3H_2^+$	e^-	C_3H	H		1.5e-07	-0.50	0.0
1026	$C_3H_2^+$	e^-	C_2H	CH		1.5e-07	-0.50	0.0
1027	$C_3H_3^+$	e^-	C_3H_2	H		1.5e-07	-0.50	0.0
1028	$C_3H_3^+$	e^-	C_2H_2	CH		1.5e-07	-0.50	0.0
1029	C	γ_2	C^+	e^-		2.6e+02	0.00	0.0
1030	CH	γ_2	C	H		1.1e+03	0.00	0.0
1031	CH	γ_2	CH^+	e^-		5.8e+02	0.00	0.0
1032	oCH_2	γ_2	oH_2	C		2.9e+02	0.00	0.0
1033	pCH_2	γ_2	pH_2	C		2.9e+02	0.00	0.0
1034	oCH_3	γ_2	oH_2	CH		2.8e+02	0.00	0.0
1035	pCH_3	γ_2	oH_2	CH		1.4e+02	0.00	0.0
1036	pCH_3	γ_2	pH_2	CH		1.4e+02	0.00	0.0

Table D6 – *continued* (part 15)

#	Reactants		Products			α	β	γ
1037	oCH_3	γ_2	oCH_3^+	e^-		3.8e+02	0.00	0.0
1038	pCH_3	γ_2	pCH_3^+	e^-		3.8e+02	0.00	0.0
1039	mCH_4	γ_2	oCH_3	H		1.5e+03	0.00	0.0
1040	pCH_4	γ_2	pCH_3	H		1.5e+03	0.00	0.0
1041	oCH_4	γ_2	oCH_3	H		5.0e+02	0.00	0.0
1042	oCH_4	γ_2	pCH_3	H		1.0e+03	0.00	0.0
1043	mCH_4	γ_2	mCH_4^+	e^-		2.2e+01	0.00	0.0
1044	pCH_4	γ_2	pCH_4^+	e^-		2.2e+01	0.00	0.0
1045	oCH_4	γ_2	oCH_4^+	e^-		2.2e+01	0.00	0.0
1046	CH^+	γ_2	C	H^+		2.2e+02	0.00	0.0
1047	oCH_2^+	γ_2	CH^+	H		8.9e+01	0.00	0.0
1048	pCH_2^+	γ_2	CH^+	H		8.9e+01	0.00	0.0
1049	mCH_4^+	γ_2	oCH_3^+	H		2.7e+01	0.00	0.0
1050	pCH_4^+	γ_2	pCH_3^+	H		2.7e+01	0.00	0.0
1051	oCH_4^+	γ_2	oCH_3^+	H		9.0e+00	0.00	0.0
1052	oCH_4^+	γ_2	pCH_3^+	H		1.8e+01	0.00	0.0
1053	C_2	γ_2	C	C		1.8e+02	0.00	0.0
1054	C_2	γ_2	C_2^+	e^-		2.5e+02	0.00	0.0
1055	C_2H	γ_2	C_2	H		1.1e+03	0.00	0.0
1056	C_2H_2	γ_2	C_2H	H		3.5e+03	0.00	0.0
1057	C_2H_2	γ_2	$C_2H_2^+$	e^-		3.8e+02	0.00	0.0
1058	C_3	γ_2	C_2	C		6.9e+03	0.00	0.0
1059	C_3H	γ_2	C_3	H		3.0e+03	0.00	0.0
1060	C_3H_2	γ_2	C_3H	H		3.4e+03	0.00	0.0
1061	C^+	Gr	Gr^+	C		4.6e-07	0.50	0.0
1062	C^+	Gr^-	Gr	C		4.6e-07	0.50	0.0
1063	C^+	mCH_4	$C_2H_2^+$	oH_2		3.3e-10	0.00	0.0
1064	C^+	pCH_4	$C_2H_2^+$	oH_2		1.6e-10	0.00	0.0
1065	C^+	pCH_4	$C_2H_2^+$	pH_2		1.6e-10	0.00	0.0
1066	C^+	oCH_4	$C_2H_2^+$	oH_2		2.2e-10	0.00	0.0
1067	C^+	oCH_4	$C_2H_2^+$	pH_2		1.1e-10	0.00	0.0
1068	C_2H	oH_3^+	$C_2H_2^+$	oH_2		1.5e-09	0.00	0.0
1069	C_2H	oH_3^+	$C_2H_2^+$	pH_2		2.1e-10	0.00	0.0
1070	C_2H	pH_3^+	$C_2H_2^+$	oH_2		1.1e-09	0.00	0.0
1071	C_2H	pH_3^+	$C_2H_2^+$	pH_2		6.4e-10	0.00	0.0
1072	C_3H	oH_3^+	$C_3H_2^+$	oH_2		1.7e-09	0.00	0.0
1073	C_3H	oH_3^+	$C_3H_2^+$	pH_2		2.5e-10	0.00	0.0
1074	C_3H	pH_3^+	$C_3H_2^+$	oH_2		1.3e-09	0.00	0.0
1075	C_3H	pH_3^+	$C_3H_2^+$	pH_2		7.5e-10	0.00	0.0
1076	C_3H^+	oH_2	$C_3H_2^+$	H		1.0e-09	0.00	500.0
1077	C_3H^+	pH_2	$C_3H_2^+$	H		1.0e-09	0.00	500.0
1078	N	CRP	N^+	e^-		2.1e+00	0.00	0.0
1079	N	NH	N_2	H		5.0e-11	0.10	0.0
1080	N	oNH_2	H	H	N_2	1.2e-10	0.00	0.0
1081	N	pNH_2	H	H	N_2	1.2e-10	0.00	0.0
1082	N^+	HD	ND^+	H		4.2e-10	0.00	0.0
1083	N_2^+	oH_2	N_2H^+	H		2.0e-09	0.24	0.0
1084	N_2^+	pH_2	N_2H^+	H		2.0e-09	0.24	0.0
1085	NH^+	oH_2	oNH_2^+	H		1.1e-09	0.00	0.0
1086	NH^+	oH_2	pNH_2^+	H		2.1e-10	0.00	0.0
1087	NH^+	pH_2	oNH_2^+	H		6.4e-10	0.00	0.0
1088	NH^+	pH_2	pNH_2^+	H		6.4e-10	0.00	0.0
1089	NH^+	oH_2	oH_3^+	N		1.5e-10	0.00	0.0
1090	NH^+	oH_2	pH_3^+	N		7.5e-11	0.00	0.0
1091	NH^+	pH_2	pH_3^+	N		2.2e-10	0.00	0.0
1092	NH^+	H	oH_2	N^+		4.9e-10	0.00	0.0
1093	NH^+	H	pH_2	N^+		1.6e-10	0.00	0.0
1094	N_2H^+	oNH_3	mNH_4^+	N_2		1.4e-09	0.00	0.0
1095	N_2H^+	oNH_3	oNH_4^+	N_2		8.6e-10	0.00	0.0
1096	N_2H^+	pNH_3	pNH_4^+	N_2		5.7e-10	0.00	0.0
1097	N_2H^+	pNH_3	oNH_4^+	N_2		1.7e-09	0.00	0.0
1098	N_2H^+	D	N_2D^+	H		1.0e-09	0.00	0.0
1099	oNH_2^+	oH_2	oNH_3^+	H		1.8e-10	0.00	0.0
1100	oNH_2^+	oH_2	pNH_3^+	H		9.0e-11	0.00	0.0
1101	oNH_2^+	pH_2	oNH_3^+	H		9.0e-11	0.00	0.0
1102	oNH_2^+	pH_2	pNH_3^+	H		1.8e-10	0.00	0.0
1103	pNH_2^+	oH_2	oNH_3^+	H		9.0e-11	0.00	0.0
1104	pNH_2^+	oH_2	pNH_3^+	H		1.8e-10	0.00	0.0
1105	pNH_2^+	pH_2	pNH_3^+	H		2.7e-10	0.00	0.0
1106	oNH_3^+	oH_2	mNH_4^+	H		1.4e-12	0.00	0.0
1107	oNH_3^+	oH_2	pNH_4^+	H		1.6e-13	0.00	0.0
1108	oNH_3^+	oH_2	oNH_4^+	H		8.4e-13	0.00	0.0
1109	oNH_3^+	pH_2	mNH_4^+	H		6.0e-13	0.00	0.0
1110	oNH_3^+	pH_2	oNH_4^+	H		1.8e-12	0.00	0.0

Table D6 – *continued* (part 16)

#	Reactants		Products		α	β	γ
1111	pNH_3^+	oH_2	mNH_4^+	H	4.0e-13	0.00	0.0
1112	pNH_3^+	oH_2	pNH_4^+	H	3.2e-13	0.00	0.0
1113	pNH_3^+	oH_2	oNH_4^+	H	1.7e-12	0.00	0.0
1114	pNH_3^+	pH_2	pNH_4^+	H	9.6e-13	0.00	0.0
1115	pNH_3^+	pH_2	oNH_4^+	H	1.4e-12	0.00	0.0
1116	ND^+	oH_2	NHD^+	H	1.3e-09	0.00	0.0
1117	ND^+	pH_2	NHD^+	H	1.3e-09	0.00	0.0
1118	ND^+	oH_2	oH_2D^+	N	2.2e-10	0.00	0.0
1119	ND^+	pH_2	pH_2D^+	N	2.2e-10	0.00	0.0
1120	ND^+	HD	NHD^+	D	6.3e-10	0.00	0.0
1121	ND^+	HD	oND_2^+	H	4.2e-10	0.00	0.0
1122	ND^+	HD	pND_2^+	H	2.1e-10	0.00	0.0
1123	N_2D^+	H	N_2H^+	D	1.0e-09	0.00	170.0
1124	N_2D^+	oNH_3	oNH_3D^+	N_2	2.3e-09	0.00	0.0
1125	N_2D^+	pNH_3	pNH_3D^+	N_2	2.3e-09	0.00	0.0
1126	NHD^+	oH_2	oNH_2D^+	H	2.2e-10	0.00	0.0
1127	NHD^+	oH_2	pNH_2D^+	H	4.5e-11	0.00	0.0
1128	NHD^+	pH_2	oNH_2D^+	H	1.3e-10	0.00	0.0
1129	NHD^+	pH_2	pNH_2D^+	H	1.3e-10	0.00	0.0
1130	NHD^+	HD	oNH_2D^+	D	1.0e-10	0.00	0.0
1131	NHD^+	HD	pNH_2D^+	D	3.4e-11	0.00	0.0
1132	NHD^+	HD	$oNHD_2^+$	H	9.0e-11	0.00	0.0
1133	NHD^+	HD	$pNHD_2^+$	H	4.5e-11	0.00	0.0
1134	oND_2^+	oH_2	$oNHD_2^+$	H	2.7e-10	0.00	0.0
1135	pND_2^+	oH_2	$pNHD_2^+$	H	2.7e-10	0.00	0.0
1136	oND_2^+	pH_2	$oNHD_2^+$	H	2.7e-10	0.00	0.0
1137	pND_2^+	pH_2	$pNHD_2^+$	H	2.7e-10	0.00	0.0
1138	oND_2^+	HD	$oNHD_2^+$	D	1.0e-10	0.00	0.0
1139	oND_2^+	HD	$pNHD_2^+$	D	3.0e-11	0.00	0.0
1140	pND_2^+	HD	$oNHD_2^+$	D	6.0e-11	0.00	0.0
1141	pND_2^+	HD	$pNHD_2^+$	D	7.5e-11	0.00	0.0
1142	oND_2^+	HD	mND_3^+	H	7.5e-11	0.00	0.0
1143	oND_2^+	HD	oND_3^+	H	6.0e-11	0.00	0.0
1144	pND_2^+	HD	pND_3^+	H	1.5e-11	0.00	0.0
1145	pND_2^+	HD	oND_3^+	H	1.2e-10	0.00	0.0
1146	oNH_2D^+	oH_2	oNH_3D^+	H	1.6e-12	0.00	0.0
1147	oNH_2D^+	oH_2	pNH_3D^+	H	8.0e-13	0.00	0.0
1148	oNH_2D^+	pH_2	oNH_3D^+	H	8.0e-13	0.00	0.0
1149	oNH_2D^+	pH_2	pNH_3D^+	H	1.6e-12	0.00	0.0
1150	pNH_2D^+	oH_2	oNH_3D^+	H	8.0e-13	0.00	0.0
1151	pNH_2D^+	oH_2	pNH_3D^+	H	1.6e-12	0.00	0.0
1152	pNH_2D^+	pH_2	pNH_3D^+	H	2.4e-12	0.00	0.0
1153	oNH_2D^+	HD	oNH_3D^+	D	8.0e-13	0.00	0.0
1154	oNH_2D^+	HD	pNH_3D^+	D	4.0e-13	0.00	0.0
1155	pNH_2D^+	HD	pNH_3D^+	D	1.2e-12	0.00	0.0
1156	oNH_2D^+	HD	$ooNH_2D_2^+$	H	6.7e-13	0.00	0.0
1157	oNH_2D^+	HD	$poNH_2D_2^+$	H	3.3e-13	0.00	0.0
1158	oNH_2D^+	HD	$opNH_2D_2^+$	H	1.3e-13	0.00	0.0
1159	oNH_2D^+	HD	$ppNH_2D_2^+$	H	6.7e-14	0.00	0.0
1160	pNH_2D^+	HD	$ooNH_2D_2^+$	H	4.0e-13	0.00	0.0
1161	pNH_2D^+	HD	$poNH_2D_2^+$	H	2.0e-13	0.00	0.0
1162	pNH_2D^+	HD	$opNH_2D_2^+$	H	4.0e-13	0.00	0.0
1163	pNH_2D^+	HD	$ppNH_2D_2^+$	H	2.0e-13	0.00	0.0
1164	$oNHD_2^+$	oH_2	$ooNH_2D_2^+$	H	2.0e-12	0.00	0.0
1165	$pNHD_2^+$	oH_2	$poNH_2D_2^+$	H	2.0e-12	0.00	0.0
1166	$oNHD_2^+$	oH_2	$opNH_2D_2^+$	H	4.0e-13	0.00	0.0
1167	$pNHD_2^+$	oH_2	$ppNH_2D_2^+$	H	4.0e-13	0.00	0.0
1168	$oNHD_2^+$	pH_2	$ooNH_2D_2^+$	H	1.2e-12	0.00	0.0
1169	$pNHD_2^+$	pH_2	$poNH_2D_2^+$	H	1.2e-12	0.00	0.0
1170	$oNHD_2^+$	pH_2	$opNH_2D_2^+$	H	1.2e-12	0.00	0.0
1171	$pNHD_2^+$	pH_2	$ppNH_2D_2^+$	H	1.2e-12	0.00	0.0
1172	$oNHD_2^+$	HD	$ooNH_2D_2^+$	D	7.0e-13	0.00	0.0
1173	$oNHD_2^+$	HD	$poNH_2D_2^+$	D	2.0e-13	0.00	0.0
1174	$pNHD_2^+$	HD	$ooNH_2D_2^+$	D	4.0e-13	0.00	0.0
1175	$pNHD_2^+$	HD	$poNH_2D_2^+$	D	5.0e-13	0.00	0.0
1176	$oNHD_2^+$	HD	$opNH_2D_2^+$	D	2.3e-13	0.00	0.0
1177	$oNHD_2^+$	HD	$ppNH_2D_2^+$	D	6.7e-14	0.00	0.0
1178	$pNHD_2^+$	HD	$opNH_2D_2^+$	D	1.3e-13	0.00	0.0
1179	$pNHD_2^+$	HD	$ppNH_2D_2^+$	D	1.7e-13	0.00	0.0
1180	$oNHD_2^+$	HD	$mNHD_3^+$	H	6.7e-13	0.00	0.0
1181	$oNHD_2^+$	HD	$oNHD_3^+$	H	5.3e-13	0.00	0.0
1182	$pNHD_2^+$	HD	$pNHD_3^+$	H	1.3e-13	0.00	0.0
1183	$pNHD_2^+$	HD	$oNHD_3^+$	H	1.1e-12	0.00	0.0
1184	mND_3^+	oH_2	$mNHD_3^+$	H	2.4e-12	0.00	0.0

Table D6 – *continued* (part 17)

#	Reactants		Products			α	β	γ
1185	pND_3^+	oH_2	$pNHD_3^+$	H		2.4e-12	0.00	0.0
1186	oND_3^+	oH_2	$oNHD_3^+$	H		2.4e-12	0.00	0.0
1187	mND_3^+	pH_2	$mNHD_3^+$	H		2.4e-12	0.00	0.0
1188	pND_3^+	pH_2	$pNHD_3^+$	H		2.4e-12	0.00	0.0
1189	oND_3^+	pH_2	$oNHD_3^+$	H		2.4e-12	0.00	0.0
1190	mND_3^+	HD	$mNHD_3^+$	D		8.0e-13	0.00	0.0
1191	mND_3^+	HD	$oNHD_3^+$	D		4.0e-13	0.00	0.0
1192	pND_3^+	HD	$pNHD_3^+$	D		4.0e-13	0.00	0.0
1193	pND_3^+	HD	$oNHD_3^+$	D		8.0e-13	0.00	0.0
1194	oND_3^+	HD	$mNHD_3^+$	D		2.5e-13	0.00	0.0
1195	oND_3^+	HD	$pNHD_3^+$	D		5.0e-14	0.00	0.0
1196	oND_3^+	HD	$oNHD_3^+$	D		9.0e-13	0.00	0.0
1197	mND_3^+	HD	lND_4^+	H		6.0e-13	0.00	0.0
1198	mND_3^+	HD	oND_4^+	H		6.0e-13	0.00	0.0
1199	pND_3^+	HD	pND_4^+	H		1.2e-12	0.00	0.0
1200	oND_3^+	HD	mND_4^+	H		3.0e-13	0.00	0.0
1201	oND_3^+	HD	oND_4^+	H		7.5e-13	0.00	0.0
1202	oND_3^+	HD	pND_4^+	H		1.5e-13	0.00	0.0
1203	N	oH_3^+	oNH_2^+	H		0.0e+00	0.00	0.0
1204	N	pH_3^+	oNH_2^+	H		0.0e+00	0.00	0.0
1205	N	pH_3^+	pNH_2^+	H		0.0e+00	0.00	0.0
1206	N_2	oH_3^+	oH_2	N_2H^+		1.3e-09	0.00	0.0
1207	N_2	pH_3^+	oH_2	N_2H^+		6.5e-10	0.00	0.0
1208	N_2	pH_3^+	pH_2	N_2H^+		6.5e-10	0.00	0.0
1209	NH	He^+	N^+	H	He	1.1e-09	0.00	0.0
1210	NH	H^+	NH^+	H		2.1e-09	0.00	0.0
1211	NH	oH_3^+	oNH_2^+	oH_2		9.8e-10	0.00	0.0
1212	NH	oH_3^+	oNH_2^+	pH_2		1.6e-10	0.00	0.0
1213	NH	oH_3^+	pNH_2^+	oH_2		1.6e-10	0.00	0.0
1214	NH	pH_3^+	oNH_2^+	oH_2		4.9e-10	0.00	0.0
1215	NH	pH_3^+	oNH_2^+	pH_2		3.3e-10	0.00	0.0
1216	NH	pH_3^+	pNH_2^+	oH_2		3.3e-10	0.00	0.0
1217	NH	pH_3^+	pNH_2^+	pH_2		1.6e-10	0.00	0.0
1218	oNH_2	He^+	NH^+	H	He	8.0e-10	0.00	0.0
1219	pNH_2	He^+	NH^+	H	He	8.0e-10	0.00	0.0
1220	oNH_2	He^+	oH_2	N^+	He	8.0e-10	0.00	0.0
1221	pNH_2	He^+	pH_2	N^+	He	8.0e-10	0.00	0.0
1222	oNH_2	H^+	oNH_2^+	H		2.9e-09	0.00	0.0
1223	pNH_2	H^+	pNH_2^+	H		2.9e-09	0.00	0.0
1224	oNH_2	oH_3^+	oNH_3^+	oH_2		1.1e-09	0.00	0.0
1225	oNH_2	oH_3^+	oNH_3^+	pH_2		1.5e-10	0.00	0.0
1226	oNH_2	oH_3^+	pNH_3^+	oH_2		4.2e-10	0.00	0.0
1227	oNH_2	oH_3^+	pNH_3^+	pH_2		1.2e-10	0.00	0.0
1228	pNH_2	oH_3^+	oNH_3^+	oH_2		4.5e-10	0.00	0.0
1229	pNH_2	oH_3^+	oNH_3^+	pH_2		4.5e-10	0.00	0.0
1230	pNH_2	oH_3^+	pNH_3^+	oH_2		9.0e-10	0.00	0.0
1231	oNH_2	pH_3^+	oNH_3^+	oH_2		4.2e-10	0.00	0.0
1232	oNH_2	pH_3^+	oNH_3^+	pH_2		3.0e-10	0.00	0.0
1233	oNH_2	pH_3^+	pNH_3^+	oH_2		8.4e-10	0.00	0.0
1234	oNH_2	pH_3^+	pNH_3^+	pH_2		2.4e-10	0.00	0.0
1235	pNH_2	pH_3^+	oNH_3^+	oH_2		3.6e-10	0.00	0.0
1236	pNH_2	pH_3^+	pNH_3^+	oH_2		7.2e-10	0.00	0.0
1237	pNH_2	pH_3^+	pNH_3^+	pH_2		7.2e-10	0.00	0.0
1238	oNH_3	He^+	oNH_3^+	He		2.6e-10	0.00	0.0
1239	pNH_3	He^+	pNH_3^+	He		2.6e-10	0.00	0.0
1240	oNH_3	He^+	oNH_2^+	H	He	1.8e-09	0.00	0.0
1241	pNH_3	He^+	oNH_2^+	H	He	8.8e-10	0.00	0.0
1242	pNH_3	He^+	pNH_2^+	H	He	8.8e-10	0.00	0.0
1243	oNH_3	He^+	oH_2	NH^+	He	1.8e-10	0.00	0.0
1244	pNH_3	He^+	oH_2	NH^+	He	8.8e-11	0.00	0.0
1245	pNH_3	He^+	pH_2	NH^+	He	8.8e-11	0.00	0.0
1246	oNH_3	H^+	oNH_3^+	H		5.2e-09	0.00	0.0
1247	pNH_3	H^+	pNH_3^+	H		5.2e-09	0.00	0.0
1248	oNH_3	oH_3^+	mNH_4^+	oH_2		4.7e-09	0.00	0.0
1249	oNH_3	oH_3^+	mNH_4^+	pH_2		5.7e-10	0.00	0.0
1250	oNH_3	oH_3^+	pNH_4^+	oH_2		3.8e-10	0.00	0.0
1251	oNH_3	oH_3^+	pNH_4^+	pH_2		2.3e-10	0.00	0.0
1252	oNH_3	oH_3^+	oNH_4^+	oH_2		2.6e-09	0.00	0.0
1253	oNH_3	oH_3^+	oNH_4^+	pH_2		5.7e-10	0.00	0.0
1254	oNH_3	pH_3^+	mNH_4^+	oH_2		1.5e-09	0.00	0.0
1255	oNH_3	pH_3^+	mNH_4^+	pH_2		1.1e-09	0.00	0.0
1256	oNH_3	pH_3^+	pNH_4^+	oH_2		7.6e-10	0.00	0.0
1257	oNH_3	pH_3^+	oNH_4^+	oH_2		4.6e-09	0.00	0.0
1258	oNH_3	pH_3^+	oNH_4^+	pH_2		1.1e-09	0.00	0.0

Table D6 – *continued* (part 18)

#	Reactants		Products		α	β	γ
1259	pNH_3	oH_3^+	mNH_4^+	oH_2	1.5e-09	0.00	0.0
1260	pNH_3	oH_3^+	mNH_4^+	pH_2	1.1e-09	0.00	0.0
1261	pNH_3	oH_3^+	pNH_4^+	oH_2	7.6e-10	0.00	0.0
1262	pNH_3	oH_3^+	oNH_4^+	oH_2	4.6e-09	0.00	0.0
1263	pNH_3	oH_3^+	oNH_4^+	pH_2	1.1e-09	0.00	0.0
1264	pNH_3	pH_3^+	mNH_4^+	oH_2	7.6e-10	0.00	0.0
1265	pNH_3	pH_3^+	pNH_4^+	oH_2	1.5e-09	0.00	0.0
1266	pNH_3	pH_3^+	pNH_4^+	pH_2	9.1e-10	0.00	0.0
1267	pNH_3	pH_3^+	oNH_4^+	oH_2	3.6e-09	0.00	0.0
1268	pNH_3	pH_3^+	oNH_4^+	pH_2	2.3e-09	0.00	0.0
1269	NH	oH_2D^+	oNH_2^+	HD	7.2e-10	0.00	0.0
1270	NH	oH_2D^+	pNH_2^+	HD	1.4e-10	0.00	0.0
1271	NH	pH_2D^+	oNH_2^+	HD	4.3e-10	0.00	0.0
1272	NH	pH_2D^+	pNH_2^+	HD	4.3e-10	0.00	0.0
1273	NH	oH_2D^+	oH_2	NHD^+	3.6e-10	0.00	0.0
1274	NH	oH_2D^+	pH_2	NHD^+	7.2e-11	0.00	0.0
1275	NH	pH_2D^+	oH_2	NHD^+	2.2e-10	0.00	0.0
1276	NH	pH_2D^+	pH_2	NHD^+	2.2e-10	0.00	0.0
1277	NH	oHD_2^+	oD_2	oNH_2^+	3.2e-10	0.00	0.0
1278	NH	pHD_2^+	pD_2	oNH_2^+	3.2e-10	0.00	0.0
1279	NH	oHD_2^+	oD_2	pNH_2^+	1.1e-10	0.00	0.0
1280	NH	pHD_2^+	pD_2	pNH_2^+	1.1e-10	0.00	0.0
1281	NH	oHD_2^+	NHD^+	HD	8.7e-10	0.00	0.0
1282	NH	pHD_2^+	NHD^+	HD	8.7e-10	0.00	0.0
1283	NH	mD_3^+	oD_2	NHD^+	1.3e-09	0.00	0.0
1284	NH	pD_3^+	pD_2	NHD^+	1.3e-09	0.00	0.0
1285	NH	oD_3^+	oD_2	NHD^+	6.5e-10	0.00	0.0
1286	NH	oD_3^+	pD_2	NHD^+	6.5e-10	0.00	0.0
1287	oNH_2	oH_2D^+	oNH_3^+	HD	8.0e-10	0.00	0.0
1288	oNH_2	oH_2D^+	pNH_3^+	HD	4.0e-10	0.00	0.0
1289	oNH_2	pH_2D^+	oNH_3^+	HD	4.0e-10	0.00	0.0
1290	oNH_2	pH_2D^+	pNH_3^+	HD	8.0e-10	0.00	0.0
1291	pNH_2	oH_2D^+	oNH_3^+	HD	4.0e-10	0.00	0.0
1292	pNH_2	oH_2D^+	pNH_3^+	HD	8.0e-10	0.00	0.0
1293	pNH_2	pH_2D^+	pNH_3^+	HD	1.2e-09	0.00	0.0
1294	oNH_2	oH_2D^+	oNH_2D^+	oH_2	4.3e-10	0.00	0.0
1295	oNH_2	oH_2D^+	oNH_2D^+	pH_2	6.7e-11	0.00	0.0
1296	oNH_2	oH_2D^+	pNH_2D^+	oH_2	6.7e-11	0.00	0.0
1297	oNH_2	oH_2D^+	pNH_2D^+	pH_2	3.3e-11	0.00	0.0
1298	oNH_2	pH_2D^+	oNH_2D^+	oH_2	2.0e-10	0.00	0.0
1299	oNH_2	pH_2D^+	oNH_2D^+	pH_2	2.0e-10	0.00	0.0
1300	oNH_2	pH_2D^+	pNH_2D^+	oH_2	2.0e-10	0.00	0.0
1301	pNH_2	oH_2D^+	oNH_2D^+	oH_2	2.0e-10	0.00	0.0
1302	pNH_2	oH_2D^+	oNH_2D^+	pH_2	2.0e-10	0.00	0.0
1303	pNH_2	oH_2D^+	pNH_2D^+	oH_2	2.0e-10	0.00	0.0
1304	pNH_2	pH_2D^+	oNH_2D^+	oH_2	3.0e-10	0.00	0.0
1305	pNH_2	pH_2D^+	pNH_2D^+	pH_2	3.0e-10	0.00	0.0
1306	oNH_2	oHD_2^+	oD_2	oNH_3^+	4.0e-10	0.00	0.0
1307	oNH_2	pHD_2^+	pD_2	oNH_3^+	4.0e-10	0.00	0.0
1308	oNH_2	oHD_2^+	oD_2	pNH_3^+	2.0e-10	0.00	0.0
1309	oNH_2	pHD_2^+	pD_2	pNH_3^+	2.0e-10	0.00	0.0
1310	pNH_2	oHD_2^+	oD_2	pNH_3^+	6.0e-10	0.00	0.0
1311	pNH_2	pHD_2^+	pD_2	pNH_3^+	6.0e-10	0.00	0.0
1312	oNH_2	oHD_2^+	oNH_2D^+	HD	1.0e-09	0.00	0.0
1313	oNH_2	pHD_2^+	oNH_2D^+	HD	1.0e-09	0.00	0.0
1314	oNH_2	oHD_2^+	pNH_2D^+	HD	2.0e-10	0.00	0.0
1315	oNH_2	pHD_2^+	pNH_2D^+	HD	2.0e-10	0.00	0.0
1316	pNH_2	oHD_2^+	oNH_2D^+	HD	6.0e-10	0.00	0.0
1317	pNH_2	pHD_2^+	oNH_2D^+	HD	6.0e-10	0.00	0.0
1318	pNH_2	oHD_2^+	pNH_2D^+	HD	6.0e-10	0.00	0.0
1319	pNH_2	pHD_2^+	pNH_2D^+	HD	6.0e-10	0.00	0.0
1320	oNH_2	mD_3^+	oD_2	oNH_2D^+	1.8e-09	0.00	0.0
1321	oNH_2	pD_3^+	pD_2	oNH_2D^+	1.8e-09	0.00	0.0
1322	oNH_2	oD_3^+	oD_2	oNH_2D^+	9.0e-10	0.00	0.0
1323	oNH_2	oD_3^+	pD_2	oNH_2D^+	9.0e-10	0.00	0.0
1324	pNH_2	mD_3^+	oD_2	pNH_2D^+	1.8e-09	0.00	0.0
1325	pNH_2	pD_3^+	pD_2	pNH_2D^+	1.8e-09	0.00	0.0
1326	pNH_2	oD_3^+	oD_2	pNH_2D^+	9.0e-10	0.00	0.0
1327	pNH_2	oD_3^+	pD_2	pNH_2D^+	9.0e-10	0.00	0.0
1328	oNH_3	oH_2D^+	mNH_4^+	HD	3.5e-09	0.00	0.0
1329	oNH_3	oH_2D^+	pNH_4^+	HD	4.0e-10	0.00	0.0
1330	oNH_3	oH_2D^+	oNH_4^+	HD	2.1e-09	0.00	0.0
1331	oNH_3	pH_2D^+	mNH_4^+	HD	1.5e-09	0.00	0.0
1332	oNH_3	pH_2D^+	oNH_4^+	HD	4.5e-09	0.00	0.0

