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Then and Now in Space



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Retropolis

Apollo 8: NASA's first moonshot was a bold and terrifying improvisation

BY JOEL ACHENBACH

• Originally Published December 21, 2018

Walter Cronkite held a tiny model of the Apollo 8 spacecraft and strode across a darkened studio where two dangling spheres represented Earth and the moon. This was the CBS Evening News, Dec. 20, 1968, and three Apollo 8 astronauts were scheduled to blast off the following morning on a huge Saturn V rocket. Cronkite explained that the astronauts would fly for three days to the vicinity of the moon, fire an engine to slow the spacecraft and enter lunar orbit, circle the moon 10 times, then fire the engine a final time to return to Earth and enter the atmosphere at 25,000 miles per hour.

“They must come in at JUST the right angle. If they come in too steeply, they will be CRUSHED in the Earth’s atmosphere. If they come in too shallow, they will SKIP OUT and go into Earth orbit and not be able to return,” Cronkite said.

Fifty years later, it’s hard to remember how mind-blowing Apollo 8 was, and how scary. No space mission had ever presented so many exotic ways to kill astronauts. Before the launch, a NASA official was overheard imagining what might go



Apollo 8 lifts off from the Kennedy Space Center in Florida on Dec. 21, 1968.

AP

wrong: “Just how do we tell Susan Borman, ‘Frank is stranded in orbit around the moon?’”

Apollo 8 was the first moonshot. No human being had ever been beyond low Earth orbit. Even the Apollo 8 astronauts — Frank Borman, James Lovell Jr. and Bill Anders — struggled to wrap their heads around what they were about to do.

A historic launch

They shared their final prelaunch lunch with Charles Lindbergh and his wife, Anne Morrow Lindbergh, at Cape Kennedy. “Think, it’s hard to believe, this time tomorrow we’ll be on our way to the moon,” one of the

astronauts said, according to Morrow Lindbergh’s subsequent article in LIFE magazine.

What’s more, Apollo 8 was improvisational. It wasn’t even supposed to be a mission to the moon.

“It was an extraordinarily bold decision,” says Teasel Muir-Harmony, curator of Apollo Spacecraft at the National Air and Space Museum.

“One of the most risky decisions in the history of spaceflight” is the verdict of historian Asif Siddiqi of Fordham University.

NASA had a clear goal, established by President John F. Kennedy in 1961, of landing an astronaut on the moon before the end of the decade.

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The agency carried out a sequence of missions that incrementally advanced its expertise in human spaceflight. Rather than sending astronauts directly from Earth to the moon's surface, NASA's engineers decided that the Apollo program should build a separate lunar lander, which greatly reduced the size of the rocket needed for the mission.

This relatively lightweight vehicle would separate from the command module in lunar orbit and two astronauts would descend to the moon's surface. They would then blast off and dock with the orbiting vehicle. Katherine Johnson, one of the NASA human "computers" made famous decades later by the movie *Hidden Figures*, said her greatest contribution to the space program was her calculations for the Apollo program, according to NASA.

By early 1967, the United States appeared to be winning the race to the moon. Then came disaster. During a test of the command module on a launchpad at Cape Kennedy, during which the cabin was filled with pure oxygen, a fire broke out and killed the three Apollo 1 astronauts — Virgil "Gus" Grissom, Roger Chaffee and Ed White.

The tragedy threatened to ruin any chance of putting boots on the moon by the decade's end. By late summer 1968, NASA was desperate to get back on schedule. The refashioned NASA schedule called for Apollo 7 to be an Earth-orbital flight that would test the re-engineered Apollo command module. Apollo 8, the first crewed flight of the Saturn V rocket,

would also stay in Earth orbit and test the lunar lander.

But the lunar lander wasn't ready to fly.

Meanwhile, the Soviets were building a giant moon rocket, the N1. The CIA circulated a report in the spring of 1968 saying that the Soviets could potentially send a human being on a mission around the moon before the end of the year. (And in September 1968, a pressurized spacecraft named Zond 5 zoomed around the moon with turtles aboard, clearly a precursor to a human mission.)

