

Supplementary Materials for

New Applications of Action Mechanics to the Thermodynamics of Atmospheric Systems

Ivan R. Kennedy, Migdat Hodzic, *Applied Mechanics*

Corresponding author: ivan.kennedy@sydney.edu.au

This PDF file includes:

1. CARNOT8/CAL. Windows TRS32 Multidos Astrocal program for Carnot Cycle data in Table 1. Data printout for Argon and Dinitrogen is included.
2. ENTROPY8/CAL. Windows TRS32 Multidos Astrocal program for calculation of translational, rotational entropy and Gibbs energy of gases in the Earth's atmosphere.
3. TURBINE5/CAL. Windows TRS32 Multidos Astrocal program for Vevor Turbine to estimate wind power.
4. TROP CYC2/CAL. Windows TRS32 Multidos Astrocal program for charging power of tropical cyclone. Data printout for charging a 500 km cyclone in the southern hemisphere is included.

All code is produced in Vernon Hester's program Astrocal for Multidos TRS80 microcomputer, based on Texas Instruments SR52 programmable logic. Programs can easily be prepared in other software, such as R, Mathematica or Python.

Please contact ivan.kennedy@sydney.edu.au for further information, suggestions for improvements or reports of errors.

CARNOTB Carnot Cycle Ar N2 H2O
 Corrected 26 Aug 2022, for use of Zt
 Estimates ratios frequency w/w, radii
 Estimates θ , hv, v, wavelength in cycl
 Inputs Y,F,R,P,H,L,M,N,A,B,C,Q
 Input rotational symmetry

0240	096	LABEL
0241	089	Y
0242	107	STD MEM
0243	056	8
0244	057	9
0245	119	print
0246	002	HALT
0247	048	0
Furnace degrees Kelvin		
0288	096	LABEL
0289	070	F
0290	107	STD MEM
0291	048	0
0292	049	1
0293	119	print
0294	002	HALT
0295	048	0
Temperature of refrigerator		
0336	096	LABEL
0337	082	R
0338	107	STD MEM
0339	048	0
0340	050	2
0341	119	print
0342	002	HALT
0343	048	0
Pressure in atm		
0384	096	LABEL
0385	080	P
0386	107	STD MEM
0387	048	0
0388	051	3
0389	119	print
0390	002	HALT
0391	048	0
Stow heat capacity Cv/R		
0432	096	LABEL
0433	072	H
0434	107	STD MEM
0435	048	0
0436	052	4
0437	119	print
0438	002	HALT
0439	048	0
Atom mass H1 polyatomic		
0480	096	LABEL
0481	076	L
0482	107	STD MEM
0483	048	0

0484	055	7
0485	119	print
0486	002	HALT
Atom monatomic Ar, or M1 or central M		
0527	096	LABEL
0528	077	M
0529	107	STD MEM
0530	048	0
0531	053	5
0532	119	print
0533	002	HALT
0534	048	0
Stow molecular mass 2 N or O		
0575	096	LABEL
0576	078	N
0577	107	STD MEM
0578	049	1
0579	053	5
0580	119	print
0581	002	HALT
0582	048	0
Bond length diatomic		
0623	096	LABEL
0624	090	Z
0625	107	STD MEM
0626	049	1
0627	054	6
0628	119	print
0629	002	HALT
0630	048	0
Moment 1 polyatomic		
0671	096	LABEL
0672	065	A
0673	107	STD MEM
0674	048	0
0675	056	8
0676	119	print
0677	002	HALT
Moment 2 polyatomic		
0718	096	LABEL
0719	066	B
0720	107	STD MEM
0721	048	0
0722	057	9
0723	119	print
0724	002	HALT
Stow moment 3 polyatomic		
0765	096	LABEL
0766	067	C
0767	107	STD MEM
0768	049	1
0769	048	0
0770	119	print
0771	002	HALT
Input source heat nkT=Qf ergs/molecule		

Input q for nkT1 as n

```
0852 096 LABEL
0853 081 Q
0854 107 STO MEM
0855 048 0
0856 054 6
0857 119 print
0858 002 HALT
```

Execute <SH>X

```
0899 096 LABEL
0900 088 X
0901 049 1
0902 048 0
0903 046 .
0904 050 2
0905 050 2
0906 057 9
0907 054 6
0908 055 7
0909 050 2
0910 119 print
```

Stow Zt translational symmetry

Zt = $2^3 \times \text{rms } v / \text{mean } v \text{ in } r99$

```
0991 107 STO MEM
0992 057 9
0993 057 9
```

Input Boltzmann's k

```
1034 049 1
1035 046 .
1036 051 3
1037 056 8
1038 048 0
1039 054 6
1040 050 2
1041 053 5
1042 057 9
1043 101 EE
1044 049 1
1045 054 6
1046 111 +/-
1047 107 STO MEM
1048 057 9
1049 055 7
1050 119 print
1051 049 1
1052 046 .
1053 048 0
1054 053 5
1055 052 4
1056 053 5
1057 057 9
1058 049 1
1059 056 8
1060 053 5
1061 101 EE
1062 050 2
1063 055 7
1064 111 +/-
1065 107 STO MEM
1066 057 9
```

```
1067 056 8
1068 119 print
Input mass H atom
```

```
1109 049 1
1110 046 .
1111 054 6
1112 055 7
1113 050 2
1114 054 6
1115 049 1
1116 052 4
1117 101 EE
1118 050 2
1119 052 4
1120 111 +/-
1121 107 STO MEM
1122 057 9
1123 054 6
1124 119 print
```

Input c speed light

```
1165 050 2
1166 046 .
1167 057 9
1168 057 9
1169 055 7
1170 057 9
1171 050 2
1172 052 4
1173 053 5
1174 056 8
1175 101 EE
1176 049 1
1177 048 0
1178 107 STO MEM
1179 057 9
1180 053 5
```

Recall pressure1 and calculate r1
 $r1^3 = (T1p2r2^3) / T2p1$

```
1261 040 (
1262 109 RCL MEM
1263 048 0
1264 049 1
1265 047 /
1266 050 2
1267 057 9
1268 056 8
1269 046 .
1270 049 1
1271 053 5
1272 041 )
1273 047 /
1274 109 RCL MEM
1275 048 0
1276 051 3
1277 061 =
1278 092 Root
1279 051 3
1280 042 x
Input r2 at 1 atm and 298.15K
1321 049 1
```

1322	046	.	1616	053	5
1323	054	6	1617	049	1
1324	057	9	1618	041	)
1325	057	9	1619	061	=
1326	054	6	Print	3kTnIn=@tn^2	uncorrected
1327	052	4	1660	119	print
1328	101	EE	1661	092	Root
1329	055	7	1662	050	2
1330	111	+/-	1663	047	/
1331	041	)	1664	040	(
1332	119	print	1665	109	RCL MEM
Store r1 radial separation			1666	057	9
1373	107	STO MEM	1667	057	9
1374	057	9	1668	092	Root
1375	048	0	1669	051	3
Go to LABEL S			1670	041	)
1416	083	S	1671	061	=
Subroutine snTn entropic energy n=1-4			Print	@tn	translational action 1-D
1457	096	LABEL	1712	119	print
1458	068	D	1713	107	STO MEM
1459	040	(	1714	056	8
1460	040	(	1715	053	5
1461	040	(	1716	047	/
1462	109	RCL MEM	1717	109	RCL MEM
1463	048	0	1718	057	9
1464	053	5	1719	056	8
1465	043	+	1720	061	=
1466	109	RCL MEM	Print	quantum number	
1467	049	1	1761	119	print
1468	053	5	1762	107	STO MEM
1469	041	)	1763	052	4
1470	042	x	1764	048	0
1471	109	RCL MEM	1765	121	Cube
1472	057	9	1766	110	LOG e
1473	054	6	1767	042	x
1474	041	)	1768	109	RCL MEM
Print mass			1769	057	9
1515	119	print	1770	055	7
1516	107	STO MEM	1771	061	=
1517	056	8	Print	translational -gt/T	Gibbs/K
1518	052	4	1812	119	print
1519	042	x	1813	107	STO MEM
1520	040	(	1814	055	7
1521	109	RCL MEM	1815	048	0
1522	053	5	1816	042	x
1523	048	0	1817	109	RCL MEM
1524	113	Square	1818	053	5
1525	041	)	1819	049	1
1526	061	=	Print	kTnln[@nt/h-)^3/zt]	=-gtn
Print In moment of inertia mr^2			1860	061	=
1567	119	print	1861	119	print
1568	042	x	1862	107	STO MEM
1569	051	3	1863	055	7
1570	042	x	1864	049	1
1571	109	RCL MEM	1865	043	+
1572	057	9	1866	040	(
1573	055	7	1867	109	RCL MEM
1574	042	x	1868	048	0
Recall temperature r51			1869	052	4
1615	109	RCL MEM	1870	042	x


```

1871 109 RCL MEM
1872 057 9
1873 055 7
1874 042 x
1875 109 RCL MEM
1876 053 5
1877 049 1
1878 041 )
1879 061 =
1880 119 print
Print stnTn for gas entropic energy
1921 107 STO MEM
1922 056 8
1923 048 0
1924 047 /
1925 109 RCL MEM
1926 053 5
1927 049 1
1928 061 =
Print stn
1969 119 print
1970 107 STO MEM
1971 056 8
1972 049 1
1973 040 (
1974 040 (
1975 109 RCL MEM
1976 055 7
1977 049 1
1978 041 )
1979 047 /
1980 109 RCL MEM
1981 053 5
1982 048 0
1983 121 Cube
1984 047 /
1985 056 8
1986 041 )
Print virtual pressure gt/a^3
2027 119 print
2028 040 (
2029 109 RCL MEM
2030 055 7
2031 049 1
2032 047 /
2033 109 RCL MEM
2034 052 4
2035 048 0
2036 041 )
Print virtual hv=gt/nt
2077 119 print
2078 047 /
2079 109 RCL MEM
2080 057 9
2081 056 8
2082 047 /
2083 050 2
2084 047 /
2085 112 pi
2086 041 )

```

```

Print virtual translational freq v
2127 119 print
2128 107 STO MEM
2129 056 8
2130 051 3
2131 114 1/x
2132 042 x
2133 109 RCL MEM
2134 057 9
2135 053 5
2136 041 )
Print wavelength virtual trans. quanta
2177 119 print
2178 107 STO MEM
2179 048 0
2180 048 0
2181 040 (
2182 109 RCL MEM
2183 048 0
2184 048 0
2185 047 /
2186 109 RCL MEM
2187 053 5
2188 048 0
2189 041 )
Print lambda/r
2230 119 print
2231 107 STO MEM
2232 052 4
2233 051 3
2234 040 (
2235 109 RCL MEM
2236 052 4
2237 051 3
2238 047 /
2239 040 (
2240 050 2
2241 042 x
2242 112 pi
2243 041 )
2244 041 )
Print lambda/2pir
2285 119 print
Estimate frequency ratio v/w
2326 040 (
2327 040 (
2328 040 (
2329 040 (
2330 040 (
2331 040 (
2332 109 RCL MEM
2333 056 8
2334 053 5
2335 042 x
2336 109 RCL MEM
2337 057 9
2338 057 9
2339 064 Inverse
2340 121 Cube
2341 041 )

```

Print mrv without Zt^{1/3} correction

```
2382 119 print
2383 041 )
2384 047 /
2385 109 RCL MEM
2386 056 8
2387 052 4
```

Print rv

```
2428 041 )
2429 119 print
2430 047 /
2431 109 RCL MEM
2432 053 5
2433 048 0
2434 041 )
```

Print v

```
2475 119 print
2476 047 /
2477 109 RCL MEM
2478 053 5
2479 048 0
```

Print w

```
2520 041 )
2521 119 print
2522 114 1/x
2523 042 x
2524 109 RCL MEM
2525 056 8
2526 051 3
2527 041 )
```

Print v/w

```
2568 119 print
Test if diatomic
2609 109 RCL MEM
2610 049 1
2611 053 5
2612 038 If zero
2613 084 T
Test if triatomic H2O
2654 109 RCL MEM
2655 048 0
2656 056 8
2657 038 If zero
2658 069 E
```

Test if non-linear

```
2699 040 (
2700 048 0
2701 045 -
2702 109 RCL MEM
2703 049 1
2704 050 2
2705 041 )
2706 064 Inverse
2707 037 If pos
2708 116 Tangent
```

Calculate Sr for water

$Sr = R \ln[\pi^{1/2} e^{1/3} / 2 a b c / h^{-1/3} z]$

Calculate @rA

```
2829 096 LABEL
2830 116 Tangent
```

```
2831 040 (
2832 109 RCL MEM
2833 048 0
2834 056 8
2835 042 x
2836 109 RCL MEM
2837 053 5
2838 049 1
2839 042 x
2840 050 2
2841 042 x
2842 109 RCL MEM
2843 057 9
2844 055 7
2845 041 )
2846 064 Inverse
2847 113 Square
2848 061 =
```

Print, stow @rA in r17

```
2889 119 print
2890 107 STO MEM
2891 049 1
2892 055 7
2893 109 RCL MEM
2894 049 1
2895 055 7
2896 047 /
```

Recall h-

```
2937 109 RCL MEM
2938 057 9
2939 056 8
2940 061 =
```

Print, stow @rA/h- in r17

```
2981 119 print
2982 107 STO MEM
2983 049 1
2984 055 7
```

Calculate @rB

```
3025 109 RCL MEM
3026 048 0
3027 057 9
3028 042 x
3029 109 RCL MEM
3030 053 5
3031 049 1
3032 042 x
3033 050 2
```

Recall k

```
3074 042 x
3075 109 RCL MEM
3076 057 9
3077 055 7
3078 041 )
3079 092 Root
3080 050 2
3081 061 =
```

