

Dissociation Constants (pKa) of Eight Amines: Measurements, Computational Chemistry Calculations, and ANN

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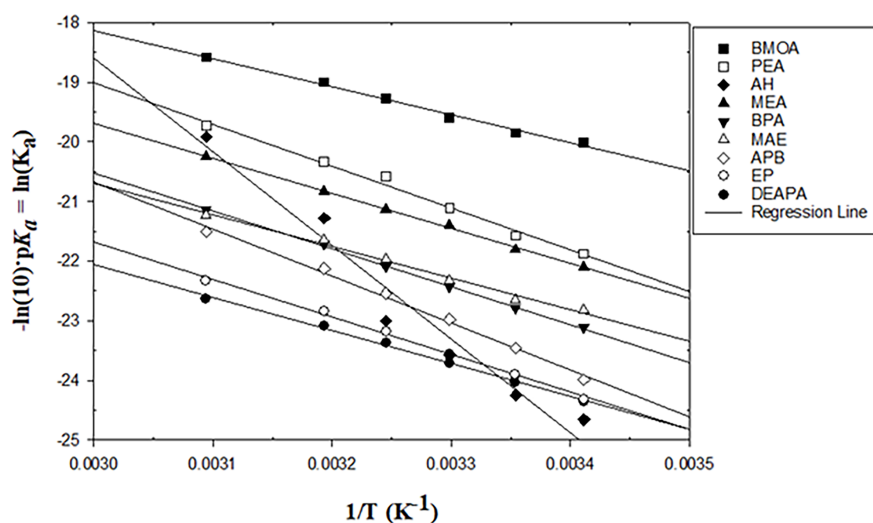
March 18, 2023

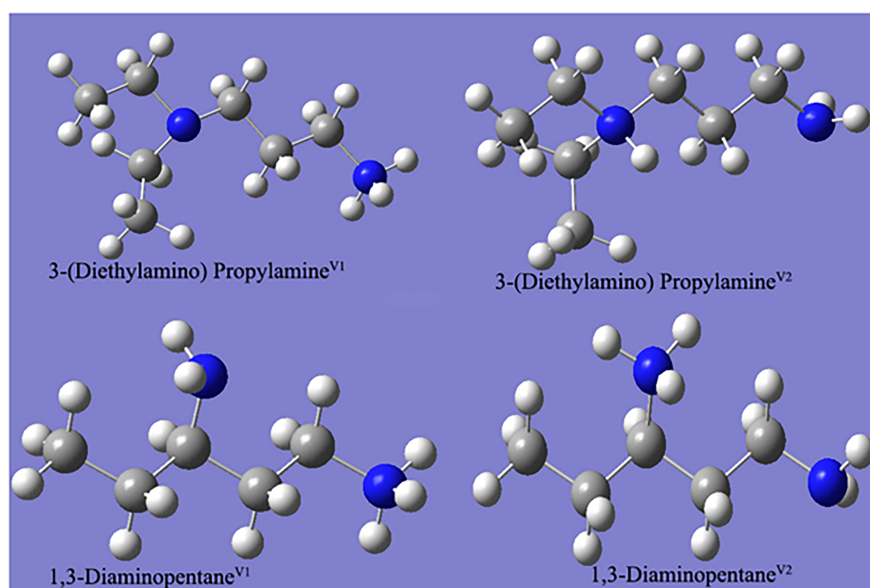
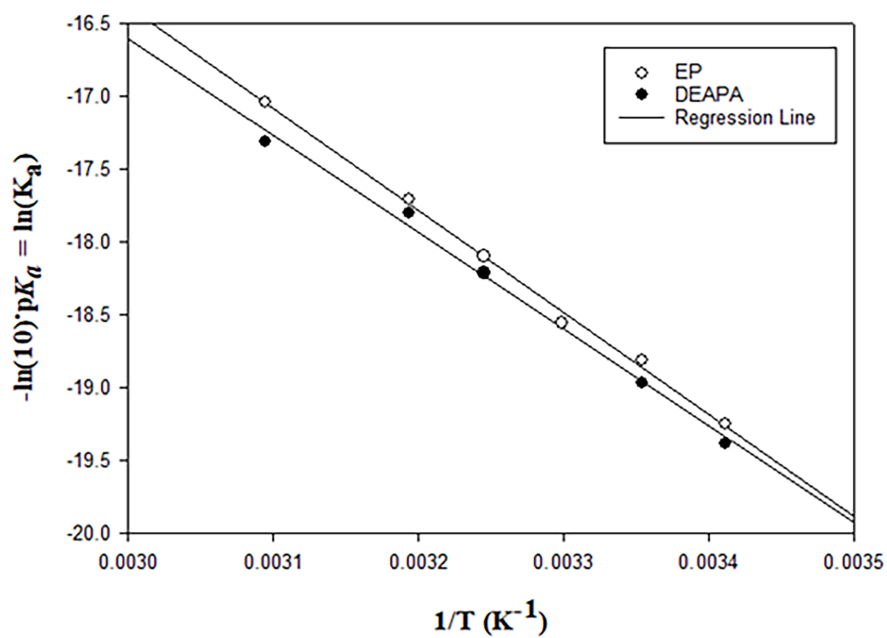
Abstract

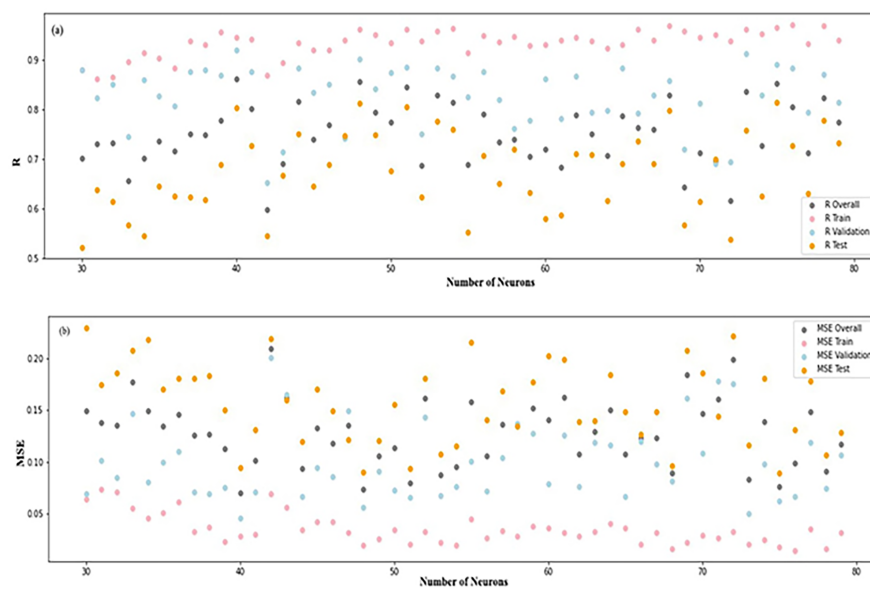
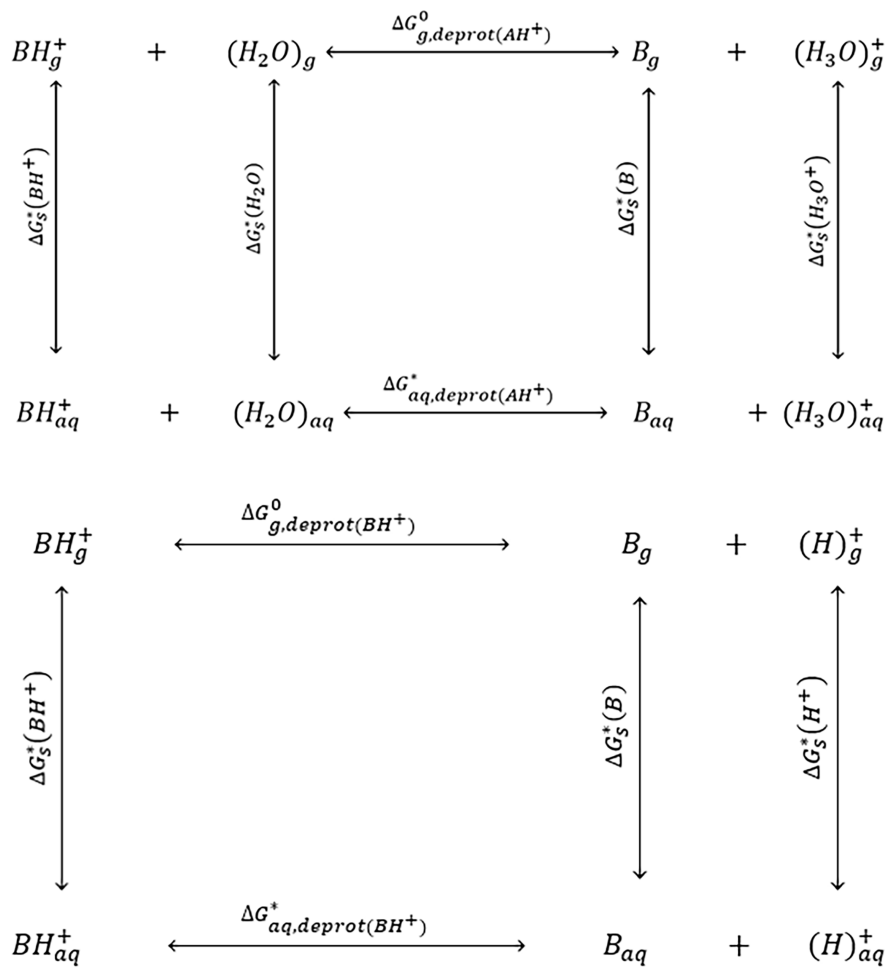
This work focused on determining the dissociation constants (pKa) for eight amines, namely, 3-(Diethylamino) propylamine, 1,3-Diaminopentane, 3-Butoxypropylamine, 2-(Methylamino) ethanol, Bis(2-methoxyethyl) Amine, α -Methylbenzylamine, 2-Aminoheptane, and 3-Amino-1-phenylbutane at temperatures ranging from 293.15 K to 323.15 K. The protonated order of two polyamines, 3-(Diethylamino) propylamine and 1, 3-Diaminopentane, were determined using computational chemistry methods. The dissociation constants at the standard temperature of 298.15 K were estimated using group functional models (paper-pencil) and computational methods using software such as COSMO-RS and Gaussian. In addition, the pKas at various temperatures were calculated using computational methods for two different thermodynamic cycle. A simple artificial neural network (ANN) method was also employed to reduce the calculation time as well as improve the accuracy. Instead of using the experimental property data, these could be generated using Aspen Plus or CosmothermX. The simulated model provided a very good fit to the pKa values.