George Low, the manager of the Apollo spacecraft program office in Houston, knew that his Apollo schedule was a mess. So he tore it up. He decided Apollo 8 should be a moonshot.

His logic was simple: We have the hardware to fly around the moon. We have the Saturn V rocket, the Apollo command module and the service module. The one missing piece is the lunar lander, and we don't need that for a mission that doesn't try to land.

On Aug. 7, Low presented the idea to Chris Kraft, the director of flight operations in Houston, and asked him to study whether it was technically feasible. On Aug. 9, Low pitched the plan to the head of the Houston center, Bob Gilruth, who embraced it right away, and Kraft reported that there were no showstoppers. They phoned a number of top NASA officials at other centers and asked them to fly to Huntsville, Ala., immediately for a 2:30 p.m. meeting. The Apollo program pivoted in a matter of hours. The top officials at NASA,

Administrator James Webb and Associate Administrator for Human Spaceflight George Mueller, were uncomfortable with what appeared to be a mad dash to the moon. Mueller feared "irresponsible scheduling" and the impact on Apollo were there to be a "catastrophic failure," according to Low's private notes. But the Apollo engineers persuaded Webb and Mueller.

The designer of the Saturn V, Wernher von Braun, who as a Nazi scientist had built the V-2 rockets launched against Britain in World War II, also signed on to the plan. According to Low's notes, von Braun said that "it doesn't matter to the launch vehicle how far we go." (As the satirist Tom Lehrer sang: "Once the rockets are up, who cares where they come down? That's not my department," says Wernher von Braun.)

'See you on the other side'

The refashioned Apollo 8 mission required NASA to send the spacecraft on an exquisitely precise trajectory that would enter the moon's gravity well, loop around the far side and come within 60 miles of the surface.

That's where the service module engine would fire, slowing the spaceship. If it didn't fire for some reason, that wouldn't be a disaster, because the trajectory was designed to fling Apollo 8 right back toward Earth, a "free return" courtesy of gravity.

But if the engine burned too long, Apollo 8 could crash on the lunar surface. If it burned too briefly, the

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spacecraft would neither enter lunar orbit nor return to Earth, but would fly off into the void of space.

The plan called for a second burn, to circularize the remaining orbits. Then would come the most anxiety-inducing burn, the one that would send the spacecraft back to Earth. If that didn't work for some reason, the astronauts would circle the moon until their oxygen ran out. That would take about nine days.

All this would happen over the Christmas holiday.

On the morning of the launch, all eyes were focused on the towering Saturn V. Apollo 8 would be only the third launch of the giant rocket. The first test launch, with no crew, had gone beautifully (Cronkite had roared with glee about the "terrific" launch as the entire observation building shook). But the second launch, also without a crew, had suffered multiple technical failures.

The engineers thought they had fixed the problems for Apollo 8. Now NASA was going to put human beings on top of this rocket that stood 363 feet tall and that had had one successful launch and one not-so-good launch.

Apollo 8 lifted off beautifully. Aerospace engineer James Oberger was watching from the beach nearby. "No TV screen or movie screen can show how bright the flame is. It's like a piece of the sun," he recalled in an interview.

The astronauts were soon in orbit, and just 2½ hours later, Michael Collins, the astronaut in Mission Control assigned to speak with his

colleagues in space, said, "Apollo 8, you are go for T.L.I." That meant Trans Lunar Injection. (These people were not poets.) The third stage of the Saturn V ignited, and they were off for the moon.

Frank Borman got sick en route with vomiting and diarrhea. Bill Anders meticulously described how a floating bolus of vomit split apart in zero gravity and confirmed Newtonian physics.

Jim Lovell peered into the eyepieces of the Apollo Guidance and Navigation System, which featured a telescope and a sextant, and navigated by the stars, the moon and the sun, as if a sailor on the high seas. NASA's Deep Space Network tracked the spacecraft with giant radio antennas, and computers in Houston handled calculations.

"How sure are you we're going to miss the moon?" one of the top NASA officials demanded of engineer John Mayer in Houston as Apollo 8 cruised toward its destination. "I'm real sure," he said, laughing, though he had an uneasy afterthought: Why aren't they more worried about a miscalculation at reentry that burns up the spacecraft?