Print, stow @rB in r18

```
3122 119 print
3123 107 STO MEM
3124 049 1
```



```

3125      056      8
3126      109      RCL MEM
3127      049      1
3128      056      8
3129      047      /
Recall h-
3170      109      RCL MEM
3171      057      9
3172      056      8
3173      061      =
Print, stow @rB/h- in r18
3214      119      print
3215      107      STO MEM
3216      049      1
3217      056      8
3218      061      =
Calculate @rC
3259      040      (
3260      109      RCL MEM
3261      049      1
3262      048      0
3263      042      x
3264      109      RCL MEM
3265      053      5
3266      049      1
3267      042      x
3268      050      2
3269      042      x
Recall k
3310      109      RCL MEM
3311      057      9
3312      055      7
3313      041      )
3314      092      Root
3315      050      2
3316      061      =
Print, stow @rC in r19
3357      119      print
3358      107      STO MEM
3359      049      1
3360      057      9
3361      109      RCL MEM
3362      049      1
3363      057      9
3364      047      /
Recall h-
3405      109      RCL MEM
3406      057      9
3407      056      8
3408      061      =
Print, stow @rC/h-
3449      119      print
3450      107      STO MEM
3451      049      1
3452      057      9
jrxjrxjr
3493      040      (
3494      040      (
3495      109      RCL MEM
3496      049      1

```

```

3497      055      7
3498      042      x
3499      109      RCL MEM
3500      049      1
3501      056      8
3502      042      x
3503      109      RCL MEM
3504      049      1
3505      057      9
3506      041      )
Print jrA x jrB x jrC
3547      119      print
Recall symmetry factor
3588      042      x
3589      040      (
3590      112      pi
3591      064      Inverse
3592      113      Square
3593      041      )
3594      041      )
Print corrected jrcubed
3635      119      print
3636      107      STO MEM
3637      054      6
3638      049      1
3639      040      (
3640      109      RCL MEM
3641      054      6
3642      049      1
3643      047      /
3644      109      RCL MEM
3645      056      8
3646      057      9
3647      041      )
3648      110      LOG e
3649      042      x
Recall k
3690      109      RCL MEM
3691      057      9
3692      055      7
3693      061      =
Print, stow -gr/T in r72
3734      119      print
3735      107      STO MEM
3736      055      7
3737      050      2
3738      119      print
3739      042      x
3740      109      RCL MEM
3741      053      5
3742      049      1
3743      061      =
Print -gr
3784      119      print
3785      107      STO MEM
3786      055      7
3787      051      3
3788      040      (
3789      109      RCL MEM
3790      055      7

```

```

3791 049 1
3792 043 +
3793 109 RCL MEM
3794 055 7
3795 051 3
3796 041 )
3797 061 =
Print -gt -gr
3838 119 print
3839 107 STO MEM
3840 055 7
3841 052 4
3842 047 /
3843 109 RCL MEM
3844 053 5
3845 049 1
3846 061 =
Print -grn/Tn - gtn/Tn
3887 119 print
3888 107 STO MEM
3889 055 7
3890 053 5
3891 040 (
3892 109 RCL MEM
3893 056 8
3894 048 0
3895 043 +
3896 109 RCL MEM
3897 055 7
3898 051 3
3899 041 )
Print total snTn
3940 119 print
3941 107 STO MEM
3942 056 8
3943 050 2
3944 047 /
3945 109 RCL MEM
3946 053 5
3947 049 1
3948 061 =
Print stn + Srn
3989 119 print
3990 040 (
3991 109 RCL MEM
3992 055 7
3993 051 3
3994 047 /
3995 109 RCL MEM
3996 054 6
3997 049 1
3998 041 )
3999 061 =
Print virtual hvr
4040 119 print
4041 047 /
4042 109 RCL MEM
4043 057 9
4044 056 8
4045 047 /

```

```

4046 050 2
4047 047 /
4048 112 pi
4049 061 =
Print vr
4090 119 print
4091 114 1/x
4092 042 x
4093 109 RCL MEM
4094 057 9
4095 053 5
4096 061 =
Print virtual rotational wavelength
4137 119 print
4138 063 Goto
4139 084 T
Calculate rotational quantum no.
4180 096 LABEL
4181 069 E
4182 109 RCL MEM
4183 048 0
4184 053 5
4185 042 x
4186 109 RCL MEM
4187 049 1
4188 053 5
4189 041 )
4190 047 /
4191 040 (
4192 109 RCL MEM
4193 048 0
4194 053 5
4195 043 +
4196 109 RCL MEM
4197 049 1
4198 053 5
4199 041 )
4200 042 x
Recall H atom mass
4241 109 RCL MEM
4242 057 9
4243 054 6
4244 042 x
4245 040 (
4246 109 RCL MEM
4247 049 1
4248 054 6
4249 113 Square
4250 041 )
4251 061 =
Print Ir
4292 119 print
4293 042 x
4294 040 (
4295 050 2
4296 042 x
4297 109 RCL MEM
4298 057 9
4299 055 7
4300 042 x

```


4301	109	RCL MEM
4302	053	5
4303	049	1
4304	041	)
4305	061	=
4306	047	/
4307	109	RCL MEM
4308	056	8
4309	057	9
4310	061	=
Print @r^2		
4351	119	print
4352	064	Inverse
4353	113	Square
4354	061	=
Print @r rotational action		
4395	119	print
4396	047	/
4397	109	RCL MEM
4398	057	9
4399	056	8
4400	061	=
Print jr		
4441	119	print
4442	107	STO MEM
4443	052	4
4444	049	1
4445	109	RCL MEM
4446	052	4
4447	049	1
4448	110	LOG e
4449	042	x
4450	109	RCL MEM
4451	057	9
4452	055	7
4453	042	x
4454	050	2
4455	061	=
Print rotational -gr/T		
4496	107	STO MEM
4497	055	7
4498	050	2
4499	119	print
4500	042	x
4501	109	RCL MEM
4502	053	5
4503	049	1
4504	061	=
Print -gr		
4545	119	print
4546	107	STO MEM
4547	055	7
4548	051	3
4549	040	(
4550	109	RCL MEM
4551	055	7
4552	049	1
4553	043	+
4554	109	RCL MEM
4555	055	7

4556	051	3
4557	041	)
4558	061	=
Print total -gt - gr		
4599	119	print
4600	107	STO MEM
4601	055	7
4602	052	4
4603	047	/
4604	109	RCL MEM
4605	053	5
4606	049	1
4607	061	=
Print -grn/Tn - gtn/Tn		
4648	119	print
4649	107	STO MEM
4650	055	7
4651	053	5
4652	040	(
4653	109	RCL MEM
4654	056	8
4655	048	0
4656	043	+
4657	109	RCL MEM
4658	055	7
4659	051	3
4660	041	)
Print Total snTn		
4701	107	STO MEM
4702	056	8
4703	050	2
4704	119	print
4705	047	/
4706	109	RCL MEM
4707	053	5
4708	049	1
4709	061	=
Print stn+srn		
4750	119	print
4751	040	(
4752	109	RCL MEM
4753	055	7
4754	051	3
4755	047	/
4756	109	RCL MEM
4757	052	4
4758	049	1
4759	041	)
4760	061	=
Print virtual hvr		
4801	119	print
4802	047	/
4803	109	RCL MEM
4804	057	9
4805	056	8
4806	047	/
4807	050	2
4808	047	/
4809	112	pi
4810	061	=

```
rint vr
B51 119 print
B52 114 1/x
B53 042 x
B54 109 RCL MEM
B55 057 9
B56 053 5
B57 061 =
```

```
rint virtual rotational wavelength
```

```
B98 119 print
B99 040 (
900 109 RCL MEM
901 052 4
902 048 0
903 121 Cube
904 042 x
905 109 RCL MEM
906 052 4
907 049 1
908 113 Square
909 041 )
```

```
Print nt^3xjr^2
```

```
4950 119 print
4951 096 LABEL
4952 084 T
4953 040 (
4954 109 RCL MEM
4955 053 5
4956 048 0
4957 121 Cube
4958 042 x
4959 056 8
4960 041 )
```

```
Print vn
```

```
5001 119 print
5002 107 STO MEM
5003 054 6
5004 048 0
5005 040 (
5006 109 RCL MEM
5007 055 7
5008 049 1
5009 047 /
5010 109 RCL MEM
5011 054 6
5012 048 0
5013 041 )
```

```
Print -gt/a^3 density Gibbs
```

```
5054 119 print
5055 107 STO MEM
5056 052 4
5057 053 5
5058 040 (
5059 109 RCL MEM
5060 055 7
5061 052 4
5062 047 /
5063 109 RCL MEM
5064 054 6
5065 048 0
```

```
5066 041 )
Print -gt+gr/a^3 Gibbs density
```

```
5107 119 print
5108 040 (
5109 109 RCL MEM
5110 057 9
5111 055 7
5112 042 x
5113 109 RCL MEM
5114 053 5
5115 049 1
5116 041 )
5117 047 /
5118 040 (
5119 109 RCL MEM
5120 053 5
5121 048 0
5122 121 Cube
5123 041 )
5124 047 /
5125 056 8
5126 061 =
```

```
Print pressure pn
```

```
5167 119 print
5168 107 STO MEM
5169 052 4
5170 054 6
5171 042 x
5172 109 RCL MEM
5173 054 6
5174 048 0
5175 061 =
```

```
Print pnv
```

```
5216 119 print
5217 047 /
5218 109 RCL MEM
5219 053 5
5220 049 1
5221 061 =
```

```
Print pnv/Tn
```

```
5262 119 print
5263 040 (
5264 109 RCL MEM
5265 052 4
5266 053 5
5267 047 /
5268 109 RCL MEM
5269 052 4
5270 054 6
5271 041 )
```

```
Print quantum p vs. molecular pressure
```

```
5312 119 print
5313 060 Return
```

```
Set up V values
```

```
5354 096 LABEL
5355 083 S
```

```
Calculate q1 source heat/molecule
```

```
5396 040 (
```

```
Input n for Qs
```

```
5437 109 RCL MEM
```



```

5438 048 0
5439 054 6
5440 042 x
5441 109 RCL MEM
5442 057 9
5443 055 7
5444 042 x
5445 109 RCL MEM
5446 048 0
5447 049 1
5448 041 )
Print Qf
5489 119 print
5490 047 /
5491 109 RCL MEM
5492 048 0
5493 049 1
5494 061 =
Print ds/molecule=kln(V2/V1)
5535 119 print
5536 047 /
5537 109 RCL MEM
5538 057 9
5539 055 7
5540 061 =
5541 064 Inverse
5542 110 LOG e
5543 061 =
Print V2/V1 = V3/V4
5584 119 print
5585 107 STO MEM
5586 053 5
5587 051 3
Calculate V2/V3=(Tr/Ts)^Cv/nR
5628 040 (
5629 109 RCL MEM
5630 048 0
5631 050 2
5632 047 /
5633 109 RCL MEM
5634 048 0
5635 049 1
5636 041 )
5637 091 Exponent
5638 109 RCL MEM
5639 048 0
5640 052 4
5641 061 =
Print V2/V3
5682 119 print
5683 114 1/x
5684 042 x
5685 109 RCL MEM
5686 053 5
5687 051 3
5688 061 =
Print V3/V1
5729 119 print
5730 107 STO MEM
5731 053 5

```

```

5732 052 4
Calculate S1T1
5773 109 RCL MEM
5774 048 0
5775 049 1
5776 107 STO MEM
5777 053 5
5778 049 1
5779 109 RCL MEM
5780 057 9
5781 048 0
5782 107 STO MEM
5783 053 5
5784 048 0
Go to Label D and return
5825 068 D
5826 109 RCL MEM
5827 053 5
5828 051 3
5829 064 Inverse
5830 121 Cube
5831 042 x
5832 109 RCL MEM
5833 057 9
5834 048 0
5835 061 =
Print r2
5876 119 print
5877 107 STO MEM
5878 053 5
5879 048 0
5880 068 D
5881 109 RCL MEM
5882 053 5
5883 052 4
5884 064 Inverse
5885 121 Cube
5886 042 x
5887 109 RCL MEM
5888 057 9
5889 048 0
5890 061 =
Print r3
5931 119 print
5932 107 STO MEM
5933 053 5
5934 048 0
5935 109 RCL MEM
5936 048 0
5937 050 2
5938 107 STO MEM
5939 053 5
5940 049 1
5941 068 D
5942 109 RCL MEM
5943 053 5
5944 048 0
5945 121 Cube
5946 042 x
5947 040 (

```


5948	109	RCL MEM	5956	061	=
5949	053	5	Print r4		
5950	051	3	5997	119	print
5951	114	1/x	5998	107	STO MEM
5952	041	)	5999	053	5
5953	061	=	6000	048	0
5954	064	Inverse	6001	068	D
5955	121	Cube	6002	002	HALT

Argon

29/8/22

6.4	0002
2.88	0002
1.5	0000
4.	0001
4.	0001
1.	0000
10.229672	
1.3806259	-0016
1.05459185	-0027
1.672614	-0024
6.410895036613	-0008
8.83600576	-0014
1.3806259	-0016
2.718281828459	0000
3.0186917696247	-0001
9.0048340006472	0000
6.690456	-0023
2.7497489929671	-0037
7.2890393821235	-0050
1.2436969770194	-0025
1.1793159382176	0002
1.9757190461663	-0015
1.2644601895464	-0012
1.3970002759464	-0012
2.1828129311663	-0015
5.9987280574185	0008
1.0721979993398	-0014
1.6181199538776	0012
1.8527208522557	-0002
2.8899566155345	0005
4.5995088068344	0004
2.69982210194	-0025
4.0353334689593	-0003
6.2944931182203	0004
9.8184310962387	0011
1.6480432953259	0000
2.1078804997381	-0021
5.9987280574185	0008
0.	0000
4.1918912201607	0007
8.83600576	-0014
1.3806259	-0016
1.4310314228976	0001
8.9471247690198	-0008
6.690456	-0023
5.3557797179579	-0037
1.419711013115	-0049
1.7357189541703	-0025
1.6458679764785	0002
2.1137816361663	-0015
1.3528202471464	-0012
1.4853603335464	-0012
2.3208755211663	-0015
2.361019785455	0008
8.2194943123013	-0015
1.2404544464462	0012
2.4167953838117	-0002
2.7011978106979	0005
4.2990898384158	0004
3.7679052709895	-0025

