

Supplementary Materials for

Applying the Action Principle of Classical Mechanics to the Thermodynamics of Tropospheric Systems

Applied Mechanics

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. TROPCYC2/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.

CARNOT8 Carnot Cycle Ar N2 H2O
 Corrected 26 Aug 2022, for use of Zt
 Estimates ratios frequency w/w, radii
 Estimates θ , $h\nu$, 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 STO 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 STO 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 STO 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 STO 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 STO 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 STO 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 STO 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 STO 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 STO 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 STO MEM
 0674 048 0
 0675 056 8
 0676 119 print
 0677 002 HALT
 Moment 2 polyatomic
 0718 096 LABEL
 0719 066 B
 0720 107 STO 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 STO MEM
 0768 049 1
 0769 048 0
 0770 119 print
 0771 002 HALT
 Input source heat $nkT=Qf$ ergs/molecule

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 STO 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 STO 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 STO 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 STO 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 STO 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 STO 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 STO 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 STO 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 STO 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 STO MEM
 0674 048 0
 0675 056 8
 0676 119 print
 0677 002 HALT

Moment 2 polyatomic

0718 096 LABEL
 0719 066 B
 0720 107 STO 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 STO 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	1067	056	8
0852 096 LABEL	1068	119	print
0853 081 Q	Input mass H atom		
0854 107 STO MEM	1109	049	1
0855 048 0	1110	046	.
0856 054 6	1111	054	6
0857 119 print	1112	055	7
0858 002 HALT	1113	050	2
Execute <SH>X	1114	054	6
0899 096 LABEL	1115	049	1
0900 088 X	1116	052	4
0901 049 1	1117	101	EE
0902 048 0	1118	050	2
0903 046 .	1119	052	4
0904 050 2	1120	111	+/-
0905 050 2	1121	107	STO MEM
0906 057 9	1122	057	9
0907 054 6	1123	054	6
0908 055 7	1124	119	print
0909 050 2	Input c speed light		
0910 119 print	1165	050	2
Stow Zt translational symmetry	1166	046	.
Zt = 2^3xrms v/mean v in r99	1167	057	9
0991 107 STO MEM	1168	057	9
0992 057 9	1169	055	7
0993 057 9	1170	057	9
Input Boltzmann's k	1171	050	2
1034 049 1	1172	052	4
1035 046 .	1173	053	5
1036 051 3	1174	056	8
1037 056 8	1175	101	EE
1038 048 0	1176	049	1
1039 054 6	1177	048	0
1040 050 2	1178	107	STO MEM
1041 053 5	1179	057	9
1042 057 9	1180	053	5
1043 101 EE	Recall pressure1 and calculate r1		
1044 049 1	$r1^3 = (T1p2r2^3)/T2p1$		
1045 054 6	1261	040	(
1046 111 +/-	1262	109	RCL MEM
1047 107 STO MEM	1263	048	0
1048 057 9	1264	049	1
1049 055 7	1265	047	/
1050 119 print	1266	050	2
1051 049 1	1267	057	9
1052 046 .	1268	056	8
1053 048 0	1269	046	.
1054 053 5	1270	049	1
1055 052 4	1271	053	5
1056 053 5	1272	041)
1057 057 9	1273	047	/
1058 049 1	1274	109	RCL MEM
1059 056 8	1275	048	0
1060 053 5	1276	051	3
1061 101 EE	1277	061	=
1062 050 2	1278	092	Root
1063 055 7	1279	051	3
1064 111 +/-	1280	042	x
1065 107 STO MEM	Input r2 at 1 atm and 298.15K		
1066 057 9	1321	049	1

```

1322 046 .
1323 054 6
1324 057 9
1325 057 9
1326 054 6
1327 052 4
1328 101 EE
1329 055 7
1330 111 +/-
1331 041 )
1332 119 print
Store r1 radial separation
1373 107 STO MEM
1374 057 9
1375 048 0

```

Go to LABEL 5

1416 083 S
Subroutine snTn entropic energy n=1-4

```

1457 096 LABEL
1458 068 D
1459 040 (
1460 040 (
1461 040 (
1462 109 RCL MEM
1463 048 0
1464 053 5
1465 043 +
1466 109 RCL MEM
1467 049 1
1468 053 5
1469 041 )
1470 042 x
1471 109 RCL MEM
1472 057 9
1473 054 6
1474 041 )

```

Print mass

```

1515 119 print
1516 107 STO MEM
1517 056 8
1518 052 4
1519 042 x
1520 040 (
1521 109 RCL MEM
1522 053 5
1523 048 0
1524 113 Square
1525 041 )
1526 061 =

```

Print In moment of inertia mr^2

```

1567 119 print
1568 042 x
1569 051 3
1570 042 x
1571 109 RCL MEM
1572 057 9
1573 055 7
1574 042 x

```

Recall temperature r51
1615 109 RCL MEM

```

1616 053 5
1617 049 1
1618 041 )
1619 061 =

```

Print $3kTnIn=\theta tn^2$ uncorrected

```

1660 119 print
1661 092 Root
1662 050 2
1663 047 /
1664 040 (
1665 109 RCL MEM
1666 057 9
1667 057 9
1668 092 Root
1669 051 3
1670 041 )
1671 061 =

```

Print θtn translational action 1-D

```

1712 119 print
1713 107 STO MEM
1714 056 8
1715 053 5
1716 047 /
1717 109 RCL MEM
1718 057 9
1719 056 8
1720 061 =

