

Supporting Information

Hydration Free Energies of Multifunctional Nitroaromatic Compounds

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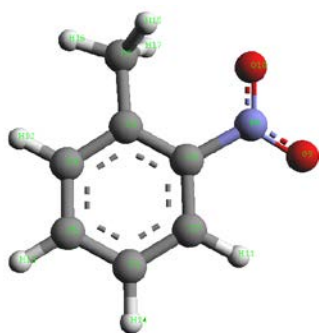
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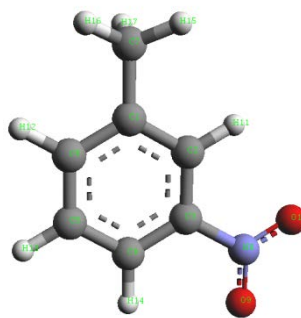
I. Nitroaromatic Compounds Studied Here

[Table ST1](#) List of the energetic compounds (ECs) studied here.

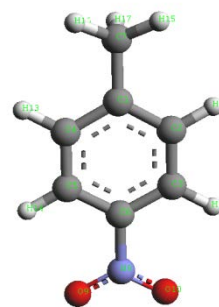
Nitroaromatic Compound		Formula	CAS	Molecular Weight (g/mol)
Name	Abbreviated Form			
2-Nitrotoluene	2-NT	C ₇ H ₇ NO ₂	88-72-2	137.14
3-Nitrotoluene	3-NT	C ₇ H ₇ NO ₂	99-08-1	137.14
4-Nitrotoluene	4-NT	C ₇ H ₇ NO ₂	99-99-0	137.14
2,3-Dinitrotoluene	2,3-DNT	C ₇ H ₆ N ₂ O ₄	602-01-7	182.14
2,4-Dinitrotoluene	2,4-DNT	C ₇ H ₆ N ₂ O ₄	121-14-2	182.14
2,6-Dinitrotoluene	2,6-DNT	C ₇ H ₆ N ₂ O ₄	606-20-2	182.14
3,4-Dinitrotoluene	3,4-DNT	C ₇ H ₆ N ₂ O ₄	610-39-9	182.14
2,4,6-Trinitrotoluene	2,4,6-TNT	C ₇ H ₅ N ₃ O ₆	118-96-7	227.13
1,3,5-Trinitrobenzene	1,3,5-TNB	C ₆ H ₃ N ₃ O ₆	99-35-4	213.11



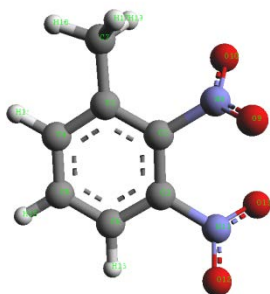
2-Nitrotoluene (2-NT)



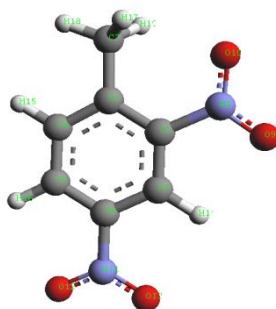
3-Nitrotoluene (3-NT)



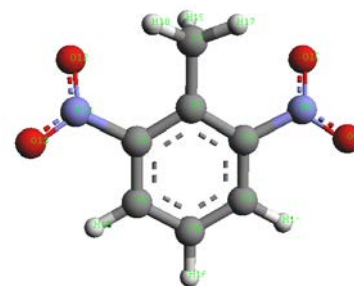
4-Nitrotoluene (4-NT)



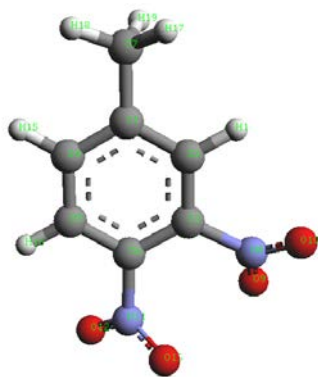
2,3-Dinitrotoluene (2,3-DNT)



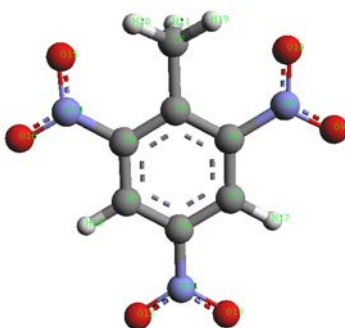
2,4-Dinitrotoluene (2,4-DNT)



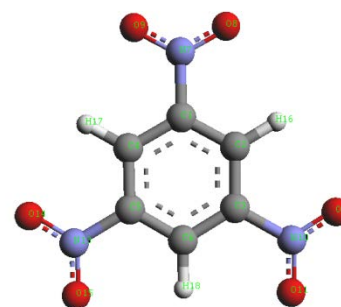
2,6-Dinitrotoluene (2,6-DNT)



3,4-Dinitrotoluene (3,4-DNT)



2,4,6-Trinitrotoluene
(2,4, 6-TNT)



1,3,5-Trinitrobenzene
(1,3,5-TNB)

Figure SF1: Molecular structures of Nitroaromatic compounds (NACs) studied here.

II. Experimental Solvation Free Energy Data

Table ST2 Experimental solvation free energies of nitroaromatic compounds (NACs) in water at room temperature calculated from measured solubilities of NACs in water and vapor pressures, and Henry's law constants as discussed in the paper.

Compound	Solvation Free Energy in Water (kcal/mol)	Tables of Experimental Data Source	
		Solubility in Water and Vapor Pressure	Henry's Law Constant
2-NT	-3.68 ± 0.07	ST6	ST7
3-NT	-3.45 ± 0.0	ST8	ST9
4-NT	-4.16 ± 0.58	ST10	ST11
2,3-DNT	-6.37 ± 0.11	ST12	---
2,4-DNT	-6.77 ± 0.14	ST13	ST14
2,6-DNT	-6.14 ± 0.10	ST15	ST16
3,4-DNT	-6.75 ± 0.17	ST17	---
2,4,6-TNT	-8.43 ± 0.27	ST18	ST19
1,3,5-TNB	-9.49 ± 0.22	ST20	ST21

III. Solvation Free Energy Calculation using Abraham LSER Method

Table ST3 Abraham¹ LSER (Linear Solvation Energy Relationships) descriptors from Prak et al.,² West et al.,³ Abraham and Acree,⁴ and calculated all using *Absolve* module of ADME Boxes⁵ by PharmaAlgorithms. Then equations (26) and (27) of Ref. 1 were used to calculate the L descriptors.

Compound	E	S	A	B	L
2-NT	0.866	1.11	0	0.28	4.866
3-NT	0.874	1.10	0	0.25	4.868
4-NT	0.870	1.11	0	0.28	4.871
2,3-DNT	1.150	1.58	0	0.49	6.266
2,4-DNT	1.150	1.70	0	0.40	6.294
2,6-DNT	1.150	1.60	0	0.45	6.287
3,4-DNT	1.120	1.77	0	0.31	6.417
2,4,6-TNT	1.430	2.23	0	0.61	7.835
1,3,5-TNB	1.430	2.42	0	0.55	7.513

IV. Fitting Statistics of Figures 2

Table ST4 Overall statistics for hydration free energies obtained from simulations compared to experimental data.

