

# Image Cover Sheet

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**TITLE**

BLACK BRANT DATA BOOKLET BB II 19 TO 22: PRE-FLIGHT PERFORMANCE CALCULATIONS  
AND WIND SENSITIVITY DATA FOR BB II 19 TO 22 ROCKET VEHICLES

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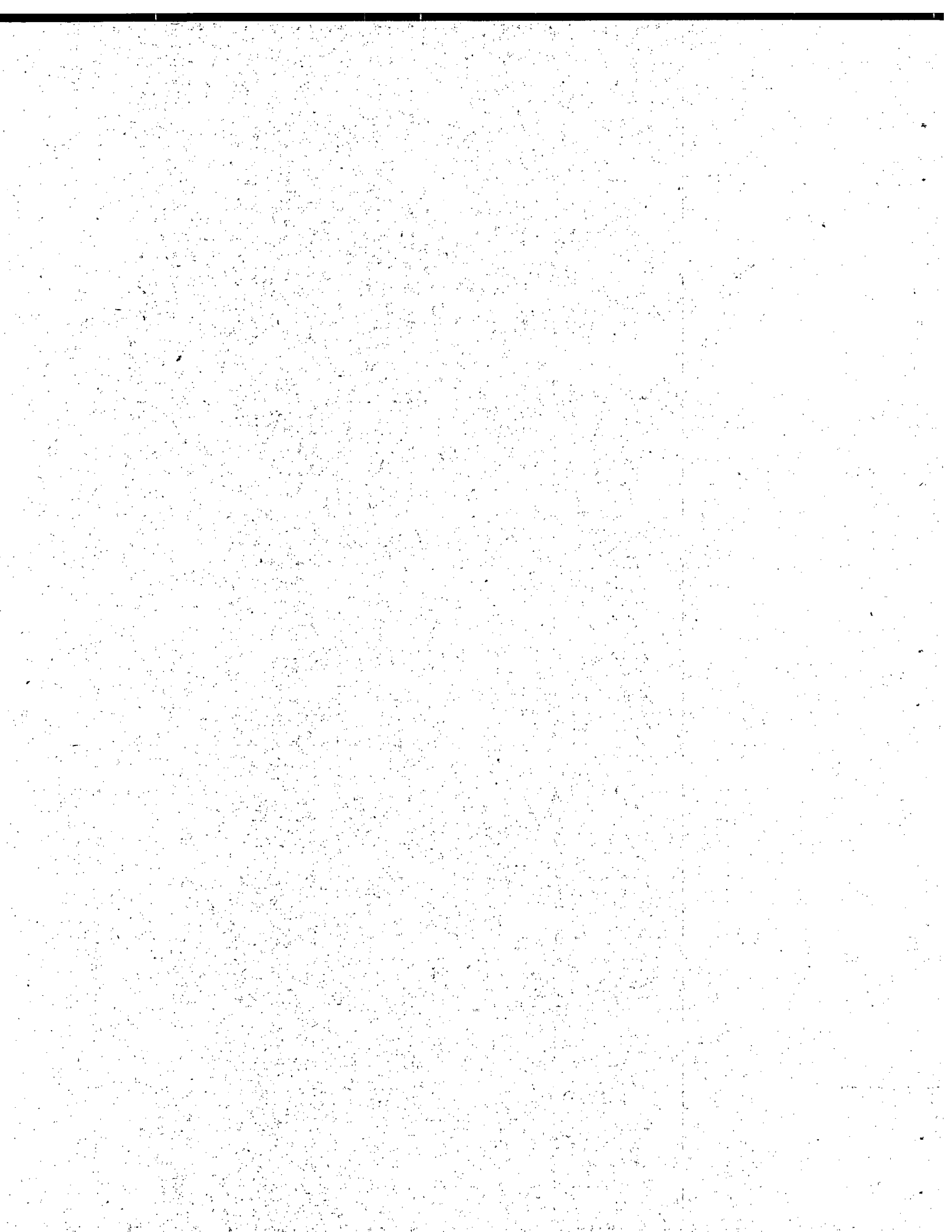
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C.A.R.D.E. BLACK BRANT  
DATA BOOKLET BB II 19 TO 22

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BB II 19 TO 22 ROCKET VEHICLES

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PRE-FLIGHT PERFORMANCE CALCULATIONS AND  
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BB II 19 TO 22 ROCKET VEHICLES

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INTRODUCTION

Pre-flight performance calculations and wind sensitivity data for BB II 19 to 22 rocket vehicles are presented in the following forms:

- TABLE I - Weight, Mass, Pitch Inertia, Dynamic Pressure, Velocity, Acceleration and Altitude as functions of Time.
- TABLE II - Mach No., Zero Lift Curve Slope, Center of Pressure, Center of Gravity, Stability Margin as functions of Time.
- TABLE III - Zero Lift Curve Slope (Nose & Body), Center of Pressure (Nose and Body), Zero Lift Curve Slope (Fins), Center of Pressure (Fins), Zero Lift Curve Slope (Vehicle), Combined Center of Pressure as functions of Mach No.
- TABLE IV - Trajectory Data.
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- FIGURE 3 - Mach No. versus time.
- FIGURE 4 - Acceleration, velocity and altitude versus time.
- FIGURE 5 - Altitude versus total flight time.
- FIGURE 6 - Trajectory.