Table D6 – *continued* (part 19)

#	Reactants		Products		α	β	γ
1333	pNH_3	oH_2D^+	mNH_4^+	HD	1.0e-09	0.00	0.0
1334	pNH_3	oH_2D^+	pNH_4^+	HD	8.1e-10	0.00	0.0
1335	pNH_3	oH_2D^+	oNH_4^+	HD	4.2e-09	0.00	0.0
1336	pNH_3	pH_2D^+	pNH_4^+	HD	2.4e-09	0.00	0.0
1337	pNH_3	pH_2D^+	oNH_4^+	HD	3.6e-09	0.00	0.0
1338	oNH_3	oH_2D^+	oNH_3D^+	oH_2	1.9e-09	0.00	0.0
1339	oNH_3	oH_2D^+	oNH_3D^+	pH_2	2.5e-10	0.00	0.0
1340	oNH_3	oH_2D^+	pNH_3D^+	oH_2	7.1e-10	0.00	0.0
1341	oNH_3	oH_2D^+	pNH_3D^+	pH_2	2.0e-10	0.00	0.0
1342	oNH_3	pH_2D^+	oNH_3D^+	oH_2	7.6e-10	0.00	0.0
1343	oNH_3	pH_2D^+	oNH_3D^+	pH_2	7.6e-10	0.00	0.0
1344	oNH_3	pH_2D^+	pNH_3D^+	oH_2	1.5e-09	0.00	0.0
1345	pNH_3	oH_2D^+	oNH_3D^+	oH_2	7.1e-10	0.00	0.0
1346	pNH_3	oH_2D^+	oNH_3D^+	pH_2	5.1e-10	0.00	0.0
1347	pNH_3	oH_2D^+	pNH_3D^+	oH_2	1.4e-09	0.00	0.0
1348	pNH_3	oH_2D^+	pNH_3D^+	pH_2	4.0e-10	0.00	0.0
1349	pNH_3	pH_2D^+	oNH_3D^+	oH_2	6.1e-10	0.00	0.0
1350	pNH_3	pH_2D^+	pNH_3D^+	oH_2	1.2e-09	0.00	0.0
1351	pNH_3	pH_2D^+	pNH_3D^+	pH_2	1.2e-09	0.00	0.0
1352	oNH_3	oHD_2^+	oD_2	mNH_4^+	1.9e-09	0.00	0.0
1353	oNH_3	pHD_2^+	pD_2	mNH_4^+	1.9e-09	0.00	0.0
1354	oNH_3	oHD_2^+	oD_2	oNH_4^+	1.1e-09	0.00	0.0
1355	oNH_3	pHD_2^+	pD_2	oNH_4^+	1.1e-09	0.00	0.0
1356	pNH_3	oHD_2^+	oD_2	pNH_4^+	7.6e-10	0.00	0.0
1357	pNH_3	pHD_2^+	pD_2	pNH_4^+	7.6e-10	0.00	0.0
1358	pNH_3	oHD_2^+	oD_2	oNH_4^+	2.3e-09	0.00	0.0
1359	pNH_3	pHD_2^+	pD_2	oNH_4^+	2.3e-09	0.00	0.0
1360	oNH_3	oHD_2^+	oNH_3D^+	HD	4.5e-09	0.00	0.0
1361	oNH_3	pHD_2^+	oNH_3D^+	HD	4.5e-09	0.00	0.0
1362	oNH_3	oHD_2^+	pNH_3D^+	HD	1.5e-09	0.00	0.0
1363	oNH_3	pHD_2^+	pNH_3D^+	HD	1.5e-09	0.00	0.0
1364	pNH_3	oHD_2^+	oNH_3D^+	HD	1.5e-09	0.00	0.0
1365	pNH_3	pHD_2^+	oNH_3D^+	HD	1.5e-09	0.00	0.0
1366	pNH_3	oHD_2^+	pNH_3D^+	HD	4.5e-09	0.00	0.0
1367	pNH_3	pHD_2^+	pNH_3D^+	HD	4.5e-09	0.00	0.0
1368	oNH_3	mD_3^+	oD_2	oNH_3D^+	9.1e-09	0.00	0.0
1369	oNH_3	pD_3^+	pD_2	oNH_3D^+	9.1e-09	0.00	0.0
1370	oNH_3	oD_3^+	oD_2	oNH_3D^+	4.6e-09	0.00	0.0
1371	oNH_3	oD_3^+	pD_2	oNH_3D^+	4.6e-09	0.00	0.0
1372	pNH_3	mD_3^+	oD_2	pNH_3D^+	9.1e-09	0.00	0.0
1373	pNH_3	pD_3^+	pD_2	pNH_3D^+	9.1e-09	0.00	0.0
1374	pNH_3	oD_3^+	oD_2	pNH_3D^+	4.6e-09	0.00	0.0
1375	pNH_3	oD_3^+	pD_2	pNH_3D^+	4.6e-09	0.00	0.0
1376	ND	oH_3^+	oH_2	NHD^+	1.3e-09	0.00	0.0
1377	ND	pH_3^+	oH_2	NHD^+	6.5e-10	0.00	0.0
1378	ND	pH_3^+	pH_2	NHD^+	6.5e-10	0.00	0.0
1379	ND	oH_2D^+	NHD^+	HD	8.7e-10	0.00	0.0
1380	ND	pH_2D^+	NHD^+	HD	8.7e-10	0.00	0.0
1381	ND	oH_2D^+	oND_2^+	oH_2	2.9e-10	0.00	0.0
1382	ND	oH_2D^+	pND_2^+	oH_2	1.4e-10	0.00	0.0
1383	ND	pH_2D^+	oND_2^+	pH_2	2.9e-10	0.00	0.0
1384	ND	pH_2D^+	pND_2^+	pH_2	1.4e-10	0.00	0.0
1385	ND	oHD_2^+	oD_2	NHD^+	3.4e-10	0.00	0.0
1386	ND	oHD_2^+	pD_2	NHD^+	9.6e-11	0.00	0.0
1387	ND	pHD_2^+	oD_2	NHD^+	1.9e-10	0.00	0.0
1388	ND	pHD_2^+	pD_2	NHD^+	2.4e-10	0.00	0.0
1389	ND	oHD_2^+	oND_2^+	HD	6.7e-10	0.00	0.0
1390	ND	oHD_2^+	pND_2^+	HD	1.9e-10	0.00	0.0
1391	ND	pHD_2^+	oND_2^+	HD	3.9e-10	0.00	0.0
1392	ND	pHD_2^+	pND_2^+	HD	4.8e-10	0.00	0.0
1393	ND	mD_3^+	oND_2^+	oD_2	8.7e-10	0.00	0.0
1394	ND	mD_3^+	oND_2^+	pD_2	2.2e-10	0.00	0.0
1395	ND	mD_3^+	pND_2^+	oD_2	2.2e-10	0.00	0.0
1396	ND	pD_3^+	oND_2^+	pD_2	4.3e-10	0.00	0.0
1397	ND	pD_3^+	pND_2^+	oD_2	4.3e-10	0.00	0.0
1398	ND	pD_3^+	pND_2^+	pD_2	4.3e-10	0.00	0.0
1399	ND	oD_3^+	oND_2^+	oD_2	4.3e-10	0.00	0.0
1400	ND	oD_3^+	oND_2^+	pD_2	3.3e-10	0.00	0.0
1401	ND	oD_3^+	pND_2^+	oD_2	3.3e-10	0.00	0.0
1402	ND	oD_3^+	pND_2^+	pD_2	2.2e-10	0.00	0.0
1403	NHD	oH_3^+	oNH_2D^+	oH_2	1.4e-09	0.00	0.0
1404	NHD	oH_3^+	oNH_2D^+	pH_2	2.2e-10	0.00	0.0
1405	NHD	oH_3^+	pNH_2D^+	oH_2	2.2e-10	0.00	0.0
1406	NHD	pH_3^+	oNH_2D^+	oH_2	6.8e-10	0.00	0.0

Table D6 – *continued* (part 20)

#	Reactants		Products		α	β	γ
1407	NHD	pH_3^+	oNH_2D^+	pH_2	4.5e-10	0.00	0.0
1408	NHD	pH_3^+	pNH_2D^+	oH_2	4.5e-10	0.00	0.0
1409	NHD	pH_3^+	pNH_2D^+	pH_2	2.2e-10	0.00	0.0
1410	NHD	oH_2D^+	oNH_2D^+	HD	1.0e-09	0.00	0.0
1411	NHD	oH_2D^+	pNH_2D^+	HD	2.0e-10	0.00	0.0
1412	NHD	pH_2D^+	oNH_2D^+	HD	6.0e-10	0.00	0.0
1413	NHD	pH_2D^+	pNH_2D^+	HD	6.0e-10	0.00	0.0
1414	NHD	oH_2D^+	$oNHD_2^+$	oH_2	3.3e-10	0.00	0.0
1415	NHD	oH_2D^+	$pNHD_2^+$	oH_2	1.7e-10	0.00	0.0
1416	NHD	oH_2D^+	$oNHD_2^+$	pH_2	6.7e-11	0.00	0.0
1417	NHD	oH_2D^+	$pNHD_2^+$	pH_2	3.3e-11	0.00	0.0
1418	NHD	pH_2D^+	$oNHD_2^+$	oH_2	2.0e-10	0.00	0.0
1419	NHD	pH_2D^+	$pNHD_2^+$	oH_2	1.0e-10	0.00	0.0
1420	NHD	pH_2D^+	$oNHD_2^+$	pH_2	2.0e-10	0.00	0.0
1421	NHD	pH_2D^+	$pNHD_2^+$	pH_2	1.0e-10	0.00	0.0
1422	NHD	oHD_2^+	oD_2	oNH_2D^+	3.5e-10	0.00	0.0
1423	NHD	oHD_2^+	pD_2	oNH_2D^+	1.0e-10	0.00	0.0
1424	NHD	pHD_2^+	oD_2	oNH_2D^+	2.0e-10	0.00	0.0
1425	NHD	pHD_2^+	pD_2	oNH_2D^+	2.5e-10	0.00	0.0
1426	NHD	oHD_2^+	oD_2	pNH_2D^+	1.2e-10	0.00	0.0
1427	NHD	oHD_2^+	pD_2	pNH_2D^+	3.3e-11	0.00	0.0
1428	NHD	pHD_2^+	oD_2	pNH_2D^+	6.7e-11	0.00	0.0
1429	NHD	pHD_2^+	pD_2	pNH_2D^+	8.3e-11	0.00	0.0
1430	NHD	oHD_2^+	$oNHD_2^+$	HD	9.3e-10	0.00	0.0
1431	NHD	oHD_2^+	$pNHD_2^+$	HD	2.7e-10	0.00	0.0
1432	NHD	pHD_2^+	$oNHD_2^+$	HD	5.3e-10	0.00	0.0
1433	NHD	pHD_2^+	$pNHD_2^+$	HD	6.7e-10	0.00	0.0
1434	NHD	mD_3^+	$oNHD_2^+$	oD_2	1.2e-09	0.00	0.0
1435	NHD	mD_3^+	$oNHD_2^+$	pD_2	3.0e-10	0.00	0.0
1436	NHD	mD_3^+	$pNHD_2^+$	oD_2	3.0e-10	0.00	0.0
1437	NHD	pD_3^+	$oNHD_2^+$	pD_2	6.0e-10	0.00	0.0
1438	NHD	pD_3^+	$pNHD_2^+$	oD_2	6.0e-10	0.00	0.0
1439	NHD	pD_3^+	$pNHD_2^+$	pD_2	6.0e-10	0.00	0.0
1440	NHD	oD_3^+	$oNHD_2^+$	oD_2	6.0e-10	0.00	0.0
1441	NHD	oD_3^+	$oNHD_2^+$	pD_2	4.5e-10	0.00	0.0
1442	NHD	oD_3^+	$pNHD_2^+$	oD_2	4.5e-10	0.00	0.0
1443	NHD	oD_3^+	$pNHD_2^+$	pD_2	3.0e-10	0.00	0.0
1444	oND_2	oH_3^+	$oNHD_2^+$	oH_2	1.8e-09	0.00	0.0
1445	pND_2	oH_3^+	$pNHD_2^+$	oH_2	1.8e-09	0.00	0.0
1446	oND_2	pH_3^+	$oNHD_2^+$	oH_2	9.0e-10	0.00	0.0
1447	pND_2	pH_3^+	$pNHD_2^+$	oH_2	9.0e-10	0.00	0.0
1448	oND_2	pH_3^+	$oNHD_2^+$	pH_2	9.0e-10	0.00	0.0
1449	pND_2	pH_3^+	$pNHD_2^+$	pH_2	9.0e-10	0.00	0.0
1450	oND_2	oH_2D^+	$oNHD_2^+$	HD	9.3e-10	0.00	0.0
1451	oND_2	oH_2D^+	$pNHD_2^+$	HD	2.7e-10	0.00	0.0
1452	pND_2	oH_2D^+	$oNHD_2^+$	HD	5.3e-10	0.00	0.0
1453	pND_2	oH_2D^+	$pNHD_2^+$	HD	6.7e-10	0.00	0.0
1454	oND_2	pH_2D^+	$oNHD_2^+$	HD	9.3e-10	0.00	0.0
1455	oND_2	pH_2D^+	$pNHD_2^+$	HD	2.7e-10	0.00	0.0
1456	pND_2	pH_2D^+	$oNHD_2^+$	HD	5.3e-10	0.00	0.0
1457	pND_2	pH_2D^+	$pNHD_2^+$	HD	6.7e-10	0.00	0.0
1458	oND_2	oH_2D^+	mND_3^+	oH_2	3.3e-10	0.00	0.0
1459	oND_2	oH_2D^+	oND_3^+	oH_2	2.7e-10	0.00	0.0
1460	pND_2	oH_2D^+	pND_3^+	oH_2	6.7e-11	0.00	0.0
1461	pND_2	oH_2D^+	oND_3^+	oH_2	5.3e-10	0.00	0.0
1462	oND_2	pH_2D^+	mND_3^+	pH_2	3.3e-10	0.00	0.0
1463	oND_2	pH_2D^+	oND_3^+	pH_2	2.7e-10	0.00	0.0
1464	pND_2	pH_2D^+	pND_3^+	pH_2	6.7e-11	0.00	0.0
1465	pND_2	pH_2D^+	oND_3^+	pH_2	5.3e-10	0.00	0.0
1466	oND_2	oHD_2^+	$oNHD_2^+$	oD_2	3.8e-10	0.00	0.0
1467	oND_2	oHD_2^+	$oNHD_2^+$	pD_2	8.3e-11	0.00	0.0
1468	oND_2	oHD_2^+	$pNHD_2^+$	oD_2	8.3e-11	0.00	0.0
1469	oND_2	oHD_2^+	$pNHD_2^+$	pD_2	5.0e-11	0.00	0.0
1470	oND_2	pHD_2^+	$oNHD_2^+$	oD_2	1.7e-10	0.00	0.0
1471	oND_2	pHD_2^+	$oNHD_2^+$	pD_2	2.0e-10	0.00	0.0
1472	oND_2	pHD_2^+	$pNHD_2^+$	oD_2	2.0e-10	0.00	0.0
1473	oND_2	pHD_2^+	$pNHD_2^+$	pD_2	3.3e-11	0.00	0.0
1474	pND_2	oHD_2^+	$oNHD_2^+$	oD_2	1.7e-10	0.00	0.0
1475	pND_2	oHD_2^+	$oNHD_2^+$	pD_2	2.0e-10	0.00	0.0
1476	pND_2	oHD_2^+	$pNHD_2^+$	oD_2	2.0e-10	0.00	0.0
1477	pND_2	oHD_2^+	$pNHD_2^+$	pD_2	3.3e-11	0.00	0.0
1478	pND_2	pHD_2^+	$oNHD_2^+$	oD_2	2.0e-10	0.00	0.0
1479	pND_2	pHD_2^+	$oNHD_2^+$	pD_2	6.7e-11	0.00	0.0
1480	pND_2	pHD_2^+	$pNHD_2^+$	oD_2	6.7e-11	0.00	0.0

Table D6 – *continued* (part 21)

#	Reactants		Products		α	β	γ
1481	pND_2	pHD_2^+	$pNHD_2^+$	pD_2	2.7e-10	0.00	0.0
1482	oND_2	oHD_2^+	mND_3^+	HD	6.7e-10	0.00	0.0
1483	oND_2	oHD_2^+	oND_3^+	HD	5.3e-10	0.00	0.0
1484	oND_2	pHD_2^+	mND_3^+	HD	3.3e-10	0.00	0.0
1485	oND_2	pHD_2^+	pND_3^+	HD	6.7e-11	0.00	0.0
1486	oND_2	pHD_2^+	oND_3^+	HD	8.0e-10	0.00	0.0
1487	pND_2	oHD_2^+	mND_3^+	HD	3.3e-10	0.00	0.0
1488	pND_2	oHD_2^+	pND_3^+	HD	6.7e-11	0.00	0.0
1489	pND_2	oHD_2^+	oND_3^+	HD	8.0e-10	0.00	0.0
1490	pND_2	pHD_2^+	pND_3^+	HD	1.3e-10	0.00	0.0
1491	pND_2	pHD_2^+	oND_3^+	HD	1.1e-09	0.00	0.0
1492	oND_2	mD_3^+	mND_3^+	oD_2	9.0e-10	0.00	0.0
1493	oND_2	mD_3^+	mND_3^+	pD_2	1.8e-10	0.00	0.0
1494	oND_2	mD_3^+	oND_3^+	oD_2	5.4e-10	0.00	0.0
1495	oND_2	mD_3^+	oND_3^+	pD_2	1.8e-10	0.00	0.0
1496	pND_2	mD_3^+	mND_3^+	oD_2	3.6e-10	0.00	0.0
1497	pND_2	mD_3^+	mND_3^+	pD_2	4.2e-10	0.00	0.0
1498	pND_2	mD_3^+	pND_3^+	oD_2	6.0e-11	0.00	0.0
1499	pND_2	mD_3^+	oND_3^+	oD_2	8.4e-10	0.00	0.0
1500	pND_2	mD_3^+	oND_3^+	pD_2	1.2e-10	0.00	0.0
1501	oND_2	pD_3^+	mND_3^+	pD_2	3.0e-10	0.00	0.0
1502	oND_2	pD_3^+	pND_3^+	oD_2	3.0e-10	0.00	0.0
1503	oND_2	pD_3^+	oND_3^+	oD_2	6.0e-10	0.00	0.0
1504	oND_2	pD_3^+	oND_3^+	pD_2	6.0e-10	0.00	0.0
1505	pND_2	pD_3^+	pND_3^+	pD_2	3.6e-10	0.00	0.0
1506	pND_2	pD_3^+	oND_3^+	oD_2	7.2e-10	0.00	0.0
1507	pND_2	pD_3^+	oND_3^+	pD_2	7.2e-10	0.00	0.0
1508	oND_2	oD_3^+	mND_3^+	oD_2	3.4e-10	0.00	0.0
1509	oND_2	oD_3^+	mND_3^+	pD_2	2.6e-10	0.00	0.0
1510	oND_2	oD_3^+	pND_3^+	oD_2	3.7e-11	0.00	0.0
1511	oND_2	oD_3^+	pND_3^+	pD_2	2.2e-11	0.00	0.0
1512	oND_2	oD_3^+	oND_3^+	oD_2	8.0e-10	0.00	0.0
1513	oND_2	oD_3^+	oND_3^+	pD_2	3.4e-10	0.00	0.0
1514	pND_2	oD_3^+	mND_3^+	oD_2	2.2e-10	0.00	0.0
1515	pND_2	oD_3^+	mND_3^+	pD_2	7.5e-11	0.00	0.0
1516	pND_2	oD_3^+	pND_3^+	oD_2	7.5e-11	0.00	0.0
1517	pND_2	oD_3^+	pND_3^+	pD_2	4.5e-11	0.00	0.0
1518	pND_2	oD_3^+	oND_3^+	oD_2	6.9e-10	0.00	0.0
1519	pND_2	oD_3^+	oND_3^+	pD_2	6.9e-10	0.00	0.0
1520	oNH_2D	H^+	oNH_2D^+	H	5.2e-09	0.00	0.0
1521	pNH_2D	H^+	pNH_2D^+	H	5.2e-09	0.00	0.0
1522	oNH_2D	oH_3^+	oNH_3D^+	oH_2	5.6e-09	0.00	0.0
1523	oNH_2D	oH_3^+	oNH_3D^+	pH_2	7.6e-10	0.00	0.0
1524	oNH_2D	oH_3^+	pNH_3D^+	oH_2	2.1e-09	0.00	0.0
1525	oNH_2D	oH_3^+	pNH_3D^+	pH_2	6.1e-10	0.00	0.0
1526	pNH_2D	oH_3^+	oNH_3D^+	oH_2	2.3e-09	0.00	0.0
1527	pNH_2D	oH_3^+	oNH_3D^+	pH_2	2.3e-09	0.00	0.0
1528	pNH_2D	oH_3^+	pNH_3D^+	oH_2	4.6e-09	0.00	0.0
1529	oNH_2D	pH_3^+	oNH_3D^+	oH_2	2.1e-09	0.00	0.0
1530	oNH_2D	pH_3^+	oNH_3D^+	pH_2	1.5e-09	0.00	0.0
1531	oNH_2D	pH_3^+	pNH_3D^+	oH_2	4.2e-09	0.00	0.0
1532	oNH_2D	pH_3^+	pNH_3D^+	pH_2	1.2e-09	0.00	0.0
1533	pNH_2D	pH_3^+	oNH_3D^+	oH_2	1.8e-09	0.00	0.0
1534	pNH_2D	pH_3^+	pNH_3D^+	oH_2	3.6e-09	0.00	0.0
1535	pNH_2D	pH_3^+	pNH_3D^+	pH_2	3.6e-09	0.00	0.0
1536	oNH_2D	oH_2D^+	oNH_3D^+	HD	4.0e-09	0.00	0.0
1537	oNH_2D	oH_2D^+	pNH_3D^+	HD	2.0e-09	0.00	0.0
1538	oNH_2D	pH_2D^+	oNH_3D^+	HD	2.0e-09	0.00	0.0
1539	oNH_2D	pH_2D^+	pNH_3D^+	HD	4.0e-09	0.00	0.0
1540	pNH_2D	oH_2D^+	oNH_3D^+	HD	2.0e-09	0.00	0.0
1541	pNH_2D	oH_2D^+	pNH_3D^+	HD	4.0e-09	0.00	0.0
1542	pNH_2D	pH_2D^+	pNH_3D^+	HD	6.1e-09	0.00	0.0
1543	oNH_2D	oH_2D^+	$ooNH_2D_2^+$	oH_2	1.5e-09	0.00	0.0
1544	oNH_2D	oH_2D^+	$poNH_2D_2^+$	oH_2	7.3e-10	0.00	0.0
1545	oNH_2D	oH_2D^+	$ooNH_2D_2^+$	pH_2	2.2e-10	0.00	0.0
1546	oNH_2D	oH_2D^+	$poNH_2D_2^+$	pH_2	1.1e-10	0.00	0.0
1547	oNH_2D	oH_2D^+	$opNH_2D_2^+$	oH_2	2.2e-10	0.00	0.0
1548	oNH_2D	oH_2D^+	$ppNH_2D_2^+$	oH_2	1.1e-10	0.00	0.0
1549	oNH_2D	oH_2D^+	$opNH_2D_2^+$	pH_2	1.1e-10	0.00	0.0
1550	oNH_2D	oH_2D^+	$ppNH_2D_2^+$	pH_2	5.6e-11	0.00	0.0
1551	oNH_2D	pH_2D^+	$ooNH_2D_2^+$	oH_2	6.7e-10	0.00	0.0
1552	oNH_2D	pH_2D^+	$poNH_2D_2^+$	oH_2	3.4e-10	0.00	0.0
1553	oNH_2D	pH_2D^+	$ooNH_2D_2^+$	pH_2	6.7e-10	0.00	0.0
1554	oNH_2D	pH_2D^+	$poNH_2D_2^+$	pH_2	3.4e-10	0.00	0.0

Table D6 – *continued* (part 22)

#	Reactants		Products		α	β	γ
1555	oNH_2D	pH_2D^+	$opNH_2D_2^+$	oH_2	6.7e-10	0.00	0.0
1556	oNH_2D	pH_2D^+	$ppNH_2D_2^+$	oH_2	3.4e-10	0.00	0.0
1557	pNH_2D	oH_2D^+	$ooNH_2D_2^+$	oH_2	6.7e-10	0.00	0.0
1558	pNH_2D	oH_2D^+	$poNH_2D_2^+$	oH_2	3.4e-10	0.00	0.0
1559	pNH_2D	oH_2D^+	$ooNH_2D_2^+$	pH_2	6.7e-10	0.00	0.0
1560	pNH_2D	oH_2D^+	$poNH_2D_2^+$	pH_2	3.4e-10	0.00	0.0
1561	pNH_2D	oH_2D^+	$opNH_2D_2^+$	oH_2	6.7e-10	0.00	0.0
1562	pNH_2D	oH_2D^+	$ppNH_2D_2^+$	oH_2	3.4e-10	0.00	0.0
1563	pNH_2D	pH_2D^+	$ooNH_2D_2^+$	oH_2	1.0e-09	0.00	0.0
1564	pNH_2D	pH_2D^+	$poNH_2D_2^+$	oH_2	5.1e-10	0.00	0.0
1565	pNH_2D	pH_2D^+	$opNH_2D_2^+$	pH_2	1.0e-09	0.00	0.0
1566	pNH_2D	pH_2D^+	$ppNH_2D_2^+$	pH_2	5.1e-10	0.00	0.0
1567	oNH_2D	oHD_2^+	oD_2	oNH_3D^+	1.6e-09	0.00	0.0
1568	oNH_2D	oHD_2^+	pD_2	oNH_3D^+	4.5e-10	0.00	0.0
1569	oNH_2D	pHD_2^+	oD_2	oNH_3D^+	9.0e-10	0.00	0.0
1570	oNH_2D	pHD_2^+	pD_2	oNH_3D^+	1.1e-09	0.00	0.0
1571	oNH_2D	oHD_2^+	oD_2	pNH_3D^+	7.9e-10	0.00	0.0
1572	oNH_2D	oHD_2^+	pD_2	pNH_3D^+	2.2e-10	0.00	0.0
1573	oNH_2D	pHD_2^+	oD_2	pNH_3D^+	4.5e-10	0.00	0.0
1574	oNH_2D	pHD_2^+	pD_2	pNH_3D^+	5.6e-10	0.00	0.0
1575	pNH_2D	oHD_2^+	oD_2	pNH_3D^+	2.4e-09	0.00	0.0
1576	pNH_2D	oHD_2^+	pD_2	pNH_3D^+	6.7e-10	0.00	0.0
1577	pNH_2D	pHD_2^+	oD_2	pNH_3D^+	1.3e-09	0.00	0.0
1578	pNH_2D	pHD_2^+	pD_2	pNH_3D^+	1.7e-09	0.00	0.0
1579	oNH_2D	oHD_2^+	$ooNH_2D_2^+$	HD	3.9e-09	0.00	0.0
1580	oNH_2D	oHD_2^+	$poNH_2D_2^+$	HD	1.1e-09	0.00	0.0
1581	oNH_2D	pHD_2^+	$ooNH_2D_2^+$	HD	2.2e-09	0.00	0.0
1582	oNH_2D	pHD_2^+	$poNH_2D_2^+$	HD	2.8e-09	0.00	0.0
1583	oNH_2D	oHD_2^+	$opNH_2D_2^+$	HD	7.9e-10	0.00	0.0
1584	oNH_2D	oHD_2^+	$ppNH_2D_2^+$	HD	2.2e-10	0.00	0.0
1585	oNH_2D	pHD_2^+	$opNH_2D_2^+$	HD	4.5e-10	0.00	0.0
1586	oNH_2D	pHD_2^+	$ppNH_2D_2^+$	HD	5.6e-10	0.00	0.0
1587	pNH_2D	oHD_2^+	$ooNH_2D_2^+$	HD	2.4e-09	0.00	0.0
1588	pNH_2D	oHD_2^+	$poNH_2D_2^+$	HD	6.7e-10	0.00	0.0
1589	pNH_2D	pHD_2^+	$ooNH_2D_2^+$	HD	1.3e-09	0.00	0.0
1590	pNH_2D	pHD_2^+	$poNH_2D_2^+$	HD	1.7e-09	0.00	0.0
1591	pNH_2D	oHD_2^+	$opNH_2D_2^+$	HD	2.4e-09	0.00	0.0
1592	pNH_2D	oHD_2^+	$ppNH_2D_2^+$	HD	6.7e-10	0.00	0.0
1593	pNH_2D	pHD_2^+	$opNH_2D_2^+$	HD	1.3e-09	0.00	0.0
1594	pNH_2D	pHD_2^+	$ppNH_2D_2^+$	HD	1.7e-09	0.00	0.0
1595	oNH_2D	mD_3^+	$ooNH_2D_2^+$	oD_2	6.1e-09	0.00	0.0
1596	oNH_2D	mD_3^+	$ooNH_2D_2^+$	pD_2	1.5e-09	0.00	0.0
1597	oNH_2D	mD_3^+	$poNH_2D_2^+$	oD_2	1.5e-09	0.00	0.0
1598	oNH_2D	pD_3^+	$ooNH_2D_2^+$	pD_2	3.0e-09	0.00	0.0
1599	oNH_2D	pD_3^+	$poNH_2D_2^+$	oD_2	3.0e-09	0.00	0.0
1600	oNH_2D	pD_3^+	$poNH_2D_2^+$	pD_2	3.0e-09	0.00	0.0
1601	oNH_2D	oD_3^+	$ooNH_2D_2^+$	oD_2	3.0e-09	0.00	0.0
1602	oNH_2D	oD_3^+	$ooNH_2D_2^+$	pD_2	2.3e-09	0.00	0.0
1603	oNH_2D	oD_3^+	$poNH_2D_2^+$	oD_2	2.3e-09	0.00	0.0
1604	oNH_2D	oD_3^+	$poNH_2D_2^+$	pD_2	1.5e-09	0.00	0.0
1605	pNH_2D	mD_3^+	$opNH_2D_2^+$	oD_2	6.1e-09	0.00	0.0
1606	pNH_2D	mD_3^+	$opNH_2D_2^+$	pD_2	1.5e-09	0.00	0.0
1607	pNH_2D	mD_3^+	$ppNH_2D_2^+$	oD_2	1.5e-09	0.00	0.0
1608	pNH_2D	pD_3^+	$opNH_2D_2^+$	pD_2	3.0e-09	0.00	0.0
1609	pNH_2D	pD_3^+	$ppNH_2D_2^+$	oD_2	3.0e-09	0.00	0.0
1610	pNH_2D	pD_3^+	$ppNH_2D_2^+$	pD_2	3.0e-09	0.00	0.0
1611	pNH_2D	oD_3^+	$opNH_2D_2^+$	oD_2	3.0e-09	0.00	0.0
1612	pNH_2D	oD_3^+	$opNH_2D_2^+$	pD_2	2.3e-09	0.00	0.0
1613	pNH_2D	oD_3^+	$ppNH_2D_2^+$	oD_2	2.3e-09	0.00	0.0
1614	pNH_2D	oD_3^+	$ppNH_2D_2^+$	pD_2	1.5e-09	0.00	0.0
1615	$oNHD_2$	H^+	$oNHD_2^+$	H	5.2e-09	0.00	0.0
1616	$pNHD_2$	H^+	$pNHD_2^+$	H	5.2e-09	0.00	0.0
1617	$oNHD_2$	oH_3^+	$ooNH_2D_2^+$	oH_2	6.8e-09	0.00	0.0
1618	$pNHD_2$	oH_3^+	$poNH_2D_2^+$	oH_2	6.8e-09	0.00	0.0
1619	$oNHD_2$	oH_3^+	$ooNH_2D_2^+$	pH_2	1.1e-09	0.00	0.0
1620	$pNHD_2$	oH_3^+	$poNH_2D_2^+$	pH_2	1.1e-09	0.00	0.0
1621	$oNHD_2$	oH_3^+	$opNH_2D_2^+$	oH_2	1.1e-09	0.00	0.0
1622	$pNHD_2$	oH_3^+	$ppNH_2D_2^+$	oH_2	1.1e-09	0.00	0.0
1623	$oNHD_2$	pH_3^+	$ooNH_2D_2^+$	oH_2	3.4e-09	0.00	0.0
1624	$pNHD_2$	pH_3^+	$poNH_2D_2^+$	oH_2	3.4e-09	0.00	0.0
1625	$oNHD_2$	pH_3^+	$ooNH_2D_2^+$	pH_2	2.3e-09	0.00	0.0
1626	$pNHD_2$	pH_3^+	$poNH_2D_2^+$	pH_2	2.3e-09	0.00	0.0
1627	$oNHD_2$	pH_3^+	$opNH_2D_2^+$	oH_2	2.3e-09	0.00	0.0
1628	$pNHD_2$	pH_3^+	$ppNH_2D_2^+$	oH_2	2.3e-09	0.00	0.0

