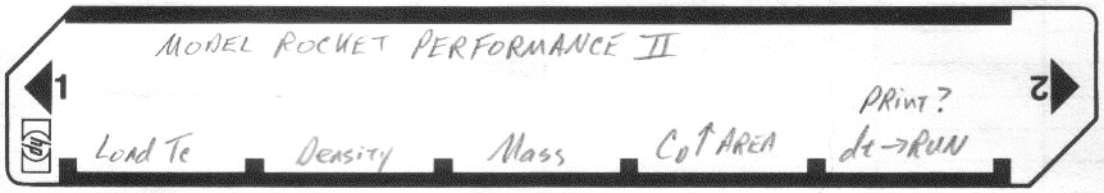
User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
①	Load PROGRAM CARd, Both sides			
②	Load Engine DATA CARd, one side			
③	TOGGLE PRINT/NO PRINT Mode		f e	0 or 1
	IN "NO PRINT" values Are still printed, but program			
	Stops After each output Segment to Allow viewing STACK			
	on HP67 -- PRess R/S TO continue After viewing			
④	Load + PREP THRUST CURVE (Moves DATA from R_{01}-R_{0E} TO R_{51}-R_{5E})		A	
⑤	ENTER AiR Density (Usually 1.2)	Density	B	
⑥	ENTER Rocket MASS - in grams (EVERything but Engine)	MASS	C	
⑦	ENTER Coefficient of DRAG And frontal SURFACE AREA (cm^2)	C_D	ENTER↑	
		AREA	D	
⑧	ENTER Time delta in seconds (usually 0.01), Begin Run	dt	E	output *
	* output foREACh segment: Mission Time (s)			
	Velocity (m/s)			
	Altitude (m)			
⑨	If print HAS FALSE (HP67 Mode), continue foreach segment.		R/S	

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLe	21 16 15	TOGGLE PRINTER(1) OR HandHeld (0) Modes
002	F0?	16 23 00	
003	GTO0	22 00	
004	SF0	16 21 00	
005	0	00	
006	RTN	24	
007	*LBL0	21 00	
008	CF0	16 22 00	
009	1	01	
010	RTN	24	
011	*LBLA	21 11	LOAD THRUST CURVE TO SECONDARY REGS
012	P≠S	16-51	
013	RCLE	36 15	
014	STO1	35 01	
015	RCLD	36 14	
016	STO2	35 02	
017	RCLC	36 13	
018	STO3	35 03	
019	RCLB	36 12	
020	STO4	35 04	
021	RCLA	36 11	
022	STO5	35 05	
023	P≠S	16-51	
024	RCLI	36 46	
025	STOE	35 15	
026	RTN	24	
027	*LBLB	21 12	Input Air Density
028	STOA	35 11	
029	RTN	24	
030	*LBLC	21 13	Input Rocket MASS
031	RCL8	36 08	
032	+	-55	
033	EEX	-23	
034	3	03	
035	÷	-24	
036	STOB	35 12	
037	RTN	24	
038	*LBLD	21 14	Input C_D And frontal SURFACE AREA
039	2	02	
040	EEX	-23	
041	4	04	
042	÷	-24	
043	x	-35	
044	STOC	35 13	
045	RTN	24	
046	*LBLE	21 15	Input dt → Run
047	STOD	35 14	
048	CLX	-51	
049	STO0	35 00	
050	STO7	35 07	
051	STO9	35 09	
052	RCLE	36 15	
053	STO1	35 46	
054	*LBL4	21 04	MAin Loop NEW SEGMENT
055	ISZI	16 26 46	
056	GSB1	23 01	
057	STO2	35 02	
058	GSB3	23 03	
059	STO4	35 04	
060	DSZI	16 25 46	
061	GSB2	23 02	
062	RCL0	36 00	
063	+	-55	
064	STO5	35 05	
065	GSB1	23 01	
066	STO1	35 01	
067	GSB3	23 03	
068	STO3	35 03	
069	RCL0	36 00	
070	*LBL5	21 05	LOOP Within SEGMENT
071	STO6	35 06	
072	RCL0	36 00	
073	-	-45	
074	RCL5	36 05	INTERPOLATION
075	RCL0	36 00	
076	-	-45	
077	÷	-24	
078	ENT↑	-21	
079	RCL4	36 04	
080	RCL3	36 03	
081	-	-45	
082	x	-35	
083	RCL3	36 03	
084	+	-55	
085	X≠Y	-41	
086	RCL2	36 02	
087	RCL1	36 01	
088	-	-45	
089	x	-35	
090	-	-45	
091	x	-35	← Using TRegister Replication
092	RCL1	36 01	
093	+	-55	
094	RCLA	36 11	
095	RCL9	36 09	
096	X^2	53	
097	x	-35	
098	RCLC	36 13	
099	x	-35	
100	-	-45	
101	X≠Y	-41	
102	RCLB	36 12	
103	X≠Y	-41	
104	-	-45	
105	÷	-24	
106	9	09	
107	.	-62	GRAVITY
108	8	08	
109	-	-45	
110	ENT↑	-21	
111	ENT↑	-21	
112	2	02	