Pre-flight performance data were based upon a vehicle launch weight of 2,800 lb., a zero wind 80° launch elevation angle and a static stability margin of 2.20 calibers (body dia.) at burnout. The aerodynamic data were corrected for fin flexibility.

Wind Sensitivity Data given in Table V should be substituted for Tables I and III in the Wind Weighting Data for Black Brant Vehicles and used in conjunction with the latter for determining the Wind Weighting information of BB II 19 to 22 rocket vehicles.

TABLE I

Time Dependent DataBB IIA 19 to 22

Time sec.	Weight lb.	Mass Slugs	Pitch Inertia Slugs ft <sup>2</sup>	Dynamic Pressure lb/ft <sup>2</sup>	Velocity ft/sec.	Acceleration ft/sec <sup>2</sup>	Altitude ft.
0	2800	86.94	3338	0	0	0	0
1	2670	82.90	3272	96	285	291	140
2	2547	79.08	3207	381	575	293	570
3	2424	75.26	3142	881	878	296	1,276
4	2301	71.45	3076	1531	1175	299	2,275
5	2179	67.66	3010	2344	1481	306	3,566
6	2058	63.90	2950	3271	1793	316	5,155
7	1938	60.17	2884	4249	2115	325	7,049
8	1818	56.45	2868	5167	2447	338	9,259
9	1700	52.78	2752	6471	2795	351	11,795
10	1585	49.21	2691	7547	3164	367	14,676
11	1471	45.67	2625	8438	3539	386	17,915
12	1359	42.19	2560	9315	3937	415	21,524
13	1254	38.94	2492	9984	4373	460	25,534
14	1154	35.84	2426	10395	4831	435	29,975
15	1084	33.66	2364	10016	5204	274	34,822
16	1047	32.51	2298	8428	5380	84	39,935
17	1029	31.95	2233	6792	5412	-18	44,619
18	1020	31.67	2168	5080	5354	-102	50,331
19	1020	31.67	2168	4503	5259	-87	55,439
20	1020	31.67	2168	2941	5178	-75	60,460

TABLE II

Time Dependent DataBB IIA 19 to 22

<u>Time sec.</u>	<u>Mach No.</u>	<u><math>C_{L\alpha}</math> Comb.</u>	<u><math>X_{cp}</math> Comb. Inches</u>	<u><math>X_{cg}</math> Inches</u>	<u><math>X_{cp} - X_{cg}</math> Inches</u>
0	0	23.0	290.8	197.4	93.4
1	.255	23.5	287.5	197.2	90.3
2	.516	24.8	286.0	197.0	89.0
3	.790	27.5	284.5	196.8	87.7
4	1.06	30.0	284.0	196.5	87.5
5	1.34	27.1	283.5	196.2	87.3
6	1.63	23.9	281.5	195.9	85.6
7	1.94	20.8	279.0	195.6	84.4
8	2.26	17.5	273.5	195.2	78.3
9	2.61	15.1	267.5	194.7	72.8
10	2.99	13.6	262.5	194.2	68.3
11	3.37	12.3	255.0	193.6	61.4
12	3.82	11.4	247.0	193.0	54.0
13	4.31	10.6	240.5	192.3	48.2
14	4.86	9.7	233.5	191.5	42.0
15	5.34	9.3	229.4	190.8	38.6
16	5.54	9.2	228.3	190.4	37.9
17	5.57	9.1	228.1	190.2	37.9
18	5.51	9.2	228.5	190.1	38.4
19	5.41	9.25	229.1	190.1	39.0
20	5.33	9.3	229.5	190.1	39.4
Ref. Area-ft <sup>2</sup>		1.614			