```

Print quantum number

```

1761 119 print
1762 107 STO MEM
1763 052 4
1764 048 0
1765 121 Cube
1766 110 LOG e
1767 042 x
1768 109 RCL MEM
1769 057 9
1770 055 7
1771 061 =

```

Print translational $-gt/T$ Gibbs/K

```

1812 119 print
1813 107 STO MEM
1814 055 7
1815 048 0
1816 042 x
1817 109 RCL MEM
1818 053 5
1819 049 1

```

Print $kTnln[\theta nt/h-)^3/zt]= -gtn$

```

1860 061 =
1861 119 print
1862 107 STO MEM
1863 055 7
1864 049 1
1865 043 +
1866 040 (
1867 109 RCL MEM
1868 048 0
1869 052 4
1870 042 x

```


1871	109	RCL MEM	Print virtual translational freq v
1872	057	9	2127 119 print
1873	055	7	2128 107 STO MEM
1874	042	x	2129 056 8
1875	109	RCL MEM	2130 051 3
1876	053	5	2131 114 1/x
1877	049	1	2132 042 x
1878	041	)	2133 109 RCL MEM
1879	061	=	2134 057 9
1880	119	print	2135 053 5
Print stnTn for gas entropic energy			2136 041)
1921	107	STO MEM	Print wavelength virtual trans. quanta
1922	056	8	2177 119 print
1923	048	0	2178 107 STO MEM
1924	047	/	2179 048 0
1925	109	RCL MEM	2180 048 0
1926	053	5	2181 040 (
1927	049	1	2182 109 RCL MEM
1928	061	=	2183 048 0
Print stn			2184 048 0
1969	119	print	2185 047 /
1970	107	STO MEM	2186 109 RCL MEM
1971	056	8	2187 053 5
1972	049	1	2188 048 0
1973	040	(	2189 041)
1974	040	(	Print lambda/r
1975	109	RCL MEM	2230 119 print
1976	055	7	2231 107 STO MEM
1977	049	1	2232 052 4
1978	041	)	2233 051 3
1979	047	/	2234 040 (
1980	109	RCL MEM	2235 109 RCL MEM
1981	053	5	2236 052 4
1982	048	0	2237 051 3
1983	121	Cube	2238 047 /
1984	047	/	2239 040 (
1985	056	8	2240 050 2
1986	041	)	2241 042 x
Print virtual pressure gt/a^3			2242 112 pi
2027	119	print	2243 041)
2028	040	(	2244 041)
2029	109	RCL MEM	Print lambda/2pir
2030	055	7	2285 119 print
2031	049	1	Estimate frequency ratio v/w
2032	047	/	2326 040 (
2033	109	RCL MEM	2327 040 (
2034	052	4	2328 040 (
2035	048	0	2329 040 (
2036	041	)	2330 040 (
Print virtual hv=gt/nt			2331 040 (
2077	119	print	2332 109 RCL MEM
2078	047	/	2333 056 8
2079	109	RCL MEM	2334 053 5
2080	057	9	2335 042 x
2081	056	8	2336 109 RCL MEM
2082	047	/	2337 057 9
2083	050	2	2338 057 9
2084	047	/	2339 064 Inverse
2085	112	pi	2340 121 Cube
2086	041	)	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

