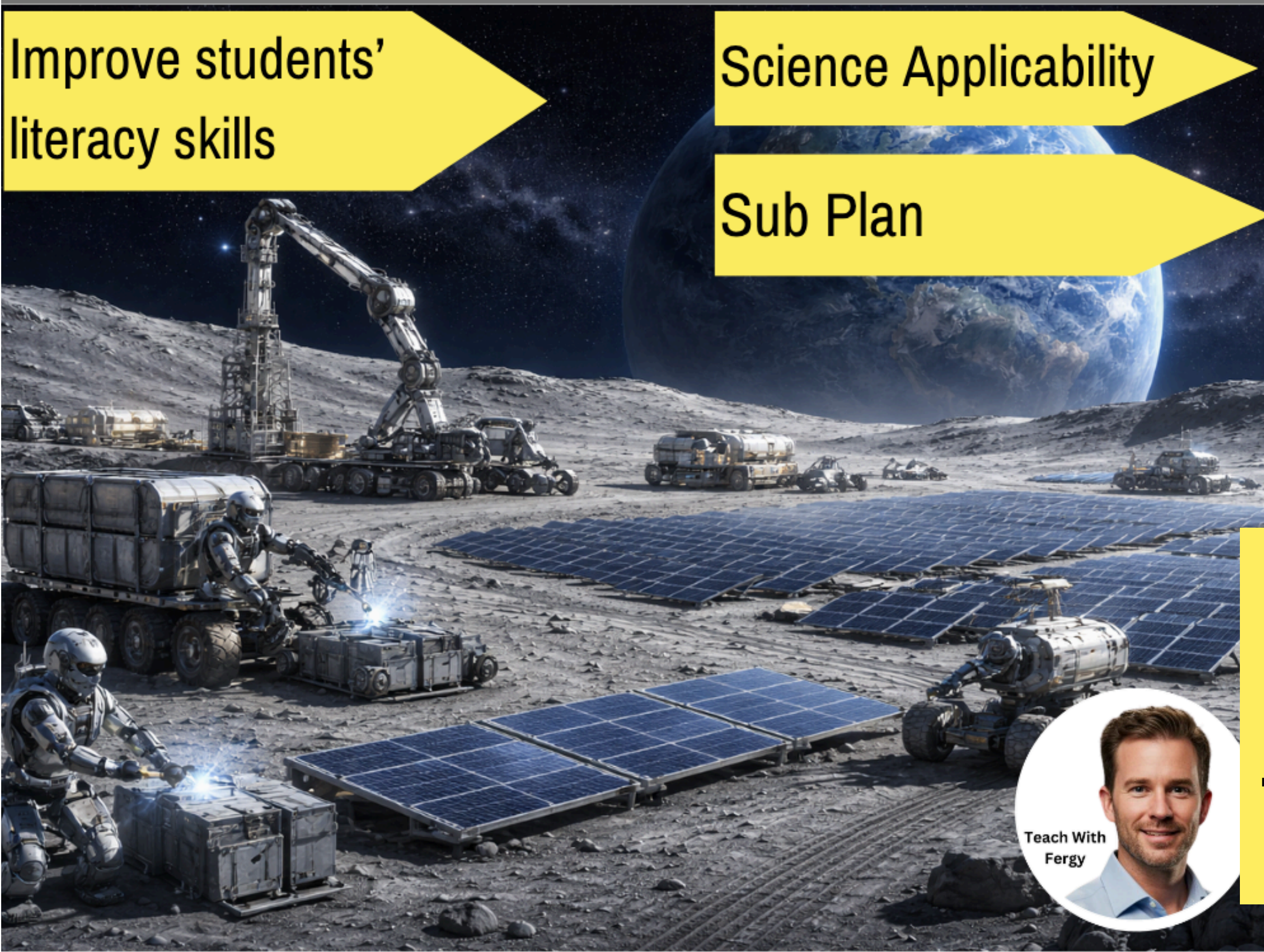


BUILDING AND UTILIZING A MOON BASE GRADE 8 AND UP READING

Improve students'
literacy skills

Science Applicability

Sub Plan



Reading Comment

“

Extremely satisfied - Great resource to work on student reading comprehension and it tied into the topic I was teaching. My students have been struggling with reading and I've been incorporating more reading into my lessons. Thank you for the resource.