TABLE V

Wind Sensitivity DataBB IIA 19 to 22

<u>Altitude</u> <u>Z</u> <u>ft.</u>	<u>S/V</u> <u>sec/ft</u>	<u>Altitude</u> <u>Z</u> <u>ft.</u>	<u>S/V</u> <u>sec/ft</u>	<u>Altitude</u> <u>Z</u> <u>ft.</u>	<u>S/V</u> <u>sec/ft</u>
15	.00711	300	.00237	4,500	.00060
20	.00665	350	.00220	5,000	.00057
25	.00635	400	.00206	6,000	.00052
30	.00603	450	.00195	7,000	.00047
35	.00575	500	.00184	8,000	.00044
40	.00552	600	.00169	9,000	.00042
45	.00533	700	.00156	10,000	.00039
50	.00516	800	.00146	12,000	.00035
60	.00485	900	.00137	14,000	.00032
70	.00455	1,000	.00130	16,000	.00030
80	.00431	1,200	.00117	18,000	.00028
90	.00411	1,400	.00110	20,000	.00026
100	.00394	1,600	.00102	25,000	.00023
120	.00364	1,800	.00096	30,000	.00021
140	.00339	2,000	.00091	35,000	.00019
160	.00321	2,500	.00081	40,000	.00019
1800	.00304	3,000	.00074	45,000	.00018
200	.00289	3,500	.00068	50,000	.00019
250	.00259	4,000	.00064	60,000	.00019

Burnout velocity ft/sec.

5412

 $K(\phi_f = K \phi_o)$ 

1.50

Elevation angles for which K may be used

70° - 90°

Launcher leaving velocity ft/sec.

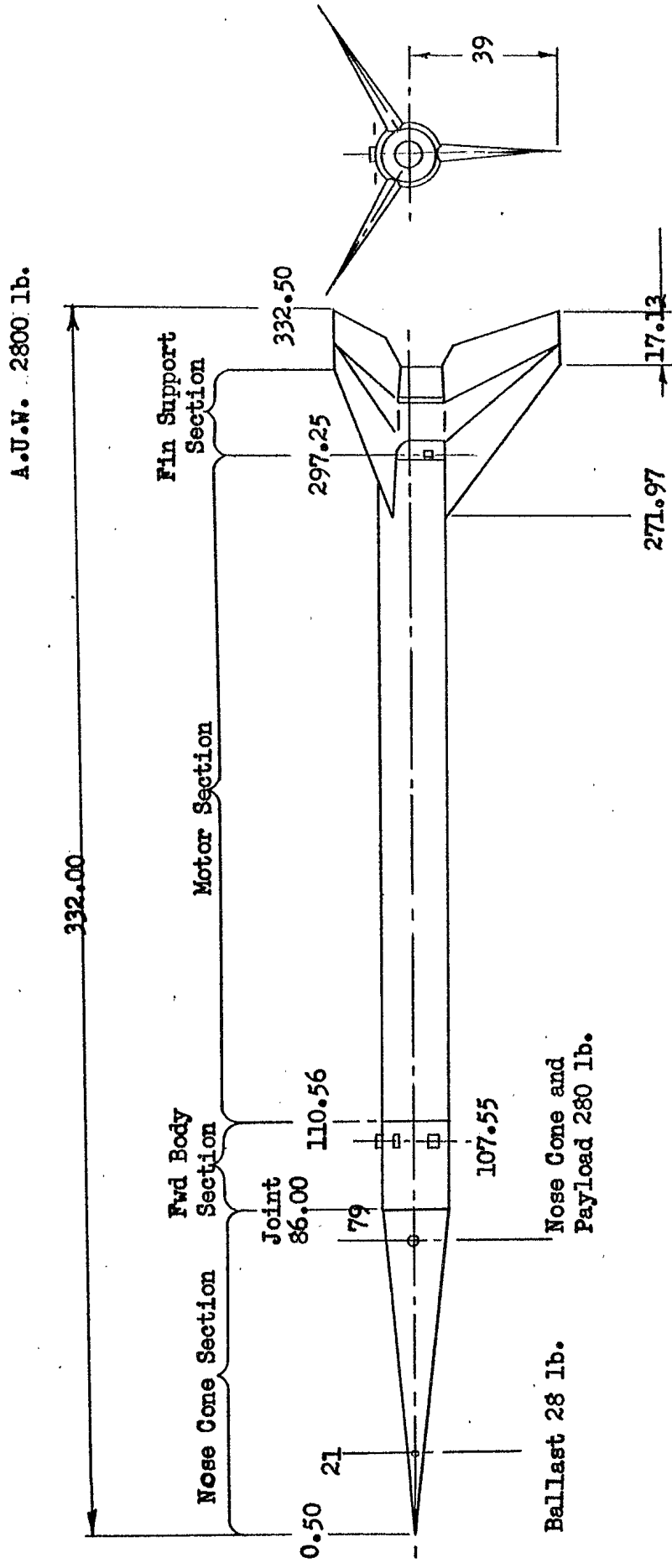
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Sensitivity leaving launcher

