SOLARC

SUN

The diameter of the Sun is 864,432 miles, 109 times that of the Earth.

More than 130,000 Earths would fit into the Sun.

The Sun is 93 million miles away, 400 times the distance to the Moon.

The distance from the Earth to the Sun is called an astronomical unit (au).

It would take 193 years to reach the Sun at 55 miles per hour.

The rotational period of the Sun is 25 days.

The temperature of the center of the Sun is more than 25 million degrees fahrenheit.

More energy is produced by the Sun in 1 second than would be used in one million years by the population of the Earth.

Sunshine takes 8 minutes to reach the Earth.

The life expectancy of the Sun is 10 trillion years.

The Sun contains almost 99.9% of mass of our Solar System.

MERCURY

The diameter of Mercury is 3029 miles, 38% that of the Earth.

Mercury rotates once every 58.65 days.

The daytime temperature on Mercury is 620 degrees fahrenheit; the nighttime temperature is -280 degrees fahrenheit.

There is no atmosphere on Mercury.

Mercury orbits the Sun once every 88 days.

You can sometimes see Mercury before sunrise or after sunset within 28 degrees of the Sun.

VENUS

The diameter of Venus is 7519 miles, almost the same size as the Earth.

Venus rotates once every 243 days.

Venus orbits the Sun once every 224.7 days.

The temperature on the surface of Venus is more than 800 degrees fahrenheit.

Venus is covered by thick clouds; the days are always dark and gloomy.

The atmospheric pressure on the surface of Venus is 90 times greater than on the surface of the Earth.

You can sometimes see Venus before sunrise or after sunset within 46 degrees of the Sun. It appears brighter than stars.

MOON

The diameter of the Moon is 2158 miles, 27% that of the Earth.

The Moon rotates once every 27.32 days and it orbits once every 27.32 days. Due to this we always see the same side of the Moon; we never see the back side.

By eye the Moon and Sun appear the same size.

The daytime temperature on the surface of the Moon is 224 degrees fahrenheit; the nighttime temperature is -244 degrees fahrenheit.

Craters on the Moon exist as wide as 161 miles in diameter.

It would take 180 days to reach the Moon at 55 miles per hour.

QUEST®

EARTH

Earth is 7921 miles in diameter.

Earth orbits the Sun once every 365.2422 days. We need an extra day every four years to take care of the quarter day difference – a leap year.

Earth orbits the Sun at 67,000 miles per hour.

MARS

The diameter of Mars is 4219 miles, 53% that of the Earth.

Mars rotates once every 1.02 days, very close to the rotational speed of the Earth.

Mars orbits the Sun once every 687 days.

The atmosphere on Mars is almost entirely carbon dioxide.

The daytime temperature on the surface of Mars is 80 degrees fahrenheit; the nighttime temperature is -100 degrees fahrenheit.

Mars has white polar caps just like Earth; they are made up of frozen carbon dioxide and ice.

The surface of Mars is reddish.

Mars has a volcano, Mount Olympus, that is three times as high as Mount Everest.

There are large canyons on Mars; one is 1800 miles long and more than 300 miles wide in some parts.

Mars is 1.5 au's from the Sun, 1.5 times the Earth's distance from the Sun.

There are no known Martians on Mars.

JUPITER

Jupiter is a gaseous planet, mostly hydrogen.

Jupiter is 88,680 miles in diameter, 11 times the diameter of the Earth.

1400 Earths would fit into Jupiter.

It takes Jupiter just under 12 years to orbit the Sun once.

Jupiter rotates once every 10 hours.

The outermost clouds of Jupiter have a temperature of about -200 degrees fahrenheit.

The great red spot on Jupiter is a giant hurricane-like storm, several times larger than the Earth.

Jupiter is five times as far away from the Sun as the Earth is – 5 au's.

SATURN

Saturn is a gaseous planet.

The diameter of Saturn is 75,000 miles, 9.4 times that of the Earth.

Saturn orbits the Sun once every 29.5 years.

Saturn is 9.5 times as far from the Sun as the Earth is – 9.5 au's.

The outermost cloud layer of Saturn has a temperature of about -260 degrees fahrenheit.

Saturn's ring is made up of small rocks and frozen water. The ring is about 40,000 miles wide and only about 6 miles thick.

