Number[1]	Reaction[2,3]	A[4]	n	E[5]	Source[1] [6]	Comments, recommendations
RPE(1)	**$O^+ + e^- \rightarrow O + h\nu$**	**4×10^{-10}**	**0.7**	**0**		
RPE(2)	**$O_2^+ + e^- \rightarrow 2O$**	**1.9×10^{-7}**	**0.7**	**0**	**[2]**	**Rate coefficient measured over the temperature range of 100-1200K**
RPE(3)	**$O_4^+ + e^- \rightarrow 2O_2$**	**4.2×10^{-6}**	**0.48**	**0**		**Temperature interval is uncertain.**
RPE(4)	**$N^+ + e^- \rightarrow N + h\nu$**	**1×10^{-12}**	**0**	**0**		
RPE(5)	**$N_2^+ + e^- \rightarrow N + N(^2D)$**	**2.2×10^{-7}**	**0.39**	**0**	**[2]**	**Rate coefficient measured over the temperature range of 100-1200K.**
RPE(6)	**$NO^+ + e^- \rightarrow N + O$**	**7.0×10^{-8}**	**0.69**	**0**	**[2]**	**Rate coefficient measured over the temperature range of 100-1200K.**
RPE(7)	**$NO^+ + e^- \rightarrow N(^2D) + O$**	**2.8×10^{-7}**	**0.69**	**0**	**[2]**	**Rate coefficient measured over the temperature range of 100-1200K.**
RPE(8)	**$NO^+(N_2) + e^- \rightarrow NO + N_2$**	**1.5×10^{-6}**	**0.9**	**0**	**[3]**	**Not studied. Only estimated from $NO^+(NO)$ recombination based on Petrignani et al.[3]**
RPE(9)	**$NO^+(CO_2) + e^- \rightarrow NO + CO_2$**	**1.5×10^{-6}**	**0.9**	**0**	**[3]**	**Not studied. Only estimated from $NO^+(NO)$ recombination based on Petrignani et al.[3]**
RPE(10)	**$NO^+(H_2O) + e^- \rightarrow NO + H_2O$**	**1.5×10^{-6}**	**0.9**	**0**	**[3]**	**Not studied. Only estimated from $NO^+(NO)$ recombination based on Petrignani et al.[3]**
RPE(11)	**$NO^+(H_2O)_2 + e^- \rightarrow NO + 2H_2O$**	**2.8×10^{-6}**	**0**	**0**	**[4]**	**Data for all NO^+ water cluster ion reactions is estimated only for T=300K.**
RPE(12)	**$NO^+(H_2O)_3 + e^- \rightarrow NO + 3H_2O$**	**5×10^{-6}**	**0**	**0**	**[4]**	
RPE(13)	$NO^+(H_2O)(N_2) + e^- \rightarrow NO + H_2O + N_2$	5×10^{-6}	0	0	[4]	
RPE(14)	$NO^+(H_2O)(CO_2) + e^- \rightarrow NO + H_2O + CO_2$	5×10^{-6}	0	0	[4]	
RPE(15)	$NO^+(H_2O)_2(N_2) + e^- \rightarrow NO + 2H_2O + N_2$	5×10^{-6}	0	0	[4]	
RPE(16)	$NO^+(H_2O)_2(CO_2) + e^- \rightarrow NO + 2H_2O + CO_2$	5×10^{-6}	0	0		Not studied. Assumed to be the same as for $NO^+(H_2O)_2(N_2)$.
RPE(17)	**$O_2^+(H_2O) + e^- \rightarrow O_2 + H_2O$**	**4.2×10^{-6}**	**0.48**	**0**	**[4]**	**Not studied. Assumed to be the same as for O_4^+.**
RPE(18)	**$H_3O^+(OH) + e^- \rightarrow OH + H + H_2O$**	**1.4×10^{-6}**	**0.66**	**0**	**[4]**	**Not studied. Assumed to be the same as for $H^+(H_2O)_2$.**
RPE(19)	**$H^+(H_2O) + e^- \rightarrow H + H_2O$**	**7.6×10^{-7}**	**0.83**	**0**	**[5, 6]**	**Rate coefficients for all $H^+(H_2O)_n$ (n=1,...,6) cluster recombination were calculated over the temperature range of 10-2000K. For larger clusters at 298K.**
RPE(20)	**$H^+(H_2O)_2 + e^- \rightarrow H + 2H_2O$**	**1.4×10^{-6}**	**0.66**	**0**	**[6]**	
RPE(21)	**$H^+(H_2O)_3 + e^- \rightarrow H + 3H_2O$**	**2.5×10^{-6}**	**0.76**	**0**	**[6]**	
RPE(22)	**$H^+(H_2O)_4 + e^- \rightarrow H + 4H_2O$**	**5.5×10^{-7}**	**0.78**	**0**	**[7]**	
RPE(23)	**$H^+(H_2O)_5 + e^- \rightarrow H + 5H_2O$**	**3.8×10^{-6}**	**0.68**	**0**	**[6]**	

RPE(24)	$H^+(H_2O)_6 + e^- \rightarrow H + 6H_2O$	3.2×10^{-6}	0.65	0	[6]	
RPE(25)	$H^+(H_2O)_7 + e^- \rightarrow H + 7H_2O$	1.3×10^{-6}	0	0	[6]	
RPE(26)	$H^+(H_2O)_8 + e^- \rightarrow H + 8H_2O$	7.8×10^{-7}	0	0	[6]	
RPE(27)	$H^+(H_2O)_2(CO_2) + e^- \rightarrow H + 2H_2O + CO_2$	2.5×10^{-6}	0.66	0		Not studied. Assumed to be the same as for $H^+(H_2O)_3$.
RPE(28)	$H^+(H_2O)_2(N_2) + e^- \rightarrow H + 2H_2O + N_2$	2.5×10^{-6}	0.66	0		Not studied. Assumed to be the same as for $H^+(H_2O)_3$.
RPE(29)	$H^+(H_2O)(CO_2) + e^- \rightarrow H + H_2O + CO_2$	2.5×10^{-6}	0.66	0		Not studied. Assumed to be the same as for $H^+(H_2O)_3$.
RPE(30)	$O_2 + N_2 + e^- \rightarrow O_2^- + N_2$	**1×10^{-31}**	**1.0**	**4.9×10^{3}**		**Temperature interval is uncertain.**
RPE(31)	$O_3 + e^- \rightarrow O^- + O_2$	**9.1×10^{-12}**	**1.46**	**0**		**Temperature interval is uncertain.**
RPE(32)	$2O_2 + e^- \rightarrow O_2^- + O_2$	**4×10^{-30}**	**0**	**1.3×10^{4}**		**Temperature interval is uncertain.**
PIR(1)	$O^+ + O_2 \rightarrow O_2^+ + O$	**1.6×10^{-11}**	**0.5**	**0**	**[8]**	**Rate coefficient was measured over the range of 300-1800K.**
PIR(2)	$O^+ + N_2 \rightarrow NO^+ + N$	**1.2×10^{-12}**	**1.0**	**0**		**Temperature interval is uncertain.**
PIR(3)	$O^+ + N(^2D) \rightarrow N^+ + O$	**1.3×10^{-10}**	**0**	**0**		
PIR(4)	$O^+ + NO \rightarrow NO^+ + O$	**8×10^{-13}**	**0**	**0**		
PIR(5)	$O_2^+ + NO \rightarrow NO^+ + O_2$	**4.4×10^{-10}**	**0**	**0**		
PIR(6)	$O_2^+ + N_2 \rightarrow NO^+ + NO$	**2×10^{-18}**	**0**	**0**		
PIR(7)	$O_2^+ + O_2 + M \rightarrow O_4^+ + M$	**3.5×10^{-30}**	**2.93**	**0**	**[9]**	**Rate coefficient was measured only for $M=O_2$ over the range of 51-340K.**
PIR(8)	$O_2^+ + H_2O + M \rightarrow O_2^+(H_2O) + M$	2.8×10^{-28}	0	0		
PIR(9)	$O_2^+ + N_2 + M \rightarrow O_2^+(N_2) + M$	1×10^{-30}	3.2	0	[10]	Rate coefficient was measured only for $M=N_2$ over the range of 100-180K
PIR(10)	$O_2^+ + N \rightarrow NO^+ + O$	**1×10^{-10}**	**0**	**0**		
PIR(11)	$O_2^+ + N(^2D) \rightarrow N^+ + O_2$	**2.5×10^{-10}**	**0**	**0**		
PIR(12)	$O_2^+(H_2O) + H_2O \rightarrow H_3O^+(OH) + O_2$	**9×10^{-10}**	**0**	**0**	**[11]**	**Rate coefficient was measured at 296K.**
PIR(13)	$O_2^+(H_2O) + H_2O \rightarrow H^+(H_2O) + OH + O_2$	**2.4×10^{-10}**	**0**	**0**	**[11]**	**Rate coefficient was measured at 296K.**
PIR(14)	$O_2^+(H_2O) + N_2 + M \rightarrow O_2^+(H_2O)(N_2) + M$	1×10^{-27}	0	0		
PIR(15)	$O_2^+(N_2) + O_2 \rightarrow O_4^+ + N_2$	5×10^{-10}	0	0		
PIR(16)	$O_2^+(N_2) + M \rightarrow O_2^+ + N_2 + M$	2.0×10^{-15}	3.2	2.2×10^{4}		Temperature interval is uncertain.
PIR(17)	$O_2^+(N_2) + CO_2 \rightarrow O_2^+(CO_2) + N_2$	1×10^{-9}	0	0	[12]	Not studied. Based on estimation only.
PIR(18)	$O_2^+(CO_2) + H_2O \rightarrow O_2^+(H_2O) + CO_2$	1×10^{-9}	0	0	[12]	Not studied. Based on estimation only.
PIR(19)	$O_2^+(H_2O)(N_2) + CO_2 \rightarrow O_2^+(H_2O)(CO_2) + N_2$	1×10^{-9}	0	0	[12]	Not studied. Based on estimation only.
PIR(20)	$O_2^+(H_2O)(N_2) + M \rightarrow O_2^+(H_2O) + N_2 + M$	7.7×10^{-13}	0	0		