.654

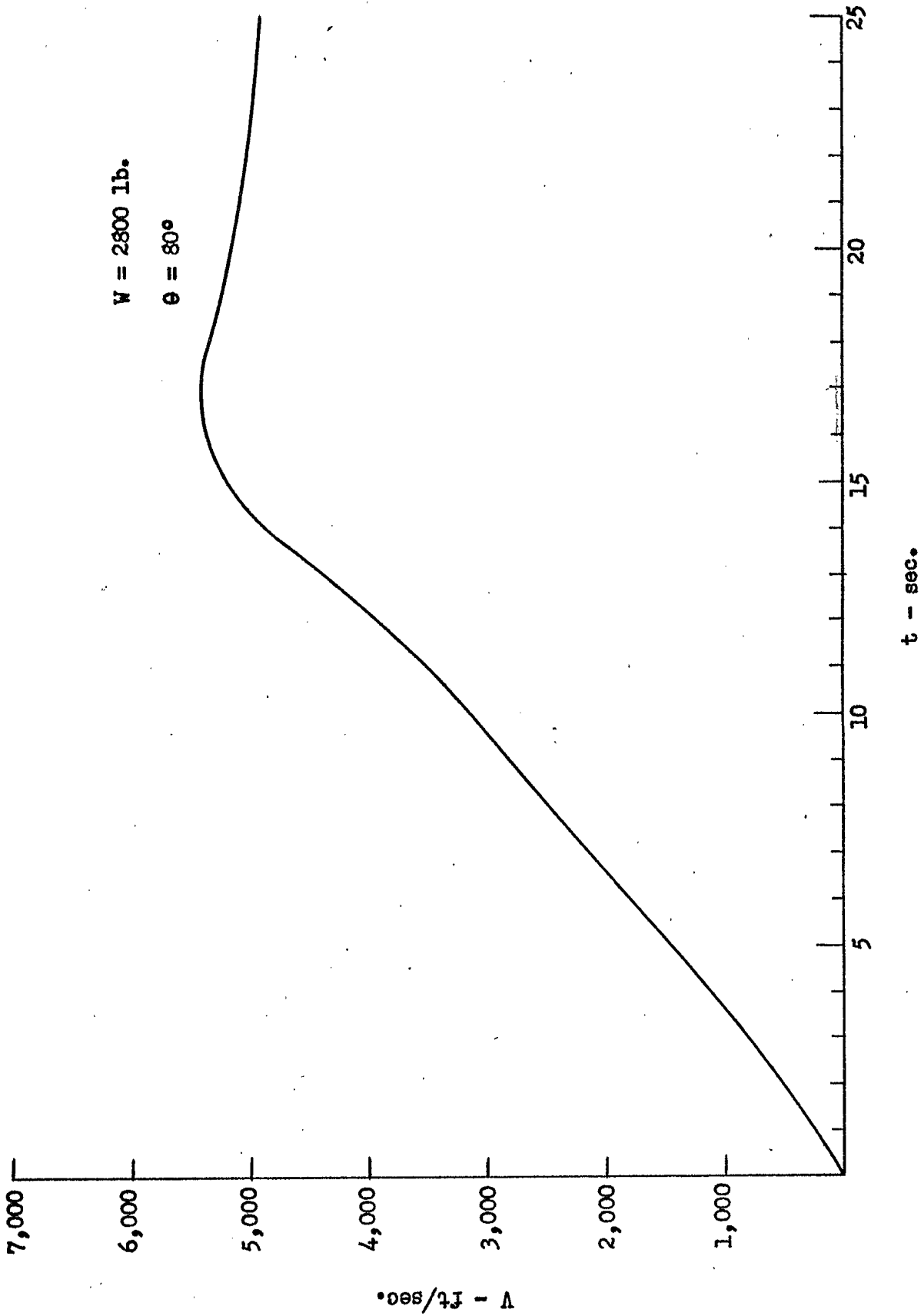
 $\phi_o = 90^\circ$  - elevation angle.

NOTE:- Wind Sensitivity Data given above should be substituted for Tables I & III in the Wind Weighting Data for Black Brant Vehicles and used in conjunction with the latter for determining the Wind Weighting Data of BB II 19 to 22 rocket vehicles.