Saturn's moon Titan is larger than Mercury.

URANUS

Uranus is a gaseous planet.

The diameter of Uranus is 4 times that of the Earth.

The outer cloud temperature of Uranus is about -350 degrees fahrenheit.

Uranus' mass is 15 times that of the Earth's.

Uranus' axis is tilted near that of the ecliptic plane.

It takes 84 years for Uranus to orbit the Sun once.

Uranus is 19 times as far away from the Sun as the Earth is – 19 au's.

The eight moons on the gameboard not labeled are: Ophelia, Bianca, Cressida, Desdemona, Juliet, Rosalind, Puck, and Belinda.

NEPTUNE

Neptune is a gaseous planet.

The diameter of Neptune is 3.8 times that of the Earth.

It takes 164.8 years for Neptune to orbit the Sun once.

Neptune spins once every 16 hours.

The outermost cloud temperature of Neptune is about -360 degrees fahrenheit.

Neptune is considered a twin to Uranus.

Neptune is 30.1 times as far away from the Sun as the Earth is – 30.1 au's.

PLUTO

Pluto is a rocky planet.

Pluto orbits the Sun once every 248 years.

The diameter of Pluto is about 1800 miles, 23.5% that of the Earth. Earth could hold about 77 Plutos.

Pluto is 39.44 times as far away from the Sun as the Earth is. At 55 miles per hour it would take 7400 years to travel there.

The surface temperature of Pluto is about -400 degrees fahrenheit.

Absolute zero, the coldest possible temperature, is -460 degrees fahrenheit.

ASTEROIDS

The asteroid belt between Mars and Jupiter is made up of hundreds of thousands of asteroids.

One asteroid, Vesta, is visible with the unaided eye.

COMETS

Most comets orbit the Sun. Many have orbital periods of more than 1000 years.

Comets are made up of rock and ice. The tail is composed of particles coming off.

The visible tail of a comet may extend up to 50 million miles.

Halley's comet orbits once every 77 years. It has a diameter of less than 40 miles.

METEORS

Most meteors are smaller than a golf ball.

Many meteor showers are remnants of comet tails.

In Arizona there is a meteorite crater 3/4 of a mile in diameter.

STARS

Light from the closest star, besides our own, takes more than four years to reach the Earth. The distance is more than 250,000 times that of our own Sun. At the present rate of space travel, 25,000 mph, it would take more than 10,000 years to get there.

Stars are made mostly of hydrogen.

A red giant is a very large star. Antares, a red giant star, has a diameter of 4 au. If it were our Sun, we would be located well within it; so would Mars.

A white dwarf is a very contracted star.

A black hole is a star so contracted that its gravitational force has increased to the point where even light cannot escape it.

The matter in a black hole is so dense that a teaspoonful would weigh more than 330,000 tons. If the Earth were part of a black hole it would occupy a sphere 272 feet in diameter; our Sun would be four miles in diameter.

Stars range in mass from 1/10th to 80 times the mass of our own Sun.

Stars sometimes explode; we see them as nebulas.

GALAXY

Our galaxy is called the Milky Way.

It is estimated that there are 300 trillion stars in our galaxy. If you could see them all it would take 4756 years to count them at 2 per second.

The center of the Milky Way is 33,000 light years away.

Our Sun is orbiting in the Milky Way at 560,000 miles per hour.

It takes the Sun 100 million years to complete one orbit in the Milky Way.

The closest galaxy, besides our own, is 160,000 light years away. At the present rate of space travel it would take more than 400 million years to reach it.

The galaxy Andromeda is visible with the unaided eye. It is about 1 million light years away.

UNIVERSE

It is estimated that there are more than 100 billion galaxies in the Universe.

Some light we see started on its journey before the Earth existed.

When we look into the sky we look into the past.

God created the Heavens and the Earth.

CONSTANTS AND CONVERSIONS

1 mile = 1.61 kilometer 1 kilometer = .621 miles

Speed of light = 186,000 mi./sec. = 300,000 km/sec.