5.6317615286454 -0003
6.2944931182203 0004
7.0352133011664 0011
1.7632080128126 0000
5.7298132590012 -0021
2.361019785455 0008
0. 0000
1.5421105995242 0007
8.83600576 -0014
1.3806259 -0016
1.5310314228976 0001 ✓
1.3337586124467 -0007
6.690456 -0023
1.1901732706573 -0036
1.419711013115 -0049
1.7357189541703 -0025 ✓
1.6458679764785 0002
2.1137816361663 -0015
6.0876911121589 -0013
6.6841215009589 -0013
2.3208755211663 -0015
3.2072359474233 0007
3.6987724405356 -0015
5.5820450090081 0011
5.3706564084705 -0002
4.0267079502627 0005
6.4087047467175 0004
3.7679052709895 -0025
5.6317615286454 -0003
4.2224743488736 0004
3.1658459855249 0011
1.7632080128126 0000
1.8981113993343 -0020
3.2072359474233 0007
0. 0000
2.0948204585856 0006
3.976202592 -0014
1.3806259 -0016
1.5310314228976 0001 ✓
9.5567980656551 -0008
6.690456 -0023
6.1105533177048 -0037
7.2890393821235 -0050
1.2436969770194 -0025 ✓
1.1793159382176 0002
1.9757190461663 -0015
5.6900708529589 -0013
6.2865012417589 -0013
2.1828129311663 -0015
8.1487399568157 0007
4.824890997029 -0015
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4.1171574494571 -0002
4.3080929629069 0005
6.8565429034605 0004
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4.2224743488736 0004
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8.1487399568157 0007
0. 0000
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3.976202592 -0014
1.3806259 -0016
1.4310314228976 0001

30/8/22

N₂

2. 0000
 6.4 0002
 2.88 0002
 4. 0001
 2.5 0000
 1.4 0001
 1.4 0001
 1.09 -0008
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 7.7468171598739 0008
 4.1918912201607 0007
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9.9379770918051 -0050
1.4522066662518 -0025
1.3770319448721 0002
2.0399164363438 -0015
1.3055465192601 -0012
1.5264466632601 -0012
2.3850729113438 -0015
2.2785149537101 0008
9.4808731498332 -0015
1.4308168858153 0012
2.0952538439549 -0002
2.3418180678667 0005
3.727119213229 0004
3.1524557240039 -0025
6.7312424999858 -0003
7.5233582561554 0004
8.4086882103239 0011
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1.39106288538 -0039
1.229143966774 -0052
1.1086676538864 -0026
1.0512765236014 0001 ✓
6.4960940777094 -0016
4.157500209734 -0013 ✓
1.7212965402335 -0012
2.6895258441148 -0015
1.9421966842335 -0012
3.0346823191148 -0015
3.9547161155006 -0014
5.9683053525124 0012
5.0230750655846 -0003
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5.7298132590012 -0021
2.2785149537101 0008
3.0041058275842 0008
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1.3806259 -0016
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4.6833192 -0023
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2.1501604770186 -0015
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7.1865128218136 -0013
2.4953169520186 -0015
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3.4460654244113 -0015
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5.7644976124126 -0002
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5.2711882898694 0004
4.1138156347068 -0025
8.7839744826849 -0003

5.0468221439543 0004
2.8996456903325 0011
1.7935533723286 0000
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7.4371687156356 -0027
7.0521773097674 0000
5.3936536709618 -0016
1.553372257237 -0013
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2.6895258441148 -0015
8.7398850790506 -0013
3.0346823191148 -0015
2.2026846305829 -0014
3.3242068676124 0012
9.018465755572 -0003
2.8857983327841 0008
4.2180253318539 -0020
1.4680950650175 0007
1.836365081204 0007
9.4266920636353 0005
3.976202592 -0014
1.3806259 -0016
1.5573809509286 0001 ✓
1.2471199833473 -0007
4.6833192 -0023
7.2840050025569 -0037
8.6888038713923 -0050
1.3578738585316 -0025
1.2875823557062 0002
2.0120978870186 -0015
5.7948419146136 -0013
6.7888925626136 -0013
2.3572543620186 -0015
3.7344520802969 0007
4.5005602079994 -0015
6.7920722484798 0011
4.4138584960886 -0002
3.5392412558748 0005
5.6328774066725 0004
2.9476777081954 -0025
6.293992748125 -0003
5.0468221439543 0004
4.0467815537753 0011
1.6783886548419 0000
1.39106288538 -0039
5.531147850483 -0053
7.4371687156356 -0027
7.0521773097674 0000
5.3936536709618 -0016
1.553372257237 -0013
7.3482141718506 -0013
2.5514632541148 -0015
8.3422648198506 -0013
2.8966197291148 -0015
2.2026846305829 -0014
3.3242068676124 0012
9.018465755572 -0003
1.0616258779981 0008
1.5517248019294 -0020

3.7344520802969 0007
4.735513773263 0007
2.5624405739059 0006
3.976202592 -0014
1.3806259 -0016
1.4573809509286 0001

ENTROPY8/CAL Jul 20, 2016.

Revises Feb 28 version

Uses action 3 to calculate entropy S
For diatomics and linear triatomics,
input mass of terminal atoms in L & N
and central atom or monatomic in M

For other polyatomics, input LNOP
Ia, Ib, and Ic as principal moments
of inertia in ABC instead

Input electronic multiplicity as Q
Get vibrational entropy using eqn
 $S_v = R \ln(e^x - 1) - R \ln(1 - e^{-x})$; $x = hv/kT$

Get vibrational kinetic heat using
 $C_{vv} = R x^2 / 2 (\cosh x - 1)$ ex Moore

Input rotational symmetry Z in r99
Add Set flag 5 at 4107

for mono-vibrational cmpds like N2

```
0680 002 HALT
0681 096 LABEL
0682 090 Z
0683 107 STO MEM
0684 057 9
0685 057 9
0686 119 print
0687 002 HALT
0688 048 0
```

Input electron multiplicity Qe in r89

```
0729 096 LABEL
0730 081 Q
0731 107 STO MEM
0732 056 8
0733 057 9
0734 119 print
0735 002 HALT
0736 048 0
```

Input gas pressure P (atm) in r01

```
0777 096 LABEL
0778 080 P
0779 107 STO MEM
0780 048 0
0781 049 1
0782 119 print
0783 002 HALT
0784 048 0
```

Input dipolyatomic mass L in r07

```
0825 096 LABEL
0826 076 L
0827 107 STO MEM
0828 048 0
0829 050 2
0830 119 print
0831 002 HALT
0832 048 0
0833 096 LABEL
0834 077 M
```

Input mon/polyatomic mass M in r03

```
0875 107 STO MEM
0876 048 0
0877 051 3
0878 119 print
```

```
0879 002 HALT
0880 048 0
Input di-polyatomic mass N in r04
0921 096 LABEL
0922 078 N
0923 107 STO MEM
0924 048 0
0925 052 4
0926 119 print
0927 002 HALT
0928 048 0
Input atomic mass3 O in r05
0969 096 LABEL
0970 079 0
0971 107 STO MEM
0972 048 0
0973 053 5
0974 119 print
0975 002 HALT
0976 048 0
Input atomic mass4 J in r06
1017 096 LABEL
1018 074 J
1019 107 STO MEM
1020 048 0
1021 054 6
1022 119 print
1023 002 HALT
1024 048 0
Input atomic mass5 Y in r07
1065 096 LABEL
1066 089 Y
1067 107 STO MEM
1068 048 0
1069 055 7
1070 119 print
1071 002 HALT
1072 048 0
1073 119 print
1074 002 HALT
1075 048 0
Input bond length r1=R in r09
1116 096 LABEL
1117 082 R
1118 107 STO MEM
1119 048 0
1120 057 9
1121 119 print
1122 002 HALT
1123 048 0
Input bond length r2=S in r10
1164 096 LABEL
1165 083 S
1166 107 STO MEM
1167 049 1
1168 048 0
1169 119 print
1170 002 HALT
1171 048 0
Input bond length r3=T in r11
```


1212	096	LABEL
1213	084	T
1214	107	STD MEM
1215	049	1
1216	049	1
1217	119	print
1218	002	HALT
1219	048	0
Input IrA rot. moment inertia in r12		
1260	096	LABEL
1261	065	A
1262	107	STD MEM
1263	049	1
1264	050	2
1265	119	print
1266	002	HALT
1267	048	0
Input IrB rot. moment inertia in r13		
1308	096	LABEL
1309	066	B
1310	107	STD MEM
1311	049	1
1312	051	3
1313	119	print
1314	002	HALT
1315	048	0
Input IrC rot. moment inertia in r14		
1356	096	LABEL
1357	067	C
1358	107	STD MEM
1359	049	1
1360	052	4
1361	119	print
1362	002	HALT
1363	109	RCL MEM
Input frequency 1 $w=c/v$, F		
1404	096	LABEL
1405	070	F
1406	107	STD MEM
1407	053	5
1408	051	3
1409	107	STD MEM
1410	051	3
1411	049	1
1412	119	print
1413	002	HALT
1414	048	0
Input frequency 2, G		
1455	096	LABEL
1456	071	G
1457	107	STD MEM
1458	051	3
1459	050	2
1460	119	print
1461	002	HALT
1462	048	0
Input frequency 3, H		
1503	096	LABEL
1504	072	H
1505	107	STD MEM

1506	051	3
1507	051	3
1508	119	print
1509	002	HALT
1510	048	0
Input frequency 4, I		
1551	096	LABEL
1552	073	I
1553	107	STD MEM
1554	051	3
1555	052	4
1556	119	print
1557	002	HALT
1558	048	0
Input degeneracy F, D		
1599	096	LABEL
1600	068	D
1601	107	STD MEM
1602	051	3
1603	053	5
1604	119	print
1605	002	HALT
1606	048	0
Input degeneracy G, E		
1647	096	LABEL
1648	069	E
1649	107	STD MEM
1650	051	3
1651	054	6
1652	119	print
1653	002	HALT
1654	048	0
Input degeneracy W, for H and I		
1695	096	LABEL
1696	087	W
1697	107	STD MEM
1698	051	3
1699	055	7
1700	119	print
1701	002	HALT
1702	048	0
Input degrees Kelvin K in r08		
1743	096	LABEL
1744	075	K
1745	107	STD MEM
1746	048	0
1747	056	8
1748	119	print
1749	002	HALT
Execute by ShiftX		
1790	096	LABEL
1791	088	X
Store H atomic mass in g in r95		
1832	049	1
1833	046	.
1834	054	6
1835	055	7
1836	051	3
1837	053	5
1838	050	2

839	053	5
840	101	EE
841	050	2
842	052	4
843	111	+/-
844	107	STO MEM
845	057	9
846	053	5
Store gas constant R in r96		
1887	056	8
1888	046	.
1889	051	3
1890	049	1
1891	052	4
1892	052	4
1893	054	6
1894	050	2
1895	049	1
1896	055	7
1897	053	5
1898	107	STO MEM
1899	057	9
1900	054	6
Store Boltzmann's constant k in r97		
1941	049	1
1942	046	.
1943	051	3
1944	056	8
1945	048	0
1946	054	6
1947	052	4
1948	056	8
1949	056	8
1950	101	EE
1951	049	1
1952	054	6
1953	111	+/-
1954	107	STO MEM
1955	057	9
1956	055	7
Store Planck's red. quantum h- in r98		
1997	049	1
1998	046	.
1999	048	0
2000	053	5
2001	052	4
2002	057	9
2003	049	1
2004	056	8
2005	053	5
2006	101	EE
2007	050	2
2008	055	7
2009	111	+/-
2010	107	STO MEM
2011	057	9
2012	056	8
2013	050	2
2014	046	.
2015	057	9

2016	057	9
2017	055	7
2018	057	9
2019	050	2
2020	052	4
2021	053	5
2022	056	8
2023	101	EE
2024	049	1
2025	048	0
2026	119	print
Store c in r94		
2067	107	STO MEM
2068	057	9
2069	052	4
2070	040	(
2071	040	(
Recall pressure (atm), find radius rt		
Calcul (TnxPo)/(ToxPn)		
2152	109	RCL MEM
2153	048	0
2154	056	8
2155	047	/
2156	109	RCL MEM
2157	048	0
2158	049	1
2159	047	/
2160	050	2
2161	057	9
2162	056	8
2163	046	.
2164	049	1
2165	053	5
2166	061	=
2167	119	print
2168	092	Root
2169	051	3
2170	042	x
2171	049	1
2172	046	.
2173	055	7
2174	049	1
2175	056	8
2176	056	8
2177	041	)
2178	042	x
2179	049	1
2180	101	EE
2181	055	7
2182	111	+/-
2183	061	=
Print radius r		
2224	119	print
2225	121	Cube
2226	042	x
2227	056	8
2228	061	=
2229	114	1/x
Print N/cm^3		
2270	119	print

2271	114	1/x
2272	047	/
2273	056	8
2274	061	=
2275	064	Inverse
2276	121	Cube
2277	061	=
2278	113	Square
2279	042	x
2280	040	(
Recall AW 1 from r02		
2321	109	RCL MEM
2322	048	0
2323	050	2
2324	043	+
Recall AW 2 from r03		
2365	109	RCL MEM
2366	048	0
2367	051	3
2368	043	+
Recall AW 3 from r04		
2409	109	RCL MEM
2410	048	0
2411	052	4
2412	043	+
Recall AW 4 from r05		
2453	109	RCL MEM
2454	048	0
2455	053	5
2456	043	+
Recall AW 5 from r06		
2497	109	RCL MEM
2498	048	0
2499	054	6
Recall AW 6 from r07		
2540	109	RCL MEM
2541	048	0
2542	055	7
2543	041	)
2544	042	x
2545	109	RCL MEM
2546	057	9
2547	053	5
2548	061	=
Print and store It in r15		
2589	119	print
2590	107	STO MEM
2591	049	1
2592	053	5
2593	042	x
Recall k		
2634	109	RCL MEM
2635	057	9
2636	055	7
2637	042	x
2638	051	3
2639	042	x
2640	109	RCL MEM
2641	048	0
2642	056	8