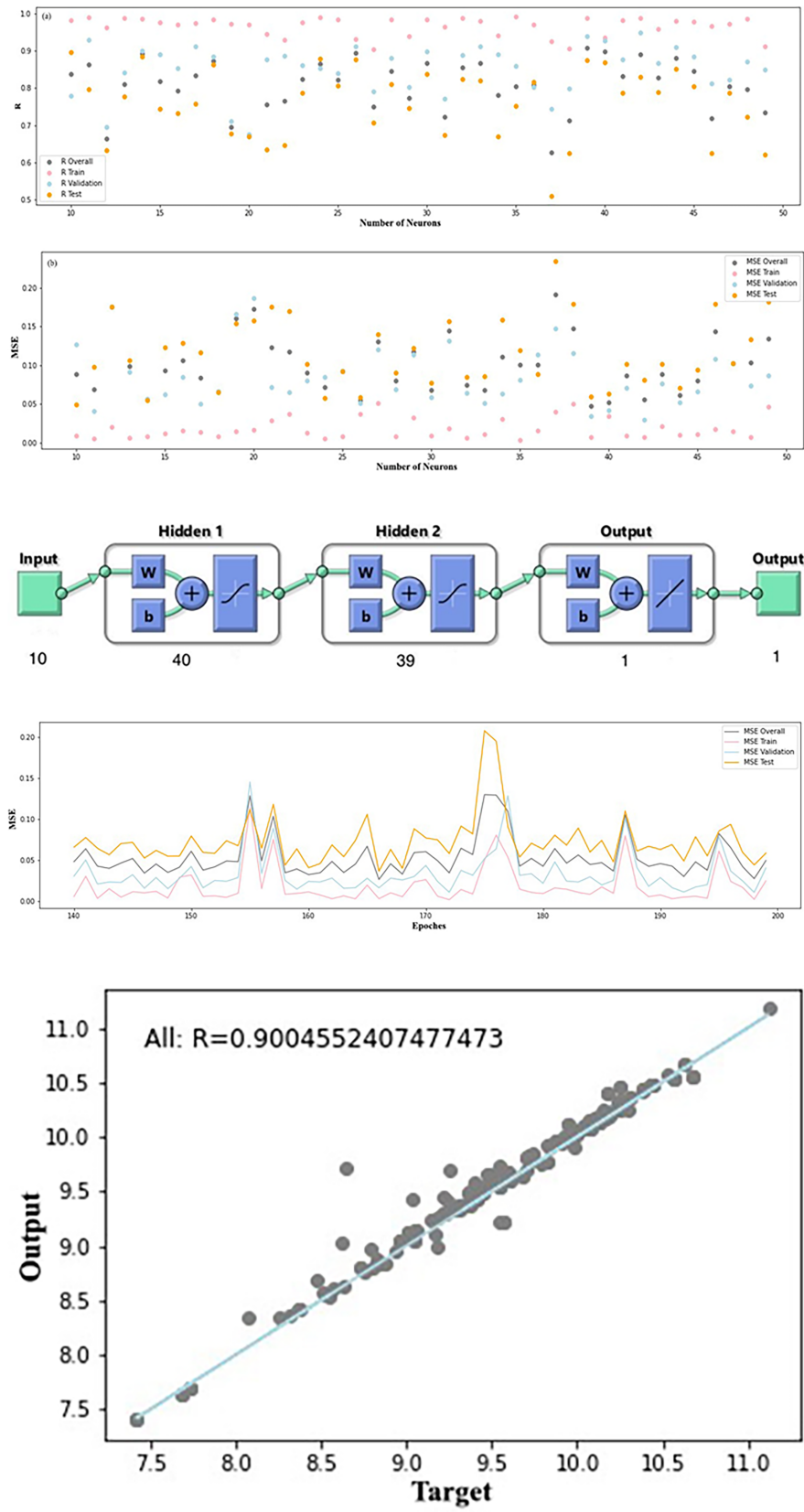
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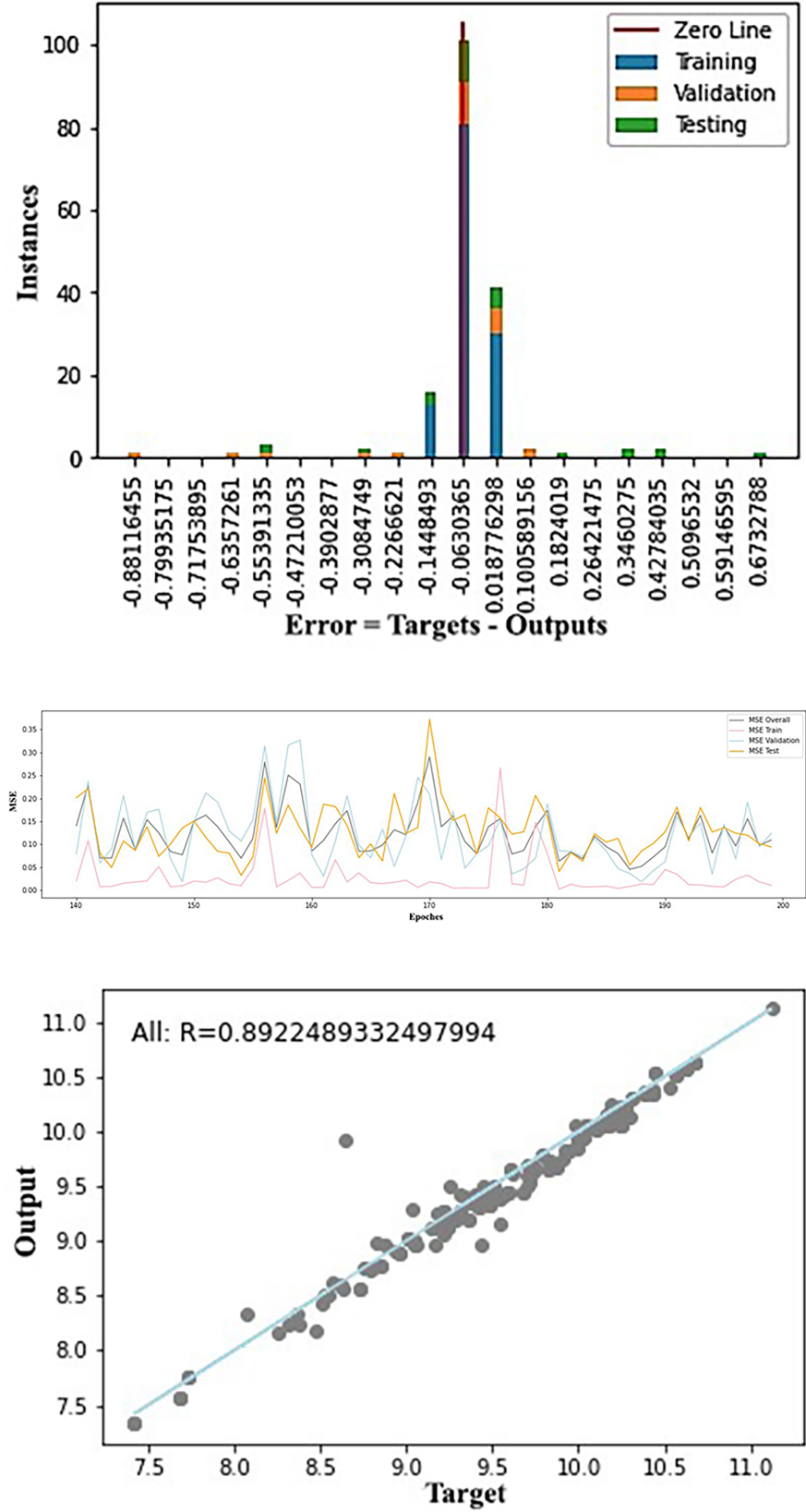
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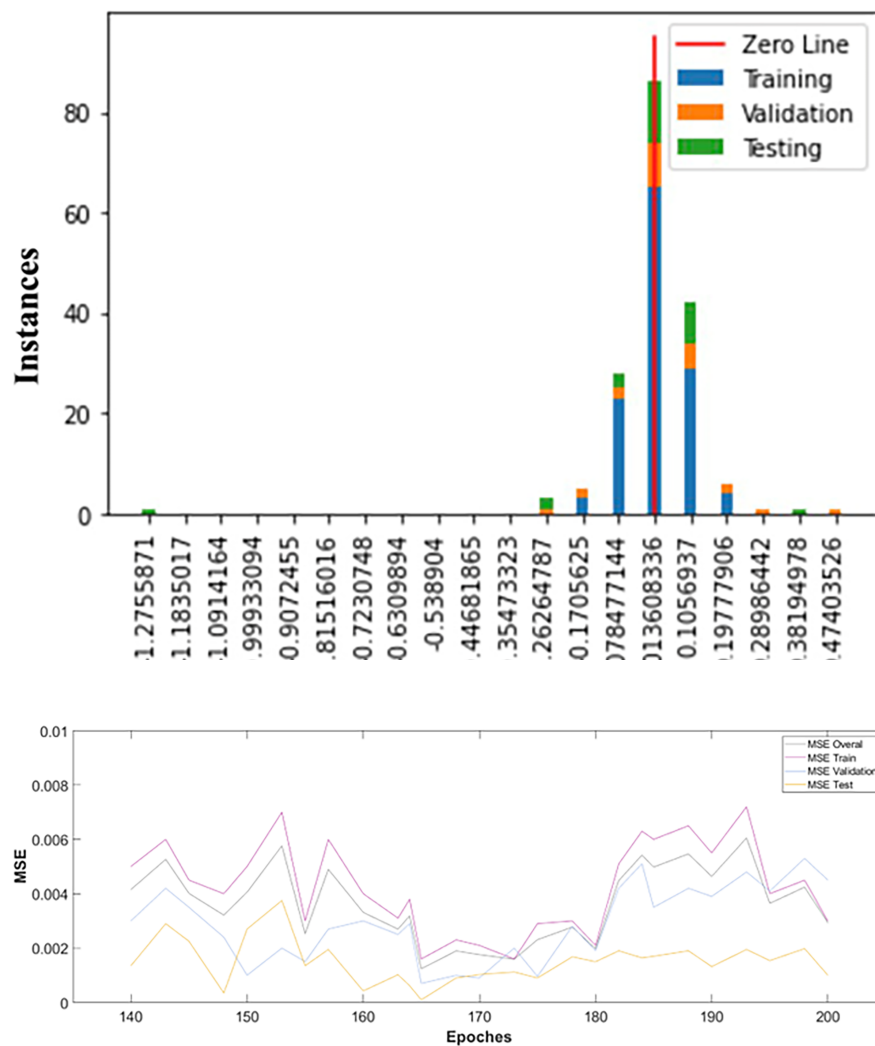












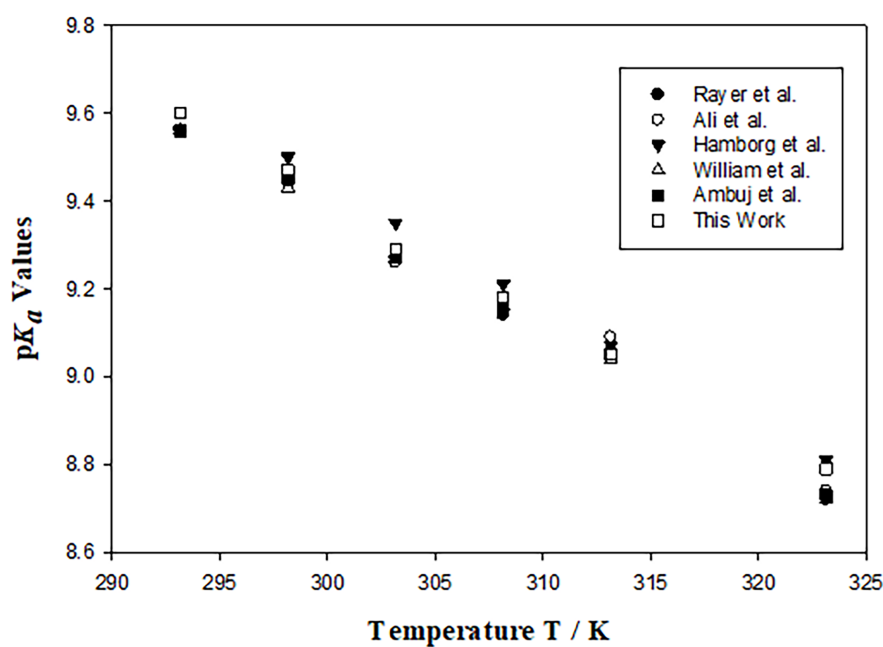
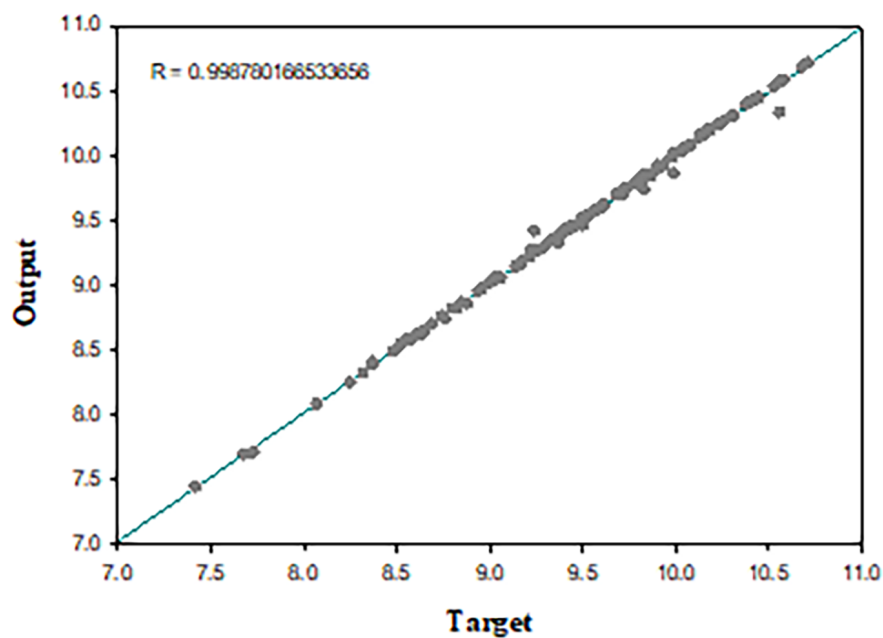


TABLE 3 Second Dissociation Constants for Diamines at Different Temperatures

Amine	Temperature T/K					
	293.15	298.15	303.15	308.15	313.15	323.15
3-(Diethylamino) Propylamine	8.42	8.24	8.06	7.91	7.73	7.52
1,3-Diaminopentane	8.36	8.17	8.06	7.86	7.69	7.4
Standard uncertainties: u(pK _a) = 0.02 and u(T) = 0.01K (0.95 level of confidence).						

