

Models of Saturn's equatorial ionosphere based on in situ data from Cassini's Grand Finale

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Tables S1 and S2, References R1

Introduction

This file contains tables of the reactions and rates used in the modeling described in the main text.

Table S1 contains electron recombination reactions.

Columns 1-2: rate coefficient $\alpha = a (300/T_e)^b \text{ cm}^3 \text{ s}^{-1}$ (a and b in column 1 and 2, respectively)

Column 3: reaction reactants

Column 4: reaction products

Column 5: reference

Table S2 contains ion-neutral reactions, separated into sections for each ion (searched for with "- ION") and then organized by corresponding neutral reactants

Column 1: rate coefficient ($\text{cm}^3 \text{s}^{-1}$, or $\text{cm}^6 \text{s}^{-1}$ for termolecular reactions)

Column 2: reaction reactants

Column 3: reaction products

Column 4: reference

References R1 contains the reference list for the reactions in tables S1 and S2.

Table S1: Ion-electron recombination rates:

1.91e-10	-0.70	H ⁺ + e	→ H	1
1.91e-10	-0.70	He ⁺ + e	→ He	1
3.06e-7	-0.60	HeH ⁺ + e	→ He + H	1
2.25e-6	-0.40	H ₂ ⁺ + e	→ 2H	1
8.00e-7	-0.50	H ₂ D ⁺ + e	→ ?	*
7.62e-7	-0.50	H ₃ ⁺ + e	→ H ₂ + H	1
9.70e-7	-0.50	H ₃ ⁺ + e	→ 3H	1
1.91e-10	-0.70	C ⁺ + e	→ C	1
1.65e-6	-0.42	CH ⁺ + e	→ C + H	1
4.33e-6	-0.50	CH ₂ ⁺ + e	→ CH + H	1
6.06e-6	-0.50	CH ₃ ⁺ + e	→ [^] 3CH ₂ + H	1
3.03e-6	-0.50	CH ₄ ⁺ + e	→ CH ₃ + H	1
3.03e-6	-0.50	CH ₄ ⁺ + e	→ [^] 3CH ₂ + 2H	1
1.52e-5	-0.50	CH ₅ ⁺ + e	→ [^] 3CH ₂ + H + H ₂	1
3.81e-6	-0.50	CH ₅ ⁺ + e	→ CH ₃ + 2H	1
2.34e-6	-0.50	C ₂ H ⁺ + e	→ C ₂ + H	1
2.34e-6	-0.50	C ₂ H ⁺ + e	→ CH + C	1
2.34e-6	-0.50	C ₂ H ₂ ⁺ + e	→ C ₂ H + C	1
2.34e-6	-0.50	C ₂ H ₂ ⁺ + e	→ 2CH	1
3.89e-6	-0.50	C ₂ H ₃ ⁺ + e	→ C ₂ H ₂ + H	1
3.89e-6	-0.50	C ₂ H ₃ ⁺ + e	→ [^] 3CH ₂ + CH	1
2.60e-6	-0.50	C ₂ H ₄ ⁺ + e	→ C ₂ H ₃ + H	1
2.60e-6	-0.50	C ₂ H ₄ ⁺ + e	→ 2 [^] 3CH ₂	1
6.41e-6	-0.50	C ₂ H ₅ ⁺ + e	→ C ₂ H ₄ + H	1
6.41e-6	-0.50	C ₂ H ₅ ⁺ + e	→ CH ₃ + [^] 3CH ₂	1
2.60e-6	-0.50	C ₂ H ₆ ⁺ + e	→ C ₂ H ₅ + H	1
2.60e-6	-0.50	C ₂ H ₆ ⁺ + e	→ 2CH ₃	1
6.06e-6	-0.50	C ₂ H ₇ ⁺ + e	→ C ₂ H ₆ + H	1
8.66e-7	-0.50	C ₃ H ₃ ⁺ + e	→ C ₃ H ₂ + H	2
3.46e-6	-0.50	C ₃ H ₄ ⁺ + e	→ C ₃ H ₃ + H	2
3.46e-6	-0.50	C ₃ H ₄ ⁺ + e	→ C ₃ H ₃ + H ₂	2
2.60e-6	-0.50	C ₃ H ₅ ⁺ + e	→ C ₃ H ₃ + H ₂	2
2.60e-6	-0.50	C ₃ H ₅ ⁺ + e	→ CH ₃ C ₂ H + H	2
6.06e-6	-0.50	C ₃ H ₇ ⁺ + e	→ C ₂ H ₆ + H	3
2.60e-6	-0.50	C ₄ H ₅ ⁺ + e	→ C ₄ H ₂ + H ₂ + H	2
2.60e-6	-0.50	C ₄ H ₅ ⁺ + e	→ CH ₃ C ₂ H + CH	2
6.06e-6	-0.50	C ₄ H ₇ ⁺ + e	→ CH ₃ C ₂ H + CH ₃	2
6.06e-6	-0.50	C ₄ H ₉ ⁺ + e	→ C ₄ H ₈ + H	2
6.50e-7	-0.50	OH ⁺ + e	→ O + H	2
2.77e-6	-0.50	H ₂ O ⁺ + e	→ OH + H	2
3.46e-6	-0.50	H ₂ O ⁺ + e	→ O + H ₂	2
6.06e-6	-0.50	H ₃ O ⁺ + e	→ H ₂ O + H	2
1.13e-5	-0.50	H ₃ O ⁺ + e	→ OH + 2H	2
3.30e-5	-1.00	HCO ⁺ + e	→ CO + H	2
1.91e-6	-0.50	HCO ₂ ⁺ + e	→ OH + CO	4
5.89e-6	-0.50	HCO ₂ ⁺ + e	→ CO ₂ + H	5
2.03e-6	-0.39	N ₂ ⁺ + e	→ 2N	6
2.97e-5	-0.84	N ₂ H ⁺ + e	→ H + N ₂	7
1.57e-6	-0.84	N ₂ H ⁺ + e	→ N + NH	7

