

Facts About Saturn V

October 26, 2016

The Saturn V is the biggest rocket ever built. Its start weight was 3 000 000kg. It was able to bring 118 000kg into LEO (Low Earth Orbit) and 45 000kg into a TLI (Trans Lunar Injection) trajectory.

1. First stage burns RP-1 (Kerosene) and LOX (Liquid Oxygen). It burns for 165 seconds. Its exhaust velocity is 2580 m.s^{-1} . Mass of the fuel burnt is 2 169 000kg, empty mass is 131 000kg.

Speed of sound was reached after slightly more than one minute at altitude between 3-4 nautical miles. (4700-7200m)

Upon completion, the rocket was at an altitude of 68km (93km downrange) and had a speed of 2500 m.s^{-1} .

2. Second stage burns LH2 (Liquid Hydrogen) and LOX (Liquid Oxygen) It burns for 360 seconds. The exhaust velocity is 4130 m.s^{-1} .

Mass of the fuel burnt in the second stage is 444 000kg. Empty mass is 36 000kg.

Upon completion, the rocket was at an altitude of 175km and at a speed of 7000 m.s^{-1} .

3. Third stages burns LH2/LOX. It burns for 165 seconds to LEO. (at 192 km) Its exhaust velocity is 4130 m.s^{-1} . Mass of the fuel is 110 800kg. Empty mass is 10 000kg.

After 2-3 orbits, it burns another 335 seconds for TLI. (Speed $10\,700 \text{ m.s}^{-1}$)

Wikipedia states a thrust $34 \cdot 10^6 N$ for the first stage, a thrust of $4.4 \cdot 10^6 N$ for the second stage, and $1 \cdot 10^6 N$ for the third stage. Do these numbers make sense?

Using the Ciólkowski equation, compute the ΔV for the three stages (the third can be separated into LEO insertion and TLI.) Do these numbers make sense?

T (m:s)	alt (m)	speed ($m.s^{-1}$)	remarks
-0:08			(starting ignition)
0:00	0	0	
0:05	31.7	11.8	
0:10	114	27.7	
0:15	273	38.8	‘we got the(a?) roll programm (ed?)’
0:20	510	56	
0:25	801	73.6	
0:30	1024	96.2	
0:35	1720	119	‘roll is complete and the pitch is programmed’
0:40	2330	145	
0:43			‘one bravo’
0:45	3020	172	
0:50	3870	202	
0:55	4790	234	
1:00	5940	271	(one mile) ‘Apollo 11, Houston, you are good at one minute’
1:10	8500	364	(downrange distance 1 mile, 1850m)
1:20	11800	495	
1:30	15600	650	
1:40	20200	837	(8 miles downrange, 15 000m)
1:50	25300	1055	
1:57			‘marked!, mode one charlie’
2:00	31200	1310	
2:10	37800	1605	
2:15			(inboard cut off)
2:20	45500	1959	
2:30	54500	2337	(downrange 35 miles, 65 000m)
2:40	65200	2716	(stage 1 shutdown and separation)
2:50	74400	2782	
3:00	84000	2830	(downrange 70 miles, 130 000m)
3:08	91200	2871	

I do not know if the downrange numbers are in statute or nautical miles. I think they are so inaccurate that it doesn’t matter anyway.

Source:

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http://www.youtube.com/watch?v=zGNrYrsT70I&list=PLC12012F54F0D9B83
http://www.youtube.com/watch?v=F0Yd-GxJ_QM
// The flight data come from this last video. For some reason,
// it has been taken off youtube.

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