Force-Field/(Charge + Water)	AUE (kcal/mol)	RMSE (kcal/mol)	Correlation with Experiment		
			R^2	Slope	Intercept
CGenFF/(CHELPG+TIP3P)	0.56	0.63	0.97	1.17 ± 0.07	0.63 ± 0.46
TraPPE/(CHELPG+TIP3P)	0.61	0.76	0.91	1.13 ± 0.14	0.86 ± 0.89
OPLS-AA/(CHELPG+TIP3P)	0.68	0.88	0.96	1.29 ± 0.10	1.31 ± 0.65
GAFF/(CHELPG+TIP3P)	1.06	1.33	0.98	1.44 ± 0.08	1.81 ± 0.53
CGenFF/(CM4+TIP3P)	0.56	0.83	0.87	1.04 ± 0.15	-0.04 ± 0.96
TraPPE/(CM4+TIP3P)	0.58	0.67	0.92	0.94 ± 0.10	0.03 ± 0.66
OPLS-AA/(CM4+TIP3P)	0.72	1.02	0.89	1.16 ± 0.15	0.44 ± 0.97
GAFF/(CM4+TIP3P)	1.38	1.72	0.95	1.42 ± 0.13	1.19 ± 0.83
TraPPE/(RESP+TIP3P)	1.70	2.24	0.88	1.51 ± 0.21	1.41 ± 1.33
CGenFF/(RESP+TIP3P)	2.28	2.42	0.98	1.38 ± 0.07	0.04 ± 0.46
OPLS-AA/(RESP+TIP3P)	2.34	2.58	0.97	1.49 ± 0.10	0.64 ± 0.66
GAFF/(RESP+TIP3P)	3.15	3.5	0.97	1.72 ± 0.12	1.25 ± 0.75
CGenFF/(CHELPG+SPC-Fw)	0.62	0.73	0.97	1.20 ± 0.08	0.75 ± 0.50
OPLS-AA/(Default Charge+TIP3P)	1.25	1.28	0.95	1.45 ± 0.13	3.41 ± 0.83
CGenFF/(ParamChem Charge+TIP3P)	1.97	1.59	0.97	1.96 ± 0.14	4.32 ± 0.87
GAFF/(AM1-BCC+TIP3P)	1.85	2.17	0.85	0.45 ± 0.07	-1.54 ± 0.46
Abraham LSER method	0.59	0.75	0.97	1.20 ± 0.09	0.79 ± 0.55
Implicit Solvation Model (SM6 of Minnesota Group) (mPW1PW91/MIDI!6D)	0.50	0.53	0.94	0.91 ± 0.09	-0.35 ± 0.57

Table ST5 Statistics for hydration free energies obtained from simulations compared to experimental data based on the number of nitro groups present in the molecules.

Force-Field/(Charge + Water)	One NO ₂ groups		Two NO ₂ groups		Three NO ₂ groups	
	AUE (kcal/mol)	RMSE (kcal/mol)	AUE (kcal/mol)	RMSE (kcal/mol)	AUE (kcal/mol)	RMSE (kcal/mol)
TraPPE/(CHELPG+TIP3P)	0.31	0.36	0.77	0.84	0.72	1.00
OPLS-AA/(CHELPG+TIP3P)	0.33	0.39	0.59	0.75	1.38	1.47
CGenFF/(CHELPG+TIP3P)	0.29	0.33	0.65	0.69	0.77	0.83
GAFF/(CHELPG+TIP3P)	0.30	0.31	0.99	1.03	2.37	2.38
CGenFF/(CM4+TIP3P)	0.29	0.29	0.92	1.20	0.23	0.30
TraPPE/(CM4+TIP3P)	0.53	0.57	0.38	0.45	1.04	1.07
OPLS-AA/(CM4+TIP3P)	0.29	0.30	1.20	1.47	0.40	0.44
GAFF/(CM4+TIP3P)	0.23	0.29	1.85	2.05	2.15	2.18
TraPPE/(RESP+TIP3P)	0.74	0.79	1.33	1.78	3.88	3.91
CGenFF/(RESP+TIP3P)	1.32	1.37	2.40	2.41	3.46	3.47
OPLS-AA/(RESP+TIP3P)	1.20	1.26	2.37	2.40	4.01	4.02
GAFF/(RESP+TIP3P)	1.57	1.60	3.08	3.11	5.65	5.65
CGenFF/(CHELPG+SPC-Fw)	0.30	0.34	0.68	0.72	0.99	1.08
OPLS-AA/(Default Charge+TIP3P)	1.37	1.39	1.08	1.12	1.39	1.40
CGenFF/(ParamChem Charge+TIP3P)	0.57	0.57	1.56	1.56	4.88	4.88
GAFF/(AM1-BCC+TIP3P)	0.77	0.84	1.72	1.75	3.72	3.76
Abraham LSER method	0.23	0.23	0.47	0.50	1.36	1.39
Implicit Solvation Model (SM6 of Minnesota Group) (mPW1PW91/MIDI!6D)	0.28	0.29	0.58	0.59	0.65	0.66

V. Details of Experimental Data Collections

Table ST6 Solvation free energy of 2-nitrotoluene (2-NT) in water calculated from experimental solubility and vapor pressure data.

Calculation No.	Solvation Free Energy (kcal/mol)	Solubility (g/L)	Vapor Pressure (mmHg)	Experimental Data		Comment
				Solubility Data Source	Vapor pressure Data Source	
1	-3.78	0.649	0.15	6	7-9	(i)Solubility data calculated at room temperature from the linear fit using $S_w[\text{g/L}] = 0.00808 \times T[\text{K}] - 1.75837$ from the data at temperatures 283.15, 293.15, 303.15, and 313.15 K (for fit and experimental see Figure SF2). (ii) Extrapolated vapor pressure data reported in ref. 7 and collected from refs. 8 and 9.
2	-3.76	0.632	0.15	10	7-9	(i)Solubility calculated at room temperature from the exponential fit [Eq.(3) of Ref. 10] $S_w[\text{mg/L}] = 15.7 \times \exp(0.0124 \times T[\text{K}])$ of ref. 10 and converted to g/L. (ii) Extrapolated vapor pressure data reported in ref. 7 and collected from refs. 8 and 9.
3	-3.77	0.646	0.15	11	7-9	(i)Solubility reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006). (ii) Extrapolated vapor pressure data reported in ref. 7 and collected from refs. 8 and 9.
4	-3.64	0.649	0.188	6	14, 15	(i)Solubility data calculated at room temperature from the linear fit using $S_w[\text{g/L}] = 0.00808 \times T[\text{K}] - 1.75837$ from the data at temperatures 283.15, 293.15, 303.15, and 313.15 K (for fit and experimental see Figure SF2). (ii)Extrapolated vapor pressure data reported in ref. 14 and calculated using the data from ref. 15.
5	-3.63	0.632	0.188	10	14, 15	(i)Solubility calculated at room temperature from the exponential fit [Eq.(3) of ref. 10] $S_w[\text{mg/L}] = 15.7 \times \exp(0.0124 \times T[\text{K}])$ of ref. 10 and converted to g/L. (ii)Extrapolated vapor pressure data reported in ref. 14 and calculated using the data from ref. 15.
6	-3.64	0.646	0.188	11	14, 15	(i)Solubility reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006). (ii)Extrapolated vapor pressure data reported in ref. 14 and calculated using the data from ref. 15.

Table ST7 Solvation free energy of 2-nitrotoluene (2-NT) in water calculated from the Henry's Law Constant

Calculation No.	Solvation Free Energy (kcal/mol)	Henry's Law Constant (atm·m ³ /mol)	Dimensionless HLC	Experimental Data Source	Comment
1	-4.49	1.25×10 ⁻⁵	5.11×10 ⁻⁴	14, 16	The original data from ref. 16 and also reported in ref. 14 .
2	-4.49	1.26×10 ⁻⁵	5.15×10 ⁻⁴	11, 12	Henry's Law Constant data reported in ref. 11 and claimed to be collected from EPI ¹² Suite™ database and NIST ¹³ Chemistry Webbook (2006).

Table ST8 Solvation free energy of 3-nitrotoluene (3-NT) in water calculated from experimental solubility and vapor pressure data.

Calculation No.	Solvation Free Energy (kcal/mol)	Solubility (g/L)	Vapor Pressure (mmHg)	Experimental Data		Comment
				Solubility Data Source	Vapor pressure Data Source	
1	-3.45	0.509	0.205	10	14,15	(i)Solubility data calculated at room temperature from the exponential fit [Eq.(3) of ref. 10] $S_w[\text{mg/L}] = 36.4 \times \exp(0.00885 \times T[\text{K}])$ of ref. 10 and converted to g/L. (ii)Vapor pressure reported in ref. 14 from the extrapolated data of ref. 15 .
2	-3.44	0.509	0.205	6	14,15	(i) Solubility data calculated at room temperature from the linear fit using $S_w[\text{g/L}] = 0.00388 \times T[\text{K}] - 0.64682$ from the data of ref. 6 at temperatures 283.15, 293.15, 303.15, and 313.15 K (for fit and experimental data see Figure SF3). (ii)Vapor pressure reported in ref. 14 from the extrapolated data of ref. 15 .