Table D6 – *continued* (part 23)

#	Reactants		Products		α	β	γ
1629	$oNHD_2$	pH_3^+	$opNH_2D_2^+$	pH_2	1.1e-09	0.00	0.0
1630	$pNHD_2$	pH_3^+	$ppNH_2D_2^+$	pH_2	1.1e-09	0.00	0.0
1631	$oNHD_2$	oH_2D^+	$ooNH_2D_2^+$	HD	3.9e-09	0.00	0.0
1632	$oNHD_2$	oH_2D^+	$poNH_2D_2^+$	HD	1.1e-09	0.00	0.0
1633	$pNHD_2$	oH_2D^+	$ooNH_2D_2^+$	HD	2.2e-09	0.00	0.0
1634	$pNHD_2$	oH_2D^+	$poNH_2D_2^+$	HD	2.8e-09	0.00	0.0
1635	$oNHD_2$	oH_2D^+	$opNH_2D_2^+$	HD	7.9e-10	0.00	0.0
1636	$oNHD_2$	oH_2D^+	$ppNH_2D_2^+$	HD	2.2e-10	0.00	0.0
1637	$pNHD_2$	oH_2D^+	$opNH_2D_2^+$	HD	4.5e-10	0.00	0.0
1638	$pNHD_2$	oH_2D^+	$ppNH_2D_2^+$	HD	5.6e-10	0.00	0.0
1639	$oNHD_2$	pH_2D^+	$ooNH_2D_2^+$	HD	2.4e-09	0.00	0.0
1640	$oNHD_2$	pH_2D^+	$poNH_2D_2^+$	HD	6.7e-10	0.00	0.0
1641	$pNHD_2$	pH_2D^+	$ooNH_2D_2^+$	HD	1.3e-09	0.00	0.0
1642	$pNHD_2$	pH_2D^+	$poNH_2D_2^+$	HD	1.7e-09	0.00	0.0
1643	$oNHD_2$	pH_2D^+	$opNH_2D_2^+$	HD	2.4e-09	0.00	0.0
1644	$oNHD_2$	pH_2D^+	$ppNH_2D_2^+$	HD	6.7e-10	0.00	0.0
1645	$pNHD_2$	pH_2D^+	$opNH_2D_2^+$	HD	1.3e-09	0.00	0.0
1646	$pNHD_2$	pH_2D^+	$ppNH_2D_2^+$	HD	1.7e-09	0.00	0.0
1647	$oNHD_2$	oH_2D^+	$mNHD_3^+$	oH_2	1.4e-09	0.00	0.0
1648	$oNHD_2$	oH_2D^+	$oNHD_3^+$	oH_2	1.1e-09	0.00	0.0
1649	$pNHD_2$	oH_2D^+	$pNHD_3^+$	oH_2	2.8e-10	0.00	0.0
1650	$pNHD_2$	oH_2D^+	$oNHD_3^+$	oH_2	2.2e-09	0.00	0.0
1651	$oNHD_2$	oH_2D^+	$mNHD_3^+$	pH_2	2.8e-10	0.00	0.0
1652	$oNHD_2$	oH_2D^+	$oNHD_3^+$	pH_2	2.2e-10	0.00	0.0
1653	$pNHD_2$	oH_2D^+	$pNHD_3^+$	pH_2	5.6e-11	0.00	0.0
1654	$pNHD_2$	oH_2D^+	$oNHD_3^+$	pH_2	4.5e-10	0.00	0.0
1655	$oNHD_2$	pH_2D^+	$mNHD_3^+$	oH_2	8.4e-10	0.00	0.0
1656	$oNHD_2$	pH_2D^+	$oNHD_3^+$	oH_2	6.7e-10	0.00	0.0
1657	$pNHD_2$	pH_2D^+	$pNHD_3^+$	oH_2	1.7e-10	0.00	0.0
1658	$pNHD_2$	pH_2D^+	$oNHD_3^+$	oH_2	1.3e-09	0.00	0.0
1659	$oNHD_2$	pH_2D^+	$mNHD_3^+$	pH_2	8.4e-10	0.00	0.0
1660	$oNHD_2$	pH_2D^+	$oNHD_3^+$	pH_2	6.7e-10	0.00	0.0
1661	$pNHD_2$	pH_2D^+	$pNHD_3^+$	pH_2	1.7e-10	0.00	0.0
1662	$pNHD_2$	pH_2D^+	$oNHD_3^+$	pH_2	1.3e-09	0.00	0.0
1663	$oNHD_2$	oHD_2^+	$ooNH_2D_2^+$	oD_2	1.5e-09	0.00	0.0
1664	$oNHD_2$	oHD_2^+	$ooNH_2D_2^+$	pD_2	3.2e-10	0.00	0.0
1665	$oNHD_2$	oHD_2^+	$poNH_2D_2^+$	oD_2	3.2e-10	0.00	0.0
1666	$oNHD_2$	oHD_2^+	$poNH_2D_2^+$	pD_2	1.9e-10	0.00	0.0
1667	$oNHD_2$	pHD_2^+	$ooNH_2D_2^+$	oD_2	6.3e-10	0.00	0.0
1668	$oNHD_2$	pHD_2^+	$ooNH_2D_2^+$	pD_2	7.6e-10	0.00	0.0
1669	$oNHD_2$	pHD_2^+	$poNH_2D_2^+$	oD_2	7.6e-10	0.00	0.0
1670	$oNHD_2$	pHD_2^+	$poNH_2D_2^+$	pD_2	1.3e-10	0.00	0.0
1671	$pNHD_2$	oHD_2^+	$ooNH_2D_2^+$	oD_2	6.3e-10	0.00	0.0
1672	$pNHD_2$	oHD_2^+	$ooNH_2D_2^+$	pD_2	7.6e-10	0.00	0.0
1673	$pNHD_2$	oHD_2^+	$poNH_2D_2^+$	oD_2	7.6e-10	0.00	0.0
1674	$pNHD_2$	oHD_2^+	$poNH_2D_2^+$	pD_2	1.3e-10	0.00	0.0
1675	$pNHD_2$	pHD_2^+	$ooNH_2D_2^+$	oD_2	7.6e-10	0.00	0.0
1676	$pNHD_2$	pHD_2^+	$ooNH_2D_2^+$	pD_2	2.5e-10	0.00	0.0
1677	$pNHD_2$	pHD_2^+	$poNH_2D_2^+$	oD_2	2.5e-10	0.00	0.0
1678	$pNHD_2$	pHD_2^+	$poNH_2D_2^+$	pD_2	1.0e-09	0.00	0.0
1679	$oNHD_2$	oHD_2^+	$opNH_2D_2^+$	oD_2	4.8e-10	0.00	0.0
1680	$oNHD_2$	oHD_2^+	$opNH_2D_2^+$	pD_2	1.1e-10	0.00	0.0
1681	$oNHD_2$	oHD_2^+	$ppNH_2D_2^+$	oD_2	1.1e-10	0.00	0.0
1682	$oNHD_2$	oHD_2^+	$ppNH_2D_2^+$	pD_2	6.3e-11	0.00	0.0
1683	$oNHD_2$	pHD_2^+	$opNH_2D_2^+$	oD_2	2.1e-10	0.00	0.0
1684	$oNHD_2$	pHD_2^+	$opNH_2D_2^+$	pD_2	2.5e-10	0.00	0.0
1685	$oNHD_2$	pHD_2^+	$ppNH_2D_2^+$	oD_2	2.5e-10	0.00	0.0
1686	$oNHD_2$	pHD_2^+	$ppNH_2D_2^+$	pD_2	4.2e-11	0.00	0.0
1687	$pNHD_2$	oHD_2^+	$opNH_2D_2^+$	oD_2	2.1e-10	0.00	0.0
1688	$pNHD_2$	oHD_2^+	$opNH_2D_2^+$	pD_2	2.5e-10	0.00	0.0
1689	$pNHD_2$	oHD_2^+	$ppNH_2D_2^+$	oD_2	2.5e-10	0.00	0.0
1690	$pNHD_2$	oHD_2^+	$ppNH_2D_2^+$	pD_2	4.2e-11	0.00	0.0
1691	$pNHD_2$	pHD_2^+	$opNH_2D_2^+$	oD_2	2.5e-10	0.00	0.0
1692	$pNHD_2$	pHD_2^+	$opNH_2D_2^+$	pD_2	8.4e-11	0.00	0.0
1693	$pNHD_2$	pHD_2^+	$ppNH_2D_2^+$	oD_2	8.4e-11	0.00	0.0
1694	$pNHD_2$	pHD_2^+	$ppNH_2D_2^+$	pD_2	3.4e-10	0.00	0.0
1695	$oNHD_2$	oHD_2^+	$mNHD_3^+$	HD	3.4e-09	0.00	0.0
1696	$oNHD_2$	oHD_2^+	$oNHD_3^+$	HD	2.7e-09	0.00	0.0
1697	$oNHD_2$	pHD_2^+	$mNHD_3^+$	HD	1.7e-09	0.00	0.0
1698	$oNHD_2$	pHD_2^+	$pNHD_3^+$	HD	3.4e-10	0.00	0.0
1699	$oNHD_2$	pHD_2^+	$oNHD_3^+$	HD	4.0e-09	0.00	0.0
1700	$pNHD_2$	oHD_2^+	$mNHD_3^+$	HD	1.7e-09	0.00	0.0
1701	$pNHD_2$	oHD_2^+	$pNHD_3^+$	HD	3.4e-10	0.00	0.0
1702	$pNHD_2$	oHD_2^+	$oNHD_3^+$	HD	4.0e-09	0.00	0.0

Table D6 – *continued* (part 24)

#	Reactants		Products		α	β	γ
1703	$pNHD_2$	pHD_2^+	$pNHD_3^+$	HD	6.7e-10	0.00	0.0
1704	$pNHD_2$	pHD_2^+	$oNHD_3^+$	HD	5.4e-09	0.00	0.0
1705	$oNHD_2$	mD_3^+	$mNHD_3^+$	oD_2	4.6e-09	0.00	0.0
1706	$oNHD_2$	mD_3^+	$mNHD_3^+$	pD_2	9.1e-10	0.00	0.0
1707	$oNHD_2$	mD_3^+	$oNHD_3^+$	oD_2	2.7e-09	0.00	0.0
1708	$oNHD_2$	mD_3^+	$oNHD_3^+$	pD_2	9.1e-10	0.00	0.0
1709	$pNHD_2$	mD_3^+	$mNHD_3^+$	oD_2	1.8e-09	0.00	0.0
1710	$pNHD_2$	mD_3^+	$mNHD_3^+$	pD_2	2.1e-09	0.00	0.0
1711	$pNHD_2$	mD_3^+	$pNHD_3^+$	oD_2	3.0e-10	0.00	0.0
1712	$pNHD_2$	mD_3^+	$oNHD_3^+$	oD_2	4.2e-09	0.00	0.0
1713	$pNHD_2$	mD_3^+	$oNHD_3^+$	pD_2	6.1e-10	0.00	0.0
1714	$oNHD_2$	pD_3^+	$mNHD_3^+$	pD_2	1.5e-09	0.00	0.0
1715	$oNHD_2$	pD_3^+	$pNHD_3^+$	oD_2	1.5e-09	0.00	0.0
1716	$oNHD_2$	pD_3^+	$oNHD_3^+$	oD_2	3.0e-09	0.00	0.0
1717	$oNHD_2$	pD_3^+	$oNHD_3^+$	pD_2	3.0e-09	0.00	0.0
1718	$pNHD_2$	pD_3^+	$pNHD_3^+$	pD_2	1.8e-09	0.00	0.0
1719	$pNHD_2$	pD_3^+	$oNHD_3^+$	oD_2	3.6e-09	0.00	0.0
1720	$pNHD_2$	pD_3^+	$oNHD_3^+$	pD_2	3.6e-09	0.00	0.0
1721	$oNHD_2$	oD_3^+	$mNHD_3^+$	oD_2	1.7e-09	0.00	0.0
1722	$oNHD_2$	oD_3^+	$mNHD_3^+$	pD_2	1.3e-09	0.00	0.0
1723	$oNHD_2$	oD_3^+	$pNHD_3^+$	oD_2	1.9e-10	0.00	0.0
1724	$oNHD_2$	oD_3^+	$pNHD_3^+$	pD_2	1.1e-10	0.00	0.0
1725	$oNHD_2$	oD_3^+	$oNHD_3^+$	oD_2	4.0e-09	0.00	0.0
1726	$oNHD_2$	oD_3^+	$oNHD_3^+$	pD_2	1.7e-09	0.00	0.0
1727	$pNHD_2$	oD_3^+	$mNHD_3^+$	oD_2	1.1e-09	0.00	0.0
1728	$pNHD_2$	oD_3^+	$mNHD_3^+$	pD_2	3.8e-10	0.00	0.0
1729	$pNHD_2$	oD_3^+	$pNHD_3^+$	oD_2	3.8e-10	0.00	0.0
1730	$pNHD_2$	oD_3^+	$pNHD_3^+$	pD_2	2.3e-10	0.00	0.0
1731	$pNHD_2$	oD_3^+	$oNHD_3^+$	oD_2	3.5e-09	0.00	0.0
1732	$pNHD_2$	oD_3^+	$oNHD_3^+$	pD_2	3.5e-09	0.00	0.0
1733	mND_3	H^+	mND_3^+	H	5.2e-09	0.00	0.0
1734	pND_3	H^+	pND_3^+	H	5.2e-09	0.00	0.0
1735	oND_3	H^+	oND_3^+	H	5.2e-09	0.00	0.0
1736	mND_3	oH_3^+	$mNHD_3^+$	oH_2	9.1e-09	0.00	0.0
1737	pND_3	oH_3^+	$pNHD_3^+$	oH_2	9.1e-09	0.00	0.0
1738	oND_3	oH_3^+	$oNHD_3^+$	oH_2	9.1e-09	0.00	0.0
1739	mND_3	pH_3^+	$mNHD_3^+$	oH_2	4.6e-09	0.00	0.0
1740	pND_3	pH_3^+	$pNHD_3^+$	oH_2	4.6e-09	0.00	0.0
1741	oND_3	pH_3^+	$oNHD_3^+$	oH_2	4.6e-09	0.00	0.0
1742	mND_3	pH_3^+	$mNHD_3^+$	pH_2	4.6e-09	0.00	0.0
1743	pND_3	pH_3^+	$pNHD_3^+$	pH_2	4.6e-09	0.00	0.0
1744	oND_3	pH_3^+	$oNHD_3^+$	pH_2	4.6e-09	0.00	0.0
1745	mND_3	oH_2D^+	$mNHD_3^+$	HD	4.0e-09	0.00	0.0
1746	mND_3	oH_2D^+	$oNHD_3^+$	HD	2.0e-09	0.00	0.0
1747	pND_3	oH_2D^+	$pNHD_3^+$	HD	2.0e-09	0.00	0.0
1748	pND_3	oH_2D^+	$oNHD_3^+$	HD	4.0e-09	0.00	0.0
1749	oND_3	oH_2D^+	$mNHD_3^+$	HD	1.3e-09	0.00	0.0
1750	oND_3	oH_2D^+	$pNHD_3^+$	HD	2.5e-10	0.00	0.0
1751	oND_3	oH_2D^+	$oNHD_3^+$	HD	4.5e-09	0.00	0.0
1752	mND_3	pH_2D^+	$mNHD_3^+$	HD	4.0e-09	0.00	0.0
1753	mND_3	pH_2D^+	$oNHD_3^+$	HD	2.0e-09	0.00	0.0
1754	pND_3	pH_2D^+	$pNHD_3^+$	HD	2.0e-09	0.00	0.0
1755	pND_3	pH_2D^+	$oNHD_3^+$	HD	4.0e-09	0.00	0.0
1756	oND_3	pH_2D^+	$mNHD_3^+$	HD	1.3e-09	0.00	0.0
1757	oND_3	pH_2D^+	$pNHD_3^+$	HD	2.5e-10	0.00	0.0
1758	oND_3	pH_2D^+	$oNHD_3^+$	HD	4.5e-09	0.00	0.0
1759	mND_3	oH_2D^+	lND_4^+	oH_2	1.5e-09	0.00	0.0
1760	mND_3	oH_2D^+	oND_4^+	oH_2	1.5e-09	0.00	0.0
1761	pND_3	oH_2D^+	pND_4^+	oH_2	3.0e-09	0.00	0.0
1762	oND_3	oH_2D^+	mND_4^+	oH_2	7.6e-10	0.00	0.0
1763	oND_3	oH_2D^+	oND_4^+	oH_2	1.9e-09	0.00	0.0
1764	oND_3	oH_2D^+	pND_4^+	oH_2	3.8e-10	0.00	0.0
1765	mND_3	pH_2D^+	lND_4^+	pH_2	1.5e-09	0.00	0.0
1766	mND_3	pH_2D^+	oND_4^+	pH_2	1.5e-09	0.00	0.0
1767	pND_3	pH_2D^+	pND_4^+	pH_2	3.0e-09	0.00	0.0
1768	oND_3	pH_2D^+	mND_4^+	pH_2	7.6e-10	0.00	0.0
1769	oND_3	pH_2D^+	oND_4^+	pH_2	1.9e-09	0.00	0.0
1770	oND_3	pH_2D^+	pND_4^+	pH_2	3.8e-10	0.00	0.0
1771	mND_3	oHD_2^+	$mNHD_3^+$	oD_2	1.5e-09	0.00	0.0
1772	mND_3	oHD_2^+	$mNHD_3^+$	pD_2	3.0e-10	0.00	0.0
1773	mND_3	oHD_2^+	$oNHD_3^+$	oD_2	9.1e-10	0.00	0.0
1774	mND_3	oHD_2^+	$oNHD_3^+$	pD_2	3.0e-10	0.00	0.0
1775	mND_3	pHD_2^+	$mNHD_3^+$	oD_2	6.1e-10	0.00	0.0
1776	mND_3	pHD_2^+	$mNHD_3^+$	pD_2	7.1e-10	0.00	0.0

Table D6 – *continued* (part 25)

#	Reactants		Products		α	β	γ
1777	mND_3	pHD_2^+	$pNHD_3^+$	oD_2	1.0e-10	0.00	0.0
1778	mND_3	pHD_2^+	$oNHD_3^+$	oD_2	1.4e-09	0.00	0.0
1779	mND_3	pHD_2^+	$oNHD_3^+$	pD_2	2.0e-10	0.00	0.0
1780	pND_3	oHD_2^+	$mNHD_3^+$	pD_2	5.1e-10	0.00	0.0
1781	pND_3	oHD_2^+	$pNHD_3^+$	oD_2	5.1e-10	0.00	0.0
1782	pND_3	oHD_2^+	$oNHD_3^+$	oD_2	1.0e-09	0.00	0.0
1783	pND_3	oHD_2^+	$oNHD_3^+$	pD_2	1.0e-09	0.00	0.0
1784	pND_3	pHD_2^+	$pNHD_3^+$	pD_2	6.1e-10	0.00	0.0
1785	pND_3	pHD_2^+	$oNHD_3^+$	oD_2	1.2e-09	0.00	0.0
1786	pND_3	pHD_2^+	$oNHD_3^+$	pD_2	1.2e-09	0.00	0.0
1787	oND_3	oHD_2^+	$mNHD_3^+$	oD_2	5.7e-10	0.00	0.0
1788	oND_3	oHD_2^+	$mNHD_3^+$	pD_2	4.4e-10	0.00	0.0
1789	oND_3	oHD_2^+	$pNHD_3^+$	oD_2	6.3e-11	0.00	0.0
1790	oND_3	oHD_2^+	$pNHD_3^+$	pD_2	3.8e-11	0.00	0.0
1791	oND_3	oHD_2^+	$oNHD_3^+$	oD_2	1.3e-09	0.00	0.0
1792	oND_3	oHD_2^+	$oNHD_3^+$	pD_2	5.8e-10	0.00	0.0
1793	oND_3	pHD_2^+	$mNHD_3^+$	oD_2	3.8e-10	0.00	0.0
1794	oND_3	pHD_2^+	$mNHD_3^+$	pD_2	1.3e-10	0.00	0.0
1795	oND_3	pHD_2^+	$pNHD_3^+$	oD_2	1.3e-10	0.00	0.0
1796	oND_3	pHD_2^+	$pNHD_3^+$	pD_2	7.6e-11	0.00	0.0
1797	oND_3	pHD_2^+	$oNHD_3^+$	oD_2	1.2e-09	0.00	0.0
1798	oND_3	pHD_2^+	$oNHD_3^+$	pD_2	1.2e-09	0.00	0.0
1799	mND_3	oHD_2^+	lND_4^+	HD	2.7e-09	0.00	0.0
1800	mND_3	oHD_2^+	mND_4^+	HD	6.1e-10	0.00	0.0
1801	mND_3	oHD_2^+	oND_4^+	HD	2.7e-09	0.00	0.0
1802	mND_3	pHD_2^+	lND_4^+	HD	1.2e-09	0.00	0.0
1803	mND_3	pHD_2^+	oND_4^+	HD	4.2e-09	0.00	0.0
1804	mND_3	pHD_2^+	pND_4^+	HD	6.1e-10	0.00	0.0
1805	pND_3	oHD_2^+	oND_4^+	HD	3.0e-09	0.00	0.0
1806	pND_3	oHD_2^+	pND_4^+	HD	3.0e-09	0.00	0.0
1807	pND_3	pHD_2^+	mND_4^+	HD	2.4e-09	0.00	0.0
1808	pND_3	pHD_2^+	pND_4^+	HD	3.6e-09	0.00	0.0
1809	oND_3	oHD_2^+	lND_4^+	HD	7.6e-10	0.00	0.0
1810	oND_3	oHD_2^+	mND_4^+	HD	9.1e-10	0.00	0.0
1811	oND_3	oHD_2^+	oND_4^+	HD	3.8e-09	0.00	0.0
1812	oND_3	oHD_2^+	pND_4^+	HD	6.1e-10	0.00	0.0
1813	oND_3	pHD_2^+	mND_4^+	HD	1.8e-09	0.00	0.0
1814	oND_3	pHD_2^+	oND_4^+	HD	3.0e-09	0.00	0.0
1815	oND_3	pHD_2^+	pND_4^+	HD	1.2e-09	0.00	0.0
1816	mND_3	mD_3^+	lND_4^+	oD_2	3.5e-09	0.00	0.0
1817	mND_3	mD_3^+	lND_4^+	pD_2	6.4e-10	0.00	0.0
1818	mND_3	mD_3^+	mND_4^+	oD_2	5.5e-10	0.00	0.0
1819	mND_3	mD_3^+	mND_4^+	pD_2	3.6e-10	0.00	0.0
1820	mND_3	mD_3^+	oND_4^+	oD_2	3.3e-09	0.00	0.0
1821	mND_3	mD_3^+	oND_4^+	pD_2	8.2e-10	0.00	0.0
1822	mND_3	pD_3^+	lND_4^+	pD_2	9.1e-10	0.00	0.0
1823	mND_3	pD_3^+	oND_4^+	oD_2	2.7e-09	0.00	0.0
1824	mND_3	pD_3^+	oND_4^+	pD_2	2.7e-09	0.00	0.0
1825	mND_3	pD_3^+	pND_4^+	oD_2	2.7e-09	0.00	0.0
1826	mND_3	oD_3^+	lND_4^+	oD_2	1.1e-09	0.00	0.0
1827	mND_3	oD_3^+	lND_4^+	pD_2	9.1e-10	0.00	0.0
1828	mND_3	oD_3^+	mND_4^+	oD_2	8.0e-10	0.00	0.0
1829	mND_3	oD_3^+	mND_4^+	pD_2	1.1e-10	0.00	0.0
1830	mND_3	oD_3^+	oND_4^+	oD_2	3.9e-09	0.00	0.0
1831	mND_3	oD_3^+	oND_4^+	pD_2	1.5e-09	0.00	0.0
1832	mND_3	oD_3^+	pND_4^+	oD_2	5.1e-10	0.00	0.0
1833	mND_3	oD_3^+	pND_4^+	pD_2	1.7e-10	0.00	0.0
1834	pND_3	mD_3^+	lND_4^+	pD_2	9.1e-10	0.00	0.0
1835	pND_3	mD_3^+	oND_4^+	oD_2	2.7e-09	0.00	0.0
1836	pND_3	mD_3^+	oND_4^+	pD_2	2.7e-09	0.00	0.0
1837	pND_3	mD_3^+	pND_4^+	oD_2	2.7e-09	0.00	0.0
1838	pND_3	pD_3^+	mND_4^+	oD_2	3.6e-09	0.00	0.0
1839	pND_3	pD_3^+	pND_4^+	pD_2	5.5e-09	0.00	0.0
1840	pND_3	oD_3^+	mND_4^+	oD_2	1.1e-09	0.00	0.0
1841	pND_3	oD_3^+	mND_4^+	pD_2	1.1e-09	0.00	0.0
1842	pND_3	oD_3^+	oND_4^+	oD_2	1.7e-09	0.00	0.0
1843	pND_3	oD_3^+	oND_4^+	pD_2	1.7e-09	0.00	0.0
1844	pND_3	oD_3^+	pND_4^+	oD_2	1.7e-09	0.00	0.0
1845	pND_3	oD_3^+	pND_4^+	pD_2	1.7e-09	0.00	0.0
1846	oND_3	mD_3^+	lND_4^+	oD_2	1.1e-09	0.00	0.0
1847	oND_3	mD_3^+	lND_4^+	pD_2	9.1e-10	0.00	0.0
1848	oND_3	mD_3^+	mND_4^+	oD_2	8.0e-10	0.00	0.0
1849	oND_3	mD_3^+	mND_4^+	pD_2	1.1e-10	0.00	0.0
1850	oND_3	mD_3^+	oND_4^+	oD_2	3.9e-09	0.00	0.0

Table D6 – *continued* (part 26)

