Table B – Organic Solutes in Aqueous Solutions

A record of reactions of Mu with organic solutes in water

This compilation is aimed at presenting data on reactions of muonioum and hydrogen atoms at ambient temperatures (293-298K) and normal pressure unless otherwise specified.

Code	Ion	Reaction	Type of Reaction	k_M (in $dm^3mol^{-1}s^{-1}$)	Notes about measurement	Reference	k_H (in $dm^3mol^{-1}s^{-1}$)	Notes about measurement	Reference	KIE = k_M / k_H
B1	Acetaldehyde	$CH_3CHO + Mu \rightarrow CH_3CH(OMu)$ $CH_3CHO + Mu \rightarrow MuH + CH_2CHO$	addition to C = O bond with Mu attached predominantly to O atom and abstraction of H	$(1.75 \pm 0.2) \times 10^8$	pH = 6 , 7	Stadlbauer, J.M., Venkateswaran, K. and Walker, D.C. *Can. J. Chem.,* 1997, **75**, 74.	3.1×10^7	N/A	www.rcdc.nd.edu/compilations/Hatom/H.HTM	5.6
B2	Acetone	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PNA**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PNA**
B3	Acetonitrile	$CH_3CN + Mu \rightarrow CH_3MuCN$?	addition to CN bond	5.1×10^7	N/A	Stadlbauer, J.M., Ng, B.W., Jean, Y.C. and Walker, D.C. *J. Phys. Chem.,* 1983, **87**, 841.	2.5×10^6 *(average of 3 values)*	N/A	www.rcdc.nd.edu/compilations/Hatom/H.HTM	20
B4	Acrylamide	$CH_2=CHCONH_2 + Mu \rightarrow MuCH_2CHCONH_2$	addition across the olefinic bond	**a)** $(1.90 \pm 0.13) \times 10^{10}$ **b)** MRMS*: $\approx 2 \times 10^{10}$ *in the CTAB micelles*	N/A	**a)** Stadlbauer, J.M. , Ng, B.W., Walker, D.C., Jean, Y.C. and Ito, Y. *Can. J. Chem.,* 1981, **59**, 3261. **b)** Barnabas, M.V. and Walker, D.C., *Can. J. Chem.* 1999, **69**, 1252.	$(7.5 \pm 1.0) 10^9$	N/A	Vojnarowits, L., at all (to be published)	2.5
B5	Acrylic acid	$CH_2 = CHCOOH + Mu \rightarrow MuCH_2–CHCOOH$	addition across the double bond	$(1.55 \pm 0.25) \times 10^{10}$	for unbuffered solution with appr. 64% solute dissociated	Stadlbauer, J.M. , Ng, B.W., Walker, D.C., Jean, Y.C. and Ito, Y. *Can. J. Chem.,* 1981, **59**, 3261.	3.3×10^9	N/A	www.rcdc.nd.edu/compilations/Hatom/H.HTM	4.7
B6	Acrylonitrile	$CH_2 = CHCN + Mu \rightarrow MuCH_2–CHCN$	addition across the double bond	$(1.14 \pm 0.2) \times 10^{10}$	N/A	Stadlbauer, J.M. , Ng, B.W., Walker, D.C., Jean, Y.C. and Ito, Y. *Can. J. Chem.,* 1981, **59**, 3261.	3.0×10^9 *(average of 2 values)*	N/A	www.rcdc.nd.edu/compilations/Hatom/H.HTM	3.8

B7	Adenine	Adenine + Mu → Mu-adenine adduct	addition	**a)** 2 x 10^9 **b)** MRMS*: ≈ 2 x 10^9 *in the CTAB micelles*	N/A	**a)** Barnabas, M.V. and Walker, D.C. *Can. J. Chem.,* 1991, **69**, 1252. **b)** Barnabas, M.V. and Walker, D.C., *Can. J. Chem.* 1999, **69**, 1252.	1 x 10^8	pH = 7.0	www.rcdc.nd.edu/compilations/Hatom/H.HTM	20
B8	Adenine 5 – monophosphate	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PNA**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PNA**
B9	Adenosine	Adenosine + Mu →?	addition	2 x 10^9	N/A	Barnabas, M.V. and Walker, D.C. *Can. J. Chem.,* 1991, **69**, 1252.	2.1 x 10^8	pH = 7	www.rcdc.nd.edu/compilations/Hatom/H.HTM	10
B10	Adenosine 5 – monophosphate	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PNA**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PNA**
B11	4-Aminobenzoic acid	**a)** ^+H_3N- C_6H_4COOH + Mu → ? **b)** H_2N- C_6H_4COOH+ Mu → ? **c)** H_2N- $C_6H_4COO^-$ + Mu → ?	predominantly addition at unsubstituted ring sites C(2) and C(3)	**a)** (1.3 ± 0.3) x 10^{10} **b)** (7 ± 3) x 10^9 **c)** (1.15 ± 0.25) x 10^{10}	**a)** pH = 1 – 2 **b)** pH ~ 4 **c)** pH ~ 10	Venkatesvaran, K., Stadlbauer, J.M., Wu, Z., Gillis, H.A. and Walker, D.C. *J. Phys. Chem.,* 1996, **100**, 3564. **And** Stadlbauer, J.M., Miyake, Y., Ng, B.W., Phillips, E.C. and Walker, D.C. *Radiat. Phys. Chem.,* 1986, **28**, 95.	unknown	N/A	N/A	N/A
B12	Aniline	**a)** $C_6H_5NH_3^+$ + Mu → $MuC_6H_5NH_3^+$ **b)** $C_6H_5NH_2$ + Mu → $MuC_6H_5NH_2$	addition into benzene ring with Mu located at ortho, meta and para to NH_2 substituents	**a)** (1.54 ± 0.4) x 10^{10} **b)** (9 ± 3) x 10^9	**a)** pH = 1 – 2 **b)** pH ≥ 4	**a) b)** Venkatesvaran, K., Stadlbauer, J.M., Wu, Z., Gillis, H.A. and Walker, D.C. *J. Phys. Chem.,* 1996, **100**, 3564.	●1.3 x 10^9 ○2.4 x 10^9	●pH = 3 ○pH 7.8 – 8.4	www.rcdc.nd.edu/compilations/Hatom/H.HTM	a) ● 12 at pH = 1-3 b) ○ 4 at pH > 4
B13	Ascorbic acid	Ascorbic acid + Mu → Mu adduct	addition	1.8 x 10^9	pH = 1.0	Percival, P.W., Roduner, E. and Fischer, H. in *Adv. Chem. Ser*. 1979, **175**, 335; ed. by H.J. Ache, ACS, Washington DC, 1979.	1.3 x 10^8 *(average of 2 values)*	N/A	www.rcdc.nd.edu/compilations/Hatom/H.HTM	14
B14	Benzene	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PNA**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PNA**