Table ST9 Solvation free energy of 3-nitrotoluene (3-NT) in water calculated from the Henry's Law Constant

Calculation No.	Solvation Free Energy (kcal/mol)	Henry's Law Constant (atm-m ³ /mol)	Dimensionless HLC	Experimental Data Source	Comment
1	-4.67	9.30×10 ⁻⁶	3.80×10 ⁻⁴	14, 16	The original data from ref. 16 and also reported in ref. 14.

Table ST10 Solvation free energy of 4-nitrotoluene (4-NT) in water calculated from experimental solubility and vapor pressure data.

Calculation No.	Solvation Free Energy (kcal/mol)	Solubility (g/L)	Vapor Pressure (mmHg)	Experimental Data		Comment
				Solubility Data Source	Vapor pressure Data Source	
1	-4.04	0.279	0.041	6	7-9	(i)Solubility calculated at room temperature from the exponential fit using $S_w[\text{g/L}] = (7.91 \times 10^{-4}) \times \exp(-T[\text{K}]/-48.30) - 0.099$ from the experimental data of ref. 6 at temperatures 283.15, 293.15, 303.15, and 313.15 K (for fit and experimental data see Figure SF4). (ii)Vapor pressure reported in ref. 7 and collected from refs. 8 and 9.
3	-4.20	0.362	0.041	17	7-9	(i)Solubility calculated at room temperature from the exponential fit [eqn. (3) of ref. 17] $S_w[\text{mg/L}] = 0.0352 \times \exp(0.031 \times T[\text{K}])$ of Ref. 17. (ii)Vapor pressure reported in ref. 7 and collected from refs. 8 and 9.
4	-4.32	0.447	0.041	11,12	7-9	(i)Solubility reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006). (ii)Vapor pressure reported in ref. 7 and collected from refs. 8 and 9.
5	-3.22	0.279	0.164	6	11,12	(i)Solubility calculated at room temperature from the exponential fit using $S_w[\text{g/L}] = (7.91 \times 10^{-4}) \times \exp(-T[\text{K}]/-48.30) - 0.099$ from the experimental

						data of ref. 6 at temperatures 283.15, 293.15, 303.15, and 313.15 K (for fit and experimental data see Figure SF4).
						(ii) Vapor pressure reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006).
6	-3.38	0.362	0.164	17	11,12	(i) Solubility calculated at room temperature from the exponential fit [eqn. (3) of ref. 17] $S_w[\text{mg/L}] = 0.0352 \times \exp(0.031 \times T[\text{K}])$ of Ref. 17. (ii) Vapor pressure reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006).
7	-3.50	0.447	0.164	11, 12	11, 12	(i) Solubility reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006). (ii) Vapor pressure reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006).
8	-4.61	0.279	0.016	6	14, 18	(i) Solubility calculated at room temperature from the exponential fit using $S_w[\text{g/L}] = (7.91 \times 10^{-4}) \times \exp(-T[\text{K}]/-48.30) - 0.099$ from the experimental data of ref. 6 at temperatures 283.15, 293.15, 303.15, and 313.15 K (for fit and experimental data see Figure SF4). (ii) Vapor pressure reported in ref. 14 from the extrapolated data of ref. 18 .
9	-4.77	0.362	0.016	17	14, 18	(i) Solubility calculated at room temperature from the exponential fit [eqn. (3) of ref. 17] $S_w[\text{mg/L}] = 0.0352 \times \exp(0.031 \times T[\text{K}])$ of Ref. 17. (ii) Vapor pressure reported in ref. 14 from the extrapolated data of ref. 18 .
10	-4.89	0.447	0.016	11, 12	14, 18	(i) Solubility reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006). (ii) Vapor pressure reported in ref. 14 from the extrapolated data of ref. 18 .

Table ST11 Solvation free energy of 4-nitrotoluene (4-NT) in water calculated from the Henry's Law Constant

Calculation No.	Solvation Free Energy (kcal/mol)	Henry's Law Constant (atm-m ³ /mol)	Dimensionless HLC	Experimental Data Source	Comment
1	-4.67	5.63×10^{-6}	2.30×10^{-4}	11,14,16	The original Henry's Law Constant data from ref. 16 and also reported in refs. 11,14 .

Table ST12 Solvation free energy of 2,3-dinitrotoluene (2,3-DNT) in water calculated from experimental solubility and vapor pressure data.

Calculation No.	Solvation Free Energy (kcal/mol)	Solubility (g/L)	Vapor Pressure (mmHg)	Experimental Data		Comment
				Solubility Data Source	Vapor pressure Data Source	
1	-6.25	0.139	3.69×10^{-4}	17	19	(i) Solubility calculated at room temperature from the exponential fit [Eqn. (3) of ref. 17] $S_w[\text{mg/L}] = 0.00051 \times \exp(0.042 \times T[\text{K}])$ of ref. 17 and converted to g/L. (ii) Vapor pressure calculated using the Clausius-Clapeyron equation ($\log_{10} P(\text{mmHg}) = 13.57 (\pm 0.36) - 5067(\pm 110)/T[\text{K}]$) and the constants reported in ref. 19 .

Table ST13 Solvation free energy of 2,4-dinitrotoluene (2,4-DNT) in water calculated from experimental solubility and vapor pressure data.

Calculation No.	Solvation Free Energy (kcal/mol)	Solubility (g/L)	Vapor Pressure (mmHg)	Experimental Data		Comment
				Solubility Data Source	Vapor pressure Data Source	
1	-6.51	0.207	3.60×10^{-4}	20	19	(i) Solubility calculated at room temperature from the exponential fit [Eqn. (3) of ref. 20] $S_w[\text{mg/L}] = 74.8 \times \exp(0.0408 T[^\circ\text{C}])$ of ref. 20 and converted to g/L. (ii) Vapor pressure calculated using the Clausius-Clapeyron equation and the constants ($\log_{10} P(\text{mmHg}) = 13.16 (\pm 0.40) - 4948(\pm 120)/T[\text{K}]$) reported in ref. 19 .
2	-6.74	0.207	2.46×10^{-4}	20	21	(i) Solubility calculated at room temperature from the exponential fit [Eqn. (3) of ref. 20] $S_w[\text{mg/L}] = 74.8 \times \exp(0.0408 T[^\circ\text{C}])$ of ref. 20 and converted to g/L. (ii) Vapor pressure calculated using the Clausius-Clapeyron equation [$\log_{10} P(\text{Pa}) = 15.03 - 4921/T(\text{K})$] using the data reported in ref. 21 and converted the data to mmHg. The coefficients in the equation were derived for the temperature range 32°C-73 °C.
3	-6.82	0.207	2.13×10^{-4}	20	22	(i) Solubility calculated at room temperature from the exponential fit [Eqn. (3) of ref. 20] $S_w[\text{mg/L}] = 74.8 \times \exp(0.0408 T[^\circ\text{C}])$ of ref. 20 and converted to g/L.