”

SCROLL
to take a look inside!

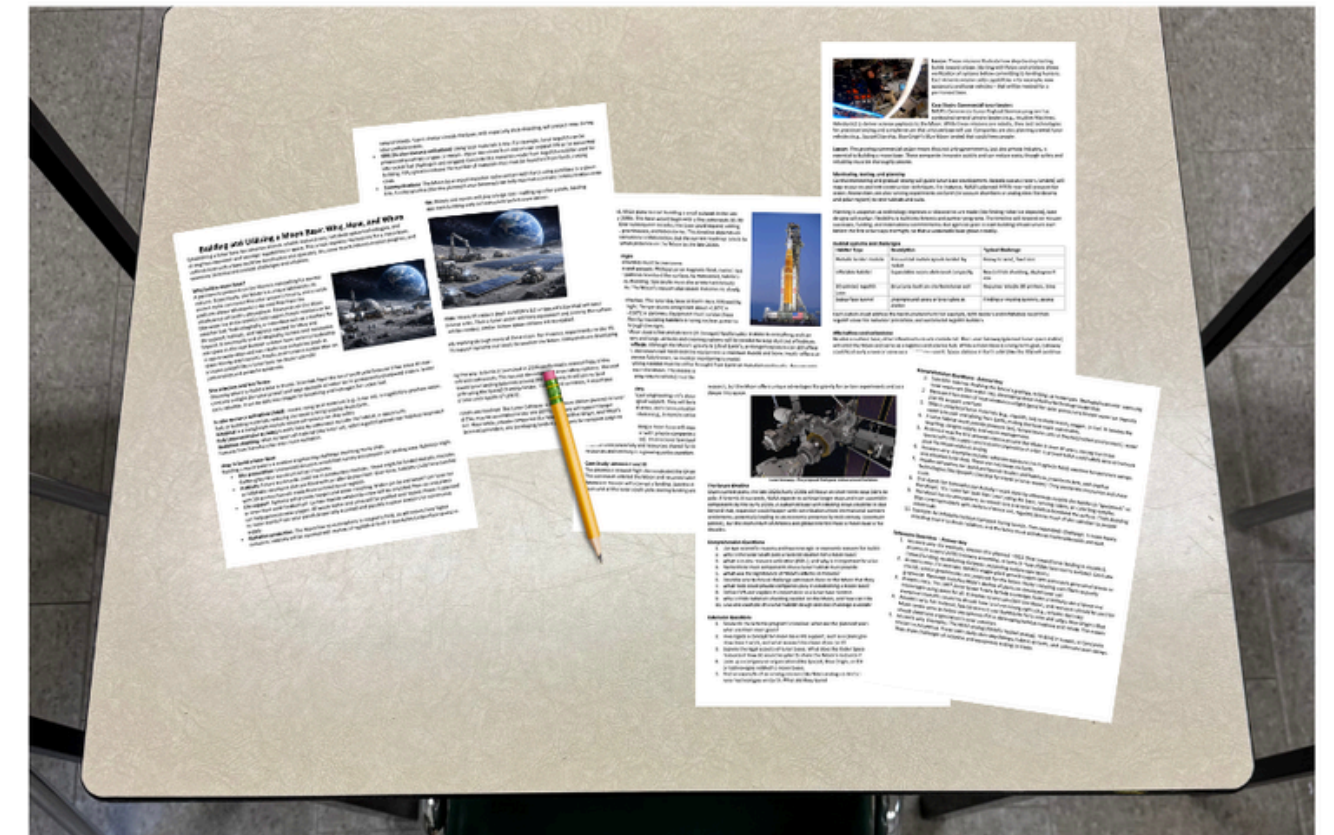


THE PROBLEMS YOU FACE

- Limited time to teach scientific literacy and strengthen students' reading and analysis skills.
- Need meaningful extension activities to engage fast-moving learners.
- Difficulty creating effective last-minute sub plans that still support student learning.