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

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		3497	055	7
3126	109	RCL MEM		3498	042	x
3127	049	1		3499	109	RCL MEM
3128	056	8		3500	049	1
3129	047	/		3501	056	8
Recall h-				3502	042	x
3170	109	RCL MEM		3503	109	RCL MEM
3171	057	9		3504	049	1
3172	056	8		3505	057	9
3173	061	=		3506	041)
Print, stow @rB/h- in r18				Print jrA x jrB x jrC		
3214	119	print		3547	119	print
3215	107	STO MEM		Recall symmetry factor		
3216	049	1		3588	042	x
3217	056	8		3589	040	(
3218	061	=		3590	112	pi
Calculate @rC				3591	064	Inverse
3259	040	(		3592	113	Square
3260	109	RCL MEM		3593	041)
3261	049	1		3594	041)
3262	048	0		Print corrected jrcubed		
3263	042	x		3635	119	print
3264	109	RCL MEM		3636	107	STO MEM
3265	053	5		3637	054	6
3266	049	1		3638	049	1
3267	042	x		3639	040	(
3268	050	2		3640	109	RCL MEM
3269	042	x		3641	054	6
Recall k				3642	049	1
3310	109	RCL MEM		3643	047	/
3311	057	9		3644	109	RCL MEM
3312	055	7		3645	056	8
3313	041	)		3646	057	9
3314	092	Root		3647	041)
3315	050	2		3648	110	LOG e
3316	061	=		3649	042	x
Print, stow @rC in r19				Recall k		
3357	119	print		3690	109	RCL MEM
3358	107	STO MEM		3691	057	9
3359	049	1		3692	055	7
3360	057	9		3693	061	=
3361	109	RCL MEM		Print, stow -gr/T in r72		
3362	049	1		3734	119	print
3363	057	9		3735	107	STO MEM
3364	047	/		3736	055	7
Recall h-				3737	050	2
3405	109	RCL MEM		3738	119	print
3406	057	9		3739	042	x
3407	056	8		3740	109	RCL MEM
3408	061	=		3741	053	5
Print, stow @rC/h-				3742	049	1
3449	119	print		3743	061	=
3450	107	STO MEM		Print -gr		
3451	049	1		3784	119	print
3452	057	9		3785	107	STO MEM
jrXjrXjr				3786	055	7
3493	040	(		3787	051	3
3494	040	(		3788	040	(
3495	109	RCL MEM		3789	109	RCL MEM
3496	049	1		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	=

```

Print vr
4851 119 print
4852 114 1/x
4853 042 x
4854 109 RCL MEM
4855 057 9
4856 053 5
4857 061 =
Print virtual rotational wavelength
4898 119 print
4899 040 (
4900 109 RCL MEM
4901 052 4
4902 048 0
4903 121 Cube
4904 042 x
4905 109 RCL MEM
4906 052 4
4907 049 1
4908 113 Square
4909 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=ln(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 SIT1		
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

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

Argon

29/8/22

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
7.2815397924491 0011
4.1171574494571 -0002
4.3080929629069 0005
6.8565429034605 0004
2.69982210194 -0025
4.0353334689593 -0003
4.2224743488736 0004
4.4182939933074 0011
1.6480432953259 0000

6.9827616086823	-0021
8.1487399568157	0007
0.	0000
5.6943123864575	0006
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
 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
 1.3584112963311 -0001
 2.001074222366 0001
 4.6833192 -0023
 1.924824295077 -0037
 5.1023275674865 -0050
 1.0405515457934 -0025
 9.8668650416119 0001
 1.9018538463438 -0015
 1.2171864616601 -0012
 1.4380866056601 -0012
 2.2470103213438 -0015
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 1.233610124925 -0014
 1.8617169213854 0012
 1.6103009783942 -0002
 2.5118192845112 0005
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 7.5233582561554 0004
 1.1735269745003 0012
 1.586428741596 0000
 1.39106288538 -0039
 1.229143966774 -0052
 1.1086676538864 -0026
 1.0512765236014 0001 ✓
 6.4960940777094 -0016
 4.157500209734 -0013
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 1.8538366266335 -0012
 2.8966197291148 -0015
 3.9547161155006 -0014
 5.9683053525124 0012 ✓
 5.0230750655846 -0003
 1.0616258779981 0008
 2.1078804997381 -0021
 5.7744566725263 0008
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 4.1918912201607 0007
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8.9471247690198 -0008
4.6833192 -0023
3.7490458025705 -0037
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
1.7015934590827 0000
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
1.5421105995242 0007
8.83600576 -0014
1.3806259 -0016
1.4775301813068 0001
1.7404961443326 -0007
4.6833192 -0023
1.4187304498693 -0036
1.6923479076358 -0049
1.8950656286663 -0025
1.7969659339452 0002
2.1501604770186 -0015
6.1924621738136 -0013
7.1865128218136 -0013
2.4953169520186 -0015
1.4680950650175 0007
3.4460654244113 -0015
5.2006693064537 0011
5.7644976124126 -0002
3.3119852814285 0005
5.2711882898694 0004
4.1138156347068 -0025
8.7839744826849 -0003

5.0468221439543 0004
2.8996456903325 0011
1.7935533723286 0000
1.39106288538 -0039
5.531147850483 -0053
7.4371687156356 -0027
7.0521773097674 0000
5.3936536709618 -0016
1.553372257237 -0013
7.7458344310506 -0013
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

$S_v = R \ln(e^x - 1) - R \ln(1 - e^{-x})$; $x = h\nu/kT$

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	1506	051	3
1213	084	T	1507	051	3
1214	107	STD MEM	1508	119	print
1215	049	1	1509	002	HALT
1216	049	1	1510	048	0
1217	119	print	Input frequency 4, I		
1218	002	HALT	1551	096	LABEL
1219	048	0	1552	073	I
Input IrA rot. moment inertia in r12			1553	107	STD MEM
1260	096	LABEL	1554	051	3
1261	065	A	1555	052	4