PIR(21)	$O_2^+(H_2O)(CO_2) + H_2O \rightarrow O_2^+(H_2O)_2 + CO_2$	5×10^{-10}	0	0		
PIR(22)	$O_2^+(H_2O)(CO_2) + H_2O \rightarrow H_3O^+(OH)(CO_2) + O_2$	5×10^{-10}	0	0		
PIR(23)	$O_2^+(H_2O)_2 + H_2O \rightarrow H_3O^+(OH)(H_2O) + O_2$	1.3×10^{-9}	0	0		
PIR(24)	$O_4^+ + O_2(^1D_g) \rightarrow O_2^+ + 2O_2$	1.5×10^{-10}	0	0	[13]	Not studied, based on estimation only
PIR(25)	$O_4^+ + H_2O \rightarrow O_2^+(H_2O) + O_2$	1.2×10^{-9}	0	0	[14]	Rate coefficient was measured at 300K. Uncertainty of measurement >50%.
PIR(26)	$O_4^+ + O \rightarrow O_2^+ + O_3$	3×10^{-10}	0	0		Uncertainty of data >67%.
PIR(27)	$O_4^+ + M \rightarrow O_2^+ + O_2 + M$	4×10^{-29}	0	0	[15]	Rate coefficient was measured only for $M=N_2$for 297K.
PIR(28)	$N^+ + O_2 \rightarrow NO^+ + O$	2.6×10^{-10}	0	0	[16, 17]	
PIR(29)	$N^+ + O_2 \rightarrow O_2^+ + N$	1.1×10^{-10}	0	0	[16, 17]	
PIR(30)	$N^+ + O_2 \rightarrow O^+ + NO$	2.7×10^{-10}	0	0	[16, 17]	
PIR(31)	$N^+ + O \rightarrow O^+ + N$	5×10^{-13}	0	0	[16, 17]	
PIR(32)	$N^+ + O_2 \rightarrow O_2^+ + N(^2D)$	2×10^{-10}	0	0		
PIR(33)	$N_2^+ + O \rightarrow NO^+ + N(^2D)$	1.4×10^{-10}	0.44	0	[18]	Rate coefficient measured at (295±5)K with 40% error
PIR(34)	$N_2^+ + O \rightarrow N^+ + NO$	9.8×10^{-12}	0.23	0	[18]	Rate coefficient at measured at (295±5)K with 40% error
PIR(35)	$N_2^+ + O_2 \rightarrow O_2^+ + N_2$	5×10^{-11}	0.8	0		
PIR(36)	$N_2^+ + NO \rightarrow NO^+ + N_2$	3.3×10^{-10}	0	0		
PIR(37)	$NO^+ + N_2 + M \rightarrow NO^+(N_2) + M$	3×10^{-31}	4.3	0	[10]	Rate coefficient was measured only for $M=N_2$ over the range of 100-180K
PIR(38)	$NO^+ + CO_2 + M \rightarrow NO^+(CO_2) + M$	1.4×10^{-29}	4.0	0	[10]	Rate coefficient was measured only for $M=N_2$ over the range of 100-180K
PIR(39)	$NO^+ + H_2O + M \rightarrow NO^+(H_2O) + M$	9.2×10^{-30}	2.83	0	[19]	Measured only for M=He over the temperature range of 150-300K.
PIR(40)	$NO^+(N_2) + CO_2 \rightarrow NO^+(CO_2) + N_2$	1×10^{-9}	0	0	[12]	Not studied. Based on estimation only.
PIR(41)	$NO^+(N_2) + H_2O \rightarrow NO^+(H_2O) + N_2$	1×10^{-9}	0	0	[12]	Not studied. Based on estimation only.
PIR(42)	$NO^+(N_2) + M \rightarrow NO^+ + N_2 + M$	2.3×10^{-20}	4.3	1.7×10^{4}		Measured only for M=He over the temperature range of 150-300K
PIR(43)	$NO^+(CO_2) + H_2O \rightarrow NO^+(H_2O) + N_2$	1×10^{-9}	0	0	[12]	Not studied. Based on estimation only.
PIR(44)	$NO^+(CO_2) + M \rightarrow NO^+ + CO_2 + M$	1×10^{-20}	5.0	2.3×10^{4}	[4]	Measured only for M=He over the temperature range of 150-300K
PIR(45)	$NO^+(H_2O) + HO_2 \rightarrow H^+(H_2O) + NO_3$	1×10^{-9}	0	0	[11]	Data is only upper limit estimation.
PIR(46)	$NO^+(H_2O) + OH \rightarrow H^+(H_2O) + NO_2$	1×10^{-10}	0	0		Data is only upper limit estimation. Uncertainty of data: 30%
PIR(47)	$NO^+(H_2O) + H \rightarrow H^+(H_2O) + NO$	7×10^{-12}	0	0		Data is only upper limit estimation. Uncertainty of data: 30%
PIR(48)	$NO^+(H_2O) + H_2O + M \rightarrow NO^+(H_2O)_2 + M$	7.1×10^{-31}	4.7	0	[19]	Measured for M=He over the temperature range of 150-300K with 40% error.

