

AEROSPACE MICRO-LESSON

Easily digestible Aerospace Principles revealed for K-12 Students and Educators. These lessons will be sent on a bi-weekly basis and allow grade-level focused learning. - AIAA STEM K-12 Committee.

THE MARINER PROJECT

Started less than five years after the first launch of rockets into orbit, the Project Mariner was the United States' first attempt to send a spacecraft to another planet. Between 1962 and 1975, Project Mariner involved the launch of ten unmanned spacecraft, seven of them successfully, to the other inner planets of the Solar System. You can find an overview of the project at [NASA's Science web site](#).

GRADES K-2

Astronomy has always been about looking at things from a distance. For centuries and longer, stars and planets were simply points of light in the sky, most of them stationary and a few of them moving. (In fact, the word "planet" is derived from the Greek word "planetes," which means "wanderer.") The invention of the telescope changed the view of planets from wandering points of light to bodies that move around the Sun, but even the best telescopes could not distinguish features smaller than a mile across on the moon and several tens of miles across on even the closest planets.

The space program changed this. By sending spacecraft to visit the moon and the planets, scientists were able to view these bodies from comparatively close up and see them in much greater detail. This revolutionized solar system astronomy and gave birth to a new science, "planetary science." Planetary science joins the fields of astronomy, geology, meteorology, and others together into a unified study of the planets.

You can illustrate the advantage that spacecraft missions to the planets gave to astronomy by taking the students outside to some place like a playground or an athletic field. Have them look at something on the other side of the playground or field and describe what they see. (It may be a fence, a building, or a piece of playground equipment, for example.) If you think the students are up to it, you can bring some inexpensive binoculars and ask them what additional details they can see in the thing that they are looking at. Finally, go over to the thing in question and take a close look at it. Up close, you can see the individual bricks or boards in the wall of a building; the individual components in a fence; the individual marks on a piece of equipment. You can see much, much more when you are up close. The Mariner missions gave us this sort of look at the inner planets of the Solar System.

GRADES K-2 (CONTINUED)

Viewing with eyes
(people have been
doing this from the
beginning of time)

Viewing with
spacecraft (first fly-by
of Venus by Mariner 2
in December 1962)



Viewing with
telescopes
(Lippershey applies
for telescope patent
1608)

GRADES 3-5

When NASA sets out to explore another planet, it uses several different types of space mission. Each type is more complicated than the previous one. The first type of mission to another planet (or other Solar System body) is a fly-by mission, in which the spacecraft flies past and then goes on its way. As it flies by, the spacecraft takes photographs and other data which it transmits by radio back to Earth. The disadvantage of a fly-by mission is that the spacecraft can only take detailed data for a few days or even hours. The [New Horizons](#) mission to Pluto is a fly-by mission.

The second type of mission to another planet is the orbiter. An orbiting spacecraft flies from the earth to the other planet and then goes into orbit around the other planet, staying there and transmitting data back to earth for years. The [Galileo](#) mission to Jupiter and the [Cassini](#) mission to Saturn were orbiters.

The third type of mission to another planet—specifically one with a solid surface—is the lander. A lander mission touches down on the surface of the planet and transmits data back to Earth from the surface. It usually includes some way to sample the soil and rocks at its landing site. The [Viking](#) missions to Mars were landers.

GRADES 3-5 (CONTINUED)

The fourth type of mission is the rover. This is a spacecraft that lands on the surface of another planet and can move around, searching for interesting things to look at and sample. At this point, it is not clear whether the spacecraft is studying astronomy or is studying geology. The [Spirit](#), [Opportunity](#), and [Curiosity](#) missions to Mars are rovers.

Other types of mission are also possible. There are ideas for sending balloons to float around in the atmospheres of Jupiter and Saturn and of buoys to float in the lakes and seas of Saturn's moon Titan. But these have not been built yet.

Because the Mariner project was the very first time NASA had tried to send spacecraft to other planets, most of the missions were fly-by missions. One of them, Mariner 9, went into orbit around Mars and sent back a wealth of data.

GRADES 6-8

Project Mariner made many historical “firsts” in the space program. Here are the most significant ones:

- Mariner 2 was the first successful mission to another planet
- Mariner 2 was the first spacecraft to visit another planet, Venus
- Mariner 4 was the first spacecraft to visit the planet Mars
- Mariner 9 was the first spacecraft to go into orbit around another planet
- Mariner 10 was the first spacecraft to fly past one planet (Venus) and on to another planet (Mercury)
- Mariner 10 was the first spacecraft to visit the planet Mercury

You can find more information at

<http://science.nasa.gov/missions/mariner-missions/>

<http://history.nasa.gov/mariner.html>

GRADES 6-8 (CONTINUED)

Other nations have also sent spacecraft to Venus. The [Soviets had quite an active program](#) and the Japanese have sent a spacecraft there recently.

GRADES 9-12

Mariner 2 was the first spacecraft to visit another planet. To give some idea of the risks involved in the program, here is what happened to the twenty-eight previous attempts to reach beyond Earth orbit:

- 6 of them exploded less than two minutes after liftoff
- 2 of them were destroyed by ground control after veering off course shortly after launch
- 9 of them failed to reach escape velocity and fell back to earth
- 3 of them were placed in low Earth “parking” orbits from which they never progressed
- 2 of them fell silent before reaching their target
- 3 of them (Luna 1, Pioneer 4, and Ranger 3, all launched toward the moon) missed their target entirely
- 3 of them (Luna 2, a lunar impact mission; Luna 3, a lunar flyby; and Pioneer 5, sent toward interplanetary space) succeeded

[NASA has compiled an excellent chronology which lists all of these missions and gives details about them.](#)

Mariner 1 was destroyed by ground control after veering off course. The problem was traced to a trifling error in the software that controlled the guidance system; the problem has been listed variously as a missing comma or a missing hyphen (minus sign) in the program itself or a missing overbar (meaning average value) in an equation that was used in writing the program. [There is a short slide essay at “IT World” listing some software bugs that doomed space missions.](#) The list is not exhaustive.

GRADES 9-12 (CONTINUED)

Even when the basic problems had been solved, other problems continued to crop up. For example, the Soviet Venera 14 mission, which landed on Venus, included a camera and a soil sampler. Unfortunately the camera's lens cover landed in the exact spot that the soil sampler touched down, causing the sampler to sample the lens cover instead of the planetary surface. This proved, incidentally, that Murphy's Law holds on other planets.

Sixty Years Ago in the Space Race:

July 17, 1956: [The American all-solid-fuel three-stage X-17 sounding rocket had its first operational test flight.](#)

A "[rockoon](#)" is a rocket that is carried aloft on a helium balloon before firing. During the latter half of July 1956, the United States launched ten rockoons from a ship in the Pacific Ocean.