1262	107	STD MEM	1556	119	print
1263	049	1	1557	002	HALT
1264	050	2	1558	048	0
1265	119	print	Input degeneracy F, D		
1266	002	HALT	1599	096	LABEL
1267	048	0	1600	068	D
Input IrB rot. moment inertia in r13			1601	107	STD MEM
1308	096	LABEL	1602	051	3
1309	066	B	1603	053	5
1310	107	STD MEM	1604	119	print
1311	049	1	1605	002	HALT
1312	051	3	1606	048	0
1313	119	print	Input degeneracy G, E		
1314	002	HALT	1647	096	LABEL
1315	048	0	1648	069	E
Input IrC rot. moment inertia in r14			1649	107	STD MEM
1356	096	LABEL	1650	051	3
1357	067	C	1651	054	6
1358	107	STD MEM	1652	119	print
1359	049	1	1653	002	HALT
1360	052	4	1654	048	0
1361	119	print	Input degeneracy W, for H and I		
1362	002	HALT	1695	096	LABEL
1363	109	RCL MEM	1696	087	W
Input frequency 1 $w=c/v$, F			1697	107	STD MEM
1404	096	LABEL	1698	051	3
1405	070	F	1699	055	7
1406	107	STD MEM	1700	119	print
1407	053	5	1701	002	HALT
1408	051	3	1702	048	0
1409	107	STD MEM	Input degrees Kelvin K in r08		
1410	051	3	1743	096	LABEL
1411	049	1	1744	075	K
1412	119	print	1745	107	STD MEM
1413	002	HALT	1746	048	0
1414	048	0	1747	056	8
Input frequency 2, G			1748	119	print
1455	096	LABEL	1749	002	HALT
1456	071	G	Execute by ShiftX		
1457	107	STD MEM	1790	096	LABEL
1458	051	3	1791	088	X
1459	050	2	Store H atomic mass in g in r95		
1460	119	print	1832	049	1
1461	002	HALT	1833	046	.
1462	048	0	1834	054	6
Input frequency 3, H			1835	055	7
1503	096	LABEL	1836	051	3
1504	072	H	1837	053	5
1505	107	STD MEM	1838	050	2

1839	053	5
1840	101	EE
1841	050	2
1842	052	4
1843	111	+/-
1844	107	STO MEM
1845	057	9
1846	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	2643	061	=
2272	047	/	2644	092	Root
2273	056	8	2645	050	2
2274	061	=	2646	061	=
2275	064	Inverse	Print and store action @t in r16		
2276	121	Cube	2687	119	print
2277	061	=	2688	107	STO MEM
2278	113	Square	2689	049	1
2279	042	x	2690	054	6
2280	040	(	2691	047	/
Recall AW 1 from r02			Recall h-		
2321	109	RCL MEM	2732	109	RCL MEM
2322	048	0	2733	057	9
2323	050	2	2734	056	8
2324	043	+	2735	061	=
Recall AW 2 from r03			Print and store @/h- in r17		
2365	109	RCL MEM	2776	107	STO MEM
2366	048	0	2777	049	1
2367	051	3	2778	055	7
2368	043	+	2779	119	print
Recall AW 3 from r04			2780	049	1
2409	109	RCL MEM	2781	048	0
2410	048	0	2782	046	.
2411	052	4	2783	050	2
2412	043	+	2784	050	2
Recall AW 4 from r05			2785	057	9
2453	109	RCL MEM	2786	055	7
2454	048	0	2787	092	Root
2455	053	5	2788	051	3
2456	043	+	2789	061	=
Recall AW 5 from r06			2790	114	1/x
2497	109	RCL MEM	2791	042	x
2498	048	0	2792	109	RCL MEM
2499	054	6	2793	049	1
Recall AW 6 from r07			2794	055	7
2540	109	RCL MEM	2795	061	=
2541	048	0	Print nt		
2542	055	7	2836	119	print
2543	041	)	2837	121	Cube
2544	042	x	2838	119	print
2545	109	RCL MEM	2839	110	LOG e
2546	057	9	2840	042	x
2547	053	5	2841	109	RCL MEM
2548	061	=	2842	057	9
Print and store It in r15			2843	054	6
2589	119	print	2844	061	=
2590	107	STO MEM	2845	107	STO MEM
2591	049	1	2846	049	1
2592	053	5	2847	056	8
2593	042	x	2848	109	RCL MEM
Recall k			2849	049	1
2634	109	RCL MEM	2850	056	8
2635	057	9	2851	119	print
2636	055	7	2852	107	STO MEM
2637	042	x	2853	054	6
2638	051	3	2854	049	1
2639	042	x	2855	109	RCL MEM
2640	109	RCL MEM	2856	054	6
2641	048	0	2857	049	1
2642	056	8	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 STD 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
 $Sr = R \ln[\pi^{1/2} e^{3/2} a^2 b^2 c / h^{-3/2}]$ 
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	=	6171	052	4
Store hv/kT = x in r45, print			6172	054	6
6074	119	print	6173	045	-
6075	107	STO MEM	6174	109	RCL MEM
6076	052	4	6175	052	4
6077	053	5	6176	055	7
Calculate Sv			6177	041)
6118	040	(	6178	107	STO MEM
6119	109	RCL MEM	6179	052	4
6120	057	9	6180	056	8
6121	054	6	Print Sv at w without degeneracy		
6122	042	x	6221	119	print
6123	109	RCL MEM	6222	042	x
6124	052	4	Recall degeneracy D		
6125	053	5	6263	109	RCL MEM
6126	047	/	6264	051	3
6127	040	(	6265	053	5
6128	040	(	6266	061	=
6129	049	1	Print and store total Sv in r49		
6130	064	Inverse	6307	119	print
6131	110	LOG e	6308	117	SUM MEM
6132	091	Exponent	6309	052	4
6133	109	RCL MEM	6310	057	9
6134	052	4	6311	119	print
6135	053	5	6312	109	RCL MEM
6136	041	)	6313	052	4
6137	045	-	6314	057	9
6138	049	1	Print cumulative Sv		
6139	041	)	6355	119	print
6140	061	=	6356	047	/
6141	107	STO MEM	6357	054	6
6142	052	4	6358	046	.
6143	054	6	6359	048	0
6144	040	(	6360	050	2
6145	049	1	6361	050	2
6146	045	-	6362	049	1
6147	040	(	6363	052	4
6148	040	(	6364	049	1
6149	049	1	6365	053	5
6150	064	Inverse	6366	101	EE
6151	110	LOG e	6367	049	1
6152	041	)	6368	054	6
6153	091	Exponent	6369	061	=
6154	109	RCL MEM	6370	119	print
6155	052	4	ergs per molecule per degree		
6156	053	5	6411	042	x
6157	111	+/-	6412	109	RCL MEM
6158	041	)	6413	048	0
6159	041	)	6414	056	8
6160	110	LOG e	6415	061	=
6161	042	x	Print sT		
6162	109	RCL MEM	6456	119	print
6163	057	9	6457	117	SUM MEM
6164	054	6	6458	053	5
6165	061	=	6459	048	0
6166	107	STO MEM	6460	109	RCL MEM
6167	052	4	6461	053	5
6168	055	7	6462	048	0
6169	040	(	Print svT		
6170	109	RCL MEM	6503	119	print

Compute Cv at T with Moore formula

$Cv = R \times \sqrt{2} (\cosh x - 1)$