B15	Benzaldehyde	$C_6H_5CHO + Mu \rightarrow MuC_6H_5CHO$	addition to benzene ring	5.1×10^9	N/A	Stadlbauer, J.M., Ng, B.W., Ganti, R. and Walker, D.C. *J. Am. Chem. Soc.,* 1984, **106**, 3151.	1.4×10^9	N/A	www.rcdc.nd.edu/compilations/Hatom/H.HTM	3.6
B16	Benzoic acid	$C_6H_5COOH + Mu \rightarrow MuC_6H_5COOH$	addition into benzene ring with Mu in ortho, meta, para position to COOH solution	**a)** $(2.5 \pm 0.5) \times 10^{10}$ **b)** $(8 \pm 3) \times 10^9$ **c)** $(8 \pm 3) \times 10^9$	**a)** pH = 1- 2 **b)** pH ~ 7 *(natural)* **c)** pH ~ 10	**a) b) c)** Venkateswaran, K., Stadlbauer, J.M., Wu, Z., Gillis, H.A. and Walker, D.C. *J. Phys. Chem.,* 1996, **100**, 3569.	9.2×10^8	pH = 3	www.rcdc.nd.edu/compilations/Hatom/H.HTM	**a)** 27 at pH = 1-2 **b)** 8.7 at pH ~ 7 **c)** N/A
B17	Benzonitrile (cyanobenzene)	$C_6H_5CN + Mu \rightarrow MuC_6H_5CN$	addition to benzene ring	7.2×10^9	N/A	Stadlbauer, J.M., Ng, B.W., Ganti, R. and Walker, D.C. *J. Am. Chem. Soc.,* 1984, **106**, 3151.	6.8×10^8	N/A	www.rcdc.nd.edu/compilations/Hatom/H.HTM	10.5
B18	Benzophenone	$(C_6H_5)_2C = O + Mu \rightarrow MuC_6H_5C(=O)C_6H_5$	addition to benzene ring	2×10^{10}	N/A	Barnabas, M.V. and Walker, D.C. *Can. J. Chem.,* 1991, **69**, 1252.	6.1×10^9 *(average from two values 6.6×10^9 and 5.6×10^9)*	N/A	www.rcdc.nd.edu/compilations/Hatom/H.HTM	>> 3
B19	1,4-Benzoquinone	$C_6H_4O_2 + Mu \rightarrow ?$	addition into benzene ring and C=O bond (?)	**a)** 2.5×10^{10} **b)** MRMS*: 2.5×10^{10} *in the CTAB micelles*	N/A	**a)** Barnabas, M.V., Venkateswaran, K. and Walker, D.C. *Can. J. Chem.,* 1989, **67**, 120. **b)** Barnabas, M.V. and Walker, D.C., *Can. J. Chem.* 1999, **69**, 1252.	8.3×10^9	N/A	www.rcdc.nd.edu/compilations/Hatom/H.HTM	3.0
B20	Bromoacetic acid	$BrCH_2COOH + Mu \rightarrow MuBr + CH_2COOH$	bromine abstraction	1.5×10^9	pH= 1.0	Percival, P.W., Roduner, E. and Fischer, H. in *Adv. Chem. Ser*. 1979, **175**, 335; ed. by H.J. Ache, ACS, Washington DC, 1979.	3.3×10^8 *(average of 3 values)*	pH = 1.0	www.rcdc.nd.edu/compilations/Hatom/H.HTM	4.5
B21	2-Bromopropionic acid	$CH_3CHBrCOOH + Mu \rightarrow MuBr + CH_3CHCOOH$	bromine abstraction	4×10^9	pH = 1.0	Percival, P.W., Roduner, E. and Fischer, H. in *Adv. Chem. Ser*. 1979, **175**, 335; ed. by H.J. Ache, ACS, Washington DC, 1979.	1.4×10^9	N/A	www.rcdc.nd.edu/compilations/Hatom/H.HTM	2.9

B22	3-Bromopropionic acid	$BrCH_2CH_2COOH + Mu \rightarrow MuBr + CH_2CH_2COOH$	bromine abstraction	3×10^8	pH = 1.0	Percival, P.W., Roduner, E. and Fischer, H. in *Adv. Chem. Ser*. 1979, **175**, 335; ed. by H.J. Ache, ACS, Washington DC, 1979.	2.5×10^8	N/A	www.rcdc.nd.edu/compilations/Hatom/H.HTM	1.2
B23	2 - Butanol	$CH_3CH_2CH(OH)CH_3 + Mu \rightarrow MuH + CH_3CH_2C(OH)CH_3$	abstraction *(proposed by analogy to H atom reaction)*	1.1×10^6	N/A	Percival, P.W., Roduner, E. and Fischer, H. in *Adv. Chem. Ser*. 1979, **175**, 335; ed. by H.J. Ache, ACS, Washington DC, 1979.	1.0×10^8 *(average of 2 values)*	N/A	www.rcdc.nd.edu/compilations/Hatom/H.HTM	~ 0.01
B24	Butanone (methylethyl ketone)	$CH_3COCH_2CH_3 + Mu \rightarrow CH_3CO(Mu)CH_2CH_3$	addition to C = O bond with Mu attached to O atom	$(9.9 \pm 1.0) \times 10^7$	N/A	Stadlbauer, J.M., Venkatesvaran, K. and Walker, D.C. *Can. J. Chem.,* 1997, **75**, 74.	$(2.20 \pm 0.32) \times 10^7$	N/A	www.rcdc.nd.edu/compilations/Hatom/H.HTM	4.3
B25	Chloroacetate ion	$ClCH_2COO^- + Mu \rightarrow HMu + ClCHCOO^-$ $ClCH_2COO^- + Mu \rightarrow Cl^- + \mu^+ + CH_2COO^-$	H atom abstraction and 'dechlorination *(atom addition or electron transfer, followed by dissociation)*	9.1×10^5	pH = 5.5 *(99.8 % of anion form)*	Stadlbauer, J.M., Venkateswaran, K. and Walker, D.C. *Radiat. Phys. Chem.,* 1997, **50**, 259.	2.4×10^6	pH ~ 7	www.rcdc.nd.edu/compilations/Hatom/H.HTM	~ 0.4
B26	Chloroacetic acid	$ClCH_2COOH + Mu \rightarrow HMu + ClCHCOOH$ $ClCH_2COOH + Mu \rightarrow Cl^- + \mu^+ + CH_2COOH$	H atom abstraction and "dechlorination" *(atom addition or electron transfer, followed by dissociation)*	2.3×10^6	pH = 1.4 – 2 *(96.3 % of undissociated acid)*	Stadlbauer, J.M., Venkateswaran, K. and Walker, D.C. *Radiat. Phys. Chem.,* 1997, **50**, 259.	**a)** 2.6×10^5 **b)** 6.5×10^3	**a)** N/A **b)** pH = 0.4 – 2.0 *(33% Cl abstraction)*	**a)** Anbar, M. and Neta, P. *J. Chem. Soc. A.* 1967, 834. **b)** www.rcdc.nd.edu/compilations/Hatom/H.HTM	*Depending on k_H KIE varies from ~ 10 to 300* **a)** 8.8 **b)** 300 *(this might indicate different types of reactions for Mu and H)*
B27	4-Chlorobenzoic acid	$p–ClC_6H_4COOH + Mu \rightarrow p–ClC_6H_4(Mu)COOH$	addition of Mu into the benzene ring	8.5×10^9	N/A	Stadlbauer, J.M., Miyake, Y., Ng., B.W., Phillips, E.C. and Walker, D.C. *Radiat. Phys. Chem.,* 1986, **28**, 95.	1.1×10^9	N/A	www.rcdc.nd.edu/compilations/Hatom/H.HTM	7.6

