131)

Luna 20

Nation: USSR (81)
Objective(s): lunar sample return
Spacecraft: Ye-8-5 (no.408)
Spacecraft Mass: c. 5,750 kg
Mission Design and Management: GSMZ Lavochkin
Launch Vehicle: 8K82K + Blok D (Proton-K no. 258-01)
Launch Date and Time: 14 February 1972 / 03:27:59 UT
Launch Site: NIIP-5 / launch site 81P
Scientific Instruments:

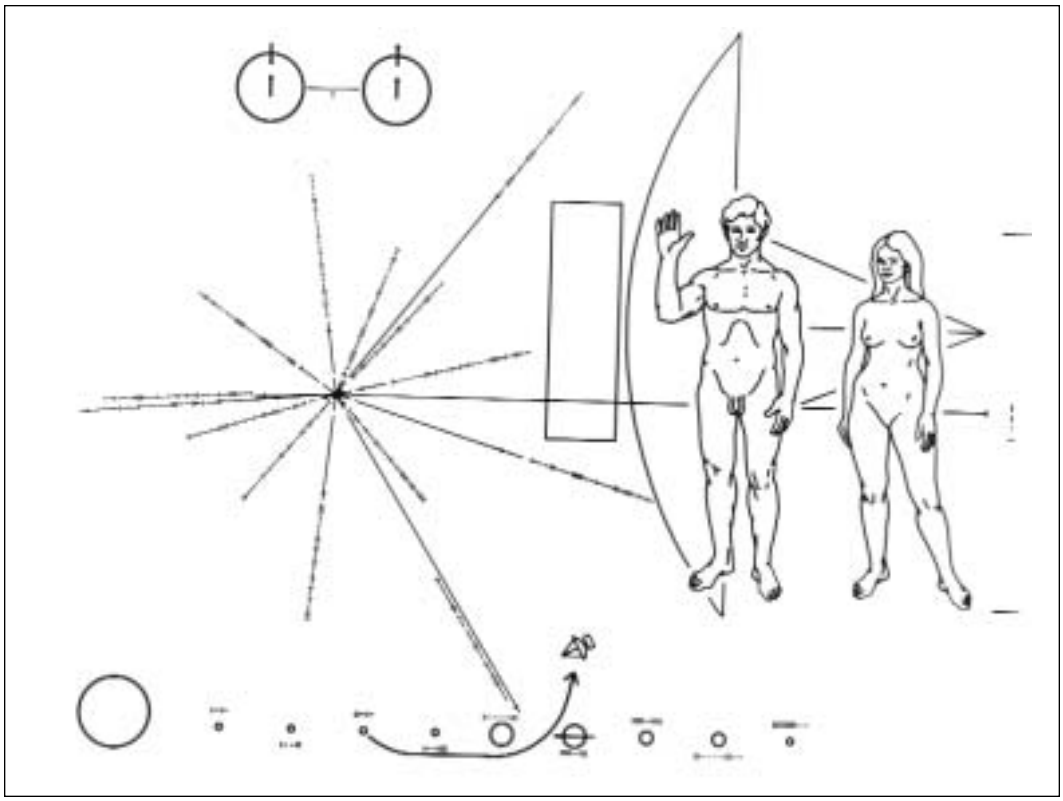
1) stereo imaging system
2) remote arm for sample collection
3) radiation detector
4) radio altimeter

Results: This was the eighth Soviet spacecraft launched to return lunar soil to Earth. It was evidently sent to complete the mission that Luna 18 had failed to accomplish. After a 4.5-day flight to the Moon, which included a single midcourse correction on 15 February, Luna 20 entered orbit around the Moon on 18 February. Initial orbital parameters were 100 x 100 kilometers at 65° inclination. Three days later, at 19:13 UT, the spacecraft fired its main engine for 267 seconds to begin descent to the lunar surface. A second firing further reduced velocity before Luna 20 set down safely on the Moon at 19:19 UT on 21 February 1972 at coordinates 3°32' north latitude and 56°33' east longitude, only 1.8 kilometers from the crash site of Luna 18. After collecting a small sample of lunar soil, the spacecraft's ascent stage lifted off at 22:58 UT on 22 February and quickly accelerated to 2.7 kilometers per second velocity—sufficient to return to Earth. The small spherical capsule eventually parachuted down safely on an island in the Karkingir River, 40 kilometers north of the town of Dzhezkazgan in Kazakhstan, at 19:19 UT on 25 February 1972. The 55-gram soil sample differed from that collected by Luna 16 in that the majority (50 to 60 percent) of the rock particles in the newer sample were ancient anorthosite (which consists largely of feldspar) rather than the basalt of the earlier one (which contained about 1 to 2 percent of anorthosite). Like the Luna 16 soil, samples of the Luna 20 collection were shared with American and French scientists.

