This sequence of stills was obtained from a YouTube.com video of the launch of MSL by United Space Alliance available at

http://www.youtube.com/watch?v=0cxsvVBemHY

This sequence shows the launch of the MSL mission from the Kennedy Space Center Launch Complex 49 on November 27, 2011 at 10:02 EST. The four images were taken, from bottom to top, at times 10:02:48 EST, 10:02:50 EST, 10:02:51 EST and 10:02:52 EST. At the distance of the launch pad, the width of each image is 400 meters.

Problem 1 - With the help of a millimeter ruler, what is the scale of each image in meters/mm?

Problem 2 - For each image, what is the distance between the bottom of the image and the base of the rocket nozzle for the Atlas V rocket in each scene?

Problem 3 – What is the estimated distance from the base of the launch pad to the rocket nozzle in each image?

Problem 4 – From the time information, what is the average speed of the rocket between A) Image 1 and 2? B) Image 2 and 3? C) Image 3 and 4?

Problem 5 – From the speed information in Problem 4, what is the average acceleration between A) Image 1 and Image 3? B) Image 2 and Image 4?

Problem 6 – Graph the height of the rocket versus the time in seconds since launch.

Problem 7 – Graph the speed of the rocket versus time in seconds after launch. For the time, use the midpoint time for each speed interval.

Problem 8 – Graph the acceleration of the rocket versus time in seconds after launch. For the time, use the midpoint time for each acceleration interval.

Problem 1 - Answer: Width = 69 mm, so scale = 400 m/69 mm = **5.8 meters/mm**

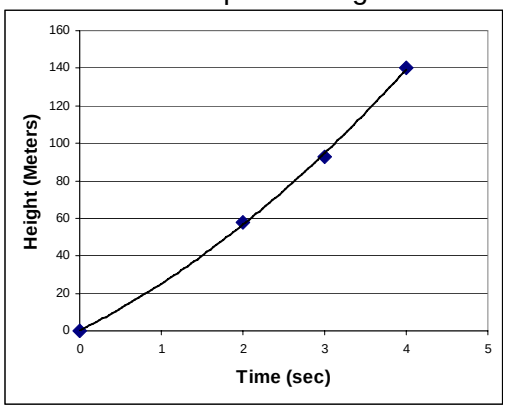
Problem 2 - Answer: 8mm, 18mm, 24mm and 32mm so using the scale of the image, the actual distances are **46m, 104m, 139m and 186 meters**.

Problem 3 – Answer: Take the differences in the measurements relative to the first image at the moment of launch to get h1 = 46m-46m = **0m**, h2=104m-46m = **58m**, h3=139m-46m = **93 m** and h4 =186m-46m = **140 m**.

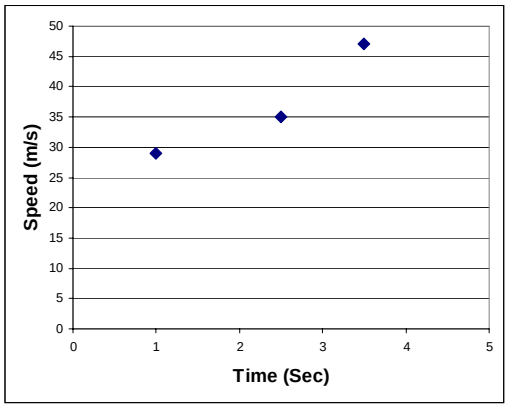
Problem 4 – Answer: A) v= distance/time, v1 = (58m-0m)/2sec = **29m/sec** B) v2 =(93m-58m)/1sec = **35 m/sec**, C) v3=(140m-93m)/1sec = **47 m/sec**.

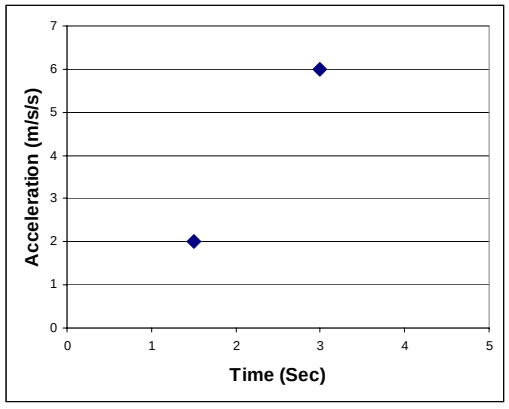
Problem 5 – Answer: A) a1 = (v2-v1)/3sec = (35-29)/3 = 6/3 = **2 m/sec^2**. B) a2 = (V3-v2)/2sec = (47-35)/2sec = **6 m/sec^2**.

Problem 6 – Graph the height of the rocket versus the time in seconds since launch.



Problem 7 – Graph the speed of the rocket versus time in seconds after launch. For the time, value, use the midpoint time for each speed interval. Answer: Left Above. For the first speed, the two height measurements are made at T=0 and T=2, so the speed V1 will be plotted at the midpoint time: T=(2-0)/2 = 1 sec





Problem 8 – Graph the acceleration of the rocket versus time in seconds after launch. For the time value, use the midpoint time for each acceleration interval. Answer: Right Above.