Narrator: The moon has captivated humanity's collective imagination since ancient times. Humans have studied it for hundreds of years — first with telescopes, then with robotic probes, even sending twelve American astronauts to the lunar surface. But in many ways, our nearest neighbor remains a mystery.

David Lehman, GRAIL Project Manager/Jet Propulsion Laboratory: And so, knowing what happened with the moon will help us understand what happened with the Earth, Venus, Mercury, and Mars. So that's the reason we want to try to understand it. We're trying to understand the past formation of the planets, so that will help us learn the future.

Narrator: Clues about our own planet's history — and the influence of the moon's gravity on Earth, 240,000 miles away — could be locked below that dusty lunar surface.

The Gravity Recovery and Interior Laboratory mission, or GRAIL, features twin spacecraft embarking on a challenging mission to map the moon's gravity.
David Lehman, GRAIL Project Manager/Jet Propulsion Laboratory: Its sole purpose is to measure gravity of the moon, to try to help us understand how the planets were formed, and how they evolved over time.

Narrator: GRAIL's two spacecraft will fly in formation above the lunar surface to measure the variations in gravity.

The mission seeks to reveal clues about our moon's thermal history, and how the inner solar system's rocky planets developed.

GRAIL is departing from Pad B at Cape Canaveral Air Force Station's Space Launch Complex 17.

Prelaunch processing -- and the final countdown -- are managed by NASA's Launch Services Program at nearby Kennedy Space Center.

Tim Dunn, NASA Launch Manager/NASA's Launch Services Program: Our team, especially, gets excited whenever we leave Earth orbit, and going to the moon excites us and excites the public.
Narrator: The two spacecraft -- called GRAIL-A and GRAIL-B -- are riding into space side-by-side aboard a powerful Delta II Heavy rocket built by United Launch Alliance.

It's a rocket with an impressive reliability record.

Tim Dunn, NASA Launch Manager/NASA's Launch Services Program: If we just look at the Delta II rocket, which is the version of the vehicle that we fly today,

NASA has a perfect launch record, 48 for 48.

Narrator: The payload for NASA's most recent lunar mission, called LRO-LCROSS, which weighed in at 6,600 pounds and was the size of a minivan.

It launched in 2009 aboard a massive Atlas V rocket, but that extra performance isn't needed for the GRAIL spacecraft, which together weigh only about 1,600 pounds.

Each unit is about the size of a washing machine, designed to be compact and rugged -- a perfect fit for the Delta II.

Preparing two spacecraft adds an extra challenge to the team's workload, from environmental testing before launch all the way through the countdown.
Bruce Reid, GRAIL Mission Manager/NASA's Launch Services Program: And then,

00:02:56,610 --> 00:03:00,590
for instance, on launch day, we have two dedicated teams -- one to GRAIL A and one to

00:03:00,590 --> 00:03:03,969
GRAIL B. And they'll have to individually power up each spacecraft, and go through

00:03:03,969 --> 00:03:08,750
their health checks, and put the spacecraft in the proper configuration for launch.

00:03:08,750 --> 00:03:13,050
Narrator: After the climb to orbit, the GRAIL spacecraft will be released from the launch

00:03:13,050 --> 00:03:18,560
vehicle one at a time, as launch controllers and managers on the ground wait for news of

00:03:18,560 --> 00:03:20,650
spacecraft separation.

00:03:20,650 --> 00:03:26,130
Bruce Reid, GRAIL Mission Manager/NASA's Launch Services Program: So we will

00:03:26,129 --> 00:03:27,389
definitely wait to celebrate until both spacecraft are safe and are on their translunar cruise

00:03:27,389 --> 00:03:30,639
to the moon.

00:03:30,639 --> 00:03:32,149
Narrator: GRAIL's journey to the moon will take three-and-a-half months,

00:03:32,150 --> 00:03:37,560
a mission plan offering

00:03:37,560 --> 00:03:38,030
plenty of time for controllers to make sure the spacecraft are ready to get to work.

00:03:38,030 --> 00:03:41,189
Bruce Reid, GRAIL Mission Manager/NASA's Launch Services Program: And

00:03:41,189 --> 00:03:44,354
regardless of when we launch, we're going to have a constant arrival date.
So GRAIL A will arrive on New Year's Eve of 2011 and GRAIL B will arrive on New Year's Day of 2012.

Narrator: Each spacecraft will have to execute a critical, 38-minute lunar orbit insertion burn to slide into lunar orbit. Then they'll spend the next five weeks reducing their orbit period and getting into formation.

During the mission's three-month science phase, the moon will rotate three times beneath the two GRAIL spacecraft as they calculate the gravity they encounter.

One spacecraft will trail the other in orbit, and each will slow down or speed up in response to the changing gravitational pull from below.

David Lehman, GRAIL Project Manager/Jet Propulsion Laboratory: And you need the two spacecraft to do that in order to measure the distance between the two very precisely.

Narrator: This data will allow scientists an unprecedented chance to study the gravity of the whole moon -- including the far side, facing away from Earth -- and envision the moon's interior from crust to core.
The GRAIL mission also marks the first time students have a dedicated camera on board a planetary spacecraft, in order to request photos of specific lunar targets. The MoonKam project is headed by Dr. Sally Ride, the first American woman to fly in space. David Lehman, GRAIL Project Manager/Jet Propulsion Laboratory: What students need to do is to go on moonkam.ucsd.edu, and that's how they register to submit for images of the moon. And then the images will be put on the Internet for the students to see. Narrator: At the mission's end, the GRAIL spacecraft will be decommissioned, eventually impacting the lunar surface. The path from the Earth to the moon has been well traveled in recent decades by pioneers like Surveyor... the Apollo astronauts... Lunar Prospector... and many more. Today, GRAIL is ready to take its place in this long line of lunar explorers. David Lehman, GRAIL Project Manager/Jet Propulsion Laboratory: The moment I'm looking forward to is when we finally get into formation flying and we're ready to start...
taking science data for the mission.

Tim Dunn, NASA Launch Manager/NASA's Launch Services Program: I'm going to be passing Complex 17 about 3:30 a.m. on my way to console.

And that hour of the morning, looking off to the east, seeing the rocket bathed in spotlights... It's an emotional time for all of us on the launch team.