2643	061	=
2644	092	Root
2645	050	2
2646	061	=
Print and store action @t in r16		
2687	119	print
2688	107	STO MEM
2689	049	1
2690	054	6
2691	047	/
Recall h-		
2732	109	RCL MEM
2733	057	9
2734	056	8
2735	061	=
Print and store @/h- in r17		
2776	107	STO MEM
2777	049	1
2778	055	7
2779	119	print
2780	049	1
2781	048	0
2782	046	.
2783	050	2
2784	050	2
2785	057	9
2786	055	7
2787	092	Root
2788	051	3
2789	061	=
2790	114	1/x
2791	042	x
2792	109	RCL MEM
2793	049	1
2794	055	7
2795	061	=
Print nt		
2836	119	print
2837	121	Cube
2838	119	print
2839	110	LOG e
2840	042	x
2841	109	RCL MEM
2842	057	9
2843	054	6
2844	061	=
2845	107	STO MEM
2846	049	1
2847	056	8
2848	109	RCL MEM
2849	049	1
2850	056	8
2851	119	print
2852	107	STO MEM
2853	054	6
2854	049	1
2855	109	RCL MEM
2856	054	6
2857	049	1
Print cumulative -G/T		


```

2898 119 print
2899 109 RCL MEM
2900 057 9
2901 054 6
2902 042 x
2903 050 2
2904 046 .
2905 053 5
2906 061 =
2907 117 SUM MEM
2908 049 1
2909 056 8
2910 107 STO MEM
2911 054 6
2912 050 2
2913 109 RCL MEM
2914 054 6
2915 050 2
Print cmulative H/T
2956 119 print
2957 109 RCL MEM
2958 049 1
2959 056 8
2960 119 print
Print St with Qe=1
Check for Qe eg 02 3, N20 4
3041 040 (
3042 049 1
3043 045 -
3044 109 RCL MEM
3045 056 8
3046 057 9
3047 041 )
3048 038 If zero
3049 104 Hyperbol
3050 109 RCL MEM
3051 056 8
3052 057 9
3053 110 LOG e
3054 042 x
3055 109 RCL MEM
3056 057 9
3057 054 6
3058 061 =
3059 117 SUM MEM
3060 054 6
3061 049 1
3062 117 SUM MEM
3063 049 1
3064 056 8
3065 109 RCL MEM
3066 049 1
3067 056 8
Print St with Qe>1
3108 119 print
3109 109 RCL MEM
3110 054 6
3111 049 1
Print cumulative -G/T
3152 119 print

```

```

3153 096 LABEL
3154 104 Hyperbol
Test if monatomic
3195 109 RCL MEM
3196 048 0
3197 052 4
3198 038 If zero
3199 115 Sine
Calculate rotational entropy
Test if non-linear
3280 040 (
3281 048 0
3282 045 -
Recall Ia
3323 109 RCL MEM
3324 049 1
3325 050 2
3326 041 )
3327 064 Inverse
3328 037 If pos
3329 116 Tangent
3330 040 (
Calculate reduced mass
3371 040 (
3372 109 RCL MEM
3373 048 0
3374 050 2
3375 042 x
3376 109 RCL MEM
3377 048 0
3378 052 4
3379 041 )
3380 047 /
3381 040 (
3382 109 RCL MEM
3383 048 0
3384 050 2
3385 043 +
3386 109 RCL MEM
3387 048 0
3388 052 4
3389 041 )
3390 042 x
Recall H atom mass
3431 109 RCL MEM
3432 057 9
3433 053 5
3434 042 x
3435 040 (
3436 109 RCL MEM
3437 048 0
3438 057 9
3439 043 +
3440 109 RCL MEM
3441 049 1
3442 048 0
3443 041 )
3444 113 Square
3445 041 )
Print and store Ir in r19

```

```

3486 119 print
3487 107 STO MEM
3488 049 1
3489 057 9
3490 040 (
3491 109 RCL MEM
3492 049 1
3493 057 9
3494 042 x
Recall degrees K
3535 109 RCL MEM
3536 048 0
3537 056 8
3538 042 x
Recall k
3579 109 RCL MEM
3580 057 9
3581 055 7
3582 042 x
3583 050 2
3584 041 )
3585 061 =
3586 092 Root
3587 050 2
3588 061 =
Print and store @r in r20
3629 119 print
3630 107 STO MEM
3631 050 2
3632 048 0
Calculate Sr
3673 040 (
3674 109 RCL MEM
3675 050 2
3676 048 0
3677 047 /
Recall h-
3718 109 RCL MEM
3719 057 9
3720 056 8
3721 041 )
Print and store @/h- in r21
3762 119 print
3763 107 STO MEM
3764 050 2
3765 049 1
Recall symmetry factor
3806 109 RCL MEM
3807 057 9
3808 057 9
3809 092 Root
3810 050 2
3811 061 =
3812 114 1/x
3813 042 x
3814 109 RCL MEM
3815 050 2
3816 049 1
3817 061 =
Print nr

```

```

3858 119 print
3859 113 Square
Print nr squared
3900 119 print
3901 110 LOG e
3902 042 x
Recall R
3943 109 RCL MEM
3944 057 9
3945 054 6
3946 061 =
Print and store -G/T in r22
3987 119 print
3988 107 STO MEM
3989 050 2
3990 050 2
3991 117 SUM MEM
3992 054 6
3993 049 1
3994 109 RCL MEM
3995 054 6
3996 049 1
3997 119 print
3998 109 RCL MEM
3999 057 9
4000 054 6
4001 117 SUM MEM
4002 054 6
4003 050 2
4004 117 SUM MEM
4005 050 2
4006 050 2
4007 109 RCL MEM
4008 054 6
4009 050 2
Print cumulative C
4050 119 print
4051 109 RCL MEM
4052 050 2
4053 050 2
4054 119 print
4055 043 +
4056 109 RCL MEM
4057 049 1
4058 056 8
4059 119 print
4060 061 =
Print St+Sr
4101 119 print
4102 107 STO MEM
4103 053 5
4104 055 7
4105 034 Set flag
4106 049 1
4107 000
4108 000
4109 040 (
4110 048 0
4111 045 -
4112 109 RCL MEM

```



```

4113 051 3
4114 049 1
4115 041 )
4116 064 Inverse
4117 037 If pos
4118 086 V
4119 109 RCL MEM
4120 053 5
4121 055 7
4122 042 x
4123 109 RCL MEM
4124 048 0
4125 056 8
4126 061 =
Print cumulative ST
4167 119 print
4168 109 RCL MEM
4169 054 6
4170 049 1
4171 042 x
4172 109 RCL MEM
4173 048 0
4174 056 8
4175 061 =
Print cumulative -G
4216 119 print
4217 109 RCL MEM
4218 054 6
4219 050 2
4220 042 x
4221 109 RCL MEM
4222 048 0
4223 056 8
4224 061 =
Print cumulative H
4265 119 print
4266 002 HALT
Calculate Sr for polyatomic gases
 $Sr = R \ln[\pi^{1/2} e^{3/2} a^3 b^3 c / h^{-3/z}]$ 
Calculate @rA
4387 096 LABEL
4388 116 Tangent
4389 040 (
4390 109 RCL MEM
4391 049 1
4392 050 2
4393 042 x
4394 109 RCL MEM
4395 048 0
4396 056 8
4397 042 x
4398 050 2
4399 042 x
Recall k
4440 109 RCL MEM
4441 057 9
4442 055 7
4443 041 )
4444 092 Root
4445 050 2

```

```

4446 061 =
Print and store @rA in r23
4487 119 print
4488 107 STO MEM
4489 050 2
4490 051 3
4491 109 RCL MEM
4492 050 2
4493 051 3
4494 047 /
Recall h-
4535 109 RCL MEM
4536 057 9
4537 056 8
4538 061 =
Print and store @rA/h- in r24
4579 119 print
4580 107 STO MEM
4581 050 2
4582 052 4
4583 109 RCL MEM
4584 057 9
4585 057 9
4586 092 Root
4587 051 3
4588 061 =
4589 114 1/x
4590 042 x
4591 109 RCL MEM
4592 050 2
4593 052 4
4594 061 =
Print nra
4635 119 print
4636 042 x
4637 040 (
4638 112 pi
4639 092 Root
4640 054 6
4641 041 )
4642 061 =
Print n with pi-exp6 correction
4683 119 print
Calculate @rB
4724 040 (
4725 109 RCL MEM
4726 049 1
4727 051 3
4728 042 x
4729 109 RCL MEM
4730 048 0
4731 056 8
4732 042 x
4733 050 2
4734 042 x
Recall k
4775 109 RCL MEM
4776 057 9
4777 055 7
4778 041 )

```

```

4779 092 Root
4780 050 2
4781 061 =
Print and store @rB in r25
4822 119 print
4823 107 STO MEM
4824 050 2
4825 053 5
4826 109 RCL MEM
4827 050 2
4828 053 5
4829 047 /

```

Recall h-

```

4870 109 RCL MEM
4871 057 9
4872 056 8
4873 061 =
Print and store @rB/h- in r26
4914 119 print
4915 107 STO MEM
4916 050 2
4917 054 6
4918 109 RCL MEM
4919 057 9
4920 057 9
4921 092 Root
4922 051 3
4923 061 =
4924 114 1/x
4925 042 x
4926 109 RCL MEM
4927 050 2
4928 054 6
4929 061 =

```

Print nrb

```

4970 119 print
4971 042 x
4972 040 (
4973 112 pi
4974 092 Root
4975 054 6
4976 041 )
4977 061 =
4978 119 print

```

Calculate @rC

```

5019 040 (
5020 109 RCL MEM
5021 049 1
5022 052 4
5023 042 x
5024 109 RCL MEM
5025 048 0
5026 056 8
5027 042 x
5028 050 2
5029 042 x

```

Recall k

```

5070 109 RCL MEM
5071 057 9
5072 055 7

```

```

5073 041 )
5074 092 Root
5075 050 2
5076 061 =
Print and store @rC in r27
5117 119 print
5118 107 STO MEM
5119 050 2
5120 055 7
5121 109 RCL MEM
5122 050 2
5123 055 7
5124 047 /

```

Recall h-

```

5165 109 RCL MEM
5166 057 9
5167 056 8
5168 061 =
Print and store @rC/h- in r28
5209 119 print
5210 107 STO MEM
5211 050 2
5212 056 8
5213 109 RCL MEM
5214 057 9
5215 057 9
5216 092 Root
5217 051 3
5218 061 =
5219 114 1/x
5220 042 x
5221 109 RCL MEM
5222 050 2
5223 056 8
5224 061 =

```

Print nrc

```

5265 119 print
5266 042 x
5267 040 (
5268 112 pi
5269 092 Root
5270 054 6
5271 041 )
5272 061 =
5273 119 print
5274 040 (
5275 109 RCL MEM
5276 050 2
5277 052 4
5278 042 x
5279 109 RCL MEM
5280 050 2
5281 054 6
5282 042 x
5283 109 RCL MEM
5284 050 2
5285 056 8
5286 041 )

```

```

Print nrA x nrB x nrC
5327 119 print

```



```

Recall symmetry factor
5368 042 x
5369 040 (
5370 112 pi
5371 092 Root
5372 050 2
5373 041 )
5374 047 /
5375 109 RCL MEM
5376 057 9
5377 057 9
5378 061 =
Print nrcubed
5419 119 print
5420 110 LOG e
5421 042 x
Recall R
5462 109 RCL MEM
5463 057 9
5464 054 6
5465 061 =
Print and store -Gr/T in r29
5506 119 print
5507 107 STO MEM
5508 050 2
5509 057 9
5510 117 SUM MEM
5511 054 6
5512 049 1
5513 109 RCL MEM
5514 054 6
5515 049 1
Print cumulative -G/T
5556 119 print
5557 040 (
5558 049 1
5559 046 .
5560 053 5
5561 042 x
5562 109 RCL MEM
5563 057 9
5564 054 6
5565 041 )
5566 117 SUM MEM
5567 050 2
5568 057 9
Print Sr
5609 119 print
5610 117 SUM MEM
5611 054 6
5612 050 2
5613 109 RCL MEM
5614 054 6
5615 050 2
Print (Ht+Hr)/T
5656 119 print
5657 109 RCL MEM
5658 050 2
5659 057 9
Print Sr non-linear molecules

```

```

5700 119 print
5701 043 +
5702 109 RCL MEM
5703 049 1
5704 056 8
5705 061 =
Print St+Sr
5746 119 print
5747 034 Set flag
5748 049 1
5749 096 LABEL
5750 086 V
5751 109 RCL MEM
5752 051 3
5753 049 1
Print wavelength cm^-1
5794 119 print
5795 042 x
5796 109 RCL MEM
5797 057 9
5798 052 4
5799 061 =
Print true frequency v
5840 119 print
5841 042 x
5842 050 2
5843 042 x
5844 112 pi
5845 042 x
5846 109 RCL MEM
5847 057 9
5848 056 8
5849 061 =
5850 119 print
Store hv in r43
5891 107 STO MEM
5892 052 4
5893 051 3
Recall temperature K
5934 109 RCL MEM
5935 048 0
5936 056 8
5937 042 x
5938 109 RCL MEM
5939 057 9
5940 055 7
5941 061 =
Print kT
5982 119 print
Store kT in r44
6023 107 STO MEM
6024 052 4
6025 052 4
6026 109 RCL MEM
6027 052 4
6028 051 3
6029 047 /
6030 109 RCL MEM
6031 052 4
6032 052 4

```

```

6033 061 =
Store hv/kT = x in r45, print
6074 119 print
6075 107 STO MEM
6076 052 4
6077 053 5
Calculate Sv
6118 040 (
6119 109 RCL MEM
6120 057 9
6121 054 6
6122 042 x
6123 109 RCL MEM
6124 052 4
6125 053 5
6126 047 /
6127 040 (
6128 040 (
6129 049 1
6130 064 Inverse
6131 110 LOG e
6132 091 Exponent
6133 109 RCL MEM
6134 052 4
6135 053 5
6136 041 )
6137 045 -
6138 049 1
6139 041 )
6140 061 =
6141 107 STO MEM
6142 052 4
6143 054 6
6144 040 (
6145 049 1
6146 045 -
6147 040 (
6148 040 (
6149 049 1
6150 064 Inverse
6151 110 LOG e
6152 041 )
6153 091 Exponent
6154 109 RCL MEM
6155 052 4
6156 053 5
6157 111 +/-
6158 041 )
6159 041 )
6160 110 LOG e
6161 042 x
6162 109 RCL MEM
6163 057 9
6164 054 6
6165 061 =
6166 107 STO MEM
6167 052 4
6168 055 7
6169 040 (
6170 109 RCL MEM