Table S2: Ion-neutral photochemical reaction rates:

			H ⁺
see reference	H ⁺ + H ₂	→ H ₂ ⁺ + H	3*
3.29e-29	H ⁺ + H ₂ + M	→ H ₃ ⁺ + M	1
1.30e-16	H ⁺ + H ₂	→ H ₃ ⁺ + hν	12 [41]
3.40e-9	H ⁺ + CH ₄	→ CH ₃ ⁺ + H ₂	12 [8]
7.47e-10	H ⁺ + CH ₄	→ CH ₄ ⁺ + H	12 [8]
4.30e-9	H ⁺ + C ₂ H ₂	→ C ₂ H ⁺ + H ₂	2
5.40e-10	H ⁺ + C ₂ H ₂	→ C ₂ H ₂ ⁺ + H	12 [125]
9.80e-10	H ⁺ + C ₂ H ₄	→ C ₂ H ₄ ⁺ + H	12 [125]
2.94e-9	H ⁺ + C ₂ H ₄	→ C ₂ H ₃ ⁺ + H ₂	12 [125]
9.80e-10	H ⁺ + C ₂ H ₄	→ C ₂ H ₂ ⁺ + H ₂ + H	12 [125]
1.30e-9	H ⁺ + C ₂ H ₆	→ C ₂ H ₃ ⁺ + 2H ₂	1
2.35e-10	H ⁺ + C ₂ H ₆	→ C ₂ H ₅ ⁺ + H ₂	12 [125]
1.41e-9	H ⁺ + C ₂ H ₆	→ C ₂ H ₄ ⁺ + H ₂ + H	12 [125]
2.82e-9	H ⁺ + C ₂ H ₆	→ C ₂ H ₃ ⁺ + H ₂ + H ₂	12 [125]
2.35e-10	H ⁺ + C ₂ H ₆	→ CH ₃ ⁺ + CH ₄	12 [125]
3.70e-9	H ⁺ + NH ₃	→ NH ₃ ⁺ + H	12 [125]
6.90e-9	H ⁺ + H ₂ O	→ H ₂ O ⁺ + H	12 [125]
1.70e-10	H ⁺ + HD	→ D ⁺ + H ₂	8
3.40e-9	H ⁺ + CH ₃	→ CH ₃ ⁺ + H	2
3.80e-9	H ⁺ + CO ₂	→ HCO ⁺ + O	10
			H ₂ ⁺
6.40e-10	H ₂ ⁺ + H	→ H ⁺ + H ₂	12 [52]
2.00e-9	H ₂ ⁺ + H ₂	→ H ₃ ⁺ + H	12 [8]
2.28e-9	H ₂ ⁺ + CH ₄	→ CH ₃ ⁺ + H + H ₂	1
1.14e-10	H ₂ ⁺ + CH ₄	→ CH ₅ ⁺ + H	12 [53]
1.41e-9	H ₂ ⁺ + CH ₄	→ CH ₄ ⁺ + H ₂	12 [53]
2.28e-9	H ₂ ⁺ + CH ₄	→ CH ₃ ⁺ + H ₂ + H	12 [53]
4.77e-10	H ₂ ⁺ + C ₂ H ₂	→ C ₂ H ₃ ⁺ + H	12 [53]
4.82e-9	H ₂ ⁺ + C ₂ H ₂	→ C ₂ H ₂ ⁺ + H ₂	12 [53]
4.82e-9	H ₂ ⁺ + C ₂ H ₂	→ C ₂ H ₂ ⁺	1
2.21e-9	H ₂ ⁺ + C ₂ H ₄	→ C ₂ H ₄ ⁺ + H ₂	12 [53]
1.81e-9	H ₂ ⁺ + C ₂ H ₄	→ C ₂ H ₃ ⁺ + H ₂ + H	12 [53]
8.82e-10	H ₂ ⁺ + C ₂ H ₄	→ C ₂ H ₂ ⁺ + H ₂ + H ₂	12 [53]
8.82e-10	H ₂ ⁺ + C ₂ H ₄	→ C ₂ H ₂ ⁺ + 2H ₂	10
1.96e-10	H ₂ ⁺ + C ₂ H ₆	→ C ₂ H ₂ ⁺ + 3H ₂	1
6.86e-10	H ₂ ⁺ + C ₂ H ₆	→ C ₂ H ₃ ⁺ + 2H ₂ + H	1
2.35e-9	H ₂ ⁺ + C ₂ H ₆	→ C ₂ H ₄ ⁺ + 2H ₂	1
1.37e-9	H ₂ ⁺ + C ₂ H ₆	→ C ₂ H ₅ ⁺ + H + H ₂	1
2.94e-10	H ₂ ⁺ + C ₂ H ₆	→ C ₂ H ₆ ⁺ + H ₂	12 [53]
2.00e-9	H ₂ ⁺ + N ₂	→ N ₂ H ⁺ + H	12 [8]
5.70e-9	H ₂ ⁺ + NH ₃	→ NH ₃ ⁺ + H ₂	12 [53]
3.43e-9	H ₂ ⁺ + H ₂ O	→ H ₃ O ⁺ + H	12 [53]
3.87e-9	H ₂ ⁺ + H ₂ O	→ H ₂ O ⁺ + H ₂	12 [53]
1.40e-10	H ₂ ⁺ + He	→ HeH ⁺ + H	1
2.23e-9	H ₂ ⁺ + CO	→ HCO ⁺ + H	10
6.44e-10	H ₂ ⁺ + CO	→ CO ⁺ + H ₂	9
2.35e-9	H ₂ ⁺ + CO ₂	→ HCO ₂ ⁺ + H	9
			H ₃ ⁺
2.40e-9	H ₃ ⁺ + CH ₄	→ CH ₅ ⁺ + H ₂	12 [8]
3.20e-9	H ₃ ⁺ + C ₂ H ₂	→ C ₂ H ₃ ⁺ + H ₂	12 [8]
2.03e-9	H ₃ ⁺ + C ₂ H ₄	→ C ₂ H ₃ ⁺ + 2H ₂	10