STEP

REGISTERS

0 TIME	1 $NN.N_t$	2 $NN.N_{t+1}$	3 $GG.G_t$	4 $GG.G_{t+1}$	5 SEG TIME END	6 SEG TIME CURRENT	7 ALTITUDE CURRENT	8 ENGINE MASS	9 VELOCITY CURRENT
S0	S1 Tc_5	S2 Tc_4	S3 Tc_3	S4 Tc_2	S5 Tc_1	S6	S7	S8	S9
A AIR DENSITY	B LIFTOFF MASS	C C_D * AREA/2	D dt	E Tc INDEX INITIAL	I Tc INDEX CURRENT				

A LOAD

a

0

5 LOOP SEG

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
113	÷	-24	
114	RCLD	36 14	
115	X²	53	
116	×	-35	
117	RCL9	36 09	
118	RCLD	36 14	
119	×	-35	
120	+	-55	
121	ST+7	35-55 07	
122	X≠Y	-41	
123	RCLD	36 14	
124	×	-35	
125	ST+9	35-55 09	
126	RCL5	36 05	
127	RCL6	36 06	
128	RCLD	36 14	
129	+	-55	
130	X≤Y?	16-35	← Within Segment?
131	GTO5	22 05	
132	RCL5	36 05	Output
133	STO0	35 00	
134	PRTX	-14	← Time
135	RCL9	36 09	
136	PRTX	-14	← Velocity
137	RCL7	36 07	
138	PRTX	-14	← Altitude
139	SPC	16-11	
140	F0?	16 23 00	← NO PRINTER?
141	R/S	51	
142	DSZI	16 25 46	← Decrement Tc Index
143	GTO4	22 04	← GTO New Segment
144	RTN	24	
145	*LBL1	21 01	
146	P≠S	16-51	
147	RCLi	36 45	Thrust
148	P≠S	16-51	
149	EEX	-23	
150	3	03	
151	×	-35	
152	INT	16 34	
153	EEX	-23	
154	1	01	
155	÷	-24	
156	RTN	24	
157	*LBL2	21 02	
158	P≠S	16-51	
159	RCLi	36 45	TIME
160	P≠S	16-51	
161	EEX	-23	
162	3	03	
163	×	-35	
164	FRC	16 44	
165	EEX	-23	
166	2	02	
167	×	-35	
168	INT	16 34	
169	EEX	-23	
170	1	01	
171	÷	-24	
172	RTN	24	
173	*LBL3	21 03	MASS
174	P≠S	16-51	
175	RCLi	36 45	
176	P≠S	16-51	
177	EEX	-23	
178	5	05	
179	×	-35	
180	FRC	16 44	
181	EEX	-23	
182	1	01	
183	÷	-24	
184	RTN	24	
185	R/S	51	

SAMPLE ENGINE DATA CARDS

A3-2T

```
7.200000000  8
0.000000000  9
0.000000000  A
0.080010070  B
0.030020180  C
0.030050350  D
0.000200350  E
4.000000000  I
```

A6-5

```
17.60000000  8
0.000000000  9
0.000000000  A
0.000000000  B
0.130020160  C
0.000010310  D
0.000500310  E
3.000000000  I
```

B4-4

```
21.00000000  8
0.000000000  9
0.000000000  A
0.130020160  B
0.030020400  C
0.030080830  D
0.000400830  E
4.000000000  I
```