```

```

6171 052 4
6172 054 6
6173 045 -
6174 109 RCL MEM
6175 052 4
6176 055 7
6177 041 )
6178 107 STO MEM
6179 052 4
6180 056 8
Print Sv at w without degeneracy
6221 119 print
6222 042 x
Recall degeneracy D
6263 109 RCL MEM
6264 051 3
6265 053 5
6266 061 =
Print and store total Sv in r49
6307 119 print
6308 117 SUM MEM
6309 052 4
6310 057 9
6311 119 print
6312 109 RCL MEM
6313 052 4
6314 057 9
Print cumulative Sv
6355 119 print
6356 047 /
6357 054 6
6358 046 .
6359 048 0
6360 050 2
6361 050 2
6362 049 1
6363 052 4
6364 049 1
6365 053 5
6366 101 EE
6367 049 1
6368 054 6
6369 061 =
6370 119 print
ergs per molecule per degree
6411 042 x
6412 109 RCL MEM
6413 048 0
6414 056 8
6415 061 =
Print sT
6456 119 print
6457 117 SUM MEM
6458 053 5
6459 048 0
6460 109 RCL MEM
6461 053 5
6462 048 0
Print svT
6503 119 print

```


Compute Cv at T with Moore formula

$$Cv = R \cdot x^2 / 2 (\cosh x - 1)$$

```

6584 040 (
6585 040 (
6586 109 RCL MEM
6587 057 9
6588 054 6
6589 042 x
6590 040 (
6591 109 RCL MEM
6592 052 4
6593 053 5
6594 113 Square
6595 041 )
6596 041 )
6597 047 /
6598 040 (
6599 050 2
6600 042 x
6601 040 (
6602 109 RCL MEM
6603 052 4
6604 053 5
6605 104 Hyperbol
6606 099 Cosine
6607 045 -
6608 049 1
6609 041 )
6610 041 )
6611 047 /
6612 050 2
6613 061 =
Print cumulative Cv/2
6654 119 print
6655 117 SUM MEM
6656 053 5
6657 049 1
6658 117 SUM MEM
6659 054 6
6660 050 2
6661 109 RCL MEM
6662 054 6
6663 050 2
Print cumulative Cv kinetic
6704 119 print
6705 109 RCL MEM
6706 053 5
6707 049 1
Print SumCvvib/2
6748 119 print
6749 047 /
6750 054 6
6751 046 .
6752 048 0
6753 050 2
6754 050 2
6755 049 1
6756 052 4
6757 049 1
6758 053 5

```

```

6759 101 EE
6760 049 1
6761 054 6
6762 061 =
Print ergs per molecule per degree
6803 119 print
6804 042 x
6805 109 RCL MEM
6806 048 0
6807 056 8
6808 061 =
Print cvvT/2 kinetic
6849 119 print
6850 117 SUM MEM
6851 053 5
6852 050 2
6853 109 RCL MEM
6854 053 5
6855 050 2
Print SumcvvT
6896 119 print
6897 035 If flag
6898 053 5
6899 125 101
6900 035 If flag
6901 052 4
6902 123 101
6903 035 If flag
6904 051 3
6905 033 !
6906 035 If flag
6907 050 2
6908 099 Cosine
6909 109 RCL MEM
6910 051 3
6911 050 2
6912 107 STO MEM
6913 051 3
6914 049 1
6915 119 print
6916 109 RCL MEM
6917 051 3
6918 054 6
6919 107 STO MEM
6920 051 3
6921 053 5
6922 064 Inverse
6923 034 Set flag
6924 049 1
6925 034 Set flag
6926 050 2
6927 086 V
6928 096 LABEL
6929 099 Cosine
6930 109 RCL MEM
6931 051 3
6932 051 3
6933 107 STO MEM
6934 051 3
6935 049 1

```

```

6936 119 print
6937 109 RCL MEM
6938 051 3
6939 055 7
6940 107 STO MEM
6941 051 3
6942 053 5
6943 064 Inverse
6944 034 Set flag
6945 050 2
6946 034 Set flag
6947 051 3
6948 086 V
6949 096 LABEL
6950 033 !
6951 109 RCL MEM
6952 051 3
6953 052 4
6954 038 If zero
6955 125 !|!
6956 107 STO MEM
6957 051 3
6958 049 1
6959 119 print
6960 109 RCL MEM
6961 051 3
6962 055 7
6963 107 STO MEM
6964 051 3
6965 053 5
6966 064 Inverse
6967 034 Set flag
6968 051 3
6969 034 Set flag
6970 052 4
6971 086 V
6972 096 LABEL
6973 123 !|!
6974 096 LABEL
6975 125 !|!
6976 040 (
6977 109 RCL MEM
6978 052 4
6979 057 9
6980 045 -
6981 109 RCL MEM
6982 053 5
6983 049 1
6984 041 )
Print Sv-Cvib/2=-Gvib/T
7025 119 print
Sum cumulative -G/T
7066 117 SUM MEM
7067 054 6
7068 049 1
7069 109 RCL MEM
7070 054 6
7071 049 1
Print cumulative -G/T
7112 119 print

```

```

7113 040 (
7114 109 RCL MEM
7115 053 5
7116 048 0
7117 045 -
7118 109 RCL MEM
7119 053 5
7120 050 2
7121 041 )
Print svT-cvvT/2=-GvT
7162 119 print
7163 040 (
7164 040 (
7165 040 (
7166 109 RCL MEM
7167 049 1
7168 056 8
7169 043 +
7170 109 RCL MEM
7171 050 2
7172 050 2
7173 043 +
7174 109 RCL MEM
7175 050 2
7176 057 9
7177 041 )
Print St+Sr
7218 119 print
7219 043 +
7220 109 RCL MEM
7221 052 4
7222 057 9
7223 041 )
7224 107 STO MEM
7225 053 5
7226 053 5
Print St+Sr+Sv
7267 119 print
7268 042 x
7269 109 RCL MEM
7270 048 0
7271 056 8
7272 061 =
Print [St+Sr+Sv]T
7313 119 print
7314 047 /
7315 054 6
7316 046 .
7317 048 0
7318 050 2
7319 050 2
7320 049 1
7321 052 4
7322 049 1
7323 053 5
7324 101 EE
7325 049 1
7326 054 6
7327 061 =
7328 119 print

```



```

[st+sr+sv]T printed
7369 040 (
7370 109 RCL MEM
7371 053 5
7372 053 5
7373 047 /
7374 054 6
7375 046 .
7376 048 0
7377 050 2
7378 050 2
7379 049 1
7380 052 4
7381 049 1
7382 053 5
7383 101 EE
7384 049 1
7385 054 6
7386 061 =

```

```

Print [st+sr+sv]
7427 119 print
7428 109 RCL MEM
7429 054 6
7430 049 1

```

```

Print cumulative -G/T
7471 119 print
7472 042 x
7473 109 RCL MEM
7474 048 0
7475 056 8
7476 061 =

```

```

Print -G
7517 119 print
7518 109 RCL MEM
7519 054 6
7520 050 2

```

```

Print cumulative H/T
7561 119 print
7562 042 x
7563 109 RCL MEM
7564 048 0
7565 056 8
7566 061 =

```

```

Print cumulative H
7607 119 print
7608 109 RCL MEM
7609 053 5
7610 051 3
7611 107 STO MEM
7612 051 3
7613 049 1
7614 048 0
7615 107 STO MEM
7616 053 5
7617 053 5
7618 107 STO MEM
7619 053 5
7620 052 4
7621 107 STO MEM
7622 053 5

```

```

7623 050 2
7624 107 STO MEM
7625 053 5
7626 049 1
7627 107 STO MEM
7628 053 5
7629 048 0
7630 107 STO MEM
7631 052 4
7632 057 9
7633 107 STO MEM
7634 049 1
7635 056 8
7636 107 STO MEM
7637 050 2
7638 048 0
7639 107 STO MEM
7640 050 2
7641 049 1
7642 107 STO MEM
7643 050 2
7644 050 2
7645 107 STO MEM
7646 050 2
7647 057 9
7648 107 STO MEM
7649 052 4
7650 050 2
7651 107 STO MEM
7652 052 4
7653 051 3
7654 107 STO MEM
7655 052 4
7656 052 4
7657 107 STO MEM
7658 052 4
7659 053 5
7660 107 STO MEM
7661 052 4
7662 054 6
7663 107 STO MEM
7664 052 4
7665 055 7
7666 107 STO MEM
7667 052 4
7668 056 8
7669 107 STO MEM
7670 054 6
7671 049 1
7672 107 STO MEM
7673 054 6
7674 050 2
7675 109 RCL MEM
7676 053 5
7677 051 3
7678 107 STO MEM
7679 051 3
7680 049 1
Ex monatomic gases
7721 044 Reset

```

7722
7723

096
115

LABEL
Sine

7724

002

HALT


```

urbine5/cal Vevor Turbine cgs
E = IW^2/2 I=MR^2/2 28/08/21 08/21
revised 14/9/21 e^0.67 TbD
revised 3/9/22 for symmetry factor 2
estimate [Tw-Tb]xRadian/sec=Power
radius of air cell say 1000 km 10^8
apered blade 2.3 to 11.5 cm
radius is R+10 cm + 1.0 cm up to 52 cm
chord from 2.30 to 11.504 +0.1769/cm
let KE and Vortical energy throughput
revised 3/10/21 mv^2 for kT in vort en
0440 096 LABEL
0441 082 R
0442 107 STO MEM
0443 048 0
0444 049 1
0445 119 print
0446 002 HALT
Cell height H say 1000 m 10^5 cm
0487 096 LABEL
0488 072 H
0489 107 STO MEM
0490 048 0
0491 050 2
0492 119 print
0493 002 HALT
Angular velocity W radians/sec
0534 096 LABEL
0535 087 W
0536 107 STO MEM
0537 048 0
0538 051 3
0539 119 print
0540 002 HALT
Mean air density g/cm^3
0581 096 LABEL
0582 068 D
0583 107 STO MEM
0584 048 0
0585 052 4
0586 119 print
0587 002 HALT
Area of wind blades A=LxC cm^2
0628 096 LABEL
0629 065 A
0630 107 STO MEM
0631 048 0
0632 053 5
0633 119 print
0634 002 HALT
Chord width of rotor blade cm
0675 096 LABEL
0676 067 C
0677 107 STO MEM
0678 048 0
0679 054 6
0680 119 print
0681 002 HALT
Angle of attack degrees
0722 096 LABEL

```

```

0723 079 0
0724 107 STO MEM
0725 048 0
0726 055 7
0727 119 print
0728 002 HALT
Length of rotor input L cm
0769 096 LABEL
0770 076 L
0771 107 STO MEM
0772 048 0
0773 056 8
0774 119 print
0775 002 HALT
Tip speed/wind ratio lambda
0816 096 LABEL
0817 083 S
0818 107 STO MEM
0819 048 0
0820 057 9
0821 119 print
0822 002 HALT
0823 096 LABEL
0824 088 X
Calculate max wind speed rw cm/sec
0865 040 (
0866 109 RCL MEM
0867 048 0
0868 049 1
0869 042 x
0870 109 RCL MEM
0871 048 0
0872 051 3
0873 041 )
Print max wind speed cm/sec
0914 119 print
0915 107 STO MEM
0916 049 1
0917 048 0
Caculate KE
Calculate volume cm^3
0998 040 (
0999 112 pi
1000 042 x
1001 109 RCL MEM
1002 048 0
1003 049 1
1004 113 Square
1005 042 x
1006 109 RCL MEM
1007 048 0
1008 050 2
1009 041 )
Print vol cm^3 of air cell, stow m11
1050 119 print
1051 107 STO MEM
1052 049 1
1053 049 1
1054 040 (
1055 109 RCL MEM

```

```

1056 049 1
1057 049 1
1058 042 x
1059 109 RCL MEM
1060 048 0
1061 052 4
1062 041 )

```

Print mass of air cell, stow m12 g

```

1103 119 print
1104 107 STO MEM
1105 049 1
1106 050 2
1107 040 (
1108 109 RCL MEM
1109 049 1
1110 050 2
1111 042 x
1112 109 RCL MEM
1113 048 0
1114 049 1
1115 113 Square
1116 047 /
1117 052 4
1118 041 )

```

Print I and stow in m13

```

1159 119 print
1160 107 STO MEM
1161 049 1
1162 051 3
1163 040 (
1164 109 RCL MEM
1165 049 1
1166 051 3
1167 042 x
1168 109 RCL MEM
1169 048 0
1170 051 3
1171 113 Square
1172 041 )

```

Print KE IW² of air cell, stow m14

```

1213 119 print
1214 107 STO MEM
1215 049 1
1216 052 4

```

Calculate KE, power of turbine volume

```

1257 040 (
1258 040 (
1259 040 (
1260 040 (
1261 109 RCL MEM
1262 049 1
1263 048 0
1264 042 x
1265 112 pi
1266 042 x
1267 109 RCL MEM
1268 048 0
1269 056 8
1270 113 Square
1271 041 )

```

```

1272 042 x
1273 040 (
1274 109 RCL MEM
1275 048 0
1276 052 4
1277 042 x
1278 109 RCL MEM

```

```

1279 049 1
1280 048 0
1281 113 Square
1282 041 )
1283 041 )
1284 047 /
1285 050 2
1286 041 )

```

Print rate kinetic energy $P = DAv^{30.6}$

```

1327 119 print
1328 042 x
1329 048 0
1330 046 .
1331 054 6
1332 041 )

```

Print adjustment for Cp

```

1373 119 print
Get vortical energy
1414 107 STO MEM
1415 049 1
1416 052 4
1417 040 (
1418 040 (
1419 040 (
1420 112 pi
1421 042 x
1422 109 RCL MEM
1423 048 0
1424 056 8
1425 113 Square
1426 041 )
1427 047 /
1428 040 (
1429 051 3
1430 042 x
1431 109 RCL MEM
1432 048 0
1433 053 5
1434 041 )
1435 041 )
1436 119 print
1437 114 1/x
1438 042 x
1439 109 RCL MEM
1440 049 1
1441 052 4
1442 041 )
1443 119 print
1444 040 (
1445 040 (
1446 040 (
1447 109 RCL MEM
1448 048 0