PIR(49)	$NO^+(H_2O) + N_2 + M \rightarrow NO^+(H_2O)(N_2) + M$	7.1×10^{-33}	4.4	0	[19]	Measured for M=He over the temperature range of 150-300K with 40% error.
PIR(50)	$NO^+(H_2O) + CO_2 + M \rightarrow NO^+(H_2O)(CO_2) + M$	7×10^{-30}	5.0	0	[19]	Measured for M=N_2 over the temperature range of 225-300K.
PIR(51)	$NO^+(H_2O)_2 + H_2O + M \rightarrow NO^+(H_2O)_3 + M$	**7.1×10^{-29}**	**4.7**	**0**	**[19]**	**Measured for M=He over the temperature range of 150-300K with 40% error.**
PIR(52)	$NO^+(H_2O)_2 + N_2 + M \rightarrow NO^+(H_2O)_2(N_2) + M$	1.6×10^{-32}	4.4	0		Measured for M=He over the temperature range of 150-300K.
PIR(53)	$NO^+(H_2O)_2 + CO_2 + M \rightarrow NO^+(H_2O)_2(CO_2) + M$	7×10^{-30}	3.0	0		Measured for M=N_2 over the temperature range of 225-300K.
PIR(54)	$NO^+(H_2O)_3 + H_2O \rightarrow H^+(H_2O)_3 + HNO_2$	**7×10^{-11}**	**0**	**0**	**[19]**	
PIR(55)	$NO^+(H_2O)(N_2) + H_2O \rightarrow NO^+(H_2O)_2 + N_2$	1×10^{-9}	0	0	[12]	Not studied. Based on estimation only.
PIR(56)	$NO^+(H_2O)(N_2) + CO_2 \rightarrow NO^+(H_2O)(CO_2) + N_2$	7.1×10^{-10}	0	0	[4]	
PIR(57)	$NO^+(H_2O)(N_2) + M \rightarrow NO^+(H_2O) + N_2 + M$	2.6×10^{-21}	5.4	1.7×10^{4}	[4]	Not studied. Based on estimation only.
PIR(58)	$NO^+(H_2O)(CO_2) + H_2O \rightarrow NO^+(H_2O)_2 + CO_2$	1×10^{-9}	0	0	[12]	Not studied. Based on estimation only.
PIR(59)	$NO^+(H_2O)(CO_2) + M \rightarrow NO^+(H_2O) + CO_2 + M$	1.5×10^{-18}	5.0	3.3×10^{4}	[4]	Not studied. Based on estimation only.
PIR(60)	$NO^+(H_2O)_2(N_2) + H_2O \rightarrow NO^+(H_2O)_3 + N_2$	1×10^{-9}	0	0	[12]	Not studied. Based on estimation only.
PIR(61)	$NO^+(H_2O)_2(N_2) + CO_2 \rightarrow NO^+(H_2O)_2(CO_2) + N_2$	6.9×10^{-10}	0	0	[4]	
PIR(62)	$NO^+(H_2O)_2(N_2) + M \rightarrow NO^+(H_2O)_2 + N_2 + M$	2.6×10^{-21}	5.4	1.5×10^{4}	[4]	Not studied. Based on estimation only.
PIR(63)	$NO^+(H_2O)_2(CO_2) + H_2O \rightarrow NO^+(H_2O)_3 + CO_2$	1×10^{-9}	0	0	[12]	Not studied. Based on estimation only.
PIR(64)	$NO^+(H_2O)_2(CO_2) + M \rightarrow NO^+(H_2O)_2 + CO_2 + M$	1.5×10^{-18}	5.0	2.7×10^{4}		Not studied. Based on estimation only.
PIR(65)	$H^+(H_2O) + H_2O + M \rightarrow H^+(H_2O)_2 + M$	**5.2×10^{-27}**	**4.0**	**0**	**[20]**	**Measured for M=O_2 over the temperature range of 23-170K with 50% error.**
PIR(66)	$H^+(H_2O) + CO_2 + M \rightarrow H^+(H_2O)(CO_2) + M$	**4.8×10^{-28}**	**4.0**	**0**	**[21, 22]**	**Measured for M=CH_4 over the temperature range of 318-813K**
PIR(67)	$H^+(H_2O) + N_2 + M \rightarrow H^+(H_2O)(N_2) + M$	**2×10^{-31}**	**4.0**	**0**	**[21, 22]**	**Measured for M=CH_4 over the temperature range of 318-813K**
PIR(68)	$H^+(H_2O)_2 + M \rightarrow H^+(H_2O) + H_2O + M$	**5.7×10^{-15}**	**5.0**	**1.3×10^{5}**	**[21, 22]**	**Measured for M=CH_4 over the temperature range of 346-497K**
PIR(69)	$H^+(H_2O)_2 + H_2O + M \rightarrow H^+(H_2O)_3 + M$	**1.3×10^{-27}**	**7.5**	**0**	**[21, 22]**	**Measured for M=CH_4 over the temperature range of 346-497K**
PIR(70)	$H^+(H_2O)_2 + CO_2 + M \rightarrow H^+(H_2O)_2(CO_2) + M$	**4.8×10^{-28}**	**4.0**	**0**	**[21, 22]**	**Measured for M=CH_4 over the temperature range of 346-497K**
PIR(71)	$H^+(H_2O)_2 + N_2 + M \rightarrow H^+(H_2O)_2(N_2) + M$	**2×10^{-31}**	**4.0**	**0**	**[21, 22]**	**Measured for M=CH_4 over the temperature range of 346-497K**
PIR(72)	$H^+(H_2O)_3 + M \rightarrow H^+(H_2O)_2 + H_2O + M$	**1.3×10^{-24}**	**8.5**	**8.5×10^{4}**	**[21, 22]**	**Measured for M=CH_4 over the temperature range of 346-497K**
PIR(73)	$H^+(H_2O)_3 + H_2O + M \rightarrow H^+(H_2O)_4 + M$	**2×10^{-27}**	**8.1**	**0**	**[21, 22]**	**Measured for M=CH_4 over the temperature range of 215-400K**
PIR(74)	$H^+(H_2O)_4 + M \rightarrow H^+(H_2O)_3 + H_2O + M$	**2.4×10^{-24}**	**9.1**	**7.4×10^{4}**	**[21, 22]**	**Measured for M=CH_4 over the temperature range of 205-310K**
PIR(75)	$H^+(H_2O)_4 + H_2O + M \rightarrow H^+(H_2O)_5 + M$	**2.6×10^{-28}**	**14.0**	**0**	**[21, 22]**	**Measured for M=CH_4 over the temperature range of 205-310K**
PIR(76)	$H^+(H_2O)_5 + M \rightarrow H^+(H_2O)_4 + H_2O + M$	**8×10^{-41}**	**15.0**	**5.3×10^{4}**	**[21, 22]**	**Measured for M=CH_4 over the**

						temperature range of 205-257K
PIR(77)	**$H^+(H_2O)_5 + H_2O + M \rightarrow H^+(H_2O)_6 + M$**	**3.3×10^{-29}**	**15.3**	**0**	**[21, 22]**	**Measured for $M=CH_4$ over the temperature range of 205-257K**
PIR(78)	$H^+(H_2O)_6 + M \rightarrow H^+(H_2O)_5 + H_2O + M$	1.6×10^{-43}	16.3	4.8×10^4	[4]	Not studied. Based on estimation only.
PIR(79)	$H^+(H_2O)_6 + H_2O + M \rightarrow H^+(H2O)7 + M$	9×10^{-28}	15.3	0	[4]	Not studied. Based on estimation only.
PIR(80)	$H^+(H_2O)_7 + M \rightarrow H^+(H_2O)_6 + H_2O + M$	1.6×10^{-43}	16.3	4.8×10^4	[4]	Not studied. Based on estimation only.
PIR(81)	$H^+(H_2O)_7 + H_2O + M \rightarrow H^+(H_2O)_8 + M$	9×10^{-28}	15.3	0	[4]	Not studied. Based on estimation only.
PIR(82)	$H^+(H_2O)_8 + M \rightarrow H^+(H_2O)_7 + H_2O + M$	1.6×10^{-43}	16.3	4.8×10^4	[4]	Not studied. Based on estimation only.
PIR(83)	$H^+(H_2O)_2(CO_2) + H_2O \rightarrow H^+(H_2O)_3 + CO_2$	1×10^{-9}	0	0		
PIR(84)	$H^+(H_2O)_2(CO_2) + M \rightarrow H^+(H_2O)_2 + CO_2 + M$	2.4×10^{-10}	5.0	5.1×10^4		Temperature regime not specified.
PIR(85)	$H^+(H_2O)_2(N_2) + CO_2 \rightarrow H^+(H_2O)_2(CO_2) + N_2$	1×10^{-9}	0	0		
PIR(86)	$H^+(H_2O)_2(N_2) + M \rightarrow H^+(H_2O)_2 + N_2 + M$	1.2×10^{-8}	5.4	2.2×10^4		Temperature regime not specified.
PIR(87)	$H^+(H_2O)_2(N_2) + H_2O \rightarrow H^+(H_2O)_3 + N_2$	1.2×10^{-8}	5.4	2.2×10^4		Temperature regime not specified.
PIR(88)	$H^+(H_2O)(CO_2) + H_2O \rightarrow H^+(H_2O)_2 + CO_2$	1×10^{-9}	0	0		
PIR(89)	$H^+(H_2O)(CO_2) + M \rightarrow H^+(H_2O) + CO_2 + M$	2.2×10^{-15}	5.0	6.4×10^4		Temperature regime not specified.
PIR(90)	$H^+(H_2O)(N_2) + CO_2 \rightarrow H^+(H_2O)(CO_2) + N_2$	1×10^{-9}	0	0		
PIR(91)	$H^+(H_2O)(N_2) + M \rightarrow H^+(H_2O) + N_2 + M$	7.5×10^{-22}	5.4	2.3×10^4		Temperature regime not specified.
PIR(92)	**$H_3O^+(OH) + H_2O \rightarrow H^+(H_2O)_2 + OH$**	**2×10^{-9}**	**0**	**0**	**[23]**	**Rate coefficient was measured at 296K.**
PIR(93)	**$H_3O^+(OH) + O_2 + M \rightarrow O_2^+(H_2O)_2 + M$**	**3.4×10^{-30}**	**4.0**	**0**	**[24]**	**Rate coefficient was measured at 337K for $M=O_2$.**
PIR(94)	$H_3O^+(OH)(H_2O) + H_2O \rightarrow H^+(H_2O)_3 + OH$	1.9×10^{-9}	0	0		
PIR(95)	$H_3O^+(OH)(CO_2) + H_2O \rightarrow H^+(H_2O)_2(CO_2) + OH$	5×10^{-10}	0	0		
PIR(96)	$H_3O^+(OH)(CO_2) + H_2O \rightarrow H^+(H_2O) + OH + CO_2$	5×10^{-10}	0	0		
PIR(97)	**$H^+(H_2O)_2 + N_2O_5 \rightarrow HNO_3 + H^+(H_2O)(HNO_3)$**	**8×10^{-10}**	**0**	**0**	**[25]**	
PIR(98)	**$H^+(H_2O)_3 + N_2O_5 \rightarrow HNO_3 + H^+(H_2O)_2(HNO_3)$**	**4.5×10^{-11}**	**0**	**0**	**[25]**	
PIR(99)	$H^+(H_2O)_4 + N_2O_5 \rightarrow HNO_3 + H^+(H_2O)_3(HNO_3)$	4×10^{-12}	0	0	[25]	
PIR(100)	$H^+(H_2O)_5 + N_2O_5 \rightarrow HNO_3 + H^+(H_2O)_4(HNO_3)$	7×10^{-12}	0	0	[25]	
PIR(101)	$H^+(H_2O)_6 + N_2O_5 \rightarrow HNO_3 + H^+(H_2O)_5(HNO_3)$	1.4×10^{-11}	0	0	[25]	
PIR(102)	$H^+(H_2O)(HNO_3) + H_2O \rightarrow H^+(H_2O)_2 + HNO_3$	1×10^{-9}	0	0	[25]	
PIR(103)	$H^+(H_2O)_2(HNO_3) + H_2O \rightarrow H^+(H_2O)_3 + HNO_3$	1×10^{-9}	0	0	[25]	
PIR(104)	$H^+(H_2O)_3(HNO_3) + H_2O \rightarrow H^+(H_2O)_4 + HNO_3$	1×10^{-9}	0	0	[25]	

