NAME _____

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CLASS _____

HISPANIC HERITAGE MONTH

Ellen Ochoa

Optical Engineering, Spaceflight, and Leadership at NASA

Engineering a Career in Orbit

Ellen Ochoa was born in Los Angeles in 1958 to a family with Mexican roots, and grew up in La Mesa, California. An accomplished flutist, she weighed a career in music before committing to science. She completed a bachelor's degree in physics, then a master's and, in 1985, a doctorate in **electrical engineering** at Stanford University.

Ochoa's doctoral and postdoctoral work was in **optical information processing** — using optics and computing to extract meaning from images. She is a co-inventor on three patents: an optical inspection system, an optical object-recognition method, and a method for removing noise from images. This is foundational **machine vision** work, the same problem space that industrial inspection and autonomous vehicles occupy today.

Selected by NASA in 1990, Ochoa first flew in April 1993 aboard Discovery on STS-56, an atmospheric science mission, becoming the first Hispanic woman in space. Over four shuttle flights she accumulated nearly 1,000 hours in orbit. She served as a **mission specialist** and flight engineer, operated the shuttle's robotic manipulator arm, and flew missions that delivered hardware and supplies to the International Space Station.

Her career then moved from the flight deck to management. She served as deputy director and, from 2013 to 2018, director of NASA's Johnson Space Center — the first Hispanic person and the second woman to hold that post, responsible for human spaceflight operations and astronaut training.

Part 1 · Comprehension & Analysis

1. Explain the connection between Ochoa's patented research and a technology in wide use today.

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2. STS-56 was an atmospheric science mission. Why is low Earth orbit a useful vantage point for studying the ozone layer?

3. Ochoa moved from flying missions to directing a NASA center. Identify two skills that transfer between those roles and one that does not.

4. Ochoa is regularly described as a role model. Based on the passage, what specifically did she do that a student today could actually imitate?

Part 2 · Quantitative Challenge

Orbital Mechanics and Mission Time

A space shuttle in low Earth orbit at roughly 300 km altitude completed one orbit in about 90 minutes, traveling at approximately 7.7 km/s. Ochoa logged approximately 1,000 hours in space. Show your work and keep units consistent.

1. Calculate the total number of orbits represented by 1,000 hours of flight time.

2. At 7.7 km/s, how far did she travel in those 1,000 hours? Express your answer in kilometers, in scientific notation.

3. The Moon is about 384,400 km from Earth. How many round trips to the Moon does that distance represent?

4. An orbit's period depends on altitude, not on the mass of the spacecraft. Explain briefly why a heavier shuttle does not orbit more slowly.

Part 3 · Discussion & Extension

Ochoa's optical-recognition research is a direct ancestor of the computer vision used in surveillance and autonomous weapons as well as in medical imaging and self-driving cars. Researchers rarely control what their work becomes. What responsibility, if any, does an engineer have for the eventual uses of a technology they helped create?