8.70e-10	H3+ + C2H4	→ C2H5+ + H2	12 [8]
2.90e-9	H3+ + C2H6	→ C2H5+ + 2H2	10
4.40e-9	H3+ + NH3	→ NH4+ + H2	12 [8]
1.86e-9	H3+ + N2	→ N2H+ + H2	12 [8]
5.30e-9	H3+ + H2O	→ H3O+ + H2	12 [8]
9.60e-10	H3+ + HD	→ H2D+ + H2	8
1.74e-9	H3+ + CO	→ HCO+ + H2	10
2.00e-9	H3+ + CO2	→ HCO2+ + H2	9
----- C+			
1.20e-16	C+ + H2	→ CH+ + H	12 [8]
3.64e-10	C+ + CH4	→ C2H2+ + H2	12 [8]
9.36e-10	C+ + CH4	→ C2H3+ + H	12 [8]
2.63e-9	C+ + C2H2	→ C3H+ + H	12 [8]
1.00e-9	C+ + C2H4	→ C3H3+ + H	1
1.20e-10	C+ + C2H4	→ C2H3+ + CH	12 [8]
2.25e-10	C+ + C2H4	→ C2H4+ + C	12 [8]
7.50e-11	C+ + C2H4	→ C3H+ + H2 + H	12 [8]
4.35e-10	C+ + C2H4	→ C3H2+ + H2	12 [8]
8.25e-11	C+ + C2H6	→ C2H2+ + CH4	12 [8]
4.95e-10	C+ + C2H6	→ C2H3+ + CH3	12 [8]
8.50e-10	C+ + C2H6	→ C3H3+ + H + H2	1
1.16e-10	C+ + C2H6	→ C2H4+ + CH2	12 [8]
2.31e-10	C+ + C2H6	→ C2H5+ + CH	12 [8]
8.25e-12	C+ + C2H6	→ C3H2+ + H2 + H2	12 [8]
7.36e-10	C+ + NH3	→ NH3+ + C	12 [8]
1.15e-10	C+ + NH3	→ HCN+ + H2	12 [8]
1.45e-9	C+ + NH3	→ HCNH+ + H	12 [8]
2.40e-10	C+ + H2O	→ H2O+ + C	12 [8]
----- CH+			
7.50e-10	CH+ + H	→ C+ + H2	12
1.20e-9	CH+ + H2	→ CH2+ + H	12 [8]
1.43e-10	CH+ + CH4	→ C2H2+ + H + H2	1
1.09e-9	CH+ + CH4	→ C2H3+ + H2	12 [8]
6.50e-11	CH+ + CH4	→ C2H4+ + H	12 [8]
2.40e-9	CH+ + C2H2	→ C3H2+ + H	12 [6]
2.60e-9	CH+ + C2H6	→ products	12 [83]
1.84e-9	CH+ + NH3	→ HCNH+ + H2	12 [119]
4.59e-10	CH+ + NH3	→ NH3+ + CH	12 [119]
4.05e-10	CH+ + NH3	→ NH4+ + C	12 [119]
1.16e-9	CH+ + H2O	→ HCO+ + H2	10
7.25e-10	CH+ + H2O	→ H3O+ + C	12
7.00e-12	CH+ + CO	→ HCO+ + C	10
----- CH2+			
1.16e-9	CH2+ + H2	→ CH3+ + H	12 [8]
9.10e-10	CH2+ + CH4	→ C2H4+ + H2	12 [8]
3.90e-10	CH2+ + CH4	→ C2H5+ + H	12 [8]
2.50e-9	CH2+ + C2H2	→ C3H3+ + H	1
2.60e-9	CH2+ + C2H6	→ products	12 [83]
8.78e-10	CH2+ + NH3	→ NH4+ + CH	12 [8]
1.78e-9	CH2+ + NH3	→ CH2NH2+ + H	12 [8]
----- CH3+			
1.10e-9	CH3+ + CH4	→ C2H5+ + H2	12 [11]
1.20e-9	CH3+ + C2H2	→ C3H3+ + H2	1
4.60e-11	CH3+ + C2H4	→ C3H3+ + 2H2	1