PIR(105)	$H^+(H_2O)_4(HNO_3) + H_2O \rightarrow H^+(H_2O)_5 + HNO_3$	1×10^{-9}	0	0	[25]
PIR(106)	$H^+(H_2O)_5(HNO_3) + H_2O \rightarrow H^+(H_2O)_6 + HNO_3$	1×10^{-9}	0	0	[25]
PIR(107)	$H^+(CH_3CN)(H_2O) + H^+(H_2O)_2 \rightarrow$ $H^+(CH_3CN)(HNO_3) + HNO_3$	7×10^{-12}	0	0	[25]
PIR(108)	$H^+(CH_3CN)(HNO_3) + H_2O \rightarrow$ $H^+(CH_3CN)(H_2O) + HNO_3$	1×10^{-9}	0	0	[25]
PIR(109)	$H^+(CH_3CN)(H_2O)_2 + N_2O_5 \rightarrow$ $H^+(CH_3CN)(H_2O)(HNO_3) + HNO_3$	7×10^{-12}	0	0	[25]
PIR(110)	$H^+(CH_3CN)(H_2O)(HNO_3) + H_2O \rightarrow$ $H^+(CH_3CN)(H_2O)_2 + HNO_3$	1×10^{-9}	0	0	[25]
PIR(111)	$H^+(CH_3CN)(H_2O)_3 + N_2O_5 \rightarrow$ $H^+(CH_3CN)\ (H_2O)_2HNO_3$	7×10^{-12}	0	0	[25]
PIR(112)	$H^+(CH_3CN)(H_2O)_2HNO_3 + H_2O \rightarrow$ $H^+(CH_3CN)\ (H_2O)_3 + HNO_3$	1×10^{-9}	0	0	[25]
PIR(113)	$H^+(CH_3CN)(H_2O)_4 + N_2O_5 \rightarrow$ $H^+(CH_3CN)\ (H_2O)_3HNO_3$	7×10^{-12}	0	0	[25]
PIR(114)	$H^+(CH_3CN)(H_2O)_3HNO_3 + H_2O \rightarrow$ $H^+(CH_3CN)(H_2O)_4 + HNO_3$	1×10^{-9}	0	0	[25]
PIR(115)	$H^+(CH_3CN)(H_2O)_5 + N_2O_5 \rightarrow$ $H^+(CH_3CN)(H_2O)_4HNO_3$	7×10^{-12}	0	0	[25]
PIR(116)	$H^+(CH_3CN)(H_2O)_4HNO_3 + H_2O \rightarrow$ $H^+(CH_3CN)(H_2O)_5 + HNO_3$	1×10^{-9}	0	0	[25]
PIR(117)	$H^+(H_2O) + CH_3CN \rightarrow H^+(CH_3CN) + H_2O$	9.6×10^{-8}	0.5	0	
PIR(118)	$H^+(H_2O)_2 + CH_3CN \rightarrow H^+(CH_3CN)(H_2O) + H_2O$	7.8×10^{-8}	0.5	0	
PIR(119)	$H^+(H_2O)_3 + CH_3CN \rightarrow H^+(CH_3CN)(H_2O)_2 + H_2O$	7.1×10^{-8}	0.5	0	
PIR(120)	$H^+(H_2O)_4 + CH_3CN \rightarrow H^+(CH_3CN)(H_2O)_3 + H_2O$	6.7×10^{-8}	0.5	0	
PIR(121)	$H^+(H_2O)_5 + CH_3CN \rightarrow H^+(CH_3CN)(H_2O)_4 + H_2O$	6.5×10^{-8}	0.5	0	
PIR(122)	$H^+(H_2O)_6 + CH_3CN \rightarrow H^+(CH_3CN)(H_2O)_5 + H_2O$	6.3×10^{-8}	0.5	0	
PIR(123)	$H^+(H_2O)_7 + CH_3CN \rightarrow H^+(CH_3CN)(H_2O)_6 + H_2O$	6.2×10^{-8}	0.5	0	

PIR(124)	$H^+(H_2O)_8 + CH_3CN \rightarrow H^+(CH_3CN)(H_2O)_7 + H_2O$	6.2×10^{-8}	0.5	0		
PIR(125)	$O_2^+(H_2O) \rightarrow O_2^+ + H_2O$	4.2×10^{-1}	0	0		
NPD(1)	$O_3^- + hv \rightarrow O^- + O_2$	4.7×10^{-1}	0	0		
NPD(2)	$O_4^- + hv \rightarrow O_2^- + O_2$	2.4×10^{-1}	0	0		
NPD(3)	$CO_3^- + hv \rightarrow O^- + CO_2$	1.5×10^{-1}	0	0		
NPD(4)	$CO_4^- + hv \rightarrow O_2^- + CO_2$	6.2×10^{-3}	0	0		
NPD(5)	$CO_3^-(H_2O) + hv \rightarrow CO_3^- + H_2O$	1	0	0		
PDE(1)	$O^- + hv \rightarrow O + e^-$	1.4	0	0		
PDE(2)	$O_2^- + hv \rightarrow O_2 + e^-$	3.8×10^{-1}	0	0		
PDE(3)	$O_3^- + hv \rightarrow O_3 + e^-$	4.7×10^{-2}	0	0		
PDE(4)	$OH^- + hv \rightarrow OH + e^-$	1.1	0	0		
PDE(5)	$CO_3^- + hv \rightarrow CO_3 + e^-$	2.2×10^{-2}	0	0		
PDE(6)	$NO_2^- + hv \rightarrow NO_2 + e^-$	8×10^{-4}	0	0		
PDE(7)	$NO_3^- + hv \rightarrow NO_3 + e^-$	5.2×10^{-2}	0	0		
EDA(1)	$O^- + O \rightarrow O_2 + e^-$	1.9×10^{-10}	0	0		
EDA(2)	$O^- + NO \rightarrow NO_2 + e^-$	3×10^{-10}	0.83	0		
EDA(3)	$O^- + O_2(^1D_g) \rightarrow O_3 + e^-$	3×10^{-10}	0	0		
EDA(4)	$O^- + M \rightarrow O + M + e^-$	5×10^{-13}	0	0		
EDA(5)	$O^- + H_2 \rightarrow H_2O + e^-$	5.8×10^{-10}	0	0		**Rate coefficient measured at 298K with 25% uncertainty.**
EDA(6)	$O_2^- + O \rightarrow O_3 + e^-$	1.5×10^{-10}	0	0		**Rate coefficient measured at 298K.**
EDA(7)	$O_2^- + O_2(^1D_g) \rightarrow 2O_2 + e^-$	2×10^{-10}	0	0	**[26]**	**Rate coefficient measured at 298K.**
EDA(8)	$O_2^- + N_2 \rightarrow N_2 + O_2 + e^-$	1.9×10^{-12}	-1.5	4.1×10^{4}		**Temperature interval is uncertain.**
EDA(9)	$O_2^- + H \rightarrow HO_2 + e^-$	1.4×10^{-9}	0	0		
EDA(10)	$O_3^- + O \rightarrow 2O_2 + e^-$	1×10^{-10}	0	0		
EDA(11)	$O_3^- + O_3 \rightarrow 3O_2 + e^-$	1×10^{-10}	0	0		
EDA(12)	$OH^- + O \rightarrow HO_2 + e^-$	2×10^{-10}	0	0		
EDA(13)	$OH^- + H \rightarrow H_2O + e^-$	1.4×10^{-9}	0	0		
EDA(14)	$Cl^- + H \rightarrow HCl + e^-$	9.6×10^{-10}	0	0		
NIR(1)	$O^- + O_3 \rightarrow O_3^- + O$	8×10^{-10}	0	0		
NIR(2)	$O^- + 2O_2 \rightarrow O_3^- + O_2$	1.0×10^{-30}	0	0	**[27]**	**Rate coefficient is measured at 300K. Uncertainty of measurement: 30%.**