#	Reactants		Products			α	β	γ
1851	oND_3	mD_3^+	oND_4^+	pD_2		1.5e-09	0.00	0.0
1852	oND_3	mD_3^+	pND_4^+	oD_2		5.1e-10	0.00	0.0
1853	oND_3	mD_3^+	pND_4^+	pD_2		1.7e-10	0.00	0.0
1854	oND_3	pD_3^+	mND_4^+	oD_2		1.1e-09	0.00	0.0
1855	oND_3	pD_3^+	mND_4^+	pD_2		1.1e-09	0.00	0.0
1856	oND_3	pD_3^+	oND_4^+	oD_2		1.7e-09	0.00	0.0
1857	oND_3	pD_3^+	oND_4^+	pD_2		1.7e-09	0.00	0.0
1858	oND_3	pD_3^+	pND_4^+	oD_2		1.7e-09	0.00	0.0
1859	oND_3	pD_3^+	pND_4^+	pD_2		1.7e-09	0.00	0.0
1860	oND_3	oD_3^+	lND_4^+	oD_2		4.3e-10	0.00	0.0
1861	oND_3	oD_3^+	lND_4^+	pD_2		1.4e-10	0.00	0.0
1862	oND_3	oD_3^+	mND_4^+	oD_2		1.2e-09	0.00	0.0
1863	oND_3	oD_3^+	mND_4^+	pD_2		8.5e-10	0.00	0.0
1864	oND_3	oD_3^+	oND_4^+	oD_2		3.0e-09	0.00	0.0
1865	oND_3	oD_3^+	oND_4^+	pD_2		2.1e-09	0.00	0.0
1866	oND_3	oD_3^+	pND_4^+	oD_2		8.5e-10	0.00	0.0
1867	oND_3	oD_3^+	pND_4^+	pD_2		5.1e-10	0.00	0.0
1868	N_2	oH_2D^+	N_2H^+	HD		8.7e-10	0.00	0.0
1869	N_2	pH_2D^+	N_2H^+	HD		8.7e-10	0.00	0.0
1870	N_2	oH_2D^+	oH_2	N_2D^+		4.3e-10	0.00	0.0
1871	N_2	pH_2D^+	pH_2	N_2D^+		4.3e-10	0.00	0.0
1872	N_2	oHD_2^+	oD_2	N_2H^+		4.3e-10	0.00	0.0
1873	N_2	pHD_2^+	pD_2	N_2H^+		4.3e-10	0.00	0.0
1874	N_2	oHD_2^+	N_2D^+	HD		8.7e-10	0.00	0.0
1875	N_2	pHD_2^+	N_2D^+	HD		8.7e-10	0.00	0.0
1876	N_2	mD_3^+	oD_2	N_2D^+		1.3e-09	0.00	0.0
1877	N_2	pD_3^+	pD_2	N_2D^+		1.3e-09	0.00	0.0
1878	N_2	oD_3^+	oD_2	N_2D^+		6.5e-10	0.00	0.0
1879	N_2	oD_3^+	pD_2	N_2D^+		6.5e-10	0.00	0.0
1880	N^+	e^-	N	γ		3.8e-12	-0.62	0.0
1881	NH^+	e^-	N	H		2.0e-07	-0.50	0.0
1882	oNH_2^+	e^-	NH	H		1.2e-07	-0.50	0.0
1883	pNH_2^+	e^-	NH	H		1.2e-07	-0.50	0.0
1884	oNH_2^+	e^-	oH_2	N		1.2e-08	-0.50	0.0
1885	pNH_2^+	e^-	pH_2	N		1.2e-08	-0.50	0.0
1886	oNH_2^+	e^-	H	H	N	1.7e-07	-0.50	0.0
1887	pNH_2^+	e^-	H	H	N	1.7e-07	-0.50	0.0
1888	oNH_3^+	e^-	oNH_2	H		1.5e-07	-0.50	0.0
1889	pNH_3^+	e^-	oNH_2	H		7.7e-08	-0.50	0.0
1890	pNH_3^+	e^-	pNH_2	H		7.7e-08	-0.50	0.0
1891	oNH_3^+	e^-	NH	H	H	1.5e-07	-0.50	0.0
1892	pNH_3^+	e^-	NH	H	H	1.5e-07	-0.50	0.0
1893	mNH_4^+	e^-	oNH_2	oH_2		1.9e-08	-0.60	0.0
1894	pNH_4^+	e^-	oNH_2	oH_2		9.4e-09	-0.60	0.0
1895	pNH_4^+	e^-	pNH_2	pH_2		9.4e-09	-0.60	0.0
1896	oNH_4^+	e^-	oNH_2	oH_2		6.3e-09	-0.60	0.0
1897	oNH_4^+	e^-	oNH_2	pH_2		6.3e-09	-0.60	0.0
1898	oNH_4^+	e^-	pNH_2	oH_2		6.3e-09	-0.60	0.0
1899	mNH_4^+	e^-	oNH_3	H		8.0e-07	-0.60	0.0
1900	pNH_4^+	e^-	pNH_3	H		8.0e-07	-0.60	0.0
1901	oNH_4^+	e^-	oNH_3	H		2.7e-07	-0.60	0.0
1902	oNH_4^+	e^-	pNH_3	H		5.3e-07	-0.60	0.0
1903	N_2^+	e^-	N	N		3.6e-08	-0.42	0.0
1904	N_2H^+	e^-	N_2	H		2.8e-07	-0.74	0.0
1905	N_2H^+	e^-	NH	N		2.1e-08	-0.74	0.0
1906	ND^+	e^-	N	D		2.0e-07	-0.50	0.0
1907	NHD^+	e^-	N	H	D	1.5e-07	-0.50	0.0
1908	NHD^+	e^-	NH	D		7.5e-08	-0.50	0.0
1909	NHD^+	e^-	ND	H		7.5e-08	-0.50	0.0
1910	oND_2^+	e^-	ND	D		1.5e-07	-0.50	0.0
1911	pND_2^+	e^-	ND	D		1.5e-07	-0.50	0.0
1912	oND_2^+	e^-	D	D	N	1.5e-07	-0.50	0.0
1913	pND_2^+	e^-	D	D	N	1.5e-07	-0.50	0.0
1914	oNH_2D^+	e^-	oNH_2	D		1.0e-07	-0.50	0.0
1915	pNH_2D^+	e^-	pNH_2	D		1.0e-07	-0.50	0.0
1916	oNH_2D^+	e^-	NHD	H		2.0e-07	-0.50	0.0
1917	pNH_2D^+	e^-	NHD	H		2.0e-07	-0.50	0.0
1918	$oNHD_2^+$	e^-	oND_2	H		1.0e-07	-0.50	0.0
1919	$pNHD_2^+$	e^-	pND_2	H		1.0e-07	-0.50	0.0
1920	$oNHD_2^+$	e^-	NHD	D		2.0e-07	-0.50	0.0
1921	$pNHD_2^+$	e^-	NHD	D		2.0e-07	-0.50	0.0
1922	mND_3^+	e^-	oND_2	D		3.0e-07	-0.50	0.0
1923	pND_3^+	e^-	pND_2	D		3.0e-07	-0.50	0.0
1924	oND_3^+	e^-	oND_2	D		1.5e-07	-0.50	0.0

Table D6 – *continued* (part 27)

#	Reactants		Products		α	β	γ
1925	oND_3^+	e^-	pND_2	D	1.5e-07	-0.50	0.0
1926	oNH_3D^+	e^-	oNH_2	HD	2.5e-07	-0.50	0.0
1927	pNH_3D^+	e^-	oNH_2	HD	1.3e-07	-0.50	0.0
1928	pNH_3D^+	e^-	pNH_2	HD	1.3e-07	-0.50	0.0
1929	oNH_3D^+	e^-	oH_2	NHD	2.5e-07	-0.50	0.0
1930	pNH_3D^+	e^-	oH_2	NHD	1.3e-07	-0.50	0.0
1931	pNH_3D^+	e^-	pH_2	NHD	1.3e-07	-0.50	0.0
1932	oNH_3D^+	e^-	oNH_3	D	1.9e-07	-0.50	0.0
1933	pNH_3D^+	e^-	pNH_3	D	1.9e-07	-0.50	0.0
1934	oNH_3D^+	e^-	oNH_2D	H	5.7e-07	-0.50	0.0
1935	pNH_3D^+	e^-	oNH_2D	H	2.9e-07	-0.50	0.0
1936	pNH_3D^+	e^-	pNH_2D	H	2.9e-07	-0.50	0.0
1937	$ooNH_2D_2^+$	e^-	oD_2	oNH_2	8.5e-08	-0.50	0.0
1938	$poNH_2D_2^+$	e^-	pD_2	oNH_2	8.5e-08	-0.50	0.0
1939	$opNH_2D_2^+$	e^-	oD_2	pNH_2	8.5e-08	-0.50	0.0
1940	$ppNH_2D_2^+$	e^-	pD_2	pNH_2	8.5e-08	-0.50	0.0
1941	$ooNH_2D_2^+$	e^-	NHD	HD	3.4e-07	-0.50	0.0
1942	$poNH_2D_2^+$	e^-	NHD	HD	3.4e-07	-0.50	0.0
1943	$opNH_2D_2^+$	e^-	NHD	HD	3.4e-07	-0.50	0.0
1944	$ppNH_2D_2^+$	e^-	NHD	HD	3.4e-07	-0.50	0.0
1945	$ooNH_2D_2^+$	e^-	oND_2	oH_2	8.5e-08	-0.50	0.0
1946	$poNH_2D_2^+$	e^-	pND_2	oH_2	8.5e-08	-0.50	0.0
1947	$opNH_2D_2^+$	e^-	oND_2	pH_2	8.5e-08	-0.50	0.0
1948	$ppNH_2D_2^+$	e^-	pND_2	pH_2	8.5e-08	-0.50	0.0
1949	$ooNH_2D_2^+$	e^-	oNH_2D	D	3.8e-07	-0.50	0.0
1950	$poNH_2D_2^+$	e^-	oNH_2D	D	3.8e-07	-0.50	0.0
1951	$opNH_2D_2^+$	e^-	pNH_2D	D	3.8e-07	-0.50	0.0
1952	$ppNH_2D_2^+$	e^-	pNH_2D	D	3.8e-07	-0.50	0.0
1953	$ooNH_2D_2^+$	e^-	$oNHD_2$	H	3.8e-07	-0.50	0.0
1954	$poNH_2D_2^+$	e^-	$pNHD_2$	H	3.8e-07	-0.50	0.0
1955	$opNH_2D_2^+$	e^-	$oNHD_2$	H	3.8e-07	-0.50	0.0
1956	$ppNH_2D_2^+$	e^-	$pNHD_2$	H	3.8e-07	-0.50	0.0
1957	$mNHD_3^+$	e^-	oD_2	NHD	2.5e-07	-0.50	0.0
1958	$pNHD_3^+$	e^-	pD_2	NHD	2.5e-07	-0.50	0.0
1959	$oNHD_3^+$	e^-	oD_2	NHD	1.3e-07	-0.50	0.0
1960	$oNHD_3^+$	e^-	pD_2	NHD	1.3e-07	-0.50	0.0
1961	$mNHD_3^+$	e^-	oND_2	HD	2.5e-07	-0.50	0.0
1962	$pNHD_3^+$	e^-	pND_2	HD	2.5e-07	-0.50	0.0
1963	$oNHD_3^+$	e^-	oND_2	HD	1.3e-07	-0.50	0.0
1964	$oNHD_3^+$	e^-	pND_2	HD	1.3e-07	-0.50	0.0
1965	$mNHD_3^+$	e^-	mND_3	H	1.9e-07	-0.50	0.0
1966	$pNHD_3^+$	e^-	pND_3	H	1.9e-07	-0.50	0.0
1967	$oNHD_3^+$	e^-	oND_3	H	1.9e-07	-0.50	0.0
1968	$mNHD_3^+$	e^-	$oNHD_2$	D	5.7e-07	-0.50	0.0
1969	$pNHD_3^+$	e^-	$pNHD_2$	D	5.7e-07	-0.50	0.0
1970	$oNHD_3^+$	e^-	$oNHD_2$	D	2.9e-07	-0.50	0.0
1971	$oNHD_3^+$	e^-	$pNHD_2$	D	2.9e-07	-0.50	0.0
1972	lND_4^+	e^-	oND_2	oD_2	5.1e-07	-0.50	0.0
1973	mND_4^+	e^-	oND_2	oD_2	2.5e-07	-0.50	0.0
1974	mND_4^+	e^-	pND_2	pD_2	2.5e-07	-0.50	0.0
1975	oND_4^+	e^-	oND_2	oD_2	1.7e-07	-0.50	0.0
1976	oND_4^+	e^-	oND_2	pD_2	1.7e-07	-0.50	0.0
1977	oND_4^+	e^-	pND_2	oD_2	1.7e-07	-0.50	0.0
1978	pND_4^+	e^-	oND_2	pD_2	1.7e-07	-0.50	0.0
1979	pND_4^+	e^-	pND_2	oD_2	1.7e-07	-0.50	0.0
1980	pND_4^+	e^-	pND_2	pD_2	1.7e-07	-0.50	0.0
1981	lND_4^+	e^-	mND_3	D	7.6e-07	-0.50	0.0
1982	mND_4^+	e^-	oND_3	D	7.6e-07	-0.50	0.0
1983	oND_4^+	e^-	mND_3	D	2.5e-07	-0.50	0.0
1984	oND_4^+	e^-	oND_3	D	5.1e-07	-0.50	0.0
1985	pND_4^+	e^-	pND_3	D	2.5e-07	-0.50	0.0
1986	pND_4^+	e^-	oND_3	D	5.1e-07	-0.50	0.0
1987	N_2D^+	e^-	N_2	D	2.8e-07	-0.74	0.0
1988	N_2D^+	e^-	ND	N	2.1e-08	-0.74	0.0
1989	NH^+	γ_2	N^+	H	2.2e+01	0.00	0.0
1990	N_2	γ_2	N	N	3.9e+01	0.00	0.0
1991	NH	γ_2	N	H	3.7e+02	0.00	0.0
1992	NH	γ_2	NH^+	e^-	7.1e+00	0.00	0.0
1993	oNH_2	γ_2	NH	H	7.2e+02	0.00	0.0
1994	pNH_2	γ_2	NH	H	7.2e+02	0.00	0.0
1995	oNH_2	γ_2	oNH_2^+	e^-	1.4e+02	0.00	0.0
1996	pNH_2	γ_2	pNH_2^+	e^-	1.4e+02	0.00	0.0
1997	oNH_3	γ_2	oH_2	NH	1.1e+03	0.00	0.0
1998	pNH_3	γ_2	oH_2	NH	5.5e+02	0.00	0.0

Table D6 – *continued* (part 28)

#	Reactants		Products			α	β	γ
1999	pNH_3	γ_2	pH_2	NH		5.5e+02	0.00	0.0
2000	oNH_3	γ_2	oNH_3^+	e^-		2.2e+02	0.00	0.0
2001	pNH_3	γ_2	pNH_3^+	e^-		2.2e+02	0.00	0.0
2002	ND	γ_2	N	D		3.7e+02	0.00	0.0
2003	ND	γ_2	ND^+	e^-		7.1e+00	0.00	0.0
2004	NHD	γ_2	NH	D		3.6e+02	0.00	0.0
2005	NHD	γ_2	ND	H		3.6e+02	0.00	0.0
2006	NHD	γ_2	NHD^+	e^-		1.4e+02	0.00	0.0
2007	oND_2	γ_2	ND	D		7.2e+02	0.00	0.0
2008	pND_2	γ_2	ND	D		7.2e+02	0.00	0.0
2009	oND_2	γ_2	oND_2^+	e^-		1.4e+02	0.00	0.0
2010	pND_2	γ_2	pND_2^+	e^-		1.4e+02	0.00	0.0
2011	oNH_2D	γ_2	NH	HD		4.5e+02	0.00	0.0
2012	pNH_2D	γ_2	NH	HD		4.5e+02	0.00	0.0
2013	oNH_2D	γ_2	oH_2	ND		2.2e+02	0.00	0.0
2014	pNH_2D	γ_2	pH_2	ND		2.2e+02	0.00	0.0
2015	oNH_2D	γ_2	NHD	H		2.9e+02	0.00	0.0
2016	pNH_2D	γ_2	NHD	H		2.9e+02	0.00	0.0
2017	oNH_2D	γ_2	oNH_2	D		1.4e+02	0.00	0.0
2018	pNH_2D	γ_2	pNH_2	D		1.4e+02	0.00	0.0
2019	oNH_2D	γ_2	oNH_2D^+	e^-		2.2e+02	0.00	0.0
2020	pNH_2D	γ_2	pNH_2D^+	e^-		2.2e+02	0.00	0.0
2021	$oNHD_2$	γ_2	ND	HD		4.5e+02	0.00	0.0
2022	$pNHD_2$	γ_2	ND	HD		4.5e+02	0.00	0.0
2023	$oNHD_2$	γ_2	oD_2	NH		2.2e+02	0.00	0.0
2024	$pNHD_2$	γ_2	pD_2	NH		2.2e+02	0.00	0.0
2025	$oNHD_2$	γ_2	NHD	D		2.9e+02	0.00	0.0
2026	$pNHD_2$	γ_2	NHD	D		2.9e+02	0.00	0.0
2027	$oNHD_2$	γ_2	oND_2	H		1.4e+02	0.00	0.0
2028	$pNHD_2$	γ_2	pND_2	H		1.4e+02	0.00	0.0
2029	$oNHD_2$	γ_2	$oNHD_2^+$	e^-		2.2e+02	0.00	0.0
2030	$pNHD_2$	γ_2	$pNHD_2^+$	e^-		2.2e+02	0.00	0.0
2031	mND_3	γ_2	oD_2	ND		6.7e+02	0.00	0.0
2032	pND_3	γ_2	pD_2	ND		6.7e+02	0.00	0.0
2033	oND_3	γ_2	oD_2	ND		3.4e+02	0.00	0.0
2034	oND_3	γ_2	pD_2	ND		3.4e+02	0.00	0.0
2035	mND_3	γ_2	oND_2	D		4.3e+02	0.00	0.0
2036	pND_3	γ_2	pND_2	D		4.3e+02	0.00	0.0
2037	oND_3	γ_2	oND_2	D		2.1e+02	0.00	0.0
2038	oND_3	γ_2	pND_2	D		2.1e+02	0.00	0.0
2039	mND_3	γ_2	mND_3^+	e^-		2.2e+02	0.00	0.0
2040	pND_3	γ_2	pND_3^+	e^-		2.2e+02	0.00	0.0
2041	oND_3	γ_2	oND_3^+	e^-		2.2e+02	0.00	0.0
2042	mNH_4^+	Gr	oNH_3	H	Gr^+	3.8e-07	0.50	0.0
2043	pNH_4^+	Gr	pNH_3	H	Gr^+	3.8e-07	0.50	0.0
2044	oNH_4^+	Gr	oNH_3	H	Gr^+	1.3e-07	0.50	0.0
2045	oNH_4^+	Gr	pNH_3	H	Gr^+	2.5e-07	0.50	0.0
2046	mNH_4^+	Gr^-	oNH_3	H	Gr	3.8e-07	0.50	0.0
2047	pNH_4^+	Gr^-	pNH_3	H	Gr	3.8e-07	0.50	0.0
2048	oNH_4^+	Gr^-	oNH_3	H	Gr	1.3e-07	0.50	0.0
2049	oNH_4^+	Gr^-	pNH_3	H	Gr	2.5e-07	0.50	0.0
2050	N_2H^+	Gr	Gr^+	N_2	H	1.0e-07	0.50	0.0
2051	N_2H^+	Gr	Gr^+	NH	N	1.9e-07	0.50	0.0
2052	N_2H^+	Gr^-	Gr	N_2	H	1.0e-07	0.50	0.0
2053	N_2H^+	Gr^-	Gr	NH	N	1.9e-07	0.50	0.0
2054	N_2D^+	Gr	Gr^+	N_2	D	3.0e-07	0.50	0.0
2055	N_2D^+	Gr^-	Gr	N_2	D	3.0e-07	0.50	0.0
2056	S	H^+	S^+	H		1.0e-15	0.00	0.0
2057	S	oH_3^+	oH_2	SH^+		2.6e-09	0.00	0.0
2058	S	pH_3^+	oH_2	SH^+		1.3e-09	0.00	0.0
2059	S	pH_3^+	pH_2	SH^+		1.3e-09	0.00	0.0
2060	SH	H	oH_2	S		1.9e-11	0.00	0.0
2061	SH	H	pH_2	S		6.3e-12	0.00	0.0
2062	SH	He^+	S^+	H	He	1.7e-09	0.00	0.0
2063	SH	H^+	SH^+	H		1.6e-09	0.00	0.0
2064	SH	H^+	oH_2	S^+		1.2e-09	0.00	0.0
2065	SH	H^+	pH_2	S^+		4.0e-10	0.00	0.0
2066	SH	oH_3^+	oH_2S^+	oH_2		1.4e-09	0.00	0.0
2067	SH	oH_3^+	oH_2S^+	pH_2		2.4e-10	0.00	0.0
2068	SH	oH_3^+	pH_2S^+	oH_2		2.4e-10	0.00	0.0
2069	SH	pH_3^+	oH_2S^+	oH_2		7.1e-10	0.00	0.0
2070	SH	pH_3^+	oH_2S^+	pH_2		4.8e-10	0.00	0.0
2071	SH	pH_3^+	pH_2S^+	oH_2		4.8e-10	0.00	0.0
2072	SH	pH_3^+	pH_2S^+	pH_2		2.4e-10	0.00	0.0

Table D6 – *continued* (part 29)

#	Reactants		Products			α	β	γ
2073	oH_2S	He^+	oH_2	S^+	He	3.6e-09	0.00	0.0
2074	pH_2S	He^+	pH_2	S^+	He	3.6e-09	0.00	0.0
2075	oH_2S	He^+	SH^+	H	He	4.8e-10	0.00	0.0
2076	pH_2S	He^+	SH^+	H	He	4.8e-10	0.00	0.0
2077	oH_2S	He^+	oH_2S^+	He		3.1e-10	0.00	0.0
2078	pH_2S	He^+	pH_2S^+	He		3.1e-10	0.00	0.0
2079	oH_2S	H^+	oH_2S^+	H		7.6e-09	0.00	0.0
2080	pH_2S	H^+	pH_2S^+	H		7.6e-09	0.00	0.0
2081	oH_2S	oH_3^+	oH_3S^+	oH_2		2.3e-09	0.00	0.0
2082	oH_2S	oH_3^+	oH_3S^+	pH_2		3.1e-10	0.00	0.0
2083	oH_2S	oH_3^+	pH_3S^+	oH_2		8.6e-10	0.00	0.0
2084	oH_2S	oH_3^+	pH_3S^+	pH_2		2.5e-10	0.00	0.0
2085	pH_2S	oH_3^+	oH_3S^+	oH_2		9.3e-10	0.00	0.0
2086	pH_2S	oH_3^+	oH_3S^+	pH_2		9.3e-10	0.00	0.0
2087	pH_2S	oH_3^+	pH_3S^+	oH_2		1.9e-09	0.00	0.0
2088	oH_2S	pH_3^+	oH_3S^+	oH_2		8.6e-10	0.00	0.0
2089	oH_2S	pH_3^+	oH_3S^+	pH_2		6.2e-10	0.00	0.0
2090	oH_2S	pH_3^+	pH_3S^+	oH_2		1.7e-09	0.00	0.0
2091	oH_2S	pH_3^+	pH_3S^+	pH_2		4.9e-10	0.00	0.0
2092	pH_2S	pH_3^+	oH_3S^+	oH_2		7.4e-10	0.00	0.0
2093	pH_2S	pH_3^+	pH_3S^+	oH_2		1.5e-09	0.00	0.0
2094	pH_2S	pH_3^+	pH_3S^+	pH_2		1.5e-09	0.00	0.0
2095	S^+	Fe	Fe^+	S		1.8e-10	0.00	0.0
2096	SH^+	H	oH_2	S^+		8.2e-11	0.00	0.0
2097	SH^+	H	pH_2	S^+		2.7e-11	0.00	0.0
2098	SH^+	oH_2	oH_3S^+	γ		6.7e-16	0.00	0.0
2099	SH^+	oH_2	pH_3S^+	γ		3.3e-16	0.00	0.0
2100	SH^+	pH_2	pH_3S^+	γ		1.0e-15	0.00	0.0
2101	SH^+	S	S^+	SH		9.7e-10	0.00	0.0
2102	SH^+	oH_2S	oH_3S^+	S		3.3e-10	0.00	0.0
2103	SH^+	oH_2S	pH_3S^+	S		1.7e-10	0.00	0.0
2104	SH^+	pH_2S	pH_3S^+	S		5.0e-10	0.00	0.0
2105	SH^+	Fe	Fe^+	SH		1.6e-09	0.00	0.0
2106	oH_2S^+	H	oH_2	SH^+		1.7e-10	0.00	0.0
2107	oH_2S^+	H	pH_2	SH^+		3.3e-11	0.00	0.0
2108	pH_2S^+	H	oH_2	SH^+		1.0e-10	0.00	0.0
2109	pH_2S^+	H	pH_2	SH^+		1.0e-10	0.00	0.0
2110	oH_2S^+	S	oH_2S	S^+		1.1e-09	0.00	0.0
2111	pH_2S^+	S	pH_2S	S^+		1.1e-09	0.00	0.0
2112	oH_2S^+	SH	oH_2S	SH^+		5.0e-10	0.00	0.0
2113	pH_2S^+	SH	pH_2S	SH^+		5.0e-10	0.00	0.0
2114	oH_2S^+	Fe	oH_2S	Fe^+		1.8e-09	0.00	0.0
2115	pH_2S^+	Fe	pH_2S	Fe^+		1.8e-09	0.00	0.0
2116	oH_3S^+	H	oH_2S^+	oH_2		4.5e-11	0.00	0.0
2117	oH_3S^+	H	oH_2S^+	pH_2		7.5e-12	0.00	0.0
2118	oH_3S^+	H	pH_2S^+	oH_2		7.5e-12	0.00	0.0
2119	pH_3S^+	H	oH_2S^+	oH_2		2.2e-11	0.00	0.0
2120	pH_3S^+	H	oH_2S^+	pH_2		1.5e-11	0.00	0.0
2121	pH_3S^+	H	pH_2S^+	oH_2		1.5e-11	0.00	0.0
2122	pH_3S^+	H	pH_2S^+	pH_2		7.5e-12	0.00	0.0
2123	S	oH_2D^+	SH^+	HD		1.7e-09	0.00	0.0
2124	S	pH_2D^+	SH^+	HD		1.7e-09	0.00	0.0
2125	S	oH_2D^+	oH_2	SD^+		8.7e-10	0.00	0.0
2126	S	pH_2D^+	pH_2	SD^+		8.7e-10	0.00	0.0
2127	S	oHD_2^+	oD_2	SH^+		8.7e-10	0.00	0.0
2128	S	pHD_2^+	pD_2	SH^+		8.7e-10	0.00	0.0
2129	S	oHD_2^+	SD^+	HD		1.7e-09	0.00	0.0
2130	S	pHD_2^+	SD^+	HD		1.7e-09	0.00	0.0
2131	S	mD_3^+	oD_2	SD^+		2.6e-09	0.00	0.0
2132	S	pD_3^+	pD_2	SD^+		2.6e-09	0.00	0.0
2133	S	oD_3^+	oD_2	SD^+		1.3e-09	0.00	0.0
2134	S	oD_3^+	pD_2	SD^+		1.3e-09	0.00	0.0
2135	SH	oH_2D^+	oH_2S^+	HD		1.6e-09	0.00	0.0
2136	SH	oH_2D^+	pH_2S^+	HD		3.2e-10	0.00	0.0
2137	SH	pH_2D^+	oH_2S^+	HD		9.5e-10	0.00	0.0
2138	SH	pH_2D^+	pH_2S^+	HD		9.5e-10	0.00	0.0
2139	SH	oHD_2^+	oD_2	oH_2S^+		1.4e-09	0.00	0.0
2140	SH	pHD_2^+	pD_2	oH_2S^+		1.4e-09	0.00	0.0
2141	SH	oHD_2^+	oD_2	pH_2S^+		4.8e-10	0.00	0.0
2142	SH	pHD_2^+	pD_2	pH_2S^+		4.8e-10	0.00	0.0
2143	oH_2S	oH_2D^+	oH_3S^+	HD		2.5e-09	0.00	0.0
2144	oH_2S	oH_2D^+	pH_3S^+	HD		1.2e-09	0.00	0.0
2145	oH_2S	pH_2D^+	oH_3S^+	HD		1.2e-09	0.00	0.0
2146	oH_2S	pH_2D^+	pH_3S^+	HD		2.5e-09	0.00	0.0

Table D6 – *continued* (part 30)

