ANSWER KEY: The Early Years: Mercury to Apollo-Soyuz

Directions:

This sheet can be used as an individual or group worksheet to accompany this lesson's reading, *The Early Years: Mercury to Apollo-Soyuz.*

Project Mercury

1. When Project Mercury first started, what were its two broad missions?
   One mission was to investigate man's ability to survive and perform in the space environment; a second was to develop the basic space technology and hardware for future manned spaceflight programs.

2. For how many astronauts was the Project Mercury spacecraft designed?
   1 astronaut

3. Use *The Early Years* document to complete the Project Mercury table below.
   - Place the following Mercury astronauts next to their spacecraft.
     - Alan B. Shepard, Jr.; Virgil I. "Gus" Grissom; Astronaut John H. Glenn, Jr.; N. Scott Carpenter; Walter N. Schirra, Jr.; and L. Gordon Cooper, Jr.
   - Next, fill out the date column.
   - As you read about each of the spacecrafts, write down one fact in the last column.

Spacecraft	Astronaut	Date	Provide 1 Fact
Freedom 7	Alan B. Shepard, Jr.	May 5, 1961	(see p. 11 from PDF for a quick look at duration, orbits)
Liberty Bell 7	Virgil I. "Gus" Grissom	July 21, 1961	
Friendship 7	John H. Glenn, Jr.	February 20, 1962	
Aurora 7	N. Scott Carpenter	May 24, 1962	First to land in Pacific
Sigma 7	Walter N. Schirra, Jr.	October 3, 1962	
Faith 7	L. Gordon Cooper, Jr.	May 15-16, 1963	

Project Gemini

4. For how many astronauts was the Project Gemini spacecraft designed?
   2 astronauts

5. What was the purpose of the two-part adapter module?
   One purpose of the two-part adapter module was to fit the narrow Gemini capsule to the broader top of the booster. It also contained attitude controls, propellant tanks, electrical components, and other support equipment. The section adjacent to the crew's re-entry module included two sets of engines: retro-rockets and space-maneuvering thrusters.

6. How many manned Gemini flights were there?
There were a total of 10 manned Gemini flights.

7. When were the first and last Gemini flights? How many days between the first and last?
From the first unmanned Gemini flight on April 8, 1964, to the final manned flight ending November 15, 1966, Gemini flight time totaled 974 hours, 37 minutes, and 42 seconds. Of this, 969 hours, 51 minutes, and 26 seconds were manned. The astronauts spent a total of 12 hours and 12 minutes in extravehicular activity (EVA, or "space-walk activities").

8. How much did Project Gemini cost?
Project Gemini cost $1.3 billion.

9. What were two space firsts for Gemini?
The highest altitude reached by the manned Gemini spacecraft — a world's record at that time — was 1,372.8 kilometers (853 miles) during the Gemini 11 mission. Orbital rendezvous was accomplished 10 times; it docked 9 times. Docking was first accomplished on March 16, 1966, during Gemini 8, and was another Gemini "space first."

Apollo

10. Summarize Apollo's successes in 1965 and 1966.
The first phase of the Saturn launch vehicle program was completed in 1965. In ten flights of the Saturn 1, all ten were successful — an unprecedented record in rocket development. Much technology was furthered in the Saturn I program. For example, the rocket guidance system was developed, the concept of clustered rocket engines was validated, and more experience was gained in the use of liquid hydrogen as a fuel. Liquid hydrogen, previously used only in the Centaur stage, provides approximately 40 percent greater power than earlier fuels. Also, the new Saturn IB launch vehicle was successfully flown three times in three attempts in 1966. Two of these flights carried spacecraft, which satisfactorily completed Apollo command and service module requirements for Earth orbital operations.

11. Summarize Apollo's setback in 1967.
On January 27, 1967, tragedy struck the space program when a fire erupted inside an Apollo spacecraft during ground testing at Complex 34. This resulted in the deaths of Astronauts Virgil Grissom, Edward White, II, and Roger Chafee. After two and a half months of investigation, involving 1,500 people, the Board of Inquiry determined the most likely cause of the accident. Electrical arcing from the spacecraft wiring in a near-total oxygen environment induced a flash fire. After an extensive investigation by an Accident Review Board, NASA followed up with detailed descriptions of corrective actions, schedule modifications, and cost estimates necessary to get the program back on track. On November 9, 1967, the first flight test of the Apollo/Saturn V space vehicle was successfully accomplished.

12. Who made America's first space walk?
Gemini 4 Astronaut Ed White made America's first space walk on June 3, 1965, during the third orbit of a four-day mission.

13. List the astronauts who were part of the “101 percent successful” Apollo 7 mission in 1968, and state why it was considered so successful.
Apollo 7 lifted off on October 11, 1968 for what became an 11-day flight. Apollo 7 ended with a precise re-entry and splashdown on October 22, and was called a “101 percent successful” mission. Manned by Astronauts Walter Schirra, Don Eisele, and Walt Cunningham, the spacecraft’s performance in space was flawless, including eight firings of the spacecraft’s primary propulsion system and the first live television broadcast from a manned space vehicle.