NIR(3)	**$O^- + H_2O \rightarrow OH^- + OH$**	**6×10^{-13}**	**0**	**0**		**Data is only upper limit estimation.**
NIR(4)	**$O^- + NO_2 \rightarrow NO_2^- + O$**	**1.2×10^{-9}**	**0**	**0**	**[28]**	**Rate coefficient is measured at 300K. Uncertainty of measurement: 10%.**
NIR(5)	**$O^- + CO_2 + M \rightarrow CO_3^- + M$**	**3.4×10^{-28}**	**0**	**0**	**[15]**	**Rate coefficient is measured at 298K. M=O_2 Uncertainty of measurement: 30%.**
NIR(6)	**$O^- + H_2 \rightarrow OH^- + H$**	**4.1×10^{-11}**	**0**	**0**	**[29]**	
NIR(7)	**$O^- + HCl \rightarrow Cl^- + OH$**	**2.0×10^{-9}**	**0**	**0**	**[15]**	**Rate coefficient is measured at 289K. Uncertainty of measurement: 30%.**
NIR(8)	**$O^- + Cl \rightarrow Cl^- + O$**	**1×10^{-10}**	**0**	**0**		
NIR(9)	**$O^- + ClO \rightarrow Cl^- + O_2$**	**1×10^{-10}**	**0**	**0**		
NIR(10)	**$O^- + CH_4 \rightarrow OH^- + CH_3$**	**1×10^{-10}**	**0**	**0**		
NIR(11)	**$O^- + HNO_3 \rightarrow NO_3^- + OH$**	**3.6×10^{-9}**	**0**	**0**		
NIR(12)	**$O^- + H_2O + M \rightarrow O^-(H_2O) + M$**	**1.4×10^{-28}**	**0**	**0**	**[15]**	**Rate coefficient is measured at 298K. M=O_2Uncertainty of measurement: 50%.**
NIR(13)	$O^-(H_2O) + O_2 \rightarrow O_3^- + H2O$	6.2×10^{-11}	0	0		
NIR(14)	**$O_2^- + O \rightarrow O^- + O_2$**	**1.8×10^{-10}**	**0**	**0**	**[30]**	
NIR(15)	**$O_2^- + O_3 \rightarrow O_3^- + O_2$**	**7×10^{-10}**	**0**	**0**	**[15]**	**Rate coefficient is measured at 298K. Uncertainty of measurement: 40%.**
NIR(16)	**$O_2^- + CO_2 + O_2 \rightarrow CO_4^- + O_2$**	**4.7×10^{-29}**	**0**	**0**	**[15]**	**Rate coefficient is measured at 298K. Uncertainty of measurement: 30%.**
NIR(17)	**$O_2^- + NO_2 \rightarrow NO_2^- + O_2$**	**8×10^{-10}**	**0**	**0**	**[15]**	**Rate coefficient is measured at 298K.**
NIR(18)	**$O_2^- + O_2 + M \rightarrow O_4^- + M$**	**3×10^{-31}**	**0**	**0**	**[31, 32]**	**Estimatedfor M=O_2 over the temperature range of 200-500K. Uncertainty of measurement: >15%.**
NIR(19)	**$O_2^- + H_2O + M \rightarrow O_2^-(H_2O) + M$**	**2.2×10^{-28}**	**0**	**0**	**[31, 32]**	**Estimatedfor M=O_2 over the temperature range of 200-500K**
NIR(20)	**$O_2^- + HCl \rightarrow Cl^- + HO_2$**	**1.6×10^{-9}**	**0**	**0**	**[15]**	**Rate coefficient is measured at 289K. Uncertainty of measurement: 30%.**
NIR(21)	**$O_2^- + Cl \rightarrow Cl^- + O_2$**	**1×10^{-10}**	**0**	**0**		
NIR(22)	**$O_2^- + ClO \rightarrow ClO^- + O_2$**	**1×10^{-10}**	**0**	**0**		
NIR(23)	**$O_2^- + HNO_3 \rightarrow NO_3^- + HO_2$**	**2.9×10^{-9}**	**0**	**0**		
NIR(24)	$O_2^-(H_2O) + CO_2 \rightarrow CO_4^- + H_2O$	5.8×10^{-10}	0	0		
NIR(25)	$O_2^-(H_2O) + NO \rightarrow NO_3^- + H_2O$	2×10^{-10}	0	0		
NIR(26)	$O_2^-(H_2O) + O_3 \rightarrow O_3^- + O_2 + H_2O$	8×10^{-10}	0	0		
NIR(27)	$O_2^-(H_2O) + H_2O + M \rightarrow O_2^-(H_2O)_2 + M$	5.4×10^{-28}	0	0		
NIR(28)	$O_2^-(H_2O) + NO_2 \rightarrow NO_2^- + H_2O + O_2$	9×10^{-10}	0	0		
NIR(29)	$O_2^-(H_2O) + M \rightarrow O_2^- + H_2O + M$	1.3×10^{-4}	-1.0	7.7×10^{4}		Temperature interval is uncertain.