```



```

1449 049 1
1450 113 Square
1451 042 x
1452 109 RCL MEM
1453 048 0
1454 051 3
1455 041 )
1456 119 print
1457 042 x
1458 040 (
1459 050 2
1460 057 9
1461 042 x
1462 049 1
1463 046 .
1464 054 6
1465 055 7
1466 101 EE
1467 050 2
1468 052 4
1469 111 +/-
1470 041 )
1471 047 /
1472 050 2
1473 041 )
Print mrv/2 for symmetry
1514 119 print
1515 047 /
1516 049 1
1517 046 .
1518 048 0
1519 053 5
1520 052 4
1521 101 EE
1522 050 2
1523 055 7
1524 111 +/-
1525 047 /
1526 050 2
1527 041 )
Print nv using symmetry no. 2
1568 119 print
1569 107 STO MEM
1570 056 8
1571 048 0
Get mv^2lnvv
1612 040 (
1613 040 (
1614 109 RCL MEM
1615 056 8
1616 048 0
1617 110 LOG e
1618 119 print
1619 042 x
1620 040 (
1621 040 (
1622 050 2
1623 057 9
1624 042 x
1625 049 1

```

```

1626 046 .
1627 054 6
1628 055 7
1629 101 EE
1630 050 2
1631 052 4
1632 111 +/-
1633 041 )
1634 042 x
1635 109 RCL MEM
1636 049 1
1637 048 0
1638 113 Square
1639 041 )
1640 107 STO MEM
1641 057 9
1642 049 1
Print mv^2
1683 119 print
1684 041 )
Print mv^2lnnv
1725 119 print
1726 041 )
1727 107 STO MEM
1728 056 8
1729 049 1
1730 040 (
1731 109 RCL MEM
1732 056 8
1733 049 1
1734 047 /
1735 109 RCL MEM
1736 056 8
1737 048 0
1738 041 )
Print hvv vortical quantum
1779 119 print
1780 047 /
1781 054 6
1782 046 .
1783 054 6
1784 050 2
1785 054 6
1786 049 1
1787 101 EE
1788 050 2
1789 055 7
1790 111 +/-
1791 041 )
Print v frequency
1832 119 print
1833 114 1/x
1834 042 x
1835 050 2
1836 046 .
1837 057 9
1838 057 9
1839 055 7
1840 057 9
1841 101 EE

```

1842	049	1	2097	050	2
1843	048	0	2098	042	x
1844	041	)	2099	109	RCL MEM
Print Y wavelength			2100	048	0
1885	119	print	2101	053	5
1886	040	(	2102	042	x
1887	040	(	2103	051	3
1888	049	1	2104	041	)
1889	046	.	Print vortical power total blade area		
1890	050	2	2145	119	print
1891	050	2	2146	107	STD MEM
1892	053	5	2147	056	8
1893	101	EE	2148	051	3
1894	051	3	Get T		
1895	111	+/-	2189	040	(
1896	047	/	2190	109	RCL MEM
1897	040	(	2191	057	9
1898	050	2	2192	049	1
1899	057	9	2193	047	/
1900	042	x	2194	040	(
1901	049	1	2195	049	1
1902	046	.	2196	046	.
1903	054	6	2197	051	3
1904	055	7	2198	056	8
1905	101	EE	2199	048	0
1906	050	2	2200	054	6
1907	052	4	2201	101	EE
1908	111	+/-	2202	049	1
1909	041	)	2203	054	6
1910	041	)	2204	111	+/-
Print N per cm^3			2205	042	x
1951	119	print	2206	051	3
1952	042	x	2207	041	)
1953	109	RCL MEM	2208	041	)
1954	056	8	Print Torque/Temperature		
1955	049	1	2249	119	print
1956	041	)	Get thrust per rotor blade @ 0 degrees		
1957	119	print	2290	040	(
Print ergs/cm^3 or vortical pressure			2291	109	RCL MEM
1998	107	STD MEM	2292	048	0
1999	056	8	2293	053	5
2000	049	1	2294	042	x
2001	040	(	2295	040	(
2002	109	RCL MEM	2296	109	RCL MEM
2003	056	8	2297	048	0
2004	049	1	2298	055	7
2005	042	x	2299	115	Sine
2006	109	RCL MEM	2300	041	)
2007	049	1	2301	042	x
2008	048	0	2302	109	RCL MEM
2009	041	)	2303	049	1
Print power pe/cm^2			2304	048	0
2050	119	print	2305	041	)
2051	107	STD MEM	Print Asin0 x v = volume per sec		
2052	056	8	2346	119	print
2053	050	2	2347	107	STD MEM
Get power for 3 blades and area			2348	049	1
2094	040	(	2349	053	5
2095	109	RCL MEM	2350	040	(
2096	056	8	2351	109	RCL MEM

2352	049	1	2568	051	3
2353	053	5	2569	048	0
2354	042	x	Print tip chord		
2355	109	RCL MEM	2610	119	print
2356	048	0	2611	107	STD MEM
2357	052	4	2612	048	0
2358	042	x	2613	054	6
2359	109	RCL MEM	Print tip width		
2360	049	1	2654	119	print
2361	048	0	2655	109	RCL MEM
2362	113	Square	2656	048	0
2363	047	/	2657	056	8
2364	050	2	2658	107	STD MEM
2365	041	)	2659	048	0
Print $MAsinOv^{2/2}$ KE impact on blade			2660	048	0
2406	119	print	2661	119	print
2407	107	STD MEM	Get Tw and Tb		
2408	049	1	2702	096	LABEL
2409	054	6	2703	084	T
Calculate SumMvsinO/sec force/blade			2704	040	(
2450	040	(	2705	040	(
2451	109	RCL MEM	2706	048	0
2452	049	1	2707	046	.
2453	053	5	2708	049	1
2454	042	x	2709	055	7
2455	109	RCL MEM	2710	054	6
2456	048	0	2711	057	9
2457	052	4	2712	117	SUM MEM
2458	042	x	2713	048	0
2459	109	RCL MEM	2714	054	6
2460	049	1	2715	041	)
2461	048	0	2716	040	(
2462	041	)	2717	109	RCL MEM
Print, stow total impact SumMvsinO/sec			2718	049	1
2503	119	print	2719	055	7
2504	107	STD MEM	2720	042	x
2505	049	1	2721	109	RCL MEM
2506	055	7	2722	048	0
Calculate Torque and anti-Torque-heat			2723	054	6
2547	040	(	2724	041	)
2548	040	(	2725	041	)
2549	109	RCL MEM	Print MvsinO/sec force/metre blade		
2550	049	1	2766	107	STD MEM
2551	055	7	2767	049	1
2552	047	/	2768	056	8
2553	109	RCL MEM	2769	040	(
2554	048	0	2770	040	(
2555	053	5	2771	050	2
2556	041	)	2772	042	x
2557	107	STD MEM	2773	109	RCL MEM
2558	049	1	2774	048	0
2559	055	7	2775	055	7
2560	041	)	2776	041	)
2561	119	print	2777	115	Sine
2562	107	STD MEM	2778	042	x
2563	049	1	2779	109	RCL MEM
2564	055	7	2780	049	1
2565	040	(	2781	056	8
2566	050	2	2782	041	)
2567	046	.	SMvsinOcos2O/metresec, action/area/sec		

```

2823 107 STO MEM
2824 049 1
2825 056 8
Label Torque or rate of Action
Get SumRotor Windward Torque Tw
2906 040 (
2907 109 RCL MEM
2908 049 1
2909 056 8
2910 042 x
2911 040 (
2912 109 RCL MEM
2913 048 0
2914 048 0
2915 043 +
2916 049 1
2917 048 0
2918 041 )
2919 042 x
2920 051 3
2921 041 )
2922 041 )
Get cumulative Tw
2963 117 SUM MEM
2964 049 1
2965 057 9
Get integrated torque or rate action
SumMvsinOcos20/metre sec; SumFxR=Tb
Get rotor reverse torque, action rate
3086 040 (
3087 040 (
3088 109 RCL MEM
3089 049 1
3090 048 0
3091 042 x
3092 109 RCL MEM
3093 048 0
3094 057 9
3095 041 )
3096 047 /
3097 109 RCL MEM
3098 048 0
3099 056 8
3100 041 )
Stow rotor W
3141 107 STO MEM
3142 050 2
3143 048 0
3144 040 (
3145 109 RCL MEM
3146 050 2
3147 048 0
3148 042 x
3149 040 (
3150 109 RCL MEM
3151 048 0
3152 048 0
3153 043 +
3154 049 1
3155 048 0

```

```

3156 041 )
3157 041 )
Get RW of blade at R and stow
3198 113 Square
3199 041 )
RVd0/sec
3240 107 STO MEM
3241 051 3
3242 048 0
3243 040 (
3244 040 (
3245 040 (
Get blade area dRcost segment at R
3286 109 RCL MEM
3287 048 0
3288 055 7
3289 099 Cosine
3290 042 x
3291 109 RCL MEM
3292 048 0
3293 054 6
3294 041 )
3295 042 x
Get inertia MR/sec, power MR^20m^2
Use 2-D density D^2/3 for Tw output
3376 040 (
3377 109 RCL MEM
3378 048 0
3379 052 4
3380 091 Exponent
3381 048 0
3382 046 .
3383 054 6
3384 055 7
3385 042 x
3386 109 RCL MEM
3387 051 3
3388 048 0
3389 041 )
3390 041 )
3391 047 /
3392 109 RCL MEM
3393 050 2
3394 048 0
3395 041 )
3396 042 x
3397 051 3
3398 041 )
Get SumMV^2cosO=MRVd0/dt=MV^2 = HEAT
3439 117 SUM MEM
3440 050 2
3441 049 1
Print total back torque, action/sec
3482 039 Dec JPNZ
3483 084 T
3484 040 (
3485 109 RCL MEM
3486 049 1
3487 057 9
3488 119 print

```


3489	045	-	3590	107	STD MEM
3490	109	RCL MEM	3591	050	2
3491	050	2	3592	051	3
3492	049	1	3593	109	RCL MEM
3493	119	print	3594	048	0
3494	041	)	3595	054	6
Print and stow	3-rotor net Torque		3596	119	print
3535	119	print	Clear	cumulative memories for reruns	
3536	107	STD MEM	3637	048	0
3537	050	2	3638	107	STD MEM
3538	050	2	3639	048	0
3539	040	(	3640	054	6
3540	109	RCL MEM	3641	107	STD MEM
3541	050	2	3642	049	1
3542	050	2	3643	057	9
3543	042	x	3644	107	STD MEM
3544	109	RCL MEM	3645	050	2
3545	050	2	3646	049	1
3546	048	0	3647	107	STD MEM
3547	119	print	3648	050	2
3548	041	)	3649	050	2
Print and stow	net Power per windmill		3650	002	HALT
3589	119	print			

TROP CYC2
 Revised Sep 1 2022 for symmetry 2
 Model 500 km, 50 km ew, r²w 5E6
 Get cyclone energy vortical and torque
 Hold r²w constant, least action
 Iterations 10

0240	096	LABEL
0241	073	I
0242	107	STD MEM
0243	048	0
0244	049	1
0245	119	print
0246	002	HALT
Radius say 5E5 500 km		
0287	096	LABEL
0288	082	R
0289	107	STD MEM
0290	048	0
0291	050	2
0292	119	print
0293	002	HALT
Eyewall barrier radius B 5E4		
0334	096	LABEL
0335	066	B
0336	107	STD MEM
0337	048	0
0338	051	3
0339	119	print
0340	002	HALT
Height effective in mass content 5E3		
0381	096	LABEL
0382	072	H
0383	107	STD MEM
0384	048	0
0385	052	4
0386	119	print
0387	002	HALT
Angular velocity radians/sec		
0428	096	LABEL
0429	087	W
0430	107	STD MEM
0431	048	0
0432	053	5
0433	119	print
0434	002	HALT
Action specific r ² w 5E6		
0475	096	LABEL
0476	065	A
0477	107	STD MEM
0478	048	0
0479	054	6
0480	119	print
0481	002	HALT
Density of air kg/m ³ 1.225		
0522	096	LABEL
0523	068	D
0524	107	STD MEM
0525	048	0
0526	055	7
0527	119	print

0528	002	HALT
Evaporation mm/day/m ² 25 mm		
0569	096	LABEL
0570	069	E
0571	107	STD MEM
0572	048	0
0573	056	8
0574	119	print
Degrees latitude L, say 17° Cairns		
0615	096	LABEL
0616	076	L
0617	107	STD MEM
0618	048	0
0619	057	9
0620	119	print
0621	002	HALT
Execute		
0662	096	LABEL
0663	088	X
Stow Earth radius		
0704	040	(
0705	054	6
0706	046	.
0707	051	3
0708	055	7
0709	049	1
0710	101	EE
0711	054	6
0712	041	)
0713	119	print
0714	107	STD MEM
0715	049	1
0716	048	0
Estimate heat evaporation /m ² /sec		
2.26 MJ/kg heat evaporation		
1 mm/m ² is kg water		
0837	040	(
0838	109	RCL MEM
0839	048	0
0840	056	8
0841	119	print
0842	107	STD MEM
0843	053	5
0844	048	0
0845	040	(
0846	109	RCL MEM
0847	053	5
0848	048	0
0849	042	x
0850	050	2
0851	046	.
0852	050	2
0853	054	6
0854	101	EE
0855	048	0
0856	054	6
0857	041	)
Print and stow J/m ² /s latent heat		
0898	119	print
0899	117	SUM MEM


```

0900 053 5
0901 049 1
0902 040 (
0903 109 RCL MEM
0904 053 5
0905 049 1
0906 042 x
0907 056 8
0908 054 6
0909 052 4
0910 048 0
0911 048 0
0912 041 )

```

Print and stow $J/m^2/day$

```

0953 119 print
0954 117 SUM MEM
0955 053 5
0956 050 2
0957 109 RCL MEM
0958 048 0
0959 049 1
0960 107 STO MEM
0961 048 0
0962 048 0