4.88e-10	CH3+ + C2H4	→ C2H3+ + CH4	12 [8]	
5.41e-10	CH3+ + C2H4	→ C3H5+ + H2	12 [8]	
1.60e-10	CH3+ + C2H6	→ C3H5+ + 2H2	1	
1.48e-9	CH3+ + C2H6	→ C2H5+ + CH4	12 [54]	
1.04e-10	CH3+ + C2H6	→ C3H7+ + H2	12 [54]	
2.63e-10	CH3+ + NH3	→ NH4+ + CH2	12 [8]	
1.49e-9	CH3+ + NH3	→ CH2NH2+ + H2	12 [8]	
3.30e-28	CH3+ + H2 + M	→ CH5+ + M	1	
-----				CH4+
3.50e-11	CH4+ + H2	→ CH5+ + H	12 [8]	
1.14e-9	CH4+ + CH4	→ CH5+ + CH3	12 [8]	
1.51e-10	CH4+ + C2H2	→ C3H3+ + H + H2	1	
1.44e-9	CH4+ + C2H2	→ C2H2+ + CH4	12 [8]	
1.12e-9	CH4+ + C2H2	→ C2H3+ + CH3	12 [8]	
1.70e-9	CH4+ + C2H4	→ C2H4+ + CH4	12 [8]	
2.60e-10	CH4+ + C2H4	→ C2H5+ + CH3	12 [8]	
6.00e-11	CH4+ + C2H4	→ C3H5+ + H2 + H	12 [8]	
1.91e-9	CH4+ + C2H6	→ C2H4+ + CH4 + H2	12 [54]	
6.00e-11	CH4+ + NH3	→ CH5+ + NH2	12 [8]	
1.35e-9	CH4+ + NH3	→ NH4+ + CH3	12 [8]	
1.59e-9	CH4+ + NH3	→ NH3+ + CH4	12 [8]	
2.50e-9	CH4+ + H2O	→ H3O+ + CH3	12 [8]	
1.04e-9	CH4+ + CO	→ HCO+ + CH3	10	
-----				CH5+
1.50e-10	CH5+ + H	→ CH4+ + H2	12 [8]	
1.48e-9	CH5+ + C2H2	→ C2H3+ + CH4	12 [8]	
1.50e-9	CH5+ + C2H4	→ C2H5+ + CH4	12 [37]	
2.02e-10	CH5+ + C2H6	→ C2H5+ + CH4 + H2	12 [8]	
1.15e-9	CH5+ + C2H6	→ C2H7+ + CH4	12 [8]	
2.30e-9	CH5+ + NH3	→ NH4+ + CH4	12 [133]	
3.70e-9	CH5+ + H2O	→ H3O+ + CH4	12 [17]	
9.90e-10	CH5+ + CO	→ HCO+ + CH4	10	
-----				C2H+
1.24e-9	C2H+ + H2	→ C2H2+ + H	12 [8]	
3.74e-10	C2H+ + CH4	→ C3H3+ + H2	1	
3.74e-10	C2H+ + CH4	→ C2H2+ + CH3	12 [117, 118]	
1.32e-10	C2H+ + CH4	→ C3H4+ + H	12 [117, 118]	
2.20e-10	C2H+ + CH4	→ C3H5+	12 [117, 118]	
1.85e-9	C2H+ + C2H2	→ C4H2+ + H	12 [8]	
1.71e-9	C2H+ + C2H4	→ C4H4+ + H	1	
8.30e-10	C2H+ + C2H4	→ C4H3+ + H2	12 [42]	
1.70e-10	C2H+ + C2H4	→ C4H2+ + H2 + H	12 [42]	
9.10e-10	C2H+ + C2H6	→ c-C3H3+ + CH4	12 [28]	
3.00e-11	C2H+ + C2H6	→ C4H4+ + H2 + H	12 [28]	
6.00e-11	C2H+ + C2H6	→ C4H5+ + H2	12 [28]	
5.50e-10	C2H+ + NH3	→ NH4+ + C2	12 [135]	
5.50e-10	C2H+ + NH3	→ HC2NH+ + H2	12 [135]	
-----				C2H2+
1.27e-27	C2H2+ + H2 + M	→ C2H4+ + M	1	
10.00e-12	C2H2+ + H2	→ C2H3+ + H	12 [8]	
1.87e-10	C2H2+ + CH4	→ C3H4+ + H2	12 [8]	
7.03e-10	C2H2+ + CH4	→ C3H5+ + H	12 [8]	
4.48e-10	C2H2+ + C2H2	→ C4H2+ + H2	12 [8]	
9.52e-10	C2H2+ + C2H2	→ C4H3+ + H	12 [8]	