The crew sent back images of Earth, and Earthlings were mesmerized. On CBS, the baritone commentator Eric Sevareid said, "Three creatures of frail flesh and blood are floating through the blackness of space in the neighborhood of the moon. It is staggering and we do not know what it means."

The spacecraft reached the moon after nearly three days of flight. "See

you on the other side," Lovell said just before the spaceship disappeared behind the moon.

People had never seen that side of the moon with their own eyes. Nor had they ever been so cut off from their fellow humans. They had no way to communicate with Mission Control. In Houston, there was nothing to do but wait. The place was silent.

Engineers wandered outside for a smoke.

Then Apollo 8 could be heard again, popping from behind the moon in exactly the right place at the right time. Who said space is hard?

The rest of the mission went splendidly, including that scary final burn, which again happened behind the moon. As the spacecraft came back into contact, on track to return to Earth, Lovell told Houston, "Please be informed, there is a Santa Claus."

The spacecraft splashed into the Pacific just a couple of miles from the Navy aircraft carrier waiting to pick up the astronauts.

On NBC, anchorman David Brinkley said, "The great adventure ended today as it began, with almost everybody in the world holding his breath and hoping it would all work. It all did. It was almost unreasonably perfect. ... The human race, without many victories lately, had one today. And it will be remembered as long as the human race lasts."

Or at least for seven months. Neil Armstrong and Buzz Aldrin walked on the moon the following July. Apollo 8 would thereafter reside in the huge shadow of Apollo 11.

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KidsPost

A new era in spaceflight: Back to the moon on the way to Mars

President John Kennedy's challenge was to put a man on the moon, but a return has a different purpose.