CLASSROOM READY

- Questions and Answer Key
- **No Prep, Ready-to-Use:** Print or assign digitally with Google Docs, Microsoft Word, and PDF formats for flexible classroom use
- **Includes Varied Question Types:** Knowledge, thinking, connecting, application, and open-ended questions.



What Will Your Students Learn?

READING COMPREHENSION ARTICLE & QUESTION BUNDLE

Article with
Comprehension
Questions

Grade 8 and Up

Print & Digital

- Why Build a Moon Base?
- Scientific, Economic, and Strategic Benefits
- Lunar South Pole and Site Selection
- In-Situ Resource Utilization (ISRU)
- Life Support Systems and Sustainability
- Habitat Design
- Radiation Shielding and Regolith Use
- Extreme Temperatures and Thermal Control
- Lunar Dust and Environmental Challenges
- Low Gravity and Human Health
- Artemis Missions and Timeline
- Lunar Gateway and Orbital Infrastructure
- Role of Private Companies and Space Industry
- Robotics and Automation in Construction
- Communication Systems and Logistics
- International Cooperation and Space Policy

Comprehension Questions

1. List two scientific reasons and two strategic or economic reasons for building a moon base?
2. Why is the lunar south pole a favored location for a moon base?
3. What is in-situ resource utilization (ISRU), and why is it important for a lunar base?
4. Name three main components that a lunar habitat must provide.
5. What was the significance of NASA's Artemis II mission?
6. Describe the challenges astronauts face on the Moon that they do NOT face on Earth.
7. What are the benefits of building a moon base?
8. Define the term "habitat" in the context of a moon base.
9. Why is radiation shielding important for a moon base?
10. Give one example of how a moon base could be used for scientific research.

Extension

1. Research the latest news about the Artemis program and write a short report.
2. Interview a local scientist or engineer about the challenges of space exploration.
3. Design a lunar habitat and write a proposal for its construction.
4. Write a story about a lunar mission.
5. Create a model of a lunar base.
6. Investigate the history of space exploration and write a timeline.
7. Compare the challenges of building a moon base to building a space station.
8. Research the role of private companies in space exploration.
9. Write a letter to a local politician advocating for space exploration.
10. Create a presentation about the benefits of building a moon base.

Building and Utilizing a Moon Base: Why, How, and When

Establishing a lunar base can advance science, enable resource use, test deep-space technologies, and strengthen economic and strategic capabilities in space. This article explains motivations for a moon base, outlines how such a base could be constructed and operated, discusses recent Artemis mission progress, and examines technical and societal challenges and solutions.

Why build a moon base?

A permanent presence on the Moon is compelling for several reasons. Scientifically, the Moon is a unique laboratory: its ancient rocks can reveal the solar system's history, and a stable platform allows telescopes to be used free from the interference of Earth's atmosphere. Resources on the Moon (like water ice at the poles) could support future missions or be used for fuel. Technologically, a moon base acts as a testbed for life support, habitats, and logistics needed for Mars and beyond. Economically and strategically, nations and companies see space as the next frontier: a moon base cements leadership in space exploration and can create new industries (such as space mining and tourism). Finally, international cooperation on a shared project like a lunar base can foster scientific partnerships and peaceful space use.



Site selection and Key Terms

Choosing where to build a base is crucial. Scientists favor the lunar south pole because it has areas of near-constant sunlight (for solar power) and large deposits of water ice in permanently shadowed craters. Water ice is valuable: it can be split into oxygen for breathing and hydrogen for rocket fuel.

In-situ resource utilization (ISRU) - means using local materials (e.g., lunar soil, or regolith) to produce water, fuel, or building materials, reducing the need to bring supplies from Earth.

A habitat is a living/work module where astronauts can stay safely.

EVA (extravehicular activity) is work done by astronauts outside the habitat, in space suits.