Astronomical unit (au) = 150,000,000 km - 93,000,000 miles

Light year = 9,460,000,000,000 km = 5,880,000,000,000 miles

Parsec = 206, 265 au = 3.26 light years

PRONUNCIATION SYMBOLS

ə	about	ē	easy	th	thin	Accent mark (') follows syllable to be stressed
ər	further	i	tip	th	this	
a	mat	ī	life	ü	food	
ā	take	j	job	u̇	foot	
ä	cot, cart	ō	bone	y	yet	
e	pet	ȯ	saw	yü	few	

Solarquest was manufactured on Planet Earth.

APOL

Background of the Apollo Program

In Greek mythology, Apollo was the son of Zeus, and symbolized the arts, prophecy, medicine, and light. NASA adopted the name 'Apollo' for a manned spaceflight project implemented by President Kennedy in 1961. The goal set for the Apollo Program was to land a man on the Moon by 1970. This goal was accomplished in July 1969 by the crew of the Apollo 11.

The Apollo Missions

The first manned Apollo mission, designated Apollo 1, suffered a fire in the command module during a countdown test on January 27th, 1967 killing astronauts Gus Grissom, Ed White, and Roger Chaffee. Apollos 2 through 6 were unmanned spaceflight missions. After extensive changes to the Apollo spacecraft, manned spaceflights resumed with Apollo 7, the first Earth-orbit test of the command-service module (CSM). Apollo 8 followed with the first Moon orbit of the CSM. Apollo 9 tested both the CSM and lunar excursion module (LEM) in Earth-orbit and Apollo 10 followed shortly with a mission to orbit the Moon in the CSM and attached LEM. During the Apollo 10 mission, astronauts piloted the LEM to within 50,000 feet of the Moon's surface. The historic first lunar landing is marked by the Apollo 11 mission in which Neil Armstrong and Buzz Aldrin spent 2 hours and 31 minutes walking on the Moon while the CSM orbited overhead. The lunar landing of Apollo 11 paved the way for the next six lunar missions. Each mission, from Apollo 12 to Apollo 17, with the exception of Apollo 13, successfully landed a LEM on the Moon's surface where the astronauts conducted scientific experiments, tested vehicles and equipment, engaged in Moon walks, and collected Moon rocks. Apollo 17 was the sixth and last lunar landing. During this mission, two astronauts stayed on the Moon for over seventy-five hours and completed three separate Moon walks.

APOLLO 13 MISSION

Crew: Jim Lovell, commander
Jack Swigert, command module pilot
Fred Haise, lunar module pilot

Liftoff - Saturday April 11, 1970 1:13 p.m. Central Standard Time

The Apollo 13 was launched on schedule on April 11th, 1970 at 1:13 p.m. Houston time. The Saturn 5 rocket easily carried the Apollo 13 command-service module (CSM), lunar excursion module (LEM), and 3 astronaut crew into Earth-orbit. The third stage rocket of the Saturn 5 then propelled the two spacecraft out of Earth-orbit beginning a 240,000 mile journey to the Moon. A short time later, the crew, within the CSM, docked with the LEM and the joined spacecrafts separated from the Saturn 5 rocket. The Apollo 13 was now on a 'free-return trajectory' to the Moon. Free-return trajectory means that without any future engine thrusts or course adjustments, the spacecraft would approach the Moon, swing around the far side of the Moon, and follow a direct trajectory back to Earth. In order for the Apollo 13 to enter the Moon's orbit and land on its surface, the spacecraft had to leave its free-return trajectory. At 30 hours into the mission, the crew fired the CSM engine adjusting its course and leaving its free-return trajectory.

LO 13

Oxygen Tank 11 Explosion

At 9:05 p.m. on April 13th, precisely 55 hours, 54 minutes, and 53 seconds into the mission, the Apollo 13's second oxygen tank exploded, crippling the CSM. The crew watched helplessly as the spacecraft's oxygen and power supplies drained away. With only minutes of oxygen remaining, the crew powered down the systems of the CSM and retreated to the now awakened LEM. With the Moon still 40,000 miles and a day away, the lunar landing part of the mission was aborted and attention was focused on surviving the voyage back to Earth. The primary problem facing NASA and the crew of the Apollo 13 was that the LEM was designed to support 2 astronauts for 2 days, not a crew of 3 astronauts more than 5 days from home.