2.80e-10	C2H2+ + C2H4	→ C3H3+ + CH3	1	
4.14e-10	C2H2+ + C2H4	→ C2H4+ + C2H2	12 [8]	
3.17e-10	C2H2+ + C2H4	→ C4H5+ + H	12 [8]	
1.31e-10	C2H2+ + C2H6	→ C2H5+ + C2H3	1	
8.76e-11	C2H2+ + C2H6	→ C3H3+ + CH3 + H2	1	
2.48e-10	C2H2+ + C2H6	→ C2H4+ + C2H4	12 [8]	
1.24e-10	C2H2+ + C2H6	→ C2H5+ + CHCH2	12 [8]	
1.38e-11	C2H2+ + C2H6	→ C3H4+ + CH4	12 [8]	
7.45e-10	C2H2+ + C2H6	→ C3H5+ + CH3	12 [8]	
6.90e-11	C2H2+ + C2H6	→ C4H5+ + H2 + H	12 [8]	
1.24e-10	C2H2+ + C2H6	→ C4H7+ + H	12 [8]	
2.14e-9	C2H2+ + NH3	→ NH3+ + C2H2	12 [8]	
9.61e-10	C2H2+ + NH3	→ NH4+ + CCH	12 [8]	
2.20e-10	C2H2+ + H2O	→ H3O+ + C2H	10	
				----- C2H3+
6.80e-11	C2H3+ + H	→ C2H2+ + H2	12 [112]	
1.90e-10	C2H3+ + CH4	→ C3H5+ + H2	12 [8]	
2.40e-10	C2H3+ + C2H2	→ C4H3+ + H2	12 [8]	
8.20e-10	C2H3+ + C2H4	→ C2H5+ + C2H2	12 [4]	
2.91e-10	C2H3+ + C2H6	→ C2H5+ + C2H4	12 [8]	
2.48e-10	C2H3+ + C2H6	→ C3H5+ + CH4	12 [8]	
8.06e-11	C2H3+ + C2H6	→ C4H7+ + H2	12 [8]	
1.11e-9	C2H3+ + H2O	→ H3O+ + C2H2	10	
				----- C2H4+
3.00e-10	C2H4+ + H	→ C2H3+ + H2	12 [8]	
6.73e-10	C2H4+ + C2H2	→ C3H3+ + CH3	1	
1.93e-10	C2H4+ + C2H2	→ C4H5+ + H	12 [8]	
4.74e-11	C2H4+ + C2H4	→ C3H4+ + CH4	12 [12]	
7.03e-10	C2H4+ + C2H4	→ C3H5+ + CH3	12 [12]	
4.74e-11	C2H4+ + C2H4	→ C4H7+ + H	12 [12]	
3.61e-13	C2H4+ + C2H6	→ C3H6+ + CH4	12 [8]	
4.79e-12	C2H4+ + C2H6	→ C3H7+ + CH3	12 [8]	
				----- C2H5+
10.00e-12	C2H5+ + H	→ C2H4+ + H2	12 [8]	
9.00e-14	C2H5+ + CH4	→ C3H7+ + H2	12 [8]	
6.84e-11	C2H5+ + C2H2	→ C3H3+ + CH4	1	
1.22e-10	C2H5+ + C2H2	→ C4H5+ + H2	12 [54]	
3.55e-10	C2H5+ + C2H4	→ C3H5+ + CH4	12 [8]	
5.46e-12	C2H5+ + C2H6	→ C3H7+ + CH4	12 [8]	
3.35e-11	C2H5+ + C2H6	→ C4H9+ + H2	12 [8]	
2.09e-9	C2H5+ + NH3	→ NH4+ + C2H4	12 [8]	
1.86e-9	C2H5+ + H2O	→ H3O+ + C2H4	12 [8]	
				----- C2H6+
1.00e-10	C2H6+ + H	→ C2H5+ + H2	12 [8]	
2.22e-10	C2H6+ + C2H2	→ C2H5+ + C2H3	1	
2.47e-10	C2H6+ + C2H2	→ C2H5+ + CHCH2	12 [8]	
9.10e-10	C2H6+ + C2H2	→ C3H5+ + CH3	12 [8]	
1.43e-10	C2H6+ + C2H2	→ C4H7+ + H	12 [8]	
1.15e-9	C2H6+ + C2H4	→ C2H4+ + C2H6	12 [54]	
7.98e-12	C2H6+ + C2H6	→ C3H8+ + CH4	12 [8]	
1.10e-11	C2H6+ + C2H6	→ C3H9+ + CH3	12 [8]	
2.95e-9	C2H6+ + H2O	→ H3O+ + CH3CH2	12 [47]	
6.24e-10	C2H6+ + NH3	→ NH3+ + C2H6	12 [47]	
1.61e-9	C2H6+ + NH3	→ NH4+ + CH3CH2	12 [47]	