NIR(30)	$O_2^-(H_2O)_2 + M \rightarrow O_2^-(H_2O) + H_2O + M$	4×10^{-10}	-1.0	7.2×10^{4}		Temperature interval is uncertain.
NIR(31)	$O_2^-(H_2O)_2 + NO_2 \rightarrow NO_2^-(H_2O) + H_2O + O_2$	9×10^{-10}	0	0		
NIR(32)	$O_2^-(H_2O)_2 + O_3 \rightarrow O_3^-(H_2O) + O_2 + H_2O$	7.8×10^{-10}	0	0		
NIR(33)	$O_3^- + O \rightarrow O_2^- + O_2$	2.5×10^{-10}	**0**	**0**	**[15]**	**Rate coefficient is measured at 298K. Uncertainty of measurement: 75%.**
NIR(34)	$O_3^- + H \rightarrow OH^- + O_2$	8.4×10^{-10}	**0**	**0**	**[15]**	**Rate coefficient is measured at 298K. Uncertainty of measurement: 40%.**
NIR(35)	$O_3^- + CO_2 \rightarrow CO_3^- + O_2$	5.5×10^{-10}	**0**	**0**	**[15]**	**Rate coefficient is measured at 298K. Uncertainty of measurement: 30%.**
NIR(36)	$O_3^- + NO \rightarrow NO_3^- + O$	1×10^{-12}	**2.15**	**0**	**[33]**	**Rate coefficient measured over the temperature range of 100-500K**
NIR(37)	$O_3^- + NO_2 \rightarrow NO_3^- + O_2$	2.5×10^{-11}	**0.79**	**0**	**[33]**	**Rate coefficient measured over the temperature range of 200-500K.**
NIR(38)	$O_3^- + H_2O + M \rightarrow O_3^-(H_2O) + M$	2.7×10^{-28}	0	0		
NIR(39)	$O_3^- + NO_2 \rightarrow NO_2^- + O_3$	7.5×10^{-11}	**0.79**	**0**	**[33]**	**Rate coefficient measured over the temperature range of 200-500K**
NIR(40)	$O_3^- + NO \rightarrow NO_2^- + O_2$	1×10^{-12}	**2.15**	**0**	**[33]**	**Rate coefficient measured over the temperature range of 100-500K**
NIR(41)	$O_3^-(H_2O) + CO_2 \rightarrow CO_3^- + H_2O + O_2$	1.7×10^{-10}	0	0		
NIR(42)	$O_3^-(H_2O) + CO_2 \rightarrow CO_3^-(H_2O) + O_2$	1.7×10^{-10}	0	0		
NIR(43)	$O_4^- + O \rightarrow O_3^- + O_2$	4×10^{-10}	**0**	**0**	**[15]**	**Rate coefficient is measured at 298K. Uncertainty of measurement: 75%.**
NIR(44)	$O_4^- + CO_2 \rightarrow CO_4^- + O_2$	4.3×10^{-10}	**0**	**0**	**[15]**	**Rate coefficient is measured at 298K. Uncertainty of measurement: 30%.**
NIR(45)	$O_4^- + NO \rightarrow NO_3^{-*} + O_2$	2.5×10^{-10}	0	0	[15]	Rate coefficient is measured at 298K. Uncertainty of measurement: 30%.
NIR(46)	$O_4^- + H_2O \rightarrow O_2^-(H_2O) + O_2$	1.5×10^{-9}	0	0	[15]	Rate coefficient estimated for 298K.
NIR(47)	$OH^- + O_3 \rightarrow O_2^- + OH$	9×10^{-10}	**0**	**0**	**[15]**	**Rate coefficient is measured at 298K. Uncertainty of measurement: 75%.**
NIR(48)	$OH^- + NO_2 \rightarrow NO_2^- + OH$	1.1×10^{-9}	**0**	**0**	**[15]**	**Rate coefficient is measured at 298K Uncertainty of measurement: 45%.**
NIR(49)	$OH^- + CO_2 + M \rightarrow HCO_3^- + M$	7.6×10^{-28}	**0**	**0**	**[15]**	**Rate coefficient is measured at 298K. Uncertainty of measurement: 30%.**
NIR(50)	$OH^- + HCl \rightarrow Cl^- + H_2O$	1×10^{-9}	**0**	**0**		**Rate coefficient estimated for 298K**
NIR(51)	$OH^- + H_2O + M \rightarrow OH^-(H_2O) + M$	2.5×10^{-28}	0	0	[15]	Rate coefficient is measured at 298K. Uncertainty of measurement: 50%.
NIR(52)	$OH^- + Cl \rightarrow Cl^- + OH$	1×10^{-10}	**0**	**0**		
NIR(53)	$OH^- + ClO \rightarrow ClO^- + OH$	1×10^{-10}	**0**	**0**		
NIR(54)	$CO_3^- + O \rightarrow O_2^- + CO_2$	1.1×10^{-10}	**0**	**0**	**[15]**	**Rate coefficient is measured at 298K. Uncertainty of measurement: 75%.**
NIR(55)	$CO_3^- + O_2 \rightarrow O_3^- + CO_2$	6×10^{-15}	**0**	**0**	**[33]**	**Value is only upper limit estimation.**
NIR(56)	$CO_3^- + H \rightarrow OH^- + CO_2$	1.7×10^{-10}	**0**	**0**	**[15]**	**Rate coefficient is measured at 298K. Uncertainty of measurement: 40%.**
NIR(57)	$CO_3^- + NO \rightarrow NO_2^- + CO_2$	1×10^{-10}	**0**	**0**	**[33]**	
NIR(58)	$CO_3^- + NO_2 \rightarrow NO_3^- + CO_2$	2×10^{-10}	**0**	**0**	**[15]**	**Rate coefficient is measured at 298K.**

NIR(59)	$CO_3^- + HCl \rightarrow Cl^- + OH + CO_2$	3×10^{-11}	0	0	[15]	Value is only upper limit estimation.
NIR(60)	$CO_3^- + H_2O + M \rightarrow CO_3^-(H_2O) + M$	1×10^{-28}	0	0	[15]	Rate coefficient is measured at 298K. Uncertainty of measurement: 50%.
NIR(61)	$CO_3^- + Cl \rightarrow Cl^- + CO_2 + O$	1×10^{-10}	0	0		
NIR(62)	$CO_3^- + Cl \rightarrow ClO^- + CO_2$	1×10^{-10}	0	0		
NIR(63)	$CO_3^- + ClO \rightarrow Cl^- + CO_2 + O_2$	1×10^{-11}	0	0		
NIR(64)	$CO_3^- + HNO_3 \rightarrow NO_3^- + CO_2 + OH$	3.5×10^{-10}	0	0		
NIR(65)	$CO_3^-(H_2O) + NO \rightarrow NO_2^- + H_2O + CO_2$	3.5×10^{-12}	0	0	[33]	
NIR(66)	$CO_3^-(H_2O) + NO_2 \rightarrow NO_3^- + H_2O + CO_2$	4×10^{-11}	0	0	[33]	
NIR(67)	$CO_3^-(H_2O) + H_2O + M \rightarrow CO_3^-(H_2O)_2 + M$	1×10^{-28}	0	0		Reaction not studied. Parameters are assumed to be equal to $CO_3^- + H_2O + M$.
NIR(68)	$CO_3^-(H_2O) + NO_2 \rightarrow NO_3^-(H_2O) + CO_2$	4×10^{-11}	0	0		
NIR(69)	$CO_3^-(H_2O) + NO \rightarrow NO_2^-(H_2O) + CO_2$	3.5×10^{-12}	0	0		
NIR(70)	$CO_3^-(H_2O) + M \rightarrow CO_3^- + H_2O + M$	7.2×10^{-4}	1.0	5.8×10^{4}		Temperature interval is uncertain.
NIR(71)	$CO_3^-(H_2O)_2 + M \rightarrow CO_3^-(H_2O) + H_2O + M$	6.5×10^{-3}	1.0	5.6×10^{4}		Temperature interval is uncertain.
NIR(72)	$CO_4^- + O_3 \rightarrow O_3^- + O_2 + CO_2$	1.3×10^{-10}	0	0	[15]	Rate coefficient is measured at 298K. Uncertainty of measurement: 75%.
NIR(73)	$CO_4^- + H \rightarrow CO_3^- + OH$	2.2×10^{-10}	0	0	[15]	Rate coefficient is measured at 298K. Uncertainty of measurement: 40%.
NIR(74)	$CO_4^- + O \rightarrow CO_3^- + O_2$	1.4×10^{-10}	0	0	[15]	Rate coefficient is measured at 298K. Uncertainty of measurement: 75%.
NIR(75)	$CO_4^- + NO \rightarrow NO_3^{*-} + CO_2$	4.8×10^{-11}	0	0	[15]	Rate coefficient is measured at 298K.
NIR(76)	$CO_4^- + H_2O \rightarrow O_2^-(H_2O) + CO_2$	2.5×10^{-10}	0	0		
NIR(77)	$CO_4^- + HCl \rightarrow Cl^- + HO_2 + CO_2$	1.2×10^{-9}	0	0	[15]	Rate coefficient is measured at 298K. Uncertainty of measurement: 30%.
NIR(78)	$CO_4^- + Cl \rightarrow Cl^- + O_2 + CO_2$	1×10^{-10}	0	0		
NIR(79)	$CO_4^- + ClO \rightarrow ClO^- + O_2 + CO_2$	1×10^{-10}	0	0		
NIR(80)	$NO_2^- + H \rightarrow OH^- + NO$	3×10^{-10}	0	0	[15]	Rate coefficient is measured at 298K. Uncertainty of measurement: 30%.
NIR(81)	$NO_2^- + NO_2 \rightarrow NO_3^- + NO$	2×10^{-13}	0	0	[15]	Value is only upper limit estimation.
NIR(82)	$NO_2^- + O_3 \rightarrow NO_3^- + O_2$	1.2×10^{-13}	0	0	[15]	Rate coefficient is measured at 298K. Uncertainty of measurement: 40%.
NIR(83)	$NO_2^- + HCl \rightarrow Cl^- + HNO_2$	1.4×10^{-9}	0	0	[15]	Rate coefficient is measured at 289K. Uncertainty of measurement: 30%.
NIR(84)	$NO_2^- + Cl \rightarrow Cl^- + NO_2$	1×10^{-10}	0	0		
NIR(85)	$NO_2^- + ClO \rightarrow Cl^- + NO_3$	1×10^{-10}	0	0		
NIR(86)	$NO_2^- + HNO_3 \rightarrow NO_3^- + HNO_2$	1.6×10^{-9}	0	0		
NIR(87)	$NO_2^- + H_2O + M \rightarrow NO_2^-(H_2O) + M$	1.6×10^{-28}	0	0	[15]	Rate coefficient is measured at 298K. Uncertainty of measurement: 50%.