BY CHRISTINA BARRON

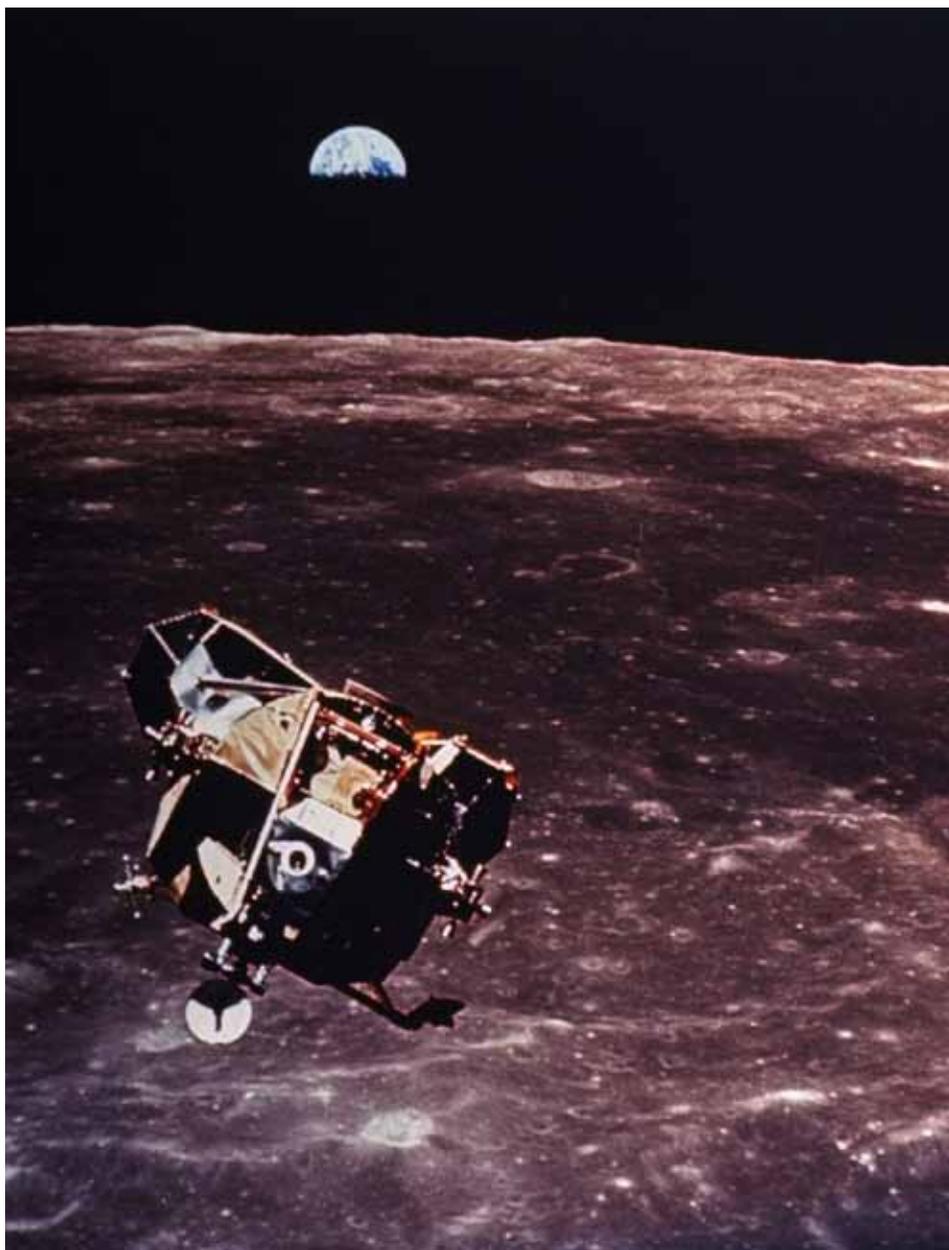
● Originally Published November 6, 2018

On May 25, 1961, President John Kennedy issued a challenge to lawmakers, the new U.S. space agency and the American people.

“I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the Earth,” Kennedy said in a speech before Congress.

It was an ambitious goal. But in July 1969, NASA would achieve it. Apollo 11 — with Neil Armstrong and Buzz Aldrin aboard — landed on the lunar surface and made it back to Earth. This moonshot was no one-shot deal. Astronauts returned to the moon five times for further exploration.

NASA announced this summer that it plans to head back there in the 2020s, about 50 years after astronauts last visited. But this time, the moon isn't considered a destination. It's a pit stop on the way to the next space goal: sending humans to Mars. To understand this new era of human spaceflight, it's important to look back at what Kennedy set in motion 57 years ago.



NASA VIA AP

The Apollo 11 lunar module ascends on July 21, 1969, after the historic moon landing. The mission had put the United States ahead of the Soviet Union in a race to space.

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A proving ground

When Kennedy made his plea to Congress, the United States had just launched its first manned spacecraft. Alan Shepard made a 15-minute suborbital flight, traveling 115 miles up and then returning to Earth. The Soviet Union had sent the first man into space several weeks earlier. Not only had Yuri Gagarin's flight lasted longer — 108 minutes — but he also completed a single orbit of the Earth. The United States was embarrassed. It didn't want the Soviets — the only other world superpower at the time — to get ahead in space exploration.

"There was this battle for hearts and minds," says Teasel Muir-Harmony, space history curator at the Smithsonian National Air & Space Museum. "Beating the Soviets in space was important for the United States' place in the world."

The president had talked with NASA scientists about which achievement was within reach for the United States and perhaps further away for the Soviets.

"The U.S. at the time was better at landings," Muir-Harmony said. "The Soviet Union at the time was having trouble with landings."

So they chose landing on the moon, which is on average 240,000 miles away. (The distance changes because its orbit is not a circle.) At that point, Gagarin had traveled the farthest from Earth — 203 miles. Muir-Harmony said Kennedy purposely chose not to aim just one step ahead of the Soviets.

"If we propose this program that's really bold . . . they'd have to invest in new technologies," Muir-Harmony

said. Members of Congress would debate spending nearly \$1.7 billion on the space program for the next year.

That money and billions more approved in the 1960s paid not only for the Apollo missions but also rockets and other technology that NASA has used in the decades since then. That, too, was part of Kennedy's pitch to Congress.

"This gives promise of some day providing a means for even more exciting and ambitious exploration of space, perhaps beyond the moon, perhaps to the very end of the solar system itself," he said.