			C2H7+
1.80e-9	C2H7+ + NH3	→ NH4+ + C2H6	12 [43]
1.00e-9	C2H7+ + C2H2	→ C2H3+ + C2H6	1
1.00e-9	C2H7+ + C2H4	→ C2H5+ + C2H6	1
			C3H4+
3.00e-11	C3H4+ + H	→ c-C3H3+ + H2	12 [32]
4.20e-10	C3H4+ + C2H2	→ C5H5+ + H	12 [12]
9.13e-11	C3H4+ + C2H4	→ C4H5+ + CH3	12 [79]
7.39e-10	C3H4+ + C2H4	→ C5H7+ + H	12 [79]
2.10e-10	C3H4+ + NH3	→ NH3+ + CH3C2H	12 [85]
1.29e-9	C3H4+ + NH3	→ NH4+ + C3H3	12 [85]
			C3H5+
5.00e-13	C3H5+ + H	→ C2H2+ + CH4	12 [32]
9.50e-12	C3H5+ + H	→ C2H3+ + CH3	12 [32]
3.80e-10	C3H5+ + C2H2	→ C5H5+ + H2	12 [10, 77]
1.19e-10	C3H5+ + C2H4	→ C5H7+ + H2	12 [10, 77]
5.10e-11	C3H5+ + C2H4	→ C5H9+ + hv	12 [10, 77]
9.00e-10	C3H5+ + NH3	→ NH4+ + CH3C2H	12 [85]
			C3H7+
3.70e-11	C3H7+ + H	→ C3H6+ + H2	12 [131]
1.00e-9	C3H7+ + C2H6	→ C4H9+ + CH4	12 [84]
1.71e-9	C3H7+ + NH3	→ NH4+ + C3H6	12 [43]
			C4H5+
1.70e-10	C4H5+ + C2H2	→ C7H7+ + hv	5
1.60e-10	C4H5+ + C2H2	→ C6H5+ + H2	12 [12]
7.30e-11	C4H5+ + C2H4	→ C6H7+ + H2	12 [12]
4.70e-10	C4H5+ + NH3	→ NH4+ + C4H4	12 [85]
			C4H9+
1.57e-9	C4H9+ + NH3	→ NH4+ + C4H8	12 [80]
3.20e-11	C4H9+ + NH3	→ adduct + hv	12 [80]
			N+
5.00e-10	N+ + H2	→ NH+ + H	12 [8]
5.75e-10	N+ + CH4	→ CH3+ + NH	12 [8]
5.75e-11	N+ + CH4	→ CH4+ + N	12 [8]
4.14e-10	N+ + CH4	→ HCNH+ + H2	12 [8]
1.15e-10	N+ + CH4	→ HCN+ + H2 + H	12 [8]
1.05e-9	N+ + C2H2	→ C2H2+ + N	12
2.25e-10	N+ + C2H2	→ CNC+ + H2	12
2.25e-10	N+ + C2H2	→ HC2N+ + H	12
1.30e-10	N+ + C2H4	→ C2H2+ + NH2	12
3.25e-10	N+ + C2H4	→ C2H3+ + NH	12
4.55e-10	N+ + C2H4	→ C2H4+ + N	12
1.30e-10	N+ + C2H4	→ HCN+ + CH3	12
1.95e-10	N+ + C2H4	→ HCNH+ + CH2	12
6.50e-11	N+ + C2H4	→ HC2N+ + H2 + H	12
1.00e-10	N+ + C2H6	→ C2H5+ + NH	12
5.50e-10	N+ + C2H6	→ C2H4+ + NH2	12
2.50e-10	N+ + C2H6	→ C2H3+ + NH3	12
1.00e-10	N+ + C2H6	→ HCNH+ + CH4	12
4.70e-10	N+ + NH3	→ NH2+ + NH	12 [8]
1.67e-9	N+ + NH3	→ NH3+ + N	12 [8]
2.12e-10	N+ + NH3	→ N2H+ + H2	12 [8]
2.70e-9	N+ + H2O	→ H2O+ + N	12 [8]
5.60e-12	N+ + CO	→ C+ + NO	12 [8]

