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1. Overview of Mars

- Position in Solar System: 4th planet from the Sun
- Distance from Sun: ~227.9 million km (1.52 AU)
- Orbital Period: 687 Earth days (1 Mars year)
- Rotation Period: 24.6 hours (1 Mars day or “sol”)
- Diameter: 6,779 km (about 53% of Earth’s)
- Gravity: 3.72 m/s² (38% of Earth’s)
- Temperature:
  - Average: -60°C (-80°F)
  - Range: -140°C (-220°F) at poles to 20°C (70°F) near the equator
- Moons: 2 (Phobos and Deimos)
- Atmosphere: Thin (mostly carbon dioxide – 95%)

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2. Key Characteristics

- Surface: Rusty red color due to iron oxide (rust).
- Geology: Volcanoes, canyons, polar ice caps, and ancient riverbeds.
- Color: Reddish, often called the “Red Planet.”
- Axial Tilt: 25.2° (Seasons similar to Earth).
- Polar Ice Caps: Composed of water and carbon dioxide ice.

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3. Orbital and Rotational Facts

- Orbital Speed: 24 km/s
- Seasons: Similar to Earth but twice as long due to longer orbit.
- Eccentric Orbit: Mars’ distance from the Sun varies, affecting seasonal extremes.

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4. Atmosphere and Climate

- Composition:
  - 95% Carbon Dioxide (CO_2)
  - 3% Nitrogen (N_2)
  - 1.6% Argon
  - Trace amounts of oxygen and water vapor
- Pressure: ~0.6% of Earth’s atmosphere (very thin).
- Weather:
  - Dust Storms: Largest in the solar system, can cover the entire planet.
  - Winds: Up to 100 km/h but feel weak due to thin atmosphere.
- Water Presence:
  - Ice exists at poles and beneath the surface.
  - Evidence of ancient rivers, lakes, and possible oceans.

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5. Surface and Geological Features

- Volcanoes:
  - Olympus Mons: Largest volcano in the solar system (22 km high).
- Canyons:
  - Valles Marineris: Massive canyon system stretching over 4,000 km (10x longer than the Grand Canyon).
- Impact Craters:
  - Hellas Basin: Largest impact crater on Mars (2,300 km wide).
- Plains: Vast, flat regions formed by ancient lava flows.

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6. Temperature and Climate

- Cold and Dry: Surface temperatures rarely rise above freezing.
- Diurnal Range: Extreme temperature shifts between day and night.
- Polar Caps: Grow and shrink with seasons, composed of dry ice (CO_2) and water ice.

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7. Moons of Mars

- Phobos:
  - Larger and closer moon, orbits Mars every 7.6 hours.
  - Slowly spiraling inward – will eventually crash into Mars or break apart.
- Deimos:
  - Smaller and farther, orbits Mars every 30.3 hours.
  - Gradually drifting away.

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8. Exploration of Mars

- Flybys and Orbiters:
  - Mariner 4 (1965): First successful Mars flyby.

    - Mars Reconnaissance Orbiter (2006): Provides high-resolution mapping.
- Rovers:
    - Pathfinder & Sojourner (1997): First rover on Mars.
    - Spirit & Opportunity (2004): Discovered evidence of ancient water.
    - Curiosity (2012 – Present): Studied Gale Crater and found organic compounds.
    - Perseverance (2021 – Present): Searching for signs of ancient life.
- Landers:
    - Viking 1 & 2 (1976): First successful landers on Mars.
    - InSight (2018 – 2022): Studied Mars' interior and seismic activity.

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9. Interesting Facts

- Tallest Volcano: Olympus Mons (3 times the height of Mount Everest).
- Longest Canyon: Valles Marineris – would stretch across the U.S.
- Ancient Water: Evidence suggests Mars once had rivers, lakes, and possibly oceans.
- Dust Storms: Can last for weeks or months and envelop the entire planet.
- Potential for Life: Past conditions may have been suitable for microbial life.

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10. Why is Mars Important?

- Habitability: Mars is the most Earth-like planet and a candidate for future human exploration.
- Search for Life: Mars may hold signs of past or present microbial life.
- Colonization: Long-term potential for human settlement and terraforming.
- Space Exploration: Understanding Mars helps advance technologies for space travel.

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11. Key Measurements

Property	Value
Diameter	6,779 km
Distance from Sun	227.9 million km (1.52 AU)
Orbital Period	687 Earth days
Rotation Period	24.6 hours
Gravity	3.72 m/s^2
Surface Temperature	-140°C to 20°C
Atmospheric Pressure	0.6% of Earth’s
Moons	2 (Phobos, Deimos)

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12. Mars in Mythology and Culture

- Named After: Mars, the Roman god of war (Greek: Ares).
- Cultural Symbolism:
  - Associated with war and conflict.
  - Astrological symbol: ♂
- Popular in Science Fiction: Featured in movies, books, and games (e.g., The Martian).

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13. Differences Between Mars and Earth

Feature	Mars	Earth
Atmosphere	95% CO_2, thin	78% N_2, 21% O_2
Surface Temp.	-60°C average	15°C average
Pressure	0.6% of Earth’s	1 bar
Moons	2	1
Water	Frozen (polar caps)	Liquid oceans

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14. Can Mars Support Life?

- Surface: Harsh for current life (low pressure and cold).
- Subsurface: Potential for microbial life beneath the surface or near hydrothermal vents.
- Terraforming: Theoretical ideas suggest Mars could be transformed into a more habitable world over centuries.