

Mars Exploration Script

By Michael Hardegree-Ullman 8/14/15

Revised: 8/12/16

Script	Bulletpoints	Sphere	Flatscreens/ Notes
<p>Mars has been known as a planet for thousands of years. The first records come from the Egyptians 3000 years before the invention of the telescope, and it was later observed by the Greeks, Chinese, and the Romans who named it after their god of war. By observing Mars in the night sky over many years they could predict when it would reappear each year. Despite careful observations, there is only so much you can learn with your eyes.</p>	<ul style="list-style-type: none"> • Pre-telescope • Seen by the Egyptians, Greeks, Chinese and Romans • Romans named after their god of war • They could predict where Mars would be in the sky 	<p>Mars color map</p>	
<p>The invention of the telescope in 1608 was a giant leap forward for astronomy. It wasn't until 50 years later that the first real drawings of Mars were created by Christiaan Huygens, a Dutch mathematician and scientist.</p>	<ul style="list-style-type: none"> • Telescope invented – 1608 • First Drawings 50 years after telescope by Christiaan Huygens in 1659 	<p>Huygens map</p>	<p>Huygens-Mars comparison</p>
<p>It was another 200 years before the first global map of the planet was made. Clouds on the planet made it impossible to tell what was permanent, until two men, Beer and Madler, decided to make the first complete map.</p>	<ul style="list-style-type: none"> • Beer and Madler Map- 1840s • First complete map • Clouds made making a map difficult 	<p>Beer and Madler Map</p>	
<p>Over the years better maps were made, but there was no real progress until the Martian opposition of 1877. Mars and Earth are in opposition when Earth is directly between Mars and the Sun. This occurs near the</p>	<ul style="list-style-type: none"> • Opposition-1877 • Opposition is when Mars is closest to Earth • Every 2 years and 2 months 	<p>Opposition Image</p>	

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time of closest approach between the two planets. Martian oppositions occur about every 2 years and 2 months.			
Asaph Hall, an astronomer from Connecticut, took this opportunity to search for Martian moons. Most people looked for moons very far away from Mars because our moon is relatively far away from the Earth. Hall decided to look 40 times closer to the planet which led to his discovery of both of Mars' tiny moons, Phobos and Deimos. Phobos, the larger moon, is so small it could fit inside of Denver.	<ul style="list-style-type: none"> • Moons-1877 • Asaph Hall looked 40 times closer to Mars • Saw Phobos and Deimos • Phobos could fit in Denver 	Moons image	
1877 is also when one of the largest controversies in astronomy began and would not be settled until the Mariner missions of the 1960s. During the opposition of 1877, Giovanni Schiaparelli, an Italian astronomer, was the first to see a series of linear features he described as "canals" on the planet. As time went on more and more people saw these elusive lines. Astronomers would debate what these surface features were for almost a century with no definitive answer.	<ul style="list-style-type: none"> • Canals-1877 • Giovanni Schiaparelli first to see them • More and More astronomers saw them after Schiaparelli • Highly Debated for almost a century 	Canals map	Schiaparelli Map
It would be almost 80 years before more was learned about Mars. Rocketry was still unheard of, and ground based telescopes were not big enough to resolve surface features on the red planet. World War 2 led to massive advancements in technology and rocket design. These early rockets, originally developed as	<ul style="list-style-type: none"> • Rockets-1877-1957 • Ground based telescopes had reached their limit • The next step was rockets • WW2 missiles helped with rocket development 		

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missiles, helped build the foundation for getting satellites to space and later to Mars.			
<p>With the launch of the first artificial satellite in 1957 by the Soviet Union, we finally escaped our atmosphere and could start working on going further. There were numerous failed attempts to reach Mars by spacecraft before the first successful flyby in 1964 by the American mission Mariner 4. The 22 photographs sent back to Earth gave us more insight on Mars than the previous 350 years of telescopic observations had done. While many astronomers expected to see canals, and a small minority even thought there would be little aliens waving at us, only a few had predicted what we saw, craters. All 22 pictures showed a surface that was heavily cratered and led some to erroneously believe Mars had a moon like surface.</p>	<ul style="list-style-type: none"> • Mariner 4-1965 • Mariner 3 failed • First successful mission to Mars • 22 images • 22 images of Earth would be useless • Craters were seen which was unexpected • No canals • They thought Mars looked like the moon after Mariners 4,6, and 7 	Mariner 4 image	22 pictures image
The next two missions, Mariners 6 and 7 photographed about 20 percent of the surface in 1969, but these too only showed craters.	<ul style="list-style-type: none"> • Mariners 6/7-1969 • Also saw only craters and only flyby missions 	Mariner 7 map	
The next Martian opposition was in 1971 and NASA was making use of it by sending the first Martian orbiters, Mariners 8 and 9. Mariner 8 was launched first and failed to reach orbit. But Mariner 9 launched later that year was a monumental success when it	<ul style="list-style-type: none"> • Mariner 9-1971 • Mariner 8 failed • First orbiter • Mars was not moonlike • Olympus Mons-largest volcano in the solar system, Valles Marineris - as long as 	Mariner 9 map	<p>Mariner 9 image</p> <p><i>There are 2 layers which</i></p>