B28	Cyanoacetate	$NCCH_2COO^-$ + Mu → $MuNCCH_2COO^-$	addition across cyanide bond	7.7×10^7	**pH** not given **E_a** = (35 ± 2) kJ mol^{-1} for T = 273 K to 353 **B =** 3.1×10^{11} $dm^3mol^{-1}s^{-1}$ *B – preexponential factor in the equation $ln(k_M/T^{1/2}) = lnB – E/RT$*	Stadlbauer, J.M., Ng, B.W., Jean, Y.C. and Walker, D.C. *J. Phys. Chem.,* 1983, **87**, 841.	2.9×10^6	for cyanoacetic acid at pH = 1.0	www.rcdc.nd.edu/compilations/Hatom/H.HTM	26
B29	Cyclodextrins (α or β) Cyclodextrin α - cyclohexaamylose Cyclodextrin β - cycloheptaamylose	Cyclodextrin + Mu → MuH + ?	H-abstraction	$(2 \pm 1) \times 10^7$	N/A	Jean, Y.C., Ng, B.W., Ito, Y., Nguyen, T.Q. and Walker, D.C. *Hyperfine Interact.,* 1981, **8**, 351.	Unknown	N/A	N/A	N/A
B30	Cyclohexanone	$C–(CH_2)_5C=O$ + Mu → $C–(CH_2)_5COMu$	addition to C=O bond with Mu attached to O atom	$(1.17 \pm 0.2) \times 10^8$	pH = 6-7	Stadlbauer, J.M., Venkatesvaran, K. and Walker, D.C. *Can. J. Chem.,* 1997, **75**, 74.	*unknown for cyclohexanone but determined for cyclopentanone:* $(4.91 \pm 0.28) \times 10^7$	N/A	Mezyk, S.P., Lossack, A. and Bartels, D.M. *Can. J. Chem.*, 1997, **75**, 1114.	assuming k_H for cyclopentanone ≈ k_H for cyclohexanone: KIE ≈ 2.5 *(with $k_M = 1.2 \times 10^8$ and $k_H = 4.9 \times 10^7$)*
B31	Cytosine	Cytosine + Mu → Mu cytosine adduct	addition to C(5) and C(6)	3×10^9	N/A	Barnabas, M.V., Venkateswaran, K. and Walker, D.C. *Can. J. Chem.,* 1989, **67**, 120.	9.2×10^7	pH = 7	www.rcdc.nd.edu/compilations/Hatom/H.HTM	≈ 30

B32	Cytosine 5-monophosphate (C5MP)	C5MP + Mu → Mu–C5MP adduct	addition to C(5) and C(6) by analogy to Mu reaction with cytosine	$(4.8 \pm 0.5) \times 10^9$	N/A	Bucci, S., Crippa, P.R., de Munari, G.M., Guidi, G., Manfredi, M., Tedeschi, R., Vecli, A. and Podini, P. *Hyperfine Interaction*, 1979, **6**, 425. Bucci, C. in *Muons and Pions in Material Research,* ed. J. Chappert and R.T. Gryszpan, Elsevier Science Publisher B.V. 1984.	9×10^7	N/A	Bucci, et al., *ibid*.	53
B33	Cysteine	$HS\text{-}CH_2CHNH_2COOH + Mu \rightarrow MuH + ?$ $HS\text{-}CH_2CH(NH_3^+)COOH + Mu \rightarrow MuH + ?$	H – atom abstraction (proposed)	6×10^9	N/A	Barnabas, M.V. and Walker, D.C. *Can. J. Chem.,* 1991, **69**, 1252.	1.8×10^{10}	pH = 6.0 for conjugated acid	www.rcdc.nd.edu/compilations/Hatom/H.HTM	3.3
B34	Dihydroxyfumaric acid	HOOCC(OH)=C(OH)COOH + Mu → HOOCMu(OH)–C(OH)COOH	addition across the olefinic bond	4.5×10^7	pH = 1.0	Percival, P.W., Roduner, E. and Fischer, H. in *Adv. Chem. Ser*. 1979, **175**, 335; ed. by H.J. Ache, ACS, Washington DC, 1979.	8×10^7	N/A	www.rcdc.nd.edu/compilations/Hatom/H.HTM	0.6
B35	2-Deoxy-D-ribose	PAGE NOT ARCHIVED	PAGE NOT ARCHIVED	PAGE NOT ARCHIVED	PAGE NOT ARCHIVED	PAGE NOT ARCHIVED	PNA	PAGE NOT ARCHIVED	PAGE NOT ARCHIVED	PNA
B36	DNA (from herring)	DNA + Mu → DNA Mu	Addition	$(4 \pm 1) \times 10^9$	N/A	Bucci, S., Crippa, P.R., de Munari, G.M., Guidi, G., Manfredi, M., Tedeschi, R., Vecli, A. and Podini, P. *Hyperfine Interaction*, 1979, **6**, 425. Bucci, C. in *Muons and Pions in Material Research,* ed. J. Chappert and R.T. Gryszpan, Elsevier Science Publisher B.V. 1984.	5×10^7	N/A	Bucci, C. et al., *ibid*.	80
B37	Dimethylthioformamide	PAGE NOT ARCHIVED	PAGE NOT ARCHIVED	PAGE NOT ARCHIVED	PAGE NOT ARCHIVED	PAGE NOT ARCHIVED	PNA	PAGE NOT ARCHIVED	PAGE NOT ARCHIVED	PNA

B38	Ethanol	$CH_3CH_2OH + Mu \rightarrow MuH + C_2H_4OH$ (C_2H_4OH mainly CH_3CHOH)	abstraction *(proposed by analogy to H atom reaction)*	$\leq$ 3 x 10^5	k_M derived from λ_0 in the pure alcohol assuming "concentration " of pure alcohol of 17.1M	Percival, P.W., Roduner, E. and Fischer, H. in *Adv. Chem. Ser*. 1979, **175**, 335; ed. by H.J. Ache, ACS, Washington DC, 1979.	(1.8 ± 0.06) x 10^7 *value recommended in RCDC:* k_H = 1.7 x 10^7	N/A	Mezyk, S.P. and Bartels, D.M. *J. Phys. Chem.,* 1997, **101**, 1329 -latest entry in www.rcdc.nd.edu/compilation/Hatom/H.HTM	< 0.015
B39	Ethylacetate	$CH_3COOC_2H_5 + Mu \rightarrow MuH + ?$	H abstraction	**a)** 1.5 x 10^7 **b)** 1.8 x 10^{10} *in the CTAB (?) micelles*	N/A	**a)** Venkateswaran, K., Barnabas, M.V., Stadlbauer, J.M. and Walker, D.C. *Can. J. Chem.,* 1990,**68**, 952. **b)** Venkateswaran, K., Barnabas, M.V., Stadlbauer, I.M. and Walker, D.C. *Can. J. Chem.* 1990, **68**, 952.	2.5 x 10^5	N/A	www.rcdc.nd.edu/compilations/Hatom/H.HTM	a) 60
B40	Ethylene	$H_2C = CH_2 + Mu \rightarrow MuH_2C–CH_2$	addition to olefinic bond	1.4 x 10^{10}	N/A	Jean, Y.C., Ganti, Cheng, K.L., Venkateswaran, K. and Walker, D.C. *Hyperfine Interact.,* 1986, **32**, 813.	3 x 10^9	N/A	www.rcdc.nd.edu/compilations/Hatom/H.HTM	5
B41	Ethylenediaminotetracetic acid (EDTA)	EDTA + Mu $\rightarrow$?	?	1.6 x 10^9	for sodium salt (value uncertain)	Byakov et al., *High Energy Chemistry*, 1995,**29**, 211.	6.0 x 10^7	for conjugated acid H_6EDTA^{2+}	www.rcdc.nd.edu/compilations/Hatom/H.HTM	25 (?)
B42	Ethyl formate	$HCOOC_2H_5 + Mu \rightarrow MuH + HCOOC_2H_4$	abstraction	1.5 x 10^7	N/A	Venkateswaran, K., Barnabas, M.V., Stadlbauer, J.M. and Walker, D.C. *Can. J. Phys.,* 1990, **68**, 952.	unknown	N/A	N/A	N/A