					(ii) Vapor pressure calculated using the Clausius-Clapeyron equation ($\log_{10} P(\text{mmHg}) = 13.08 (\pm 0.19) - 4992(\pm 59)/T[\text{K}]$) using the data reported in ref. 22 .
4	-6.48	0.200	3.60×10^{-4}	11,12	19 (i) Solubility reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006). (ii) Vapor pressure calculated using the Clausius-Clapeyron equation and the constants ($\log_{10} P(\text{mmHg}) = 13.16 (\pm 0.40) - 4948(\pm 120)/T[\text{K}]$) reported in ref. 19 .
5	-6.71	0.200	2.46×10^{-4}	11,12	21 (i) Solubility reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006). (ii) Vapor pressure calculated using the Clausius-Clapeyron equation [$\log_{10} P(\text{Pa}) = 15.03 - 4921/T (\text{K})$] using the data reported in Ref. 21 and converted the data to mmHg. The coefficients in the equation were derived for the temperature range 32°C-73 °C.
6	-6.79	0.200	2.13×10^{-4}	11,12	22 (i) Solubility reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006). (ii) Vapor pressure calculated using the Clausius-Clapeyron equation ($\log_{10} P(\text{mmHg}) = 13.08 (\pm 0.19) - 4992(\pm 59)/T[\text{K}]$) using the data reported in ref. 22 .
7	-6.68	0.280	3.60×10^{-4}	23,24	19 (i) Solubility was estimated in ref. 23 by linear interpolation between data for 22°C nad 50 °C from ref. 24 . (ii) Vapor pressure calculated using the Clausius-Clapeyron equation and the constants ($\log_{10} P(\text{mmHg}) = 13.16 (\pm 0.40) - 4948(\pm 120)/T[\text{K}]$) reported in ref. 19 .
8	-6.91	0.280	2.46×10^{-4}	23,24	21 (i) Solubility was estimated in Ref. 1 by linear interpolation between data for 22°C nad 50 °C from Ref. 24 . (ii) Vapor pressure calculated using the Clausius-Clapeyron equation [$\log_{10} P(\text{Pa}) = 15.03 - 4921/T (\text{K})$] using the data reported in ref. 21 and converted the data to mmHg. The coefficients in the equation were derived for the temperature range 32°C-73 °C.
9	-6.99	0.280	2.13×10^{-4}	23,24	22 (i) Solubility was estimated in ref. 23 by linear interpolation between data for 22°C nad 50 °C from ref. 24 . (ii) Vapor pressure calculated using the Clausius-Clapeyron equation ($\log_{10} P(\text{mmHg}) = 13.08 (\pm 0.19) - 4992(\pm 59)/T[\text{K}]$) using the data reported in ref. 22 .
10	-6.80	0.207	2.17×10^{-4}	20	22,23 (i) Solubility calculated at room temperature from the exponential fit [Eqn. (3) of ref. 20] $S_w[\text{mg/L}] = 74.8 \times \exp(0.0408 T[^\circ\text{C}])$ of ref. 20 and converted to g/L. (ii) Vapor pressure was calculated in ref. 23 using the Clausius-Clapeyron equation and the constants reported in ref. 22 .
11	-6.78	0.200	2.17×10^{-4}	11,12	22,23 (i) Solubility reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006). (ii) Vapor pressure was calculated in ref. 23 using the Clausius-Clapeyron equation and the constants reported in ref. 22 .
12	-6.98	0.280	2.17×10^{-4}	23,24	22,23 (i) Solubility was estimated in ref. 23 by linear interpolation between data for 22°C nad 50 °C from ref. 24 . (ii) Vapor pressure was calculated in ref. 23 using the Clausius-Clapeyron equation and the constants reported in ref. 22 .

13	-6.48	0.200	3.60×10^{-4}	11,12	19	(i) Solubility reported in ref. 11 and claimed to be collected from EPI ¹² Suite™ database and NIST ¹³ Chemistry Webbook (2006). (ii) Vapor pressure calculated using the Clausius-Clapeyron equation and the constants ($\log_{10} P(\text{mmHg}) = 13.16 (\pm 0.40) - 4948(\pm 120)/T[\text{K}]$) reported in ref. 2 .
14	-6.71	0.200	2.46×10^{-4}	11,12	21	(i) Solubility reported in ref. 11 and claimed to be collected from EPI ¹² Suite™ database and NIST ¹³ Chemistry Webbook (2006). (ii) Vapor pressure calculated using the Clausius-Clapeyron equation [$\log_{10} P(\text{Pa}) = 15.03 - 4921/T(\text{K})$] using the data reported in ref. 21 and converted the data to mmHg. The coefficients in the equation were derived for the temperature range 32°C-73 °C.
15	-6.79	0.200	2.13×10^{-4}	11,12	22	(i) Solubility reported in ref. 11 and claimed to be collected from EPI ¹² Suite™ database and NIST ¹³ Chemistry Webbook (2006). (ii) Vapor pressure calculated using the Clausius-Clapeyron equation ($\log_{10} P(\text{mmHg}) = 13.08 (\pm 0.19) - 4992(\pm 59)/T[\text{K}]$) using the data reported in ref. 22 .
16	-6.78	0.200	2.17×10^{-4}	11,12	22,23	(i) Solubility reported in ref. 11 and claimed to be collected from EPI ¹² Suite™ database and NIST ¹³ Chemistry Webbook (2006). (ii) Vapor pressure was calculated in ref. 23 using the Clausius-Clapeyron equation and the constants reported in ref. 22 .
17	-6.82	0.207	2.10×10^{-4}	20	7-9	(i) Solubility calculated at room temperature from the exponential fit [Eqn. (3) of ref. 20] $S_w[\text{mg/L}] = 74.8 \times \exp(0.0408 T[^\circ\text{C}])$ of ref. 20 and converted to g/L. (ii) Extrapolated value: vapor pressure reported in ref. 7 and collected from refs. 8 and 9 .
18	-6.80	0.200	2.10×10^{-4}	11,12	7-9	(i) Solubility reported in Ref. 11 and claimed to be collected from EPI ¹² Suite™ database and NIST ¹³ Chemistry Webbook (2006). (ii) Extrapolated value: vapor pressure reported in ref. 7 and collected from refs. 8 and 9 .
19	-7.00	0.280	2.10×10^{-4}	23,24	7-9	(i) Solubility was estimated in ref. 23 by linear interpolation between data for 22°C and 50 °C from ref. 24 . (ii) Extrapolated value: vapor pressure reported in ref. 7 and collected from refs. 8 and 9 .
20	-6.80	0.200	2.10×10^{-4}	11,12	7-9	(i) Solubility reported in ref. 11 and claimed to be collected from EPI ¹² Suite™ database and NIST ¹³ Chemistry Webbook (2006). (ii) Extrapolated value: vapor pressure reported in ref. 7 and collected from refs. 8 and 9 .

Table ST14 Solvation free energy of 2,4-dinitrotoluene (2,4-DNT) in water calculated from the Henry's Law Constant

Calculation No.	Solvation Free Energy (kcal/mol)	Henry's Law Constant (atm-m ³ /mol)	Dimensionless HLC	Experimental Data Source	Comment
1	-7.72	5.40×10 ⁻⁸	2.21×10 ⁻⁶	14,16	The original Henry's Law Constant data from ref. 16 and also reported in ref. 14 .
2	-7.72	5.37×10 ⁻⁸	2.19×10 ⁻⁶	11	Henry's Law Constant data reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006).

Table ST15 Solvation free energy of 2,6-dinitrotoluene (2,6-DNT) in water calculated from experimental solubility and vapor pressure data.

Calculation No.	Solvation Free Energy (kcal/mol)	Solubility (g/L)	Vapor Pressure (mmHg)	Experimental Data		Comment
				Solubility Data Source	Vapor pressure Data Source	
1	-5.96	0.179	7.77×10 ⁻⁴	17	19	(i)Solubility calculated at room temperature from the exponential fit [Eq.(3) of ref. 17] $S_w[\text{mg/L}] = 0.00011 \times \exp(0.048 \times T[\text{K}])$ of ref. 17 and converted to g/L. (ii)Vapor pressure calculated using the Clausius-Clapeyron equation ($\log_{10} P(\text{mmHg}) = 14.35 (\pm 0.38) - 5203(\pm 120)/T[\text{K}]$) and the constants reported in ref. 19 .
2	-6.16	0.179	5.56×10 ⁻⁴	17	22	(i)Solubility calculated at room temperature from the exponential fit [Eq.(3) of ref. 17] $S_w[\text{mg/L}] = 0.00011 \times \exp(0.048 \times T[\text{K}])$ of ref. 17 and converted to g/L. (ii)Vapor pressure calculated using the Clausius-Clapeyron equation ($\log_{10} P(\text{mmHg}) = 13.99 (\pm 0.18) - 5139(\pm 52)/T[\text{K}]$) using the data reported in ref. 22 .
3	-6.05	0.208	7.77×10 ⁻⁴	2,25	19	(i)The solubility originally from Ref. 25 and also reported in ref. 2 and converted to g/L. (ii)Vapor pressure calculated using the Clausius-Clapeyron equation ($\log_{10} P(\text{mmHg}) = 14.35 (\pm 0.38) - 5203(\pm 120)/T[\text{K}]$) and the constants reported in ref. 19 .

