



On December 14, 1972 at 10:54:37 p.m. GMT, Astronauts Eugene Cernan and Harrison Schmidt blasted off from the lunar surface in the Lunar Module (LM). The launch was recorded by a camera left behind at the landing site in the Taurus-Litrow region. A sequence of images from this recording is shown to the left.

The sequence of images runs from the top to the bottom. The top image was taken at 10:54:37.00 p.m. and the bottom image was taken at 4.9 seconds later at 10:54:41.87 p.m. The width of the LM is 4.3 meters. See the YouTube video of the LM launch at <http://www.youtube.com/watch?v=iziumckIDbM&feature=related>

Table of LM Heights and Times

Image	Time (seconds)	Height (meters)	Speed (m/s)
1	0	0	
2	1.8	2	
3	2.3	6	
4	2.9	10	
5	3.2	15	
6	3.7	18	
7	4.9	21	

Problem 1 - What is the average speed of the LM during the 4.9 seconds covered by this image sequence?

Problem 2 - What are the average speeds of the LM between Image 1 and A) Image 2? B) Image 3? C) Image 4? D) Image 5? E) Image 6? F) Image 7? Enter these speeds in the above table.

Problem 1 - What is the average speed of the LM during the 4.9 seconds covered by this image sequence?

Answer: The distance traveled was 21.0 meters, which took 4.9 seconds, so the average speed was $S = 21.0 \text{ m}/4.9\text{s}$ so **S = +4.3 meters/sec.**

Problem 2 - What are the average speeds of the LM between Image 1 and A) Image 2? B) Image 3? C) Image 4? D) Image 5? E) Image 6? F) Image 7? Enter these speeds in the table.

Answer: A) distance traveled = 2 meters, time = 1.8 seconds, so speed = $2/1.8 = 1.1$ **meters/sec.**

B) distance traveled = 6 meters, time = 2.3 seconds, so speed = $6/2.3 = 2.6$ **meters/sec.**

C) distance traveled = 10 meters, time = 2.9 seconds, so speed = $10 / 2.9 \text{ s} = 3.4$ **meters/sec.**

D) distance traveled = 15.0 meters, time = 3.2 seconds, so speed = $15\text{m} / 3.2\text{s} = 4.7$ **meters/sec.**

E) distance traveled = 18.0 meters, time = 3.7 seconds, so speed = $18.0 \text{ m} / 3.7 \text{ s} = 4.9$ **meters/sec.**

F) distance traveled = 21.0 meters, time = 4.9 seconds, so speed = $21 \text{ m} / 4.9 \text{ s} = 4.3$ **meters/sec.**

Table of LM Heights and Times

Image	Time (seconds)	Height (meters)	Speed (m/s)
1	0	0	
2	1.8	2	1.1
3	2.3	6	2.6
4	2.9	10	3.4
5	3.2	15	4.7
6	3.7	18	4.9
7	4.9	21	4.3

Note: These speeds are approximate due to the quality of the video images, which had no time stamps to verify when the individual frames were taken. The times and heights were estimated from an approximate analysis of the video sequence.