



PART 1

Read the text below and answer questions 1–13.

THE CHALLENGES OF HUMAN SETTLEMENT ON MARS

A

For more than a century, Mars has served as a canvas for scientific ambition and popular imagination, shifting from “canals” in early telescopes to rover panoramas and orbital mineral maps. In the 21st century, the idea of a permanent settlement has moved from speculative fiction into policy discussions and private-sector roadmaps. Yet a long-lived community is not simply a longer expedition. A settlement must function as an interdependent system—habitat, power, life-support, agriculture, medicine, and governance—under conditions that are fundamentally unlike Earth’s. The main obstacles are not single “show-stoppers” but coupled constraints: every solution adds mass, energy demand, failure points, and human workload, and those costs compound over years.

B

Among the most serious hazards is ionising radiation, especially galactic cosmic rays and episodic solar particle events. On Earth, a strong magnetosphere and thick atmosphere reduce exposure; Mars has neither a protective global magnetic field nor sufficient air mass to provide comparable shielding. Measurements from orbiters and surface missions indicate that cumulative doses on the surface could become significant over long durations, elevating cancer risk and potentially affecting the nervous system. Because shielding mass is expensive to launch, engineers consider strategies that use local materials: covering habitats with regolith, surrounding living quarters with water or polyethylene, or placing modules partly or fully underground. However, each approach introduces design trade-offs—excavation equipment, structural reinforcement, dust management, and emergency egress—so radiation protection becomes a systems-engineering problem rather than a single barrier.

C

Basic survival on Mars also requires transforming an environment that is physiologically incompatible with unprotected humans. Average temperatures are far below freezing, atmospheric pressure is a fraction of Earth’s, and the air is dominated by carbon dioxide. Even small leaks or thermal failures can cascade rapidly in a closed habitat. Water, essential for drinking, hygiene, and oxygen production, is present mainly as ice, often embedded in regolith and frequently contaminated with dust or salts. Extracting usable water therefore demands energy-intensive excavation, heating, filtration, and chemical processing. Crucially, a settlement cannot rely on frequent resupply; it must operate life-



support systems that recycle air and water at high efficiency, tolerate component failures, and be maintainable by a small crew with limited spare parts.

D

Food production is another bottleneck that turns “staying” into a fundamentally different challenge from “arriving”. Shipping all calories from Earth is prohibitively costly and risky, so settlers would need to produce at least some food locally and progressively expand that share. Yet Martian regolith is not fertile soil: it lacks organic matter, has unfamiliar physical properties, and may contain perchlorates that are toxic unless removed or stabilised. Agricultural designs therefore emphasise controlled environments—sealed grow chambers, artificial lighting, and strict nutrient management—to avoid contamination and ensure predictable yields. In practice, the most plausible early approach is hydroponics, supplemented by processed regolith as an inert growth medium once hazards are mitigated. The agricultural system must also integrate with habitat life-support, using captured carbon dioxide, recovered water, and waste recycling without introducing pathogens or chemical residues.

E

Human factors may prove as limiting as engineering. A crew living for years in confinement, under monotony and constant risk, faces psychosocial stressors that cannot be solved by hardware alone. The distance to Earth produces communication delays that undermine real-time guidance and emotional support, increasing the need for local decision-making and robust conflict-resolution norms. Medical contingencies are especially complex: evacuation may be impossible for months, and small teams cannot carry the full range of specialist expertise. Moreover, chronic stress and disrupted circadian rhythms can interact with immune function and cognition, amplifying operational risk. A viable settlement therefore requires not only technical redundancy but also training, selection, and community practices that sustain cooperation when fatigue, fear, and disagreement are inevitable.

F

Power generation and maintenance underpin every other subsystem. Solar energy is abundant in principle, but output can be sharply reduced by dust storms, seasonal dust loading, and accumulation on panels; the same fine particles that tint the sky can gradually degrade hardware and seals. Nuclear systems offer steadier baseload power but raise safety, logistical, and political challenges, including launch risk and long-term stewardship. Maintenance, meanwhile, becomes a daily discipline: machinery must be modular, diagnosable, and repairable with minimal inventory, suggesting standardised parts and additive manufacturing. Yet “printing” replacement components still requires



feedstock, precision tools, quality assurance, and skilled operators. In effect, reliability is not a single property of a device but the outcome of a maintenance ecosystem that must function even when the settlement is tired, understaffed, or dealing with simultaneous failures.

G

Beyond technology, governance and ethics create uncertainty that may shape feasibility as strongly as any engineering constraint. International space law, including the Outer Space Treaty, restricts national appropriation of celestial bodies, but it leaves unresolved questions about private actors, resource extraction, labour rights, and jurisdiction. As commercial missions become more central, authority can fragment: who sets safety standards, adjudicates disputes, and enforces environmental rules when the “workplace” is another planet? Decisions about planetary protection add further complexity. Preventing contamination is not only a scientific concern—protecting the search for indigenous life and preserving Mars as a research environment—but also a policy question about acceptable risk and enforceable norms. A settlement that treats Mars as a frontier for exploitation may impose irreversible consequences before the global community has agreed on safeguards.

H

For these reasons, the long-term viability of a Martian community depends on planning for sustainability rather than celebrating heroic first landings. A base that survives a year is not the same as a society that can persist for decades under delayed resupply and occasional disaster. Settlement planners therefore emphasise redundancy, cross-training, reliable governance, and a culture that can withstand conflict and failure without collapse. Progress is likely to be incremental—robotic construction, long-duration habitat tests in analogue environments, and evolving international governance frameworks—rather than a sudden technological leap. Ultimately, the central question is not whether humans can reach Mars, but whether they can live there safely and responsibly, with honest public communication about risk, cost, and the limits of current technology.

Questions 1–4

Choose the correct heading for each paragraph.

List of Headings

- i Mental and medical pressures created by isolation and distance
- ii The difficulties of producing food safely on Mars
- iii Why radiation protection would be essential for settlers



iv The limits of solar power as a settlement energy source

v Obtaining water and maintaining reliable life-support

vi Legal uncertainty over ownership and responsibility

1 Paragraph **B**

2 Paragraph **C**

3 Paragraph **D**

4 Paragraph **E**

Questions 5–8

The text has eight paragraphs, **A–H**. Which paragraph contains the following information?
Choose the correct letter, **A–H**.

5 A reference to dust storms reducing the effectiveness of solar energy.

6 The view that privately funded missions complicate questions of authority and regulation.

7 A suggestion that building below the surface could help protect against radiation.

8 The argument that long-term survival requires planning beyond an initial landing phase.

Questions 9–13

Complete the sentences below. Choose **NO MORE THAN TWO WORDS** from the text for each answer.

9 Mars has no global, so radiation reaches the surface more easily.

10 Much of Mars's water is found as ice mixed with dust or

11 The most plausible early method for growing food on Mars is

12 Communication delays can increase the need for local

13 Decisions about planetary may have long-term consequences.

Answer Key

1. iii

2. v

3. ii



4. i
5. F
6. G
7. B
8. H
9. magnetic field
10. salts
11. hydroponics
12. decision-making
13. protection