4	-6.25	0.208	5.56×10^{-4}	2,25	22	(i)The solubility originally from ref. 25 and also reported in ref. 2 and converted to g/L. (ii)Vapor pressure calculated using the Clausius-Clapeyron equation ($\log_{10} P(\text{mmHg}) = 13.99 (\pm 0.18) - 5139(\pm 52)/T[\text{K}]$) using the data reported in ref. 22 .
5	-5.97	0.182	7.77×10^{-4}	11	19	(i)Solubility reported in ref. 11 and claimed to be collected from EPI ¹² Suite™ database and NIST ¹³ Chemistry Webbook (2006). (ii)Vapor pressure calculated using the Clausius-Clapeyron equation ($\log_{10} P(\text{mmHg}) = 14.35 (\pm 0.38) - 5203(\pm 120)/T[\text{K}]$) and the constants reported in ref. 19 .
6	-6.17	0.182	5.56×10^{-4}	11	22	(i)Solubility reported in ref. 11 and claimed to be collected from EPI ¹² Suite™ database and NIST ¹³ Chemistry Webbook (2006). (ii)Vapor pressure calculated using the Clausius-Clapeyron equation ($\log_{10} P(\text{mmHg}) = 13.99 (\pm 0.18) - 5139(\pm 52)/T[\text{K}]$) using the data reported in ref. 22 .
7	-6.15	0.179	5.69×10^{-4}	17	11	(i)Solubility calculated at room temperature from the exponential fit [Eq.(3) of ref. 17] $S_w[\text{mg/L}] = 0.00011 \times \exp(0.048 \times T[\text{K}])$ of ref. 17 and converted to g/L. (ii)Vapor pressure data reported in ref. 11 and claimed to be collected from EPI ¹² Suite™ database and NIST ¹³ Chemistry Webbook (2006).
8	-6.24	0.208	5.69×10^{-4}	2,25	11	(i)The solubility originally from ref. 25 and also reported in ref. 2 and converted to g/L. (ii)Vapor pressure data reported in ref. 11 and claimed to be collected from EPI ¹² Suite™ database and NIST ¹³ Chemistry Webbook (2006).
9	-6.16	0.182	5.69×10^{-4}	11	11	(i)Solubility reported in ref. 11 and claimed to be collected from EPI ¹² Suite™ database and NIST ¹³ Chemistry Webbook (2006). (ii)Vapor pressure data reported in ref. 11 and claimed to be collected from EPI ¹² Suite™ database and NIST ¹³ Chemistry Webbook (2006).
10	-6.04	0.206	7.77×10^{-4}	23	19	(i)Solubility reported in ref. 23 and claimed to be collected from ref. 26 . (ii)Vapor pressure calculated using the Clausius-Clapeyron equation ($\log_{10} P(\text{mmHg}) = 14.35 (\pm 0.38) - 5203(\pm 120)/T[\text{K}]$) and the constants reported in ref. 19 .
11	-6.24	0.206	5.56×10^{-4}	23	22	(i)Solubility reported in ref. 23 and claimed to be collected from ref. 26 . (ii)Vapor pressure calculated using the Clausius-Clapeyron equation ($\log_{10} P(\text{mmHg}) = 13.99 (\pm 0.18) - 5139(\pm 52)/T[\text{K}]$) using the data reported in ref. 22 .
12	-6.23	0.206	5.69×10^{-4}	23	11	(i)Solubility reported in ref. 23 and claimed to be collected from ref. 26 . (ii)Vapor pressure data reported in ref. 11 and claimed to be collected from EPI ¹² Suite™ database and NIST ¹³ Chemistry Webbook (2006).

Table ST16 Solvation free energy of 2,6-dinitrotoluene (2,6-DNT) in water calculated from the Henry's Law Constant

Calculation No.	Solvation Free Energy (kcal/mol)	Henry's Law Constant (atm·m ³ /mol)	Dimensionless HLC	Experimental Data Source	Comment
1	-6.17	7.41×10^{-7}	3.03×10^{-5}	11	Henry's Law Constant data reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006).

Table ST17 Solvation free energy of 3,4-dinitrotoluene (3,4-DNT) in water calculated from experimental solubility and vapor pressure data.

Calculation No.	Solvation Free Energy (kcal/mol)	Solubility (g/L)	Vapor Pressure (mmHg)	Experimental Data		Comment
				Solubility Data Source	Vapor pressure Data Source	
2	-6.85	0.153	1.53×10^{-4}	27	19	(i) Solubility calculated at room temperature from the exponential fit [Eqn. (2) of ref. 27] $S_w[\text{mg/L}] = 0.00032 \times \exp(0.044 \times T [\text{K}])$ of ref. 27 and converted to g/L. (ii) Vapor pressure calculated using the Clausius-Clapeyron equation ($\log_{10} P(\text{mmHg}) = 13.63 (\pm 0.34) - 5199(\pm 100)/T[\text{K}]$) and the constants reported in ref. 19 .
3	-6.58	0.100	1.53×10^{-4}	14	19	(i) The original solubility data from ref. 28 and reported in ref. 14 . (ii) Vapor pressure calculated using the Clausius-Clapeyron equation ($\log_{10} P(\text{mmHg}) = 13.63 (\pm 0.34) - 5199(\pm 100)/T[\text{K}]$) and the constants reported in ref. 19 .

Table ST18 Solvation free energy of 1,3,5-trinitrobenzene (1,3,5-TNB) in water calculated from experimental solubility and vapor pressure data.

Calculation No.	Solvation Free Energy (kcal/mol)	Solubility (g/L)	Vapor Pressure (mmHg)	Experimental Data		Comment
				Solubility Data Source	Vapor pressure Data Source	
1	-9.75	0.493	2.93×10^{-6}	17	29,30	(i) Solubility calculated at room temperature from the exponential fit [Eqn. (3) of ref. 17] $S_w[\text{mg/L}] = 0.104 \times \exp(0.0284 \times T[\text{K}])$ of ref. 17. (ii) Vapor pressure calculated using the Clausius-Clapeyron equation ($\log_{10} P(\text{Pa}) = 15.41 - 5608/T[\text{K}]$) and the constants reported in refs. 29 and 30.
2	-9.61	0.385	2.93×10^{-6}	23,31	29,30	(i) Solubility reported in ref. 23 (converted to g/L) was estimated by interpolation of a plot of $\ln S$ vs $1/T[\text{K}]$ for 17°C, 50 °C and 100 °C from ref. 31. (ii) Vapor pressure calculated using the Clausius-Clapeyron equation ($\log_{10} P(\text{Pa}) = 15.41 - 5608/T[\text{K}]$) and the constants reported in refs. 29 and 30.
3	-9.31	0.493	6.44×10^{-6}	17	14,32	(i) Solubility calculated at room temperature from the exponential fit [Eqn. (3) of ref. 17] $S_w[\text{mg/L}] = 0.104 \times \exp(0.0284 \times T[\text{K}])$ of ref. 17. (ii) Vapor pressure calculated in ref. 14 using the extrapolated data of ref. 32.
4	-9.16	0.385	6.44×10^{-6}	23,31	14,32	(i) Solubility reported in ref. 23 (converted to g/L) was estimated by interpolation of a plot of $\ln S$ vs $1/T[\text{K}]$ for 17°C, 50 °C and 100 °C from ref. 31. (ii) Vapor pressure calculated in ref. 14 using the extrapolated data of ref. 32.