```

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 !
6900 035 If flag
6901 052 4
6902 123 !
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	7113	040	(
6937	109	RCL MEM	7114	109	RCL MEM
6938	051	3	7115	053	5
6939	055	7	7116	048	0
6940	107	STO MEM	7117	045	-
6941	051	3	7118	109	RCL MEM
6942	053	5	7119	053	5
6943	064	Inverse	7120	050	2
6944	034	Set flag	7121	041)
6945	050	2	Print svT-cvvT/2=-GvT		
6946	034	Set flag	7162	119	print
6947	051	3	7163	040	(
6948	086	V	7164	040	(
6949	096	LABEL	7165	040	(
6950	033	!	7166	109	RCL MEM
6951	109	RCL MEM	7167	049	1
6952	051	3	7168	056	8
6953	052	4	7169	043	+
6954	038	If zero	7170	109	RCL MEM
6955	125	!|!	7171	050	2
6956	107	STO MEM	7172	050	2
6957	051	3	7173	043	+
6958	049	1	7174	109	RCL MEM
6959	119	print	7175	050	2
6960	109	RCL MEM	7176	057	9
6961	051	3	7177	041)
6962	055	7	Print St+Sr		
6963	107	STO MEM	7218	119	print
6964	051	3	7219	043	+
6965	053	5	7220	109	RCL MEM
6966	064	Inverse	7221	052	4
6967	034	Set flag	7222	057	9
6968	051	3	7223	041)
6969	034	Set flag	7224	107	STO MEM
6970	052	4	7225	053	5
6971	086	V	7226	053	5
6972	096	LABEL	Print St+Sr+Sv		
6973	123	!|!	7267	119	print
6974	096	LABEL	7268	042	x
6975	125	!|!	7269	109	RCL MEM
6976	040	(	7270	048	0
6977	109	RCL MEM	7271	056	8
6978	052	4	7272	061	=
6979	057	9	Print [St+Sr+Sv]T		
6980	045	-	7313	119	print
6981	109	RCL MEM	7314	047	/
6982	053	5	7315	054	6
6983	049	1	7316	046	.
6984	041	)	7317	048	0
Print Sv-Cvib/2=-Gvib/T			7318	050	2
7025	119	print	7319	050	2
Sum cumulative -G/T			7320	049	1
7066	117	SUM MEM	7321	052	4
7067	054	6	7322	049	1
7068	049	1	7323	053	5
7069	109	RCL MEM	7324	101	EE
7070	054	6	7325	049	1
7071	049	1	7326	054	6
Print cumulative -G/T			7327	061	=
7112	119	print	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

Turbine5/cal Vevor Turbine cgs
 KE = $IW^2/2$ 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 $[Tw-Tb] \times \text{Radian/sec} = \text{Power}$
 Radius of air cell say 1000 km 10^8
 Tapered 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
 Get 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/cm³
 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 $A=L \times C$ cm²
 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 cm³
 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 cm³ 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		1272	042	x
1057	049	1		1273	040	(
1058	042	x		1274	109	RCL MEM
1059	109	RCL MEM		1275	048	0
1060	048	0		1276	052	4
1061	052	4		1277	042	x
1062	041	)		1278	109	RCL MEM
Print mass of air cell, stow m12 g				1279	049	1
1103	119	print		1280	048	0
1104	107	STO MEM		1281	113	Square
1105	049	1		1282	041)
1106	050	2		1283	041)
1107	040	(		1284	047	/
1108	109	RCL MEM		1285	050	2
1109	049	1		1286	041)
1110	050	2		Print rate kinetic energy $P=DAV^{30.6}$		
1111	042	x		1327	119	print
1112	109	RCL MEM		1328	042	x
1113	048	0		1329	048	0
1114	049	1		1330	046	.
1115	113	Square		1331	054	6
1116	047	/		1332	041)
1117	052	4		Print adjustment for Cp		
1118	041	)		1373	119	print
Print I and stow in m13				Get vortical energy		
1159	119	print		1414	107	STO MEM
1160	107	STO MEM		1415	049	1
1161	049	1		1416	052	4
1162	051	3		1417	040	(
1163	040	(		1418	040	(
1164	109	RCL MEM		1419	040	(
1165	049	1		1420	112	pi
1166	051	3		1421	042	x
1167	042	x		1422	109	RCL MEM
1168	109	RCL MEM		1423	048	0
1169	048	0		1424	056	8
1170	051	3		1425	113	Square
1171	113	Square		1426	041)
1172	041	)		1427	047	/
Print KE IW^2 of air cell, stow m14				1428	040	(
1213	119	print		1429	051	3
1214	107	STO MEM		1430	042	x
1215	049	1		1431	109	RCL MEM
1216	052	4		1432	048	0
Calculate KE, power of turbine volume				1433	053	5
1257	040	(		1434	041)
1258	040	(		1435	041)
1259	040	(		1436	119	print
1260	040	(		1437	114	1/x
1261	109	RCL MEM		1438	042	x
1262	049	1		1439	109	RCL MEM
1263	048	0		1440	049	1
1264	042	x		1441	052	4
1265	112	pi		1442	041)
1266	042	x		1443	119	print
1267	109	RCL MEM		1444	040	(
1268	048	0		1445	040	(
1269	056	8		1446	040	(
1270	113	Square		1447	109	RCL MEM
1271	041	)		1448	048	0