B43	Formate ion	$HCOO^- + Mu \rightarrow MuH + CO_2^{\bullet -}$	abstraction	**a)** 5.6×10^6 **b)** 4.8×10^6 **c)** 7.8×10^6 **Muonium Reactions at High Temperatures and Pressures (See ANNEX 1)**	**a)** pH = 7 $\log(A/dm^3mol^{-1}s^{-1}) = 11.92 \pm 0.15$ $E_a = (29.5 \pm 0.8)$ kJ mol^{-1} for T ~ 276 K to 376 K **b)** pH = natural (HCOONa) $A = 4.12 \times 10^{12}$ $dm^3mol^{-1}s^{-1}$ $E_a = (33 \pm 2)$ kJ mol^{-1} **c)** pH = 7	**a)** Lossack, A.M., Roduner, E. and Bartels, D.M. *Phys. Chem. Chem.Phys.,* 2001, **3**, 2031. **b)** Ng, B.W., Jean, Y.C., Ito, Y., Suzuki, T., Brewer, J.H., Fleming, D.G. and Walker, D.C. *J. Phys. Chem.*, 1981, **85**, 454. **c)** Pericval, P.W., Roduner, E. and Fischer, H. in Adv. Chem. Ser. 1979, 175, 335; ed. by H.J Ache, ACS, Washington DC, 1979.	**a)** $k(H + HCOO^-) = (1.91 \pm 0.08) \times 10^8$ **b)** 1.9×10^8 **c)** 1.24×10^8	**a)** pH = 7 $\log(A/dm^3mol^{-1}s^{-1}) = 11.89 \pm 0.08$ $E_a = (20.6 \pm 0.4)$ kJ mol^{-1} for T ~ 276 K to 376 K **b) & c)** N.A.	**a) & b**) All data for k_M, k_H and k_D from the paper by Lossack, A.M., Roduner, E. and Bartels, D.M. *Phys. Chem. Chem.Phys.,* 2001, **3**, 2031. **c)** www.rcdc.nd.edu/compilations/Hatom/H.HTM	**a)** $KIE_{M/H} = k_M / k_H = 0.03$ $KIE_{M/D} = 0.025$ $KIE_{H/D} = 0.9$ *With $k_H = 1.9 \times 10^8$ and $k_D = 2.2 \times 10^8$* **b)** 0.024 **c)** 0.06
B44	Formate – d_1 ion	$DCOO^- + Mu \rightarrow MuD + CO_2^-$	H-atom abstraction	**a)** $(3.4 \pm 0.3) \times 10^5$ **b)** 1.1×10^6	**a)** pH = 7 $\log(A/dm^3mol^{-1}s^{-1}) = 12.16 \pm 0.06$ $E_a = (37.8 \pm 0.9)$ kJ mol^{-1} for T ~ 276 K to 367 K **b)** pH = 7 $E_a = (39 \pm 3)$ kJ mol^{-1}	**a)** Lossack, A.M., Roduner, E. and Bartels, D.M. *Phys. Chem. Chem.Phys.,* 2001, **3**, 2031. **b)** Ng, B.W. Ph.D. Thesis, University of British Columbia, 1983.	**a)** **i)** $k(H + DCOO^-) = (3.5 \pm 0.3) \times 10^7$ **ii)** $k(D + DCOO^-) = (5.2 \pm 0.5) \times 10^7$ **b)** 3.5 x 10	**a)** **i)** pD = 7.0 $\log A(dm^3mol^{-1}s^{-1}) = 11.66 \pm 0.20$ $E_a = (22.5 \pm 1.0)$ kJ mol^{-1} for T ~ 276 K to 367 K ii) pD = 7.0 $\log A(dm^3mol^{-1}s^{-1}) = 11.66 \pm 0.20$ $E_a = (22.5 \pm 1.0)$ kJ mol^{-1} **b)** N/A	Lossack, A.M., Roduner, E. and Bartels, D.M. *Phys. Chem. Chem.Phys.,* 2001, **3**, 2031.	**a)** **i)** $KIE_{M/H} \sim 0.01$ **ii)** $KIE_{M/D} \sim 0.007$ $KIE_{H/D} = k_H / k_D \sim 0.7$ **b)** 0.03

B45	Formic acid	N/A	N/A	to be measured – probably < 10^5	N/A	N/A	**a)** 4.4 x 10^5 **b)** (4.2 ± 0.6) x 10^5	N/A	**a)** www.rcdc.nd.edu/compilations/Hatom/H.HTM **b)** Lossack, A.M., Bartels, D.M. and Roduner, E. *Res. Chem. Intermed.,* 2001, **27**, 475.	N/A
B46	Fumaric acid	HOOCC(H) = C(H)COOH + Mu → HOOCH(Mu)-C(H)COOH	addition across the olefinic bond	1.4 x 10^{10}	pH = 1.0	Percival, P.W., Roduner, E. and Fischer, H. in *Adv. Chem. Ser*. 1979, **175**, 335; ed. by H.J. Ache, ACS, Washington DC, 1979.	3.7 x 10^9	N/A	recent data from Vojnarowits at all (to be published)	≈ 4
B47	Guanine-5-monophosphate (G5MP)	G5MP + Mu → Mu G5MP	addition	(3.1 ± 0.5) x 10^9	N/A	Bucci, S., Crippa, P.R., de Munari, G.M., Guidi, G., Manfredi, M., Tedeschi, R., Vecli, A. and Podini, P. *Hyperfine Interaction*, 1979, **6**, 425. **and** Bucci, C. in *Muons and Pions in Material Research,* ed. J. Chappert and R.T. Gryszpan, Elsevier Science Publisher B.V. 1984.	unknown	N/A	N/A	N/A
B48	Hemin	Hemin + Mu → ?	proposed Fe^{3+} reduction and spin conversion	2.7 x 10^9	pH = 8.8	Jean, Y.C., Ng, B.W. and Walker, D.C. *Chem. Phys. Lett.,* 1980, **75, 561.**	unknown	N/A	N/A	N/A