Navigation and Conservation

In the minutes following the explosion, NASA engineers scrambled to design ways to conserve oxygen and power while the crew raced to transfer critical navigational information from the CSM computer to the computer onboard the LEM. Without this navigational data, the Apollo 13 would be lost with no hope of returning to Earth. Once the data was transferred, the crew needed to look out the LEM's tiny windows to perform a visual star alignment and verify the spacecraft's navigational position. The problem was that the -280° Fahrenheit temperature of outer space had instantly crystallized the oxygen venting from the damaged tank resulting in an icy cloud surrounding the ship. This cloud made it impossible to use visual star alignment to verify the spacecraft's navigational position. On its current trajectory, the spacecraft was approaching the Moon at 3000 miles per hour and would slingshot around the Moon but miss the Earth by more than 40,000 miles. After an unsuccessful attempt to escape the icy oxygen cloud and verify the spacecraft's position, the crew fired the LEM's engine and blindly nudged the spacecraft back on a free return trajectory. Miraculously, this maneuver placed the spacecraft right on track. Now, without any subsequent accelerations or course adjustments, the Apollo 13 spacecraft and crew would return to Earth ... but not necessarily before running out of water, oxygen, and power.

PC+2 Acceleration

With the Moon less than a day away and approaching more rapidly as its gravitational pull became stronger, NASA searched for options to shorten the Apollo 13's return voyage. NASA's solution was a PC+2 engine burn. NASA's theory was that firing the LEM's engine precisely 2 hours after the spacecraft's closest approach to the back surface of the Moon (130 miles above the surface) would strengthen the slingshot effect and deliver the Apollo 13 crew back to Earth more than a day ahead of its current trajectory. Combined with water, oxygen, and power conservation, this plan would mean a safe return to Earth for the Apollo 13. In the moments before the Apollo 13 was to disappear around the back side of the Moon for 25 minutes of radio silence, NASA controllers uploaded instructions for a PC+2 engine burn. When the spacecraft emerged from the back side of the Moon, the crew fired the LEM's engine and accelerated the spacecraft by 16 feet per second, completing a successful PC+2 engine burn.

Carbon Dioxide Filtration

Three and one-half days into the mission, the spacecraft's Earth-bound trajectory was secure. With more than two days of space travel ahead, and the CSM's air filtration system off-line, the crew's attention was turned to constructing adapters to remove poisonous carbon dioxide from the LEM's breathable air. Carbon dioxide is a by-product of the human respiratory system. NASA had not designed the LEM to be occupied for more than two days, so its filters had become saturated. The crew successfully modified the filters from the dormant CSM for use in the LEM. When the newly adapted respiratory system was filtering properly, all non-essential systems were powered down to conserve the electricity that remained in the LEM's four batteries.

Reentry Corridor Alignment and Battery Explosion

In order for a spacecraft to return safely to Earth it must be positioned correctly within a reentry corridor. This corridor allows the spacecraft to align itself properly to reenter the Earth's atmosphere. If a spacecraft approaches the Earth at a shallow angle within the reentry corridor it would most likely skip off the Earth's atmosphere and enter a permanent orbit around the sun. If a spacecraft approaches the Earth's atmosphere at too steep an angle, it would most likely be crushed by its excessive speed before reaching the Earth's surface. Following the PC+2 engine burn, the Apollo 13 spacecraft was approaching Earth at a slightly shallow angle in its reentry corridor. As the crew prepared to fire the LEM's engine once more to correct its position, one of the LEM's four batteries unexpectedly exploded. Automatically, the other three batteries increased their output and stabilized the power grid. In a completely manual maneuver, the astronauts fired the LEM's engine and corrected the spacecraft's approach angle.

