194246 195228 197206 197206 198.110 198.80 200.610 201.38 202.128 202.84 204.218 204.218 204.218 205.50 205.50 205.61 207.86 207

221.250 222.035 222.791 223.520 224.225

224.906 225.566 226.206 226.826 227.429

200786 200786 200786 200786 200786 200786 200786 200786 200786 200786 200786 200786 200786 200786

216.811 217.778 218.702 219.587 220.435

ರವರ್ಷದ ವರ್ಷದ ಪರ್ಷವರ ಪರ್ಷವರ

77,060 31,321 31

208.950 209.473 209.983 210.481 210.968

228.584 229.138 229.678 230.205

211.443 211.908 212.363 212.808 213.244

230.718 231.219 231.708 232.186 232.653

213.671

233.110 233.557 233.994 234.423 234.843

215.684

20.786 20.786 20.786 20.786 20.786 20.786 20.786 20.786

235.255 235.658 236.054 236.443

PREVIOUS

Radon (Rn)	REFERENCE STATE	A _r = 222 Radon (Rn)	Radon (Rr	2						Rn ₁ (ref)	
	0 to 6000 K Ideal Monatomic Gas	lenessen.	Enthalpy Re	ference Ter	nperature	Enthalpy Reference Temperature = T, = 298.15 K I·K -¹mol-1		Standard Stat	Standard State Pressure = $p^* = 0.1 \text{ MPa}$ k1·mol ⁻¹	0.1 MPa	
IP(Rn, g) = 86692.5 ± 0.2 cm ⁻¹		$\Delta_p H^{\circ}(0 \text{ K}) = 0 \text{ kJ} \cdot \text{mol}^{-1}$	τÆ	ະ	S• -{G	S[GH'(T,)]T	$H^{\bullet}-H^{\bullet}(T_{i})$	Δ _r H•	₽G.	log K _r	
$5.(298.13 \text{ K}) = 1.02.33 \pm 0.003 \text{ J·K}$		Δ _t H ⁻ (298.15 K) = 0 kJ·mol ⁻¹	0	oʻ	ó	INFINITE	-6.197	Ö	Ö	ó	
			88	20.786	153.527	194.715	-4.119	Ö	ď	ď	
	Electronic Levels and Ouantum Weights		ឱន	20.786	172.574	176.577	-2040	ರ ರ	ರ ರ	ರ ರ	
	State 6. cm ⁻¹		298.15	20,786	176,235	176.235	ď	oʻ	ó	ö	
			300	20.786	176.363	176235	0.038	ó	Ö	o	
	الم 0		350	20.786	179,567	176.488	1.078	ó	ó	o	
			\$ 2	20.786	82.343	17.00	2117	o c	o c	oʻ c	
Heat of Formation			8	20.786	186.981	178.590	81.8	်ဝံ	်ဝံ	်ငံ	
Zero by definition.			009	20.786	170.71	180314	6274	ó	ó	ó	
			700	20.786	193,975	182.043	8.353	ó	o'	ď	
Heat Capacity and Entropy			8	20.786	156.75	183.711	10.431	oʻ (oʻ	o' (
Information on the electronic energy levels and	Information on the electronic energy levels and quantum weights is taken from Moore. 19 Many of the theoretically predicted levels have	theoretically predicted levels have	88	20.786	201389	186.800	14589	ರ ರ	ರೆಂ	ď	
not been observed. Our calculations indicate that any reasonable method of filling in these	any reasonable method of filling in these missing leve	missing levels and cutting off the summation in	1100	20.786	203.370	188.218	16.667	d	c	c	
the partition function ² has little effect on the thermodynamic properties to 6000 K. This is		undoubtedly a result of the high energy of these	1200	20.786	205.179	189.557	18.746	ö	ó	ď	
levels: the first excited level is over 54620 cm ⁻¹		nd state only. Extension to higher	1300	20.786	206.843	190.824	20.824	oʻ	0	ö	
temperatures may require consideration of excited	temperatures may require consideration of excited states and utilization of different fill and cutoff procedures.	dures.	85	20.786	208.383	192.024	22,903	o' c	oʻ c	o'c	• - ,
Thermodynamic functions at 298.15 K are recommended by CODATA3 for all rare g	commended by CODATA3 for all rare gases except r	gases except radon. This table agrees with other	091	20.786	211.159	194.246	27.060	ံဝံ	ံဝံ	ó	
		,						,	;	•	