Radiation shielding refers to layers of material (like lunar soil, called regolith) placed over habitats to protect humans from harmful solar and cosmic radiation.

How to build a lunar base

Building a moon base is a massive engineering challenge. Key steps include:

- **Site preparation:** Establishing a base involves several steps: flattening the landing area, building a habitat, and setting up life support systems.
- **Habitat construction:** Habitats must be built to withstand the harsh lunar environment, including extreme temperatures, radiation, and dust.
- **Life support systems:** These systems are essential for sustaining human life on the Moon. They include air filtration, water recycling, and food production.
- **Power generation:** Solar panels are the primary power source, but backup systems like batteries or small nuclear reactors are also needed.
- **Communication:** A robust communication system is vital for coordinating activities and sending data back to Earth.
- **Transportation:** Reliable transport systems are necessary for moving supplies and personnel between the base and lunar rovers or landers.

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Your Reading

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How to build a lunar base

Building a moon base is a massive engineering challenge involving many steps, from site selection to habitat construction and resource utilization.

- Site preparation:** Unmanned missions would first survey and prep the site, flattening ground or constructing initial structures.
- Habitats:** Future astronauts could live in pressurized modules, or inflatable structures that are filled with air after deployment. Other options include 3D-printed tunnels made from sintered lunar regolith.
- Life support:** Systems will provide oxygen and water recycling. Water can be extracted from solar-heated soil. Carbon dioxide exhaled by crew can be used to help generate new oxygen. All waste water and urine will be recycled. Power will come mainly from solar panels (especially at the poles) and possibly nuclear reactors.
- Radiation protection:** The Moon has no atmosphere or magnetic field to protect against cosmic radiation. Habitats will be covered with meters of regolith or built underground.



natural shields. Storm shelters inside the base, with especially thick shielding, will protect crew during solar particle events.

- ISRU (in-situ resource utilization):** Using local materials is key. For example, lunar regolith can be processed to extract oxygen or metals. Water ice mined from craters can support life or be converted into rocket fuel (hydrogen and oxygen). Concrete-like materials made from regolith could be used for building. ISRU greatly reduces the number of materials that must be launched from Earth, cutting costs.
- Communications:** The Moon base would maintain radio contact with Earth using satellites or a direct link. A relay satellite (like the planned Lunar Gateway) can help maintain constant communication even on the far side.
- Robotics and logistics:** Robots and rovers will play a large role—setting up solar panels, hauling materials, and perhaps even building early infrastructure before crew arrives.



- Launch and transportation:** Heavy-lift rockets (such as NASA's SLS or SpaceX's Starship) will send modules and supplies to lunar orbit. Then a lunar lander will ferry equipment and crew to the surface. Frequent supply flights will be needed, similar to how space stations are resupplied.

NASA and its partners are already working through many of these steps. For instance, experiments on the ISS have tested plant growth and life support systems that could be used on the Moon. Companies are developing lunar landers and rovers.

Artemis missions and timeline

NASA's Artemis program is paving the way. Artemis II (launched in 2026) performed a crewed flyby of the Moon, testing the Orion spacecraft with astronauts. This success demonstrated crew safety systems. The next goal, Artemis III, is slated for a crewed lunar landing (planned around 2027). Artemis III will aim to land astronauts near the lunar south pole using the SpaceX Starship lander. If Artemis III succeeds, it would put humans on the Moon for the first time since Apollo 17 (1972).

International and commercial partners are involved. The Lunar Gateway, a small space station planned in lunar orbit by NASA with ESA, JAXA, and CSA, may be assembled in the late 2020s. Gateway will support longer missions by acting as a staging point. Meanwhile, private companies like SpaceX and Blue Origin, and NASA's CLPS (Commercial Lunar Payload Services) providers, are developing landers and rovers to transport cargo to the Moon in the early 2020s.