TABLE 4 The Standard State Enthalpy Change (ΔH^0 / kJ·mol⁻¹) and Entropy Change (ΔS^0 / kJ·mol⁻¹·K⁻¹) of the First Dissociation Constants of the Studied Amines

Amine	ΔH^0 (kJ·mol ⁻¹)	ΔS^0 (kJ·mol ⁻¹ ·K ⁻¹)
3-(Diethylamino) Propylamine	46.05	-0.05
1,3-Diaminopentane	52.40	-0.02
3-Butoxypropylamine	52.83	-0.01
2-(methylamino) Ethanol	44.27	-0.04
Bis(2-methoxyethyl) Amine	39.21	-0.03
α -Methylbenzylamine	58.30	0.02
2-Aminoheptane	130.9	0.24
3-Amino-1-PhenylButane	65.68	0.03

TABLE 5 Standard State Free Energy of Reaction (ΔG° , kJ·mol⁻¹) of the First Dissociation Constants of the Studied Amines

Amine	Temperature T/K					
	293.15	298.15	303.15	308.15	313.15	323.15
3-(Diethylamino) propylamine	59.38	59.59	59.78	59.88	60.13	60.81
1,3-Diaminopentane	59.27	59.25	59.37	59.41	59.47	60.01
3-Butoxypropylamine	56.35	56.51	56.53	56.58	56.53	56.79
2-(Methylamino) ethanol	55.62	56.17	56.30	56.28	56.35	57.04
Bis(2-methoxyethyl) amine	48.77	49.20	49.39	49.38	49.46	49.93
α -Methylbenzylamine	53.32	53.48	53.22	52.74	52.94	53.02
2-Aminoheptane	60.11	60.11	59.43	58.94	55.40	53.51
3-Amino-1-phenylbutane	58.48	58.16	57.92	57.76	57.61	57.78

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TABLE 6 The Standard State Enthalpy Change (ΔH° / kJ·mol⁻¹) and Entropy Change (ΔS° / kJ·mol⁻¹·K⁻¹) of the Second Dissociation Constants of 3-(Diethylamino) propylamine and 1,3-Diaminopentane

Amine	ΔH° (kJ·mol ⁻¹)	ΔS° (kJ·mol ⁻¹ ·K ⁻¹)
3-(Diethylamino) propylamine	55.33	0.03
1,3-Diaminopentane	58.18	0.04

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TABLE 7 Standard State Free Energy of Reaction (ΔG° , $\text{kJ}\cdot\text{mol}^{-1}$) of the Second Dissociation Constants of 3-(Diethylamino) Propylamine and 1,3-Diaminopentane

Amine	Temperature T/K					
	293.15	298.15	303.15	308.15	313.15	323.15
3-(Diethylamino) propylamine	47.26	47.03	46.78	46.66	46.34	46.52
1,3-Diaminopentane	1.35	1.29	1.24	1.19	1.14	1.07

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TABLE 8 The Difference in Potential Energy Surface (PES) Between Protonated 3-(Diethyl-amino) propylamine and 1,3-Diaminopentane Structures

Model/Basis Set	ΔE ($\text{kJ}\cdot\text{mol}^{-1}$)	
	3-(Diethylamino) propylamine	1,3-Diaminopentane
HF/6-311G+(d,p)	64.91	-7.13
DFT/B3LYP/3-21G	5.72	-17.71
DFT/B3LYP/6-311G+(d,p)	14.93	-6.13
MP2/6-311G+(d,p)	21.00	-8.65

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TABLE 9 The Estimated pK_a Values of the Eight Amines with Three Different Methods at T = 298.15 K

Solvent	$pK_{a, PDS}^{19}$	$pK_{a, Summa}^{20}$	$pK_{a, QSSR}^{21}$	$pK_a^{Exp.}$
3-(Diethylamino) propylamine ^{V1}	10.63	10.44	10.24	10.44
3-(Diethylamino) propylamine ^{V2}	10.37	10.46	10.28	
1,3-Diaminopentane ^{V1}	10.64	10.46	10.28	10.38
1,3-Diaminopentane ^{V2}	10.64	10.46	10.28	
3-Butoxypropylamine	10.58	10.38	10.13	9.90
2-(Methylamino) ethanol	10.51	10.50	10.20	9.84
Bis(2-methoxyethyl) Amine	10.19	9.98	9.24	8.62
α -Methylbenzylamine	10.77	10.60	10.60	9.37
2-Aminoheptane	10.77	10.60	10.60	10.53
3-Amino-1-phenylbutane	10.77	10.60	10.60	10.19

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TABLE 10 Comparison Between the Estimated pK_a Values by Different Methods with Experimental Dissociation Constants

Amine	SHE Method		Theoretical Method			Cosmo-RS Method	Experimental Values
	pK_a without correction	pK_a with correction	DFT/B3LYP 6-31G(d)	DFT/B3LYP 6-311G++(d,p)	MP2 6-31G(d)		
3-(Diethylamino) propylamine ^{V1}	8.81	8.11	6.95	3.69	6.60	10.36	10.44
3-(Diethylamino) propylamine ^{V2}	10.27	9.57	8.74	6.81	8.23	9.89	
1,3-Diaminopentane ^{V1}	9.47	8.77	5.01	3.21	5.38	10.65	10.38
1,3-Diaminopentane ^{V2}	8.42	7.72	7.99	4.11	7.16	9.39	
3-Butoxypropylamine	8.18	7.48	7.88	4.94	6.24	10.02	9.90
2-(methylamino) ethanol	8.32	7.62	6.51	3.80	6.07	9.50	9.84
Bis(2-methoxyethyl) amine	6.65	5.95	4.45	1.70	3.76	7.07	8.62
α -Methylbenzylamine	7.69	6.49	5.20	2.13	4.74	9.29	9.37
2-Aminoheptane	8.78	8.08	7.21	4.30	6.31	10.43	10.53
3-Amino-1-phenylbutane	8.30	7.10	6.20	3.34	5.47	9.83	10.19

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TABLE 11 Dissociation Constant Values of the Studied Amines at Various Temperatures (K) for DFT1 (DFT/B3LYP/6-31G(d)), DFT2 (DFT/B3LYP/6-311G++(d,p)), and MP2 (MP2/6-31G(d)) Calculations by Hydronium Thermodynamic Cycle

Amine	Temperature /K																	
	293.15			298.15			303.15			308.15			313.15			323.15		
	DFT1	DFT2	MP2	DFT1	DFT2	MP2	DFT1	DFT2	MP2	DFT1	DFT2	MP2	DFT1	DFT2	MP2	DFT1	DFT2	MP2
3-(Diethylamino) propylamine ^{V1}	7.34	7.43	7.87	7.24	7.32	7.77	7.14	7.23	7.66	7.05	7.13	7.56	6.96	7.04	7.47	6.79	6.87	7.28
3-(Diethylamino) propylamine ^{V2}	9.16	10.61	9.53	9.03	10.45	9.40	8.91	10.31	9.27	8.79	10.16	9.15	8.68	10.02	9.03	8.46	9.76	8.80
1,3-Diaminopentane ^{V1}	8.41	7.85	8.44	8.29	7.75	8.32	8.17	7.64	8.21	8.06	7.54	8.10	7.96	7.44	7.99	7.76	7.25	7.79
1,3-Diaminopentane ^{V2}	5.34	6.94	6.62	5.30	6.94	6.63	5.26	6.77	6.46	5.23	6.09	6.38	5.19	6.61	6.30	5.12	6.45	6.16
3-Butoxypropylamine	8.32	8.71	7.50	8.18	8.57	7.40	8.04	8.44	7.31	7.91	8.31	7.21	7.79	8.18	7.12	7.55	7.94	6.95
2-(Methylamino) ethanol	6.90	7.54	7.33	6.81	7.43	7.24	6.72	7.33	7.14	6.63	7.24	7.05	6.55	7.15	6.96	6.40	6.97	6.79
Bis(2-methoxyethyl) amine	4.79	5.40	4.98	4.74	5.34	4.93	4.69	5.28	4.88	4.65	5.22	4.83	4.60	5.17	4.78	4.51	5.06	4.69
α -Methylbenzylamine	5.56	5.84	5.97	5.49	5.77	5.90	5.43	5.70	5.84	5.37	5.63	5.77	5.31	5.57	5.71	5.20	5.44	5.58
2-Aminoheptane	7.60	8.04	7.58	7.50	7.93	7.48	7.41	7.83	7.38	7.32	7.73	7.29	7.23	7.64	7.20	7.06	7.45	7.02
3-Amino-1-phenylbutane	6.58	7.07	6.72	6.49	6.98	6.63	6.41	6.88	6.55	6.33	6.80	6.47	6.26	6.71	6.39	6.11	6.55	6.24

TABLE 12 Dissociation Constant Values of the Studied Amines at Various Temperatures (K) for DFT1 (DFT/B3LYP/6-31G(d)), DFT2 (DFT/B3LYP/6-311G++(d,p)), and MP2 (MP2/6-31G(d)) Calculations by Protonated Thermodynamic Cycle

Amine	Temperature /K																	
	293.15			298.15			303.15			308.15			313.15			323.15		
	DFT1	DFT2	MP2	DFT1	DFT2	MP2	DFT1	DFT2	MP2	DFT1	DFT2	MP2	DFT1	DFT2	MP2	DFT1	DFT2	MP2
3-(Diethylamino) propylamine ^{V1}	10.45	7.13	10.09	10.19	6.93	9.85	9.95	6.74	9.61	9.71	6.56	9.38	9.48	6.38	9.16	9.04	6.03	8.73
3-(Diethylamino) propylamine ^{V2}	12.27	10.31	11.75	11.99	10.06	11.48	11.72	9.82	11.22	11.45	9.59	10.96	11.20	9.36	10.72	10.71	8.93	10.24
1,3-Diaminopentane ^{V1}	11.51	7.56	10.66	11.24	7.35	10.40	10.98	7.16	10.15	10.73	6.96	9.91	10.48	6.78	9.68	10.01	6.42	9.24
1,3-Diaminopentane ^{V2}	8.45	6.64	8.84	8.26	6.46	8.62	8.07	6.28	8.41	7.89	6.11	8.20	7.71	5.94	7.99	7.37	5.62	7.61
3-Butoxypropylamine	11.42	8.42	9.72	11.13	8.18	9.48	10.85	7.95	9.25	10.58	7.73	9.03	10.31	7.52	8.81	9.81	7.11	8.40
2-(methylamino) ethanol	10.00	7.24	9.55	9.76	7.04	9.32	9.52	6.85	9.09	9.29	6.66	8.87	9.07	6.48	8.65	8.65	6.14	8.24
Bis(2-methoxyethyl) amine	7.90	5.11	7.20	7.70	4.95	7.01	7.50	4.80	6.82	7.31	4.65	6.64	7.12	4.51	6.47	6.77	4.23	6.14
α -Methylbenzylamine	8.67	5.54	8.19	8.45	5.38	7.98	8.24	5.21	7.78	8.03	5.06	7.58	7.83	4.90	7.39	7.46	4.61	7.03
2-Aminoheptane	10.71	7.75	9.80	10.46	7.54	9.56	10.22	7.35	9.33	9.98	7.16	9.10	9.75	6.97	8.89	9.32	6.62	8.47
3-Amino-1-phenylbutane	9.69	6.77	8.94	9.45	6.58	8.71	9.22	6.40	8.49	9.00	6.22	8.28	8.78	6.05	8.08	8.37	5.72	7.68

TABLE 15 Neurons, Weights, and Biases for the Output Layer for the ANN Model in this Study

Second Hidden Layer Neuron																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Weight	-0.2425	0.1079	0.1664	-0.3607	-0.4238	0.1753	0.3360	-0.2893	-0.3036	-0.2694	0.4022	-0.1757	-0.0361	-0.2227	0.3160	0.2980	0.1107	-0.2892	0.1082	-0.4448