#	Reactants		Products			α	β	γ
2147	pH_2S	oH_2D^+	oH_3S^+	HD		1.2e-09	0.00	0.0
2148	pH_2S	oH_2D^+	pH_3S^+	HD		2.5e-09	0.00	0.0
2149	pH_2S	pH_2D^+	pH_3S^+	HD		3.7e-09	0.00	0.0
2150	oH_2S	oHD_2^+	oD_2	oH_3S^+		2.5e-09	0.00	0.0
2151	oH_2S	pHD_2^+	pD_2	oH_3S^+		2.5e-09	0.00	0.0
2152	oH_2S	oHD_2^+	oD_2	pH_3S^+		1.2e-09	0.00	0.0
2153	oH_2S	pHD_2^+	pD_2	pH_3S^+		1.2e-09	0.00	0.0
2154	pH_2S	oHD_2^+	oD_2	pH_3S^+		3.7e-09	0.00	0.0
2155	pH_2S	pHD_2^+	pD_2	pH_3S^+		3.7e-09	0.00	0.0
2156	S^+	Gr	Gr^+	S		2.8e-07	0.50	0.0
2157	S^+	Gr^-	Gr	S		2.8e-07	0.50	0.0
2158	oH_3S^+	Gr	oH_2S	H	Gr^+	2.7e-07	0.50	0.0
2159	pH_3S^+	Gr	oH_2S	H	Gr^+	1.4e-07	0.50	0.0
2160	pH_3S^+	Gr	pH_2S	H	Gr^+	1.4e-07	0.50	0.0
2161	oH_3S^+	Gr^-	oH_2S	H	Gr	2.7e-07	0.50	0.0
2162	pH_3S^+	Gr^-	oH_2S	H	Gr	1.4e-07	0.50	0.0
2163	pH_3S^+	Gr^-	pH_2S	H	Gr	1.4e-07	0.50	0.0
2164	S^+	e^-	S	γ		3.9e-12	-0.63	0.0
2165	SH^+	e^-	S	H		2.0e-07	-0.50	0.0
2166	oH_2S^+	e^-	SH	H		1.5e-07	-0.50	0.0
2167	pH_2S^+	e^-	SH	H		1.5e-07	-0.50	0.0
2168	oH_2S^+	e^-	H	H	S	1.5e-07	-0.50	0.0
2169	pH_2S^+	e^-	H	H	S	1.5e-07	-0.50	0.0
2170	oH_2S^+	e^-	oH_2S	γ		1.1e-10	-0.70	0.0
2171	pH_2S^+	e^-	pH_2S	γ		1.1e-10	-0.70	0.0
2172	oH_3S^+	e^-	oH_2S	H		3.0e-07	-0.50	0.0
2173	pH_3S^+	e^-	oH_2S	H		1.5e-07	-0.50	0.0
2174	pH_3S^+	e^-	pH_2S	H		1.5e-07	-0.50	0.0
2175	oH_3S^+	e^-	oH_2	SH		1.0e-07	-0.50	0.0
2176	pH_3S^+	e^-	oH_2	SH		5.0e-08	-0.50	0.0
2177	pH_3S^+	e^-	pH_2	SH		5.0e-08	-0.50	0.0
2178	SD^+	e^-	S	D		2.0e-07	-0.50	0.0
2179	S	γ_2	S^+	e^-		8.0e+02	0.00	0.0
2180	SH	γ_2	S	H		1.1e+03	0.00	0.0
2181	SH	γ_2	SH^+	e^-		3.4e+01	0.00	0.0
2182	oH_2S	γ_2	SH	H		3.4e+03	0.00	0.0
2183	pH_2S	γ_2	SH	H		3.4e+03	0.00	0.0
2184	oH_2S	γ_2	oH_2S^+	e^-		6.2e+02	0.00	0.0
2185	pH_2S	γ_2	pH_2S^+	e^-		6.2e+02	0.00	0.0
2186	SH^+	γ_2	S^+	H		4.6e+02	0.00	0.0
2187	O	CH	HCO^+	e^-		2.4e-14	0.50	0.0
2188	O	CH	CO	H		6.6e-11	0.00	0.0
2189	O	oCH_2	H	H	CO	1.0e-10	0.00	0.0
2190	O	pCH_2	H	H	CO	1.0e-10	0.00	0.0
2191	O	oCH_2	oH_2	CO		4.0e-11	0.00	0.0
2192	O	pCH_2	pH_2	CO		4.0e-11	0.00	0.0
2193	O	oCH_3	oH_2	H	CO	1.8e-10	0.50	0.0
2194	O	pCH_3	oH_2	H	CO	9.0e-11	0.50	0.0
2195	O	pCH_3	pH_2	H	CO	9.0e-11	0.50	0.0
2196	O	C_2	CO	C		2.0e-10	-0.12	0.0
2197	O	C_2H	CO	CH		1.0e-10	0.00	250.0
2198	O	C_3	CO	C_2		5.0e-11	0.50	0.0
2199	O	C_3H	C_2H	CO		5.0e-11	0.50	0.0
2200	O	C_3H_2	C_2H_2	CO		5.0e-11	0.50	0.0
2201	O	NH	NO	H		6.6e-11	0.00	0.0
2202	O	oNH_2	NH	OH		7.0e-12	-0.10	0.0
2203	O	pNH_2	NH	OH		7.0e-12	-0.10	0.0
2204	O	CN	CO	N		5.0e-11	0.00	0.0
2205	O	HNC	CO	NH		2.0e-10	0.50	200.0
2206	O	SH	OH	S		1.7e-11	0.67	956.0
2207	O	SH	SO	H		1.6e-10	0.00	0.0
2208	O	CS	CO	S		2.6e-10	0.00	760.0
2209	O	oCH_3^+	oH_2	HCO^+		3.1e-10	0.00	0.0
2210	O	pCH_3^+	oH_2	HCO^+		1.6e-10	0.00	0.0
2211	O	pCH_3^+	pH_2	HCO^+		1.6e-10	0.00	0.0
2212	O	oCH_3^+	oH_3^+	CO		1.3e-11	0.00	0.0
2213	O	pCH_3^+	pH_3^+	CO		1.3e-11	0.00	0.0
2214	O	pCH_5^+	oH_3O^+	oCH_2		2.2e-10	0.00	0.0
2215	O	oCH_5^+	oH_3O^+	oCH_2		5.4e-11	0.00	0.0
2216	O	oCH_5^+	oH_3O^+	pCH_2		5.4e-11	0.00	0.0
2217	O	oCH_5^+	pH_3O^+	oCH_2		1.1e-10	0.00	0.0
2218	O	mCH_5^+	oH_3O^+	oCH_2		4.3e-11	0.00	0.0
2219	O	mCH_5^+	pH_3O^+	oCH_2		8.6e-11	0.00	0.0
2220	O	mCH_5^+	pH_3O^+	pCH_2		8.6e-11	0.00	0.0

Table D6 – *continued* (part 31)

#	Reactants		Products		α	β	γ
2221	O	HCO_2^+	HCO^+	O_2	1.0e-09	0.00	0.0
2222	O	SH^+	SO^+	H	2.9e-10	0.00	0.0
2223	O	SH^+	S^+	OH	2.9e-10	0.00	0.0
2224	O	oH_2S^+	SH^+	OH	3.1e-10	0.00	0.0
2225	O	pH_2S^+	SH^+	OH	3.1e-10	0.00	0.0
2226	O	oH_2S^+	oH_2	SO^+	3.1e-10	0.00	0.0
2227	O	pH_2S^+	pH_2	SO^+	3.1e-10	0.00	0.0
2228	O	HCS^+	HCO^+	S	1.0e-09	0.00	0.0
2229	C	OH	CO	H	3.1e-11	-0.36	0.0
2230	C	O_2	CO	O	3.3e-11	0.50	0.0
2231	C	NH	CN	H	1.2e-10	0.00	0.0
2232	C	oNH_2	HCN	H	3.0e-11	-0.20	-6.0
2233	C	pNH_2	HCN	H	3.0e-11	-0.20	-6.0
2234	C	oNH_2	HNC	H	3.0e-11	-0.20	-6.0
2235	C	pNH_2	HNC	H	3.0e-11	-0.20	-6.0
2236	C	NO	CN	O	6.0e-11	-0.16	0.0
2237	C	NO	CO	N	9.0e-11	-0.16	0.0
2238	C	SH	CS	H	2.0e-11	0.00	0.0
2239	C	SO	CO	S	7.2e-11	0.00	0.0
2240	C	SO	CS	O	1.7e-10	0.00	0.0
2241	C	oH_3O^+	oH_2	HCO^+	1.0e-11	0.00	0.0
2242	C	pH_3O^+	oH_2	HCO^+	5.0e-12	0.00	0.0
2243	C	pH_3O^+	pH_2	HCO^+	5.0e-12	0.00	0.0
2244	C	HCO^+	CH^+	CO	1.1e-09	0.00	0.0
2245	C	O_2^+	CO^+	O	5.2e-11	0.00	0.0
2246	C	O_2^+	C^+	O_2	5.2e-11	0.00	0.0
2247	C	SH^+	CS^+	H	9.9e-10	0.00	0.0
2248	C	oH_2S^+	HCS^+	H	1.0e-09	0.00	0.0
2249	C	pH_2S^+	HCS^+	H	1.0e-09	0.00	0.0
2250	C	oH_2DO^+	oH_2	DCO^+	1.0e-11	0.00	0.0
2251	C	pH_2DO^+	pH_2	DCO^+	1.0e-11	0.00	0.0
2252	C	oHD_2O^+	DCO^+	HD	1.0e-11	0.00	0.0
2253	C	pHD_2O^+	DCO^+	HD	1.0e-11	0.00	0.0
2254	C	mD_3O^+	oD_2	DCO^+	1.0e-11	0.00	0.0
2255	C	pD_3O^+	pD_2	DCO^+	1.0e-11	0.00	0.0
2256	C	oD_3O^+	oD_2	DCO^+	5.0e-12	0.00	0.0
2257	C	oD_3O^+	pD_2	DCO^+	5.0e-12	0.00	0.0
2258	N	CH	CN	H	1.4e-10	0.41	0.0
2259	N	CN	N_2	C	8.8e-11	0.42	0.0
2260	N	NO	N_2	O	7.3e-11	0.44	12.7
2261	N	oCH_2	HCN	H	5.0e-11	0.17	0.0
2262	N	pCH_2	HCN	H	5.0e-11	0.17	0.0
2263	N	oCH_2	HNC	H	3.0e-11	0.17	0.0
2264	N	pCH_2	HNC	H	3.0e-11	0.17	0.0
2265	N	oCH_3	oH_2	HCN	1.3e-11	0.50	0.0
2266	N	pCH_3	oH_2	HCN	6.5e-12	0.50	0.0
2267	N	pCH_3	pH_2	HCN	6.5e-12	0.50	0.0
2268	N	OH	NO	H	5.0e-11	0.00	6.0
2269	N	O_2^+	NO^+	O	7.8e-11	0.00	0.0
2270	N	oCH_2^+	HCN^+	H	9.4e-10	0.00	0.0
2271	N	pCH_2^+	HCN^+	H	9.4e-10	0.00	0.0
2272	N	C_2H^+	C_2N^+	H	8.3e-10	0.00	0.0
2273	N	oCH_3^+	oH_2	HCN^+	6.7e-11	0.00	0.0
2274	N	pCH_3^+	oH_2	HCN^+	3.4e-11	0.00	0.0
2275	N	pCH_3^+	pH_2	HCN^+	3.4e-11	0.00	0.0
2276	N	oCH_3^+	$HCNH^+$	H	6.7e-11	0.00	0.0
2277	N	pCH_3^+	$HCNH^+$	H	6.7e-11	0.00	0.0
2278	N	$C_2H_2^+$	CH^+	HCN	2.5e-11	0.00	0.0
2279	N	SO	NO	S	1.7e-11	0.50	750.0
2280	S	CH	CS	H	1.1e-12	0.00	0.0
2281	S	OH	SO	H	1.0e-10	0.00	100.0
2282	S	O_2	SO	O	5.2e-12	0.00	265.0
2283	S	CH^+	S^+	CH	4.7e-10	0.00	0.0
2284	S	CH^+	SH^+	C	4.7e-10	0.00	0.0
2285	S	CH^+	CS^+	H	4.7e-10	0.00	0.0
2286	S	oCH_3^+	oH_2	HCS^+	1.4e-09	0.00	0.0
2287	S	pCH_3^+	oH_2	HCS^+	7.0e-10	0.00	0.0
2288	S	pCH_3^+	pH_2	HCS^+	7.0e-10	0.00	0.0
2289	S	pCH_5^+	mCH_4	SH^+	1.3e-09	0.00	0.0
2290	S	oCH_5^+	mCH_4	SH^+	3.3e-10	0.00	0.0
2291	S	oCH_5^+	oCH_4	SH^+	9.8e-10	0.00	0.0
2292	S	mCH_5^+	pCH_4	SH^+	5.2e-10	0.00	0.0
2293	S	mCH_5^+	oCH_4	SH^+	7.8e-10	0.00	0.0
2294	S	HCO^+	SH^+	CO	3.3e-10	0.00	0.0

Table D6 – *continued* (part 32)

#	Reactants		Products			α	β	γ
2295	S	O_2^+	SO^+	O		5.4e-10	0.00	0.0
2296	S	O_2^+	S^+	O_2		5.4e-10	0.00	0.0
2297	S	HNO^+	SH^+	NO		1.1e-09	0.00	0.0
2298	S	N_2H^+	SH^+	N_2		1.1e-09	0.00	0.0
2299	CO	He^+	C^+	O	He	1.5e-09	0.00	0.0
2300	SO	He^+	O^+	S	He	8.3e-10	0.00	0.0
2301	SO	He^+	S^+	O	He	8.3e-10	0.00	0.0
2302	NO	He^+	N^+	O	He	1.4e-09	0.00	0.0
2303	NO	He^+	O^+	N	He	2.2e-10	0.00	0.0
2304	CN	He^+	C^+	N	He	8.8e-10	0.00	0.0
2305	CN	He^+	N^+	C	He	8.8e-10	0.00	0.0
2306	CS	He^+	C^+	S	He	1.3e-09	0.00	0.0
2307	CS	He^+	S^+	C	He	1.3e-09	0.00	0.0
2308	N_2	He^+	N^+	N	He	7.9e-10	0.00	0.0
2309	N_2	He^+	N_2^+	He		4.1e-10	0.00	0.0
2310	HCN	He^+	CN^+	H	He	1.5e-09	0.00	0.0
2311	HCN	He^+	CH^+	N	He	6.2e-10	0.00	0.0
2312	HCN	He^+	C^+	NH	He	7.8e-10	0.00	0.0
2313	HCN	He^+	N^+	CH	He	2.5e-10	0.00	0.0
2314	HNC	He^+	CN^+	H	He	1.6e-09	0.00	0.0
2315	HNC	He^+	C^+	NH	He	1.6e-09	0.00	0.0
2316	CO_2	He^+	CO^+	O	He	7.7e-10	0.00	0.0
2317	CO_2	He^+	O^+	CO	He	1.8e-10	0.00	0.0
2318	CO_2	He^+	C^+	O_2	He	4.0e-11	0.00	0.0
2319	SO_2	He^+	S^+	O_2	He	8.6e-10	0.00	0.0
2320	SO_2	He^+	SO^+	O	He	3.4e-09	0.00	0.0
2321	OCS	He^+	CS^+	O	He	7.6e-10	0.00	0.0
2322	OCS	He^+	S^+	CO	He	7.6e-10	0.00	0.0
2323	OCS	He^+	CO^+	S	He	7.6e-10	0.00	0.0
2324	OCS	He^+	O^+	CS	He	7.6e-11	0.00	0.0
2325	CH	SH^+	oCH_2^+	S		4.3e-10	0.00	0.0
2326	CH	SH^+	pCH_2^+	S		1.4e-10	0.00	0.0
2327	oH_2O	pCH_5^+	mCH_4	oH_3O^+		1.9e-09	0.00	0.0
2328	oH_2O	pCH_5^+	pCH_4	oH_3O^+		1.6e-10	0.00	0.0
2329	oH_2O	pCH_5^+	oCH_4	oH_3O^+		8.5e-10	0.00	0.0
2330	oH_2O	pCH_5^+	mCH_4	pH_3O^+		5.7e-10	0.00	0.0
2331	oH_2O	pCH_5^+	oCH_4	pH_3O^+		2.0e-10	0.00	0.0
2332	pH_2O	pCH_5^+	mCH_4	oH_3O^+		6.2e-10	0.00	0.0
2333	pH_2O	pCH_5^+	oCH_4	oH_3O^+		1.9e-09	0.00	0.0
2334	pH_2O	pCH_5^+	mCH_4	pH_3O^+		1.2e-09	0.00	0.0
2335	oH_2O	oCH_5^+	mCH_4	oH_3O^+		4.7e-10	0.00	0.0
2336	oH_2O	oCH_5^+	pCH_4	oH_3O^+		2.3e-10	0.00	0.0
2337	oH_2O	oCH_5^+	oCH_4	oH_3O^+		1.4e-09	0.00	0.0
2338	oH_2O	oCH_5^+	mCH_4	pH_3O^+		8.5e-10	0.00	0.0
2339	oH_2O	oCH_5^+	pCH_4	pH_3O^+		1.8e-10	0.00	0.0
2340	oH_2O	oCH_5^+	oCH_4	pH_3O^+		5.6e-10	0.00	0.0
2341	pH_2O	oCH_5^+	mCH_4	oH_3O^+		3.5e-10	0.00	0.0
2342	pH_2O	oCH_5^+	pCH_4	oH_3O^+		7.0e-10	0.00	0.0
2343	pH_2O	oCH_5^+	oCH_4	oH_3O^+		1.1e-09	0.00	0.0
2344	pH_2O	oCH_5^+	mCH_4	pH_3O^+		7.0e-10	0.00	0.0
2345	pH_2O	oCH_5^+	oCH_4	pH_3O^+		8.8e-10	0.00	0.0
2346	oH_2O	mCH_5^+	mCH_4	oH_3O^+		3.2e-10	0.00	0.0
2347	oH_2O	mCH_5^+	pCH_4	oH_3O^+		4.7e-10	0.00	0.0
2348	oH_2O	mCH_5^+	oCH_4	oH_3O^+		9.7e-10	0.00	0.0
2349	oH_2O	mCH_5^+	mCH_4	pH_3O^+		4.7e-10	0.00	0.0
2350	oH_2O	mCH_5^+	pCH_4	pH_3O^+		3.5e-10	0.00	0.0
2351	oH_2O	mCH_5^+	oCH_4	pH_3O^+		1.1e-09	0.00	0.0
2352	pH_2O	mCH_5^+	mCH_4	oH_3O^+		2.6e-10	0.00	0.0
2353	pH_2O	mCH_5^+	oCH_4	oH_3O^+		7.9e-10	0.00	0.0
2354	pH_2O	mCH_5^+	pCH_4	pH_3O^+		1.1e-09	0.00	0.0
2355	pH_2O	mCH_5^+	oCH_4	pH_3O^+		1.6e-09	0.00	0.0
2356	oH_2O	C_3H^+	C_2H_2	HCO^+		2.5e-10	0.00	0.0
2357	pH_2O	C_3H^+	C_2H_2	HCO^+		2.5e-10	0.00	0.0
2358	oH_2O	C_3H^+	$C_2H_3^+$	CO		2.0e-10	0.00	0.0
2359	pH_2O	C_3H^+	$C_2H_3^+$	CO		2.0e-10	0.00	0.0
2360	oH_2O	oNH_3^+	mNH_4^+	OH		1.5e-10	0.00	0.0
2361	oH_2O	oNH_3^+	pNH_4^+	OH		1.7e-11	0.00	0.0
2362	oH_2O	oNH_3^+	oNH_4^+	OH		8.7e-11	0.00	0.0
2363	pH_2O	oNH_3^+	mNH_4^+	OH		6.3e-11	0.00	0.0
2364	pH_2O	oNH_3^+	oNH_4^+	OH		1.9e-10	0.00	0.0
2365	oH_2O	pNH_3^+	mNH_4^+	OH		4.2e-11	0.00	0.0
2366	oH_2O	pNH_3^+	pNH_4^+	OH		3.3e-11	0.00	0.0
2367	oH_2O	pNH_3^+	oNH_4^+	OH		1.7e-10	0.00	0.0
2368	pH_2O	pNH_3^+	pNH_4^+	OH		1.0e-10	0.00	0.0

Table D6 – *continued* (part 33)

#	Reactants		Products		α	β	γ
2369	pH_2O	pNH_3^+	oNH_4^+	OH	1.5e-10	0.00	0.0
2370	oH_2O	N_2H^+	oH_3O^+	N_2	1.7e-09	0.00	0.0
2371	oH_2O	N_2H^+	pH_3O^+	N_2	8.7e-10	0.00	0.0
2372	pH_2O	N_2H^+	pH_3O^+	N_2	2.6e-09	0.00	0.0
2373	oH_2O	HNO^+	oH_3O^+	NO	1.5e-09	0.00	0.0
2374	oH_2O	HNO^+	pH_3O^+	NO	7.7e-10	0.00	0.0
2375	pH_2O	HNO^+	pH_3O^+	NO	2.3e-09	0.00	0.0
2376	oH_2O	SH^+	oH_3O^+	S	4.2e-10	0.00	0.0
2377	oH_2O	SH^+	pH_3O^+	S	2.1e-10	0.00	0.0
2378	pH_2O	SH^+	pH_3O^+	S	6.3e-10	0.00	0.0
2379	oH_2O	oH_2S^+	oH_3O^+	SH	5.4e-10	0.00	0.0
2380	oH_2O	oH_2S^+	pH_3O^+	SH	2.7e-10	0.00	0.0
2381	oH_2O	pH_2S^+	oH_3O^+	SH	2.7e-10	0.00	0.0
2382	oH_2O	pH_2S^+	pH_3O^+	SH	5.4e-10	0.00	0.0
2383	pH_2O	oH_2S^+	oH_3O^+	SH	2.7e-10	0.00	0.0
2384	pH_2O	oH_2S^+	pH_3O^+	SH	5.4e-10	0.00	0.0
2385	pH_2O	pH_2S^+	pH_3O^+	SH	8.1e-10	0.00	0.0
2386	oNH_3	SH^+	oNH_3^+	SH	5.3e-10	0.00	0.0
2387	pNH_3	SH^+	pNH_3^+	SH	5.3e-10	0.00	0.0
2388	oNH_3	SH^+	mNH_4^+	S	6.1e-10	0.00	0.0
2389	oNH_3	SH^+	oNH_4^+	S	3.7e-10	0.00	0.0
2390	pNH_3	SH^+	pNH_4^+	S	2.4e-10	0.00	0.0
2391	pNH_3	SH^+	oNH_4^+	S	7.3e-10	0.00	0.0
2392	oNH_3	oH_2S^+	mNH_4^+	SH	7.9e-10	0.00	0.0
2393	oNH_3	oH_2S^+	pNH_4^+	SH	9.1e-11	0.00	0.0
2394	oNH_3	oH_2S^+	oNH_4^+	SH	4.8e-10	0.00	0.0
2395	oNH_3	pH_2S^+	mNH_4^+	SH	3.4e-10	0.00	0.0
2396	oNH_3	pH_2S^+	oNH_4^+	SH	1.0e-09	0.00	0.0
2397	pNH_3	oH_2S^+	mNH_4^+	SH	2.3e-10	0.00	0.0
2398	pNH_3	oH_2S^+	pNH_4^+	SH	1.8e-10	0.00	0.0
2399	pNH_3	oH_2S^+	oNH_4^+	SH	9.5e-10	0.00	0.0
2400	pNH_3	pH_2S^+	pNH_4^+	SH	5.4e-10	0.00	0.0
2401	pNH_3	pH_2S^+	oNH_4^+	SH	8.2e-10	0.00	0.0
2402	oNH_3	oH_2S^+	oNH_3^+	oH_2S	3.4e-10	0.00	0.0
2403	oNH_3	pH_2S^+	oNH_3^+	pH_2S	3.4e-10	0.00	0.0
2404	pNH_3	oH_2S^+	pNH_3^+	oH_2S	3.4e-10	0.00	0.0
2405	pNH_3	pH_2S^+	pNH_3^+	pH_2S	3.4e-10	0.00	0.0
2406	oNH_3	oH_3S^+	mNH_4^+	oH_2S	9.9e-10	0.00	0.0
2407	oNH_3	oH_3S^+	mNH_4^+	pH_2S	1.2e-10	0.00	0.0
2408	oNH_3	oH_3S^+	pNH_4^+	oH_2S	7.9e-11	0.00	0.0
2409	oNH_3	oH_3S^+	pNH_4^+	pH_2S	4.7e-11	0.00	0.0
2410	oNH_3	oH_3S^+	oNH_4^+	oH_2S	5.5e-10	0.00	0.0
2411	oNH_3	oH_3S^+	oNH_4^+	pH_2S	1.2e-10	0.00	0.0
2412	oNH_3	pH_3S^+	mNH_4^+	oH_2S	3.2e-10	0.00	0.0
2413	oNH_3	pH_3S^+	mNH_4^+	pH_2S	2.4e-10	0.00	0.0
2414	oNH_3	pH_3S^+	pNH_4^+	oH_2S	1.6e-10	0.00	0.0
2415	oNH_3	pH_3S^+	oNH_4^+	oH_2S	9.5e-10	0.00	0.0
2416	oNH_3	pH_3S^+	oNH_4^+	pH_2S	2.4e-10	0.00	0.0
2417	pNH_3	oH_3S^+	mNH_4^+	oH_2S	3.2e-10	0.00	0.0
2418	pNH_3	oH_3S^+	mNH_4^+	pH_2S	2.4e-10	0.00	0.0
2419	pNH_3	oH_3S^+	pNH_4^+	oH_2S	1.6e-10	0.00	0.0
2420	pNH_3	oH_3S^+	oNH_4^+	oH_2S	9.5e-10	0.00	0.0
2421	pNH_3	oH_3S^+	oNH_4^+	pH_2S	2.4e-10	0.00	0.0
2422	pNH_3	pH_3S^+	mNH_4^+	oH_2S	1.6e-10	0.00	0.0
2423	pNH_3	pH_3S^+	pNH_4^+	oH_2S	3.2e-10	0.00	0.0
2424	pNH_3	pH_3S^+	pNH_4^+	pH_2S	1.9e-10	0.00	0.0
2425	pNH_3	pH_3S^+	oNH_4^+	oH_2S	7.6e-10	0.00	0.0
2426	pNH_3	pH_3S^+	oNH_4^+	pH_2S	4.8e-10	0.00	0.0
2427	oNH_3	SO^+	oNH_3^+	SO	1.3e-09	0.00	0.0
2428	pNH_3	SO^+	pNH_3^+	SO	1.3e-09	0.00	0.0
2429	oNH_3	O_2^+	oNH_3^+	O_2	2.0e-09	0.00	0.0
2430	pNH_3	O_2^+	pNH_3^+	O_2	2.0e-09	0.00	0.0
2431	CO	OH	CO_2	H	4.4e-13	-1.15	390.0
2432	CO	oH_2^+	HCO^+	H	2.2e-09	0.00	0.0
2433	CO	pH_2^+	HCO^+	H	2.2e-09	0.00	0.0
2434	CO	oH_2^+	oH_2	CO^+	6.4e-10	0.00	0.0
2435	CO	pH_2^+	pH_2	CO^+	6.4e-10	0.00	0.0
2436	CO	oH_3^+	oH_2	HCO^+	1.7e-09	0.00	0.0
2437	CO	pH_3^+	oH_2	HCO^+	8.5e-10	0.00	0.0
2438	CO	pH_3^+	pH_2	HCO^+	8.5e-10	0.00	0.0
2439	CO	pCH_5^+	mCH_4	HCO^+	9.9e-10	0.00	0.0
2440	CO	oCH_5^+	mCH_4	HCO^+	2.5e-10	0.00	0.0
2441	CO	oCH_5^+	oCH_4	HCO^+	7.4e-10	0.00	0.0
2442	CO	mCH_5^+	pCH_4	HCO^+	4.0e-10	0.00	0.0

Table D6 – *continued* (part 34)

#	Reactants		Products		α	β	γ
2443	CO	mCH_5^+	oCH_4	HCO^+	5.9e-10	0.00	0.0
2444	CO	oH_2D^+	HCO^+	HD	1.1e-09	0.00	0.0
2445	CO	pH_2D^+	HCO^+	HD	1.1e-09	0.00	0.0
2446	CO	oH_2D^+	oH_2	DCO^+	5.7e-10	0.00	0.0
2447	CO	pH_2D^+	pH_2	DCO^+	5.7e-10	0.00	0.0
2448	CO	oHD_2^+	oD_2	HCO^+	5.7e-10	0.00	0.0
2449	CO	pHD_2^+	pD_2	HCO^+	5.7e-10	0.00	0.0
2450	CO	oHD_2^+	DCO^+	HD	1.1e-09	0.00	0.0
2451	CO	pHD_2^+	DCO^+	HD	1.1e-09	0.00	0.0
2452	CO	mD_3^+	oD_2	DCO^+	1.7e-09	0.00	0.0
2453	CO	pD_3^+	pD_2	DCO^+	1.7e-09	0.00	0.0
2454	CO	oD_3^+	oD_2	DCO^+	8.5e-10	0.00	0.0
2455	CO	oD_3^+	pD_2	DCO^+	8.5e-10	0.00	0.0
2456	SO	OH	SO_2	H	2.0e-10	-0.17	0.0
2457	SO	H^+	SO^+	H	3.2e-09	0.00	0.0
2458	SO	oH_3^+	oH_2	HSO^+	1.9e-09	0.00	0.0
2459	SO	pH_3^+	oH_2	HSO^+	9.5e-10	0.00	0.0
2460	SO	pH_3^+	pH_2	HSO^+	9.5e-10	0.00	0.0
2461	SO	CH^+	OH^+	CS	1.0e-09	0.00	0.0
2462	SO	CH^+	SH^+	CO	1.0e-09	0.00	0.0
2463	SO	oCH_3^+	oH_2	$HOCS^+$	9.5e-10	0.00	0.0
2464	SO	pCH_3^+	oH_2	$HOCS^+$	4.8e-10	0.00	0.0
2465	SO	pCH_3^+	pH_2	$HOCS^+$	4.8e-10	0.00	0.0
2466	SO	HCO^+	HSO^+	CO	7.5e-10	0.00	0.0
2467	NO	CH	HCN	O	1.2e-11	-0.13	0.0
2468	NO	H^+	NO^+	H	1.9e-09	0.00	0.0
2469	NO	oH_3^+	oH_2	HNO^+	1.1e-09	0.00	0.0
2470	NO	pH_3^+	oH_2	HNO^+	5.5e-10	0.00	0.0
2471	NO	pH_3^+	pH_2	HNO^+	5.5e-10	0.00	0.0
2472	NO	HCO_2^+	HNO^+	CO_2	1.0e-10	0.00	0.0
2473	NO	O_2^+	NO^+	O_2	4.4e-10	0.00	0.0
2474	NO	SH^+	NO^+	SH	3.3e-10	0.00	0.0
2475	NO	oH_2S^+	oH_2S	NO^+	3.7e-10	0.00	0.0
2476	NO	pH_2S^+	pH_2S	NO^+	3.7e-10	0.00	0.0
2477	NO	oH_2D^+	HNO^+	HD	7.3e-10	0.00	0.0
2478	NO	pH_2D^+	HNO^+	HD	7.3e-10	0.00	0.0
2479	NO	oHD_2^+	oD_2	HNO^+	3.7e-10	0.00	0.0
2480	NO	pHD_2^+	pD_2	HNO^+	3.7e-10	0.00	0.0
2481	CN	oNH_3	oNH_2	HCN	2.8e-11	-0.85	0.0
2482	CN	pNH_3	oNH_2	HCN	1.4e-11	-0.85	0.0
2483	CN	pNH_3	pNH_2	HCN	1.4e-11	-0.85	0.0
2484	CN	oH_3^+	oH_2	HCN^+	1.0e-09	0.00	0.0
2485	CN	pH_3^+	oH_2	HCN^+	5.0e-10	0.00	0.0
2486	CN	pH_3^+	pH_2	HCN^+	5.0e-10	0.00	0.0
2487	CN	oH_3^+	$HCNH^+$	H	1.0e-09	0.00	0.0
2488	CN	pH_3^+	$HCNH^+$	H	1.0e-09	0.00	0.0
2489	CN	oH_3O^+	$HCNH^+$	OH	4.5e-09	0.00	0.0
2490	CN	pH_3O^+	$HCNH^+$	OH	4.5e-09	0.00	0.0
2491	CN	oH_2D^+	$HCNH^+$	D	1.0e-09	0.00	0.0
2492	CN	pH_2D^+	$HCNH^+$	D	1.0e-09	0.00	0.0
2493	CN	oH_2D^+	HCN^+	HD	1.0e-09	0.00	0.0
2494	CN	pH_2D^+	HCN^+	HD	1.0e-09	0.00	0.0
2495	CS	OH	OCS	H	1.7e-10	0.00	0.0
2496	CS	OH	CO	SH	3.0e-11	0.00	0.0
2497	CS	H^+	CS^+	H	4.9e-09	0.00	0.0
2498	CS	oH_3^+	oH_2	HCS^+	2.9e-09	0.00	0.0
2499	CS	pH_3^+	oH_2	HCS^+	1.4e-09	0.00	0.0
2500	CS	pH_3^+	pH_2	HCS^+	1.4e-09	0.00	0.0
2501	CS	oH_2D^+	HCS^+	HD	2.9e-09	0.00	0.0
2502	CS	pH_2D^+	HCS^+	HD	2.9e-09	0.00	0.0
2503	CS	oHD_2^+	oD_2	HCS^+	2.9e-09	0.00	0.0
2504	CS	pHD_2^+	pD_2	HCS^+	2.9e-09	0.00	0.0
2505	SO	oH_2D^+	HSO^+	HD	1.9e-09	0.00	0.0
2506	SO	pH_2D^+	HSO^+	HD	1.9e-09	0.00	0.0
2507	SO	oHD_2^+	oD_2	HSO^+	1.9e-09	0.00	0.0
2508	SO	pHD_2^+	pD_2	HSO^+	1.9e-09	0.00	0.0
2509	HCN	H^+	HCN^+	H	1.1e-08	0.00	0.0
2510	HCN	oH_3^+	oH_2	$HCNH^+$	9.5e-09	0.00	0.0
2511	HCN	pH_3^+	oH_2	$HCNH^+$	4.8e-09	0.00	0.0
2512	HCN	pH_3^+	pH_2	$HCNH^+$	4.8e-09	0.00	0.0
2513	HCN	oH_3O^+	oH_2O	$HCNH^+$	4.5e-09	0.00	0.0
2514	HCN	pH_3O^+	oH_2O	$HCNH^+$	2.2e-09	0.00	0.0
2515	HCN	pH_3O^+	pH_2O	$HCNH^+$	2.2e-09	0.00	0.0
2516	HCN	oH_3S^+	oH_2S	$HCNH^+$	1.9e-09	0.00	0.0