132)

Pioneer 10

Nation: U.S. (51)
Objective(s): Jupiter flyby
Spacecraft: Pioneer-F
Spacecraft Mass: 258 kg
Mission Design and Management: NASA ARC
Launch Vehicle: Atlas-Centaur (AC-27 / Atlas 3C no. 5007C / Centaur D-1A)

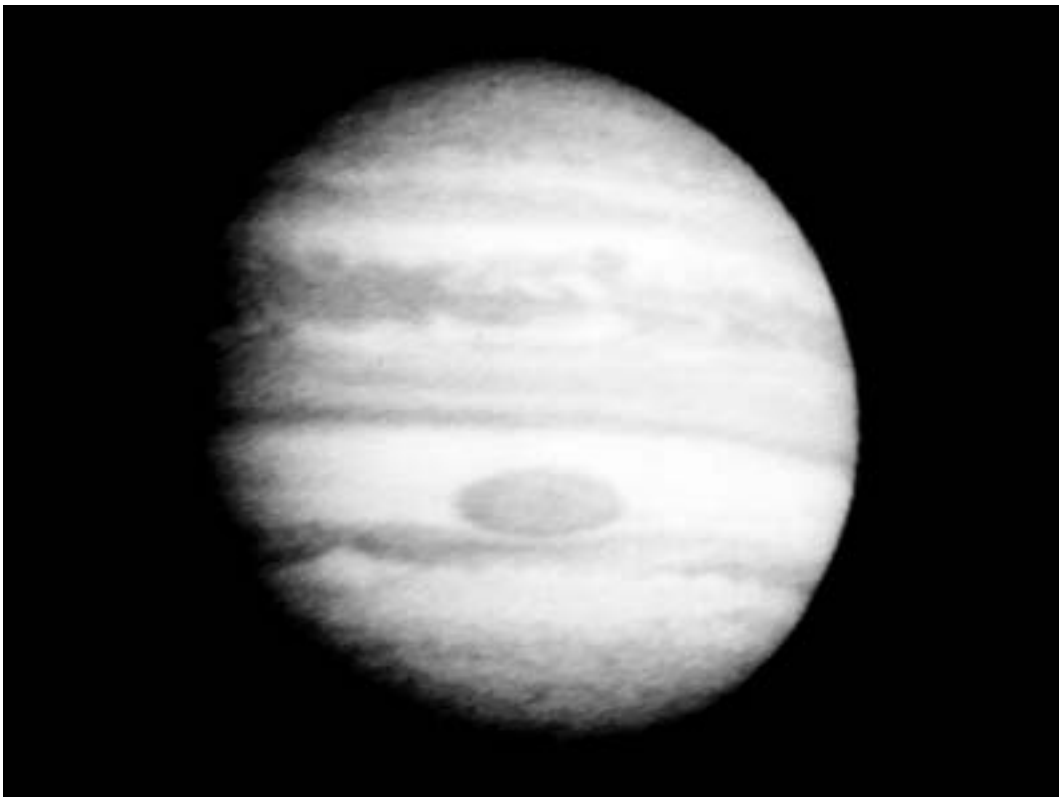


The Pioneer 10 and 11 spacecraft, which were the first humanmade objects to escape from the solar system into interstellar space, carried this pictorial plaque. It was designed to show scientifically educated inhabitants of other star systems, who might intercept it millions of years from now, when Pioneer was launched, from where, and by what kind of beings (with the hope that those who found the craft would not invade Earth). The design is etched into a 6-inch by 9-inch gold-anodized aluminum plate attached to the spacecraft's antenna support struts in a position to help shield it from erosion by interstellar dust. The radiating lines at left represents the positions of 14 pulsars, a cosmic source of radio energy, arranged to indicate our sun as the home star of our civilization. The "1-" symbols at the ends of the lines are binary numbers that represent the frequencies of these pulsars at the time of launch of Pioneers 10 and 11 relative of that to the hydrogen atom shown at the upper left with a "1" unity symbol. The hydrogen atom is thus used as a "universal clock," and the regular decrease in the frequencies of the pulsars will enable another civilization to determine the time that has elapsed since Pioneer was launched. Across the bottom are the planets, ranging outward from the Sun, with the spacecraft trajectory arching away from Earth, passing Mars, and swinging by Jupiter.

Launch Date and Time: 2 March 1972 / 01:49:04 UT
Launch Site: ETR / launch complex 36A
Scientific Instruments:

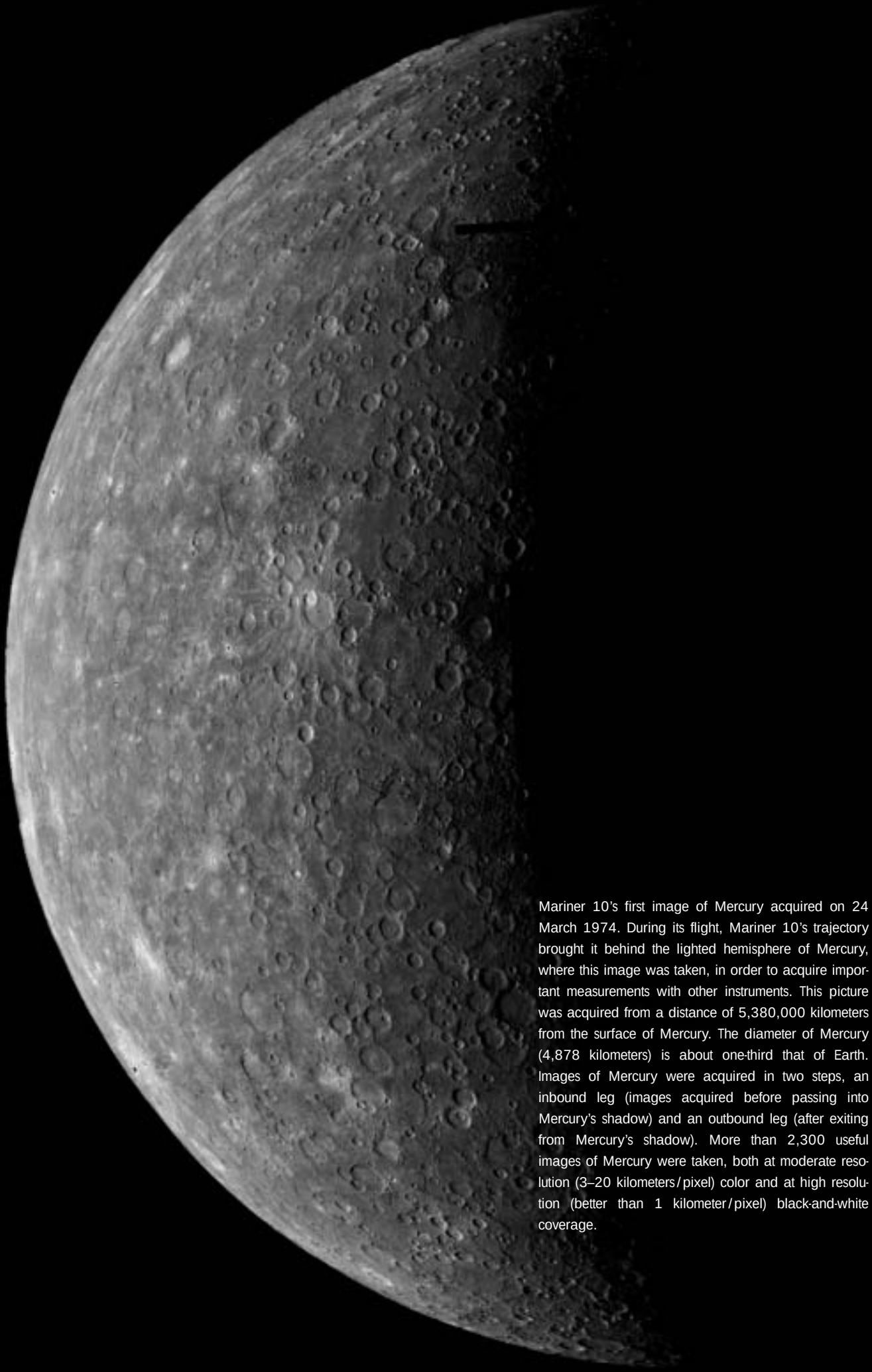
1) imaging photopolarimeter
2) magnetometer
3) infrared radiometer
4) plasma analyzer
5) ultraviolet photometer
6) charged-particle composition instrument
7) cosmic-ray telescope
8) Geiger tube telescopes
9) asteroid/meteoroid detector
10) Jovian trapped-radiation detector
11) meteoroid detector