Second Hidden Layer Neuron																				
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Bias
Weight	-0.3494	-0.2602	-0.1228	0.1338	0.2542	0.1623	-0.1214	0.2947	-0.2579	0.1706	-0.1471	0.4089	0.4170	0.2894	-0.2602	0.1802	0.0809	0.4036	0.3339	0.2847

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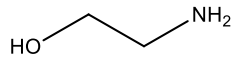
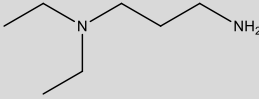
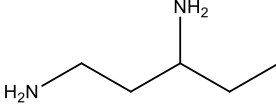
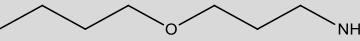
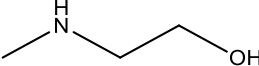
TABLE 16 Comparisons of the Reduced ANN Models' Performance

Removed Inputs	R_{test}	$\text{MSE}_{\text{train}}$	$\text{MSE}_{\text{validation}}$	MSE_{test}
Density	0.8165	0.0139	0.1127	0.0882
Refractive Index	0.8295	0.0020	0.6125	0.1453
Sound Velocity	0.8425	0.0127	0.1369	0.0369
Viscosity	0.6939	0.0578	0.1931	0.1629
Molecular Weight (MW)	0.7976	0.0317	0.0973	0.1132
Sound Velocity & MW	0.8416	0.0053	0.0740	0.0903
Refractive Index & MW	0.8321	0.0084	0.0847	0.0905
Density & MW	0.7231	0.0058	0.1476	0.1427
Density & Sound Velocity	0.8871	0.0105	0.0661	0.0532
Density & Refractive Index	0.6270	0.0367	0.2419	0.1563
Density & Viscosity	0.8141	0.0038	0.1202	0.0782
Refractive Index & Sound Velocity	0.8922	0.0088	0.0295	0.0789
Refractive Index & Viscosity	0.6970	0.0028	0.1146	0.1953
Sound Velocity & Viscosity	0.7965	0.0080	0.1086	0.1048

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TABLE 19 Neurons, Weights, and Biases for the Output Layer for the Reduced (Refractive Index & Sound Velocity) ANN Model																				
Second Hidden Layer Neuron																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Weight	-0.3520	-0.0192	-0.2240	0.2270	0.4230	-0.2280	0.4020	-0.3160	0.1970	-0.4130	0.1430	-0.1250	-0.3330	0.4030	-0.2460	0.1050	-0.1970	-0.0096	-0.3040	-0.3800
Second Hidden Layer Neuron																				
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Bias
Weight	0.3080	-0.2810	0.3210	-0.0485	-0.3340	0.3540	-0.3420	0.1720	0.4340	0.3530	-0.4710	0.2620	-0.3130	0.2380	0.3790	-0.2280	0.1970	0.0030	0.2470	0.3220

TABLE 1 Chemical Name, Structures, Suppliers, and Mass Purity (%) of the Studied Amines

Full Name	IUPAC Name	Abbreviation Name	CAS Reg. No.	Molecular Structure	Molecular	Supplier	Mass Fraction
					Mass (g·gmol ⁻¹)		Purity (%)
Monoethanolamine	2-Aminoethanol	MEA	141-43-5		61.08	Sigma- Aldrich	≥99
3-(Diethylamino) propylamine	N',N'-diethylpropane-1,3- diamine	DEAPA	104-78-9		130.23	Sigma- Aldrich	≥99
1,3-Diaminopentane	Pentane-1,3-diamine	EP	589-37-7		102.18	Sigma- Aldrich	98
3-Butoxypropylamine	3-Butoxypropan-1-amine	BPA	16499-88-0		131.22	Sigma- Aldrich	99
2-(Methylamino) ethanol	2-(Methylamino)ethanol	MAE	109-83-1		75.11	Sigma- Aldrich	≥98

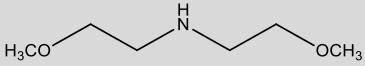
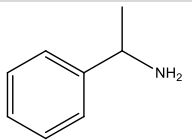
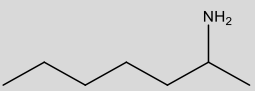
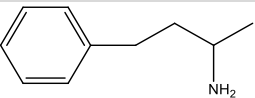
Bis(2-methoxyethyl) amine	2-Methoxy- <i>N</i> -(2-methoxyethyl)ethanamine	BMOA	11-95-5		133.19	Sigma-Aldrich	98
α -Methylbenzylamine	1-Phenylethanamine	PEA	618-36-0		121.18	Sigma-Aldrich	99
2-Aminoheptane	[(2 <i>R</i>)-heptan-2-yl]azanium	AH	123-82-0		115.22	Sigma-Aldrich	99
3-Amino-1-phenylbutane	4-Phenylbutan-2-amine	APB	22374-89-6		149.24	TCI	98

TABLE 2 Variations of the First pK_a of MEA and the Eight Amines Studied With Temperature (T/K)

Amine	Temperature T/K					
	293.15	298.15	303.15	308.15	313.15	323.15
3-(Diethylamino) propylamine (DEAPA)	10.58	10.44	10.3	10.15	10.03	9.83
1,3-Diaminopentane (EP)	10.56	10.38	10.23	10.07	9.92	9.7
3-Butoxypropylamine (BPA)	10.04	9.9	9.74	9.59	9.43	9.18
2-(Methylamino) ethanol (MAE)	9.91	9.84	9.7	9.54	9.4	9.22
Bis(2-methoxyethyl) amine (BMOA)	8.69	8.62	8.51	8.37	8.25	8.07
α -Methylbenzylamine	9.5	9.37	9.17	8.94	8.83	8.57
2-Aminoheptane	10.71	10.53	10.24	9.99	9.24	8.65

(AH)

3-Amino-1-phenylbutane	10.42	10.19	9.98	9.79	9.61	9.34
(APB)						
MEA ^{This Study}	9.60	9.47	9.29	9.18	9.05	8.79
MEA ¹⁴	9.56	9.45	9.27	9.14	9.06	8.72
MEA ¹⁵		9.47	9.26		9.09	8.74
MEA ¹¹	9.56	9.50	9.35	9.21	9.07	8.81
MEA ¹⁰	9.56	9.43	9.28	9.16	9.04	8.72
MEA ⁹	9.56	9.45	9.27	9.16	9.05	8.73

Standard uncertainties: $u(pK_a) = 0.03$ and $u(T) = 0.01\text{K}$ (0.95 level of confidence).

TABLE 13 Neurons, Weights and Biases for the First Hidden Layer for the ANN Model in this Study

Neuron	Temperature	Molecular Weight	Number of C	Number of H	Number of N	Number of O	Refractive Index	Sound Velocity	Density	Viscosity	Bias
1	-0.1606	0.0418	-0.2179	0.1791	-0.5387	0.5581	-0.0116	0.5601	0.3960	0.5408	0.1280
2	-0.0019	0.2824	-0.4485	0.6275	-0.4088	-0.0983	0.2342	0.2044	-0.2735	-0.9534	0.4230
3	0.3512	0.5736	-0.4307	-0.0813	-0.7615	-0.0966	0.6547	0.1445	-0.7132	-0.5333	0.3857
4	-0.7657	0.4059	0.2351	-0.1342	0.4731	0.5649	-0.5287	0.4273	-0.5889	0.4599	0.0970
5	-0.5625	0.6416	-0.0182	-0.5174	0.3660	0.6449	-0.1326	-0.6361	-0.2539	0.2892	-0.1645
6	0.0953	0.3919	-0.3118	0.3992	0.7698	-0.6674	-0.5810	-0.1775	-0.4318	-0.7450	0.1681
7	0.2029	0.7125	-0.5716	0.0432	-0.3829	0.6687	-0.4168	0.2658	0.2181	0.0705	-0.1781
8	-0.3264	-0.7266	0.3055	0.0234	-0.7161	0.0598	-0.5198	0.0999	0.6816	-0.4716	0.1862
9	-0.6917	0.3358	-0.2423	-0.3921	0.5583	0.2305	0.3588	-0.6494	0.4169	-0.7451	0.1513
10	-0.5985	-0.8256	-0.0713	0.6598	-0.2951	-0.1735	-0.0084	0.6206	0.4261	0.3258	-0.2165
11	0.7704	0.3803	0.4634	0.6663	-0.4879	0.6356	0.4890	0.1110	0.2620	-0.2092	0.0304
12	-0.3404	-0.5674	-0.7932	-0.5772	-0.4899	-0.2049	-0.5343	0.2947	-0.1619	-0.1266	0.0807
13	-0.0338	-0.6166	-0.3253	-0.7251	0.0677	0.6614	0.4311	-0.7018	-0.6937	-0.4153	0.1659
14	-0.2682	-0.5091	0.0480	0.3170	-0.7225	0.8834	-0.3158	0.0101	-0.4100	-0.1235	0.2524
15	0.2565	-0.1078	0.3414	-0.4316	-0.2166	0.0072	-0.7935	0.5236	-0.0566	-0.4636	-0.0757
16	0.3958	0.4307	-0.0701	0.2972	-0.6833	0.5825	0.6117	-0.5569	-0.6424	-0.5044	0.2795
17	0.0319	0.0469	-0.3511	0.0314	-0.9649	0.7494	0.4980	0.2465	-0.7343	0.5067	0.2693
18	-0.5768	-0.2701	0.6151	-0.5232	0.0859	-0.7951	-0.0321	0.0401	0.2094	-0.0761	0.3236
19	-0.1144	-0.7453	-0.0239	0.6069	0.8351	-0.2969	-0.0053	0.0238	-0.1657	0.5311	0.1203
20	-0.3066	0.4596	-0.4190	0.0733	-0.7205	-0.9337	-0.1272	-0.2780	-0.3781	0.2868	0.4707
21	-0.7033	-0.3322	-0.7593	0.0392	-0.3011	0.8993	0.5743	-0.6363	-0.5388	-0.5341	0.1583
22	-0.2757	0.5471	-0.7170	-0.3693	-0.8787	0.6861	-0.6731	-0.6895	0.0206	-0.1790	0.3536

23	0.0430	-0.5891	-0.5039	-0.0625	-0.5739	-0.1442	-0.3621	0.2378	-0.2223	-0.0527	0.3039
24	0.0180	0.8456	-0.2889	-0.6364	0.6036	-0.0969	-0.3055	0.2153	-0.3660	0.1361	0.1386
25	0.4003	0.1114	0.5461	-0.3675	0.6447	-0.0693	-0.7118	0.6243	-0.0737	0.0206	0.3567
26	0.2454	-0.4345	0.3552	0.4435	-0.8293	0.3049	-0.3266	-0.6133	-0.5094	-0.0145	-0.1643
27	-0.3604	0.1635	0.4420	0.7140	0.8929	0.0178	-0.2349	-0.6850	0.2051	0.4970	0.1628
28	0.3333	0.0583	0.3531	-0.1965	-0.3599	0.5106	-0.2346	-0.7218	0.7650	-0.3121	0.3366
29	-0.4641	-0.4724	-0.5901	0.2899	-0.0581	-0.5267	-0.3159	-0.8717	-0.0177	-0.0139	0.1253
30	0.1067	-0.4578	-0.2740	0.2515	-0.7895	-0.2120	0.1888	-0.3705	0.6872	-0.1911	0.3330
31	-0.3392	-0.1498	0.3646	0.6204	-0.1839	0.6582	-0.3199	0.1551	0.3568	0.1923	0.1583
32	0.4965	0.5742	-0.3691	0.1134	-0.0984	-0.8393	-0.8090	-0.2186	-0.6202	0.1156	0.2307
33	0.6700	0.2042	-0.0350	0.3204	0.3162	0.4469	-0.8651	0.5723	0.0352	0.3410	-0.2331
34	0.1773	-0.5900	0.4932	0.3290	-0.4802	-0.3170	0.5759	0.5560	-0.6513	-0.9507	0.3155
35	-0.2870	-0.0699	-0.0866	-0.2916	-0.1423	0.3922	0.7709	0.0266	-0.4360	0.1056	-0.1400
36	0.3352	-0.3374	-0.7176	-0.3203	0.6644	-0.0147	0.3215	0.2830	-0.7252	0.4149	0.3521
37	0.0020	-0.2064	-0.5518	-0.0655	0.2919	-0.6655	-0.6246	-0.6007	0.7581	0.5035	-0.1730
38	0.7213	-0.0464	0.2616	-0.7370	0.0446	-0.4197	-0.6358	-0.5214	-0.4455	0.3504	0.1515
39	0.0745	0.7063	0.3609	0.0959	-0.1461	-0.2016	-0.1824	0.7324	0.1838	-0.7503	0.2346
40	-0.7435	-0.4516	0.6738	-0.1484	-0.1391	0.3766	0.5637	0.3620	-0.5014	-0.2568	0.1497