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<p>became the first spacecraft to orbit another planet. It was the first spacecraft to see Olympus Mons, the largest volcano in the Solar System, and Valles Marineris, a canyon as long as the United States from coast to coast, and 4 times deeper than the Grand Canyon in Northern Arizona. The Soviet missions Mars 2 and 3 also arrived that year and accomplished the first crash landing and first soft landing onto Mars.</p>	<p>the united states from coast to coast</p> <ul style="list-style-type: none"> • Saw most of Mars • Two Soviet missions achieved first crash and first soft landing on Mars 		<p><i>can be zoomed in on to see Olympus Mons and Valles Marineris</i></p>
<p>Despite the success of the Mariner orbiter program, many Mars scientists wanted a lander to learn about the surface. The Viking program consisted of two missions, they both had an lander to study the surface, and an orbiter to study the global images and provide a relay for the lander to communicate with Earth. They were launched a few weeks apart in 1975. After arriving at Mars, Viking showed us that there used to be liquid water on the planet, however it found no evidence of life. It would be over 20 years before another spacecraft successfully went to Mars.</p>	<ul style="list-style-type: none"> • Vikings 1 and 2-1976 • First successful landers • Found evidence of past water • Nothing successful for 20+ years after Viking 	<p>Mars Color Map</p>	<p>First image from the Martian surface from Viking Lander 1 (20 July 1976)</p>
<p>Missions to Mars resumed in the late 1990s. In 1997 the Mars Pathfinder mission was launched. It included a landing package with the first small rover, Sojourner; about the size of a microwave oven. The next two important rovers were the Mars Exploration Rovers Spirit and Opportunity. They were the first large rovers to land on Mars. You might have seen our life-size model in front of Space Odyssey. Most recently in</p>	<ul style="list-style-type: none"> • Rovers-1997, 2004, 2012 • Pathfinder/Sojourner-included first rover, size of microwave oven • Spirit and Opportunity-size of golf cart • Curiosity--Size of a small car • Helped us learn about rock and soil composition, the past and present habitability 	<p>Various Rover images</p>	

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<p>2011, the Mars Curiosity Rover, about the size of a small car, was launched. These rovers have helped us learn about rock and soil composition, the past and present habitability of Mars, and many other important scientific aspects of Mars.</p>	<p>of Mars</p>		
<p>Over the course of the last 2 decades there have also been numerous orbiters sent by many different countries. These include the Mars Global Surveyor, Mars Odyssey, Mars Express, MAVEN, and the Mars Orbiter.</p>	<ul style="list-style-type: none"> • Orbiters • Mars Express, MAVEN, and India's Mars Orbiter. 		
<p>One of the most productive spacecraft to have been sent to the red planet is the Mars Reconnaissance Orbiter or MRO. Launched in 2005, it was designed to characterize the climate and geology of the planet. MRO makes one polar orbit every 90 minutes. During this time the MARS Color Imager, or MARCI, takes a picture of the strip of the Martian surface directly beneath the spacecraft. Over the course of the day, as Mars also rotates on its axis, MRO continues to take pictures until it has imaged the entire planet. MARCI takes pictures at 7 different wavelengths of light. After overlapping images are taken of one patch of Mars, stacking pictures from 3 different color filters can produce a full color image.</p>	<ul style="list-style-type: none"> • MRO, MARCI/HiRISE/CTX-2005 to present • Polar orbit every 90 minutes • Mars color imager- MARCI - takes images in 7 wavelengths • Red, Green, and Blue wavelengths are put together to form a color image 	<p>Strip map RGB map</p>	

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<p>MARCI is not the only camera on MRO. There are also cameras meant to take much higher resolution images over a small area. The ConTeXt camera, or CTX, images a much smaller area. Its main purpose is to provide context of the area for all the instruments on MRO and the much higher resolution HiRISE (High Resolution Imaging Science Experiment) camera. The HiRISE camera is able to resolve objects about the size of a car from orbit. These have helped us map the surface of Mars in more detail than ever before.</p>	<ul style="list-style-type: none"> • Higher resolution, Context and HiRISE cameras • HiRISE can make out your car from orbit 	<p>Mars color map</p>	
<p>These full Mars maps have helped us learn about global weather patterns and climate, and help us explain changes on the Martian surface. (Layers) When observed in August 2009 the area looked like just another dark spot on the Martian surface. However, shortly after this picture was taken there was a malfunction in the spacecraft. Some scientists feared the mission was over, but fortunately the problem was fixed after a 4 month shutdown. When the spacecraft re-imaged the dark spot, it had disappeared. The most likely explanation is that a dust storm occurred on Mars during the shutdown and covered the region with a layer of bright dust. This is just one of the many scientific curiosities found with</p>	<ul style="list-style-type: none"> • Disappearing spot was most likely caused by a dust storm • Propontis is roughly the size of Colorado <p>Purpose of MRO</p>	<p>Mars year 29</p>	<p>Propontis scale</p> <p><i>There is one layer that needs to be turned on to show the disappearing spot</i></p>

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MRO.			
<p>I have focused on a subset of recent American led missions to Mars, but over the next 20 years more ambitious missions are planned, including a manned mission. These include the ExoMars program from the European Space Agency, NASA's Insight mission in 2016, and a rover in 2020. NASA is also working on the Orion Spacecraft which is the next generation of manned spacecraft that will hopefully take us to Mars in the 2030s.</p>	<ul style="list-style-type: none"> • Planned Missions-Future • European Space Agency-Exomars-2016,2020 • InSight-2018 • Mars 2020 Rover-2020 • Orion-now until 2039 	<p>Planned Missions Image</p>	<p>Orion Image</p>
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