B49	Histidine	Histidine + Mu → Mu – histidine adduct	addition	**a)** 2.5 x 10^9 **b)** 2.5 x 10^9 *in the CTAB micelles*	N/A	**a)** Barnabas, M.V. and Walker, D.C. *Can. J. Chem.,* 1991, **69**, 1252. **b)** Barnabas, M.V. and Walker, D.C., *Can. J. Chem.* 1999, **69**, 1252.	2.3 x 10^8	pH = 7.0	www.rcdc.nd.edu/compilations/HAtom/H.htm	10
B50	Hydroquinone	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PNA**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PNA**
B51	4-Hydroxybenzoic acid	p-$HOC_6H_4NO_2$ + Mu → p-$HOC_6H_4MuNO_2$	addition to ring	7.4 x 10^9	N/A	Stadlbauer, J.M., Miyake, Y., Ng., B.W., Phillips, E.C. and Walker, D.C. *Radiat. Phys. Chem.,* 1986, **28**, 95.	1.0 x 10^9 *(average of 2 values)*	N/A	www.rcdc.nd.edu/compilations/HAtom/H.htm	4
B52	Maleic acid	HOOCC(H) = C(H)COOH + Mu → HOOCCH(Mu)-C(H)COOH	addition to olefinic bond	**a)** (1.2 ± 0.1) x 10^{10} **b)** 1.4 x 10^{10} **c)** 1.1 x 10^{10}	**a)** pH = 3.5 – 4.5 **b)** pH = 1 **c)** pH = natural A = (2.3 ± 0.2) x 10^{13} $dm^3mol^{-1}s^{-1}$ E_a = (18.8 ± 1.7) kJ mol^{-1} for T = 276 K to 364 K	**a)** Percival, P.W., Roduner, E., Fischer, H., Camani, M., Gygax, F.N. and Schenck, A. *Chem. Phys. Lett.,* 1973, **47**, 11. **b)** Percival, P.W., Roduner, E. and Fischer, H. in *Adv. Chem. Ser*. 1979, **175**, 335; ed. by H.J. Ache, ACS, Washington DC, 1979. **c)** Ng, B.W., Jean, Y.C., Ito, Y., Suzuki, T., Brewer, J.H., Fleming, D.G. and Walker, D.C. *J. Phys. Chem.*, 1981, **85**, 454.	2.1 x 10^9	N/A	Vojnarowits, L., at all (to be published)	**a)** 5.7 **b)** N/A **c)** N/A
B53	Methanol	CH_3OH + Mu → MuH + CH_2OH	H abstraction	**a)** ≤ 3 x 10^4 **b)** N/A **c)** 3 x 10^4	**a)** k_M derived from I_0 in the pure alcohol assuming "concentration " of pure alcohol of 24.7M **b)** A = 2.5 x 10^9 $dm^3mol^{-1}s^{-1}$ E_a = 34.4 kJ mol^{-1}	**a)** Percival, P.W., Roduner, E. and Fischer, H.in *Adv. Chem. Ser*. 1979, **175**, 335; ed. by H.J. Ache, ACS, Washington DC, 1979. **b)** Roduner, E. and Fischer, H. *Hyperfine Interact,* 1979, **6**, 413. **c)** Ito, Y., Ng, B.W., Jean Y.C. and Walker, D.C. *Can. J. Chem.,* 1980, **58**, 2395.	●2.6 x 10^6 *(average of 2 values)* ○ recently: (2.84 ± 0.07) x 10^6	log(A/dm^3 $mol^{-1}s^{-1}$) = 11.64 ± 0.17 E_a = (29.4 ± 0.8) kJ mol^{-1} for T = 283 K to 359 K	● www.rcdc.nd.edu/compilations/HAtom/H.htm ○ Mezyk, S.P. and Bartels, D.M. *J. Phys. Chem.,* 1994, **98**, 10578.	○ » 0.001

B54	Methionine	$CH_3SCH_2CH_2C(H)(NH_2)$ –COOH + Mu → MuH + ?	H – atom abstraction	**a)** 1.4 x 10^7 **b)** MRMS*: 1.4 x 10^7 *in the SDDS micelles*	N/A	**a)** Barnabas, M.V. and Walker, D.C. *Can. J. Chem.,* 1991, **69**, 1252. **b)** Barnabas, M.V. and Walker, D.C., *Can. J. Chem.* 1999, **69**, 1252.	3.5 x 10^8	pH = 1.0 ie for conjugated acid	www.rcdc.nd.edu/compilations/HAtom/H.htm	0.04
B55	Methylcyanoacetate	$NCCH_2$-$COOCH_3$ + Mu → MuN = CCH_2-$COOCH_3$	addition across C ≡ N bond	1 x 10^8	N/A	Barnabas, M.V. and Walker, D.C. *Can. J. Chem.,* 1991, **69**, 1252.	unknown	N/A	N/A	N/A
B56	Methylmethacrylate	$H_2C=C(CH_3)COOCH_3$ + Mu → Mu $CH_2C(CH_3)COOCH_3$	addition across the olefinic bond	(9.5 ± 1.9) x 10^9	N/A	Stadlbauer, J.M. , Ng, B.W., Walker, D.C., Jean, Y.C. and Ito, Y. *Can. J. Chem.,* 1981, **59**, 3261.	7.2 x 10^8	N/A	www.rcdc.nd.edu/compilations/HAtom/H.htm	13
B57	6-Methyluracil	$CH_3C_4H_3N_2$ + Mu → $CH_3C_4H_3(Mu)N_2$	addition to C = C bond with Mu attached to C(5) and C(6) atoms	4 x 10^9	N/A	Barnabas, M.V., Venkateswaran, K., Stadlbauer, J.M., Wu, Z. and Walker, D.C. *J. Phys. Chem.,* 1991, **95**, 10204.	6 x 10^8	N/A	www.rcdc.nd.edu/compilations/HAtom/H.htm	6.5
B58	Naphthalene	$C_{10}H_8$ + Mu → $MuC_{10}H_8$	addition to aromatic ring	**a)** (1.3 ± 0.3) x 10^9 **b)** MRMS*: (0.8 ± 0.5) x 10^9 *in NaLS micelles*	N/A	**a)** Ng, B.W., Stadlbauer, J.M. and Walker, D.C. *J. Chem. Phys.,* 1981, **75**, 2879. **b)** Jean, Y.C., Ng, B.W., Stadlbauer, I.M. and Walker, D.C., *J. Chem. Phys.*, 1981, **75**,	3.4 x 10^9	N/A	www.rcdc.nd.edu/compilations/HAtom/H.htm	0.4
B59	Nitrobenzene	$C_6H_5NO_2$ + Mu → $MuC_6H_5NO_2$	addition to benzene ring	1.1 x 10^{10}	N/A	Stadlbauer, J.M., Ng, B.W., Ganti, R. and Walker, D.C. *J. Am. Chem. Soc.,* 1984, **106**, 3151	1.6 x 10^9 *(average of 2 values)*	N/A	www.rcdc.nd.edu/compilations/HAtom/H.htm	7