Table D6 – *continued* (part 35)

#	Reactants		Products		α	β	γ
2517	HCN	pH_3S^+	oH_2S	$HCNH^+$	9.5e-10	0.00	0.0
2518	HCN	pH_3S^+	pH_2S	$HCNH^+$	9.5e-10	0.00	0.0
2519	HCN	HCO^+	$HCNH^+$	CO	3.7e-09	0.00	0.0
2520	HCN	oH_2D^+	$HCNH^+$	HD	9.5e-09	0.00	0.0
2521	HCN	pH_2D^+	$HCNH^+$	HD	9.5e-09	0.00	0.0
2522	HNC	H	HCN	H	1.0e-15	0.00	0.0
2523	HNC	H^+	H^+	HCN	1.0e-09	0.00	0.0
2524	HNC	oH_3^+	oH_2	$HCNH^+$	9.5e-09	0.00	0.0
2525	HNC	pH_3^+	oH_2	$HCNH^+$	4.8e-09	0.00	0.0
2526	HNC	pH_3^+	pH_2	$HCNH^+$	4.8e-09	0.00	0.0
2527	HNC	oH_2D^+	$HCNH^+$	HD	9.5e-09	0.00	0.0
2528	HNC	pH_2D^+	$HCNH^+$	HD	9.5e-09	0.00	0.0
2529	HNC	oH_3O^+	oH_2O	$HCNH^+$	4.5e-09	0.00	0.0
2530	HNC	pH_3O^+	oH_2O	$HCNH^+$	2.2e-09	0.00	0.0
2531	HNC	pH_3O^+	pH_2O	$HCNH^+$	2.2e-09	0.00	0.0
2532	HNC	HCO^+	$HCNH^+$	CO	3.7e-09	0.00	0.0
2533	CO_2	H^+	HCO^+	O	4.2e-09	0.00	0.0
2534	CO_2	oH_3^+	oH_2	HCO_2^+	2.0e-09	0.00	0.0
2535	CO_2	pH_3^+	oH_2	HCO_2^+	1.0e-09	0.00	0.0
2536	CO_2	pH_3^+	pH_2	HCO_2^+	1.0e-09	0.00	0.0
2537	CO_2	oH_2D^+	HCO_2^+	HD	1.3e-09	0.00	0.0
2538	CO_2	pH_2D^+	HCO_2^+	HD	1.3e-09	0.00	0.0
2539	CO_2	oH_2D^+	oH_2	DCO_2^+	6.7e-10	0.00	0.0
2540	CO_2	pH_2D^+	pH_2	DCO_2^+	6.7e-10	0.00	0.0
2541	CO_2	oHD_2^+	oD_2	HCO_2^+	6.7e-10	0.00	0.0
2542	CO_2	pHD_2^+	pD_2	HCO_2^+	6.7e-10	0.00	0.0
2543	CO_2	oHD_2^+	DCO_2^+	HD	1.3e-09	0.00	0.0
2544	CO_2	pHD_2^+	DCO_2^+	HD	1.3e-09	0.00	0.0
2545	CO_2	mD_3^+	oD_2	DCO_2^+	2.0e-09	0.00	0.0
2546	CO_2	pD_3^+	pD_2	DCO_2^+	2.0e-09	0.00	0.0
2547	CO_2	oD_3^+	oD_2	DCO_2^+	1.0e-09	0.00	0.0
2548	CO_2	oD_3^+	pD_2	DCO_2^+	1.0e-09	0.00	0.0
2549	CO_2	N_2D^+	DCO_2^+	N_2	1.4e-09	0.00	0.0
2550	SO_2	oH_3^+	oH_2	HSO_2^+	1.3e-09	0.00	0.0
2551	SO_2	pH_3^+	oH_2	HSO_2^+	6.5e-10	0.00	0.0
2552	SO_2	pH_3^+	pH_2	HSO_2^+	6.5e-10	0.00	0.0
2553	SO_2	oH_2D^+	HSO_2^+	HD	1.3e-09	0.00	0.0
2554	SO_2	pH_2D^+	HSO_2^+	HD	1.3e-09	0.00	0.0
2555	SO_2	oHD_2^+	oD_2	HSO_2^+	1.3e-09	0.00	0.0
2556	SO_2	pHD_2^+	pD_2	HSO_2^+	1.3e-09	0.00	0.0
2557	OCS	H^+	SH^+	CO	5.9e-09	0.00	0.0
2558	OCS	oH_3^+	oH_2	$HOCS^+$	1.9e-09	0.00	0.0
2559	OCS	pH_3^+	oH_2	$HOCS^+$	9.5e-10	0.00	0.0
2560	OCS	pH_3^+	pH_2	$HOCS^+$	9.5e-10	0.00	0.0
2561	OCS	HCO^+	$HOCS^+$	CO	1.1e-09	0.00	0.0
2562	oH_2S	oH_3O^+	oH_3S^+	oH_2O	1.2e-09	0.00	0.0
2563	oH_2S	oH_3O^+	oH_3S^+	pH_2O	1.6e-10	0.00	0.0
2564	oH_2S	oH_3O^+	pH_3S^+	oH_2O	4.4e-10	0.00	0.0
2565	oH_2S	oH_3O^+	pH_3S^+	pH_2O	1.3e-10	0.00	0.0
2566	pH_2S	oH_3O^+	oH_3S^+	oH_2O	4.8e-10	0.00	0.0
2567	pH_2S	oH_3O^+	oH_3S^+	pH_2O	4.8e-10	0.00	0.0
2568	pH_2S	oH_3O^+	pH_3S^+	oH_2O	9.5e-10	0.00	0.0
2569	oH_2S	pH_3O^+	oH_3S^+	oH_2O	4.4e-10	0.00	0.0
2570	oH_2S	pH_3O^+	oH_3S^+	pH_2O	3.2e-10	0.00	0.0
2571	oH_2S	pH_3O^+	pH_3S^+	oH_2O	8.9e-10	0.00	0.0
2572	oH_2S	pH_3O^+	pH_3S^+	pH_2O	2.5e-10	0.00	0.0
2573	pH_2S	pH_3O^+	oH_3S^+	oH_2O	3.8e-10	0.00	0.0
2574	pH_2S	pH_3O^+	pH_3S^+	oH_2O	7.6e-10	0.00	0.0
2575	pH_2S	pH_3O^+	pH_3S^+	pH_2O	7.6e-10	0.00	0.0
2576	SH	HCO^+	oH_2S^+	CO	6.2e-10	0.00	0.0
2577	SH	HCO^+	pH_2S^+	CO	2.0e-10	0.00	0.0
2578	CS	HCO^+	HCS^+	CO	1.2e-09	0.00	0.0
2579	oH_2S	HCO^+	oH_3S^+	CO	1.1e-09	0.00	0.0
2580	oH_2S	HCO^+	pH_3S^+	CO	5.3e-10	0.00	0.0
2581	pH_2S	HCO^+	pH_3S^+	CO	1.6e-09	0.00	0.0
2582	oH_2S	O_2^+	oH_2S^+	O_2	1.4e-09	0.00	0.0
2583	pH_2S	O_2^+	pH_2S^+	O_2	1.4e-09	0.00	0.0
2584	oH_2S	oNH_3^+	mNH_4^+	SH	3.5e-10	0.00	0.0
2585	oH_2S	oNH_3^+	pNH_4^+	SH	4.0e-11	0.00	0.0
2586	oH_2S	oNH_3^+	oNH_4^+	SH	2.1e-10	0.00	0.0
2587	pH_2S	oNH_3^+	mNH_4^+	SH	1.5e-10	0.00	0.0
2588	pH_2S	oNH_3^+	oNH_4^+	SH	4.5e-10	0.00	0.0
2589	oH_2S	pNH_3^+	mNH_4^+	SH	1.0e-10	0.00	0.0
2590	oH_2S	pNH_3^+	pNH_4^+	SH	8.0e-11	0.00	0.0

Table D6 – *continued* (part 36)

#	Reactants		Products		α	β	γ
2591	oH_2S	pNH_3^+	oNH_4^+	SH	4.2e-10	0.00	0.0
2592	pH_2S	pNH_3^+	pNH_4^+	SH	2.4e-10	0.00	0.0
2593	pH_2S	pNH_3^+	oNH_4^+	SH	3.6e-10	0.00	0.0
2594	OCS	oH_2D^+	$HOCS^+$	HD	1.9e-09	0.00	0.0
2595	OCS	pH_2D^+	$HOCS^+$	HD	1.9e-09	0.00	0.0
2596	OCS	oHD_2^+	oD_2	$HOCS^+$	1.9e-09	0.00	0.0
2597	OCS	pHD_2^+	pD_2	$HOCS^+$	1.9e-09	0.00	0.0
2598	S	N_2D^+	SD^+	N_2	1.1e-09	0.00	0.0
2599	oH_2O	N_2D^+	oH_2DO^+	N_2	2.6e-09	0.00	0.0
2600	pH_2O	N_2D^+	pH_2DO^+	N_2	2.6e-09	0.00	0.0
2601	CO	N_2D^+	DCO^+	N_2	8.8e-10	0.00	0.0
2602	C^+	S	S^+	C	5.5e-12	0.86	681.0
2603	C^+	OH	CO^+	H	8.0e-10	0.00	0.0
2604	C^+	OH	H^+	CO	8.0e-10	0.00	0.0
2605	C^+	oH_2O	HCO^+	H	2.4e-09	-0.63	0.0
2606	C^+	pH_2O	HCO^+	H	2.4e-09	-0.63	0.0
2607	C^+	O_2	O^+	CO	5.1e-10	0.00	0.0
2608	C^+	O_2	CO^+	O	3.1e-10	0.00	0.0
2609	C^+	CO_2	CO^+	CO	1.1e-09	0.00	0.0
2610	C^+	NH	CN^+	H	7.8e-10	0.00	0.0
2611	C^+	oNH_2	HCN^+	H	1.1e-09	0.00	0.0
2612	C^+	pNH_2	HCN^+	H	1.1e-09	0.00	0.0
2613	C^+	oNH_3	oNH_3^+	C	5.3e-10	0.00	0.0
2614	C^+	pNH_3	pNH_3^+	C	5.3e-10	0.00	0.0
2615	C^+	oNH_3	H_2NC^+	H	7.8e-10	0.00	0.0
2616	C^+	pNH_3	H_2NC^+	H	7.8e-10	0.00	0.0
2617	C^+	oNH_3	$HCNH^+$	H	7.8e-10	0.00	0.0
2618	C^+	pNH_3	$HCNH^+$	H	7.8e-10	0.00	0.0
2619	C^+	oNH_3	oH_2	HCN^+	2.1e-10	0.00	0.0
2620	C^+	pNH_3	oH_2	HCN^+	1.0e-10	0.00	0.0
2621	C^+	pNH_3	pH_2	HCN^+	1.0e-10	0.00	0.0
2622	C^+	HCN	C_2N^+	H	3.4e-09	0.00	0.0
2623	C^+	HNC	C_2N^+	H	3.4e-09	0.00	0.0
2624	C^+	NO	NO^+	C	3.4e-09	0.00	0.0
2625	C^+	NO	N^+	CO	9.0e-10	0.00	0.0
2626	C^+	SH	CS^+	H	1.1e-09	0.00	0.0
2627	C^+	oH_2S	HCS^+	H	1.3e-09	0.00	0.0
2628	C^+	pH_2S	HCS^+	H	1.3e-09	0.00	0.0
2629	C^+	oH_2S	oH_2S^+	C	4.2e-10	0.00	0.0
2630	C^+	pH_2S	pH_2S^+	C	4.2e-10	0.00	0.0
2631	C^+	SO	S^+	CO	2.6e-10	0.00	0.0
2632	C^+	SO	CS^+	O	2.6e-10	0.00	0.0
2633	C^+	SO	SO^+	C	2.6e-10	0.00	0.0
2634	C^+	SO	CO^+	S	2.6e-10	0.00	0.0
2635	C^+	SO_2	SO^+	CO	2.3e-09	0.00	0.0
2636	C^+	CS	CS^+	C	1.6e-09	0.00	700.0
2637	C^+	OCS	CS^+	CO	1.6e-09	0.00	0.0
2638	C^+	OD	CO^+	D	8.0e-10	0.00	0.0
2639	C^+	OD	D^+	CO	8.0e-10	0.00	0.0
2640	C^+	HDO	DCO^+	H	1.2e-09	-0.63	0.0
2641	C^+	HDO	HCO^+	D	1.2e-09	-0.63	0.0
2642	C^+	oD_2O	DCO^+	D	2.4e-09	-0.63	0.0
2643	C^+	pD_2O	DCO^+	D	2.4e-09	-0.63	0.0
2644	N^+	O_2	O_2^+	N	2.8e-10	0.00	0.0
2645	N^+	O_2	NO^+	O	2.4e-10	0.00	0.0
2646	N^+	O_2	O^+	NO	3.3e-11	0.00	0.0
2647	N^+	CO	CO^+	N	8.3e-10	0.00	0.0
2648	N^+	CO	NO^+	C	1.5e-10	0.00	0.0
2649	N^+	NO	NO^+	N	4.5e-10	0.00	0.0
2650	N^+	NO	N_2^+	O	7.9e-11	0.00	0.0
2651	S^+	CH	CS^+	H	6.2e-10	0.00	0.0
2652	S^+	oCH_2	HCS^+	H	1.0e-11	0.00	0.0
2653	S^+	pCH_2	HCS^+	H	1.0e-11	0.00	0.0
2654	S^+	OH	SO^+	H	6.1e-10	0.00	0.0
2655	S^+	NO	NO^+	S	3.2e-10	0.00	0.0
2656	S^+	oNH_3	oNH_3^+	S	1.6e-09	0.00	0.0
2657	S^+	pNH_3	pNH_3^+	S	1.6e-09	0.00	0.0
2658	S^+	O_2	SO^+	O	2.3e-11	0.00	0.0
2659	S^+	oNH_2D	oNH_2D^+	S	1.6e-09	0.00	0.0
2660	S^+	pNH_2D	pNH_2D^+	S	1.6e-09	0.00	0.0
2661	S^+	$oNHD_2$	$oNHD_2^+$	S	1.6e-09	0.00	0.0
2662	S^+	$pNHD_2$	$pNHD_2^+$	S	1.6e-09	0.00	0.0
2663	S^+	mND_3	mND_3^+	S	1.6e-09	0.00	0.0
2664	S^+	pND_3	pND_3^+	S	1.6e-09	0.00	0.0

Table D6 – *continued* (part 37)

#	Reactants		Products			α	β	γ
2665	S^+	oND_3	oND_3^+	S		1.6e-09	0.00	0.0
2666	CO^+	oH_2	HCO^+	H		1.3e-09	0.00	0.0
2667	CO^+	pH_2	HCO^+	H		1.3e-09	0.00	0.0
2668	CO^+	H	H^+	CO		7.5e-10	0.00	0.0
2669	HCO^+	CH	oCH_2^+	CO		4.7e-10	0.00	0.0
2670	HCO^+	CH	pCH_2^+	CO		1.6e-10	0.00	0.0
2671	HCO^+	oCH_2	oCH_3^+	CO		5.7e-10	0.00	0.0
2672	HCO^+	oCH_2	pCH_3^+	CO		2.9e-10	0.00	0.0
2673	HCO^+	pCH_2	pCH_3^+	CO		8.6e-10	0.00	0.0
2674	HCO^+	oH_2O	oH_3O^+	CO		1.7e-09	0.00	0.0
2675	HCO^+	oH_2O	pH_3O^+	CO		8.3e-10	0.00	0.0
2676	HCO^+	pH_2O	pH_3O^+	CO		2.5e-09	0.00	0.0
2677	HCO^+	OH	HCO_2^+	H		1.0e-09	0.00	0.0
2678	HCO^+	C_2H	$C_2H_2^+$	CO		7.8e-10	0.00	0.0
2679	HCO^+	C_2H_2	$C_2H_3^+$	CO		1.4e-09	0.00	0.0
2680	HCO^+	C_3H	$C_3H_2^+$	CO		1.4e-09	0.00	0.0
2681	HCO^+	C_3H_2	$C_3H_3^+$	CO		1.4e-09	0.00	0.0
2682	HCO^+	NH	oNH_2^+	CO		4.8e-10	0.00	0.0
2683	HCO^+	NH	pNH_2^+	CO		1.6e-10	0.00	0.0
2684	HCO^+	oNH_2	oNH_3^+	CO		5.9e-10	0.00	0.0
2685	HCO^+	oNH_2	pNH_3^+	CO		3.0e-10	0.00	0.0
2686	HCO^+	pNH_2	pNH_3^+	CO		8.9e-10	0.00	0.0
2687	HCO^+	oNH_3	mNH_4^+	CO		1.2e-09	0.00	0.0
2688	HCO^+	oNH_3	oNH_4^+	CO		7.1e-10	0.00	0.0
2689	HCO^+	pNH_3	pNH_4^+	CO		4.8e-10	0.00	0.0
2690	HCO^+	pNH_3	oNH_4^+	CO		1.4e-09	0.00	0.0
2691	HCO^+	Fe	Fe^+	CO	H	1.9e-09	0.00	0.0
2692	HCO_2^+	CO	HCO^+	CO_2		1.0e-09	0.00	0.0
2693	HCO_2^+	mCH_4	pCH_5^+	CO_2		4.7e-10	0.00	0.0
2694	HCO_2^+	mCH_4	oCH_5^+	CO_2		3.1e-10	0.00	0.0
2695	HCO_2^+	pCH_4	mCH_5^+	CO_2		7.8e-10	0.00	0.0
2696	HCO_2^+	oCH_4	oCH_5^+	CO_2		5.2e-10	0.00	0.0
2697	HCO_2^+	oCH_4	mCH_5^+	CO_2		2.6e-10	0.00	0.0
2698	oH_3O^+	CH	oCH_2^+	oH_2O		5.1e-10	0.00	0.0
2699	oH_3O^+	CH	oCH_2^+	pH_2O		8.5e-11	0.00	0.0
2700	oH_3O^+	CH	pCH_2^+	oH_2O		8.5e-11	0.00	0.0
2701	pH_3O^+	CH	oCH_2^+	oH_2O		2.5e-10	0.00	0.0
2702	pH_3O^+	CH	oCH_2^+	pH_2O		1.7e-10	0.00	0.0
2703	pH_3O^+	CH	pCH_2^+	oH_2O		1.7e-10	0.00	0.0
2704	pH_3O^+	CH	pCH_2^+	pH_2O		8.5e-11	0.00	0.0
2705	oH_3O^+	oCH_2	oCH_3^+	oH_2O		5.8e-10	0.00	0.0
2706	oH_3O^+	oCH_2	oCH_3^+	pH_2O		7.8e-11	0.00	0.0
2707	oH_3O^+	oCH_2	pCH_3^+	oH_2O		2.2e-10	0.00	0.0
2708	oH_3O^+	oCH_2	pCH_3^+	pH_2O		6.3e-11	0.00	0.0
2709	oH_3O^+	pCH_2	oCH_3^+	oH_2O		2.4e-10	0.00	0.0
2710	oH_3O^+	pCH_2	oCH_3^+	pH_2O		2.4e-10	0.00	0.0
2711	oH_3O^+	pCH_2	pCH_3^+	oH_2O		4.7e-10	0.00	0.0
2712	pH_3O^+	oCH_2	oCH_3^+	oH_2O		2.2e-10	0.00	0.0
2713	pH_3O^+	oCH_2	oCH_3^+	pH_2O		1.6e-10	0.00	0.0
2714	pH_3O^+	oCH_2	pCH_3^+	oH_2O		4.4e-10	0.00	0.0
2715	pH_3O^+	oCH_2	pCH_3^+	pH_2O		1.3e-10	0.00	0.0
2716	pH_3O^+	pCH_2	oCH_3^+	oH_2O		1.9e-10	0.00	0.0
2717	pH_3O^+	pCH_2	pCH_3^+	oH_2O		3.8e-10	0.00	0.0
2718	pH_3O^+	pCH_2	pCH_3^+	pH_2O		3.8e-10	0.00	0.0
2719	oH_3O^+	oNH_3	mNH_4^+	oH_2O		1.1e-09	0.00	0.0
2720	oH_3O^+	oNH_3	mNH_4^+	pH_2O		1.4e-10	0.00	0.0
2721	oH_3O^+	oNH_3	pNH_4^+	oH_2O		9.2e-11	0.00	0.0
2722	oH_3O^+	oNH_3	pNH_4^+	pH_2O		5.5e-11	0.00	0.0
2723	oH_3O^+	oNH_3	oNH_4^+	oH_2O		6.3e-10	0.00	0.0
2724	oH_3O^+	oNH_3	oNH_4^+	pH_2O		1.4e-10	0.00	0.0
2725	oH_3O^+	pNH_3	mNH_4^+	oH_2O		3.7e-10	0.00	0.0
2726	oH_3O^+	pNH_3	mNH_4^+	pH_2O		2.7e-10	0.00	0.0
2727	oH_3O^+	pNH_3	pNH_4^+	oH_2O		1.8e-10	0.00	0.0
2728	oH_3O^+	pNH_3	oNH_4^+	oH_2O		1.1e-09	0.00	0.0
2729	oH_3O^+	pNH_3	oNH_4^+	pH_2O		2.7e-10	0.00	0.0
2730	pH_3O^+	oNH_3	mNH_4^+	oH_2O		3.7e-10	0.00	0.0
2731	pH_3O^+	oNH_3	mNH_4^+	pH_2O		2.7e-10	0.00	0.0
2732	pH_3O^+	oNH_3	pNH_4^+	oH_2O		1.8e-10	0.00	0.0
2733	pH_3O^+	oNH_3	oNH_4^+	oH_2O		1.1e-09	0.00	0.0
2734	pH_3O^+	oNH_3	oNH_4^+	pH_2O		2.7e-10	0.00	0.0
2735	pH_3O^+	pNH_3	mNH_4^+	oH_2O		1.8e-10	0.00	0.0
2736	pH_3O^+	pNH_3	pNH_4^+	oH_2O		3.7e-10	0.00	0.0
2737	pH_3O^+	pNH_3	pNH_4^+	pH_2O		2.2e-10	0.00	0.0
2738	pH_3O^+	pNH_3	oNH_4^+	oH_2O		8.8e-10	0.00	0.0

Table D6 – *continued* (part 38)

#	Reactants		Products			α	β	γ
2739	pH_3O^+	pNH_3	oNH_4^+	pH_2O		5.5e-10	0.00	0.0
2740	CN^+	oH_2	HCN^+	H		1.0e-09	0.00	0.0
2741	CN^+	pH_2	HCN^+	H		1.0e-09	0.00	0.0
2742	HCN^+	oH_2	$HCNH^+$	H		9.8e-10	0.00	0.0
2743	HCN^+	pH_2	$HCNH^+$	H		9.8e-10	0.00	0.0
2744	$HCNH^+$	CH	oCH_2^+	HCN		2.4e-10	0.00	0.0
2745	$HCNH^+$	CH	pCH_2^+	HCN		7.9e-11	0.00	0.0
2746	$HCNH^+$	CH	oCH_2^+	HNC		2.4e-10	0.00	0.0
2747	$HCNH^+$	CH	pCH_2^+	HNC		7.9e-11	0.00	0.0
2748	$HCNH^+$	oCH_2	oCH_3^+	HCN		2.9e-10	0.00	0.0
2749	$HCNH^+$	oCH_2	pCH_3^+	HCN		1.4e-10	0.00	0.0
2750	$HCNH^+$	pCH_2	pCH_3^+	HCN		4.3e-10	0.00	0.0
2751	$HCNH^+$	oCH_2	oCH_3^+	HNC		2.9e-10	0.00	0.0
2752	$HCNH^+$	oCH_2	pCH_3^+	HNC		1.4e-10	0.00	0.0
2753	$HCNH^+$	pCH_2	pCH_3^+	HNC		4.3e-10	0.00	0.0
2754	$HCNH^+$	oNH_2	oNH_3^+	HCN		3.0e-10	0.00	0.0
2755	$HCNH^+$	oNH_2	pNH_3^+	HCN		1.5e-10	0.00	0.0
2756	$HCNH^+$	pNH_2	pNH_3^+	HCN		4.5e-10	0.00	0.0
2757	$HCNH^+$	oNH_2	oNH_3^+	HNC		3.0e-10	0.00	0.0
2758	$HCNH^+$	oNH_2	pNH_3^+	HNC		1.5e-10	0.00	0.0
2759	$HCNH^+$	pNH_2	pNH_3^+	HNC		4.5e-10	0.00	0.0
2760	$HCNH^+$	oNH_3	mNH_4^+	HCN		6.9e-10	0.00	0.0
2761	$HCNH^+$	oNH_3	oNH_4^+	HCN		4.1e-10	0.00	0.0
2762	$HCNH^+$	pNH_3	pNH_4^+	HCN		2.7e-10	0.00	0.0
2763	$HCNH^+$	pNH_3	oNH_4^+	HCN		8.3e-10	0.00	0.0
2764	$HCNH^+$	oNH_3	mNH_4^+	HNC		6.9e-10	0.00	0.0
2765	$HCNH^+$	oNH_3	oNH_4^+	HNC		4.1e-10	0.00	0.0
2766	$HCNH^+$	pNH_3	pNH_4^+	HNC		2.7e-10	0.00	0.0
2767	$HCNH^+$	pNH_3	oNH_4^+	HNC		8.3e-10	0.00	0.0
2768	$HCNH^+$	oH_2S	oH_3S^+	HCN		1.1e-10	0.00	0.0
2769	$HCNH^+$	oH_2S	pH_3S^+	HCN		5.7e-11	0.00	0.0
2770	$HCNH^+$	pH_2S	pH_3S^+	HCN		1.7e-10	0.00	0.0
2771	$HCNH^+$	oH_2S	oH_3S^+	HNC		1.1e-10	0.00	0.0
2772	$HCNH^+$	oH_2S	pH_3S^+	HNC		5.7e-11	0.00	0.0
2773	$HCNH^+$	pH_2S	pH_3S^+	HNC		1.7e-10	0.00	0.0
2774	N_2H^+	CO	HCO^+	N_2		8.8e-10	0.00	0.0
2775	N_2H^+	CO_2	HCO_2^+	N_2		1.4e-09	0.00	0.0
2776	N_2H^+	NO	HNO^+	N_2		3.4e-10	0.00	0.0
2777	C_2N^+	oNH_3	C_2H_2	N_2H^+		1.9e-09	0.00	0.0
2778	C_2N^+	pNH_3	C_2H_2	N_2H^+		1.9e-09	0.00	0.0
2779	NO^+	Fe	Fe^+	NO		1.0e-09	0.00	0.0
2780	HNO^+	C	CH^+	NO		1.0e-09	0.00	0.0
2781	HNO^+	CO	HCO^+	NO		1.0e-10	0.00	0.0
2782	HNO^+	CO_2	HCO_2^+	NO		1.0e-10	0.00	0.0
2783	HNO^+	OH	oH_2O^+	NO		4.6e-10	0.00	0.0
2784	HNO^+	OH	pH_2O^+	NO		1.6e-10	0.00	0.0
2785	SO^+	Fe	Fe^+	SO		1.6e-09	0.00	0.0
2786	CS^+	oH_2	HCS^+	H		4.8e-10	0.00	0.0
2787	CS^+	pH_2	HCS^+	H		4.8e-10	0.00	0.0
2788	HCO^+	Gr	Gr^+	CO	H	3.0e-07	0.50	0.0
2789	HCS^+	Gr	Gr^+	CS	H	2.4e-07	0.50	0.0
2790	HCO^+	Gr^-	Gr	CO	H	3.0e-07	0.50	0.0
2791	HCS^+	Gr^-	Gr	CS	H	2.4e-07	0.50	0.0
2792	CO^+	e^-	C	O		1.0e-07	-0.46	0.0
2793	HCO^+	e^-	CO	H		2.4e-07	-0.69	0.0
2794	HCO_2^+	e^-	CO_2	H		2.2e-07	-0.50	0.0
2795	HCO_2^+	e^-	CO	OH		1.2e-07	-0.50	0.0
2796	CN^+	e^-	C	N		1.8e-07	-0.50	0.0
2797	C_2N^+	e^-	C_2	N		1.0e-07	-0.50	0.0
2798	C_2N^+	e^-	CN	C		2.0e-07	-0.50	0.0
2799	HCN^+	e^-	CN	H		1.5e-07	-0.50	0.0
2800	HCN^+	e^-	CH	N		1.5e-07	-0.50	0.0
2801	$HCNH^+$	e^-	HCN	H		9.6e-08	-0.65	0.0
2802	$HCNH^+$	e^-	HNC	H		9.6e-08	-0.65	0.0
2803	$HCNH^+$	e^-	CN	H	H	9.1e-08	-0.65	0.0
2804	H_2NC^+	e^-	HNC	H		1.8e-07	-0.50	0.0
2805	H_2NC^+	e^-	CN	H	H	1.8e-08	-0.50	0.0
2806	NO^+	e^-	N	O		4.3e-07	-0.37	0.0
2807	HNO^+	e^-	NO	H		3.0e-07	-0.50	0.0
2808	CS^+	e^-	C	S		2.0e-07	-0.50	0.0
2809	HCS^+	e^-	CS	H		7.0e-07	-0.50	0.0
2810	SO^+	e^-	S	O		2.0e-07	-0.50	0.0
2811	HSO^+	e^-	SO	H		2.0e-07	-0.50	0.0
2812	HSO_2^+	e^-	SO	H	O	1.0e-07	-0.50	0.0