Looking ahead, NASA plans to start building a small outpost in the late 2020s or early 2030s. This base would begin with a few astronauts 30–90 day missions. Over subsequent decades, the base could expand, adding more habitats, greenhouses, and laboratories. This timeline depends on funding and international collaboration, but the current roadmap points to a continuous human presence on the Moon by the late 2030s.

Technical challenges

Several technical hurdles must be overcome:

- Radiation and vacuum:** Without air or magnetic field, cosmic rays and solar particles bombard the surface. As mentioned, habitats need heavy shielding. Spacesuits must also protect astronauts during EVAs. The Moon's vacuum also causes materials to slowly degrade.



It takes 14 Earth days, followed by a 14-day return trip. The temperature on the Moon ranges from about +120°C in direct sunlight to -180°C in shadow. Astronauts must survive these conditions or using nuclear power to generate heat.

Life support systems are a major challenge. Astronauts must bring everything they need, including food, water, and oxygen. The Moon's gravity is 1/6 of Earth's, which could lead to muscle and bone loss. Medical monitoring is crucial. Equipment must be highly reliable, and emergency systems must be planned.

Communication is also a challenge. The Moon is about 384,400 km from Earth. Astronauts will work 12-hour days but must be isolated and confined, so habitat design must include communication links to Earth (though with about 1.3 second delay). Communication systems on base then back to Earth must consider health and safety.

Cost is another major hurdle. Building a moon base will require tens of billions of dollars over many years. NASA is exploring public-private partnerships, and the Outer Space Treaty also plays a role in how countries share or compete for space resources.

The Orion spacecraft's life-support systems beyond Earth orbit are being tested. Artemis III will mark the first human landing on the Moon and habitat plans.



Lesson: These missions illustrate how we can build toward a base. Starting with flybys and landings, we can verify systems before committing to a permanent base. Each Artemis mission adds capabilities—like testing spacesuits and lunar vehicles—that will be essential for a permanent base.

Case Study: Commercial lunar landers

NASA's Commercial Lunar Payload Services (CLPS) program has contracted several private landers (e.g., Intuitive Space's Peregrine, SpaceX's Starship, Blue Origin's Blue Moon lander) that could ferry people, equipment, and science payloads to the Moon. While these missions are robotic, they will verify systems before committing to a permanent base. Each Artemis mission adds capabilities—like testing spacesuits and lunar vehicles—that will be essential for a permanent base.

Lesson: The growing commercial sector means that not only governments, but also private companies, can contribute to lunar exploration. These companies innovate quickly and can reduce costs. Reliability must be thoroughly proven.

Monitoring, testing, and planning

Careful monitoring and gradual testing will guide lunar base development. Robotic scout missions and test construction techniques. For instance, NASA's planned VIPER rover will test water resources. Researchers are also running experiments on Earth (in vacuum chambers or analog habitats) to test habitats and suits.

Planning is adaptive: as technology improves or discoveries are made (like finding richer resources), plans will evolve. Flexibility is built into Artemis and partner programs. The timeline will be adjusted based on successes, funding, and international commitments. But agencies plan to start building a sustainable base grows steadily.

Habitat systems and challenges

Habitat Type	Description	Typical Challenge
Metallic lander module	Pressurized metal capsule landed by rocket	Heavy to send, fragile
Inflatable habitat	Expandable rooms delivered by lander	Needs thick shielding, risk of puncture
3D-printed regolith base	Structures built on-site from lunar soil	Requires reliable 3D printers, time
Subsurface tunnel	Underground caves or lava tubes as shelter	Finding or making tunnels, access

Each system must address the harsh lunar environment: for example, both landers and inflatables need thick shielding for radiation protection, and automated regolith builders.

Alternatives and extensions

Besides a surface base, other infrastructures are considered. The Lunar Gateway will orbit the Moon and serve as a logistics and science hub. While a moon base could host early crews or serve as a rendezvous point. Space stations in Earth orbit can test life support systems.

research, but the Moon offers unique advantages like gravity for certain experiments and as a launchpad deeper into space.



