Mission to Mars

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Proposed path to Mars

θ Depart: 78.02
θ Arrival: 78.91

Depart Earth:
January 27, 2027

Arrive at Mars:
July 6, 2027
Proposed Return to Earth

θ Depart: 79.58
θ Arrival: 80.99

Depart Mars:
August 5, 2027

Arrive at Earth:
January 8, 2028

Total Trip Time: 346 days
Path to Mars’ Surface
Path to Mars’ Surface
Path to Mars’ Surface

Not all landing patterns work
Hohmann Transfer

$$
\epsilon = \frac{\alpha - r_{\text{min}}}{r_{\text{min}}}
$$

$$
\alpha = \frac{2r_{\text{min}}r_{\text{max}}}{r_{\text{min}} + r_{\text{max}}}
$$
Equations

Time Integral

\[ \int \frac{1}{(1 + \epsilon \cos \theta)^2} \, dy = \frac{\epsilon \sin \theta}{(\epsilon^2 - 1)(\epsilon \cos \theta + 1)} - \frac{2 \tanh^{-1} \left( \frac{(\epsilon - 1) \tan \left( \frac{\theta}{2} \right)}{\sqrt{\epsilon^2 - 1}} \right)}{(\epsilon^2 - 1)^{3/2}} \]

\[ \Delta t = \frac{\alpha^2}{\sqrt{GM}} \left[ \int_0^{\theta_f} \frac{1}{(1 + \epsilon \cos \theta)^2} \, d\theta - \int_0^{\theta_i} \frac{1}{(1 + \epsilon \cos \theta)^2} \, d\theta \right] \]
Analytic Integration vs Numerical Integration
ΔV1: 0          Launch
ΔV2: 24,860.3    Depart LEO
ΔV3: 12,851.5    Arrive LMO
ΔV4: 104.0969    Begin Transfer to Surface
ΔV5: 103.8207    Match Surface Speeds
ΔV6: 103.8207    Leave Mars Surface
ΔV7: 104.0969    Enter LMO
ΔV8: 15.1976     Depart LMO
Velocity vector

\[ \mathbf{v} = \sqrt{\frac{GM}{\alpha}} \cdot \left( \epsilon \sin \theta \hat{r}, (1+\epsilon) \hat{\theta} \right) \]
Transfer orbit paths

\[ \epsilon = \frac{r_2 - r_1}{r_1 \cos(\theta_1 - \omega_T) - r_2 \cos(\theta_2 - \omega_T)} \]

\[ \alpha = r_1 (\epsilon \cos(\theta_1 - \omega_T) + 1) \]
Space Launch System

SLS 130-metric-ton Evolved Configuration

Advanced Boosters

Interstage

RS-25 Engines (4)

Core Stage

Upper Stage with J-2X Engines (2)

Cargo Payload Adapter

Payload Fairing

Instrument Unit

http://www.nasa.gov/pdf/664158main_sls_fs_master.pdf
Dry Mass of SLS: 2950000 kg
Max Payload: 130 000 kg
Height: 117 m
Fuel: LH2 and LOX

Mass Initial: 2.1453E10 kg
Needed SLS’s: 16502

http://www.spacenews.com/article/civil-space/36581nasa-defends-space-launch-system-against-charge-it-is-draining-the
Solid Rocket Boosters

RS-25
Isp: 452s

J-2X
Isp: 448s
Orion

Heat Shielding

Outersurface: Avcoat
Generates surface temp of 6000° F
Max surface temp 3000° F

Backshell: AETB-8 tiles
Protection from excessive reentry heat and debris

Radiation

Maximize material already on board
Introduction of Tesseract
Combination of metals to block gamma rays

Power

UltraFlex solar array
Electrical power for life support
Propulsion and communications systems

6000 watts of power
Rechargeable lithium-ion batteries
Life Support

Air

Regeneration:
- CO₂ collected and broken down
- Produces water and methane
  - Water → oxygen and hydrogen

Water

Fuel cells:
- Generates drinkable water
Recycling:
- Generates drinkable and washable water

Nutrition

Male: 708g
Female: 566g
Total Food: 1982g * 346 = 686 kg

http://microgravity.genc.nasa.gov/print/orion_prt.htm
Costs

SLS: $500 million
Orion: $1 billion
Launch Pad and Kennedy Space Centre Upkeep: $400 million
Engineering: $1.5 billion
Fuel: LH2: 98 cents per gallon
  LOX: 67 cents per gallon
  Cost: $3,166,916.54
Total Cost: $82.5 trillion