convenience of the reader and have not been evaluated by the present authors. As a result of the low values, the reference state for radon is Hultgren et al. had recommended a melting point of 202 K and a boiling point of 211 K (1 atm). These values are provided for the Phase Data

tabulations except for two minor changes. First, the entropy differs by 0.1094 J·K⁻¹·mol⁻¹ because this table uses a reference pressure of 1 bar, whereas the other tabulations are based on 1 atm. Second, entropy differences of the order of 0.001–0.004 J·K⁻¹·mol⁻¹ for the rare gases arise due to the use of slightly different values for R and the relative atomic mass, this table uses R = 8.31441 J·K⁻¹·mol⁻¹. With some minor changes, our tables agree within the estimated uncertainty with those by Hilsenrath *et al.*, ³ Gurvich *et al.*, ⁴ and Wagman *et al.* ¹⁰ The estimated uncertainty is due to uncertainties in the relative atomic mass and fundamental constants which are based on the 1981 scale⁸ and the 1973

chosen to be the ideal gas at all temperatures. This may differ from the choice of other authors.

values,7 respectively.

E. Moore, U. S. Nat. Bur. Stand., NSRDS-NBS-35, Volume III, (1970) [Reprint of NBS Circular 467, Volume III, 1958]

R. Downey, Jr., The Dow Chemical Co., AFOSR-TR-78-0960, Contract No. F44620-75-1-0048, (1978)

Cox, ICSU-CODATA Task Group, J. Chem. Thermodyn. 10, 903 (1978)

Hultgren, P. D. Desai et al. "Selected Values of the Thermodynamic Properties of the Elements," American Society for Metals, Metals

Hilsenrath, C. G Messina and W. H. Evans, U.S. Nat. Bur. Stand., Report AD-606163 (avail. NTIS), (1964)

J. Hisemath, C. G Messina and W. H. Evans, U.S. Nat. Bur. Stan N. E. Holden and R. L. Martin, Pure Appl. Chem. 51, 405 (1979). E. R. Cohen and B. N. Taylor, J. Phys. Chem. Ref. Data 2, 663 (1

R. Cohen and B. N. Taylor, J. Phys. Chem. Ref. Data 2, 663 (1973).
V. Gurvich, I. V. Veits et al., "Thermodynamic Properties of Individual Substances," 3rd ed., Volume I, Nauka, Moscow, (1978).
E. Moore, U. S. Nat. Bur Stand., NSRDS-NBS-34, 8 pp. (1970).
D. Wagman, W. H. Evans et al., J. Phys. Chem. Ref. Data 11, Supp. 2, 44 (1982).

Rn₁(g)

Radon, Ion (Rn1)

 $\Delta_t H^0(0 \text{ K}) = 1037.073 \pm 0.002 \text{ kJ} \cdot \text{mol}^{-1}$

Radon, Ion (Rn*)