1449	049	1	1626	046	.
1450	113	Square	1627	054	6
1451	042	x	1628	055	7
1452	109	RCL MEM	1629	101	EE
1453	048	0	1630	050	2
1454	051	3	1631	052	4
1455	041	)	1632	111	+/-
1456	119	print	1633	041)
1457	042	x	1634	042	x
1458	040	(	1635	109	RCL MEM
1459	050	2	1636	049	1
1460	057	9	1637	048	0
1461	042	x	1638	113	Square
1462	049	1	1639	041)
1463	046	.	1640	107	STD MEM
1464	054	6	1641	057	9
1465	055	7	1642	049	1
1466	101	EE	Print mv^2		
1467	050	2	1683	119	print
1468	052	4	1684	041)
1469	111	+/-	Print mv^2lnnv		
1470	041	)	1725	119	print
1471	047	/	1726	041)
1472	050	2	1727	107	STD MEM
1473	041	)	1728	056	8
Print mrv/2 for symmetry			1729	049	1
1514	119	print	1730	040	(
1515	047	/	1731	109	RCL MEM
1516	049	1	1732	056	8
1517	046	.	1733	049	1
1518	048	0	1734	047	/
1519	053	5	1735	109	RCL MEM
1520	052	4	1736	056	8
1521	101	EE	1737	048	0
1522	050	2	1738	041)
1523	055	7	Print hvv vortical quantum		
1524	111	+/-	1779	119	print
1525	047	/	1780	047	/
1526	050	2	1781	054	6
1527	041	)	1782	046	.
Print nv using symmetry no. 2			1783	054	6
1568	119	print	1784	050	2
1569	107	STD MEM	1785	054	6
1570	056	8	1786	049	1
1571	048	0	1787	101	EE
Get mv^2lnnv			1788	050	2
1612	040	(	1789	055	7
1613	040	(	1790	111	+/-
1614	109	RCL MEM	1791	041)
1615	056	8	Print v frequency		
1616	048	0	1832	119	print
1617	110	LOG e	1833	114	1/x
1618	119	print	1834	042	x
1619	042	x	1835	050	2
1620	040	(	1836	046	.
1621	040	(	1837	057	9
1622	050	2	1838	057	9
1623	057	9	1839	055	7
1624	042	x	1840	057	9
1625	049	1	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	STO 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	STO 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	STO MEM	Print Asin0 x v = volume per sec		
2052	056	8	2346	119	print
2053	050	2	2347	107	STO 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


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2352 049 1
2353 053 5
2354 042 x
2355 109 RCL MEM
2356 048 0
2357 052 4
2358 042 x
2359 109 RCL MEM
2360 049 1
2361 048 0
2362 113 Square
2363 047 /
2364 050 2
2365 041 )
Print MAsinDv^2/2 KE impact on blade
2406 119 print
2407 107 STO MEM
2408 049 1
2409 054 6
Calculate SumMvsinD/sec force/blade
2450 040 (
2451 109 RCL MEM
2452 049 1
2453 053 5
2454 042 x
2455 109 RCL MEM
2456 048 0
2457 052 4
2458 042 x
2459 109 RCL MEM
2460 049 1
2461 048 0
2462 041 )
Print, stow total impact SumMvsinD/sec
2503 119 print
2504 107 STO MEM
2505 049 1
2506 055 7
Calculate Torque and anti-Torque-heat
2547 040 (
2548 040 (
2549 109 RCL MEM
2550 049 1
2551 055 7
2552 047 /
2553 109 RCL MEM
2554 048 0
2555 053 5
2556 041 )
2557 107 STO MEM
2558 049 1
2559 055 7
2560 041 )
2561 119 print
2562 107 STO MEM
2563 049 1
2564 055 7
2565 040 (
2566 050 2
2567 046 .

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2568 051 3
2569 048 0
Print tip chord
2610 119 print
2611 107 STO MEM
2612 048 0
2613 054 6
Print tip width
2654 119 print
2655 109 RCL MEM
2656 048 0
2657 056 8
2658 107 STO MEM
2659 048 0
2660 048 0
2661 119 print
Get Tw and Tb
2702 096 LABEL
2703 084 T
2704 040 (
2705 040 (
2706 048 0
2707 046 .
2708 049 1
2709 055 7
2710 054 6
2711 057 9
2712 117 SUM MEM
2713 048 0
2714 054 6
2715 041 )
2716 040 (
2717 109 RCL MEM
2718 049 1
2719 055 7
2720 042 x
2721 109 RCL MEM
2722 048 0
2723 054 6
2724 041 )
2725 041 )
Print MvsinD/sec force/metre blade
2766 107 STO MEM
2767 049 1
2768 056 8
2769 040 (
2770 040 (
2771 050 2
2772 042 x
2773 109 RCL MEM
2774 048 0
2775 055 7
2776 041 )
2777 115 Sine
2778 042 x
2779 109 RCL MEM
2780 049 1
2781 056 8
2782 041 )
SMvsinDcos2D/metresec, action/area/sec