Results: Pioneer 10, the first NASA mission to the outer planets, garnered a series of firsts perhaps unmatched by any other robotic spacecraft in the space era: the first vehicle placed on a trajectory to escape the solar system into interstellar space; the first spacecraft to fly beyond Mars; the first to fly through the asteroid belt; the first to fly past Jupiter; the first to use all-nuclear electrical power; and the first humanmade object to leave this solar system. After launch by a three-stage version of the Atlas-Centaur (with



This view of Jupiter shows the giant planet's cloud tops taken by the Pioneer 10 spacecraft as it flew past Jupiter in December 1973. This view was taken from 2,695,000 kilometers away. It shows the 40,200-kilometer-long Great Red Spot, which is large enough to swallow up several Earths. Individual cloud formations are visible in some detail. The bright zones appear to become split up into the detailed flow patterns of Jupiter's atmosphere and clouds. The area surrounding the Spot in the bright South Tropical Zone suggests a flow pattern about the Spot that bulges toward the north by the Spot. The gigantic cloud swirls are thousands or more kilometers across. Pioneer 10 flew past Jupiter in December 1973. A sister spacecraft, Pioneer 11, reached Jupiter in December 1974. The Pioneer project was managed by NASA's Ames Research Center, Mountain View, California. The spacecraft was built by TRW Systems.

a TE-M-364-4 solid-propellant engine modified from the Surveyor lander), Pioneer 10 reached an initial speed of 51,800 kilometers per hour, faster than any previous humanmade object. There were some initial problems during the outbound voyage when direct sunlight caused heating problems. On 15 July 1972, the spacecraft entered the asteroid belt, emerging in February 1973 after a 435-million-kilometer voyage through the relatively densely packed rings. During this period, the spacecraft encountered some asteroid hits (although many fewer than expected) and also measured the density of Zodiacal light in interplanetary space. On 7 August, in conjunction with Pioneer 9 (in solar orbit), Pioneer 10 recorded details of one of the most violent solar storms in recent record. The spacecraft entered Jupiter's bow-shock wave (where the solar wind interacts with the planet's magnetic field) on 26 November, crossed the magnetopause, reentered the magnetic field on 1 December, and then crossed the magnetopause for the second time. By the following day, the spacecraft was returning better quality photos than possible with the best Earth-based telescopes—it had already begun imaging as early as 6 November 1973. Also during this period, Pioneer 10 took about 300 photos of Jupiter that included images of the planet's terminator and the Great Red Spot. Command-and-return time was up to 92 minutes by this time. Pioneer 10's closest approach to Jupiter was at 02:25 UT on 4 December



Mariner 10's first image of Mercury acquired on 24 March 1974. During its flight, Mariner 10's trajectory brought it behind the lighted hemisphere of Mercury, where this image was taken, in order to acquire important measurements with other instruments. This picture was acquired from a distance of 5,380,000 kilometers from the surface of Mercury. The diameter of Mercury (4,878 kilometers) is about one-third that of Earth. Images of Mercury were acquired in two steps, an inbound leg (images acquired before passing into Mercury's shadow) and an outbound leg (after exiting from Mercury's shadow). More than 2,300 useful images of Mercury were taken, both at moderate resolution (3–20 kilometers/pixel) color and at high resolution (better than 1 kilometer/pixel) black-and-white coverage.