Back and forward

NASA has sent spacecraft to explore the far reaches of our solar system and beyond, but none has included humans. Instead, astronauts have been studying the effects of living and working in space by orbiting Earth, first on Skylab and since 2000 on the International Space Station (ISS).

The missions have become more collaborative than competitive. NASA has four international partners: space agencies in Russia, Canada, Japan and Europe. More than 100 astronauts and cosmonauts have stayed on the ISS for long-term assignments. And private companies have partnered with NASA to take supplies to the station. Two companies, Boeing and SpaceX, are set to next year become the first private companies to ferry astronauts to the ISS.

NASA aims to work with these partners and others as it moves toward human missions to Mars.

The agency's leader, Jim Bridenstine, explained in September that the plan to get to Mars involves returning to the moon with landers, rovers, robots and humans.

"The glory of the moon is that's it's only a three-day journey home," Bridenstine told members of Congress. "So we can prove all of the technologies, we can reduce all of the risks."

And in the event of an emergency, NASA can get astronauts home quickly, he said. The journey from Mars, which is on average 140 million miles from Earth, would take about eight months.

Bridenstine announced in October that NASA is planning to send scientific equipment to the moon in 2019 or 2020. A human trip to orbit the moon, on NASA's Orion spacecraft, would launch in 2023. An orbiting "gateway," or a lunar space station, would follow. The gateway would allow humans and equipment to get to the moon's surface. Eventually it would serve as a launchpad to Mars.

These moon missions will be similar to Apollo in that the United States wants to prove its leadership in space exploration. But Muir-Harmony pointed out an important difference.

"We want to expand our knowledge of the universe. We want to advance science," she said. "There's not an end goal."

Editor's note: *This story has been updated to include mention of NASA's Orion spacecraft. This story is one in a series about U.S. human spaceflight.*

THE JOURNEY

How we got there ...

In 1951, the United States launched its first astronaut into space using a Redstone rocket originally designed for the U.S. Army. Over time, the rockets used to launch humans into space got bigger and more powerful.

Command module
Service module
Maximum crew size: 3

The Apollo missions used multiple vehicles to successfully land on the moon. The service module provided propulsion. The lunar module landed on the moon's surface, and the command module capsule returned the astronauts back to Earth.

Lunar module

Who are the astronauts?

It's not easy to become an astronaut. Some of the requirements candidates may need are a college degree in a STEM field, three years of professional experience or 1,000 hours of commanding an aircraft and be physically fit. Since 2012, only 338 astronaut have ever been selected by NASA.



The first Mercury astronauts were all military test pilots.



In 1968, NASA started to accept scientists as well as pilots to be astronauts.



On the space shuttle in 1983, Sully Srinivasan became the first American woman in space.

NASA

NASA — the National Aeronautics and Space Administration — was created by the U.S. government as a response to the Soviet Union's successful launch of Sputnik into space. Since then, it has been NASA's mission to lead the way for the nation in space exploration.

What are space capsules?

The heart of its human spaceflight program, NASA has sent people to space in capsules, launched on top of rockets. After their mission, the capsule would parachute back to Earth, usually landing in the ocean.



Cap
Maximum crew size: 1

Cap
Maximum crew size: 2

Cap
Maximum crew size: 3

How rockets work

If you could turn inside a rocket, you would see that most of the space is taken up by two large tanks.

One tank is for fuel, and the other is for an oxidizer.

When mixed together and ignited, they create a thrust of hot gases that pushes the rocket upward.



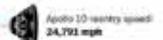
Space shuttle orbiter
The space shuttle was the first reusable spacecraft — designed to launch like a rocket into orbit — and then glide and land back on Earth like an airplane.

Maximum crew size: 3

The space shuttle used its own like a private truck fuel, delivering equipment and structures to space.

The fastest humans ever

The fastest speed humans have ever traveled was at blazing 24,791 miles per hour — about 45 times faster than your average commercial jet flight. The record was set by three astronauts from the Apollo 10 mission while returning to Earth.



KEY TO SPACE

... and what is to come

NASA's next chapter in human flight will involve private space companies. They plan to use rockets and spacecraft from Boeing/United Launch Alliance and SpaceX to get astronauts to space.