TABLE 14 Neurons, Weights and Biases for the Second Hidden Layer of the ANN Model in this Study

Second Hidden Layer	First Hidden Layer																				
	Neuron	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	1	-0.1406	-0.5220	0.2620	0.0433	0.0436	0.2505	0.0772	0.3252	0.4780	-0.2089	0.1207	0.3259	-0.0076	-0.3707	0.2342	0.1582	-0.4062	0.2941	0.2141	-0.4805
	2	-0.0641	0.3851	-0.0597	0.2090	-0.2911	0.2493	0.0592	0.4414	0.1089	0.0300	0.0559	-0.1437	0.0879	0.1158	0.1559	0.3365	0.3371	-0.0560	0.2150	-0.0775
	3	0.1139	0.3216	-0.0013	0.2787	0.0364	0.1226	-0.4049	0.2608	0.1083	-0.2419	0.1292	-0.1896	-0.0055	-0.2848	0.2669	0.2151	0.0622	0.4145	-0.0195	-0.2681
	4	-0.3921	0.2468	-0.2404	0.0857	-0.1646	-0.1200	-0.2069	-0.2492	0.0629	-0.2256	-0.3930	0.0401	-0.0819	-0.3141	0.0236	0.1730	-0.2725	-0.3016	-0.0239	-0.3218
	5	-0.3081	0.2905	-0.2567	0.2731	-0.2699	-0.0662	0.0145	-0.4032	-0.3600	-0.2934	0.0785	0.2710	-0.0830	0.1712	-0.0867	0.3642	-0.0871	-0.4488	-0.1178	0.1331
	6	0.0524	0.5694	0.3378	-0.0142	-0.1306	0.3685	0.1986	0.0699	-0.3546	0.3959	0.2108	0.3006	0.3608	0.0919	0.2979	-0.1522	0.1566	0.3083	0.2956	0.1799
	7	0.1532	0.4936	0.1777	-0.0361	-0.3961	0.0101	0.0091	0.3864	0.2972	-0.2380	0.1046	-0.2154	-0.1241	0.3974	-0.0636	-0.0613	0.3664	0.0290	0.4316	-0.1164
	8	-0.2971	0.2172	-0.4004	-0.3254	0.2207	-0.0646	-0.0109	0.3193	0.3355	0.2138	0.1669	-0.0251	-0.1417	-0.0079	-0.1347	-0.1352	-0.1244	-0.1763	-0.2312	0.0903
	9	-0.2667	-0.5043	-0.4362	0.2141	0.1282	0.2850	0.4435	0.0080	0.3238	-0.4930	-0.3327	-0.1548	-0.1791	0.2022	-0.3028	-0.0363	-0.1057	-0.1486	0.1679	-0.0762
	10	-0.3028	-0.0350	-0.0890	-0.0354	0.3422	0.2009	-0.2660	0.0356	-0.1812	0.2848	-0.1420	0.3929	-0.2222	0.1075	-0.0936	-0.2289	0.3026	0.1279	0.0528	-0.0947
	11	0.2781	-0.1349	0.0426	0.0235	-0.2321	-0.1963	-0.1786	0.1776	-0.4179	-0.3884	0.0947	-0.4087	0.0784	-0.1527	0.1976	0.1873	0.3724	0.4615	0.3817	0.4288
	12	-0.3314	0.1522	-0.0697	-0.1476	-0.2753	0.2824	-0.4825	-0.3862	-0.2801	-0.2798	-0.4228	0.1474	-0.2675	-0.2088	0.0903	-0.1468	0.0241	-0.0179	0.0285	0.2227
	13	-0.0243	-0.3137	0.3234	0.3165	0.2108	-0.0599	-0.1065	-0.2375	0.0897	0.2386	0.2943	-0.3956	0.4071	-0.1538	0.1853	0.0392	0.1325	-0.2416	0.2460	-0.3155
	14	-0.4207	-0.4424	-0.4699	0.2896	-0.1649	0.1521	-0.1741	0.0379	-0.2452	-0.0617	-0.2094	-0.3117	0.3083	0.3793	0.3327	0.0777	-0.4512	-0.0947	0.2239	0.1765
	15	0.1307	0.1257	0.0679	-0.2171	-0.1956	0.0543	0.1855	0.1408	-0.0027	-0.2647	-0.4571	-0.0934	0.0649	0.3730	-0.0351	-0.2535	0.4531	0.1238	-0.0314	0.1276
	16	0.1312	0.1767	0.2067	-0.3377	-0.1273	0.4508	-0.0290	-0.2301	0.2660	-0.0051	0.2071	-0.2144	-0.0116	-0.0501	-0.3595	0.3049	0.0258	0.1592	-0.1188	0.4361
	17	0.0100	0.5449	0.3225	0.3089	0.1688	0.0145	0.2309	0.3835	0.2629	-0.2570	0.2010	-0.1687	0.3562	0.2249	-0.3358	0.2508	-0.2291	0.0774	-0.2082	0.3325
	18	-0.2277	-0.0677	-0.0486	-0.3494	-0.3043	0.2349	-0.1302	-0.0291	0.2950	-0.4888	0.2906	-0.0258	0.2462	0.2469	-0.4652	0.1856	0.0874	0.2405	-0.3172	-0.2777
	19	-0.1043	0.0572	-0.0568	0.2316	0.0118	0.4908	0.1115	0.2316	0.1884	0.1855	-0.1505	-0.3323	-0.3209	-0.1386	-0.1029	0.2485	-0.1091	0.1514	0.4495	0.0753
	20	-0.2704	-0.3722	0.2123	0.0795	-0.1884	0.1651	-0.4748	-0.3302	-0.1993	-0.0650	-0.2008	0.2241	-0.1425	0.0771	0.0132	-0.2348	-0.1603	-0.1179	0.0771	0.0409

	21	-0.4568	0.2047	0.0152	-0.3129	-0.4263	0.1829	-0.3396	0.0342	-0.3056	0.0135	0.2356	-0.3022	-0.1676	0.0394	0.3372	0.4071	0.1740	-0.3581	-0.0536	-0.0808
	22	-0.0709	-0.1581	-0.2812	0.3837	-0.1724	0.3719	0.3878	0.0189	-0.2325	-0.2006	0.4298	-0.3183	-0.3252	0.1380	-0.0273	-0.0010	0.1012	0.0870	0.3157	-0.1116
	23	0.0786	0.2550	-0.3996	0.1617	0.4286	-0.3293	0.2945	-0.6878	-0.0589	0.0038	0.3619	-0.5059	-0.3676	-0.1545	-0.0067	0.1836	-0.0754	-0.2292	0.0969	0.0506
	24	0.0422	0.0068	-0.1938	0.1053	-0.2720	0.0101	-0.0283	0.2374	-0.2937	-0.0122	0.1374	0.3433	-0.1765	0.2998	-0.0573	0.2604	0.1388	0.2053	-0.2033	0.5564
	25	0.2520	0.3857	-0.3463	-0.3316	-0.2794	-0.3172	-0.0038	-0.0044	-0.4220	-0.1891	-0.2214	-0.4116	0.0366	-0.0049	-0.0745	0.1595	0.0171	0.1823	-0.0339	0.3030
	26	0.0248	0.3386	0.0091	0.0098	-0.2635	0.4802	-0.0837	-0.0436	0.0693	0.3055	0.1646	0.3271	0.3730	0.0243	-0.4007	0.3458	-0.1571	0.2863	-0.1073	0.4638
	27	-0.1794	-0.3931	0.3003	-0.4865	-0.3378	0.2500	0.3262	-0.2257	-0.0038	-0.1156	-0.0936	-0.0671	-0.2760	-0.2080	0.4135	0.3486	-0.2006	0.2483	0.2931	-0.1503
	28	0.1610	0.2878	0.2982	-0.1795	0.2950	0.0791	-0.3599	-0.1901	-0.1720	0.3546	0.3006	0.0699	0.1269	0.1191	0.0898	0.4007	0.0054	-0.2089	0.2814	0.3455
	29	-0.2899	-0.0251	0.1417	0.1799	0.2286	-0.0092	-0.2084	-0.2463	-0.2812	0.1181	-0.3383	-0.0005	-0.3666	0.1527	0.2171	-0.0763	0.1146	-0.2853	0.3364	-0.1187
	30	0.0222	0.0368	0.3488	0.3453	-0.3677	0.1315	-0.2404	0.2383	-0.0613	-0.2496	-0.0408	0.1619	0.0431	-0.2558	0.0675	0.1443	0.4499	0.4638	0.2888	0.0531
	31	-0.0876	-0.3058	-0.3741	-0.1372	0.2921	0.0369	-0.2710	0.0701	-0.0215	-0.1588	0.3393	-0.4207	0.3685	0.1215	-0.3683	0.1407	-0.0506	-0.3704	0.2876	0.0111
	32	0.2372	0.1311	-0.1026	0.0616	-0.1637	0.1571	-0.1361	0.3294	-0.1954	0.0055	-0.0174	-0.2463	0.2527	-0.2722	-0.4205	0.1578	0.0866	-0.0876	0.4029	0.4013
	33	0.3074	0.5796	0.2672	0.1706	0.0452	0.2762	-0.1420	-0.2147	0.0023	0.1806	-0.1328	-0.0393	0.3985	0.1586	0.1846	0.2657	0.2756	0.4651	-0.2641	0.4316
	34	0.1582	0.4017	0.1298	0.2009	-0.2780	-0.2077	-0.1437	-0.2995	-0.3896	0.0455	0.0544	0.3745	-0.0589	0.2888	-0.2097	0.0206	0.1857	-0.2535	-0.5150	0.1893
	35	-0.2777	-0.1416	-0.0215	-0.0303	0.1246	-0.1345	0.0066	-0.2876	0.4103	-0.0667	0.1351	-0.2339	0.0424	-0.1074	-0.1454	0.0655	-0.5144	-0.1339	-0.3041	-0.1637
	36	0.0803	0.0987	0.4278	0.1621	0.0003	0.4169	0.1084	-0.4187	0.3001	0.2790	-0.2786	0.1928	-0.2995	-0.1375	-0.4427	-0.2169	0.1860	-0.0640	-0.0608	0.0502
	37	-0.0223	0.1187	0.1217	0.2629	0.2363	-0.2881	-0.1345	-0.0720	0.0416	-0.1344	0.1771	0.1962	-0.2916	0.2605	-0.2993	-0.1979	0.1469	-0.0677	0.2635	-0.0695
	38	0.3396	0.1540	-0.2236	-0.0463	-0.1797	0.2892	-0.3870	0.2219	0.2963	-0.0250	0.2840	0.3957	0.1636	-0.0511	-0.3449	-0.2259	0.1768	-0.0775	0.1079	0.0958
	39	0.0267	0.2729	-0.1904	-0.2475	-0.3583	0.0162	-0.3899	-0.1279	0.1726	-0.1347	-0.1325	0.0407	-0.1970	-0.0160	-0.4419	-0.3002	0.1439	0.2575	0.0403	-0.0307

Second Hidden Layer	First Hidden Layer																				
	Neuron	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1	0.0768	-0.2115	0.0147	-0.0994	-0.0585	-0.3543	-0.1715	0.2062	0.3290	0.2921	-0.5487	-0.3978	0.5125	-0.1825	-0.0264	-0.0328	0.3035	-0.1804	-0.2091	0.1079	-0.1644