Vehicle configuration for BB IIA 19 to 22

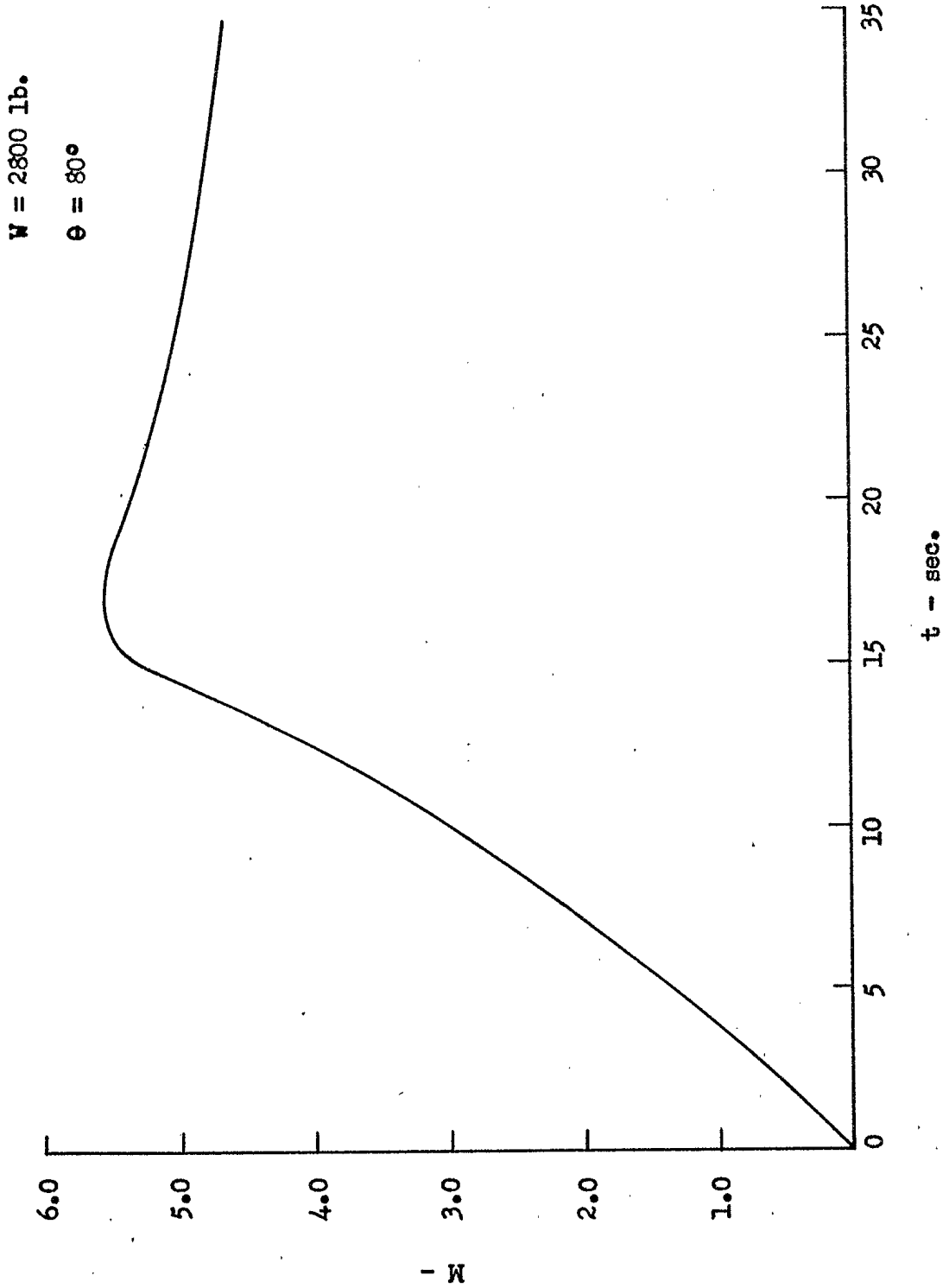
FIGURE I



Velocity versus time