Enthalpy Reference	eference T	Temperature = T,	- T, - 298.15 K		Standard State Pressure	1	p - 0.1 MPa
7.K	ប)- s	-[G*-H*(T,)]/T	H*-H*(T,)	Α.πο. Α.π.	₽ <i>G</i> •	log K,
0000	0. 20.786 20.786	0.165.054	INFINITE 206.241 189.662	-6.197 -4.119 -2.040	1037.073		
28.52	20.786	184.100	188.103	1001-	07.6 29.01	013 6101	5
8	20.786	187.889	187.761	0.038	1043.309	1033.519	-181.079
S &	20.786	191,094	188.014	8,01	1044.348	1031.805	-153.988
38	20.786	198.507	189303	3.156	1046.427	1027.949	-119.321
8	20.786	202.297	191.840	6274	1049.545	1021.320	-88.914
58	20.786	205.501	193.569	8.353	1051.623	1016.451	-75.849
88	20.786	210.725	196.825	12.510	1055.780	1005.858	-58.378
200	20.786	214.896	199.744	16.667	1059.938	994.333	-47217
38	20.786	218.369	202,350	18.746	1062.016	988.277	-43.019
1500 1500	20.786 20.786	219.909 221.343	203.550 204.689	22.903	1066.173	975.659	-36.402
0021	20.786	222.685	205.772	27.060	1070.331	962.445	-31.421
88	20.786	225.133	207.790	31.217	1072.409	955.638	-29363
88	20.786	226.251 227.323	208.733 209.636	33.2% 35.375	1076.566 1078.645	941.665	-25.888
2200	20.786	228.337	210.502	37.453	1080.724	927.253	-23.064
183	20.786	230.228	212.137	41.610	1084.881	912.836	-20.722
2500	20.786	231.81	212.909 213.654	43.689 45.768	1086.959 1089.038	904.903 897.275	-19.695
7,00 7,00 7,00 7,00 7,00 7,00 7,00 7,00	20.786	232.777	214.374	47.846	1091.117	889.563	-17.872
280	20.786	234317	215.744	52.004	1095.274	873.903	-16.303
3000	20.786	235.751	215.397	54.082 56.161	1097.352 1099.431	865.961 857.946	-15.598
3200 3200	20.787 20.787	236.433	217.646	58.239	1101.510	849.862	-14,320
330	20.787	237.732	218.824	62.397	1105.667	833.496	-13.193
3200	20.788	238.955	219.389	64.476 66.554	1109.825	825.217 816.877	-12.678 -12.191
3600	20.789	239.541	220.476	68.633	1111.903	808.478	-11.731
3800	20.791	240.665	221.510	72.791	1116.061	791.507	-10.880
4000	20.792	241.732	222.494	74.870 76.949	1118.140	782.939	-10.486
4200 4200	20.796	242.245	222.970	79.029	1122.299	765.644	-9.754
96	20.800	243.236	223.889	83.189	1126.459	748.147	-9.088
4500	20.807	244.181	224.770	87349	1130.619	730,456	-8.479
4100 4100	20.811	244.639 245.086	225.197 225.616	89.430	1132.700	721.540	-8.193
4800 600	20.820	245.525	226,026	93.593	1136.863	703.574	-7.656
2000	20.831	246.375	226.823	93.57 97.78	1138.946	694.526 685.435	-7.404
230 200 200	20.838 20.845	246.787 247.192	227.211	99.842	1143.112	676,303	-6.927
S 30 2	20.853	247.589	227.964	104.011	1147.281	657.916	-6.484
2200	20.870	248,362	228.692	108,183	1151.453	639.371	-6.072
5700 5700	20.879 20.890	248.738 249.108	229.047 229.3%	110.270	1153.541	620.042	-5.877
2800	20.901	249.471 249.828	229.739 230.076	114.448	1157.719	611.272	-5.505
9	20.924	250.180	230.408	118.631	1161.901	592.357	-5.157
REVIOUS:					3	CURRENT: March 1982 (1 bar)	1982 (1 bar)

$S^{\circ}(298.15 \text{ K}) = 187.761 \pm 0.003 \text{ J·K}^{-1} \cdot \text{mol}^{-1}$			Δητ' (0 K) = 103/.0/3 ± 0.002 kJ·mol · Δητ'(298.15 K) = [1043.270] kJ·mol · ·
	Electronic State	Electronic Levels and Quantum Weights State	m Weights
	P ₃₂ 2P ₁₂	30895.1	4 7
Heat of Formation The ionization limit of neutral radon (86692.5 ± s converted from cm ⁻¹ to kJ-mol ⁻¹ using the factor constants. The uncertainty in the ionization limit is the heat of formation. Gurvich et al.* adooted the sa	± 0.2 cm ⁻¹) represent to sestimated to ame ionization	ported by Moore! is s 1196266 kJ·mol-1, w be ±0.2 cm ⁻¹ which potential but the mol	Heat of Formation The ionization limit of neutral radon (86692.5 ± 0.2 cm ⁻¹) reported by Moore ¹ is adopted as $\Delta_t H^0(0 K)$ for Rn ⁺ (g). The ionization limit is converted from cm ⁻¹ to kJ-mol ⁻¹ using the factor, 1 cm ⁻¹ = 0.01196266 kJ-mol ⁻¹ , which is derived from the latest CODATA fundamental constants. ² The uncertainty in the ionization limit is estimated to be ± 0.2 cm ⁻¹ which corresponds to an uncertainty of ± 0.0002 kJ-mol ⁻¹ in the heat of formation. Gurvich et al. ³ adopted the same ionization potential hat the use of elights of fifteent with the Norman et al. 30 cm ⁻¹ the Norman et a