B60	3-Nitrobenzoic acid	m–$O_2NC_6H_4COOH$ + Mu → m–$O_2NC_6H_4$(Mu)COOH	addition of Mu into the benzene ring	1.1 x 10^{10}	N/A	Stadlbauer, J.M., Miyake, Y., Ng., B.W., Phillips, E.C. and Walker, D.C. *Radiat. Phys. Chem.,* 1986, **28**, 95.	unknown probably similar to k(H + p-nitrobenzoic acid) = 9.9 x 10^8	N/A	N/A	≈ 11
B61	4-Nitrobenzoic acid	p–$O_2NC_6H_4COOH$ + Mu → p–$O_2NC_6H_4$(Mu)COOH	addition of Mu into the benzene ring	1.25 x 10^{10}	N/A	Stadlbauer, J.M., Miyake, Y., Ng., B.W., Phillips, E.C. and Walker, D.C. *Radiat. Phys. Chem.,* 1986, **28**, 95.	9.9 x 10^8 *(average of 2 values)*	N/A	www.rcdc.nd.edu/compilations/HAtom/H.htm	12.6
B62	4-Nitrophenol	$O_2NC_6H_4OH$ + Mu → $O_2NMuC_6H_4OH$	addition to aromatic ring	8 x 10^9		Ng, B.W., Jean, Y.C., Ito, Y., Suzuki, T., Brewer, J.H., Fleming, D.G. and Walker, D.C. *J. Phys. Chem.*, 1981, **85**, 454.	unknown for nitrophenol but can be estimated as $k_H = (1.65 \pm 1) \times 10^9$ *(an average value of k (H + nitrobenzene) = 1.6 x 10^9 $dm^3mol^{-1}s^{-1}$ and k(H + phenol) – 1.7 x 10^9 $dm^3mol^{-1}s^{-1}$)*	N/A	www.rcdc.nd.edu/compilations/HAtom/H.htm	5.0
B63	Oxalic acid	HOOC–COOH + Mu → HOOCC(OMu)OH	addition to C=O of carboxylate group with Mu attached to an O atom	**a) i)** k_M^{obs} = (4.8 ±) x 10^8 **ii)** k_M^{obs} = (3.4 ± 0.3) x 10^8 **b) i)** k_M^{obs} = 2 x 10^9 **ii)** k_M = (5.6 ± 0.6) x 10^8	**a) i)** pH = 0.52 (ca. 83% $H_2C_2O_4$ and 17 % $HC_2O_4^-$) **ii)** pH = 1.0 (ca. 50 %) $H_2C_2O_4$ and 50 % $HC_2O_4^-$) **b) i)** pH =1.0 **ii)** for $H_2C_2O_4$ (value deduced)	**a)** Stadlbauer, J.M., Barnabas, M.V. and Walker, D.C. *J. Phys. Chem.A*, 1997, **101**, 2442. **b)** Barnabas, M.V. and Walker, D.C. *Can. J. Chem.,* 1991, **69**, 1252.	$k_{H(obs)}$ = 3.4 x 10^5 *(average of 2 values)*	pH=1.0	www.rcdc.nd.edu/compilations/HAtom/H.htm	**a) ii)** 1000 *KIE value indicate different routes for Mu and H atoms*

B64	Oxalate monoanion $HC_2O_4^-$	$^-OOCCOOH + Mu \rightarrow {}^-HOOCC(OMu)OH$	addition to C=O of carboxylate group with Mu attached to an O atom	$k_{M(obs)} = 6.8 \times 10^7$ $k_M = 7.1 \times 10^7$ *value deduced*	pH ≈ 3 (90 % $HC_2O_4^-$)	Stadlbauer, J.M., Barnabas, M.V. and Walker, D.C. *J. Phys. Chem.*, 1997, **101**, 2442.	Unknown at pH»3	pH ≈ 3	N/A	N/A
B65	Oxalate dianoanion $C_2O_4^{2-}$	$^-OOCCOO^- + Mu \rightarrow {}^-OOCC(OMu)O^-$	addition to C=O of carboxylate group with Mu attached to an O atom	$k_M^{obs} = 5.4 \times 10^6$	pH ≥ 7 (> 99 % $C_2O_4^{2-}$)	Stadlbauer, J.M., Barnabas, M.V. and Walker, D.C. *J. Phys. Chem.*, 1997, **101**, 2442.	$k_H^{obs} \leq 4 \times 10^4$	pH ≥ 7	www.rcdc.nd.edu/compilations/HAtom/H.htm	> 135
B66	Penicillamine	$HSC(CH_2)CH(H)NH_2C(=O)OH + Mu \rightarrow MuH + ?$	H – atom abstraction (proposed)	**a)** 4×10^9 **b)** MRMS*: 4×10^9 *in the CTAB micelles*	N/A	**a) & b)** Barnabas, M.V. and Walker, D.C., *Can. J. Chem.* 1999, **69**, 1252.	2.3×10^9	pH = 6.0	www.rcdc.nd.edu/compilations/HAtom/H.htm	»1.6
B67	3-Pentanone (diethyl ketone)	$CH_3C(=O)C_2H_5 + Mu \rightarrow CH_3C(OMu)C_2H_5$	addition to C=O bond with Mu attached to O atom	$(8.4 \pm 1.5) \times 10^7$	pH = 6-7	Stadlbauer, J.M., Venkatesvaran, K. and Walker, D.C. *Can. J. Chem.*, 1997, **75**, 74.	$(4.20 \pm 0.15) \times 10^7$	N/A	Mezyk, S.P., Lossack, A. and Bartels, D.M. *Can. J. Chem.*, 1997, **75**, 1114.	2.0
B68	Phenol	$C_6H_5OH + Mu \rightarrow MuC_6H_5OH$	addition to ring	**a)** 7×10^9 **b)** MRMS*: (1.4 ± 0.3) 10^9 *in the NaOSA micelles*	N/A	**a)** Jean, Y.C., Brewer, J.H., Fleming, D.G., Garner, D.M., Mikula, R.J., Vaz, L.C. and Walker, D.C. *Chem. Phys. Lett.*, 1978, 57, 293. **b)** Jean, Y.C., Ng, B.W., Stadlbauer, I.M. and Walker, D.C., *J. Chem. Phys.*, 1981, 75, 2879	1.7×10^9 *(average of 3 values)*	pH = 2 – 7	www.rcdc.nd.edu/compilations/HAtom/H.htm	4
B69	Poly - dT	PolydT + Mu → MuPolydT	addition	$(14.3 \pm 2) \times 10^9$	N/A	Bucci, S., Crippa, P.R., de Munari, G.M., Guidi, G., Manfredi, M., Tedeschi, R., Vecli, A. and Podini, P. *Hyperfine Interaction*, 1979, 6, 425. **and** Bucci, C. in *Muons and Pions in Material Research,* ed. J. Chappert and R.T. Gryszpan, Elsevier Science Publisher B.V. 1984.	unknown	N/A	N/A	N/A

B70	Propanol	$CH_3CH(OH) + Mu \rightarrow MuH + CH_3C(OH)CH_3$	abstraction of inner H atom	**a)** $\approx 7 \times 10^5$ **b)** 5×10^5 **c)** 1.3×10^6 **d)** MRMS*: $\approx 2.6 \times 10^{10}$ *in the CTAB micelles* $\approx 3.7 \times 10^{10}$ *in the pEO micelles* *Average*: $k_M^{av} = (1 \pm 0.3) \times 10^6$	**a)** pH = 7 **b)** N/A **c)** N/A	**a)** Percival, P.W., Roduner, E. and Fischer, H. in *Adv. Chem. Ser*. 1979, **175**, 335; ed. by H.J. Ache, ACS, Washington DC, 1979. **b)** Walker, D.C., Jean, Y.C. and Fleming, D.G. of *Phys. Chem.* 1979, 4534. **c)** Venkateswaran, K., Barnabas, M., Wu, Z. and Walker, D.C. *Radiat. Phys. Chem.,* 1988, **32**, 65. **d)** Venkatesvaran, K., Barnabas, M.V, Wu, Z., Stadlbauer, I.M., Ng, B.W. and Walker, D.C. *Can. J. Chem.* 1990, 68, 952. Venkateswaran, K., Barnabas, M.V., Stadlbauer, I.M. and Walker, D.C. *Radiat. Phys. Chem.,* 1988, 32, 65.	$(1.01 \pm 0.07) \times 10^8$	pH = 2 – 4.7 $\log(A/dm^3 mol^{-1}s^{-1}) = 11.86 \pm 0.05$ $E_a = (22.0 \pm 0.26)$ kJ $mol^{-1}$for T = 277 K to 354 K	Mezyk, S.P. and Bartels, D.M. *J. Phys. Chem. A.,* 1997, **101**, 1329.	0.01 *(with $k_M^{av} = 1 \times 10^6$ and $k_H = 1.01 \times 10^8$)*
B71	Protoporphyrin	Protoporphyrin + Mu → Mu-protoporphyrin adduct	proposed addition to peripherial double bond	$(6.0 \pm 0.5) \times 10^8$	N/A	Jean, Y.C., Ng, B.W. and Walker, D.C. *Chem. Phys. Lett.,* 1980, **75, 561.**	unknown	N/A	N/A	N/A
B72	Pyrazine (1,4-diazine)	$C_4H_4N_2 + Mu \rightarrow MuC_4H_4N_2$	addition to ring	$(7.7 \pm 0.5) \times 10^9$	N/A	Wu, Z., Stadlbauer, J.M. and Walker, D.C. *J. Am. Chem. Soc.,* 1992, **114**, 3988.	3.0×10^8	pH ~ 1 *(30 % of the solute have one of their N atoms protonated)*	www.rcdc.nd.edu/compilations/HAtom/H.htm	25