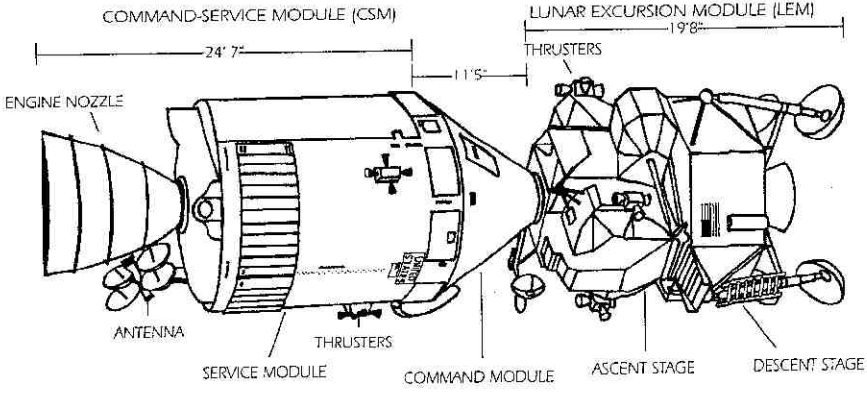
Helium Disk Explosion

Within hours of adjusting the spacecraft's alignment in the reentry corridor, the LEM's helium disk exploded, venting the helium into space. Helium was used on the Apollo spacecraft to force the engine fuel into the combustion chamber. Without an operational helium disk, the LEM's engine would not fire and the spacecraft's position could not be changed. Given that the LEM's engine was now inoperative, the crew hoped that another trajectory correction requiring the LEM's main engine would not be necessary. For the next day and a half, the crippled ship fought against the odds and continued its trek home.

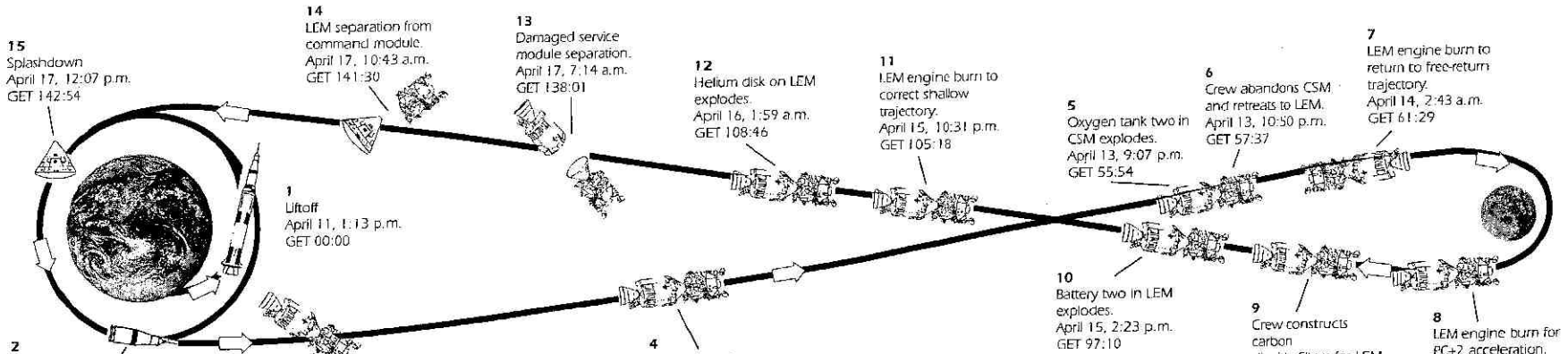
Reentry

At 7:00 a.m. on Friday, April 17th, the Apollo 13 spacecraft was 37,000 miles from Earth and traveling at 7000 miles per hour. It was now time for the crew to prepare for their last struggle, reentry. At 7:14 a.m., the damaged service module was detached from the command module and released to drift endlessly in space. The crew watched in amazement as the lifeless service module tumbled away, its internal parts dangling from where the explosion had ripped apart an entire side panel. Free from the burden of the damaged service module, the crew set about the task of powering up the sleeping command-module and preparing it for reentry. Several hours later, at 10:30 a.m., the command module and LEM were 11,000 miles above the Earth and traveling at over 10,000 miles per hour. With just over an hour to reentry, the crew sealed the command module, fastened themselves into their seats, and stabilized their environment. At 10:43 a.m., the LEM, having dutifully towed its parent spacecraft over a quarter of a million miles, was released from the command module. The crew watched as the faithful LEM began its own Earth-bound descent. With a final 'go' from NASA's Mission Control, the command module and crew entered the Earth's atmosphere. The spacecraft quickly accelerated to 25,000 miles per hour and by 35,000 feet above the Earth's surface, it had slowed to a comfortable 300 miles per hour. At 24,000 feet above sea level, the command module parachutes opened and at 12:07 p.m., the Apollo 13 astronauts safely splashed down in the South Pacific Ocean.

Splashdown - Friday April 17, 1970 12:07 p.m.



THE APOLLO 13 FLIGHT PATH



All times are Central Standard Time

GET = Ground Elapsed Time