NIR(88)	$NO_2^-(H_2O) + M \rightarrow NO_2^- + H_2O + M$	5.7×10^{-4}	1.0	6.3×10^{4}		Temperature interval is uncertain.
NIR(89)	$NO_3^- + O \rightarrow NO_2^- + O_2$	1×10^{-11}	0	0	[15]	Upper limit estimation for 298K.
NIR(90)	$NO_3^- + O_3 \rightarrow NO_2^- + 2O_2$	1×10^{-13}	0	0	[15]	Upper limit estimation for 298K.
NIR(91)	$NO_3^- + H_2O + M \rightarrow NO_3^-(H_2O) + M$	7.5×10^{-29}	0	0	[34]	Rate coefficient is measured at 300K.
NIR(92)	$NO_3^- + HCl \rightarrow Cl^- + HNO_3$	1×10^{-12}	0	0	[15]	Upper limit estimation for 298K.
NIR(93)	$NO_3^- + HCl + M \rightarrow NO_3^-(HCl) + M$	5.2×10^{-28}	-2.62	0	[35]	Rate coefficient is measured over the temperature range of 153-300K. Uncertainty of measurement: 30-50%
NIR(94)	$NO_3^- + HNO_3 + M \rightarrow NO_3^-(HNO_3) + M$	1.4×10^{-26}	0	0		
NIR(95)	$NO_3^-(H_2O) + M \rightarrow NO_3^- + H_2O + M$	1×10^{-3}	1.0	6.0×10^{4}	[4]	
NIR(96)	$NO_3^-(H_2O) + H_2O + M \rightarrow NO_3^-(H_2O)_2 + M$	1.6×10^{-28}	0	0		Reaction not studied. Parameters are assumed to be equal to $NO_3^- + H_2O + M$.
NIR(97)	$NO_3^-(H_2O) + N_2O_5 \rightarrow NO_3^-(HNO_3) + HNO_3$	7×10^{-10}	0	0		
NIR(98)	$NO_3^-(H_2O)_2 + M \rightarrow NO_3^-(H_2O) + H_2O + M$	1.5×10^{-2}	1.0	5.9×10^{4}		
NIR(99)	$NO_3^-(H_2O)_2 + N_2O_5 \rightarrow NO_3^-(HNO_3) + HNO_3 + H_2O$	7×10^{-10}	0	0		
NIR(100)	$NO_3^-(H_2O) + HNO_3 \rightarrow NO_3^-(HNO_3) + H_2O$	1.6×10^{-9}	0	0		
NIR(101)	$NO_3^-(HNO_3) + M \rightarrow NO_3^- + HNO_3 + M$	6×10^{-3}	1.0	1.0×10^{5}		
NIR(102)	$NO_3^-(HNO_3) + HNO_3 + M \rightarrow NO_3^-(HNO_3)_2 + M$	1×10^{-26}	0	0		
NIR(103)	$NO_3^-(HNO_3)_2 + M \rightarrow NO_3^-(HNO_3) + HNO_3 + M$	3.6×10^{1}	1.0	6.6×10^{4}		
NIR(104)	$NO_3^-(HCl) + HNO_3 \rightarrow NO_3^-(HNO_3) + HCl$	7.6×10^{-10}	0	0		
NIR(105)	$NO_3^{-*} + CO_2 \rightarrow CO_3^- + NO_2$	1×10^{-11}	0	0		
NIR(106)	$NO_3^{-*} + H \rightarrow NO_2^- + OH$	7.2×10^{-10}	0	0		
NIR(107)	$NO_3^{-*} + NO \rightarrow NO_2^- + NO_2$	1×10^{-12}	0	0		
NIR(108)	$NO_3^{-*} + HCl \rightarrow Cl^- + HNO_3$	1×10^{-12}	0	0		
NIR(109)	$NO_3^{-*} + Cl \rightarrow Cl^- + NO + O_2$	1×10^{-10}	0	0		
NIR(110)	$NO_3^{-*} + ClO \rightarrow Cl^- + NO_2 + O_2$	1×10^{-11}	0	0		
NIR(111)	$HCO_3^- + Cl \rightarrow Cl^- + OH + CO_2$	1×10^{-10}	0	0		
NIR(112)	$HCO_3^- + ClO \rightarrow Cl^- + HO_2 + CO_2$	1×10^{-9}	0	0		
NIR(113)	$Cl^- + NO_2 \rightarrow NO_2^- + Cl$	6×10^{-12}	0	0	[15]	Data is only upper limit estimation for 298K.
NIR(114)	$Cl^- + H_2O + M \rightarrow Cl^-(H_2O) + M$	2×10^{-29}	0	0	[15]	Data is only upper limit estimation for 298K.Uncertainty of measurement: 50%
NIR(115)	$Cl^- + HNO_3 \rightarrow NO_3^- + HCl$	2.8×10^{-9}	0	0		

NIR(116)	$Cl^- + CO_2 + M \rightarrow Cl^-(CO_2) + M$	4×10^{-29}	2.1	0	[4]	
NIR(117)	**$Cl^- + HCl + M \rightarrow Cl^-(HCl) + M$**	**1×10^{-27}**	**0**	**0**		
NIR(118)	**$Cl^-(H_2O) + M \rightarrow Cl^- + H_2O + M$**	**2×10^{-8}**	**0**	**5.4×10^{4}**	**[15]**	
NIR(119)	**$Cl^-(H_2O) + HCl \rightarrow Cl^-(HCl) + H_2O$**	**1.3×10^{-9}**	**0**	**0**	**[36]**	**Rate coefficient measured only at 298K.**
NIR(120)	$Cl^-(CO_2) + M \rightarrow Cl^- + CO_2 + M$	2.6×10^{-5}	3.0	3.3×10^{4}	[4]	
NIR(121)	**$Cl^-(HCl) + M \rightarrow Cl^- + HCl + M$**	**3.3×10^{-3}**	**1.0**	**9.9×10^{4}**		
NIR(122)	**$ClO^- + NO \rightarrow Cl^- + NO_2$**	**2.9×10^{-11}**	**0**	**0**		
NIR(123)	**$ClO^- + NO \rightarrow Cl + NO_2^-$**	**2.9×10^{-12}**	**0**	**0**		
NIR(124)	**$ClO^- + O \rightarrow Cl^- + O_2$**	**2×10^{-10}**	**0**	**0**		**Rate coefficient is measured at 298K.**
IIR[7]	$X^+ + Y^- \rightarrow$ Products	1×10^{-6}	0.5	0		Due to the lack of available data, the same values are estimated to all ion-ion reactions.

References

1. Turunen, E., H. Matveinen, J. Tolvanen, and H. Ranta, *D-region ion chemistry model*. Handbook of Ionospheric Models, ed. R.W. Schunk. 1996, Boulder, Colorado: SCOSTEP Secr.
2. Sheehan, C.H., St.-Maurice, J-P., *Dissociative recombination of N_2^+, O_2^+, and NO^+: rate coefficients for ground state and vibrationally excited ions.* J.Geophys.Res., 2004. **109**(3): p. 3302.
3. Petrignani, A., Andersson, P.U., Pettersson, J.B.C., Thomas, R.D., Hellberg, F., Ehlerding, A., Larsson, M., van der Zande, W.J., *Dissociative recombination of the weakly bound NO-dimer cation: cross sections and three-body dynamics.* J.Chem.Phys., 2005. **123**(19): p. 194306.
4. Pavlov, A.A., *Photochemistry of Ions at D-region Altitudes of the Ionosphere: A Review.* Surv.Geophys., 2014. **35**(2): p. 259-334.
5. Neau, A., Al Khalili, A., Rosen, S., Le Padellec, A., Derkatch, A.M., Shi, W., Vikor, L., Larsson, M., Semaniak, J., Thomas, R., Nagard, M.B., Andersson, K., Danared, H., af Ugglas, M., *Dissociative recombination of D_3O^+ and H_3O^+: absolute cross sections and branching ratios.* J.Chem.Phys., 2000. **113**(5): p. 1762–1770.
6. Öjekull, J., Andersson, P.U., Någård, M.B., Pettersson, J.B.C., Marković, N., Derkatch. A.M., Neau, A., Khalili, A.Al., Rosén, S., Larsson, M., Semaniak, J., Danared, H., Källberg, A., Österdahl, F., Ugglas, M. af., *Dissociative recombination of $H^+(H_2O)_3$ and $D^+(D_2O)_3$ water cluster ions with electrons: Cross sections and branching ratios.* J.Chem.Phys., 2007. **127**: p. 194301.
7. Öjekull, J., Andersson, P.U., Pettersson, J.B.C., Markovic´, N., Thomas, R.D., Al Khalili, A., Ehlerding, A., Österdahl, F., Af Ugglas, M., Larsson, M., Danared, H., Kallberg, A., *Dissociative recombination of water cluster ions with free electrons: Cross sections and branching ratios.* J.Chem.Phys., 2008. **128**(4): p. 044311.
8. Hierl, P.M., Paulson, J.F., *Translational energy dependence of cross sections for reactions of $OH^-(H_2O)_n$ with CO_2 and SO_2.* J.Chem.Phys., 1984. **80**(10): p. 4890–4900.
9. Böhringer, H., Arnold, F., *Temperature dependence of three-body association reactions from 45 to 400 K. The reactions $N_2^+ + 2N_2$ -> $N_4^+ + N_2$ and $O_2^+ + 2O_2$ -> $O_4^+ + O_2$.* J.Chem.Phys., 1982. **77**(11): p. 5534–5541.
10. Dheandhanoo, S., Johnsen, R., *Laboratory measurements of the association rate coefficients of NO^+, O_2^+, N^+, and N_2^+ ions with N_2 and CO_2 at temperatures between 100 K and 400 K.* Plan. Space Sci., 1983. **31**(8): p. 933-938.
11. Fehsenfeld, F.C., Howard, C.G., Harrop, W.J., Ferguson, E.E., *Laboratory measurements of the reactions of $NO^+(H_2O)$ with H and OH and their significance for D region ion chemistry.* J.Geophys.Res., 1975. **80**(16): p. 2229–2235.