Lunar Gateway – The proposed first space station around the Moon

The future timeline

Given current plans, the late 2020s/early 2030s will focus on short-term stays (days to weeks). Artemis III succeeds, NASA expects to achieve longer stays and start assembling components by the early 2030s. A sustained base with rotating crews could be in place by the mid-2030s. Beyond that, expansion could happen with contributions from international partners. Settlements, potentially leading to an economic presence by mid-century. Uncertain timelines, but the momentum of Artemis and global interest make a moon base a realistic goal in the next decades.

Comprehension Questions

- List two scientific reasons and two strategic or economic reasons for building a moon base.
- Why is the lunar south pole a favored location for a moon base?
- What is in-situ resource utilization (ISRU), and why is it important for a lunar base?
- Name three main components that a lunar habitat must provide.
- What was the significance of NASA's Artemis II mission?
- Describe one technical challenge astronauts face on the Moon that they do not face on Earth.
- What roles could private companies play in establishing a moon base?
- Define EVA and explain its importance in a lunar base context.
- Why is radiation shielding needed on the Moon, and how can it be provided?
- Give one example of a lunar habitat design and one challenge associated with it.

Extension Questions

- Research the Artemis program's timeline: what are the planned years for Artemis II, III, and IV? What are their main goals?
- Investigate a concept for moon base life support, such as a plant growth system. How does it work, and what research has been done on it?
- Explore the legal aspects of lunar bases. What does the Outer Space Treaty say about resource ownership? How do countries plan to share the Moon's resources?
- Look up a company or organization (like SpaceX, Blue Origin, or ESA) and describe one technology related to moon bases.
- Find an example of an analog mission (like Mars analogs or Arctic stations) where humans or robots tested life support systems. What did they learn?

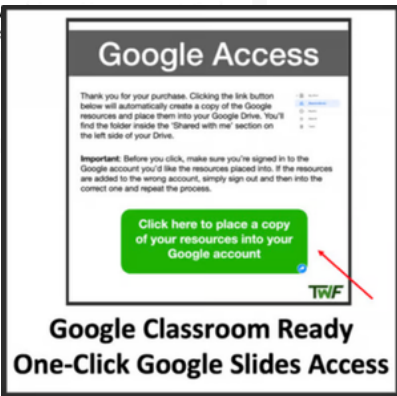
Comprehension Questions - Answer Key

- Scientific reasons: studying the Moon's geology, setting up telescopes. Strategic/economic: accessing lunar resources (like water ice), developing space industry/technology leadership.
- Because it has areas of near-constant sunlight (good for solar power) and known water ice deposits (for life support and fuel).
- ISRU is using local lunar materials (e.g., regolith, ice) to make water, oxygen, or fuel. It reduces the need to launch everything from Earth, making the base more sustainable.
- A lunar habitat must provide pressure (air), temperature control (heated/cooled environment), water recycling, oxygen supply, and waste management.
- Artemis II was the first crewed mission around the Moon in over 50 years, testing the Orion spacecraft's life support and systems beyond Earth orbit. It proved NASA could safely send astronauts past the Moon without landing.
- Answers vary: examples include radiation exposure (no magnetic field), extreme temperature swings, and abrasive lunar dust. These are not issues on Earth.
- Private companies can build and launch landers and habitats, provide rockets, and develop technologies (like SpaceX's Starship for travel or lunar rovers). They accelerate innovation and share costs.
- EVA stands for Extravehicular Activity—work done by astronauts outside the habitat (a "spacewalk" on the Moon). It's crucial for tasks like constructing the base, running cables, or collecting samples.
- The Moon has no atmosphere, so cosmic rays and solar radiation bombard the surface. Thick shielding (like covering habitats with meters of moon soil, regolith) blocks much of this radiation to protect astronauts.
- Example: An inflatable habitat (compact during launch, then expanded). Challenge: it needs heavy shielding over it to block radiation, and the fabric must withstand micrometeoroids and dust.