1973, when the spacecraft raced by the planet at a range of 130,354 kilometers and a speed of 132,000 kilometers per hour. Of the spacecraft's eleven scientific instruments, six operated continuously through the encounter. The spacecraft passed by a series of Jovian moons, obtaining photos of Callisto, Ganymede, and Europa (but not Io). Pioneer 10 fulfilled all objectives except one (that one failure was due to false commands triggered by Jupiter's intense radiation). Based on incoming data, scientists identified plasma in Jupiter's magnetic field. The spacecraft crossed Saturn's orbit in February 1976, recording data that indicated that Jupiter's enormous magnetic tail, almost 800 million kilometers long, covered the whole distance between the two planets. Still operating nominally, Pioneer 10 crossed the orbit of Neptune (then the outermost planet) on 13 June 1983, thus becoming the first humanmade object to escape the solar system. Now the spacecraft is generally heading in the direction of the red star Aldebaran, a star that forms the eye of the Taurus constellation. It is expected to pass by Aldebaran in about two million years. In case of an intercept by intelligent life, Pioneer 10 carries an aluminum plaque with diagrams of a man and a woman, the solar system, and its location relative to fourteen pulsars. Pioneer 10 is heading out of the solar system in a direction very different from those of the two Voyager probes and Pioneer 11, that is, heading in an opposite direction toward the nose of the heliosphere in an upstream direction relative to the inflowing interstellar gas. NASA officially terminated routine contact with the vehicle at 19:35 UT on 31 March 1997 for budgetary reasons, although intermittent contact continues (as permitted by the onboard power source) with collection of data from the Geiger tube telescope and the charged-particle instrument. For example, ground control received a signal from the spacecraft on 28 April 2001. Pioneer 10 was the farthest humanmade object in existence until 17 February 1998, when Voyager 1 exceeded its range. By 1 July 2001, Pioneer 10 was 11.83 billion kilometers from Earth, traveling at 12.24 kilometers per second relative to the Sun.

133)

Venera 8

Nation: USSR (82)
Objective(s): Venus landing
Spacecraft: 3V (no. 670)
Spacecraft Mass: 1,184 kg
Mission Design and Management: GSMZ Lavochkin
Launch Vehicle: 8K78M
Launch Date and Time: 27 March 1972 / 04:15:01 UT
Launch Site: NIIP-5 / launch site 31
Scientific Instruments:

Bus:
1) cosmic-ray detector
2) solar wind detector
3) ultraviolet spectrometer

Lander:
1) thermometer
2) barometer
3) radio altimeter
4) photometer
5) gamma-ray spectrometer
6) gas analyzer
7) wind speed recorder

Results: Venera 8 was the first in another pair of Soviet spacecraft designed to explore Venus. Although similar in design to its predecessors, the 495-kilogram lander was substantially modified based on the Results from Venera 7. The new capsule was designed to withstand pressures of "only" 105 atmospheres (versus 180 atmospheres on Venera 7) and carried extra scientific instrumentation. After one midcourse correction on 6 April 1972, Venera 8's lander separated from the flyby bus and entered the Venusian atmosphere at 08:37 UT on 22 July 1972 at a velocity of 11.6 kilometers per second. Successful landing took place at 09:32 UT, about 500 kilometers from the morning terminator on the sunlit side of Venus. Landing coordinates were 10° south latitude and 335° longitude. The probe transmitted data for another 50 minutes 11 seconds from the hostile surface before succumbing to ground conditions. The transmitted information indicated that temperature and pressure at the landing site were 470 ± 8°C and 90 ± 1.5 atmospheres respectively. Wind speed was less than 1 kilometer per second below 10 kilometers altitude. The spacecraft also recorded a sharp change in illumination between 30 and 35 kilometers altitude. The data indicate that

visibility on the ground was about one kilometer at the time Venera 8 landed.