14. Be an engineer! You have just been assigned as an engineer to help develop the Crew Exploration Vehicle for NASA's return to the Moon. What information from the Apollo Program might be useful to you in your job today?
Answers will vary.

Skylab

15. Why was the two-stage Saturn V design for Skylab 1 a smart design decision?
Sixty-three seconds after launch, the meteoroid shield ripped away from the Skylab, trailing an aluminum strap, which caught on the unopened solar wing. The shield became tethered to the lab while at the same time prying the opposite wing partly open. The countdown for the launch of the first Skylab crew was halted until they could assess the problem and send the crew up with the necessary materials and tools to fix the Skylab.

16. Which of the Skylab launches were manned?
Skylab 2, Skylab 3 and Skylab 4

17. How many years did the Skylab project last, how did it end and how much did it cost?
After over six years in space, the demise of the orbital workshop came on its 34,981st orbit. Skylab program costs totaled $2.6 billion.

18. Provide one fact for each of the four Skylabs.
Skylab 1
Dates/Recovery Ship: Launched May 14, 1973
Crew: Unmanned
Mission Duration: Re-entered atmosphere July 11, 1979 on orbit 34,981
Remarks: 100-ton space station visited by three crews

Skylab 2
Dates/Recovery Ship: May 25-June 22, 1973/Ticonderoga (P)
Crew: Navy Capt. Charles Conrad, Jr., Navy Comdr. Paul J. Weitz, Navy Comdr. Joseph P. Kerwin (MD)
Mission Duration: 28 days 49 min. 49 sec.
Remarks: Repaired Skylab; 404 orbits; 392 experiment hours, three EVAs total 5 hrs. 34 min.

Skylab 3
Dates/Recovery Ship: July 28- Sept. 25, 1973/New Orleans (P)
Crew: Navy Capt. Alan L. Bean, Marine Maj. Jack R. Lousma, Civilian Owen K. Garriott (Ph.D.)
Mission Duration: 59 days 11 hrs. 9 min. 4 sec.
Remarks: Performance maintenance, 858 orbits; 1,081 experiment hours; three EVAs total 13 hrs. 42

min.

Skylab 4
Dates/Recovery Ship: Nov. 16, 1973-Feb. 8, 1974/New Orleans (P)
Crew: Marine Lt. Col. Gerald P. Carr, USAF Lt. Col. William R. Pogue, Civilian Edward G. Gibson (Ph.D.)
Mission Duration: 84 days 1 hr. 15 min. 31 sec.
Remarks: Observed Comet Kohoutek; 1,214 orbits; 1,563 experiment hours; four EVAs total 22 hrs. 25 min.

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19. What was accomplished during the Apollo-Soyuz Test Project?
The Soyuz maneuver to the planned orbit for docking was successfully completed over Europe on the 17th orbit, at an altitude of 222 kilometers (138 miles.) The Apollo crew completed the rendezvous sequence as planned; docking with Soyuz was accomplished on July 17 when the Apollo spacecraft was gradually piloted toward the orbiting Soyuz. During the next two days, the crews accomplished four transfer operations between the two spacecraft and completed five scheduled experiments. In addition, the crews provided television views of the interior of the two spacecraft, and demonstrated various aspects of space operations. This mission marked the first time that voice, TV, and telemetry were relayed between an orbiting Apollo spacecraft and the ground via the ATS-6 communications satellite. This new technique more than tripled the communications coverage otherwise available. Following the first undocking, a joint solar eclipse experiment was performed. Then Apollo performed a second docking, this time with the Soyuz apparatus locking the two spacecraft together. The final undocking occurred on July 19. The two spacecraft were moved to a station-keeping distance, and a joint ultraviolet absorption experiment was performed, involving a complicated series of orbital maneuvers. Afterward Apollo entered a separate orbit, and unilateral activities were conducted by both the Soyuz and Apollo crews. The Soyuz landed safely on July 21, after six mission days, and the Apollo flight was successfully concluded on July 24, 1975, nine days after launch. The primary objectives of the program were met, including rendezvous, docking, crew transfer, and control center-crew interaction. All objectives of the scientific experiments were met. The unilateral portion of the Apollo flight was a full scientific mission in itself, and yielded significant results.

20. The last page of this NASA Information Summary provides information about the future of manned space flight. Is the Space Shuttle still the future of manned space flight? Explain your answer.
Answers will vary, but possible good answers may include:

- **The document was written in 1991. It's hard to tell without more research.**
- **The Space Shuttle first launched in 1981 and is still launching, and it is year 200X. It would be reasonable to assume NASA is planning for future manned space exploration projects using the advanced technologies of today.**
- **The next generation of manned space flight is ARES and ORION. I've read about this and know that a lot of what they are doing will be based on Apollo technologies and Space Shuttle technologies.**