Table D6 – *continued* (part 39)

#	Reactants		Products			α	β	γ
2813	HSO_2^+	e^-	SO	OH		1.0e-07	-0.50	0.0
2814	$HOCS^+$	e^-	OH	CS		2.0e-07	-0.50	0.0
2815	$HOCS^+$	e^-	OCS	H		2.0e-07	-0.50	0.0
2816	Fe^+	e^-	Fe	γ		3.7e-12	-0.65	0.0
2817	DCO^+	e^-	CO	D		2.4e-07	-0.69	0.0
2818	DCO_2^+	e^-	CO_2	D		2.2e-07	-0.50	0.0
2819	DCO_2^+	e^-	CO	OD		1.2e-07	-0.50	0.0
2820	CO_2	γ_2	CO	O		6.0e+02	0.00	0.0
2821	CO	γ_2	C	O		4.6e+01	0.00	0.0
2822	CO	γ_2	CO^+	e^-		1.4e+01	0.00	0.0
2823	HCO^+	γ_2	CO^+	H		3.3e+00	0.00	0.0
2824	CO^+	γ_2	C^+	O		7.7e+01	0.00	0.0
2825	CN	γ_2	C	N		4.5e+02	0.00	0.0
2826	CN	γ_2	CN^+	e^-		8.3e+00	0.00	0.0
2827	HCN	γ_2	CN	H		2.0e+03	0.00	0.0
2828	HCN	γ_2	HCN^+	e^-		1.4e+00	0.00	0.0
2829	HNC	γ_2	CN	H		2.0e+03	0.00	0.0
2830	NO	γ_2	N	O		3.0e+02	0.00	0.0
2831	NO	γ_2	NO^+	e^-		2.4e+02	0.00	0.0
2832	SO	γ_2	S	O		5.5e+03	0.00	0.0
2833	SO	γ_2	SO^+	e^-		4.5e+02	0.00	0.0
2834	CS	γ_2	S	C		1.9e+03	0.00	0.0
2835	CS	γ_2	CS^+	e^-		2.0e+01	0.00	0.0
2836	OCS	γ_2	CO	S		5.2e+03	0.00	0.0
2837	SO_2	γ_2	SO	O		2.7e+03	0.00	0.0
2838	N	$C_2H_2^+$	CH^+	HNC		2.5e-11	0.00	2600.0
2839	HNC	pCH_5^+	$C_2H_3^+$	oNH_3		8.3e-10	0.00	0.0
2840	HNC	pCH_5^+	$C_2H_3^+$	pNH_3		1.7e-10	0.00	0.0
2841	HNC	oCH_5^+	$C_2H_3^+$	oNH_3		5.0e-10	0.00	0.0
2842	HNC	oCH_5^+	$C_2H_3^+$	pNH_3		5.0e-10	0.00	0.0
2843	HNC	mCH_5^+	$C_2H_3^+$	oNH_3		3.0e-10	0.00	0.0
2844	HNC	mCH_5^+	$C_2H_3^+$	pNH_3		7.0e-10	0.00	0.0
2845	oH_3O^+	C_3H	$C_3H_2^+$	oH_2O		1.7e-09	0.00	0.0
2846	oH_3O^+	C_3H	$C_3H_2^+$	pH_2O		2.5e-10	0.00	0.0
2847	pH_3O^+	C_3H	$C_3H_2^+$	oH_2O		1.3e-09	0.00	0.0
2848	pH_3O^+	C_3H	$C_3H_2^+$	pH_2O		7.5e-10	0.00	0.0
2849	$C_2H_3^+$	e^-	oH_2	C_2H		1.0e-07	-0.50	0.0
2850	$C_2H_3^+$	e^-	oCH_2	CH		1.0e-07	-0.50	0.0
2851	$C_2H_3^+$	e^-	pCH_2	CH		6.8e-08	-0.50	0.0
2852	C_2H_2	H^+	oH_2	C_2H^+		1.3e-09	0.00	0.0
2853	C_2H_2	H^+	pH_2	C_2H^+		6.7e-10	0.00	0.0
2854	C_3H_2	H^+	oH_2	C_3H^+		1.3e-09	0.00	0.0
2855	C_3H_2	H^+	pH_2	C_3H^+		6.7e-10	0.00	0.0
2856	C_2H_2	He^+	pH_2	C_2^+	He	1.6e-09	0.00	0.0
2857	C_3H_2	He^+	pH_2	C_3^+	He	1.0e-09	0.00	0.0
2858	oH_3^+	C_2H_2	$C_2H_3^+$	oH_2		2.3e-09	0.00	0.0
2859	oH_3^+	C_2H_2	$C_2H_3^+$	pH_2		5.1e-10	0.00	0.0
2860	pH_3^+	C_2H_2	$C_2H_3^+$	oH_2		1.9e-09	0.00	0.0
2861	pH_3^+	C_2H_2	$C_2H_3^+$	pH_2		1.0e-09	0.00	0.0
2862	oH_3^+	C_3H_2	$C_3H_3^+$	oH_2		1.6e-09	0.00	0.0
2863	oH_3^+	C_3H_2	$C_3H_3^+$	pH_2		4.0e-10	0.00	0.0
2864	pH_3^+	C_3H_2	$C_3H_3^+$	oH_2		1.3e-09	0.00	0.0
2865	pH_3^+	C_3H_2	$C_3H_3^+$	pH_2		7.0e-10	0.00	0.0
2866	oH_2D^+	C_2H_2	$C_2H_3^+$	HD		2.9e-09	0.00	0.0
2867	pH_2D^+	C_2H_2	$C_2H_3^+$	HD		2.9e-09	0.00	0.0
2868	oH_2D^+	C_3H_2	$C_3H_3^+$	HD		2.0e-09	0.00	0.0
2869	pH_2D^+	C_3H_2	$C_3H_3^+$	HD		2.0e-09	0.00	0.0
2870	C_2H_2	pHD_2^+	$C_2H_3^+$	pD_2		2.9e-09	0.00	0.0
2871	C_3H_2	pHD_2^+	$C_3H_3^+$	pD_2		2.0e-09	0.00	0.0
2872	$C_2H_2^+$	oH_2O	oH_3O^+	C_2H		1.1e-10	0.00	0.0
2873	$C_2H_2^+$	oH_2O	pH_3O^+	C_2H		1.1e-10	0.00	0.0
2874	$C_2H_2^+$	pH_2O	oH_3O^+	C_2H		7.3e-11	0.00	0.0
2875	$C_2H_2^+$	pH_2O	pH_3O^+	C_2H		1.8e-10	0.00	0.0
2876	$C_2H_2^+$	N	oH_2	C_2N^+		2.2e-10	0.00	0.0
2877	$C_2H_2^+$	N	pH_2	C_2N^+		2.2e-10	0.00	0.0
2878	H_2CO	γ_2	oH_2	CO		1.1e+04	0.00	0.0
2879	H_2CO	γ_2	pH_2	CO		1.1e+04	0.00	0.0
2880	oH_3O^+	C_3H_2	$C_3H_3^+$	oH_2O		2.4e-09	0.00	0.0
2881	oH_3O^+	C_3H_2	$C_3H_3^+$	pH_2O		6.0e-10	0.00	0.0
2882	pH_3O^+	C_3H_2	$C_3H_3^+$	oH_2O		2.0e-09	0.00	0.0
2883	pH_3O^+	C_3H_2	$C_3H_3^+$	pH_2O		1.1e-09	0.00	0.0
2884	$C_2H_3^+$	oH_2O	oH_3O^+	C_2H_2		6.1e-10	0.00	0.0
2885	$C_2H_3^+$	oH_2O	pH_3O^+	C_2H_2		5.0e-10	0.00	0.0
2886	$C_2H_3^+$	pH_2O	oH_3O^+	C_2H_2		3.9e-10	0.00	0.0

Table D6 – *continued* (part 40)

#	Reactants		Products		α	β	γ
2887	$C_2H_3^+$	pH_2O	pH_3O^+	C_2H_2	7.2e-10	0.00	0.0
2888	oH_3^+	HD	pH_3^+	HD	7.7e-11	0.44	-4.8
2889	oH_3^+	HD	pH_2D^+	oH_2	1.6e-10	-0.02	-0.4
2890	oH_3^+	HD	oH_2D^+	pH_2	1.5e-10	-0.16	1.1
2891	oH_3^+	HD	oH_2D^+	oH_2	1.1e-09	0.01	0.3
2892	pH_3^+	HD	oH_3^+	HD	1.2e-10	0.33	29.2
2893	pH_3^+	HD	pH_2D^+	pH_2	1.1e-10	-0.41	2.9
2894	pH_3^+	HD	pH_2D^+	oH_2	2.5e-10	-0.27	3.3
2895	pH_3^+	HD	oH_2D^+	pH_2	2.8e-10	-0.32	1.9
2896	pH_3^+	HD	oH_2D^+	oH_2	1.2e-09	0.30	22.8
2897	oH_3^+	oH_2	pH_3^+	pH_2	1.3e-10	0.08	-0.7
2898	oH_3^+	oH_2	oH_3^+	pH_2	9.7e-11	0.00	-0.2
2899	oH_3^+	pH_2	pH_3^+	oH_2	3.5e-10	-0.90	154.2
2900	oH_3^+	pH_2	oH_3^+	oH_2	5.0e-10	-0.42	180.4
2901	oH_3^+	oH_2	pH_3^+	oH_2	4.1e-10	0.02	-0.5
2902	pH_3^+	oH_2	pH_3^+	pH_2	1.9e-10	-0.18	1.1
2903	pH_3^+	oH_2	oH_3^+	pH_2	1.7e-10	-0.28	1.7
2904	pH_3^+	oH_2	oH_3^+	oH_2	6.7e-10	-0.07	33.3
2905	pH_3^+	pH_2	pH_3^+	oH_2	1.0e-09	-0.57	180.4
2906	pH_3^+	pH_2	oH_3^+	oH_2	9.2e-10	-0.54	216.9
2907	oH_3^+	oD_2	oH_2D^+	HD	1.2e-09	0.34	-0.8
2908	oH_3^+	oD_2	oHD_2^+	oH_2	6.2e-10	-0.22	1.2
2909	oH_3^+	pD_2	oH_2D^+	HD	9.1e-10	0.05	-0.4
2910	oH_3^+	pD_2	pHD_2^+	oH_2	6.5e-10	-0.06	0.5
2911	pH_3^+	oD_2	pH_2D^+	HD	5.3e-10	0.24	-1.6
2912	pH_3^+	oD_2	oH_2D^+	HD	5.8e-10	0.38	-3.7
2913	pH_3^+	oD_2	oHD_2^+	pH_2	2.6e-10	-0.27	2.2
2914	pH_3^+	oD_2	oHD_2^+	oH_2	4.0e-10	-0.13	1.3
2915	pH_3^+	pD_2	pH_2D^+	HD	4.0e-10	0.06	-1.1
2916	pH_3^+	pD_2	oH_2D^+	HD	4.7e-10	-0.03	0.2
2917	pH_3^+	pD_2	pHD_2^+	pH_2	2.6e-10	-0.06	0.5
2918	pH_3^+	pD_2	pHD_2^+	oH_2	4.1e-10	0.00	0.6
2919	oH_2D^+	oH_2	pH_3^+	HD	7.9e-11	0.27	-4.0
2920	oH_2D^+	oH_2	oH_3^+	HD	1.3e-10	-0.12	7.4
2921	oH_2D^+	oH_2	pH_2D^+	pH_2	7.6e-11	-0.00	-1.3
2922	oH_2D^+	oH_2	pH_2D^+	oH_2	1.5e-10	-0.04	-0.7
2923	oH_2D^+	oH_2	oH_2D^+	pH_2	1.4e-10	-0.16	0.6
2924	oH_2D^+	pH_2	pH_3^+	HD	9.4e-11	-0.79	154.6
2925	oH_2D^+	pH_2	oH_3^+	HD	1.1e-10	-0.52	184.4
2926	oH_2D^+	pH_2	pH_2D^+	oH_2	8.2e-10	-0.04	82.2
2927	oH_2D^+	pH_2	oH_2D^+	oH_2	9.3e-10	-0.41	177.1
2928	pH_2D^+	oH_2	pH_3^+	HD	9.0e-11	-0.69	68.2
2929	pH_2D^+	oH_2	oH_3^+	HD	8.7e-11	-0.58	99.6
2930	pH_2D^+	oH_2	oH_2D^+	pH_2	4.9e-10	-0.40	3.8
2931	pH_2D^+	oH_2	oH_2D^+	oH_2	7.5e-10	-0.43	91.3
2932	pH_2D^+	pH_2	pH_3^+	HD	2.7e-10	-1.08	245.4
2933	pH_2D^+	pH_2	oH_2D^+	oH_2	3.1e-09	-0.55	267.1
2934	oH_2D^+	HD	pH_3^+	pD_2	4.8e-12	-0.61	155.0
2935	oH_2D^+	HD	pH_3^+	oD_2	4.7e-12	-0.10	65.3
2936	oH_2D^+	HD	oH_3^+	pD_2	1.5e-11	-0.61	188.4
2937	oH_2D^+	HD	oH_3^+	oD_2	1.1e-11	-0.49	106.9
2938	oH_2D^+	HD	pH_2D^+	HD	1.7e-10	0.31	-3.5
2939	oH_2D^+	HD	pHD_2^+	pH_2	3.2e-11	-0.30	3.2
2940	oH_2D^+	HD	pHD_2^+	oH_2	2.0e-10	-0.16	0.8
2941	oH_2D^+	HD	oHD_2^+	pH_2	6.0e-11	-0.39	3.7
2942	oH_2D^+	HD	oHD_2^+	oH_2	4.7e-10	-0.04	-0.3
2943	pH_2D^+	HD	pH_3^+	pD_2	2.5e-11	-0.49	218.2
2944	pH_2D^+	HD	pH_3^+	oD_2	2.2e-11	-0.40	140.6
2945	pH_2D^+	HD	oH_2D^+	HD	8.4e-10	-0.11	88.8
2946	pH_2D^+	HD	pHD_2^+	pH_2	8.6e-11	-0.65	5.4
2947	pH_2D^+	HD	pHD_2^+	oH_2	1.0e-10	-0.76	53.4
2948	pH_2D^+	HD	oHD_2^+	pH_2	2.3e-10	-0.48	4.9
2949	pH_2D^+	HD	oHD_2^+	oH_2	4.7e-10	0.35	-3.5
2950	oH_2D^+	oD_2	oH_2D^+	pD_2	1.1e-10	0.27	83.4
2951	oH_2D^+	oD_2	pHD_2^+	HD	2.7e-10	-0.02	-0.1
2952	oH_2D^+	oD_2	oHD_2^+	HD	9.3e-10	0.02	0.3
2953	oH_2D^+	oD_2	oD_3^+	oH_2	6.0e-11	-0.10	-0.2
2954	oH_2D^+	oD_2	mD_3^+	oH_2	7.2e-11	-0.32	1.2
2955	oH_2D^+	pD_2	oH_2D^+	oD_2	8.1e-11	0.30	-2.5
2956	oH_2D^+	pD_2	pHD_2^+	HD	5.8e-10	-0.05	0.7
2957	oH_2D^+	pD_2	oHD_2^+	HD	5.1e-10	-0.01	-0.4
2958	oH_2D^+	pD_2	pD_3^+	oH_2	1.4e-11	-0.03	-0.2
2959	oH_2D^+	pD_2	oD_3^+	oH_2	1.1e-10	-0.10	1.4
2960	pH_2D^+	oD_2	pH_2D^+	pD_2	8.5e-11	0.28	73.5

Table D6 – *continued* (part 41)

#	Reactants		Products		α	β	γ
2961	pH_2D^+	oD_2	pHD_2^+	HD	2.7e-10	0.02	-0.8
2962	pH_2D^+	oD_2	oHD_2^+	HD	1.2e-09	0.21	-1.2
2963	pH_2D^+	oD_2	oD_3^+	pH_2	4.6e-11	-0.52	5.0
2964	pH_2D^+	oD_2	mD_3^+	pH_2	3.8e-11	-0.74	5.8
2965	pH_2D^+	pD_2	pH_2D^+	oD_2	3.5e-11	-0.11	-0.4
2966	pH_2D^+	pD_2	pHD_2^+	HD	6.9e-10	0.01	-0.2
2967	pH_2D^+	pD_2	oHD_2^+	HD	5.6e-10	0.01	0.7
2968	pH_2D^+	pD_2	pD_3^+	pH_2	5.6e-12	-0.45	3.4
2969	pH_2D^+	pD_2	oD_3^+	pH_2	5.7e-11	-0.37	2.2
2970	oHD_2^+	oH_2	pH_3^+	oD_2	7.1e-12	-1.09	182.4
2971	oHD_2^+	oH_2	oH_3^+	oD_2	1.9e-11	-1.24	215.7
2972	oHD_2^+	oH_2	pH_2D^+	HD	2.6e-10	0.44	12.3
2973	oHD_2^+	oH_2	oH_2D^+	HD	1.2e-09	-0.42	109.4
2974	oHD_2^+	oH_2	oHD_2^+	pH_2	1.4e-10	-0.47	4.2
2975	oHD_2^+	pH_2	pH_3^+	oD_2	4.0e-11	-1.29	357.6
2976	oHD_2^+	pH_2	pH_2D^+	HD	8.1e-10	-0.64	196.4
2977	oHD_2^+	pH_2	oH_2D^+	HD	1.2e-09	-0.92	288.2
2978	oHD_2^+	pH_2	oHD_2^+	oH_2	9.2e-10	-0.68	178.8
2979	pHD_2^+	oH_2	pH_3^+	pD_2	9.8e-12	-0.87	220.4
2980	pHD_2^+	oH_2	oH_3^+	pD_2	3.5e-11	-0.82	249.9
2981	pHD_2^+	oH_2	pH_2D^+	HD	1.9e-10	0.37	-1.4
2982	pHD_2^+	oH_2	oH_2D^+	HD	8.1e-10	-0.06	53.5
2983	pHD_2^+	oH_2	pHD_2^+	pH_2	1.3e-10	-0.31	2.1
2984	pHD_2^+	pH_2	pH_3^+	pD_2	9.3e-11	-0.68	388.7
2985	pHD_2^+	pH_2	pH_2D^+	HD	3.3e-10	-0.55	144.3
2986	pHD_2^+	pH_2	oH_2D^+	HD	7.0e-10	-0.59	236.4
2987	pHD_2^+	pH_2	pHD_2^+	oH_2	6.5e-10	-0.73	182.4
2988	oHD_2^+	HD	pH_2D^+	pD_2	4.3e-11	-0.49	200.3
2989	oHD_2^+	HD	pH_2D^+	oD_2	6.8e-11	-0.27	113.0
2990	oHD_2^+	HD	oH_2D^+	pD_2	2.2e-10	-0.85	290.0
2991	oHD_2^+	HD	oH_2D^+	oD_2	2.7e-10	-0.82	205.4
2992	oHD_2^+	HD	pHD_2^+	HD	6.7e-10	0.03	53.0
2993	oHD_2^+	HD	oD_3^+	pH_2	1.3e-11	-0.93	8.6
2994	oHD_2^+	HD	oD_3^+	oH_2	4.7e-11	-0.77	7.0
2995	oHD_2^+	HD	mD_3^+	pH_2	2.0e-11	-0.84	8.1
2996	oHD_2^+	HD	mD_3^+	oH_2	5.9e-11	-0.52	4.7
2997	pHD_2^+	HD	pH_2D^+	pD_2	7.3e-11	-0.11	143.7
2998	pHD_2^+	HD	pH_2D^+	oD_2	2.5e-11	0.05	56.0
2999	pHD_2^+	HD	oH_2D^+	pD_2	2.9e-10	-0.64	238.6
3000	pHD_2^+	HD	oH_2D^+	oD_2	1.0e-10	-0.49	149.5
3001	pHD_2^+	HD	oHD_2^+	HD	9.0e-10	0.40	-1.7
3002	pHD_2^+	HD	pD_3^+	pH_2	3.6e-12	-0.58	4.6
3003	pHD_2^+	HD	pD_3^+	oH_2	1.2e-11	-0.49	3.6
3004	pHD_2^+	HD	oD_3^+	pH_2	3.2e-11	-0.51	3.9
3005	pHD_2^+	HD	oD_3^+	oH_2	1.2e-10	-0.48	5.1
3006	oHD_2^+	oD_2	pHD_2^+	pD_2	1.8e-10	-0.36	143.7
3007	oHD_2^+	oD_2	pHD_2^+	oD_2	1.6e-10	-0.05	55.6
3008	oHD_2^+	oD_2	oHD_2^+	pD_2	2.5e-10	0.17	83.8
3009	oHD_2^+	oD_2	oD_3^+	HD	3.3e-10	-0.24	2.7
3010	oHD_2^+	oD_2	mD_3^+	HD	4.7e-10	-0.09	0.9
3011	oHD_2^+	pD_2	pHD_2^+	pD_2	1.0e-10	0.07	54.2
3012	oHD_2^+	pD_2	pHD_2^+	oD_2	1.3e-10	-0.14	0.5
3013	oHD_2^+	pD_2	oHD_2^+	oD_2	1.8e-10	0.22	-2.6
3014	oHD_2^+	pD_2	pD_3^+	HD	2.3e-11	-0.45	3.2
3015	oHD_2^+	pD_2	oD_3^+	HD	4.9e-10	-0.13	2.3
3016	oHD_2^+	pD_2	mD_3^+	HD	1.9e-10	-0.15	0.6
3017	pHD_2^+	oD_2	pHD_2^+	pD_2	7.8e-11	-0.01	86.3
3018	pHD_2^+	oD_2	oHD_2^+	pD_2	2.6e-10	0.20	31.9
3019	pHD_2^+	oD_2	oHD_2^+	oD_2	2.1e-10	0.32	0.8
3020	pHD_2^+	oD_2	pD_3^+	HD	4.1e-11	-0.26	2.7
3021	pHD_2^+	oD_2	oD_3^+	HD	5.0e-10	-0.16	0.8
3022	pHD_2^+	oD_2	mD_3^+	HD	2.2e-10	-0.12	1.4
3023	pHD_2^+	pD_2	pHD_2^+	oD_2	5.7e-11	0.04	-0.3
3024	pHD_2^+	pD_2	oHD_2^+	pD_2	1.4e-10	0.44	-0.7
3025	pHD_2^+	pD_2	oHD_2^+	oD_2	2.1e-10	0.17	-0.4
3026	pHD_2^+	pD_2	pD_3^+	HD	7.0e-11	-0.08	-0.5
3027	pHD_2^+	pD_2	oD_3^+	HD	5.7e-10	-0.15	1.3
3028	oD_3^+	oH_2	oH_2D^+	pD_2	2.3e-10	-1.01	324.3
3029	oD_3^+	oH_2	oH_2D^+	oD_2	1.3e-10	-0.67	227.0
3030	oD_3^+	oH_2	pHD_2^+	HD	1.1e-09	-0.21	71.6
3031	oD_3^+	oH_2	oHD_2^+	HD	5.8e-10	-0.13	18.7
3032	mD_3^+	oH_2	oH_2D^+	oD_2	8.8e-10	-0.52	270.7
3033	mD_3^+	oH_2	oHD_2^+	HD	3.7e-09	0.41	60.2
3034	mD_3^+	pH_2	pH_2D^+	oD_2	8.1e-10	-0.57	355.0

Table D6 – *continued* (part 42)

#	Reactants		Products			α	β	γ
3035	mD_3^+	pH_2	oHD_2^+	HD		9.6e-09	-0.01	236.9
3036	pD_3^+	oH_2	oH_2D^+	pD_2		6.1e-10	-0.55	304.6
3037	pD_3^+	oH_2	pHD_2^+	HD		2.3e-09	0.17	50.1
3038	oD_3^+	pH_2	pH_2D^+	pD_2		3.1e-10	-0.67	400.1
3039	oD_3^+	pH_2	pH_2D^+	oD_2		1.5e-10	-0.85	315.3
3040	oD_3^+	pH_2	pHD_2^+	HD		1.3e-09	-0.75	253.9
3041	oD_3^+	pH_2	oHD_2^+	HD		9.2e-10	-0.59	197.8
3042	pD_3^+	pH_2	pH_2D^+	pD_2		8.2e-10	-0.18	378.0
3043	pD_3^+	pH_2	pHD_2^+	HD		3.5e-09	-0.34	233.0
3044	oD_3^+	HD	pHD_2^+	pD_2		4.2e-10	-0.85	259.0
3045	oD_3^+	HD	pHD_2^+	oD_2		3.8e-10	-0.56	166.4
3046	oD_3^+	HD	oHD_2^+	pD_2		7.3e-10	-0.18	199.3
3047	oD_3^+	HD	oHD_2^+	oD_2		3.6e-10	-0.24	114.1
3048	oD_3^+	HD	pD_3^+	HD		4.5e-11	-0.33	19.2
3049	oD_3^+	HD	mD_3^+	HD		2.1e-10	-0.07	0.4
3050	mD_3^+	HD	pHD_2^+	oD_2		7.5e-10	-0.32	213.9
3051	mD_3^+	HD	oHD_2^+	pD_2		2.0e-09	0.31	238.1
3052	mD_3^+	HD	oHD_2^+	oD_2		2.9e-09	0.30	151.8
3053	mD_3^+	HD	oD_3^+	HD		1.1e-09	0.25	44.1
3054	pD_3^+	HD	pHD_2^+	pD_2		1.6e-09	-0.13	232.6
3055	pD_3^+	HD	pHD_2^+	oD_2		6.9e-10	-0.21	146.1
3056	pD_3^+	HD	oHD_2^+	pD_2		8.9e-10	0.05	176.9
3057	pD_3^+	HD	oD_3^+	HD		9.5e-10	0.08	-0.7
3058	oD_3^+	oD_2	pD_3^+	pD_2		2.5e-11	-0.60	110.1
3059	oD_3^+	oD_2	pD_3^+	oD_2		2.0e-11	-0.57	20.8
3060	oD_3^+	oD_2	oD_3^+	pD_2		4.9e-10	-0.26	88.4
3061	oD_3^+	oD_2	mD_3^+	pD_2		2.2e-10	-0.23	41.9
3062	oD_3^+	oD_2	mD_3^+	oD_2		1.3e-10	-0.33	2.4
3063	oD_3^+	pD_2	pD_3^+	pD_2		3.2e-11	-0.24	18.1
3064	oD_3^+	pD_2	pD_3^+	oD_2		4.4e-11	-0.00	-0.3
3065	oD_3^+	pD_2	oD_3^+	oD_2		3.5e-10	-0.21	1.9
3066	oD_3^+	pD_2	mD_3^+	pD_2		3.7e-11	-0.06	0.1
3067	oD_3^+	pD_2	mD_3^+	oD_2		6.2e-10	0.99	-8.3
3068	mD_3^+	oD_2	oD_3^+	pD_2		3.4e-09	1.08	126.4
3069	mD_3^+	oD_2	oD_3^+	oD_2		6.5e-10	-0.02	46.2
3070	mD_3^+	oD_2	mD_3^+	pD_2		2.9e-10	0.11	84.5
3071	mD_3^+	pD_2	pD_3^+	oD_2		3.2e-11	-0.42	3.5
3072	mD_3^+	pD_2	oD_3^+	pD_2		1.9e-10	0.24	43.9
3073	mD_3^+	pD_2	oD_3^+	oD_2		8.1e-10	0.11	-0.5
3074	mD_3^+	pD_2	mD_3^+	oD_2		2.2e-10	0.18	-2.6
3075	pD_3^+	oD_2	oD_3^+	pD_2		1.3e-09	0.35	66.1
3076	pD_3^+	oD_2	oD_3^+	oD_2		4.1e-10	-0.17	0.9
3077	pD_3^+	oD_2	mD_3^+	pD_2		1.8e-10	-0.36	25.9
3078	pD_3^+	pD_2	oD_3^+	pD_2		6.6e-10	0.15	-1.8
3079	pD_3^+	pD_2	oD_3^+	oD_2		4.7e-10	-0.00	0.6
3080	pH_3^+	e^-	pH_2	H		9.2e-09	-0.73	1.0
3081	pH_3^+	e^-	oH_2	H		9.2e-09	-0.73	1.0
3082	pH_3^+	e^-	H	H	H	3.6e-08	-0.73	1.0
3083	oH_3^+	e^-	oH_2	H		2.5e-08	0.16	-1.0
3084	oH_3^+	e^-	H	H	H	4.9e-08	0.16	-1.0
3085	pH_2D^+	e^-	H	H	D	5.6e-07	0.44	-2.8
3086	pH_2D^+	e^-	HD	H		1.3e-07	0.44	-2.8
3087	pH_2D^+	e^-	pH_2	D		5.2e-09	0.44	-2.8
3088	oH_2D^+	e^-	H	H	D	1.5e-07	-0.00	-3.5
3089	oH_2D^+	e^-	HD	H		3.7e-08	-0.00	-3.5
3090	oH_2D^+	e^-	oH_2	D		1.4e-08	-0.00	-3.5
3091	pHD_2^+	e^-	D	D	H	1.7e-07	0.69	-9.4
3092	pHD_2^+	e^-	HD	D		2.2e-08	0.69	-9.4
3093	pHD_2^+	e^-	pD_2	H		2.0e-08	0.69	-9.4
3094	oHD_2^+	e^-	D	D	H	9.4e-08	0.66	-12.5
3095	oHD_2^+	e^-	HD	D		1.2e-08	0.66	-12.5
3096	oHD_2^+	e^-	oD_2	H		1.1e-08	0.66	-12.5
3097	pD_2^+	e^-	D	D		2.3e-08	-0.69	0.0
3098	oD_2^+	e^-	D	D		2.3e-08	-0.69	0.0
3099	pD_3^+	e^-	D	D	D	5.8e-08	-0.60	9.2
3100	pD_3^+	e^-	pD_2	D		1.9e-08	-0.60	9.2
3101	mD_3^+	e^-	D	D	D	3.7e-08	-0.49	-2.8
3102	mD_3^+	e^-	oD_2	D		1.2e-08	-0.49	-2.8
3103	oD_3^+	e^-	D	D	D	7.4e-08	-0.77	15.0
3104	oD_3^+	e^-	pD_2	D		1.2e-08	-0.77	15.0
3105	oD_3^+	e^-	oD_2	D		1.2e-08	-0.77	15.0
3106	oH_2	H^+	pH_2	H^+		1.8e-10	0.13	-0.0
3107	pH_2	H^+	oH_2	H^+		1.6e-09	0.13	170.5
3108	N^+	pH_2	NH^+	H		8.4e-10	0.00	168.5