2	0.4092	0.5371	0.3804	0.0179	0.0640	0.3294	-0.3631	-0.2145	-0.1189	0.3614	-0.0715	0.3624	0.1609	0.4641	0.1006	0.4432	-0.2340	-0.3445	0.3538	-0.0251	0.4134
3	-0.3651	-0.2190	-0.0987	0.4580	0.2708	0.2857	0.2903	0.3870	-0.2020	-0.1909	0.1149	-0.1917	0.2763	-0.2033	-0.4119	0.4892	-0.1086	0.1483	0.0987	0.0931	0.2474
4	0.1350	-0.2927	0.2175	0.1051	-0.2861	-0.0382	-0.3253	0.3285	0.1030	-0.1720	0.3702	-0.2329	-0.1797	0.1661	0.0731	0.0200	-0.0478	0.0874	0.3169	0.1547	-0.0280
5	-0.2425	0.0364	0.0037	-0.2898	-0.1407	0.1771	0.2238	-0.2577	-0.4197	0.1141	0.2041	-0.2762	0.0760	0.1236	0.0119	0.2809	-0.1828	-0.1005	-0.3647	0.3120	-0.0463
6	0.4142	0.1872	0.2236	0.3866	-0.1688	-0.3020	0.2444	0.3114	-0.1808	0.2120	0.1345	-0.2245	-0.3553	-0.0980	-0.2091	0.3503	0.1050	0.3917	0.3177	0.0107	0.3189
7	0.0223	0.4778	0.3185	0.1326	-0.2195	-0.2555	-0.4893	-0.2962	0.1763	0.5453	-0.0360	-0.2170	0.2171	0.1882	-0.4124	0.2948	-0.2496	0.0910	-0.0572	0.2494	0.3130
8	0.3333	0.0980	0.3247	-0.2698	-0.3194	-0.0073	0.1240	-0.4326	-0.1819	-0.0623	-0.3973	0.0911	0.1929	-0.0298	0.3843	0.0455	-0.3282	-0.2059	-0.2972	-0.3177	-0.1035
9	0.3598	0.3110	0.2687	-0.3894	-0.0076	0.2168	-0.2589	-0.0210	-0.0376	-0.5393	-0.2733	-0.1299	0.2692	0.0982	-0.0028	0.2771	-0.1642	0.3826	-0.4205	0.0409	-0.1543
10	-0.0953	0.0665	0.3227	-0.3548	-0.2585	0.1379	-0.4123	-0.2009	-0.2568	-0.2654	0.0734	0.2714	0.3240	0.1576	-0.1206	0.1251	0.3158	-0.3566	-0.3726	0.2681	-0.2014
11	0.0458	0.0744	-0.1277	-0.2280	0.0205	-0.1742	0.3784	-0.0088	-0.1059	0.0576	0.1523	0.3100	-0.2735	0.3601	-0.2291	0.1558	-0.4212	-0.0450	-0.1154	0.3918	0.3126
12	0.2147	0.1505	0.2628	0.0269	-0.1339	0.3442	0.2972	-0.1315	0.3019	-0.0895	-0.1776	0.0536	-0.3029	-0.1803	0.0692	-0.0582	0.3272	-0.3341	-0.3433	-0.2139	-0.1349
13	0.3632	-0.2730	-0.2979	-0.3590	-0.2084	-0.1768	0.3498	0.4246	0.1995	0.2020	0.0999	0.1912	-0.3977	0.2876	-0.1727	-0.4491	-0.2983	0.3381	-0.0804	0.2067	-0.1565
14	0.1828	0.3223	-0.2847	-0.1042	-0.0538	-0.0545	-0.1139	-0.0173	0.1147	0.1866	-0.2594	-0.1400	0.0958	-0.2323	0.2645	-0.0352	0.0840	0.2827	-0.1351	-0.2243	-0.1283
15	0.3233	0.3846	0.2227	0.2052	0.1877	0.0643	0.2911	0.2369	0.3335	0.3638	-0.0743	-0.0556	-0.4286	0.4726	-0.2963	0.4134	0.3043	0.0039	0.0831	-0.2960	0.3516
16	0.1076	0.4335	-0.1987	0.3943	0.0108	0.1632	0.0260	-0.2115	-0.1259	0.4290	0.1836	0.0185	-0.0354	0.0629	-0.4009	0.3964	0.3355	-0.2840	-0.0638	-0.3073	0.3290
17	0.0945	-0.0016	0.0906	0.1655	0.3999	-0.1266	0.1329	-0.2400	0.0474	-0.0254	-0.3284	0.3026	-0.4537	0.1651	0.2115	-0.0801	-0.2859	0.3218	-0.1546	0.4495	0.3774
18	0.0656	0.0566	-0.4382	-0.0410	0.0271	0.1031	0.1107	0.4151	-0.1047	-0.1403	-0.2433	-0.3944	0.3803	-0.0117	0.2807	0.2279	0.3073	-0.2450	0.2814	0.2454	-0.1655
19	-0.2544	-0.3225	0.2706	0.2289	0.1437	0.1439	0.2801	0.3142	0.0274	-0.2264	-0.3394	-0.1081	-0.4067	0.3922	-0.3898	0.2621	-0.2371	-0.1866	-0.0031	0.2040	0.3144
20	0.3372	0.1532	0.3816	0.1402	0.0152	0.4948	-0.3293	-0.4918	0.4262	-0.5084	-0.5253	0.3098	0.3345	-0.1641	-0.3705	-0.1531	0.2976	-0.1324	-0.3610	0.0824	-0.0927
21	-0.3999	-0.4606	-0.3476	0.0986	0.0051	0.0378	-0.0709	-0.0559	-0.2388	0.4424	0.1879	-0.4341	0.0372	-0.0603	0.1180	0.0371	-0.1459	0.0330	0.3200	0.2854	-0.1162
22	-0.1028	-0.3448	-0.1991	-0.1618	0.2872	-0.3268	0.0497	-0.3798	-0.2699	-0.4961	0.2881	-0.3615	-0.0233	-0.2507	0.3174	-0.2758	0.2484	0.0631	0.3159	-0.2641	-0.0715
23	-0.3099	-0.0873	0.0028	0.1242	-0.6426	-0.2623	-0.2061	0.0927	-0.0629	-0.4159	-0.0286	-0.4137	0.1579	-0.3793	-0.0194	-0.1521	0.3298	-0.3829	-0.0159	-0.1715	-0.0265
24	-0.2692	0.3070	0.0665	-0.2796	-0.1868	0.4225	0.0645	0.3148	0.3030	0.3923	0.0418	-0.1556	-0.1325	-0.1062	-0.2433	0.1793	-0.3519	0.2869	0.2944	-0.2146	0.3654
25	-0.1678	-0.3027	0.3130	-0.3195	0.2117	-0.3045	-0.3834	-0.2386	-0.4193	0.2101	0.0036	0.0073	0.3075	-0.0898	-0.0688	-0.0589	-0.0459	-0.1477	-0.1263	-0.0533	0.0114

26	0.1722	0.2609	-0.0387	0.0130	0.1732	0.3656	-0.0309	0.1643	0.3881	0.3819	0.2843	-0.2041	-0.3372	-0.1243	-0.2628	0.1515	-0.0367	-0.3337	-0.2197	0.1892	0.3510
27	-0.0566	-0.3334	0.3504	-0.3445	0.0224	0.2836	0.2706	-0.0897	-0.1879	-0.1814	-0.4275	0.0805	0.0043	0.1290	0.2662	-0.0484	0.2067	0.2821	0.0961	0.3103	-0.1659
28	0.0355	0.2943	0.3186	0.0362	0.0576	-0.0247	-0.1003	0.0155	0.2863	0.1684	0.1270	0.2510	-0.3091	0.0321	0.0459	-0.0124	0.0469	-0.3546	0.3117	0.2399	0.3114
29	-0.0427	0.0004	-0.3161	-0.2563	0.0967	-0.1734	0.2595	-0.1448	-0.1880	-0.0135	-0.1192	-0.0035	-0.3545	0.1559	0.0771	-0.5105	0.2219	-0.1221	-0.1376	-0.3183	-0.0795
30	-0.2031	0.1744	-0.1012	0.0341	0.2824	-0.3173	0.2654	0.2101	-0.1753	0.3096	0.0469	0.1292	-0.4504	0.2142	0.0907	-0.2426	-0.2603	-0.1283	-0.2757	0.4494	0.3747
31	-0.1771	-0.3055	-0.2837	-0.3544	0.1830	-0.0731	0.2997	0.4541	-0.0374	0.2708	0.1544	0.1015	0.1715	0.1272	0.1744	-0.2146	0.1630	0.2823	0.2248	-0.4986	-0.1474
32	-0.2729	-0.4100	-0.0402	-0.2369	0.3211	-0.4620	-0.3468	-0.4386	0.2452	0.1687	-0.2917	-0.1681	0.2985	0.3626	0.1712	-0.0989	0.1732	-0.0771	-0.2158	0.0572	0.2211
33	0.1280	-0.0678	0.4240	0.2189	0.3553	0.3110	0.3399	0.3294	-0.0337	0.0175	-0.0358	0.2161	0.2083	-0.1373	0.0923	0.1798	-0.0126	0.3294	0.3085	0.0494	0.2954
34	-0.1181	0.4813	0.2657	-0.2980	-0.1540	0.0114	-0.5148	0.3089	0.0464	0.2665	0.1773	-0.2325	-0.0546	-0.2807	0.0767	-0.1897	-0.0663	-0.0438	0.3282	0.1695	0.2822
35	0.4581	0.3894	0.1499	-0.2715	-0.2068	-0.1187	-0.1987	-0.2565	0.3042	-0.1692	0.0147	0.3637	0.1131	0.2892	0.2375	0.3863	0.3747	0.0534	0.0752	0.2193	-0.1500
36	-0.3805	-0.2995	0.2911	0.1375	0.3437	-0.3888	0.2640	0.0043	-0.1504	0.4632	-0.3192	-0.1903	0.1491	0.4511	0.1718	-0.0885	0.2726	0.3631	0.1532	-0.2430	0.2411
37	-0.1288	0.4878	0.3445	-0.0369	0.1648	-0.1732	0.1582	-0.2456	0.2495	0.0618	0.1647	0.3431	-0.2958	0.1673	0.0529	-0.1069	-0.2629	0.0394	0.2848	0.4427	0.3552
38	0.1515	0.2402	-0.2384	0.3824	0.0711	-0.1920	0.3547	0.2359	-0.0921	0.1478	0.0240	0.0551	-0.2322	0.1581	0.0075	0.0301	-0.2963	0.2191	-0.0286	0.1005	0.3033
39	-0.0981	-0.3711	0.0208	0.3721	0.2402	-0.1475	-0.4202	-0.2950	0.0904	-0.1111	0.0284	0.3176	-0.0301	0.4134	-0.0569	0.4671	-0.1343	-0.0426	0.3297	0.0781	0.2472

TABLE 17 Neurons, Weights and Biases for the First Hidden Layer for the Reduced (Refractive Index & Sound Velocity) ANN Model

Neuron	Temperature	Molecular weight	Number of C	Number of H	Number of N	Number of O	Density	Viscosity	Bias
1	-0.1124	0.6348	-0.1873	0.4645	0.1034	0.2243	0.0002	-0.1052	-0.1158
2	0.0615	-0.3450	-0.8294	-0.1796	-0.4868	-0.2349	0.0533	-0.3133	0.1328
3	0.5461	-0.0927	0.6757	0.2881	-0.6074	0.4297	-0.4679	-0.5559	0.1199
4	0.0927	0.5841	-0.1074	0.5233	-0.4246	-0.4336	-0.4754	0.5572	-0.1090
5	0.1490	-0.5444	0.6037	0.4292	0.4622	-0.4950	-0.2201	-1.0798	0.3012
6	0.5757	0.2660	-0.5993	0.0854	-0.4168	0.5109	-0.3404	0.8664	0.2324
7	0.5141	0.5379	0.4001	0.5429	-0.2441	0.4389	-0.5126	0.3049	0.1068
8	0.0563	0.2174	0.4328	0.5608	0.5297	-0.1892	-0.3629	0.4120	0.2365
9	0.4652	-0.3000	0.1158	0.7321	0.3856	-0.8809	0.3438	0.4824	-0.0531
10	0.7418	0.3283	-0.6438	0.7119	0.4064	-0.8005	-0.1244	-0.3977	0.1852
11	0.2276	0.8759	0.6164	0.8747	0.0400	0.3592	-0.8716	0.6410	-0.2100
12	0.1087	-0.7280	0.2788	0.0503	-1.2021	-0.0328	0.3785	-0.0224	0.3546
13	-0.5202	0.6770	-0.0261	-0.6915	0.8760	-0.9841	0.0394	0.6508	0.1744
14	0.0531	0.8788	0.9902	-0.0819	-0.3536	-0.1227	-0.2712	0.7150	0.1844
15	0.2421	0.8376	-0.6455	0.9184	0.6953	0.4072	-0.2738	0.8454	-0.1895
16	0.0890	0.4068	0.0635	0.5081	0.5596	-0.4588	-0.4789	-0.8583	0.2146
17	0.2639	-0.3405	-0.6563	-0.5088	0.1728	0.3697	-0.4624	-0.4943	0.1529
18	0.7855	-0.3594	0.5913	0.1127	0.3087	0.1566	0.6119	-0.3837	0.1080
19	0.1410	-0.0114	0.7488	-0.7060	-0.6965	0.3823	0.6775	-0.2402	0.2199
20	0.3099	-0.6274	-0.3260	-0.1632	-0.4577	-0.4790	-0.7153	0.0169	0.3601
21	0.4944	0.0026	0.5356	-0.0617	-0.0308	0.5477	-0.6159	-0.7886	0.3109
22	0.7639	-0.1264	0.2089	0.9107	-0.5838	-0.7296	0.6672	-0.2214	-0.2152