4.93e-10	N+ + CO	→ CO+ + N	12 [8]
6.16e-11	N+ + CO	→ NO+ + C	12 [8]
----- N2+			
10.00e-12	N2+ + H	→ H+ + N2	12 [110]
2.00e-9	N2+ + H2	→ N2H+ + H	12 [8]
1.04e-9	N2+ + CH4	→ CH3+ + H + N2	5
1.03e-10	N2+ + CH4	→ CH2+ + H2 + N2	5
3.76e-10	N2+ + C2H2	→ C2H2+ + N2	12
2.40e-11	N2+ + C2H2	→ N2H+ + C2H	12
1.30e-10	N2+ + C2H4	→ HCN+ + HCN + H2	5
1.30e-10	N2+ + C2H4	→ HCNH+ + HCN + H	5
8.58e-10	N2+ + C2H4	→ C2H3+ + N2 + H	12
3.77e-10	N2+ + C2H4	→ C2H2+ + N2 + H2	12
6.50e-11	N2+ + C2H4	→ N2H+ + C2H3	12
2.16e-10	N2+ + C2H6	→ C2H5+ + N2 + H	12 [100]
4.32e-10	N2+ + C2H6	→ C2H4+ + N2 + H2	12 [100]
5.04e-10	N2+ + C2H6	→ C2H3+ + N2 + H2 +	12 [100]
2.88e-10	N2+ + C2H6	→ C2H2+ + N2 + H2 +	12 [100]
1.95e-9	N2+ + NH3	→ NH3+ + N2	12 [8]
1.90e-9	N2+ + H2O	→ H2O+ + N2	12 [8]
8.00e-10	N2+ + CO2	→ CO2+ + N2	6
----- N2H+			
5.10e-18	N2H+ + H2	→ H3+ + N2	12 [8]
8.90e-10	N2H+ + CH4	→ CH5+ + N2	12 [24]
1.40e-9	N2H+ + C2H2	→ C2H3+ + N2	12 [82]
1.00e-9	N2H+ + C2H4	→ C2H5+ + N2	12 [82]
1.13e-9	N2H+ + C2H6	→ C2H5+ + N2 + H2	12 [69]
1.69e-10	N2H+ + C2H6	→ C2H7+ + N2	12 [69]
2.30e-9	N2H+ + NH3	→ NH4+ + N2	12 [43]
2.60e-9	N2H+ + H2O	→ H3O+ + N2	12 [8]
8.80e-10	N2H+ + CO	→ HCO+ + N2	9
1.40e-9	N2H+ + CO2	→ HCO2+ + N2	9
----- H2O+			
7.60e-10	H2O+ + H2	→ H3O+ + H	12 [8]
1.12e-9	H2O+ + CH4	→ H3O+ + CH3	12 [8]
1.90e-9	H2O+ + C2H2	→ C2H2+ + H2O	12 [102]
8.00e-10	H2O+ + C2H4	→ C2H5+ + OH	10
1.50e-9	H2O+ + C2H4	→ C2H4+ + H2O	12 [102]
1.33e-9	H2O+ + C2H6	→ H3O+ + C2H5	10
1.33e-9	H2O+ + C2H6	→ H3O+ + CH3CH2	12 [69]
1.92e-10	H2O+ + C2H6	→ C2H4+ + H2O + H2	12 [69]
1.60e-11	H2O+ + C2H6	→ C2H5+ + H2O + H	12 [69]
6.40e-11	H2O+ + C2H6	→ C2H6+ + H2O	12 [69]
1.13e-28	H2O+ + N2	→ adduct	12 [48]
1.85e-9	H2O+ + H2O	→ H3O+ + OH	12 [8]
----- H3O+			
5.15e-11	H3O+ + C2H4	→ C2H5+ + H2O	10
----- D+			
1.40e-9	D+ + H2	→ H+ + HD	8
9.50e-10	D+ + HD	→ H+ + D2	8
2.37e-9	D+ + CH4	→ CH3+ + HD	8
8.72e-10	D+ + CH4	→ CH2D+ + H2	8
8.72e-10	D+ + CH4	→ CH4+ + D	8
----- H2D+			