On the space shuttle *Columbia* in 1982, Sally Ride became the first American woman in space.

The space shuttle *Columbia* was the first reusable spacecraft — designed to launch like a jet, take orbit — and then glide and drop or Earth for an airplane.

Maximum crew size: 

The space shuttle used its own big piggy-back boosters, delivering equipment and structures to space.



Starliner capsule
Boeing's CST-100 Starliner is slightly bigger than the Apollo command module and was designed to be compatible with many different rockets.

Maximum crew size: 

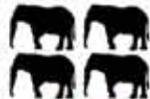
Starliner astronauts will wear a new suit featuring a helmet and visor incorporated into the suit and touchscreen-sensitive gloves.

Boeing

The Boeing company has been around for more than 100 years. One of its earliest products was selling airplanes to the U.S. Navy. Since the 1960s, Boeing has developed many space vehicles for NASA, and in 2014 it won one of two contracts to develop crew transportation systems to replace the space shuttle as a way to get Americans into orbit.



The Atlas V rocket is operated by the United Launch Alliance, a joint venture of Boeing and Lockheed Martin. It is very reliable and has had about 80 launches with no complete failures to date.



It's also powerful. A one-launch mission can **45,000 pounds** into low Earth orbit — that is equal to the average combined weight of four full-grown elephants.

2009
Atlas V

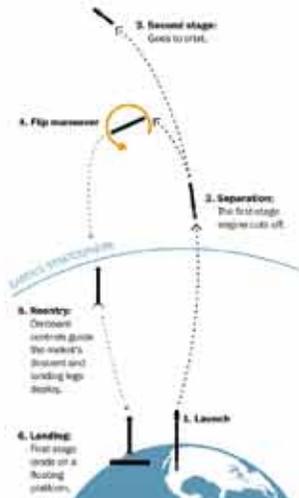
Dragon capsule
SpaceX's Dragon spacecraft can be configured as a number of ways to deliver cargo, carry a crew or as an in-space refueling service tank.

Maximum crew size: 

Similar to Boeing, SpaceX will also provide Dragon retrocasts with a new flight suit. The new design is lightweight but could be strong enough to allow astronauts to survive the return of space if needed.

SpaceX

SpaceX is a new company with Silicon Valley DNA. It was the first commercial business to create and launch a liquid-fuel rocket into orbit. Since then, the company has continued to innovate. One of its greatest successes is the development of a rocket with a first stage that can beber the atmosphere, land upright and be reused — which has the potential to significantly lower the cost of spaceflight.



2010
Falcon 9

How far we have gone

The farthest distance humans have ever traveled was **248,005 miles** from Earth, as the Apollo 13 crew swung around the far side of the moon.



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THEN



NEIL ARMSTRONG/NASA VIA AP

Edwin “Buzz” Aldrin stands near the American flag that he and Neil Armstrong planted on the moon during the first moon landing in July 1969.



NASA VIA AP

Neil Armstrong poses for a picture inside the Apollo 11 lunar module after walking on the moon.



NASA VIA AP

A footprint of the first man on the moon.

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NOW

SPACEX

Astronaut Sunita "Suni" Williams trains April 3 in a mock-up of SpaceX's Crew Dragon spacecraft in Hawthorne, California. SpaceX and Boeing are private companies that have partnered with NASA to ferry astronauts to the International Space Station beginning next year.



JONATHAN NEWTON/THE WASHINGTON POST

Chris Ferguson, a former NASA astronaut who now works for Boeing, and Williams practice an emergency escape from the crew access tower at Kennedy Space Center in June. Ferguson is scheduled to be on Boeing's test flight; Williams is set to be on Boeing's first mission to the ISS.