```

Print number iterations

```

1003 119 print
1004 096 LABEL
1005 089 Y

```

Get vortical torque and Gibbs energy

Get specific action r^2w

```

1086 040 (
1087 109 RCL MEM
1088 048 0
1089 054 6

```

Print specific action

```

1130 119 print
1131 047 /
1132 040 (
1133 109 RCL MEM
1134 048 0
1135 051 3
1136 042 x
1137 109 RCL MEM
1138 048 0
1139 048 0
1140 119 print

```

Print $m00$

```

1181 041 )

```

Print current radius

```

1222 119 print
1223 107 STO MEM
1224 048 0
1225 050 2
1226 041 )

```

Print and stow current velocity rw

```

1267 119 print
1268 107 STO MEM
1269 053 5
1270 051 3

```

Get torque $mv^2=mr^2w d\phi/dt$

```

1311 040 (
1312 050 2
1313 057 9
1314 042 x
1315 049 1
1316 046 .
1317 054 6
1318 055 7
1319 101 EE
1320 050 2
1321 055 7
1322 111 +/-
1323 042 x
1324 109 RCL MEM
1325 053 5
1326 051 3
1327 113 Square
1328 041 )

```

Print and stow mv^2 torque

```

1369 119 print
1370 107 STO MEM
1371 053 5
1372 052 4

```

Get inertial acceleration rw^2

```

1413 040 (
1414 109 RCL MEM
1415 048 0
1416 054 6
1417 113 Square
1418 047 /
1419 109 RCL MEM
1420 048 0
1421 050 2
1422 091 Exponent
1423 051 3
1424 041 )

```

Print, stow rw^2 inertial acceleration

```

1465 119 print
1466 107 STO MEM
1467 052 4
1468 055 7

```

Get Coriolis acceleration at 5 degrees

```

1509 040 (
1510 040 (
1511 050 2
1512 042 x
1513 112 pi
1514 042 x
1515 109 RCL MEM
1516 049 1
1517 048 0
1518 041 )
1519 047 /
1520 056 8
1521 054 6
1522 052 4
1523 048 0
1524 048 0
1525 041 )

```

Print $d\phi/dt$ /sec

```

1566 119 print
1567 107 STO MEM
1568 052 4
1569 056 8
1570 040 (
1571 109 RCL MEM
1572 052 4
1573 056 8
1574 047 /
1575 109 RCL MEM
1576 049 1
1577 048 0
1578 041 )
1579 119 print
1580 113 Square
1581 107 STO MEM
1582 052 4
1583 057 9
1584 040 (
1585 109 RCL MEM
1586 052 4
1587 057 9
1588 042 x
1589 109 RCL MEM
1590 049 1
1591 048 0
1592 042 x
1593 109 RCL MEM
1594 048 0
1595 057 9
1596 099 Cosine
1597 041 )
Print, stow Coriolis accleration
1638 119 print
1639 107 STO MEM
1640 052 4
1641 048 0
1642 040 (
1643 109 RCL MEM
1644 048 0
1645 057 9
1646 115 Sine
1647 042 x
1648 109 RCL MEM
1649 052 4
1650 057 9
1651 042 x
1652 050 2
1653 042 x
1654 109 RCL MEM
1655 049 1
1656 048 0
1657 041 )
Print and stow 2Wrwsin(phi)
1698 119 print
1699 107 STO MEM
1700 052 4
1701 049 1
Get ratio inertial/Coriolis
1742 040 (

```

```

1743 109 RCL MEM
1744 052 4
1745 055 7
1746 047 /
1747 109 RCL MEM
1748 052 4
1749 048 0
1750 041 )
Print ratio
1791 119 print
Get second ratio
1832 040 (
1833 109 RCL MEM
1834 052 4
1835 055 7
1836 047 /
1837 109 RCL MEM
1838 052 4
1839 049 1
1840 041 )
Print second ratio
1881 119 print
Get action and nv
1922 040 (
1923 109 RCL MEM
1924 048 0
1925 054 6
1926 042 x
1927 050 2
1928 057 9
1929 042 x
1930 049 1
1931 046 .
1932 054 6
1933 055 7
1934 101 EE
1935 050 2
1936 055 7
1937 111 +/-
Divide by symmetry factor 2
1978 047 /
1979 050 2
1980 041 )
Print and stow action/molecule=@v
2021 119 print
2022 107 STO MEM
2023 053 5
2024 053 5
2025 040 (
2026 109 RCL MEM
2027 053 5
2028 053 5
2029 047 /
2030 049 1
2031 046 .
2032 048 0
2033 053 5
2034 052 4
2035 053 5
2036 055 7

```


2037	051	3
2038	101	EE
2039	051	3
2040	052	4
2041	111	+/-
2042	041	)

Print and stow quantum number nv

2083	119	print
2084	107	STO MEM
2085	053	5
2086	054	6
Get -g Gibbs field energy		
2127	040	(
2128	109	RCL MEM
2129	053	5
2130	054	6
2131	110	LOG e
2132	119	print
2133	042	x
2134	109	RCL MEM
2135	053	5
2136	052	4
2137	041	)

Print and stow mv^2/2mnv -gv

2178	119	print
2179	107	STO MEM
2180	053	5
2181	055	7
2182	040	(
2183	109	RCL MEM
2184	053	5
2185	055	7
2186	047	/
2187	109	RCL MEM
2188	053	5
2189	052	4
2190	041	)

Print ratio -gv/mv^2/torque

2231	119	print
2232	040	(
2233	109	RCL MEM
2234	053	5
2235	055	7
2236	047	/
2237	109	RCL MEM
2238	053	5
2239	054	6
2240	041	)

Print hv vortical quantum, stow

2281	119	print
2282	107	STO MEM
2283	053	5
2284	056	8
2285	040	(
2286	109	RCL MEM
2287	053	5
2288	056	8
2289	047	/
2290	054	6
2291	046	.

2292	054	6
2293	050	2
2294	054	6
2295	049	1
2296	101	EE
2297	051	3
2298	052	4

2299	111	+/-
2300	041	)

Print v frequency

2341	119	print
2342	114	1/x
2343	042	x
2344	050	2
2345	046	.
2346	057	9
2347	057	9
2348	055	7
2349	057	9
2350	050	2
2351	052	4
2352	053	5
2353	056	8
2354	101	EE

2355	048	0
2356	056	8
2357	041	)

Print Y wavelength

2398	119	print
------	-----	-------

Get N/m^3

2439	040	(
2440	109	RCL MEM
2441	048	0
2442	055	7
2443	047	/
2444	040	(
2445	050	2
2446	057	9
2447	042	x
2448	049	1
2449	046	.
2450	054	6
2451	055	7
2452	101	EE
2453	050	2
2454	055	7
2455	111	+/-
2456	041	)
2457	041	)

Print N/m^3

2498	119	print
2499	107	STO MEM
2500	053	5
2501	057	9
2502	040	(
2503	040	(
2504	109	RCL MEM
2505	053	5
2506	057	9
2507	042	x

```

2508      109      RCL MEM
2509      053      5
2510      055      7
2511      041      )
Print J/m^3 vortical pressure
2552      119      print
2553      042      x
2554      049      1
2555      101      EE
2556      057      9
2557      041      )
Print J/km^3 vortical pressure
2598      119      print
2599      107      STO MEM
2600      054      6
2601      048      0
Get cell height J/km^3
2642      040      (
2643      109      RCL MEM
2644      054      6
2645      048      0
2646      042      x
2647      109      RCL MEM
2648      048      0
2649      052      4
2650      042      x
2651      049      1
2652      101      EE
2653      051      3
2654      111      +/-
2655      041      )
Print total vortical energy /km^2
Print and stow
2736      119      print
2737      107      STO MEM
2738      054      6
2739      051      3
Get circumference energies
2780      040      (
2781      109      RCL MEM
2782      054      6
2783      051      3
2784      042      x
2785      040      (
2786      109      RCL MEM
2787      048      0
2788      050      2
2789      042      x
2790      049      1
2791      101      EE
2792      051      3
2793      111      +/-
2794      041      )
2795      042      x
2796      050      2
2797      042      x
2798      112      pi
2799      041      )
2800      119      print
2801      117      SUM MEM

```

```

2802      054      6
2803      052      4
2804      109      RCL MEM
2805      054      6
2806      052      4
2807      119      print
2808      040      (
2809      109      RCL MEM
2810      053      5
2811      052      4
2812      047      /
2813      050      2
2814      042      x
2815      109      RCL MEM
2816      053      5
2817      057      9
2818      041      )
Print and stow kinetic/m^3
2859      119      print
2860      107      STO MEM
2861      054      6
2862      049      1
Get KEnergy /km^3 and per km^2
2903      040      (
2904      040      (
2905      109      RCL MEM
2906      054      6
2907      049      1
2908      042      x
2909      049      1
2910      101      EE
2911      057      9
2912      041      )
2913      119      print
2914      042      x
2915      109      RCL MEM
2916      048      0
2917      052      4
2918      042      x
2919      049      1
2920      101      EE
2921      051      3
2922      111      +/-
2923      041      )
2924      119      print
2925      107      STO MEM
2926      054      6
2927      053      5
Get circumference cell
2968      040      (
2969      109      RCL MEM
2970      054      6
2971      053      5
2972      042      x
2973      109      RCL MEM
2974      048      0
2975      050      2
2976      042      x
2977      050      2
2978      042      x

```


2979	112	pi	3116	042	x
2980	042	x	3117	040	(
2981	049	1	3118	049	1
2982	101	EE	3119	045	-
2983	051	3	3120	040	(
2984	111	+/-	3121	057	9
2985	041	)	3122	047	/
2986	119	print	3123	109	RCL MEM
2987	117	SUM MEM	3124	048	0
2988	054	6	3125	049	1
2989	054	6	3126	041	)
2990	109	RCL MEM	3127	041	)
2991	054	6	3128	041	)
2992	054	6	Print total vortical energy		
2993	119	print	3169	119	print
2994	040	(	3170	040	(
2995	109	RCL MEM	3171	109	RCL MEM
2996	053	5	3172	054	6
2997	057	9	3173	054	6
2998	042	x	3174	042	x
2999	109	RCL MEM	3175	040	(
3000	053	5	3176	040	(
3001	055	7	3177	109	RCL MEM
3002	041	)	3178	048	0
Print -g vortical per m^3			3179	049	1
3043	119	print	3180	045	-
3044	107	STO MEM	3181	049	1
3045	054	6	3182	041	)
3046	050	2	3183	042	x
3047	040	(	3184	053	5
3048	109	RCL MEM	3185	048	0
3049	054	6	3186	041	)
3050	050	2	3187	042	x
3051	047	/	3188	040	(
3052	109	RCL MEM	3189	049	1
3053	054	6	3190	045	-
3054	049	1	3191	057	9
3055	041	)	3192	047	/
Print ratio -Gibbs/torque			3193	109	RCL MEM
3096	119	print	3194	048	0
3097	039	Dec JPNZ	3195	049	1
3098	089	Y	3196	041	)
3099	040	(	3197	041	)
3100	109	RCL MEM	Print total kinetic energy		
3101	054	6	3238	119	print
3102	052	4	3239	048	0
3103	042	x	3240	107	STO MEM
3104	040	(	3241	053	5
3105	040	(	3242	049	1
3106	109	RCL MEM	3243	107	STO MEM
3107	048	0	3244	053	5
3108	049	1	3245	050	2
3109	045	-	3246	107	STO MEM
3110	049	1	3247	054	6
3111	041	)	3248	052	4
3112	042	x	3249	107	STO MEM
3113	053	5	3250	054	6
3114	048	0	3251	054	6
3115	041	)	3252	002	HALT

1/9/22

$$\textcircled{a} = \text{nrw} / 2$$

1.	0001
5.	0005
5.	0004
5.	0003
5.	0006
1.225	0000
2.5	0001
2.5	0001
1.7	0001
6.371	0006
2.5	0001
5.65	0007
4.8816	0012
1.	0001
5.	0006 <i>R</i>
1.	0001 <i>rw</i>
5.	0005
1.	0001 ✓
4.843	-0024 <i>t</i>
2.	-0004
4.6331219435233	0002
7.272205216643	-0005
3.2220789116881	-0002
1.970176762768	-0002
6.2071726199659	-0003
1.0151373408699	-0002
1.21075	-0019
1.1480950109665	0015 <i>a</i>
3.4676880451549	0001
1.6794013202685	-0022 - <i>g</i>
3.4676880451549	0001
1.4627720739373	-0037
2.2075913039907	-0004
1.3580070616244	0012
2.5294239107991	0025
4.2479178553148	0003
4.2479178553148	0012
2.1239589276574	0013
6.6726137636549	0016
6.6726137636549	0016
6.125	0001
6.125	0010
3.0625	0011
9.6211275016187	0014
9.6211275016187	0014
4.2479178553148	0003
6.9353760903099	0001
5.	0006
9.	0000
4.5	0005 <i>R</i>
1.11111111111111	0001 ✓ <i>rw</i>
5.979012345679	-0024 <i>t</i>
2.7434842249657	-0004
4.6331219435233	0002 ,
7.272205216643	-0005
3.2220789116881	-0002
1.970176762768	-0002
8.5146400822578	-0003
1.3925066404251	-0002
1.21075	-0019

1.1480950109665 0015 @
 3.4676880451549 0001
 2.0733349632945 -0022 -g
 3.4676880451549 0001
 1.8058914493053 -0037
 2.7254213629515 -0004
 1.0999857199158 0012
 2.5294239107991 0025
 5.2443430312528 0003 p3
 5.2443430312528 0012
 2.6221715156264 0013
 7.4140152929499 0016
 1.4086629056605 0017
 7.5617283950617 0001
 7.5617283950617 0010
 3.7808641975309 0011
 1.0690141668465 0015
 2.0311269170084 0015
 5.2443430312528 0003
 6.9353760903099 0001
 5. 0006
 8. 0000
 4. 0005
 1.25 0001
 7.5671875 -0024 t
 3.90625 -0004
 4.6331219435233 0002
 7.272205216643 -0005
 3.2220789116881 -0002
 1.970176762768 -0002
 1.2123384023371 -0002
 1.9826901188866 -0002
 1.21075 -0019
 1.1480950109665 0015
 3.4676880451549 0001
 2.6240645629196 -0022 -g
 3.4676880451549 0001
 2.285581365527 -0037
 3.4493614124855 -0004
 8.6912451943962 0011
 2.5294239107991 0025
 6.6373716489294 0003 p3
 6.6373716489294 0012
 3.3186858244647 0013
 8.3407672045687 0016
 2.2427396261174 0017
 9.5703125 0001
 9.5703125 0010
 4.78515625 0011
 1.2026409377023 0015
 3.2337678547107 0015
 6.6373716489294 0003
 6.9353760903099 0001
 5. 0006
 7. 0000
 3.5 0005
 1.4285714285714 0001
 9.8836734693878 -0024 t
 5.8309037900875 -0004
 4.6331219435233 0002