Table ST19 Solvation free energy of 1,3,5-trinitrobenzene (1,3,5-TNB) in water calculated from the Henry's Law Constant.

Calculation No.	Solvation Free Energy (kcal/mol)	Henry's Law Constant (atm-m ³ /mol)	Dimensionless HLC	Experimental Data Source	Comment
1	-9.61	2.21×10 ⁻⁹	9.03×10 ⁻⁸	23	
2	-8.97	6.50 ×10 ⁻⁹	2.66 ×10 ⁻⁷	14	

Table ST20 Solvation free energy of 2,4,6-trinitrotoluene (2,4,6-TNT) in water calculated from experimental solubility and vapor pressure data.

Calculation No.	Solvation Free Energy (kcal/mol)	Solubility (g/L)	Vapor Pressure (mmHg)	Experimental Data		Comment
				Solubility Data Source	Vapor pressure Data Source	
1	-8.97	0.138	3.00×10 ⁻⁶	20	7-9	(i)Solubility calculated at room temperature from the exponential fit [Eqn. (4) of ref. 20] $S_w[\text{mg/L}] = 50.3 \times \exp(0.0403 T[^\circ\text{C}])$ of ref. 20 and converted to g/L. (ii)Vapor pressure reported in Ref. 7 and collected from refs. 8 and 9.
2	-8.86	0.115	3.00×10 ⁻⁶	11-13	7-9	(i)Solubility data reported in Ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006). (ii)Vapor pressure reported in ref. 7 and collected from refs. 8 and 9.
3	-8.38	0.138	8.04×10 ⁻⁶	20	11-13	(i)Solubility calculated at room temperature from the exponential fit [Eqn. (4) of ref. 20] $S_w[\text{mg/L}] = 50.3 \times \exp(0.0403 T[^\circ\text{C}])$ of ref. 20 and converted to g/L. (ii) Vapor pressure data reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006).
4	-8.27	0.115	8.04×10 ⁻⁶	11-13	11-13	(i)Solubility data reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006). (ii) Vapor pressure data reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006).

5	-8.38	0.138	8.02×10^{-6}	20	22	(i) Solubility calculated at room temperature from the exponential fit [Eqn. (4) of ref. 20] $S_w[\text{mg/L}] = 50.3 \times \exp(0.0403 T[^\circ\text{C}])$ of ref. 20 and converted to g/L. (ii) Vapor pressure calculated from ref. 22 for $T=298.15$ K.
6	-8.28	0.115	8.02×10^{-6}	11-13	22	(i) Solubility data reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006). (ii) Vapor pressure calculated from ref. 22 for $T=298.15$ K.
7	-9.02	0.150	3.00×10^{-6}	23,31	7-9	(i) The original solubility from ref. 31 and also reported in ref. 23 . (ii) Vapor pressure reported in ref. 7 and collected from refs. 8 and 9 .
8	-8.43	0.150	8.04×10^{-6}	23,31	11-13	(i) The original solubility from ref. 31 and also reported in ref. 23 . (ii) Vapor pressure data reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006).
9	-8.43	0.150	8.02×10^{-6}	23,31	22	(i) The original solubility from ref. 31 and also reported in ref. 23 . (ii) Vapor pressure calculated from ref. 22 for $T=298.15$ K.
10	-8.20	0.102	8.04×10^{-6}	33	11-13	(i) Solubility of reference 2,4,6-TNT at pH 3.5 and converted to g/L collected from ref. 33 . (ii) Vapor pressure data reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006).
11	-8.20	0.101	8.04×10^{-6}	33	11-13	(i) Solubility of reference 2,4,6-TNT at pH 6.8 and converted to g/L collected from ref. 33 . (ii) Vapor pressure data reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006).
12	-8.25	0.111	8.04×10^{-6}	33	11-13	(i) Solubility of reference 2,4,6-TNT at pH 9.1 and converted to g/L collected from ref. 33 . (ii) Vapor pressure data reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006).
13	-8.15	0.0923	8.04×10^{-6}	33	11-13	(i) Solubility of reference 2,4,6-TNT at pH 3.8 and converted to g/L collected from ref. 33 . (ii) Vapor pressure data reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006).
14	-8.24	0.108	8.04×10^{-6}	33	11-13	(i) Solubility of reference 2,4,6-TNT at pH 6.8 and converted to g/L collected from ref. 33 . (ii) Vapor pressure data reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006).
15	-8.22	0.105	8.04×10^{-6}	33	11-13	(i) Solubility of reference 2,4,6-TNT at pH 7.9 and converted to g/L collected from ref. 33 . (ii) Vapor pressure data reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006).

Table ST21 Solvation free energy of 2,4,6- trinitrotoluene (2,4,6-TNT) in water calculated from the Henry's Law Constant.

Calculation No.	Solvation Free Energy (kcal/mol)	Henry's Law Constant (atm-m ³ /mol)	Dimensionless HLC	Experimental Data Source	Comment
1	-8.66	1.10×10 ⁻⁸	4.50×10 ⁻⁷	23	
2	-8.28	2.09×10 ⁻⁸	8.54×10 ⁻⁷	11-13	Henry's Law Constant data reported in ref. 11 and claimed to be collected from EPI ¹² Suite TM database and NIST ¹³ Chemistry Webbook (2006).

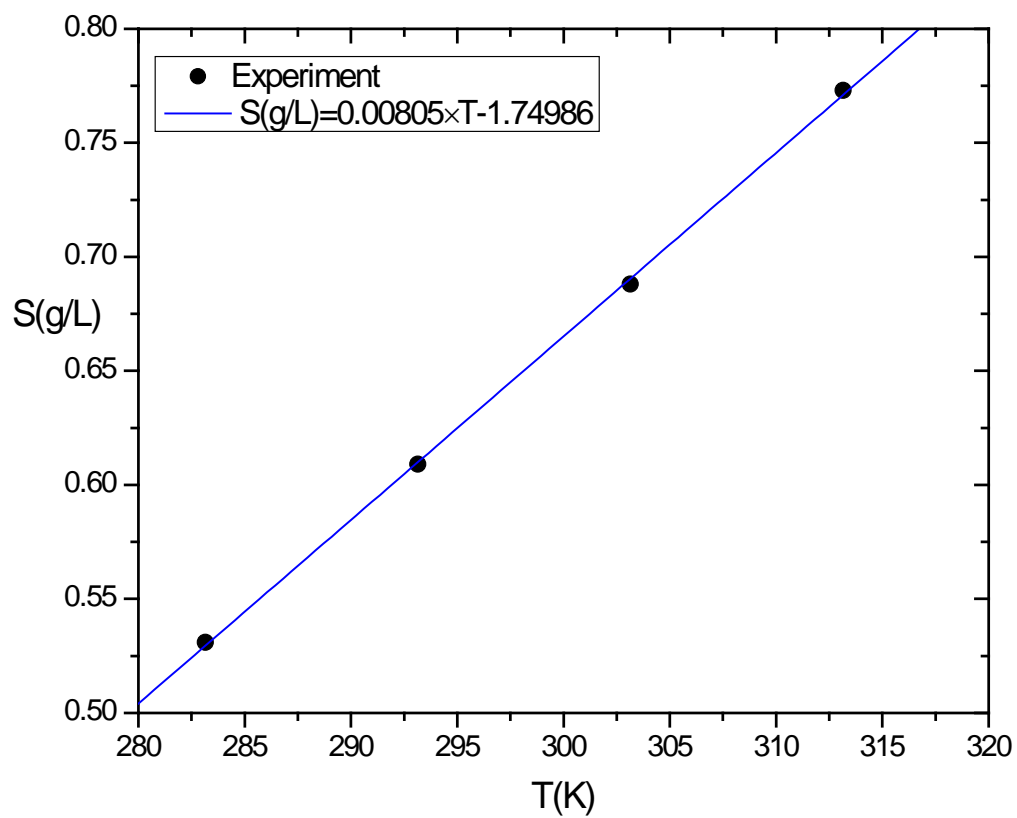


Figure SF2: 2-NT data fitted using the data from [ref. 6](#).