5.30e-10	H2D+ + H2	→ H3+ + HD	8	
5.00e-11	H2D+ + HD	→ H3+ + D2	8	
4.50e-10	H2D+ + HD	→ HD2+ + H2	8	
-----				He+
2.04e-16	He+ + H2	→ H+ + H + He	3*	
9.35e-15	He+ + H2	→ H2+ + He	1	
4.76e-10	He+ + CH4	→ H+ + CH3 + He	1	
2.38e-10	He+ + CH4	→ CH+ + H2 + He	1	
8.50e-10	He+ + CH4	→ CH2+ + H2 + He	1	
8.50e-11	He+ + CH4	→ CH3+ + H + He	1	
5.10e-11	He+ + CH4	→ CH4+ + He	1	
7.70e-10	He+ + C2H2	→ CH+ + CH + He	1	
1.61e-9	He+ + C2H2	→ C2+ + H2 + He	1	
8.75e-10	He+ + C2H2	→ C2H+ + H + He	1	
2.45e-10	He+ + C2H2	→ C2H2+ + He	1	
4.08e-10	He+ + C2H4	→ CH2+ + 3CH2 + He	1	
4.42e-10	He+ + C2H4	→ C2H+ + H + H2 + He	1	
2.18e-9	He+ + C2H4	→ C2H2+ + H2 + He	1	
1.70e-10	He+ + C2H4	→ C2H3+ + H + He	1	
2.38e-10	He+ + C2H4	→ C2H4+ + He	1	
8.12e-10	He+ + C2H6	→ C2H2+ + 2H2 + He	10	
1.68e-9	He+ + C2H6	→ C2H3+ + H + H2 + H	10	
4.06e-10	He+ + C2H6	→ C2H4+ + H2 + He	10	
1.85e-10	He+ + H2O	→ H+ + OH + He	10	
2.60e-10	He+ + H2O	→ OH+ + H + He	10	
5.50e-10	He+ + H2O	→ H2O+ + He	10	
1.60e-9	He+ + CO	→ C+ + O + He	10	
7.80e-10	He+ + CO2	→ CO+ + O + He	10	
1.30e-9	He+ + N2	→ N+ + N + He	10	
1.20e-9	He+ + N2	→ N2+ + He	10	
-----				HeH+
1.50e-9	HeH+ + H2	→ H3+ + He	1	
9.10e-10	HeH+ + H	→ H2+ + He	1	
2.10e-9	HeH+ + C2H4	→ C2H3+ + H2 + He	1	
7.00e-10	HeH+ + C2H4	→ C2H4+ + H + He	1	
1.05e-9	HeH+ + C2H6	→ C2H3+ + 2H2 + He	1	
1.05e-9	HeH+ + C2H6	→ C2H5+ + H2 + He	1	
-----				C3H3+
1.10e-9	C3H3+ + C2H2	→ C5Hn+ + H2	2	
5.50e-10	C3H3+ + C2H4	→ C5H5+ + H2	5	
5.50e-10	C3H3+ + C2H4	→ C5H6+ + hv	5	
-----				OH+
9.70e-10	OH+ + H2	→ H2O+ + H	10	
1.89e-10	OH+ + CH4	→ CH5+ + O	10	
1.26e-9	OH+ + CH4	→ H3O+ + ^3CH2	10	
2.90e-9	OH+ + H2O	→ H3O+ + O	10	
8.40e-10	OH+ + CO	→ HCO+ + O	10	
1.10e-9	OH+ + CO2	→ HCO2+ + O	10	
-----				HCO+
1.36e-9	HCO+ + C2H2	→ C2H3+ + CO	10	
1.20e-10	HCO+ + C2H6	→ C2H7+ + CO	10	
2.60e-9	HCO+ + H2O	→ H3O+ + CO	10	
-----				HCO2+
1.37e-9	HCO2+ + N2	→ N2H+ + CO2	9	

References R1

Citations in the tables refer to the following references (and references within *Vuitton et al.* are also identified by brackets):

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