FIGURE 2



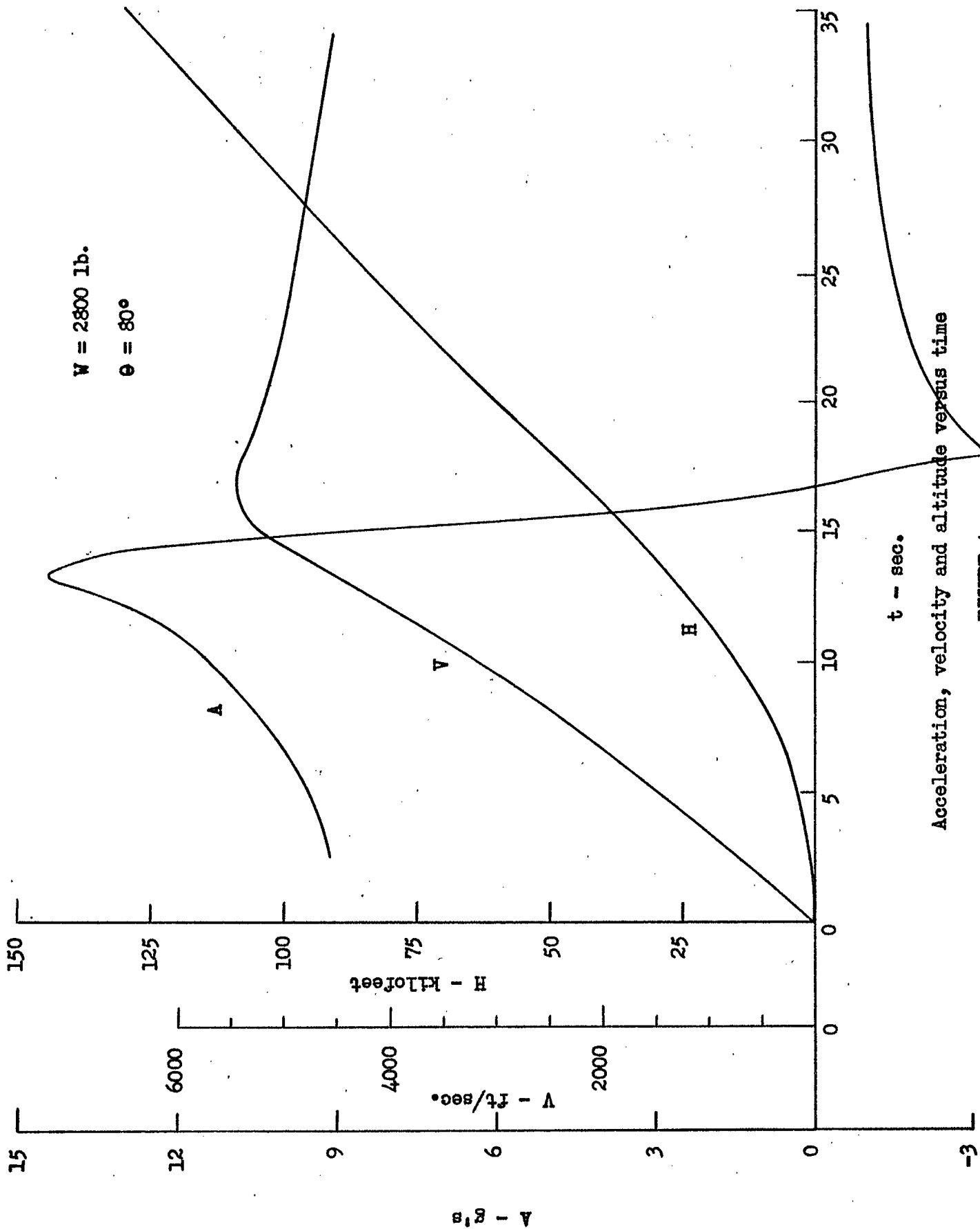


Mach No. versus time

FIGURE 3

W = 2800 lb.