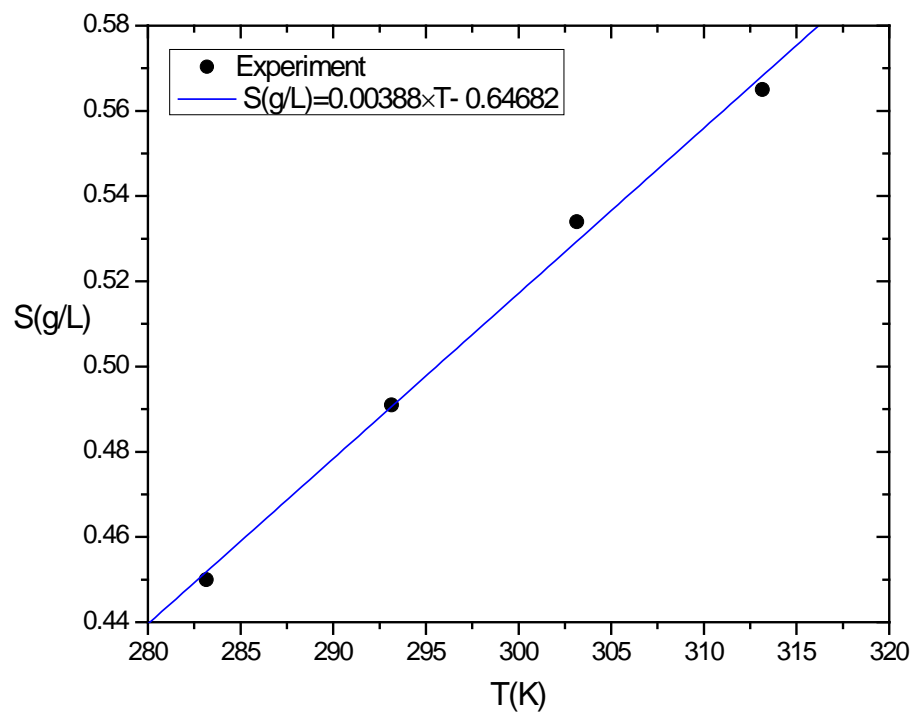


Figure SF3: 3-NT data fitted using the data from [ref. 6](#).

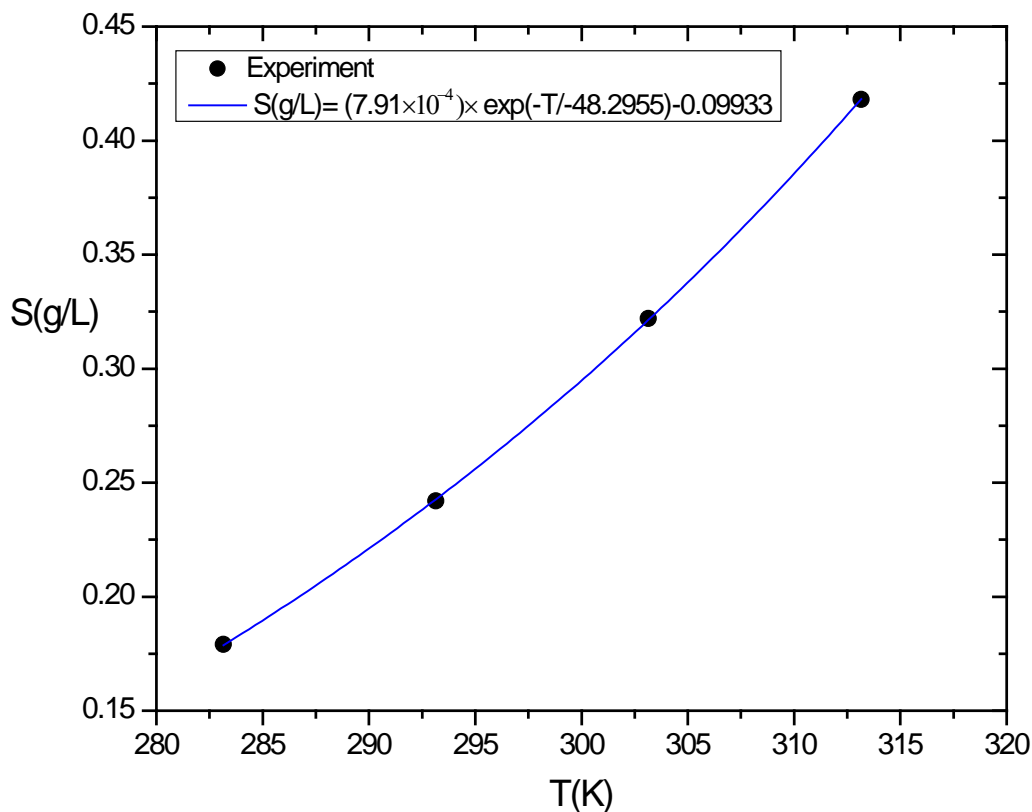


Figure SF4: 4-NT data fitted using the data from [ref. 6](#).

VI. Simulation Details

A. Force Fields and Partial Atomic Charges

The use of the MDynaMix^{34,35} program for solvation free energies requires an input script and two *mmol* files. The complete atomistic information of the molecule, including partial charges, Lennard-Jones parameters, bonding, bending and dihedral parameters are given in the *mmol* file, and two are required; one for the solute and another for the solvent water. The details

of different steps followed in the preparation and execution of the simulations are outlined briefly in the following sections.

Molecular Geometry

All the molecular geometries of the NACs listed in [Table ST1](#) and also in Figure SF1 of the Supplementary Information (SI) were initially generated by ArgusLab³⁶ software. These geometries were transferred to AmberTools-1.5³⁷ for the automated GAFF atom type assignments and AM1-BCC charge calculations. Before obtaining parameters for the force fields, 3D Cartesian coordinate files from ArgusLab were converted to a Gaussian input file for further geometry optimization using Gaussian 09³⁸ and the Becke three-parameter (B3) density functional hybrid method in combination with the Lee-Yang-Parr (LYP) gradient corrected correlation functional (B3LYP)^{39,40} with the 6-31G(d)^{41,42} basis set. The optimization was verified by all convergence criteria being successfully met, and by converged single point energy and frequency calculations to insure there were no imaginary frequencies.

General Procedure for Preparing MDynaMix *smol* Files

All the MDynaMix *smol* (in mol2 format) files were created manually with the optimized Cartesian coordinates obtained from the Gaussian 09 output file. The assignment of atom types and atomic charges were force field specific, while the molecular atomic connectivity was the same for all the force fields.

General Procedure for Preparing MDynaMix *mmol* Files

Force field parameters were collected either from the literature or in an automated way using the companion utility programs or interactive web interfaces of the respective packages as described shortly, and converted to the units of the MDynaMix package. The parameter files were prepared in the specified format for use with the *makemol* utility, and the MDynaMix *mmol*

files were generated using this utility in conjunction with *smol* and parameter files. However, improper dihedrals, when necessary, had to be added manually to the *mmol* file.

GAFF Parameters and AM1-BCC Charges

The GAFF⁴³ parameters and AM1-BCC^{44,45} charges were obtained using AmberTools-1.5 with the MOPAC BCC flag ON. The *prmtop* files were then generated for each compound. This was done in an automated way as implemented in the AmberTools-1.5³⁵ using the *pdb* files generated by ArgusLab with the geometries obtained earlier. For the nitroaromatics studied here, the parameters for ca-o-no-o improper dihedral were not found in GAFF, and the parameters were obtained following the GAFF generic rule of assigning improper dihedrals as was also done by Mobley et al.⁴⁶ The parameters thus obtained from AmberTools-1.5 were manually transferred to a force field parameter file in the specified format (for details see MDynaMix user manual). The *smol* files were then prepared with GAFF atom types and AM1-BCC charges.