B73	Pyridazine (1,2-diazine)	$C_4H_4N_2$ + Mu → $MuC_4H_4N_2$	addition to ring	(5.0 ± 0.3) x 10^9	N/A	Wu, Z., Stadlbauer, J.M. and Walker, D.C. *J. Am. Chem. Soc.,* 1992, **114**, 3988.	2.7 x 10^8	pH ~ 1 *(~ 99 % solute have one of their N atoms protonated)*	www.rcdc.nd.edu/compilations/HAtom/H.htm	18.5
B74	Pyridine	C_5H_5N + Mu → MuC_5H_5N	addition to ring: at N (42%), C(ortho) position (28%), C(meta) position (30%)	**a)** (5.8 ± 0.4) x 10^9 **b)** (7.4 ± 0.5) x 10^9	**a)** pH ~ 7 **b)** pH = 1.2	Wu, Z., Stadlbauer, J.M. and Walker, D.C. *J. Am. Chem. Soc.,* 1992, **114**, 3988.	●7.8 x 10^8 ○ 4 x 10^8	●pH ~ 7 ○ pH ~ 1 *(~ 99 % of solute as $C_6H_5NH^+$)*	www.rcdc.nd.edu/compilations/HAtom/H.htm	**a)** ● 7.4 **b)** ○ 20
B75	Pyrimidine (1,3 diazine)	$C_4H_4N_2$ + Mu → $MuC_4H_4N_2$	addition to ring	(3.7 ± 0.2) x 10^9	N/A	Wu, Z., Stadlbauer, J.M. and Walker, D.C. *J. Am. Chem. Soc.,* 1992, **114**, 3988.	9.2 x 10^7	pH ~ 1 *(65 % of solute protonated at N atom)*	www.rcdc.nd.edu/compilations/HAtom/H.htm	» 40
B76	Pyruvic acid	CH_3-CO COOH+ Mu → CH_3-CO(Mu)COOH	addition to C = O bond	1 x 10^9	N/A	Barnabas, M.V. and Walker, D.C. *Can. J. Chem.,* 1991, **69**, 1252.	unknown	N/A	N/A	N/A
B77	Ribose	Ribose + Mu → MuH + ?	H atom abstraction proposed	**a)** 2 x 10^6 **b)** MRMS*: ≈ 1 x 10^8 *in the SDDS micelles*	N/A	**a)** Barnabas, M.V. and Walker, D.C.*Can. J. Chem.,* 1991, 69, 1252. **b)** Barnabas, M.V. and Walker, D.C., *Can. J. Chem.* 1999, 69, 1252.	5.1 x 10^7	N/A	www.rcdc.nd.edu/compilations/HAtom/H.htm	0.04
B78	Ribose 5-monophosphate	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PNA**	**PAGE NOT ARCHIVED**	**PAGE NOT ARCHIVED**	**PNA**

B79	Styrene	$C_6H_5CH=CH_2$ + Mu → $C_6H_5CH–CH_2Mu$ $C_6H_5CH=CH_2$ + Mu → (Mu) $C_6H_5CH=CH_2$	addition to side chain (predominantly) and into benzene ring	**a)** 2.0 x 10^{10} **b)** 9 x 10^9 **c)** MRMS*: 8 x 10^{10} *in the CTAB micelles*	N/A	**a)** Venkateswaran, K., Barnabas, M.V., Wu, Z., Stadlbauer, J.M., Ng, B.W. and Walker, D.C. *Chem. Phys.*, 1989, **137**, 239. **b)** Venkateswaran, K., Barnabas, M.V., Stadlbauer, J.M. and Walker, D.C. *Can. J. Chem.* 1990, **68**, 952. **c)** Venkateswaran, K., Barnabas, M.V., Stadlbauer, I.M. and Walker, D.C. *Can. J. Chem.* 1990, **68**, 952.	5.7 x 10^9	for addition to side chain	www.rcdc.nd.edu/compilations/HAtom/H.htm	2.5
B80	TEMPO – 2,2,6,6-tetramethyl-1-piperidynyloxy (free radical)	TEMPO + Mu → TEMPOMu TEMPO + Mu (↑↑) → TEMPO + Mu(↑↓)	combination and (?) spin exchange	(1.6 ± 0.3) x 10^{10}	N/A	Karolczak, S., Gillis, H.A., Porter, G.B. and Walker, D.C. *Can. J. Chem.*, 2003, **81**, 175	4.9 x 10^9	N/A	www.rcdc.nd.edu/compilations/HAtom/H.htm	3.7 ± 1.0
B81	TEMPO–OH-2,2,6,6-tetramethyl-4-hydroxy-1-piperidinyloxy (free radical)	TEMPO-OH + Mu → TEMPO-Mu TEMPO-OH + Mu () → TEMPO + Mu(↑↓)	combination and (?) spin exchange	(1.4 ± 0.3) x 10^{10}	N/A	Karolczak, S., Gillis, H.A., Porter, G.B. and Walker, D.C. *Can. J. Chem.*, 2003, **81**, 175	unknown	N/A	N/A	N/A
B82	Tetramethylthiourea	$[(CH_3)_2N]_2C=S$ + Mu → $[(CH_3)_2N]_2CSMu$	addition to C=S bond with Mu added to S atom	**a)** 4 x 10^{10} **b)** 3 x 10^9 **c)** MRMS*: 2 x 10^{10} *in the CTAB micelles*	**a)** pH = 7.0 **b)** pH = 1.0 **c)** N/A	**a)** Barnabas, M.V., Venkateswaran, K. and Walker, D.C. *Can. J. Chem.*, 1989, **67**, 120. **b)** Barnabas, M.V. and Walker, D.C. *Can. J. Chem.*, 1991, **69**, 1252. **c)** Barnabas, M.V. and Walker, D.C., *Can. J. Chem.* 1999, **69**, 1252.	unknown	N/A	N/A	N/A