Extension Questions – Answer Key

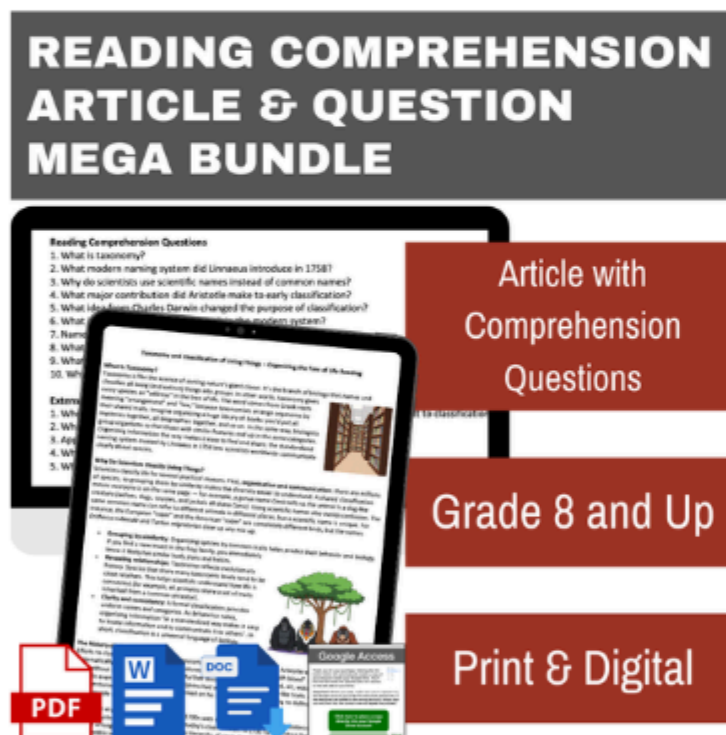
- Answers vary. For example, Artemis III is planned ~2025 (first crewed lunar landing in decades), Artemis IV around 2028 (Gateway assembly), Artemis V ~late 2020s (scientist to surface). Goals are crewed landing, establishing Gateway, expanding surface operations.
- Answers vary. For example, NASA's Veggie plant growth system lets astronauts grow small plants on the ISS; similar greenhouses are proposed for the Moon. Water recycling uses filters to purify greywater. Research includes NASA's studies of plants in simulated lunar soil.
- Answers vary. The 1967 Outer Space Treaty forbids sovereign claims or military use of space and encourages using space for all. It implies no one can claim the Moon, and resources should be used for everyone's benefit. Countries discuss how to share mining rights (e.g., Artemis Accords).
- Answers vary. For instance, SpaceX plans to use Starship to ferry crew and cargo; Blue Origin's Blue Moon lander aims to deliver equipment; ESA is developing habitat modules and robots. The answer should detail one organization's lunar activities.
- Answers vary. Examples: The HERA analog (NASA's Habitat analog), HI-SEAS in Hawaii, or Concordia Station in Antarctica. These tests study team psychology, habitat systems, and communication delays. They show challenges of isolation and equipment testing on Earth.

Comprehension and Extension Questions



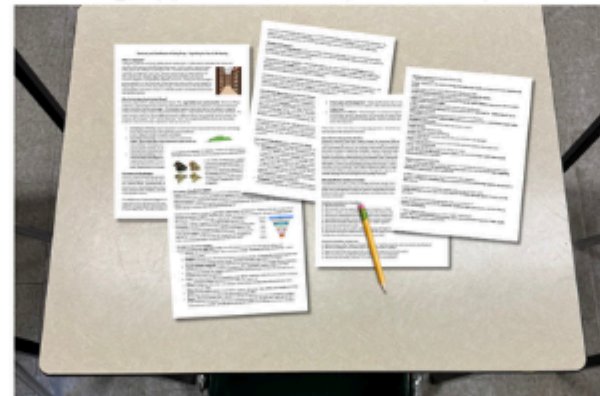
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★★★★★ Extremely satisfied - It is a good supplemental activity either for review and at the same time introducing some concept. I also use this for sub plan. It is well presented, organized and interesting.

★★★★★ Extremely satisfied - This a great resource. I used this for a sub plan. It was fun and engaging for my students.

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