12. Reid, G.C., *The production of water-cluster positive ions in the quiet daytime D region.* Plan. Space Sci., 1977. **25**(3): p. 275–290.
13. Fehsenfeld, F.C., Ferguson, E.E., *Recent laboratory measurements of D- and E-region ion-neutral reactions.* Radio Sci., 1972. **7**(1): p. 113-115.
14. Dotan, I., Davidson, J.A., Fehsenfeld, F.C., Albritton, D.L., *Reactions of O_2^+ and O_2 with CO_2, O_3, and CH_4 and O_2, O_3 with H_2O and CH_4 and their role in stratospheric ion chemistry.* J.Geophys.Res., 1978. **83**(8): p. 4036–4038.
15. Albritton, D.L., *Ion-neutral reaction-rate constants measured in flow reactors through 1977.* At Data Nucl. Data Tables, 1978. **21**(1): p. 1-89.
16. O'Keefe, A., Mauclaire, G., Parent, D., Bowers, M.T., *Product energy disposal in the reaction of $N^+(^3P)$ with $O_2(X^3R)$.* J.Chem.Phys., 1986. **84**(1): p. 215–219.
17. Viggiano, A.A., Knighton, W.B., Williams, S., Arnold, S.T., Midey, A.J., Dotan, I., *A reexamination of the temperature dependence of the reaction of N^+ with O_2.* Int. J. Mass Spectrom., 2003. **223-224**: p. 397–402.
18. Scott, G.B.I., Fairley, D.A., Freeman, C.G., McEwan, M.J., Anicich, V.G., *Gas-phase reactions of some positive ions with atomic and molecular nitrogen.* J.Chem.Phys., 1998. **109**(20): p. 9010–9014.
19. Eyet, N., Shuman, N.S., Viggiano, A.A., Troe, J., Relph, R.A., Steele, R.P., Johnson, M.A., *The importance of $NO^+(H_2O)_4$ in the conversion of $NO^+(H_2O)_n$ to $H_3O^+(H_2O)_n$: I. Kinetics measurements and statistical rate modeling.* J.Phys.Chem. A, 2011. **115**: p. 7582-7590.
20. Hamon, S., Speck, T., Mitchell, J.B.A., Rowe, B., Troe, J., *Experimental and modeling study of the ion-molecule association reaction $H_3O^+ + H_2O$ (+M) -> $H_5O_2^+$ (+M).* J.Chem.Phys., 2005. **123**(5): p. 054303.
21. Cunningham, A.J., Payzant, J.D., Kebarle, P., *Kinetic study of the proton hydrate $H^+(H_2O)_n$ equilibriums in the gas phase.* J.Am.Chem.Soc., 1972. **94**(22): p. 7627–7632.
22. Lau, Y.K., Ikuta, S., Kebarle, P., *Thermodynamics and kinetics of the gas-phase reactions $H_3O^+(H_2O)_{n-1}$ + water = $H_3O^+(H_2O)_n$.* J.Am.Chem.Soc., 1982. **104**(6): p. 1462-1469.
23. Howard, C.J., Rundle, H.W., Kaufman, F., *Water cluster formation rates of NO^+ in He, Ar, N_2 and O_2 at 296K.* J.Chem.Phys., 1972. **55**(10): p. 4772–4776.
24. Rakshit, A.B., Warneck, P., *A drift chamber study of the formation of water cluster ions in oxygen.* J.Chem.Phys., 1980. **73**(10): p. 5074–5080.
25. Böhringer, H., Fahey, D.W., Fehsenfeld, F.C., Ferguson, E.E. , *The role of ion-molecule reactions in the conversion of N_2O_5 to HNO_3 in the stratosphere.* Plan. Space Sci., 1983. **31**(2): p. 185-191.
26. Midey, A., Dotan, I., Viggiano, A.A., *Temperature dependences for the reactions of O^- and O_2^- with $O_2(a^1D_g)$ from 200 to 700 K.* J.Phys.Chem. A, 2008. **112**(14): p. 3040-3045.
27. Snuggs, R.M., Volz, D.J., Gatland, I.R., Schummers, J.H., Martin, D.W., McDaniel, E.W., *Ion-molecule reactions between O^- and O_2 at thermal energies and above.* Phys.Rev.A, 1971. **3**(1): p. 487-493.
28. Lifshitz, C., Tassa, R., *A study of the reaction $O^- + NO_2$ -> $O + NO_2^-$ in a pulsed ion source.* Int. J. Mass Spectrom. Ion Phys., 1973. **12**(5): p. 433-437.
29. Viggiano, A.A., Morris, R.A., Deakyne, C.A., Dale, F., Paulson, J.F., *Effects of hydration on reactions of oxide hydrate [$O^-(H_2O)_n$ (n = 0-2)]. 2. Reactions with hydrogen and deuterium.* J.Phys.Chem, 1991. **95**(9): p. 3644–3647.
30. Poutsma, J.C., Midey, A.J., Viggiano, A.A., *Absolute rate coefficients for the reactions of $O_2^- + N(^4S_{3/2})$ and $O_2^- + O(^3P)$ at 298 K in a selected-ion flow tube instrument.* J.Chem.Phys., 2006. **124**(7): p. 074301.
31. Aleksandrov, N.L., *Reviews of topical problems: three-body electron attachment to a molecule.* Soviet Phys. Uspekhi, 1988. **32**(2): p. 101-118.
32. Kossyi, I.A., Kostinsky, A.Yu., Matveyev, A.A., Silakov, V.P., *Kinetic scheme of the non-equilibrium discharge in nitrogen-oxygen mixture.* Plasma Sources Sci. Technol., 1992. **1**(3): p. 207-220.
33. Arnold, S.T., Morris, R.A., Viggiano, A.A., *Temperature dependencies of the reactions of $CO_3^-(H_2O)_{0,1}$ and O_3^- with NO and NO_2.* J.Chem.Phys., 1995. **103**(7): p. 2454–2458.
34. Payzant, J.D., Cunningham, A.J., Kebarle, P., *Kinetics and rate constants of reactions leading to hydration of NO_2^-, and NO_3^-, in gaseous oxygen, argon, and helium containing traces of water.* Can.J.Chem., 1972. **50**(14): p. 2230–2236.
35. Viggiano, A.A., *Three-body ion-molecule association rate coefficients as a function of temperature and cluster size: $NO_3^-(HNO_3)_n$ + HCl (+M) ->*

$NO_3^-(HNO_3)_n(HCl)$.J.Chem.Phys., 1984. **81**(6): p. 2639–2645.
36. Amelynck, C., Arijs, E., Schoon, N., Van Bavel, A-M., *Gas phase reactions of HNO_3 with Cl^-, $Cl^-(H_2O)$, and $Cl^-(HCl)$, of Cl_2 with $Cl^-(H_2O)$ and $Cl^-(HCl)$, and of HCl with $Cl^-(H_2O)$.* Int. J. Mass Spectrom., 1998. **181**(1-3): p. 113-121.

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[1] RPE: Recombination of positive ions with electrons
PIR: Positive ion reaction
NPD: Negative ion photodissociation
PDE: Photodetachment of electrons from negative ions
EDA: Electron detachment from negative ions
NIR: Negative ion reaction
IIR: Ion-ion reaction

[2] Rate coefficients are expressed in the form $k = A\ (300/T)^n\ (-E/RT)$

[3] Shaded reactions corresponds to the reactions in the reduced model.

[4] Units are in (cm^3 $molecule^{-1}$ $s^{-1})^{(m-1)}$ where *m* is the reaction order. For three body reactions the values are corrected for M=N_2 by a factor of (Molar mass of X / Molar mass of N_2 (28 g mol^{-1})) - X is reported third body.

[5] Units are in $Jmol^{-1}$

[6] All rate coefficients are taken from Turunen*et al.*, 1996 unless indicated.

[7] Ion-ion recombination reactions. X^+: positive ion, Y^-: negative ion, Products on the right hand side labels the sum of neutral products.