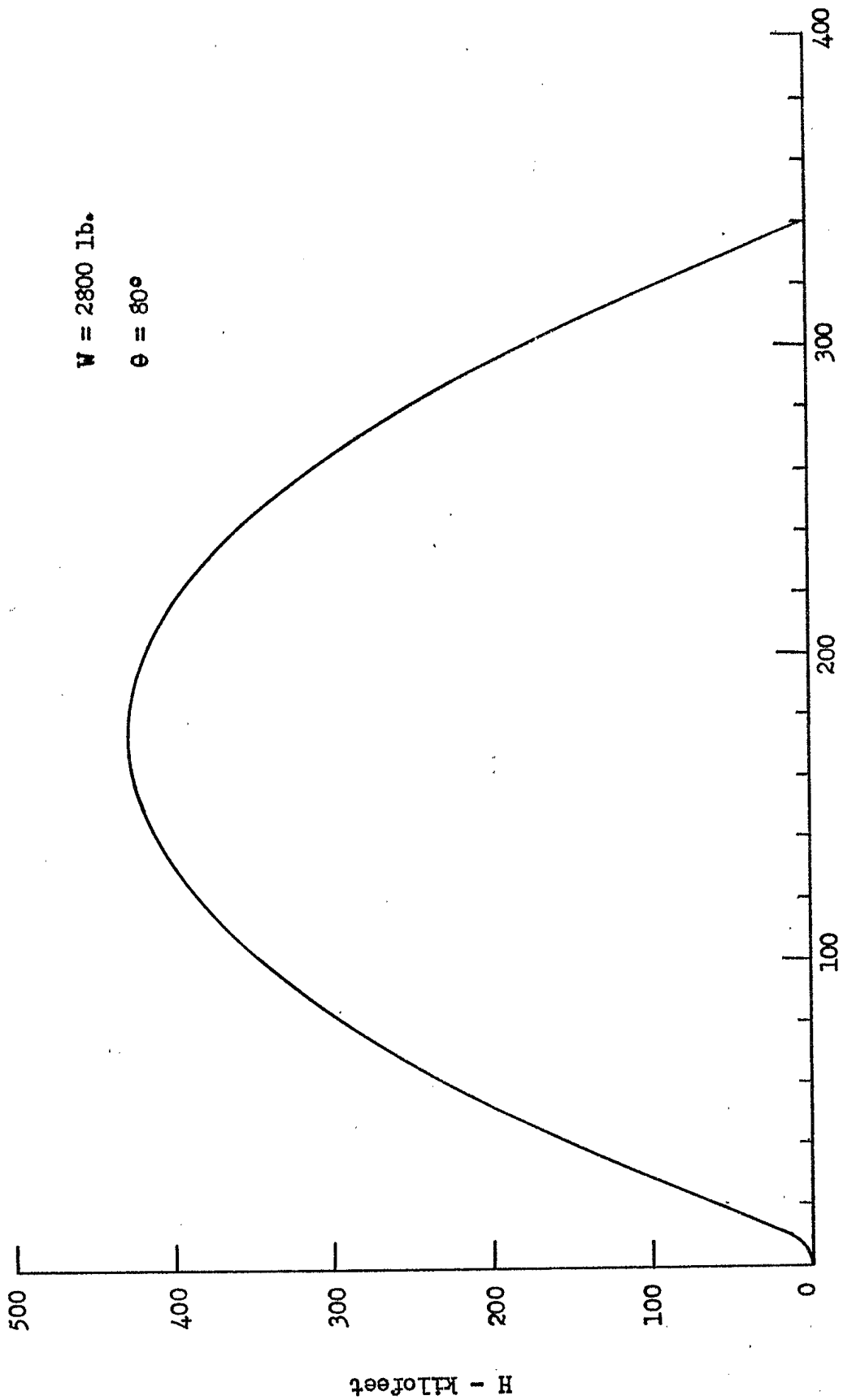
$\theta = 80^\circ$



t - sec.