B83	Thioacetamide	PAGE NOT ARCHIVED	PAGE NOT ARCHIVED	PAGE NOT ARCHIVED	PAGE NOT ARCHIVED	PAGE NOT ARCHIVED	PNA	PAGE NOT ARCHIVED	PAGE NOT ARCHIVED	PNA
B84	Thiourea	$(H_2N)_2C=S + Mu \rightarrow (H_2N)_2C(SMu)$	addition to C=S with Mu added to S atom	**a)** 5×10^7 **b)** 2×10^9 **c)** MRMS*: $\approx 8 \times 10^8$ *in the CTAB micelles* $\approx 5.6 \times 10^7$ *in the SOS micelles*	**a)** pH = 7.0 **b)** pH = 1.0 *(strong influence of pH)*	**a)** Barnabas, M.V., Venkateswaran, K. and Walker, D.C. *Can. J. Chem.,* **b)** Barnabas, M.V. and Walker, D.C. *Can. J. Chem.,* 1991, **69**, 1252. **c)** Barnabas, M.V. and Walker, D.C., *Can. J. Chem.* 1999, **69**, 1252.	6×10^9	N/A	www.rcdc.nd.edu/compilations/HAtom/H.htm	**a)** 0.008 **b)** 0.33
B85	Thiouracyl	$C_4H_4ON_2S + Mu \rightarrow C_4H_4ON_2SMu$	addition to C=S bond – formation of thiyl radical (Mu addition to C(2))	2×10^{10}	N/A	Barnabas, M.V. and Walker, D.C. *Can. J. Chem.,* 1991, **69**, 1252.	unknown	N/A	N/A	N/A
B86	Thymine(5-methyluracil)	Thymine + Mu → Mu + Thymine adduct	addition to C(5) and C(6)	**a)** 3×10^9 **b)** $[(8 \pm 1) \div (9.5 \pm 1.0)] \times 10^9$ **c)** MRMS*: 3×10^9 in the CTAB micelles	**a)** N/A **b)** rate constant dependent on the magnetic field applied **c)** N/A	**a)** Barnabas, M.V., Venkateswaran, K. and Walker, D.C. *Can. J. Chem.,* 1989, **67**, 120. **b)** Bucci, S., Crippa, P.R., de Munari, G.M., Guidi, G., Manfredi, M., Tedeschi, R., Vecli, A. and Podini, P. *Hyperfine Interaction*, 1979, **6**, 425. AND Bucci, C. in *Muons and Pions in Material Research,* ed. J. Chappert and R.T. Gryszpan, Elsevier Science Publisher B.V. 1984. **c)** Barnabas, M.V. and Walker, D.C., *Can. J. Chem.* 1999, **69**, 1252.	5.7×10^8 *(average of 2 values)*		www.rcdc.nd.edu/compilations/HAtom/H.htm	**a)** 5.3 **b)** » 15 *(with $k_M = 8.7 \times 10^9$)* **c)** N/A

B87	Thymine 5-monophosphate (T5MP)	Thymine-5-monophosphate + Mu → MuT5MP	addition to C(5) and C(6) in the ring	$(7 \pm 1) \times 10^9$ *(average of 2 values)*	N/A	Bucci, S., Crippa, P.R., de Munari, G.M., Guidi, G., Manfredi, M., Tedeschi, R., Vecli, A. and Podini, P. *Hyperfine Interaction*, 1979, **6**, 425. **and** Bucci, C. in *Muons and Pions in Material Research,* ed. J. Chappert and R.T. Gryszpan, Elsevier Science Publisher B.V. 1984.	2.3×10^8	N/A	Bucci, Et al., *ibid*.	30
B88	Uracil	Uracil + Mu → Mu adduct	addition to C=C bond with Mu at C(5) or C(6)	**a)** 6×10^9 **b)** 4.3×10^9 **c)** MRMS*: 6×10^9 *in the CTAB micelles*	**a)** pH = 7.0 **b)** pH = 1.0 **c)** N/A	**a)** Barnabas, M.V., Venkatsewaran,K and Walker, D.C. *Can. J. Chem.,* 1989, **67**, 120. **b)** Barnabas, M.V. and Walker, D.C. *Can. J. Chem.,* 1991, **69**, 1252. **c)** Barnabas, M.V. and Walker, D.C., *Can. J. Chem.* 1999, **69**, 1252.	3.8×10^8	N/A	www.rcdc.nd.edu/compilations/HAtom/H.htm	**a)** 16 **b)** 11
B89	Uracil 5-monophosphate (U5MP)	Uracil-5-monophosphate + Mu → MuU5MP adduct	addition to C(5) and C(6) in the ring	$(4.75 \pm 0.5) \times 10^9$	N/A	Bucci, S., Crippa, P.R., de Munari, G.M., Guidi, G., Manfredi, M., Tedeschi, R., Vecli, A. and Podini, P. *Hyperfine Interaction*, 1979, **6**, 425. **And** Bucci, C. in *Muons and Pions in Material Research,* ed. J. Chappert and R.T. Gryszpan, Elsevier Science Publisher B.V. 1984.	2.8×10^8	N/A	Bucci, et al., *ibid*.	≈ 17

B90	Valine	$(CH_3)_2CH–C(H)(NH_2)–C(=O)OH + Mu \rightarrow MuH + ?$	H abstraction proposed	**a)** 5×10^6 **b)** MRMS*: $\approx 10^8$ *in the CTAB micelles* $\approx 5 \times 10^7$ *in the SOS micelles*	**a)** Barnabas, M.V. and Walker, D.C. *Can. J. Chem.,* 1991, **69**, 1252. **b)** Barnabas, M.V. and Walker, D.C., *Can. J. Chem.* 1999, **69**, 1252.	1.2×10^7	pH = 7.0	www.rcdc.nd.edu/compilations/HAtom/H.htm	0.4

* MRMS = Muonium reactions in the micellar systems

ANNEX 1: Formate ion - Muonium reactions at high temperatures and pressures

Source: Ghandi,K., Addison-Jones,B., Brodovitch, McKenzie,I., Kecman,S. and Percival,P.W.. Physica B ,2003, 326,55

T/℃	*P/bar*	k_{Mu} */10^{9} M^{-1} s^{-1}*
290	390	11.9(13)
290	346	12.0(13)
292	399	14.0(14)
292	361	10.2(10)
292	329	12.1(15)
292	280	11.8(10)
292	255	9.2(10)
274	235	7.17(71)
286	225	7.3(11)
293	306	13.8(22)
325	219	15.6(14)
360	310	23.5(24)
360	235	18.1(12)
67	1	0.09(4)
185.3	235	0.45(7)
202.3	235	0.67(9)
223.8	243	1.08(9)
247	231	1.72(17)
290	240	6.8(10)
362	252	14.2(24)
382	255	1.76(13)
392	246	1.49(24)
402	255	1.85(24)
380	230	1.55(21)
380	240	0.80(13)
375	240	0.76(9)
360	226	4.81(91)
360	243	14.5(11)
360	260	20.8(13)
360	272	18.4(10)

360	311	23.9(13)
360	323	25.5(14)
360	302	24.1(13)
360	297	22.8(17)
360	296	22.5(19)
360	293	21.5(18)
360	282	18.3(13)
360	343	29.6(19)
360	378	27.9(21)
360	399	35.1(18)
360	254	12.84(94)
360	237	6.21(89)
385	311	10.2(10)
385	332	16.0(11)
385	285	8.5(11)
37	1.5	0.01(1)
107	257	0.07(2)
127	242	0.12(2)
147	240	0.21(3)
147	390	0.19(2)