 $\Delta H^0(Rn^+, g.~298.15 \, K)$ is obtained from $\Delta H^0(Rn, g.~0 \, K)$ by using IP(Rn) with JANAF³ enthalpies $H^0(0 \, K)$ — $H^0(298.15 \, K)$ for Rn⁺(g). Rn(r), and e ⁻(r). $\Delta H^0(Rn \to Rn^+ + e^-, 298.15 \, K)$ differs from a room temperature threshold energy due to inclusion of these enthalpies and to threshold effects discussed by Rosenstock et al. 3 $\Delta H^0(298.15 \, K)$ should be changed by $-6.197 \, k$ J·mol⁻¹if it is to be used in the ion The information on electronic energy levels and quantum weights of Moore* is incomplete because no levels have been observed. Our calculations indicate that any reasonable method of filling in missing levels and cutting off the summation in the partition function* has no effect on the thermodynamic functions to 6000 K. This is a result of the high energy of all levels other than the ground state and the ²P_{1/2} level; the next lowest level is estimated to be over 80000 cm⁻¹ above the ground state. Since inclusion of these upper levels has no effect on the thermodynamic functions (to 6000 K) we list only the ground state and the ²P_{1/2} state, with the energy of the latter state taken from a more recent study by Moore. The reported uncertainty in \$7(298.15 K) is due to uncertainties in the relative ionic mass and fundamental constants. Extension of these calculations above 6000 K may require consideration of the higher excited states and use of different fill and cutoff convention that excludes the enthalpy of the electron. in a heat of formation difference of 0.010 kJ mol-1 Heat Capacity and Entropy

The thermodynamic functions reported here agree with those of Green et al., * Hilsenrath et al., 7 and Gurvich et al. * except for two minor changes. First, the entropy differs by 0.1094 J-K⁻¹-mol⁻¹ because this table uses a standard state pressure of 1 bar, whereas the cited references used a pressure of 1 atm. Second, smaller differences arise from the use of different values for the fundamental constants, the relative ionic mass, and the position of the P_{Da} electronic level.

References

E. R. Cohen and B. N. Taylor, J. Phys. Chem. Ref. Data 2, 663 (1973). C. E. Moore, U. S. Nat. Bur. Stand., NSRDS-NBS-34, 8 pp. (1970).

JANAF Thermochemical Tables: Rn(r), 3-31-82; e⁻(r), 3-31-82.

C. E. Moore, U. S. Nat. Bur. Stand., NSRDS-NBS-35, Volume III, (1970) [Reprint of NBS Circular 467, Volume III, 1958].

J. R. Downey, Jr., The Dow Chemical Co., AFOSR-TR-78-0960, Contract No. F44620-75-1-0048, (1978).
 J. W. Green, D. E. Poland and J. L. Magrave, University of Wisconsin, Report AD-275542 (avail. NTIS), (1961).

Hilsenrath, C. G. Messina, and W. H. Evans, U.S. Nat. Bur. Stand., Report AD-606163 (avail. NTIS), (1964).
 V. Gurvich, I. V. Veits et al., "Thermodynamic Properties of Individual Substances," 3rd ed., Volume I, Nauka, Moscow, (1978).
 H. M. Rosenstock, K. Draxl et al., J. Phys. Chem. Ref. Data 6, Supp. 1, 783 pp. (1977).
 D. D. Wagman, W. H. Evans et al., J. Phys. Chem. Ref. Data 11, Supp. 2, 44 (1982).