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2823	107	STD MEM	3156	041)
2824	049	1	3157	041)
2825	056	8	Get RW of blade at R and stow		
Label Torque or rate of Action			3198	113	Square
Get SumRotor Windward Torque Tw			3199	041)
2906	040	(	RVd0/sec		
2907	109	RCL MEM	3240	107	STD MEM
2908	049	1	3241	051	3
2909	056	8	3242	048	0
2910	042	x	3243	040	(
2911	040	(	3244	040	(
2912	109	RCL MEM	3245	040	(
2913	048	0	Get blade area dRcost segment at R		
2914	048	0	3286	109	RCL MEM
2915	043	+	3287	048	0
2916	049	1	3288	055	7
2917	048	0	3289	099	Cosine
2918	041	)	3290	042	x
2919	042	x	3291	109	RCL MEM
2920	051	3	3292	048	0
2921	041	)	3293	054	6
2922	041	)	3294	041)
Get cumulative Tw			3295	042	x
2963	117	SUM MEM	Get inertia MR/sec, power MR^20m^2		
2964	049	1	Use 2-D density D^2/3 for Tw output		
2965	057	9	3376	040	(
Get integrated torque or rate action			3377	109	RCL MEM
SumMvsin0cos20/metre sec; SumFxR=Tb			3378	048	0
Get rotor reverse torque, action rate			3379	052	4
3086	040	(	3380	091	Exponent
3087	040	(	3381	048	0
3088	109	RCL MEM	3382	046	.
3089	049	1	3383	054	6
3090	048	0	3384	055	7
3091	042	x	3385	042	x
3092	109	RCL MEM	3386	109	RCL MEM
3093	048	0	3387	051	3
3094	057	9	3388	048	0
3095	041	)	3389	041)
3096	047	/	3390	041)
3097	109	RCL MEM	3391	047	/
3098	048	0	3392	109	RCL MEM
3099	056	8	3393	050	2
3100	041	)	3394	048	0
Stow rotor W			3395	041)
3141	107	STD MEM	3396	042	x
3142	050	2	3397	051	3
3143	048	0	3398	041)
3144	040	(	Get SumMV^2cos0=MRVd0/dt=MV^2 = HEAT		
3145	109	RCL MEM	3439	117	SUM MEM
3146	050	2	3440	050	2
3147	048	0	3441	049	1
3148	042	x	Print total back torque, action/sec		
3149	040	(	3482	039	Dec JPNZ
3150	109	RCL MEM	3483	084	T
3151	048	0	3484	040	(
3152	048	0	3485	109	RCL MEM
3153	043	+	3486	049	1
3154	049	1	3487	057	9
3155	048	0	3488	119	print

3489	045	-	3590	107	STO 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	STO MEM	3637	048	0
3537	050	2	3638	107	STO MEM
3538	050	2	3639	048	0
3539	040	(	3640	054	6
3540	109	RCL MEM	3641	107	STO MEM
3541	050	2	3642	049	1
3542	050	2	3643	057	9
3543	042	x	3644	107	STO MEM
3544	109	RCL MEM	3645	050	2
3545	050	2	3646	049	1
3546	048	0	3647	107	STO 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			