134)
Kosmos 482 / [Venera]
Nation: USSR (83)
Objective(s): Venus landing
Spacecraft: 3V (no. 671)
Spacecraft Mass: c. 1,180 kg
Mission Design and Management: GSMZ Lavochkin
Launch Vehicle: 8K78M
Launch Date and Time: 31 March 1972 / 04:02:33 UT
Launch Site: NIIP-5 / launch site 31
Scientific Instruments:

Bus:
1) cosmic-ray detector
2) solar wind detector
3) ultraviolet spectrometer

Lander:
1) thermometer
2) barometer
3) radio altimeter
4) photometer
5) gamma-ray spectrometer
6) gas analyzer
7) wind speed recorder

Results: This was the sister craft to Venera 8 (launched four days earlier). Unfortunately, the spacecraft never left Earth orbit. The Blok L escape stage's main engine prematurely cut off after only 125 seconds of firing due to a failure in the onboard timer. As a result, the spacecraft entered an elliptical orbit around Earth. Officially, the Soviets named the probe Kosmos 482 to disguise its true mission. The spacecraft reentered Earth's atmosphere in May 1981.

135)
Apollo 16 Particle and Fields Subsatellite
Nation: U.S. (52)
Objective(s): lunar orbit
Spacecraft: Apollo 16 P&FS
Spacecraft Mass: 42 kg
Mission Design and Management: NASA
Launch Vehicle: Apollo 16 CSM-113 (itself launched by Saturn V SA-511)
Launch Date and Time: 16 April 1972 / 17:54:00 UT (subsatellite ejection on 24 April 1972 / 09:56:09 UT)
Launch Site: ETR / launch complex 39A
Scientific Instruments:

1) magnetometer
2) S-band transponder
3) charged-particle detectors

Results: Nearly identical to its predecessor, the Apollo 16 Particle and Fields Subsatellite was ejected from the Apollo 16 Command and Service Module about 4 hours prior to the crew's trans-Earth injection burn, which sent them home from the Moon. Because of problems with the Apollo CSM main engine, the crew was forced to release the subsatellite in a low lunar orbit of 100 x 100 kilometers at 10° inclination. Thus, the probe eventually crashed onto the lunar surface after thirty-four days in orbit rather than the planned one year. Impact point was at 10.2° north latitude and 112° east longitude at 21:00 UT on 29 May 1972. However, because of its low orbit, the spacecraft did return some valuable low-altitude data.

136)
no name / [N1 launch test]
Nation: USSR (84)
Objective(s): lunar orbit
Spacecraft: 7K-LOK (no. 6A)
Spacecraft Mass: c. 9,500 kg
Mission Design and Management: TsKBEM
Launch Vehicle: N1 (no. 15007)
Launch Date and Time: 23 November 1972 / 06:11:55 UT
Launch Site: NIIP-5 / launch site 110L
Scientific Instruments: unknown
Results: This was the fourth test launch of the giant Soviet N1 booster. The first two, launched in 1969, attempted to send rigged-up 7K-L1 ("Zond") spacecraft to lunar orbit. The third booster carried a payload mockup for tests in Earth orbit. All three failed. This fourth launch was intended to send a fully equipped 7K-LOK spacecraft (similar to a beefed-up Soyuz) on a robotic lunar orbiting mission during which the spacecraft would spend 3.7 days circling the Moon (over 42 orbits), taking photographs of future landing sites for piloted missions. The booster lifted off without problems, but a few seconds prior to first-stage cutoff, at T+107 seconds, a powerful explosion ripped apart the bottom of the first stage, destroying Soviet hopes of ever sending cosmonauts to the Moon. There was never a conclusive reason for the explosion; some sug-

gested that there had been an engine failure, and others were convinced that the scheduled shutdown of six central engines had caused a structural shock wave that eventually caused the explosion.