Acceleration, velocity and altitude versus time

FIGURE 4

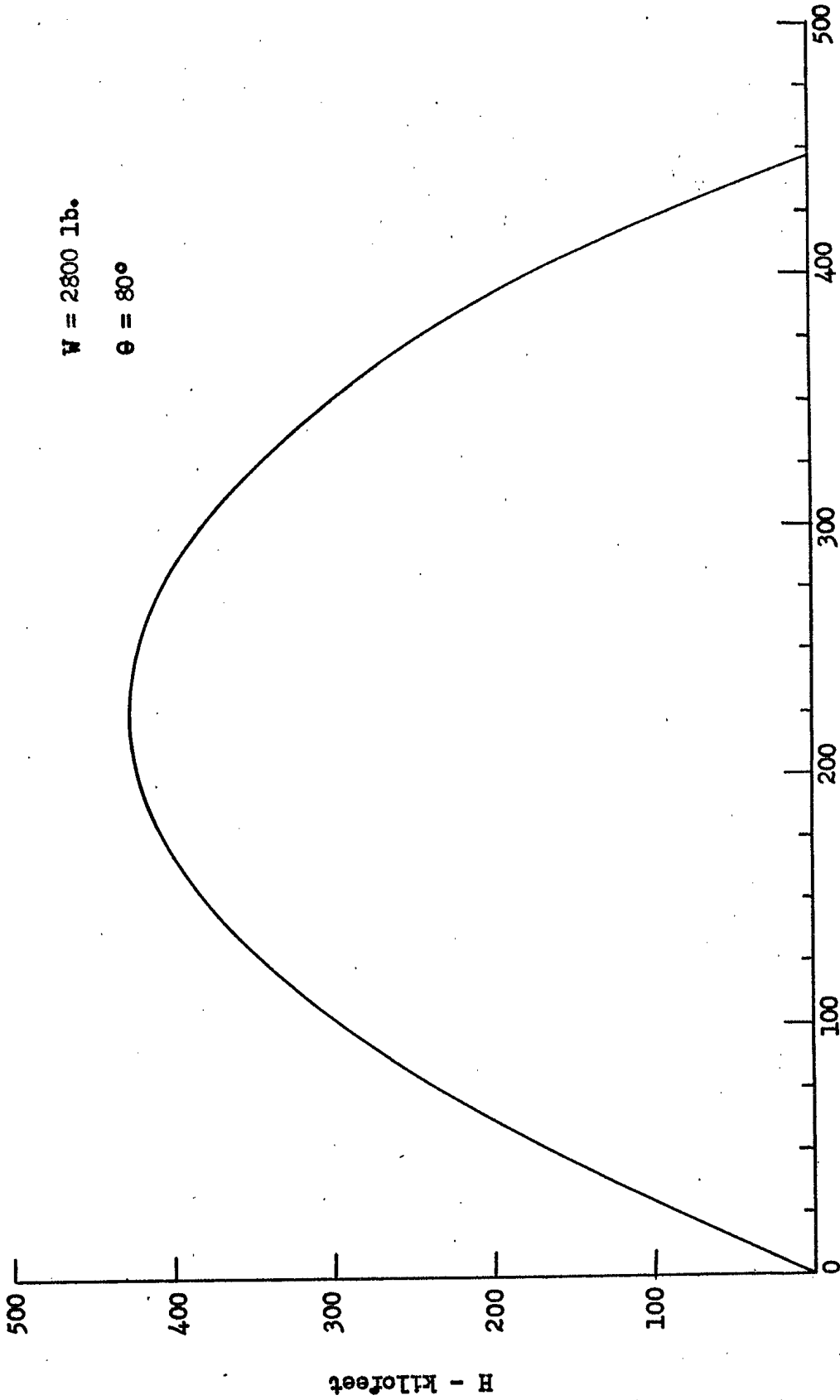


Altitude versus total flight time

FIGURE 5

$W = 2800 \text{ lb.}$

$\theta = 80^\circ$



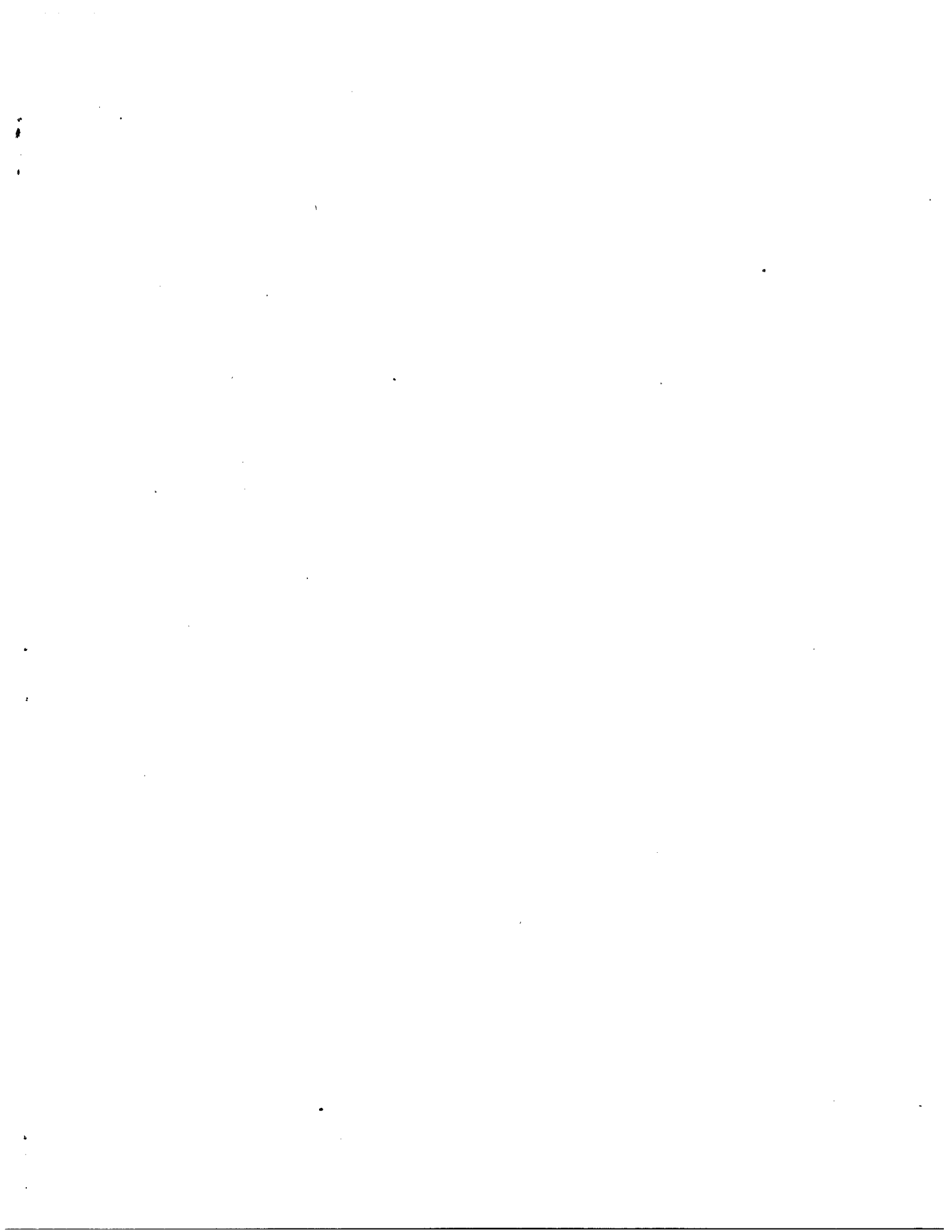
R - kilofeet

Trajectory

FIGURE 6







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