TROPCYC2	0528	002	HALT
Revised Sep 1 2022 for symmetry 2	Evaporation	mm/day/m ²	25 mm
Model 500 km, 50 km ew, r ² w 5E6	0569	096	LABEL
Get cyclone energy vortical and torque	0570	069	E
Hold r ² w constant, least action	0571	107	STO MEM
Iterations 10	0572	048	0
0240 096 LABEL	0573	056	8
0241 073 I	0574	119	print
0242 107 STO MEM	Degrees latitude L, say 17° Cairns		
0243 048 0	0615 096 LABEL		
0244 049 1	0616 076 L		
0245 119 print	0617 107 STO MEM		
0246 002 HALT	0618 048 0		
Radius say 5E5 500 km	0619 057 9		
0287 096 LABEL	0620 119 print		
0288 082 R	0621 002 HALT		
0289 107 STO MEM	Execute		
0290 048 0	0662 096 LABEL		
0291 050 2	0663 088 X		
0292 119 print	Stow Earth radius		
0293 002 HALT	0704 040 (
Eyewall barrier radius B 5E4	0705 054 6		
0334 096 LABEL	0706 046 .		
0335 066 B	0707 051 3		
0336 107 STO MEM	0708 055 7		
0337 048 0	0709 049 1		
0338 051 3	0710 101 EE		
0339 119 print	0711 054 6		
0340 002 HALT	0712 041)		
Height effective in mass content 5E3	0713 119 print		
0381 096 LABEL	0714 107 STO MEM		
0382 072 H	0715 049 1		
0383 107 STO MEM	0716 048 0		
0384 048 0	Estimate heat evaporation /m ² /sec		
0385 052 4	2.26 MJ/kg heat evaporation		
0386 119 print	1 mm/m ² is kg water		
0387 002 HALT	0837 040 (
Angular velocity radians/sec	0838 109 RCL MEM		
0428 096 LABEL	0839 048 0		
0429 087 W	0840 056 8		
0430 107 STO MEM	0841 119 print		
0431 048 0	0842 107 STO MEM		
0432 053 5	0843 053 5		
0433 119 print	0844 048 0		
0434 002 HALT	0845 040 (
Action specific r ² w 5E6	0846 109 RCL MEM		
0475 096 LABEL	0847 053 5		
0476 065 A	0848 048 0		
0477 107 STO MEM	0849 042 x		
0478 048 0	0850 050 2		
0479 054 6	0851 046 .		
0480 119 print	0852 050 2		
0481 002 HALT	0853 054 6		
Density of air kg/m ³ 1.225	0854 101 EE		
0522 096 LABEL	0855 048 0		
0523 068 D	0856 054 6		
0524 107 STO MEM	0857 041)		
0525 048 0	Print and stow J/m ² /s latent heat		
0526 055 7	0898 119 print		
0527 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^2wdphi/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 8 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 deltaphi/sec

```

1566	119	print	1743	109	RCL MEM
1567	107	STD MEM	1744	052	4
1568	052	4	1745	055	7
1569	056	8	1746	047	/
1570	040	(	1747	109	RCL MEM
1571	109	RCL MEM	1748	052	4
1572	052	4	1749	048	0
1573	056	8	1750	041)
1574	047	/	Print ratio		
1575	109	RCL MEM	1791	119	print
1576	049	1	Get second ratio		
1577	048	0	1832	040	(
1578	041	)	1833	109	RCL MEM
1579	119	print	1834	052	4
1580	113	Square	1835	055	7
1581	107	STD MEM	1836	047	/
1582	052	4	1837	109	RCL MEM
1583	057	9	1838	052	4
1584	040	(	1839	049	1
1585	109	RCL MEM	1840	041)
1586	052	4	Print second ratio		
1587	057	9	1881	119	print
1588	042	x	Get action and nv		
1589	109	RCL MEM	1922	040	(
1590	049	1	1923	109	RCL MEM
1591	048	0	1924	048	0
1592	042	x	1925	054	6
1593	109	RCL MEM	1926	042	x
1594	048	0	1927	050	2
1595	057	9	1928	057	9
1596	099	Cosine	1929	042	x
1597	041	)	1930	049	1
Print, stow Coriolis accleration			1931	046	.
1638	119	print	1932	054	6
1639	107	STD MEM	1933	055	7
1640	052	4	1934	101	EE
1641	048	0	1935	050	2
1642	040	(	1936	055	7
1643	109	RCL MEM	1937	111	+/-
1644	048	0	Divide by symmetry factor 2		
1645	057	9	1978	047	/
1646	115	Sine	1979	050	2
1647	042	x	1980	041)
1648	109	RCL MEM	Print and stow action/molecule=@v		
1649	052	4	2021	119	print
1650	057	9	2022	107	STD MEM
1651	042	x	2023	053	5
1652	050	2	2024	053	5
1653	042	x	2025	040	(
1654	109	RCL MEM	2026	109	RCL MEM
1655	049	1	2027	053	5
1656	048	0	2028	053	5
1657	041	)	2029	047	/
Print and stow 2Wrwsin(phi)			2030	049	1
1698	119	print	2031	046	.
1699	107	STD MEM	2032	048	0
1700	052	4	2033	053	5
1701	049	1	2034	052	4
Get ratio inertial/Coriolis			2035	053	5
1742	040	(	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^2lnnv -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	2802	054	6
2509	053	5	2803	052	4
2510	055	7	2804	109	RCL MEM
2511	041	)	2805	054	6
Print J/m ³ vortical pressure			2806	052	4
2552	119	print	2807	119	print
2553	042	x	2808	040	(
2554	049	1	2809	109	RCL MEM
2555	101	EE	2810	053	5
2556	057	9	2811	052	4
2557	041	)	2812	047	/
Print J/km ³ vortical pressure			2813	050	2
2598	119	print	2814	042	x
2599	107	STO MEM	2815	109	RCL MEM
2600	054	6	2816	053	5
2601	048	0	2817	057	9
Get cell height J/km ³			2818	041)
2642	040	(	Print and stow kinetic/m ³		
2643	109	RCL MEM	2859	119	print
2644	054	6	2860	107	STO MEM
2645	048	0	2861	054	6
2646	042	x	2862	049	1
2647	109	RCL MEM	Get KEnergy /km ³ and per km ²		
2648	048	0	2903	040	(
2649	052	4	2904	040	(
2650	042	x	2905	109	RCL MEM
2651	049	1	2906	054	6
2652	101	EE	2907	049	1
2653	051	3	2908	042	x
2654	111	+/-	2909	049	1
2655	041	)	2910	101	EE
Print total vortical energy /km ²			2911	057	9
Print and stow			2912	041)
2736	119	print	2913	119	print
2737	107	STO MEM	2914	042	x
2738	054	6	2915	109	RCL MEM
2739	051	3	2916	048	0
Get circumference energies			2917	052	4
2780	040	(	2918	042	x
2781	109	RCL MEM	2919	049	1
2782	054	6	2920	101	EE
2783	051	3	2921	051	3
2784	042	x	2922	111	+/-
2785	040	(	2923	041)
2786	109	RCL MEM	2924	119	print
2787	048	0	2925	107	STO MEM
2788	050	2	2926	054	6
2789	042	x	2927	053	5
2790	049	1	Get circumference cell		
2791	101	EE	2968	040	(
2792	051	3	2969	109	RCL MEM
2793	111	+/-	2970	054	6
2794	041	)	2971	053	5
2795	042	x	2972	042	x
2796	050	2	2973	109	RCL MEM
2797	042	x	2974	048	0
2798	112	pi	2975	050	2
2799	041	)	2976	042	x
2800	119	print	2977	050	2
2801	117	SUM MEM	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

@ = mru / 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>p</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 @
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>
1.1111111111111	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 -90
 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 -90
 3.4676880451549 0001
 2.285581365527 -0037
 3.4493614124855 -0004
 8.6912451943962 0011
 2.5294239107991 0025
 6.6373716489294 0003 P6
 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	90
3.	4676880451549	0001	
2.	9852491304842	-0037	
4.	5052883754912	-0004	
6.	6542346019596	0011	
2.	5294239107991	0025	
8.	6692201128874	0003	p9
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	90
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	p9
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
3.33333333333333 0001
5.38111111111111 -0023 Ry
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
6.80555555555556 0002
6.80555555555556 0011
3.40277777777778 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
3.4676880451549	0001
1.4627720739373	-0035
2.2075913039907	-0002
1.3580070616244	0010
2.5294239107991	0025
4.2479178553148	0005
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

-g°

g/p

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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

GIBGRAN 1

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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