NAME _____

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HISPANIC HERITAGE MONTH

Franklin Chang Díaz

Seven Missions, and a Rocket That Runs on Plasma

Two Careers in Spaceflight

Franklin Chang Díaz was born in San José, Costa Rica, in 1950, to a Costa Rican mother and a father of Chinese descent. Captivated by the space race as a child, he moved to the United States as a teenager with limited English and very little money, repeated a year of high school to master the language, and went on to earn a doctorate in **applied plasma physics** from MIT in 1977.

NASA selected him as an astronaut in 1980 — the first immigrant from Latin America chosen for the corps. Between 1986 and 2002 he flew **seven** space shuttle missions, tying the record for the most spaceflights by any astronaut. His missions deployed satellites, conducted materials and life-science research, and delivered components to the International Space Station.

Throughout his astronaut career he pursued a second line of work: **electric propulsion**. Conventional chemical rockets burn fuel and expel it at roughly 4.5 kilometers per second. That limits how far a given mass of propellant can take you. Chang Díaz's design, the **VASIMR** engine, instead heats a gas into plasma using radio waves, then uses magnetic fields to channel and accelerate it — reaching exhaust velocities an order of magnitude higher.

The trade-off is thrust. A plasma engine produces a very gentle push, useless for launching from Earth's surface but valuable in the vacuum of space, where it can run continuously for months and build enormous speed. Chang Díaz founded Ad Astra Rocket Company to develop the technology for cargo and crewed missions beyond Earth orbit.

Part 1 · Reading Comprehension

1. What two very different careers did Chang Díaz pursue at the same time?

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2. Explain the difference between a chemical rocket and the VASIMR engine in how they produce thrust.

3. Why can a plasma engine not launch a spacecraft from the ground?

4. Why does higher exhaust velocity matter for a long journey?

Part 2 · Critical Thinking

Chang Díaz had already achieved the rare goal of becoming an astronaut, and then spent decades on a difficult engine project that may not be finished in his lifetime. Why might someone choose a problem they may never see solved?

Part 3 · STEM Challenge

Exhaust Velocity and Propellant

Rocket performance depends heavily on exhaust velocity — how fast propellant leaves the engine. Compare a chemical rocket at 4.5 km/s with a plasma engine at 50 km/s. Show your work.

1. How many times greater is the plasma engine's exhaust velocity?

2. A chemical rocket burns 9,000 kg of propellant for a maneuver. Roughly how much would a plasma engine need for a similar change in speed, using your ratio?

3. The plasma engine's thrust is thousands of times weaker. Explain in one or two sentences why it is still the better choice for a months-long journey but the wrong choice for launch.

4. If saved propellant mass can be replaced by cargo, why does this matter for a Mars mission?