23	0.1166	0.1045	0.3700	-0.9411	0.8753	0.2054	0.3032	0.1617	-0.0329
24	0.0609	-0.1350	-0.1921	0.3794	-0.8310	0.6281	0.6988	-0.6927	0.2667
25	-0.6552	0.7355	-0.4250	0.3771	0.2129	-0.3710	-0.0342	-0.6665	0.3866
26	0.6890	-0.5657	0.6196	-0.2864	-0.3520	-0.2700	0.5165	0.5083	-0.1347
27	-0.6732	0.2030	0.5096	-0.1973	-0.9718	-0.6391	0.6424	-0.6936	0.2777
28	0.2173	0.5484	-0.3094	0.0621	0.1741	-0.6550	0.2073	0.4688	-0.0303
29	-0.6974	0.4656	0.1492	-0.3026	0.7717	0.9050	-0.7429	-0.6089	0.1536
30	0.1526	-0.4806	-0.6957	0.8162	-0.7643	0.4780	0.2927	0.7566	0.1915
31	0.0945	-0.5134	-0.2309	0.7205	0.9501	-0.5224	-0.5596	0.6869	0.0859
32	0.2465	-0.2837	-0.2653	0.6383	-0.7153	-0.4952	-0.4650	-0.5650	0.5163
33	0.0365	-0.7152	0.6098	0.8256	-0.3674	-0.8255	-0.1359	0.8580	-0.2322
34	0.5208	0.2592	-0.8057	0.1775	0.1458	0.3018	-0.5660	0.3805	-0.3196
35	-0.2938	-0.7255	0.7986	0.3319	-0.0357	0.0326	0.2618	0.4753	0.2338
36	0.0461	-0.5900	0.9098	-0.7344	-0.6309	0.5015	-0.2017	0.5709	0.3059
37	0.1191	0.5190	0.5997	-0.7229	-0.3856	0.8398	-0.3775	-0.2760	0.2416
38	0.9021	0.4589	-0.7767	0.2780	-0.1635	0.1610	-0.3135	0.6061	-0.2489
39	-0.2666	-0.0804	0.1347	0.1864	-0.7957	0.4831	-0.7491	-0.6082	0.6132
40	0.2850	0.7118	-0.7793	-0.2098	-0.5247	0.3116	-0.1219	0.4998	-0.1063

TABLE 18 Neurons, Weights and Biases for the Second Hidden Layer of the Reduced (Refractive Index & Sound Velocity) ANN Model

Second Hidden Layer	First Hidden Layer																				
	Neuron	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	1	-0.1130	0.2500	0.3210	-0.2440	-0.0862	0.2500	0.1120	0.1610	-0.0157	-0.0831	0.0158	-0.0696	-0.1380	-0.5570	-0.2110	-0.3910	0.0779	-0.0925	0.2760	0.2720
	2	0.1920	0.0169	-0.0515	-0.0243	0.2800	0.1490	0.0796	0.0199	-0.0004	-0.3660	0.0374	-0.2410	0.0160	-0.0773	0.1210	0.1660	-0.4440	-0.3050	0.2660	-0.0588
	3	0.3380	0.0986	-0.2280	0.1810	0.0651	0.2510	-0.1890	-0.2970	-0.0560	-0.3270	0.1470	-0.3060	-0.0109	0.0110	-0.0519	0.3530	0.0070	-0.1130	0.0289	0.0852
	4	0.0029	-0.2870	-0.1520	0.2410	-0.0852	-0.2720	-0.3080	0.2290	0.0400	-0.3450	-0.1940	-0.2340	-0.2220	0.2550	-0.2780	-0.1950	-0.2800	-0.3630	0.1030	0.2020
	5	-0.0007	0.1900	-0.3000	0.3990	0.0803	-0.0425	-0.0978	0.0110	-0.1940	-0.1910	0.2480	-0.1630	-0.4170	0.3800	-0.0309	0.1470	0.3210	-0.0858	-0.3130	0.0712
	6	0.0756	-0.3330	0.3130	-0.3870	0.3590	0.0350	0.3970	0.3560	-0.0578	0.1760	0.3720	0.3200	0.2500	0.1930	-0.2960	-0.2860	0.2310	0.0960	-0.1210	0.0331
	7	0.1040	-0.2420	0.4010	0.2160	0.0436	-0.0560	0.1370	0.2910	-0.1320	-0.0003	0.2710	-0.3060	-0.0497	0.1310	-0.1280	0.3250	-0.3770	0.2800	0.1590	0.2920
	8	-0.4420	-0.0948	0.2920	0.1810	0.4170	0.0836	-0.3010	0.2410	0.4190	-0.2300	0.3710	-0.3380	-0.1050	0.3020	-0.1650	0.1830	-0.0523	0.2230	0.1380	-0.4550
	9	-0.2180	0.0290	0.3720	0.0618	-0.2620	0.1110	0.4140	-0.2540	-0.2210	-0.0907	-0.0221	0.0773	-0.4180	-0.0377	0.0335	0.0189	-0.5090	0.2020	0.3530	-0.3040
	10	-0.2720	0.2590	-0.1100	-0.1360	0.2760	0.2640	-0.1120	-0.2390	-0.2080	0.1240	0.4520	0.3210	0.2330	-0.0212	0.0116	-0.1730	-0.3350	0.1470	-0.1530	0.3590
	11	-0.2510	0.3300	-0.2370	-0.0599	0.1830	-0.2230	-0.0796	-0.2410	-0.0792	0.1490	0.0378	0.3650	-0.2550	-0.4200	-0.0699	0.3110	-0.3300	-0.4470	-0.3490	0.1100
	12	0.0316	0.3330	-0.3090	-0.1350	0.0516	0.2210	0.0025	-0.2220	0.3730	-0.1260	-0.1940	-0.2900	-0.1520	0.3920	0.0601	-0.1390	0.2470	0.0685	-0.0674	0.1090
	13	-0.0388	-0.3170	-0.2070	-0.1660	0.2590	-0.2280	-0.2220	-0.1330	0.1220	0.3330	-0.1190	0.1020	0.0698	0.1670	0.1320	0.1160	-0.0554	-0.2800	0.1730	-0.0591
	14	0.0190	0.0555	0.1490	0.1250	0.0242	-0.3140	0.0072	0.1240	-0.0191	0.2440	0.0171	-0.1740	-0.3590	-0.4420	0.2790	-0.4100	-0.0249	-0.3060	0.0589	-0.2580
	15	-0.2480	-0.1440	0.1710	0.0332	0.2420	-0.3640	0.2500	0.3490	0.2740	-0.2760	-0.1150	-0.1000	0.1400	-0.3710	-0.2810	-0.0389	-0.0917	-0.4830	-0.0861	-0.3190
	16	0.2560	-0.3850	-0.1730	-0.2310	-0.2540	-0.2530	0.4930	0.0831	-0.1310	-0.3690	-0.1120	-0.3630	-0.3610	-0.1680	-0.0180	0.1160	0.2210	0.0690	-0.1470	-0.4690
	17	-0.0384	-0.3590	0.5390	-0.2420	-0.3240	-0.0394	0.2010	0.3080	-0.4700	0.2240	0.0091	0.0401	0.0514	0.1080	-0.2060	0.0955	-0.4210	0.3750	-0.0885	0.2980
	18	-0.2950	-0.3000	-0.1890	0.1410	-0.2440	0.0490	-0.2770	-0.2220	-0.2540	-0.1050	0.2530	-0.3600	0.0608	0.1560	-0.3110	0.1850	-0.1350	0.3540	0.0164	0.4220
	19	-0.2430	-0.3460	0.0064	-0.0890	0.1500	-0.1740	0.3440	-0.2930	0.3920	-0.1010	0.2510	0.0933	-0.1920	-0.2670	-0.2180	-0.0743	-0.0221	-0.2540	0.0888	-0.0590
	20	0.3380	-0.1120	0.0249	-0.2560	-0.2260	0.0755	-0.0957	0.0723	0.1660	-0.3140	-0.1740	-0.1030	0.2620	-0.0429	0.3520	-0.0546	-0.5240	-0.3140	-0.2880	0.2930

Second Hidden
Layer

21	0.3230	-0.2700	-0.1200	0.3670	-0.1290	0.2630	0.1230	0.0128	0.1540	0.1810	0.3660	-0.2640	0.0532	0.2870	0.2850	-0.3410	-0.0020	-0.1740	-0.1340	-0.0187
22	0.0352	-0.0088	0.5040	-0.2230	-0.0909	-0.0749	0.3040	-0.1270	-0.1930	-0.2020	-0.1280	0.1080	0.3320	-0.0513	0.0652	-0.4480	-0.1390	0.2900	-0.3190	0.4650
23	0.1490	-0.0417	-0.0190	0.0193	0.1130	0.4670	-0.3390	-0.0389	-0.6830	0.1560	-0.2640	0.3310	0.1060	-0.5160	-0.0698	-0.1700	0.0358	0.0629	-0.3860	0.3450
24	-0.2800	0.3840	-0.2310	0.2820	-0.0917	-0.3810	0.1120	-0.4170	0.4020	0.2990	-0.1880	0.1770	0.1130	-0.1740	0.3190	0.4320	-0.1500	-0.1340	0.1130	-0.3120
25	0.1340	-0.2330	0.3780	0.1480	0.3840	0.0049	0.4240	0.3490	-0.1530	0.0334	0.1990	0.0184	0.1930	0.4150	0.0104	-0.1710	-0.2410	-0.2550	0.2260	-0.0698
26	0.1170	-0.0838	0.2580	-0.1580	-0.1960	0.2170	0.0862	0.1630	0.0054	-0.1030	-0.3430	0.1080	0.3290	0.0529	-0.2430	-0.0290	0.1090	-0.2080	0.0738	-0.0798
27	-0.0954	-0.2500	-0.2370	0.0241	0.2720	-0.4600	-0.2940	-0.0971	0.0194	0.2640	0.3480	-0.3600	0.2010	0.1520	-0.0396	0.1520	0.2660	-0.2790	-0.0808	-0.1420
28	-0.4080	-0.0986	0.1700	-0.0138	0.1070	-0.3740	-0.0988	0.1680	-0.3900	-0.2110	0.2860	-0.4180	0.2430	0.4610	0.3830	-0.2890	-0.1340	-0.1910	-0.1510	-0.3600
29	0.2320	-0.1360	0.0196	-0.1240	-0.2440	-0.1990	0.3110	0.0540	0.2630	0.1390	0.0372	-0.0138	0.1140	-0.3000	-0.3360	0.3680	-0.0042	0.2600	-0.3650	0.2610
30	-0.2010	-0.3090	0.0304	0.1500	-0.1350	-0.0872	0.0809	-0.0779	0.3430	-0.1970	0.2830	-0.0369	0.2690	-0.1400	-0.3710	0.3700	0.3680	0.0276	0.0356	0.0485
31	-0.0109	0.2620	0.0684	-0.3730	0.3830	-0.3660	0.1570	0.0693	-0.3550	-0.1110	0.0335	0.0252	0.0903	-0.2630	-0.1930	0.3330	0.2560	-0.2560	-0.0864	0.0487
32	0.1300	0.1450	0.2550	-0.1580	0.3840	0.2800	0.0257	0.3190	0.3320	-0.3570	0.0169	0.0013	-0.2150	0.2470	-0.3410	0.3160	-0.3590	-0.3670	-0.0673	-0.2200
33	0.1370	-0.3300	0.5440	-0.3770	-0.1580	0.0080	0.2370	0.1800	-0.5010	-0.1450	-0.4210	0.0773	0.0540	-0.3490	-0.1650	-0.3110	-0.1160	0.2390	-0.0323	-0.1220
34	0.3330	0.1900	0.1750	-0.1040	-0.3110	0.3150	-0.2790	-0.4850	-0.0676	0.1020	0.3610	-0.2340	0.1930	-0.2300	-0.2990	0.2350	0.0459	0.0252	0.3210	-0.1690
35	-0.2650	-0.3780	0.2790	0.0695	-0.0657	-0.1310	0.0574	0.1130	0.2480	0.0132	0.0252	-0.4200	-0.0322	0.1710	0.2310	-0.2350	0.3410	-0.3970	-0.0309	-0.5530
36	-0.4190	0.1270	0.2730	-0.2380	0.2420	0.1230	0.4570	0.0449	-0.1700	0.0361	0.4880	-0.2730	-0.2990	-0.1060	-0.1830	0.0858	-0.0591	0.1280	-0.2980	0.0320
37	0.1960	-0.3640	-0.3330	0.3330	-0.0504	0.0437	-0.1210	-0.0168	-0.2780	0.4350	-0.2780	0.0938	-0.3890	-0.2170	0.2900	0.3750	0.3900	0.1480	0.0185	0.2540
38	-0.1250	0.1690	0.3140	-0.3080	0.3440	-0.1110	-0.3820	-0.1420	-0.0428	0.1510	0.3200	-0.0004	-0.3230	-0.2000	0.3560	-0.2130	-0.2230	-0.1290	-0.1020	-0.2820
39	0.2530	-0.3750	0.1610	-0.3010	0.4360	0.0415	0.1960	0.1800	0.1160	-0.0007	0.2630	-0.0127	-0.8470	0.3670	-0.2930	0.1230	0.0762	0.1090	-0.2980	0.2700