C6-7

```
26.90000000  8
0.000000000  9
0.130020160  A
0.050020320  B
0.050121200  C
0.000011250  D
0.000701250  E
5.000000000  I
```

LABELS

A Load Tc	B Input Density	C Input MASS	D Input CD And AREA	E Input alt And →RUN	0 PRINT FLAG
a	b	c	d	e PRINT FLAG TOGGLE	1
0	1 Calc THRUST	2 Calc TIME	3 Calc MASS	4 New SEGMENT	2
5 Loop within Segment	6	7	8	9	3

FLAGS

	ON	OFF
0	☐	☑
1	☐	☑
2	☐	☑
3	☐	☑

SET STATUS

TRIG		DISP	
DEG	☑	FIX	☑
GRAD	☐	SCI	☐
RAD	☐	ENG	☐
		n	8

Program Description

Program Title MODEL ROCKET PERFORMANCE II

Name John GARZA (3665) **Date** JAN 3, 1998

Address 405 S. RIVERSHIRE

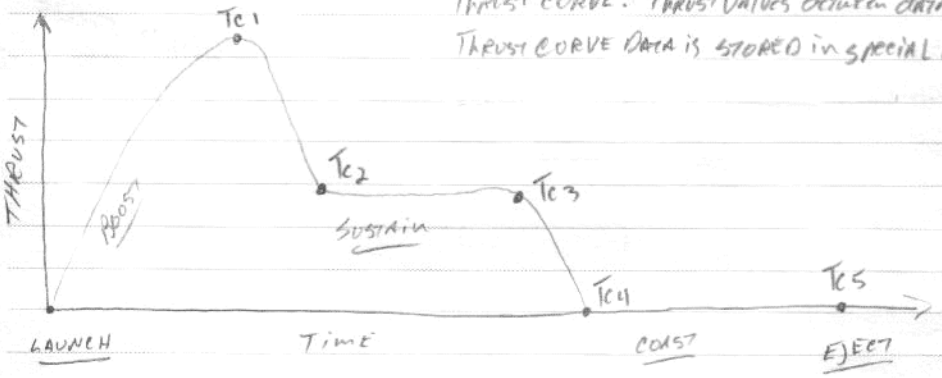
City CONROE **State** TX **Zip Code** 77304

Program Description, Equations, Variables, etc. This upgrade to my original MRP program takes into account Engine thrust curves instead of assuming a uniform thrust, And stores Engine DATA on seperate DATA CARDS.

$Alt_{n+1} = ((Thrust - Density * V^2 * CD * Area/2) / (Mass + FuelMass) - G) / 2 * DT^2 + V * DT + Alt_n$

$V_{n+1} = ((Thrust - Density * V_n^2 * CD * Area/2) / (Mass + FuelMass) - G) * DT + V_n$

TYPICAL THRUST CURVE:



UP TO 5 DATA POINTS ($T_{c_1} \ldots T_{c_5}$) ARE AVAILABLE TO define the THRUST CURVE. THRUST values between DATA POINTS ARE INTERPOLATED. THRUST CURVE DATA IS STORED in special PACKED DATA FORMAT.

THRUST CURVE DATA FORMAT:

0.NNN, SS, GGG.G

- GG.G (CUMULATIVE GRAMS BURNED)
- S.S (SECONDS THIS SEGMENT)
- NN.N (NEWTONS THRUST THIS SEGMENT)

R_G = Engine MASS (including fuel) in grams

R_I = NUMBER of THRUST CURVE DATA points

$R_A - R_E$ = THRUST CURVE DATA in ABOVE FORMAT

NOTES ON DRAG COEFFICIENT ESTIMATES:

Alpha Rocket, NO PAINT, NO SANDING:	$C_D = 0.98$
Alpha Rocket, SANDED, PAINTED, SQ fins:	$C_D = 0.78$
Alpha Rocket, SANDED, PAINTED, Airfoils:	$C_D = 0.65$
High Efficiency Design (Estes SPIRIT):	$C_D = 0.42$

Expert finish, Airfoils, boattail, small fins

SOURCE: ESTES TR11
ESTES TN1

Operating Limits and Warnings According to Estes TR-11 p.41, its NOT uncommon to HAVE ± 5% VARIATION in Altitude using A8-5 Engines in Identical Alpha Rockets.

DO NOT USE THIS SPACE