CGenFF Parameters and Charges

The CGenFF⁴⁷⁻⁴⁹ atom types and charges were obtained by uploading the *pdb* files (without bond order) into the ParamChem⁵⁰ website where the parameters were generated by the CGenFF program beta version 0.9.6. Every molecule was checked manually by examining the intermediate *mol2* files from the ParamChem website after successful assignment of atom types and charges. The intermediate molecular geometry file (in *mol2* format) for each compound was also visually verified using ArgusLab to ensure that the atom type and charge assignments were done based on the correct molecular structure. To capture short- and medium-range inductive and mesomeric effects, the ParamChem website calculation of the atomic charges for the CGenFF atom types using the extended bond-charge increment method⁴⁹ was used. The neutrality of a molecule was confirmed by summing all the atomic charges in the molecule, and

the relative electropositivity or negativity was manually examined as a consistency check on the charge assignments. Then the MDynaMix *smol* files were created according the procedure outlined earlier. The CGenFF topology and parameter files version 2b7⁵¹ were converted to the force field parameter file using the modified⁵² version of *char2mdx* utility module of MDynaMix package. With the *smol* files and the force field parameter file obtained earlier, the *mmol* files were generated using a modified version of the *makemol* module of the MDynaMix package. The improper dihedrals were added manually to the *mmol* files.

OPLS-AA force field Parameters

OPLS-AA⁵³⁻⁵⁶ force field parameters were collected from the literature, converted to the units of MDynaMix package, and a parameter file was prepared for use with the *makemole* utility. Then *smol* and *mmol* files were generated according the method discussed earlier, and improper dihedrals were added manually in the *mmol* file.

TraPPE force field parameters

The TraPPE force field parameters were collected from the literature⁵⁷⁻⁶⁰ and converted to the units of MDynaMix. Since the TraPPE explicit hydrogen (EH) force field does not have parameters for a methyl group connected to an aromatic ring, TraPPE-UA parameters were used for both the methyl group⁵⁷ and the aromatic ring,⁵⁸ and explicit hydrogen parameters were used for the nitro group.⁵⁸ We refer to this hybrid version of the TraPPE force field as TraPPE-UA FF. The *smol* and *mmol* files were generated following the already discussed procedure.

Charge Assignment to the Atoms

The default atomic charges for the OPLS-AA and TraPPE force fields are commonly used in molecular simulations. In OPLS-AA FF partial charges are available for the atom types in toluene and nitrobenzene, and we have used these atom types and charges in our simulations.

To determine the difference in the predictive accuracy between the use of the default charges for each force field and charges obtained from either the quantum or semiempirical methods, hydration free energies were also calculated with CHELPG charges for all force fields, and with the AM1-BCC charges for GAFF only. The AM1-BCC charges were calculated using the semiempirical method implemented in AmberTools-1.5 following the procedure discussed earlier. CHELPG⁶¹ charges were calculated using Gaussian 09 at B3LYP/6-311G(d,p) wave function with the previously mentioned optimized geometries.

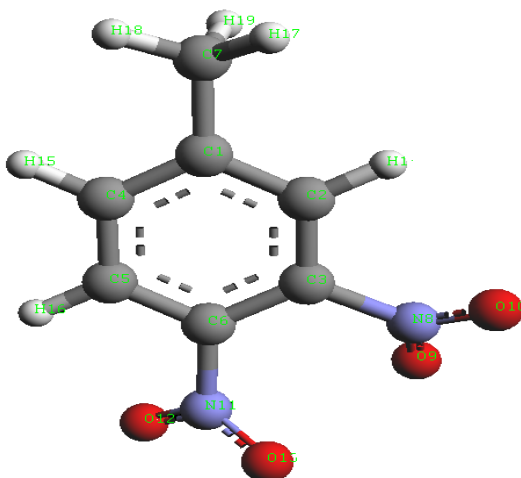
B. Calculation of Abraham's LSER Solvation Free Energies

Abraham descriptors for the calculation of LSER (Linear Solvation Energy Relationships) solvation free energies were collected from the literature, except for 3,4-dinitrotoluene for which the descriptors were calculated using *Absolve* module of ADME Boxes⁶² version 5.0 with the Platts⁶³ fragment method to predict the descriptors. Prak² calculated the Abraham parameters for 2,3-DNT, 2,4-DNT, 2,6-DNT and TNT using ADME Boxes version 3.0⁵ and West et al.⁶⁴ calculated the descriptors for 2-NT, 3-NT, 4-NT, 2,4-DNT, and 2,6-DNT using ADME Boxes version 3.5. Also, the *Absolve* database was also searched for experimentally derived solute descriptors that were available there as part of the fragment training set; however, for most of the NACs studied here, experimentally-based descriptors were not available. The descriptors for 1,3,5-TNB were collected from Abraham and Acree.⁴ Then equations (26) and (27) of Ref. 1 were used to calculate the L descriptors.

VII. Partial Atomic Charges

Table ST22 CHELPG (gas) and CM4 (aqueous) partial atomic charges of 3,4-dinitrotoluene (3,4-DNT). CHELPG and CM4 partial atomic charges were obtained using Gaussian 09 and SMxGauss version 3.3 with SM6, respectively.

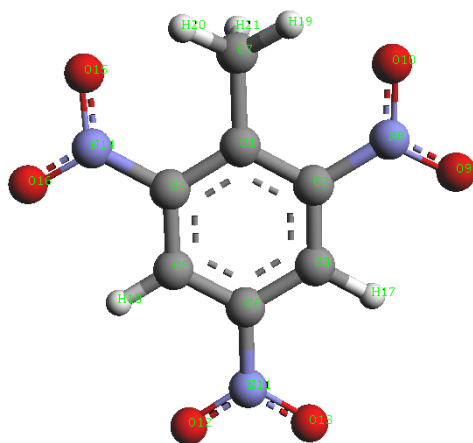
Atom	CM4 (SM6)	CHELPG (Gaussian 09)
	mPW1PW91/MIDI!6D (cal.)// B3LYP/cc-pVTZ (opt.)	B3LYP/6-311G(d,p) (cal.)// B3LYP/6-31G(d) (opt.)
	water	Gas
C1	0.007	0.2258
C2	-0.051	-0.1771
C3	0.108	-0.0321
C4	-0.042	-0.1762
C5	-0.041	-0.0644
C6	0.089	-0.0240
C7	-0.174	-0.2872
N8	0.293	0.6851
O9	-0.271	-0.3629
O10	-0.264	-0.3935
N11	0.297	0.6593
O12	-0.268	-0.3900
O13	-0.281	-0.3609
H14	0.106	0.1526
H15	0.104	0.1306
H16	0.111	0.1322
H17	0.091	0.0943
H18	0.087	0.0913
H19	0.100	0.0969



3,4-Dinitrotoluene (3,4-DNT)

Table [ST23](#) CHELPG (gas) and CM4 (aqueous) partial atomic charges of 2,4,6-trinitrotoluene (**246-TNT**). CHELPG and CM4 partial atomic charges were obtained using Gaussian 09 and SMxGauss version 3.3 with SM6, respectively.

Atom	CM4 (SM6)	CHELPG (Gaussian 09)
	mPW1PW /MIDI!6D// B3LYP/cc-pVTZ	B3LYP/6- 311G(d,p)// B3LYP/6-31G(d)
	water	Gas
C1	0.036	0.1808
C2	0.110	-0.0624
C3	-0.018	-0.0982
C4	0.110	-0.0623
C5	-0.018	-0.0982
C6	0.101	0.0388
C7	-0.181	-0.4334
N8	0.296	0.7003
O9	-0.264	-0.3910
O10	-0.252	-0.3812
N11	0.303	0.6319
O12	-0.268	-0.3680
O13	-0.268	-0.3680
N14	0.296	0.7002
O15	-0.252	-0.3812
O16	-0.264	-0.3910
H17	0.125	0.1584
H18	0.125	0.1583
H19	0.086	0.1503
H20	0.086	0.1503
H21	0.112	0.1656



2,4,6-Trinitrotoluene
(2,4, 6-TNT)

VIII. References

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