Where We Have Been, Where We Will Go

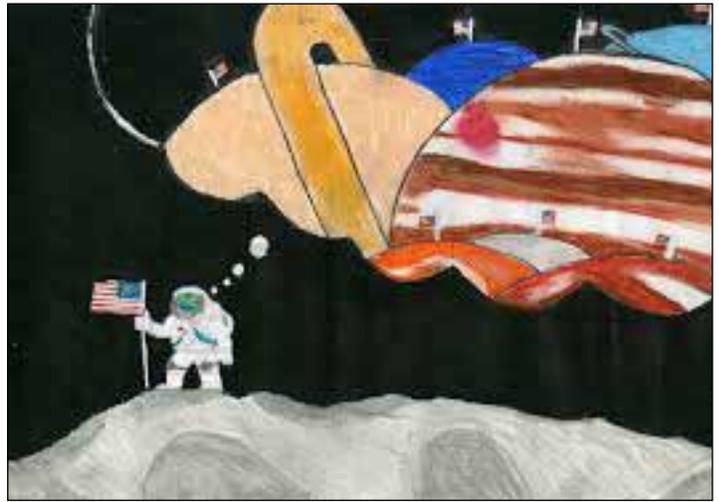
Read “Returning to the moon on the way to Mars.” Answer the following questions and discuss the benefits and drawbacks of planned missions to Mars.

1. Which U.S. president asked the U.S. “to commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the Earth”?
2. Explain why landing on the moon was chosen as a U.S. goal.
3. Between 1969 and 2019, how many times have astronauts landed on the moon?
4. What made the flight of Soviet cosmonaut Yuri Gagarin significant?
5. For what were the first Congressional appropriations for the space program spent?
6. The U.S. space program is composed of American-only and collaborative programs. Give two examples of collaborative partnerships.
 - a.
 - b.
7. How long does it take to get to the moon? Give two examples of future projects that can take advantage of this proximity.
8. NASA’s leader Jim Bridenstine stated that NASA has plans to return to the “moon with landers, rovers, robots and humans.” If you were a mission leader what project would you pitch to use the equipment?
9. How important is U.S. leadership in space exploration to you? To your classmates? Do you or any of them think of a career with NASA or private companies involved in space exploration?
10. If you had \$2 billion to spend, would you use it to take a flight to orbit the Earth, to fund a project on the moon or to sponsor an Earth-bound project? Explain your reasons and goal(s).

What Color? What Shape? What Marvels!



FIRST PLACE Moubon Ray Kurukumbi, 11
Fairfax, Virginia



SECOND PLACE Cora Arnold, 11
Burke, Virginia



THIRD PLACE Keira Allen, 13
McLean, Virginia

1. In 2018 KidsPost asked students to show what “America’s Return to Space’ looks like.” What do the top three entries communicate about a return to space?

Get out your pens, your brushes and your keen observations

2. Now it is your turn. Select one of these prompts to inspire you.

Sketch a Series of Moons

What do you know about the moon? Read scientific and NASA website information about what is known. Pull out of yourself the emotions you associate with the moon. You need three sketches. Write a short statement about your sketches or your thoughts about the moon. Your sketches could include:

- The view of the moon from a window
- Phases of the moon
- The moon with astronauts on it
- A blue moon
- The moon in an editorial cartoon
- The moon in relation to Earth and Mars
- What the moon might look like based on an astronaut's description

Display the Planets

Read about recent NASA probes and explorations in space. What have telescopes and cameras revealed about the colors of the planets, their moons and other bodies such as asteroids? Are ice, sand or rocks on the surface? Are they flat or mountainous? Select one of the planets or other celestial bodies. You may draw it, create a 3-D model or sculpt it. With your classmates create a gallery of your artwork. In the wall labels include information about the recent discoveries that have influenced your interpretation.

Suspend a Solar System Mobile

Work in a group to create a mobile of the solar system. Determine the scale, from smallest to largest. Research the latest information on the colors and features of the planets. Determine an aesthetic way to hang the mobile in your classroom or a school display case. Also create a key to the planets that may be read by viewers.

Take a Trip Around the Moon

Japanese billionaire Yusaku Maezawa plans to be a SpaceX client. He will take several artists — sculptors, painters, architects and film directors — on a trip around the moon. The Post's Christian Davenport reported that Maezawa "hopes the trip would help their work 'inspire the dreamer in all of us.'" Apply to be one of the artists to accompany Maezawa. In addition to your persuasive essay include an example of your artwork. It should reveal your observational as well as your artistic skills.