Table D6 – *continued* (part 43)

#	Reactants		Products				α	β	γ
3109	N^+	oH_2	NH^+	H			4.2e-10	-0.15	44.1
3110	oH_2	HCO^+	pH_2	HCO^+			1.3e-10	0.00	0.0
3111	pH_2	HCO^+	oH_2	HCO^+			1.1e-09	0.00	170.7
3112	HD	H^+	D^+	pH_2			4.4e-10	0.00	458.0
3113	HD	H^+	D^+	oH_2			7.1e-10	0.00	628.7
3114	oD_2	D^+	D^+	pD_2			6.0e-10	0.00	86.0
3115	pD_2	D^+	D^+	oD_2			4.0e-10	0.00	0.0
3116	oD_2	DCO^+	pD_2	DCO^+			3.7e-10	0.00	86.0
3117	pD_2	DCO^+	oD_2	DCO^+			2.5e-10	0.00	0.0
3118	$C_2H_2^+$	pH_2	$C_2H_3^+$	H			5.0e-10	0.00	800.0
3119	$C_2H_2^+$	oH_2	$C_2H_3^+$	H			5.0e-10	0.00	629.3
3120	HD^+	H	pH_2^+	D			1.0e-09	0.00	285.0
3121	pH_2D^+	H	pH_3^+	D			1.0e-09	0.00	644.2
3122	oH_2D^+	H	pH_3^+	D			1.0e-09	0.00	644.2
3123	pHD_2^+	H	pH_2D^+	D			1.0e-09	0.00	599.6
3124	oHD_2^+	H	pH_2D^+	D			1.0e-09	0.00	599.6
3125	pD_3^+	H	pHD_2^+	D			1.0e-09	0.00	646.2
3126	mD_3^+	H	pHD_2^+	D			1.0e-09	0.00	646.2
3127	oD_3^+	H	pHD_2^+	D			1.0e-09	0.00	646.2
3128	pNH_3	OH	pNH_2	pH_2O			3.5e-12	0.00	925.0
3129	oNH_3	OH	pNH_2	pH_2O			3.5e-12	0.00	925.0
3130	pH_2S	OH	SH	pH_2O			6.1e-12	0.00	80.0
3131	oH_2S	OH	SH	pH_2O			6.1e-12	0.00	80.0
3132	oCH_4	He^+	CH^+	oH_2	H	He	1.7e-10	0.00	0.0
3133	oCH_4	He^+	CH^+	pH_2	H	He	8.5e-11	0.00	0.0
3134	mCH_4	He^+	CH^+	oH_2	H	He	2.6e-10	0.00	0.0
3135	pCH_4	He^+	CH^+	oH_2	H	He	1.3e-10	0.00	0.0
3136	pCH_4	He^+	CH^+	pH_2	H	He	1.3e-10	0.00	0.0
3137	oCH_4^+	e^-	oCH_2	H	H		2.0e-07	-0.60	0.0
3138	oCH_4^+	e^-	pCH_2	H	H		1.0e-07	-0.60	0.0
3139	mCH_4^+	e^-	oCH_2	H	H		3.0e-07	-0.60	0.0
3140	pCH_4^+	e^-	oCH_2	H	H		1.5e-07	-0.60	0.0
3141	pCH_4^+	e^-	pCH_2	H	H		1.5e-07	-0.60	0.0
3142	oCH_5^+	e^-	CH	oH_2	oH_2		4.4e-08	-0.30	0.0
3143	oCH_5^+	e^-	CH	oH_2	pH_2		4.4e-08	-0.30	0.0
3144	mCH_5^+	e^-	CH	oH_2	oH_2		3.5e-08	-0.30	0.0
3145	mCH_5^+	e^-	CH	pH_2	oH_2		3.5e-08	-0.30	0.0
3146	mCH_5^+	e^-	CH	pH_2	pH_2		1.8e-08	-0.30	0.0
3147	pCH_5^+	e^-	CH	oH_2	oH_2		8.7e-08	-0.30	0.0
3148	oCH_5^+	e^-	oCH_2	oH_2	H		4.4e-08	-0.30	0.0
3149	oCH_5^+	e^-	oCH_2	pH_2	H		2.2e-08	-0.30	0.0
3150	oCH_5^+	e^-	pCH_2	oH_2	H		2.2e-08	-0.30	0.0
3151	mCH_5^+	e^-	oCH_2	oH_2	H		3.5e-08	-0.30	0.0
3152	mCH_5^+	e^-	oCH_2	pH_2	H		1.8e-08	-0.30	0.0
3153	mCH_5^+	e^-	pCH_2	oH_2	H		1.8e-08	-0.30	0.0
3154	mCH_5^+	e^-	pCH_2	pH_2	H		1.8e-08	-0.30	0.0
3155	pCH_5^+	e^-	oCH_2	oH_2	H		8.7e-08	-0.30	0.0
3156	oNH_4^+	e^-	oNH_2	H	H		8.1e-08	-0.60	0.0
3157	oNH_4^+	e^-	pNH_2	H	H		4.1e-08	-0.60	0.0
3158	mNH_4^+	e^-	oNH_2	H	H		1.2e-07	-0.60	0.0
3159	pNH_4^+	e^-	oNH_2	H	H		6.1e-08	-0.60	0.0
3160	pNH_4^+	e^-	pNH_2	H	H		6.1e-08	-0.60	0.0
3161	CH_3OH	γ_2	pCH_3	OH			3.0e+03	0.00	0.0
3162	Gr	γ_2	Gr^+	e^-			6.3e+07	0.00	0.0
3163	Gr^-	γ_2	Gr	e^-			4.2e+08	0.00	0.0
3164	Gr	e^-	Gr^-	γ			6.9e-05	0.50	0.0
3165	Gr^+	e^-	Gr	γ			6.9e-05	0.50	0.0
3166	Fe	γ_2	Fe^+	e^-			4.8e+02	0.00	0.0

Table D7. Species-to-species rates for the inter-conversion reactions of H_3^+ with HD, H_2, and D_2. The rates have been fitted, in the 5 to 50 K temperature range, by a modified Arrhenius function of the form $k(T) = \alpha\,(T/300)^{\beta}\,\exp(-\gamma/T)$ in $cm^3\,s^{-1}$. Elastic channels are not reported. Rates at 10 K are also listed.

#	Reactants		Products		α $cm^3\,s^{-1}$	β	γ K	$k(10)$ $cm^3\,s^{-1}$
1	oH_3^+	HD	pH_3^+	HD	7.7e-11	0.44	-4.8	2.8e-11
2	oH_3^+	HD	pH_2D^+	oH_2	1.6e-10	-0.02	-0.4	1.8e-10
3	oH_3^+	HD	oH_2D^+	pH_2	1.5e-10	-0.16	1.1	2.3e-10
4	oH_3^+	HD	oH_2D^+	oH_2	1.1e-09	0.01	0.3	1.0e-09
5	pH_3^+	HD	oH_3^+	HD	1.2e-10	0.33	29.2	2.1e-12
6	pH_3^+	HD	pH_2D^+	pH_2	1.1e-10	-0.41	2.9	3.3e-10
7	pH_3^+	HD	pH_2D^+	oH_2	2.5e-10	-0.27	3.3	4.5e-10
8	pH_3^+	HD	oH_2D^+	pH_2	2.8e-10	-0.32	1.9	6.9e-10
9	pH_3^+	HD	oH_2D^+	oH_2	1.2e-09	0.30	22.8	4.4e-11
10	oH_3^+	oH_2	pH_3^+	pH_2	1.3e-10	0.08	-0.7	1.1e-10
11	oH_3^+	oH_2	oH_3^+	pH_2	9.7e-11	0.00	-0.2	9.9e-11
12	oH_3^+	pH_2	pH_3^+	oH_2	3.5e-10	-0.90	154.2	1.5e-15
13	oH_3^+	pH_2	oH_3^+	oH_2	5.0e-10	-0.42	180.4	3.1e-17
14	oH_3^+	oH_2	pH_3^+	oH_2	4.1e-10	0.02	-0.5	4.0e-10
15	pH_3^+	oH_2	pH_3^+	pH_2	1.9e-10	-0.18	1.1	3.1e-10
16	pH_3^+	oH_2	oH_3^+	pH_2	1.7e-10	-0.28	1.7	3.7e-10
17	pH_3^+	oH_2	oH_3^+	oH_2	6.7e-10	-0.07	33.3	3.0e-11
18	pH_3^+	pH_2	pH_3^+	oH_2	1.0e-09	-0.57	180.4	1.0e-16
19	pH_3^+	pH_2	oH_3^+	oH_2	9.2e-10	-0.54	216.9	2.2e-18
20	oH_3^+	oD_2	oH_2D^+	HD	1.2e-09	0.34	-0.8	4.1e-10
21	oH_3^+	oD_2	oHD_2^+	oH_2	6.2e-10	-0.22	1.2	1.2e-09
22	oH_3^+	pD_2	oH_2D^+	HD	9.1e-10	0.05	-0.4	8.0e-10
23	oH_3^+	pD_2	pHD_2^+	oH_2	6.5e-10	-0.06	0.5	7.6e-10
24	pH_3^+	oD_2	pH_2D^+	HD	5.3e-10	0.24	-1.6	2.7e-10
25	pH_3^+	oD_2	oH_2D^+	HD	5.8e-10	0.38	-3.7	2.3e-10
26	pH_3^+	oD_2	oHD_2^+	pH_2	2.6e-10	-0.27	2.2	5.2e-10
27	pH_3^+	oD_2	oHD_2^+	oH_2	4.0e-10	-0.13	1.3	5.5e-10
28	pH_3^+	pD_2	pH_2D^+	HD	4.0e-10	0.06	-1.1	3.6e-10
29	pH_3^+	pD_2	oH_2D^+	HD	4.7e-10	-0.03	0.2	5.1e-10
30	pH_3^+	pD_2	pHD_2^+	pH_2	2.6e-10	-0.06	0.5	3.0e-10
31	pH_3^+	pD_2	pHD_2^+	oH_2	4.1e-10	0.00	0.6	3.9e-10

Table D8. Same as Table D7 for reactions involving H_2D^+.

#	Reactants		Products		α cm^3 s^{-1}	β	γ K	$k(10)$ cm^3 s^{-1}
1	oH_2D^+	oH_2	pH_3^+	HD	7.9e-11	0.27	-4.0	4.7e-11
2	oH_2D^+	oH_2	oH_3^+	HD	1.3e-10	-0.12	7.4	9.3e-11
3	oH_2D^+	oH_2	pH_2D^+	pH_2	7.6e-11	-0.00	-1.3	8.7e-11
4	oH_2D^+	oH_2	pH_2D^+	oH_2	1.5e-10	-0.04	-0.7	1.8e-10
5	oH_2D^+	oH_2	oH_2D^+	pH_2	1.4e-10	-0.16	0.6	2.3e-10
6	oH_2D^+	pH_2	pH_3^+	HD	9.4e-11	-0.79	154.6	2.7e-16
7	oH_2D^+	pH_2	oH_3^+	HD	1.1e-10	-0.52	184.4	6.3e-18
8	oH_2D^+	pH_2	pH_2D^+	oH_2	8.2e-10	-0.04	82.2	2.5e-13
9	oH_2D^+	pH_2	oH_2D^+	oH_2	9.3e-10	-0.41	177.1	7.6e-17
10	pH_2D^+	oH_2	pH_3^+	HD	9.0e-11	-0.69	68.2	1.0e-12
11	pH_2D^+	oH_2	oH_3^+	HD	8.7e-11	-0.58	99.6	3.0e-14
12	pH_2D^+	oH_2	oH_2D^+	pH_2	4.9e-10	-0.40	3.8	1.3e-09
13	pH_2D^+	oH_2	oH_2D^+	oH_2	7.5e-10	-0.43	91.3	3.5e-13
14	pH_2D^+	pH_2	pH_3^+	HD	2.7e-10	-1.08	245.4	2.3e-19
15	pH_2D^+	pH_2	oH_2D^+	oH_2	3.1e-09	-0.55	267.1	5.1e-20
16	oH_2D^+	HD	pH_3^+	pD_2	4.8e-12	-0.61	155.0	7.1e-18
17	oH_2D^+	HD	pH_3^+	oD_2	4.7e-12	-0.10	65.3	9.6e-15
18	oH_2D^+	HD	oH_3^+	pD_2	1.5e-11	-0.61	188.4	7.9e-19
19	oH_2D^+	HD	oH_3^+	oD_2	1.1e-11	-0.49	106.9	1.3e-15
20	oH_2D^+	HD	pH_2D^+	HD	1.7e-10	0.31	-3.5	8.4e-11
21	oH_2D^+	HD	pHD_2^+	pH_2	3.2e-11	-0.30	3.2	6.4e-11
22	oH_2D^+	HD	pHD_2^+	oH_2	2.0e-10	-0.16	0.8	3.2e-10
23	oH_2D^+	HD	oHD_2^+	pH_2	6.0e-11	-0.39	3.7	1.6e-10
24	oH_2D^+	HD	oHD_2^+	oH_2	4.7e-10	-0.04	-0.3	5.5e-10
25	pH_2D^+	HD	pH_3^+	pD_2	2.5e-11	-0.49	218.2	4.4e-20
26	pH_2D^+	HD	pH_3^+	oD_2	2.2e-11	-0.40	140.6	6.7e-17
27	pH_2D^+	HD	oH_2D^+	HD	8.4e-10	-0.11	88.8	1.7e-13
28	pH_2D^+	HD	pHD_2^+	pH_2	8.6e-11	-0.65	5.4	4.6e-10
29	pH_2D^+	HD	pHD_2^+	oH_2	1.0e-10	-0.76	53.4	6.4e-12
30	pH_2D^+	HD	oHD_2^+	pH_2	2.3e-10	-0.48	4.9	7.2e-10
31	pH_2D^+	HD	oHD_2^+	oH_2	4.7e-10	0.35	-3.5	2.0e-10
32	oH_2D^+	oD_2	oH_2D^+	pD_2	1.1e-10	0.27	83.4	1.0e-14
33	oH_2D^+	oD_2	pHD_2^+	HD	2.7e-10	-0.02	-0.1	2.9e-10
34	oH_2D^+	oD_2	oHD_2^+	HD	9.3e-10	0.02	0.3	8.4e-10
35	oH_2D^+	oD_2	oD_3^+	oH_2	6.0e-11	-0.10	-0.2	8.6e-11
36	oH_2D^+	oD_2	mD_3^+	oH_2	7.2e-11	-0.32	1.2	1.9e-10
37	oH_2D^+	pD_2	oH_2D^+	oD_2	8.1e-11	0.30	-2.5	3.7e-11
38	oH_2D^+	pD_2	pHD_2^+	HD	5.8e-10	-0.05	0.7	6.4e-10
39	oH_2D^+	pD_2	oHD_2^+	HD	5.1e-10	-0.01	-0.4	5.5e-10
40	oH_2D^+	pD_2	pD_3^+	oH_2	1.4e-11	-0.03	-0.2	1.6e-11
41	oH_2D^+	pD_2	oD_3^+	oH_2	1.1e-10	-0.10	1.4	1.3e-10
42	pH_2D^+	oD_2	pH_2D^+	pD_2	8.5e-11	0.28	73.5	2.1e-14
43	pH_2D^+	oD_2	pHD_2^+	HD	2.7e-10	0.02	-0.8	2.7e-10
44	pH_2D^+	oD_2	oHD_2^+	HD	1.2e-09	0.21	-1.2	6.6e-10
45	pH_2D^+	oD_2	oD_3^+	pH_2	4.6e-11	-0.52	5.0	1.6e-10
46	pH_2D^+	oD_2	mD_3^+	pH_2	3.8e-11	-0.74	5.8	2.6e-10
47	pH_2D^+	pD_2	pH_2D^+	oD_2	3.5e-11	-0.11	-0.4	5.3e-11
48	pH_2D^+	pD_2	pHD_2^+	HD	6.9e-10	0.01	-0.2	6.8e-10
49	pH_2D^+	pD_2	oHD_2^+	HD	5.6e-10	0.01	0.7	5.0e-10
50	pH_2D^+	pD_2	pD_3^+	pH_2	5.6e-12	-0.45	3.4	1.8e-11
51	pH_2D^+	pD_2	oD_3^+	pH_2	5.7e-11	-0.37	2.2	1.6e-10

Table D9. Same as Table D7 for reactions involving D_2H^+.

#	Reactants		Products		α cm^3 s^{-1}	β	γ K	$k(10)$ cm^3 s^{-1}
1	oHD_2^+	oH_2	pH_3^+	oD_2	7.1e-12	-1.09	182.4	3.5e-18
2	oHD_2^+	oH_2	oH_3^+	oD_2	1.9e-11	-1.24	215.7	5.5e-19
3	oHD_2^+	oH_2	pH_2D^+	HD	2.6e-10	0.44	12.3	1.7e-11
4	oHD_2^+	oH_2	oH_2D^+	HD	1.2e-09	-0.42	109.4	8.9e-14
5	oHD_2^+	oH_2	oHD_2^+	pH_2	1.4e-10	-0.47	4.2	4.5e-10
6	oHD_2^+	pH_2	pH_3^+	oD_2	4.0e-11	-1.29	357.6	9.5e-25
7	oHD_2^+	pH_2	pH_2D^+	HD	8.1e-10	-0.64	196.4	2.1e-17
8	oHD_2^+	pH_2	oH_2D^+	HD	1.2e-09	-0.92	288.2	8.4e-21
9	oHD_2^+	pH_2	oHD_2^+	oH_2	9.2e-10	-0.68	178.8	1.6e-16
10	pHD_2^+	oH_2	pH_3^+	pD_2	9.8e-12	-0.87	220.4	5.1e-20
11	pHD_2^+	oH_2	oH_3^+	pD_2	3.5e-11	-0.82	249.9	8.0e-21
12	pHD_2^+	oH_2	pH_2D^+	HD	1.9e-10	0.37	-1.4	6.2e-11
13	pHD_2^+	oH_2	oH_2D^+	HD	8.1e-10	-0.06	53.5	4.7e-12
14	pHD_2^+	oH_2	pHD_2^+	pH_2	1.3e-10	-0.31	2.1	3.0e-10
15	pHD_2^+	pH_2	pH_3^+	pD_2	9.3e-11	-0.68	388.7	1.2e-26
16	pHD_2^+	pH_2	pH_2D^+	HD	3.3e-10	-0.55	144.3	1.2e-15
17	pHD_2^+	pH_2	oH_2D^+	HD	7.0e-10	-0.59	236.4	2.8e-19
18	pHD_2^+	pH_2	pHD_2^+	oH_2	6.5e-10	-0.73	182.4	9.3e-17
19	oHD_2^+	HD	pH_2D^+	pD_2	4.3e-11	-0.49	200.3	4.6e-19
20	oHD_2^+	HD	pH_2D^+	oD_2	6.8e-11	-0.27	113.0	2.1e-15
21	oHD_2^+	HD	oH_2D^+	pD_2	2.2e-10	-0.85	290.0	1.0e-21
22	oHD_2^+	HD	oH_2D^+	oD_2	2.7e-10	-0.82	205.4	5.3e-18
23	oHD_2^+	HD	pHD_2^+	HD	6.7e-10	0.03	53.0	3.0e-12
24	oHD_2^+	HD	oD_3^+	pH_2	1.3e-11	-0.93	8.6	1.3e-10
25	oHD_2^+	HD	oD_3^+	oH_2	4.7e-11	-0.77	7.0	3.2e-10
26	oHD_2^+	HD	mD_3^+	pH_2	2.0e-11	-0.84	8.1	1.5e-10
27	oHD_2^+	HD	mD_3^+	oH_2	5.9e-11	-0.52	4.7	2.2e-10
28	pHD_2^+	HD	pH_2D^+	pD_2	7.3e-11	-0.11	143.7	6.1e-17
29	pHD_2^+	HD	pH_2D^+	oD_2	2.5e-11	0.05	56.0	7.8e-14
30	pHD_2^+	HD	oH_2D^+	pD_2	2.9e-10	-0.64	238.6	1.1e-19
31	pHD_2^+	HD	oH_2D^+	oD_2	1.0e-10	-0.49	149.5	1.7e-16
32	pHD_2^+	HD	oHD_2^+	HD	9.0e-10	0.40	-1.7	2.7e-10
33	pHD_2^+	HD	pD_3^+	pH_2	3.6e-12	-0.58	4.6	1.6e-11
34	pHD_2^+	HD	pD_3^+	oH_2	1.2e-11	-0.49	3.6	4.4e-11
35	pHD_2^+	HD	oD_3^+	pH_2	3.2e-11	-0.51	3.9	1.2e-10
36	pHD_2^+	HD	oD_3^+	oH_2	1.2e-10	-0.48	5.1	3.7e-10
37	oHD_2^+	oD_2	pHD_2^+	pD_2	1.8e-10	-0.36	143.7	3.5e-16
38	oHD_2^+	oD_2	pHD_2^+	oD_2	1.6e-10	-0.05	55.6	7.3e-13
39	oHD_2^+	oD_2	oHD_2^+	pD_2	2.5e-10	0.17	83.8	3.2e-14
40	oHD_2^+	oD_2	oD_3^+	HD	3.3e-10	-0.24	2.7	5.7e-10
41	oHD_2^+	oD_2	mD_3^+	HD	4.7e-10	-0.09	0.9	5.8e-10
42	oHD_2^+	pD_2	pHD_2^+	pD_2	1.0e-10	0.07	54.2	3.5e-13
43	oHD_2^+	pD_2	pHD_2^+	oD_2	1.3e-10	-0.14	0.5	2.0e-10
44	oHD_2^+	pD_2	oHD_2^+	oD_2	1.8e-10	0.22	-2.6	1.1e-10
45	oHD_2^+	pD_2	pD_3^+	HD	2.3e-11	-0.45	3.2	7.7e-11
46	oHD_2^+	pD_2	oD_3^+	HD	4.9e-10	-0.13	2.3	6.1e-10
47	oHD_2^+	pD_2	mD_3^+	HD	1.9e-10	-0.15	0.6	3.0e-10
48	pHD_2^+	oD_2	pHD_2^+	pD_2	7.8e-11	-0.01	86.3	1.4e-14
49	pHD_2^+	oD_2	oHD_2^+	pD_2	2.6e-10	0.20	31.9	5.4e-12
50	pHD_2^+	oD_2	oHD_2^+	oD_2	2.1e-10	0.32	0.8	6.5e-11
51	pHD_2^+	oD_2	pD_3^+	HD	4.1e-11	-0.26	2.7	7.6e-11
52	pHD_2^+	oD_2	oD_3^+	HD	5.0e-10	-0.16	0.8	8.0e-10
53	pHD_2^+	oD_2	mD_3^+	HD	2.2e-10	-0.12	1.4	2.9e-10
54	pHD_2^+	pD_2	pHD_2^+	oD_2	5.7e-11	0.04	-0.3	5.1e-11
55	pHD_2^+	pD_2	oHD_2^+	pD_2	1.4e-10	0.44	-0.7	3.4e-11
56	pHD_2^+	pD_2	oHD_2^+	oD_2	2.1e-10	0.17	-0.4	1.2e-10
57	pHD_2^+	pD_2	pD_3^+	HD	7.0e-11	-0.08	-0.5	9.7e-11
58	pHD_2^+	pD_2	oD_3^+	HD	5.7e-10	-0.15	1.3	8.3e-10

Table D10. Same as Table D7 for reactions involving D_3^+.

#	Reactants		Products		α cm^3 s^{-1}	β	γ K	$k(10)$ cm^3 s^{-1}
1	oD_3^+	oH_2	oH_2D^+	pD_2	2.3e-10	-1.01	324.3	5.9e-23
2	oD_3^+	oH_2	oH_2D^+	oD_2	1.3e-10	-0.67	227.0	1.8e-19
3	oD_3^+	oH_2	pHD_2^+	HD	1.1e-09	-0.21	71.6	1.7e-12
4	oD_3^+	oH_2	oHD_2^+	HD	5.8e-10	-0.13	18.7	1.4e-10
5	mD_3^+	oH_2	oH_2D^+	oD_2	8.8e-10	-0.52	270.7	9.0e-21
6	mD_3^+	oH_2	oHD_2^+	HD	3.7e-09	0.41	60.2	2.2e-12
7	mD_3^+	pH_2	pH_2D^+	oD_2	8.1e-10	-0.57	355.0	2.2e-24
8	mD_3^+	pH_2	oHD_2^+	HD	9.6e-09	-0.01	236.9	5.1e-19
9	pD_3^+	oH_2	oH_2D^+	pD_2	6.1e-10	-0.55	304.6	2.3e-22
10	pD_3^+	oH_2	pHD_2^+	HD	2.3e-09	0.17	50.1	8.6e-12
11	oD_3^+	pH_2	pH_2D^+	pD_2	3.1e-10	-0.67	400.1	1.3e-26
12	oD_3^+	pH_2	pH_2D^+	oD_2	1.5e-10	-0.85	315.3	5.5e-23
13	oD_3^+	pH_2	pHD_2^+	HD	1.3e-09	-0.75	253.9	1.6e-19
14	oD_3^+	pH_2	oHD_2^+	HD	9.2e-10	-0.59	197.8	1.8e-17
15	pD_3^+	pH_2	pH_2D^+	pD_2	8.2e-10	-0.18	378.0	5.8e-26
16	pD_3^+	pH_2	pHD_2^+	HD	3.5e-09	-0.34	233.0	8.5e-19
17	oD_3^+	HD	pHD_2^+	pD_2	4.2e-10	-0.85	259.0	4.3e-20
18	oD_3^+	HD	pHD_2^+	oD_2	3.8e-10	-0.56	166.4	1.5e-16
19	oD_3^+	HD	oHD_2^+	pD_2	7.3e-10	-0.18	199.3	3.0e-18
20	oD_3^+	HD	oHD_2^+	oD_2	3.6e-10	-0.24	114.1	9.0e-15
21	oD_3^+	HD	pD_3^+	HD	4.5e-11	-0.33	19.2	2.0e-11
22	oD_3^+	HD	mD_3^+	HD	2.1e-10	-0.07	0.4	2.6e-10
23	mD_3^+	HD	pHD_2^+	oD_2	7.5e-10	-0.32	213.9	1.1e-18
24	mD_3^+	HD	oHD_2^+	pD_2	2.0e-09	0.31	238.1	3.2e-20
25	mD_3^+	HD	oHD_2^+	oD_2	2.9e-09	0.30	151.8	2.7e-16
26	mD_3^+	HD	oD_3^+	HD	1.1e-09	0.25	44.1	5.7e-12
27	pD_3^+	HD	pHD_2^+	pD_2	1.6e-09	-0.13	232.6	2.0e-19
28	pD_3^+	HD	pHD_2^+	oD_2	6.9e-10	-0.21	146.1	6.4e-16
29	pD_3^+	HD	oHD_2^+	pD_2	8.9e-10	0.05	176.9	1.6e-17
30	pD_3^+	HD	oD_3^+	HD	9.5e-10	0.08	-0.7	7.8e-10
31	oD_3^+	oD_2	pD_3^+	pD_2	2.5e-11	-0.60	110.1	3.2e-15
32	oD_3^+	oD_2	pD_3^+	oD_2	2.0e-11	-0.57	20.8	1.7e-11
33	oD_3^+	oD_2	oD_3^+	pD_2	4.9e-10	-0.26	88.4	1.7e-13
34	oD_3^+	oD_2	mD_3^+	pD_2	2.2e-10	-0.23	41.9	7.3e-12
35	oD_3^+	oD_2	mD_3^+	oD_2	1.3e-10	-0.33	2.4	3.1e-10
36	oD_3^+	pD_2	pD_3^+	pD_2	3.2e-11	-0.24	18.1	1.2e-11
37	oD_3^+	pD_2	pD_3^+	oD_2	4.4e-11	-0.00	-0.3	4.5e-11
38	oD_3^+	pD_2	oD_3^+	oD_2	3.5e-10	-0.21	1.9	5.9e-10
39	oD_3^+	pD_2	mD_3^+	pD_2	3.7e-11	-0.06	0.1	4.5e-11
40	oD_3^+	pD_2	mD_3^+	oD_2	6.2e-10	0.99	-8.3	4.9e-11
41	mD_3^+	oD_2	oD_3^+	pD_2	3.4e-09	1.08	126.4	2.8e-16
42	mD_3^+	oD_2	oD_3^+	oD_2	6.5e-10	-0.02	46.2	6.9e-12
43	mD_3^+	oD_2	mD_3^+	pD_2	2.9e-10	0.11	84.5	4.3e-14
44	mD_3^+	pD_2	pD_3^+	oD_2	3.2e-11	-0.42	3.5	9.4e-11
45	mD_3^+	pD_2	oD_3^+	pD_2	1.9e-10	0.24	43.9	1.0e-12
46	mD_3^+	pD_2	oD_3^+	oD_2	8.1e-10	0.11	-0.5	5.9e-10
47	mD_3^+	pD_2	mD_3^+	oD_2	2.2e-10	0.18	-2.6	1.5e-10
48	pD_3^+	oD_2	oD_3^+	pD_2	1.3e-09	0.35	66.1	5.3e-13
49	pD_3^+	oD_2	oD_3^+	oD_2	4.1e-10	-0.17	0.9	6.7e-10
50	pD_3^+	oD_2	mD_3^+	pD_2	1.8e-10	-0.36	25.9	4.6e-11
51	pD_3^+	pD_2	oD_3^+	pD_2	6.6e-10	0.15	-1.8	4.7e-10
52	pD_3^+	pD_2	oD_3^+	oD_2	4.7e-10	-0.00	0.6	4.4e-10