7. 272205216643 -0005
 3. 2220789116881 -0002
 1. 970176762768 -0002
 1. 8096713177743 -0002
 2. 9595840841689 -0002
 1. 21075 -0019
 1. 1480950109665 0015
 3. 4676880451549 0001
 3. 4273496332011 -0022 g.
 3. 4676880451549 0001
 2. 9852491304842 -0037
 4. 5052883754912 -0004
 6. 6542346019596 0011
 2. 5294239107991 0025
 8. 6692201128874 0003 p.
 8. 6692201128874 0012
 4. 3346100564437 0013
 9. 5323053766499 0016
 3. 1959701637824 0017
 1. 25 0002
 1. 25 0011
 6. 25 0011
 1. 3744467859455 0015
 4. 6082146406563 0015
 8. 6692201128874 0003
 6. 9353760903099 0001
 5. 0006
 6. 0000
 3. 0005
 1. 6666666666667 0001
 1. 3452777777778 -0023
 9. 2592592592593 -0004
 4. 6331219435233 0002
 7. 272205216643 -0005
 3. 2220789116881 -0002
 1. 970176762768 -0002
 2. 873691027762 -0002
 4. 6997099114349 -0002
 1. 21075 -0019
 1. 1480950109665 0015
 3. 4676880451549 0001
 4. 6650036674126 -0022 g.
 3. 4676880451549 0001
 4. 0632557609369 -0037
 6. 1321980666408 -0004
 4. 8888254218479 0011
 2. 5294239107991 0025
 1. 1799771820319 0004
 1. 1799771820319 0013
 5. 8998859101595 0013
 1. 1121022939425 0017
 4. 3080724577248 0017
 1. 7013888888889 0002
 1. 7013888888889 0011
 8. 5069444444444 0011
 1. 6035212502698 0015
 6. 2117358909261 0015
 1. 1799771820319 0004 p.
 6. 9353760903099 0001
 5. 0006

1.9140625	0012	
2.4052818754047	0015	
1.0541243266655	0016	
2.6549486595718	0004	Pa
6.9353760903099	0001	
5.	0006	
3.	0000	
1.5	0005	
3.3333333333333	0001	
5.3811111111111	-0023	Pa
7.4074074074074	-0003	
4.6331219435233	0002	
7.272205216643	-0005	
3.2220789116881	-0002	
1.970176762768	-0002	
2.2989528222096	-0001	
3.7597679291479	-0001	
1.21075	-0019	
1.1480950109665	0015	
3.4676880451549	0001	
1.866001466965	-0021	- 9°
3.4676880451549	0001	
1.6253023043747	-0036	
2.4528792266563	-0003	
1.222206355462	0011	
2.5294239107991	0025	
4.7199087281276	0004	
4.7199087281276	0013	
2.3599543640638	0014	
2.224204587885	0017	
9.5349532392546	0017	
6.8055555555556	0002	
6.8055555555556	0011	
3.4027777777778	0012	
3.2070425005396	0015	
1.3748285767194	0016	
4.7199087281276	0004	Pa
6.9353760903099	0001	
5.	0006	
2.	0000	
1.	0005	
5.	0001	
1.21075	-0022	
2.5	-0002	
4.6331219435233	0002	
7.272205216643	-0005	
3.2220789116881	-0002	
1.970176762768	-0002	
7.7589657749574	-0001	
1.2689216760874	0000	
1.21075	-0019	
1.1480950109665	0015	
3.4676880451549	0001	
4.1985033006713	-0021	- 9°
3.4676880451549	0001	
3.6569301848432	-0036	
5.5189782599767	-0003	
5.4320282464976	0010	
2.5294239107991	0025	
1.0619794638287	0005	Pa

1.0619794638287	0014
5.3098973191435	0014
3.3363068818275	0017
1.2871260121082	0018
1.53125	0003
1.53125	0012
7.65625	0012
4.8105637508094	0015
1.8558849518003	0016
1.0619794638287	0005
6.9353760903099	0001
5.	0006
1.	0000
5.	0004
1.	0002
4.843	-0022
2.	-0001
4.6331219435233	0002
7.272205216643	-0005
3.2220789116881	-0002
1.970176762768	-0002
6.2071726199659	0000
1.0151373408699	0001
1.21075	-0019
1.1480950109665	0015
3.4676880451549	0001
1.6794013202685	-0020 -g
3.4676880451549	0001
1.4627720739373	-0035
2.2075913039907	-0002
1.3580070616244	0010
2.5294239107991	0025
4.2479178553148	0005 g/p
4.2479178553148	0014
2.1239589276574	0015
6.6726137636549	0017
1.9543873884737	0018
6.125	0003
6.125	0012
3.0625	0013
9.6211275016187	0015
2.8179977019622	0016
4.2479178553148	0005
6.9353760903099	0001
8.7947432481316	0019
1.268098965883	0018

GIBGRAV1:2 31/8/22

Input radius, cgs

0080 096 LABEL

0081 082 R

0082 107 STO MEM

0083 048 0

0084 049 1

0085 119 print

0086 002 HALT

Input particle mass number n

0127 096 LABEL

0128 077 M

0129 107 STO MEM

0130 048 0

0131 050 2

0132 119 print

0133 002 HALT

Execute program

0174 096 LABEL

0175 088 X

Stow Planck's h-

0216 049 1

0217 046 .

0218 048 0

0219 053 5

0220 052 4

0221 053 5

0222 057 9

0223 049 1

0224 056 8

0225 053 5

0226 101 EE

0227 050 2

0228 055 7

0229 111 +/-

0230 107 STO MEM

0231 057 9

0232 056 8

0233 119 print

Stow mass H atom

0274 049 1

0275 046 .

0276 054 6

0277 055 7

0278 050 2

0279 054 6

0280 049 1

0281 052 4

0282 101 EE

0283 050 2

0284 052 4

0285 111 +/-

0286 107 STO MEM

0287 057 9

0288 054 6

0289 119 print

Stow light speed c

0330 050 2

0331 046 .

0332 057 9

0333 057 9

0334 055 7

0335 057 9

0336 050 2

0337 052 4

0338 053 5

0339 056 8

0340 101 EE

0341 049 1

0342 048 0

0343 107 STO MEM

0344 057 9

0345 053 5

0346 119 print

Stow gravitational constant G

0387 054 6

0388 046 .

0389 054 6

0390 055 7

0391 052 4

0392 048 0

0393 056 8

0394 101 EE

0395 056 8

0396 111 +/-

0397 107 STO MEM

0398 057 9

0399 055 7

0400 119 print

Stow Boltzmann's constant k

0441 049 1

0442 046 .

0443 051 3

0444 056 8

0445 048 0

0446 054 6

0447 050 2

0448 050 2

0449 053 5

0450 057 9

0451 101 EE

0452 049 1

0453 054 6

0454 111 +/-

0455 107 STO MEM

0456 057 9

0457 057 9

0458 119 print

0459 107 STO MEM

0460 056 8

0461 048 0

Stow Earth's mass

0502 053 5

0503 046 .

0504 057 9

0505 055 7

0506 050 2

0507 101 EE

0508 050 2

0509 055 7

1842	040	(
1843	109	RCL MEM
1844	056	8
1845	057	9
1846	047	/
1847	109	RCL MEM
1848	057	9
1849	053	5
1850	113	Square
1851	041	)

Print mass quanta		
1892	119	print
1893	042	x
1894	109	RCL MEM
1895	048	0
1896	049	1
1897	041	)
Print mr inertia		
1938	119	print
1939	002	HALT

GIBGAN1

31/8/22

5. 0009
2.8 0001
1.05459185 -0027
1.672614 -0024
2.99792458 0010
6.67408 -0008
1.38062259 -0016
5.972 0027
3.985760576 0020
4.4347567283027 -0001
2.8233882396865 0005
6.611414175989 -0008
3.1345843304161 0019
5.646776479373 -0005
3.7333178064368 -0012
1.6759465945012 -0010
4.4891613342202 0001
5.3466310612186 -0030
8.0689298166073 -0004
1.2393217226178 0003
3.7153930547639 0013
1.1826463403899 0003
1.1137937863551 -0002
1. 0010
1.05459185 -0027
1.672614 -0024
2.99792458 0010
6.67408 -0008
1.38062259 -0016
5.972 0027
3.985760576 0020
4.4347567283027 -0001
1.9964369702047 0005
0. 0000
0. 0000
1.9964369702047 -0005
0. 0000
0. 0000
1. 0000
1. 0000
1.5091615120285 0026
6.6261960169913 -0027
1.9864835911236 -0016
3.1615868289827 -0027
2.1054261578165 -0032
1. 0010
2.8 0001
1.05459185 -0027
1.672614 -0024
2.99792458 0010
6.67408 -0008
1.38062259 -0016
5.972 0027
3.985760576 0020
4.4347567283027 -0001
1.9964369702047 0005
9.3499515941494 -0008
4.4329716724766 0019
1.9964369702047 -0005
1.8666589032184 -0012

8.4444264402975 -0011
4.5238186932482 0001
1.9049132419968 -0030
2.8748217485751 -0004
3.4784765368345 0003
1.0428210310729 0014
1.6597012185545 0003
1.1052609176098 -0002

5. 0009

1.05459185 -0027

1.672614 -0024

2.99792458 0010

6.67408 -0008

1.38062259 -0016

5.972 0027

3.985760576 0020

4.4347567283027 -0001

2.8233882396865 0005

6.611414175989 -0008

3.1345843304161 0019

5.646776479373 -0005

3.7333178064368 -0012

1.6759465945012 -0010

4.4891613342202 0001

5.3466310612186 -0030

8.0689298166073 -0004

1.2393217226178 0003

3.7153930547639 0013

1.1826463403899 0003

1.1137937863551 -0002

1. 0010

1.05459185 -0027

1.672614 -0024

2.99792458 0010

6.67408 -0008

1.38062259 -0016

5.972 0027

3.985760576 0020

4.4347567283027 -0001

1.9964369702047 0005

9.3499515941494 -0008

4.4329716724766 0019

1.9964369702047 -0005

1.8666589032184 -0012

8.4444264402975 -0011

4.5238186932482 0001

1.9049132419968 -0030

2.8748217485751 -0004

3.4784765368345 0003

1.0428210310729 0014

1.6597012185545 0003

1.1052609176098 -0002

1.5 0010

1.05459185 -0027

1.672614 -0024

2.99792458 0010

6.67408 -0008

1.38062259 -0016

5.972 0027

3.985760576 0020

n_t

Gerne t

-g_o

n_t

figs are

-g_o

2.875 × 10⁻⁴

sec

v/v

4.4347567283027 -0001
 1.6300839602098 0005
 1.1451305262694 -0007
 5.4292593208899 0019 n.
 1.0867226401399 -0005
 1.2444392688123 -0012 t
 5.6548464619782 -0011 -go
 4.5440919486536 0001 8/t
 1.041550260869 -0030
 1.5718675665467 -0004
 6.361859111305 0003
 1.9072373804278 0014
 2.0236417116315 0003
 1.1003298473046 -0002
 2. 0010
 1.05459185 -0027
 1.672614 -0024
 2.99792458 0010
 6.67408 -0008
 1.38062259 -0016
 5.972 0027
 3.985760576 0020
 4.4347567283027 -0001
 1.4116941198432 0005
 1.3222828351978 -0007
 6.2691686608321 0019 n.
 7.0584705992162 -0006 w.
 9.3332945160919 -0013 t
 4.2545599540446 -0011 -go
 4.5584760522762 0001 -g/t
 6.7864818833569 -0031 h
 1.0241897260441 -0004 t
 9.7638159666224 0003 st
 2.9271183880934 0014
 2.3293268024012 0003
 1.0968577969173 -0002
 2.5 0010
 1.05459185 -0027
 1.672614 -0024
 2.99792458 0010
 6.67408 -0008
 1.38062259 -0016
 5.972 0027
 3.985760576 0020
 4.4347567283027 -0001
 1.2626576061625 0005
 1.4783571524917 -0007
 7.009143644016 0019
 5.05063042465 -0006
 7.4666356128735 -0013
 3.4119786211708 -0011
 4.5696332298419 0001
 4.8678965569264 -0031
 7.3464421282495 -0005
 1.3612031273678 0004
 4.0807843139089 0014
 2.5979079810019 0003
 1.0941797182644 -0002
 3. 0010
 1.05459185 -0027

$$\begin{aligned}
 & \frac{1.67}{28} \\
 & \frac{13 \ 36}{33 \ 4} \\
 & \frac{4.254 \times 10^{-11}}{9 \times 10^{20}} = 0.48 \times 10^{-31} \\
 & \frac{4.676 \times 10^{-23}}{0.48 \times 10^{-31}} = 10^9
 \end{aligned}$$

$$1.024 \times 10^{-4}$$

$$\begin{array}{cc}
 6.786 \times 10^{-31} & 2 \\
 1.9 \times 10^{-20} & 1
 \end{array}
 \begin{array}{c}
 6.8 \\
 \frac{3}{4}
 \end{array}$$

1.672614 -0024
2.99792458 0010
6.67408 -0008
1.38062259 -0016
5.972 0027
3.985760576 0020
4.4347567283027 -0001
1.1526434221678 0005
1.6194591209376 -0007
7.678132165243 0019
3.8421447405593 -0006
6.2221963440613 -0013
2.848987720263 -0011
4.5787493076816 0001
3.7105218547287 -0031
5.5997767726972 -0005
1.7857854707275 0004
5.3536501573008 0014
2.8401996203971 0003
1.0920012571144 -0002