First Hidden Layer																					
Neuron	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Bias
1	-0.2730	0.0241	0.0586	0.1230	-0.3640	0.4180	-0.0802	0.3160	-0.2580	0.2790	0.0292	0.0445	0.0115	0.2910	0.0121	0.4050	-0.1890	0.2620	0.2830	-0.2870	-0.1300
2	-0.1890	-0.2880	-0.1730	-0.2920	-0.4680	0.0963	0.1120	-0.1130	-0.2070	-0.0012	-0.3620	0.1670	0.1280	0.3690	-0.0649	-0.1080	0.0911	-0.3640	0.1360	0.0472	-0.0060

3	0.0824	-0.3320	0.0834	0.0689	0.2140	0.2460	-0.3180	-0.1520	0.0215	0.2540	-0.1190	-0.2150	0.1340	0.2970	-0.2680	0.0341	-0.1290	-0.1840	-0.3580	0.2840	-0.2810
4	0.0893	0.2420	0.0307	0.3120	0.1910	0.3050	0.3240	0.3570	0.1880	0.3640	-0.2310	-0.2110	-0.2420	-0.0009	-0.2650	0.2470	-0.2180	-0.3790	0.2430	-0.2340	0.1110
5	0.2660	-0.3340	0.1300	-0.3480	0.3930	-0.3470	-0.3070	0.4240	0.2150	0.3310	0.2440	0.2470	-0.0926	-0.2160	0.1730	0.0244	0.5080	-0.0909	0.2340	-0.0719	0.3590
6	0.2710	0.0494	-0.3220	-0.3120	0.0197	-0.0076	-0.1170	-0.0111	-0.2800	0.1310	0.3040	0.3420	-0.0285	0.2520	0.2470	-0.3650	0.2370	-0.5280	0.2230	0.3720	-0.2220
7	-0.0358	-0.0607	0.2880	0.1010	-0.1510	0.1890	-0.0261	-0.0277	0.3520	-0.2860	0.3980	0.2860	-0.0266	0.2570	-0.4420	-0.3840	-0.0780	-0.0569	0.2790	0.1100	0.3390
8	0.1120	-0.0708	0.1320	0.2400	-0.2110	-0.0409	0.2030	0.2640	-0.2500	0.1240	0.2240	0.1500	-0.2300	-0.1210	-0.2290	0.1440	-0.2230	-0.0033	0.3100	0.3630	-0.1380
9	-0.2270	0.2440	0.1670	0.0033	-0.1700	-0.3710	-0.1400	0.1080	-0.2710	0.2220	0.1310	0.1720	-0.3310	0.4130	0.1710	0.0056	0.2040	-0.0890	0.0505	0.1320	0.4180
10	0.0282	-0.2740	-0.0571	-0.0259	-0.3390	0.2080	0.3370	0.4490	0.2060	0.2130	-0.0665	-0.1800	-0.2940	-0.2830	-0.0382	0.1600	0.3900	-0.4600	0.2140	0.3370	-0.0764
11	-0.0297	0.2340	-0.1780	0.2200	0.2170	0.0996	-0.1510	0.1020	-0.2890	-0.1040	0.4440	-0.3110	-0.2700	0.1840	-0.1570	0.1150	-0.2330	-0.1200	-0.2480	0.1060	0.3660
12	0.3220	-0.2130	0.4240	-0.3430	0.0036	0.2010	-0.3630	0.2500	0.0003	0.5270	0.0604	-0.1120	0.0187	0.0065	0.0328	-0.3520	0.5280	-0.0426	0.1910	0.2680	-0.0493
13	0.3570	0.3450	0.3840	-0.1080	0.5010	0.3540	-0.2540	0.3480	0.4640	0.1770	0.2810	-0.0030	0.0358	0.2670	-0.0289	-0.2560	-0.1920	0.1600	0.3160	0.3140	-0.2050
14	-0.0115	0.4120	-0.0639	-0.0970	0.1810	0.3550	-0.3820	-0.3680	0.0968	-0.2860	-0.1490	0.2160	-0.1550	0.2590	-0.5380	-0.1340	0.1890	-0.1370	-0.1760	-0.3930	0.4180
15	0.0546	-0.2080	-0.2710	0.2860	-0.2560	-0.1530	-0.2860	-0.1730	-0.3360	0.1330	0.1880	-0.0471	0.2890	-0.1130	-0.1450	0.1470	-0.2460	0.1130	-0.2760	-0.2520	-0.0389
16	-0.1790	-0.4350	-0.2260	0.0623	-0.1380	-0.2760	0.1010	0.3770	0.4480	0.3390	-0.2290	0.4560	-0.1200	0.4730	0.3230	0.2110	-0.1630	0.0827	0.1550	-0.1650	0.4360
17	-0.0218	0.2120	-0.0201	0.2200	-0.0996	-0.0491	0.1340	-0.0855	0.0624	-0.0366	-0.2980	-0.0259	-0.0883	0.3030	0.0039	-0.2320	0.1990	0.1650	0.2060	0.1050	-0.0284
18	-0.1460	-0.0002	0.2940	0.1470	-0.3310	0.0808	-0.0047	0.2240	0.3140	0.1410	-0.0268	-0.3220	0.2880	0.2940	0.0685	-0.0824	-0.2120	0.0935	0.2750	-0.0016	-0.0134
19	-0.1430	0.3190	0.4000	-0.4270	-0.0802	-0.3670	-0.1450	0.3060	0.0910	-0.3340	0.2900	-0.1600	-0.2540	0.1960	0.3460	-0.0326	0.0948	0.0627	0.1100	-0.0681	-0.0467
20	-0.0757	0.2630	0.4100	0.1670	-0.0939	0.3280	0.0689	-0.1040	0.2590	0.2390	-0.1910	-0.0578	0.0517	0.3660	0.2950	-0.5640	0.2400	-0.2340	0.2460	0.0994	-0.2430
21	-0.3380	0.3370	0.2970	0.2730	0.3100	0.1590	-0.1330	-0.3640	0.2090	-0.2960	-0.3620	0.2770	-0.0921	0.2440	0.2370	-0.4540	0.4140	-0.0264	0.3810	0.1650	0.3660
22	-0.0518	0.2050	-0.0306	0.3290	0.0575	-0.3510	0.0622	0.1970	-0.1130	-0.1160	-0.1040	-0.2270	0.3280	-0.2470	0.0266	0.1070	-0.4230	0.0395	-0.3440	-0.0499	-0.2410
23	0.0831	0.1980	-0.0057	0.1180	0.4100	0.1190	0.2250	-0.0615	-0.4070	0.2060	-0.0358	-0.3850	-0.2600	0.1350	-0.3720	0.0546	0.0049	0.3020	-0.3770	-0.3620	0.3520
24	0.1650	-0.3540	-0.0870	0.1900	0.1660	-0.3150	-0.3580	0.2960	0.1360	0.2370	0.1390	0.3780	0.2800	-0.0392	0.2460	-0.1910	-0.1820	-0.3840	0.1600	0.0449	-0.1320
25	0.0142	-0.1400	0.0656	0.1770	0.1780	0.0130	-0.2910	-0.0520	0.2430	0.1050	-0.0088	0.1500	-0.2160	0.4340	0.0893	0.0348	0.0881	0.0479	0.1570	-0.0406	-0.0833
26	0.1350	0.1630	0.0975	0.1040	-0.2940	0.2350	-0.0977	-0.0799	0.2770	-0.3640	0.1580	0.0133	-0.2110	0.0938	0.0750	-0.1290	-0.2430	0.0005	0.0342	0.1580	0.2940

27	0.2840	0.1460	-0.2810	-0.0268	-0.1660	0.2460	-0.0308	0.2130	0.2660	0.0197	0.2720	0.4390	-0.1730	0.4530	0.0600	-0.1360	0.2340	-0.3820	-0.0679	0.4550	-0.0389
28	-0.0367	0.3100	-0.0807	0.1320	-0.3480	0.3960	-0.0883	-0.2700	-0.2210	-0.0311	-0.0597	0.0086	0.1270	0.2940	0.2920	0.3870	0.4010	-0.1280	-0.2870	0.3280	0.4150
29	0.1880	0.2810	-0.1410	-0.3250	-0.3330	0.3290	-0.2420	-0.3820	-0.1540	0.1030	-0.5220	0.0084	-0.0021	-0.0271	-0.3290	-0.0818	0.2060	0.1660	0.2080	-0.1210	0.3650
30	-0.2180	-0.3470	0.4060	-0.0490	-0.1130	-0.0974	0.2960	-0.2990	-0.1380	0.0404	0.1530	0.3010	-0.2890	0.2020	0.0073	0.2320	0.5000	0.0542	0.0797	0.3700	0.3550
31	0.3260	0.2310	0.0774	-0.0236	-0.2220	-0.2830	-0.3340	0.0838	0.1500	-0.2440	0.1750	0.1870	-0.3610	-0.1330	0.3800	-0.0907	-0.0522	0.2330	0.4460	-0.1470	-0.0919
32	0.3100	0.1300	0.0115	0.0298	0.2330	-0.2130	-0.3090	-0.1380	0.2270	0.2880	-0.3850	0.2100	-0.3050	-0.2590	0.1610	0.2330	0.4720	0.0809	-0.2720	0.0171	0.4060
33	0.2420	0.2010	0.2560	0.5010	0.5700	-0.4740	0.0251	-0.3590	-0.4110	-0.0292	-0.0418	-0.3860	0.1180	-0.1380	-0.2850	-0.1780	-0.4230	-0.2220	-0.2670	0.1840	-0.0154
34	-0.1170	0.3720	-0.1490	0.3640	-0.0036	0.0038	-0.2390	0.1490	-0.2370	0.2480	-0.3150	-0.1940	-0.3910	-0.0069	-0.0771	-0.4080	-0.2070	-0.1090	0.2070	-0.1420	0.3260
35	-0.3790	-0.0276	0.1140	-0.3410	0.1120	0.3910	-0.0957	-0.0765	0.3670	0.2200	0.1070	-0.2050	0.2610	-0.0786	0.1930	-0.3680	0.0401	-0.4460	0.3450	0.2160	0.4100
36	-0.0678	0.2650	0.0287	-0.2950	-0.4210	0.4100	0.0842	0.2690	0.2560	0.2190	0.0226	-0.0609	-0.1530	0.0761	0.4220	-0.1060	-0.1370	-0.1380	0.3630	0.4110	-0.0845
37	-0.0603	-0.1800	0.1390	-0.0983	0.1170	0.0986	0.1820	-0.1960	-0.0012	-0.1290	-0.2580	0.4070	-0.1000	0.3660	-0.1360	-0.6470	0.3620	-0.1590	-0.1610	0.0724	0.4610
38	0.2140	-0.0106	-0.3590	0.3200	0.2470	0.0174	-0.0384	-0.1490	-0.3600	0.3110	-0.3310	-0.1590	0.3370	-0.1420	-0.0017	0.0373	-0.3480	0.3090	-0.0060	-0.3920	-0.1270
39	0.4130	0.3740	0.0496	-0.0222	0.2280	-0.0449	-0.0397	0.5130	0.2090	0.2650	-0.5730	0.0793	0.1410	-0.1630	-0.2370	-0.4570	0.4560	0.0582	0.5070	0.2690	0.3590